

Corporate Climate Change Adaptation Plan

Town of Pelham



2021

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Executive Summary

The consequences of climate change are being experienced across the globe. In Canada, the impacts of climate change are increasingly being felt by communities. Warmer temperatures, heavier precipitation and extreme weather events have become the ‘new normal’ with harmful consequences for human, natural and built systems. It is now evident that some amount of climate change is inevitable even with successful mitigation efforts. Therefore, adaptation is not only recommended but mandatory to protect our communities and the environment from the impacts of climate change.

To combat the adverse effects of climate change at the municipal scale, investments in climate change adaptation planning are recommended by scientists, governments, and policymakers alike. This information has translated to the local levels as hundreds of Canadian municipalities have developed climate plans and are engaging in climate action. To foster resilience to climate change, the Town of Pelham embarked on a two-year planning process to produce this Corporate Climate Change Adaptation Plan (henceforth ‘the Plan’ or the ‘CCCAP’). The planning process was undertaken in partnership with the Federation of Canadian Municipalities (FCM) and Niagara Adapts (NA), a community-university partnership with Brock University. The Plan was developed by following a five-step planning process, drawing on the aspects of ICLEI’s Building Adaptive and Resilient Communities (BARC) program, and support from the Niagara Adapts partnership. Based on the data gathered, the Town identified 53 impacts of climate change in total and 16 prioritized impacts. The information led to the formation of 8 goals and 45 adaptation actions. The Town then designed strategies to support the successful implementation and monitoring of the adaptation actions. The goals that will guide the Town to become more resilient and adaptive towards climate change include:

Goal 1. Protect community members and outdoor workers from potential health risks related to climate change

Goal 2. Build awareness of climate change impacts and risks among Town’s staff and community members

Goal 3. Develop a comprehensive strategy to manage extreme weather events and emergencies

Goal 4. Foster adaptive capacity in the design, construction, and maintenance of Town-owned infrastructure

Goal 5. Preserve, protect, and restore Town’s urban and rural forests

Goal 6. Cultivate resiliency to heavy rainfall and flooding events

Goal 7. Streamline Town services to provide sustained support to Pelham community

Goal 8. Mainstream climate change information into Town’s planning, policy, and decision-making processes

The Plan was constructed with the input from the members of the Adaptation Steering Committee (ASC), Stakeholder Advisory Group (SAG), Municipal Staff at the Town, Niagara Adapts (NA) team at Brock University, and the residents of the Town of Pelham at various stages of development. This Plan serves as the guiding document for the Town of Pelham to strive towards becoming more resilient and reduce its vulnerability to the adverse impacts of the changing climate.

Message from the Mayor



On behalf of Pelham Town Council, I am pleased to present the Town of Pelham's Climate Change Adaptation Plan. The Town has developed this plan to mitigate the anticipated impacts of climate on our community. Our weather events are more severe than they were twenty years ago. Unless we adapt, we will be forced to face climate change's environmental and financial repercussions and its impacts on our natural and human-made resources. This plan is a commitment to ambitious but achievable goals to become more resilient and reduce our vulnerability to the changing climate's adverse effects. In the Town's strategic plan, there are commitments to developing a risk management framework, building strong communities, and protecting our environmental assets. These strategic priorities are intrinsically linked to adapting to climate change and alleviating its effect on Pelham, Niagara, and beyond. As municipal leaders, we are responsible for shaping the future of our Town. Ignoring climate change as part of the decision-making process would be irresponsible. We are committed to taking thoughtful, research-driven action on an issue that will affect us for generations

Mayor Marvin Junkin

Terms and Definitions

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|------------------------|---|
| Adaptation | In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects. |
| Adaptation Options | The array of strategies and measures that are available and appropriate for addressing adaptation. They include a wide range of actions that can be categorized as structural, institutional, ecological or behavioural. |
| Adaptive Capacity | The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. |
| Anthropogenic | Resulting from or produced by human activities. |
| Baseline | A climatological baseline is a reference period, typically three decades (or 30 years), that is used to compare fluctuations of climate between one period and another. Baselines can also be called references or reference periods. |
| Biodiversity | Biological diversity means the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UN, 1992). |
| Climate | Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. Climate in a wider sense is the state, including a statistical description, of the climate system. |
| Climate Change | Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. |
| Climate Projection | A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. |
| Extreme Weather Events | An extreme weather event is an event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. |

| | |
|--|--|
| Greenhouse Gas (GHG) Emissions | Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation, emitted by the Earth's surface, the atmosphere itself, and by clouds. Water vapour (H ₂ O), carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O), ozone (O ₃), and chlorofluorocarbons (CFCs) are the six primary greenhouse gases in the Earth's atmosphere in order of abundance. |
| Hazard | The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. See also Disaster, Exposure, Risk, and Vulnerability. |
| Heatwave | A period of abnormally hot weather. Heatwaves and warm spells have various and in some cases overlapping definitions. |
| Impacts | The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. |
| Maladaptive Actions | Actions that may lead to increased risk of adverse climate-related outcomes, including via increased GHG emissions, increased vulnerability to climate change, or diminished welfare, now or in the future. Maladaptation is usually an unintended consequence |
| Mitigation | A human intervention to reduce emissions or enhance the sinks of greenhouse gases. |
| Representative Concentration Pathways (RCPs) | Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover. |
| Resilience | The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation. |
| Risk | The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. |
| Vulnerability | The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. |
| Weather | The day-to-day state of the atmosphere, and its short-term variation in minutes to weeks. |

List of Acronyms

| | |
|----------------|--|
| AR | Assessment Report |
| ASC | Adaptation Steering Committee |
| BARC | Building Adaptive and Resilient Communities |
| BAU | Business-as-usual |
| CCCAP | Corporate Climate Change Adaptation Plan |
| FCM | Federation of Canadian Municipalities |
| GHG | Greenhouse Gases |
| IPCC | Intergovernmental Panel on Climate Change |
| M&E | Monitoring and Evaluation |
| MCC | Meridian Community Centre |
| MCIP | Municipalities for Climate Innovation Program |
| NA | Niagara Adapts |
| NRCan | Natural Resources Canada |
| RCP | Representative Concentration Pathways |
| SAC | Stakeholder Advisory Committee |
| TOP | Town of Pelham |
| UNEP | United Nations Environment Programme |
| WMO | World Meteorological Organization |

Acknowledgements

The Project Team would like to thank everyone who contributed to the development of the Town's Corporate Climate Change Adaptation Plan. This strategy was formulated with indispensable input from the Mayor and the Council Members, Public Works Department, Adaptation Steering Committee, Stakeholder Advisory Group, Niagara Adapts, Municipal Staff, Community Members & FCM. It represents a true collaboration between the community and the municipality of the Town of Pelham.

The Project Team

The Project Team is responsible for the development of the Town of Pelham's Corporate Climate Change Adaptation Plan (CCCAP). The team has provided research, consultation, and synthesized data from both the internal Adaptation Steering Committee (ASC) and the external Stakeholder Advisory Group (SAG) into the final draft of the plan. The Project Team consisted of staff from the Town of Pelham along with sustainability experts from Brock University. Also, the Project Team withdrew crucial climate data and adaptation methodology from the Niagara Adapts partnership with Brock University.

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The Project Team would also like to acknowledge **Jason Marr**, Director, Public Works, Town of Pelham and **Marc MacDonald**, Communications and Public Relations Specialist, Town of Pelham for their support on the project. Outside of the corporation, the Project Team would like to acknowledge the **Niagara Region Public Health Department (NRPH)**, **Niagara College**, and the **Niagara Peninsula Conservation Authority (NPCA)**. The Team would also like to thank **Patricia Dehnel**, Community Energy Association, for MCIP community of practice coaching support.

Adaptation Steering Committee

The Adaptation Steering Committee (ASC) involved Town Staff and provided strategic direction and input for the plan. Members of the committee were employed by the Town and were strategically selected from each municipal department within the corporation. The Adaptation Steering Committee completed key milestones, such as identifying local impacts, conducting risk and vulnerability assessments, collaborated on adaptation options, and providing final endorsements of the plan.

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1. Introduction

The Town of Pelham is experiencing the impacts of the changing climate. Over the past few years, Pelham has observed increased severity in extreme weather events, temperature changes that led to heat waves and invasive species infestations, and heavy precipitation that has caused flooding in the region. The Town has dealt with recurring Gypsy Moth infestation in 2008, 2009, 2017, 2018, 2019 and 2020. The most conspicuous evidence of storm severity was observed in February 2019 when the iconic Pelham Arches were irreparably damaged resulting in temporary road closure and removal of the arches. Ice storms have led to a power failure in 2013 and 2018. In the summer of 2020, a heavy storm led to multiple fallen trees and branches which required the cleaning up of debris from power lines.

The Town has also called for 16 closures (days) of any public services due to severe storms/extreme weather within Pelham over the past three years. In February 2019, Pelham municipal buildings offices and libraries were closed at the MCC due to severe freezing rain. Also, nine extreme weather warnings have been issued for the Town in the past years. In the summer of 2018, 2019 and 2020, an 'excessive heat' alert was issued for Niagara by the Niagara Region Public Health. In July 2018 and 2020, Pelham's Fire Chief issued a burn ban. The Town's annual Summerfest experienced extremely high temperatures in 2018 and 2019 leading to the cancellation of some events and lower attendance.

In response to the increasing threats and impacts of climate change, the Town committed to increasing the adaptive capacity and resiliency of its community in 2019 as a part of its strategic planning priorities.



Photo: NiagaraThisWeek.com

About the Town of Pelham

The Town of Pelham is one of the 12 municipalities in Niagara Region, which reflects a fusion of rural and urban communities offering unique lifestyles rich with history, agriculture, and commercial industries. The Town is composed of five historic communities including Fonthill, Ridgeville, Effingham, North Pelham, and Fenwick.

Within its jurisdiction, the Town serves approximately 18,000 residents through various integrated systems of services, including but not limited to water and wastewater management, stormwater management, roads, sidewalks and trail maintenance, streetlights, building codes, libraries, parks, playgrounds, community events, and much more.

With Fonthill and Fenwick regarded as the main economic hubs, Pelham's location in the Niagara Region almost permits excellent access to Niagara Falls, St. Catharines, Welland, West Lincoln, Thorold and the Niagara Escarpment.



2. Climate Change

Global Climate Change

According to the IPCC's Fifth Assessment Report (AR5), climate systems are warming during the Industrial Era at an unprecedented rate which is impacting natural and human systems. The AR5 indicates that the increase in global average surface temperature is linked to an anthropogenic increase in greenhouse gas emissions since the mid-20th century. More recently in 2021, World Meteorological Organization (WMO) released a statement that indicated 2020 was one of the three warmest years on record. The changing climate is impacting ocean pH, ocean heat content, global mean sea level, glacial mass, and sea ice extent. The WMO statements further elaborate on Climate Indicators to emphasize the extent of climate change. In 2019, carbon dioxide reached 410.5 ± 0.2 ppm which is 148% of preindustrial levels. The global mean surface temperature is 1.2°C above the preindustrial levels (1850-1900). More frequent and extreme weather events such as heavy rainfall and floods, droughts, fires, cold and heatwaves, and severe storms have been observed around the world. The ocean is warming strongly across all depths over the past two decades and 82% of the ocean experienced at least one heat wave to date in 2020.



The statistics are alarming; IPCC's special report on impacts of global warming of 1.5°C published in 2018 indicated that unchecked global warming is likely to reach 1.5°C between 2030 to 2050. The Paris Agreement signed by 196 countries in 2015 aimed to maintain a global average temperature below 2°C and further invest in keeping the temperature increase to 1.5°C above pre-industrial levels. The report states that ongoing mitigation and adaptation efforts are not enough to meet the goals of the Paris Agreement. The future risks of climate change can be reduced by intensifying and upscaling far-reaching and cross-sectoral mitigation attempts and incremental as well as transformational adaptation.

Climate Change in Canada

Canada has been experiencing continuous global warming and on average past and future warming is double the magnitude of global rate. According to Canada's Changing Climate Report published in 2019, the annual and seasonal mean temperatures have increased with more warming in winters. The report states that the best estimate of the mean annual temperature increase is 1.7°C for Canada as a whole and 2.3°C for northern Canada between 1948 and 2016. In terms of precipitation, on average, annual mean precipitation has increased and is projected to increase over Canada in the 21st century. Compared to the 1986-2005 reference period, the low warming (emissions) scenario leads to a 2°C rise in temperature which remains consistent with the goals of the Paris Agreement. However, in a high warming (emissions) scenario, the temperature will continue to rise and will reach 6°C higher by the end of the 21st century.

Additionally, Canadian Arctic and Antarctic oceans have experienced longer and more widespread sea-ice-free periods. Oceans have warmed, become more acidic, and less oxygenated which has threatened the health of marine ecosystems. Extreme weather events such as storms, heatwaves, droughts, floods will be intensified due to warmer temperatures. Local sea-level rise will cause increased coastal flooding. These effects are experienced at the local levels by communities and the ability to withstand the negative impacts of climate change is closely associated with climate change adaptation planning.

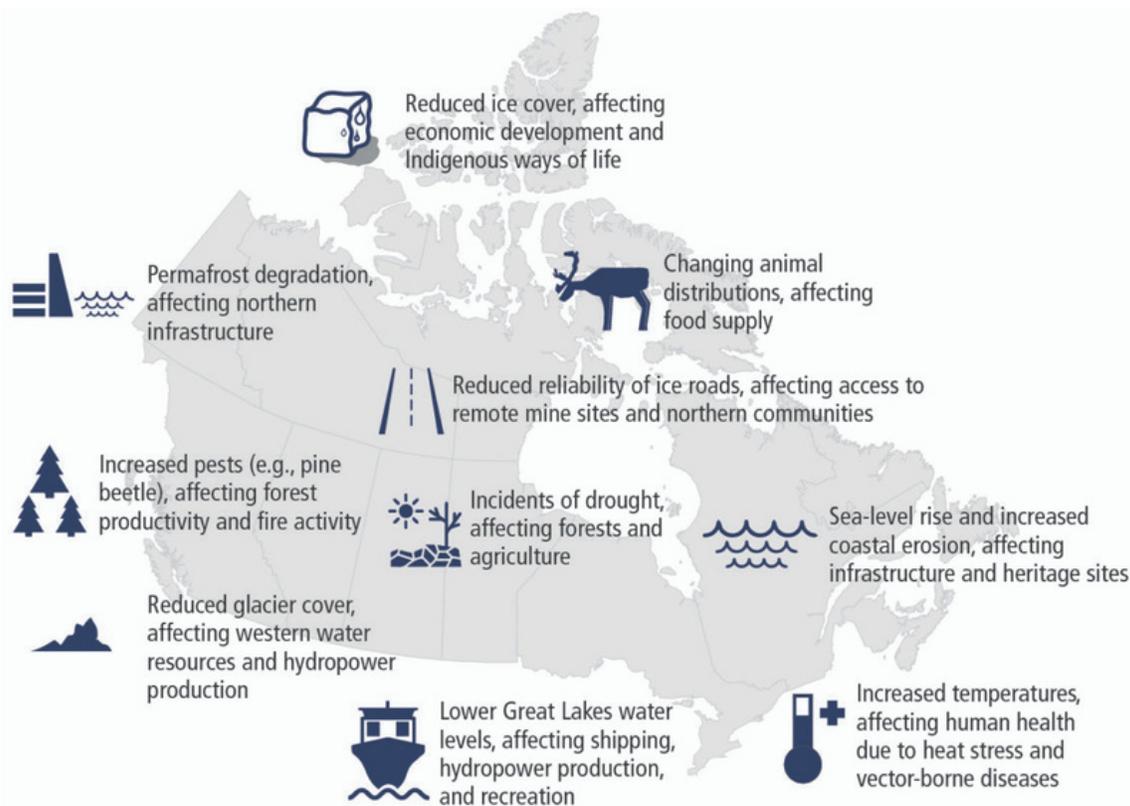


Figure 3: Climate Change Impacts in Canada

Credits: Canadian Council of Academies | Canada's Top Climate Change Risks, 2019

Regional Climate Change

In Niagara Region, the climate is becoming **warmer, wetter, and more extreme**. In the last 40 years, the average annual temperature has increased by 1.3°C. Niagara has been experiencing more rain and less snow in winter, frequent droughts, and heavy rainfall events. Climate change is impacting agriculture, infrastructure, transport, local economies, public health, and species and ecosystem health.

Record heat wave for Niagara

NEWS Sep 25, 2017 Niagara Falls Review



Staff at St. Edward Catholic School in Jordan try to keep the students as cool as possible during record-breaking heat on Monday, Sept. 25, 2017. The classroom lights were off, like Mrs. Karen Petrovsky's grade two class, students had indoor recess and lighter schedules to avoid the heat. (JULIE JOCSAK/POSTMEDIA NEWS)

Photo: Niagara Falls Review

Climate Change in Pelham

Consistent with national and regional patterns, Pelham faces most of the challenges posed by the changing climate. Extreme temperatures, heavy rainfall, and extreme events are some of the major manifestations of the changing climate for the Town. The summary of the climate change projections for the Town is presented in section 4 on climate change projections and impacts. The data has been collected from climateatlas.ca and climatedata.ca. The modelling of these projections is based on information generated in the event of business as usual approach and no significant reduction in greenhouse gas emissions (RCP8.5).

Federal, Provincial and Regional Commitment to Climate Change

The Government of Canada has shown a significant commitment to tackling climate change. It is one of 196 countries that signed the Paris Climate Agreement to maintain the global average temperature below 2°C and further invest in keeping the temperature increase to 1.5°C above pre-industrial levels. Also, the 2016 Pan-Canadian Framework on Clean Growth and Climate Change underscores the nation's commitment towards reducing greenhouse gas emissions and building resilient communities. In 2019, the government declared a commitment to achieving net-zero emissions by 2050.

On a provincial and regional scale, Ontario has been supporting strong initiatives to combat climate change. In November 2018, Ontario released the 'Made-in-Ontario Environment Plan' that caters to the province's specific priorities, challenges, and opportunities, and commits to reducing the province's emissions to 30 percent below 2005 levels by 2030. Other plans and initiatives include 'A Place to Grow-Growth Plan' and 'Greenbelt Plan'. Niagara Region is also invested in climate change planning as an added component of its Niagara Official Plan.

Pelham's Commitment to Climate Change

One of the six strategic priorities defined in the Town of Pelham's Strategic Plan 2019-2022 includes a commitment to grow revenue by promoting cultural assets while protecting environmental assets. To accomplish this priority, actions listed in the plan indicate that the Town will "introduce best practices related to climate change and for the protection and preservation of environmental assets" as well as "educate and create community awareness in regards to [the] importance of environmental assets and climate change impacts".

Other supporting municipal documents, such as the Town's Official Plan, also mention the need to understand the natural environment to manage climate risks. Components of the plan include the commitment to "maintain, enhance or restore ecosystem health and integrity", "protect natural resources", and "ensure that all infrastructure including sanitary sewers, water distribution and stormwater management facilities, public service facilities, and roads meet the needs of present and future residents and businesses". These commitments aim to address the concern to increase the Town's capacity to adapt to climate change. As such, the Town of Pelham sanctioned the development and implementation of a Corporate Climate Change Adaptation Plan (CCCAP).

According to FCM, Canada's infrastructure is vulnerable to the threats of climate change. Approximately, 60% of the core public infrastructure is owned by the municipalities and 35% of municipal infrastructure is in fair, poor or very poor condition. To address these concerns and to stay within the scope of the time frame of two years, the focus of the Town's CCCAP is to increase the adaptive capacity and resiliency of the Town of Pelham's assets (such as buildings, vehicles, streetlights and traffic signals, bridges and culverts, sanitary sewer networks, water distribution networks and roads) and services to current and future climate impacts, and to integrate climate change adaptation practices into day-to-day operations. The Plan is supported through the Municipalities for Climate Innovation Program (MCIP), a five-year program funded by Infrastructure Canada and delivered by the Federation of Canadian Municipalities.

Even though the strategy is focused on adaptation, the Town is committed to mitigation practices to reduce GHG emissions through the Conservation and Demand Management Plan. Under the plan, the Town commits to:

- Reductions in energy consumption and greenhouse gas emissions
- Continuous improvement in energy-efficient equipment installations
- Utilization and assessment of renewable energy projects
- Establishment of educational programs in energy demand to help promote behavioural changes

Some of the proposed initiatives include:

- Switching streetlights to LED
- Updating the building policy, ensuring that all Town-owned buildings, both new and/or renovated are LEED Silver certified
- Shifting to renewable energy for energy supply

2. Planning Process

Climate change is a complex phenomenon. As such, the strategies employed at global, national, and regional scales aim to lower greenhouse gas emissions i.e. mitigation and/or aim to tackle the impacts of climate change through adaptation. Mitigation refers to a human intervention to reduce emissions or enhance the sinks of greenhouse gases, whereas adaptation in human systems is the process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities (IPCC, 2018). Certain measures qualify as both adaptation and mitigation. The IPCC recommends both mitigation and adaptation to combat the ill effects of climate change on natural and human systems.

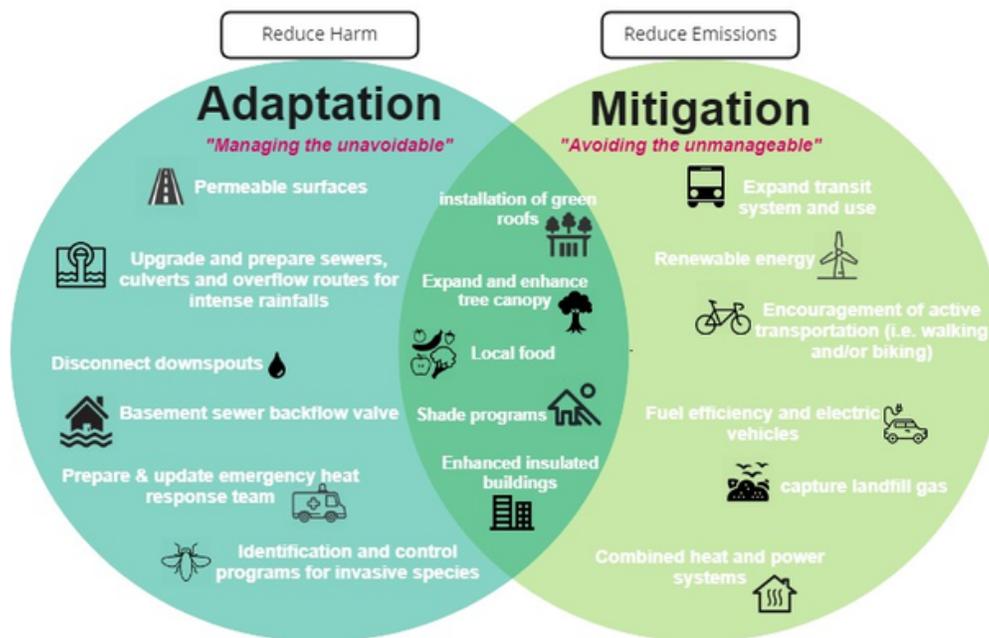


Figure 1: Adaptation, Mitigation and Synergies between them

This plan presents a corporate adaptation planning strategy for the Town of Pelham. The Town recognizes the need for both mitigation and adaptation. In terms of mitigation, the Town's focus lies in improving energy efficiency through promoting green energy, LED streetlights, etc. While extremely crucial in successfully managing the impacts of climate change, an in-depth analysis of mitigation opportunities and challenges is beyond the scope and purpose of this plan.

Adaptation is a process that reduces the negative impacts of climate change and/or takes advantage of new opportunities. Natural Resources Canada indicates that adaptation includes both anticipatory (i.e. actions taken before impacts are observed) and reactive (i.e. actions after impacts have been felt) activities. It recognizes the need for adaptation as some degree of climate change is inevitable even in the best-case scenario and the impacts will affect natural and human systems. It suggests integrating climate into policy and processes as an effective response to tackling climate change. The urgency of adaptation actions and the need to upscale adaptation is acknowledged by the government. In response, adaptation planning is being adopted by municipalities with support from FCM, and Pelham is responding to the initiative by creating a Corporate Climate Change Adaptation Plan (CCCAP).

Climate change is cost-intensive. According to studies by the Insurance Bureau of Canada, more than 50 percent of all property and casualty claims in Canada are flood-related, followed by hail, wind, ice, and fire (Feltmate, 2015). In 2018, insurance payouts increased to \$1.9B per year (Insurance Bureau of Canada, 2019). It is projected that by the 2050s, flooding from climate change could cost between \$1B and \$8B per year for damage to Canada's coasts (Demerse, 2016). Therefore, adaptation planning can secure Canada's future by reducing the financial costs of climate change, human costs by maintaining public health and environmental costs by protecting its natural assets.

According to the Adaptation Gap Report 2020 published by the UNEP (2021), climate change adaptation planning is gaining more relevance among municipalities, cities, and countries. More leaders are recognizing the need to adapt to the changing climate and are officially integrating adaptation plans in policy and planning. Therefore, an increase in the adoption of better adaptation planning practices has been observed. This is an important first step in responding to the changing climate in a structured manner. The Paris Agreement underscores the importance of adaptation planning for "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change".

The Town recognizes that the intersection of communities and municipalities fosters an environment that is conducive to the adoption of the climate change adaptation planning process. It creates an amalgamation of bottom-up and top-down management approaches to natural and built resource management in the context of climate change. The bottom-up approach, i.e., increasing participation of communities in adaptation planning to foster environmental stewardship by enhancing community ownership, support, and accountability are fundamental to climate change adaptation planning. The top-down approach involves support from the Town staff and leadership in the provision of resources, expertise, and opportunities to adapt to climate change. Local municipalities are at the forefront of climate change adaptation planning as the impacts of the changing climate are associated with government assets and infrastructure, policy planning and delivering seamless services to the community.



Figure 2: Planning Process for the Town's CCCAP

The Town developed a 5-step plan drawing on ICLEI Canada's Building Adaptive and Resilient Communities (BARC) program for adaptation planning and garnered additional support from Niagara Adapts at Brock University and Federation of Canadian Municipalities (FCM).

Pelham's project planning began in April 2019 with the creation of a climate adaptation team, followed by a council resolution and the formation of the Adaptation Steering Committee by the end of 2019. In 2020, the identification of adaptation actions, stakeholder engagement at two stages of development, and creation of an implementation strategy followed. See [Appendix A](#) for the detailed timeline for the project.

4. Climate Change Projections and Impacts

Climate Change Projections in Pelham

Temperature



- The annual mean temperature from 1976-2005 was 9°C and is expected to increase by 3°C to 15°C between 2021-2050
- Projected warming across seasons with severe warming occurring over fall and winter months
- Expected number of hot days (days > 30°C) increase from 8 days in 1976-2005 to 43 in 2021-2050 projections
- Extremely hot temperatures are projected to rise from 33°C (1976-2005) to 39°C (2100)
- Extremely cold temperatures are projected to become milder from -20°C (1976-2005) to -8°C (2100)
- Heatwaves are projected to increase; more freeze-thaw cycles

Precipitation



- Annual precipitation projected to increase from 884 mm (1976-2005) to 1046 mm in 2021-2050 projection
- Extreme changes in precipitation projected for the spring and winter months by the 2050s
- Number of wet days likely to increase; maximum precipitation on a single day likely to increase

Extreme Weather Events



- Increased intensity, duration, and frequency of heavy rainfall events
- Increased intensity and frequency of winter precipitation (i.e. freezing rain) projected
- Frequent extreme weather events such as thunder, hail or windstorms projected

Note(s): More information is found in [Appendix B](#).

Impacts

The Planning Team identified impacts of climate change on the community through one-on-one interviews with the ASC which were verified by the SAG. 53 climate impact statements were developed and cover different areas/functions of the society. Each statement reflects the cause, impact, and outcome for a particular climate variable. The impacts were observed on Town-owned infrastructure, urban tree canopy cover, public health, the health of ecosystems and community services. Pelham is facing and will continue to face climate change impacts in managing its **Natural Resources and the Environment**, conducting **Public Administration** duties, securing **Public Health and Safety**, sustaining the **Local Economy**, and delivering seamless **Community Services**.



Natural resources and the Environment

Healthy ecosystems are an underlying condition for maintaining Town's natural resources. However, climate change is impacting Town's natural ecosystems. Extreme rainfall and other extreme events damage trees, plants, and aquatic biodiversity. Changes in annual temperatures are causing alterations in agricultural patterns and invasive species infestations which are affecting Town's Urban canopy cover. Summer droughts add stress to existing flora and fauna.



Local Economy

Heavy precipitation is linked to flooding and therefore it impacts infrastructure. It also overburdens stormwater management infrastructure. In addition, there is an increased likelihood of extreme weather events and more winter precipitation. These impacts are causing financial implications for the residents, building owners and municipality budgets. Insurance, equipment, and repair costs are adding financial stress to the economy.



Public Health and Safety

As the temperature becomes more extreme, vulnerable populations face a risk to their health and safety. Heat and cold-related health stress equally impact workers and Town staff that operate in outdoor settings. Extreme weather events are detrimental to the health of workers and residents alike.



Public Administration

Town's physical infrastructure is being impacted due to heavy rainfall, freezing rain, extreme weather events and more rampant freeze-thaw cycles. It is causing resource and time shortages to manage infrastructure and respond to events such as Gypsy Moth infestations. Summer droughts are affecting green infrastructure and its maintenance.



Community Services

Heavy rainfall, heat and extreme weather events lead to disruptions in organizing community events. Vulnerable populations are unable to participate in these events due to health risks. Moreover, many Town facilities and centres temporarily shut down, events stand cancelled due to the seasonal and chronic climate change impacts faced by the Town.

Summary of Projected Impacts

Heavy Rainfall

- Washouts, erosions, and floods result in damage to Town-owned infrastructure and natural assets causing an increase in repair and maintenance costs
- Local flooding impacts the demand for Emergency Response Services (i.e. emergency evacuations and/or increased response time to accidents)
- Heavy rainfall leads to overland flooding of parks, trails etc. causing delays and cancellation of Town events



Freezing Rain

- Winter precipitation (i.e. freezing rain and/or freeze-thaw cycles) present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets
- Winter precipitation leads to potential health and safety hazards to Town staff and residents who use Town roads, trails, sidewalks, or parking lots
- Winter precipitation increases the response time for emergency storm clean-up (i.e. removing debris from roads), limit road access and major routes for public use



Temperature Changes

- Extreme temperatures (i.e. $>30^{\circ}\text{C}$) present additional health and safety risks (i.e. heatstroke, renal/cardiovascular/skin issues, mental health, etc.) to vulnerable populations along with Town staff that operate in an outdoor setting
- Higher annual temperatures lead to large infestations of invasive species, as temperature increases and the survival rate for native tree species decline
- Milder winter temperatures cause overburdening of storm sewer systems resulting in surcharge and runoff from rapid snow melts



Extreme weather Events

- Frequent events of extreme weather (i.e. thunder, hail, and/or windstorms) inflict damage upon Town-owned infrastructure and assets, leading to possible increased replacement and/or maintenance costs
- Extreme weather leads to a higher likelihood of tree mortality, affecting the Town's total urban forest canopy
- Extreme weather events cause service disruptions (i.e. power outages and electrical surges) to Town residents, thereby worsening crises to vulnerable populations (i.e. seniors, children $< 5\text{yrs}$, or individuals with pre-existing health conditions)



Potential Opportunities

Climate change is negatively impacting the functionality of built, natural and human systems, yet some opportunities could be utilized for the potential benefit of these systems. Even though they are reflected as 'opportunities', climate change remains a much bigger threat to maintaining the life-supporting functionality of natural, built and human systems. For the Town of Pelham, some of the opportunities are listed below:

- Longer construction periods due to an increase in temperature
- Increased ability to conduct outdoor events due to milder winter temperatures
- Increased growing seasons for certain crops



Note(s): More information on climate change impacts can be found in [Appendix C](#).

5. Vulnerability and Risk Assessment

Vulnerability Assessment

Niagara Adapts' Team at Brock University conducted a comprehensive vulnerability assessment for the Town. Vulnerability assessments involve the systematic collection and analysis of information about exposure, sensitivity and adaptive capacity relevant to a system of interest. Vulnerability assessments can be conducted for any system and at any scale. Taking a holistic approach, the vulnerability assessment encompassed biophysical and socioeconomic determinants of vulnerability and adaptive capacity. The assessment provided data on the current state of vulnerability in Pelham and highlighted potential opportunities to build adaptive capacity.

Findings from the analysis revealed a final vulnerability index value of 0.509 for Pelham, where 0 represents highly vulnerable and 1 represents highly robust.

- Exposure and sensitivity indicators from the assessment determined that extreme heat and cold temperatures, along with senior residents and/or individuals with pre-existing health conditions within Pelham are highly vulnerable to climate change.
- Adaptive capacity indicators determined that parks and forest and wetlands ranked high in vulnerability, along with political leadership for climate action, flexibility in institutional decision-making, and the level of community participation in decision-making processes.

These insights provided crucial information on Pelham's core areas of vulnerability to climate change. Combined with the vulnerability and risk assessments carried out by the ASC, these results determined the set of impacts that will need to be incorporated and prioritized into "items of action" for the adaptation plan.

The identified impact statements were further assessed by the ASC for vulnerability to understand service areas and departments that were most susceptible to the ongoing and future climate change impacts affecting the Town. Vulnerability is defined as the susceptibility of a given department to harm arising from climate change impacts. Vulnerability is the function of exposure, the department's sensitivity to climate change and its capacity to adapt to the impacts of climate change (or adaptive capacity).

The components and given formula of a vulnerability assessment can be found below:

$$\text{Vulnerability} = \frac{\text{Exposure} \times \text{Sensitivity}}{\text{Adaptive Capacity}}$$

- **Exposure** = the degree to which a system is exposed to a climatic threat (i.e. floods, ice storms, extreme winds, etc.) which was already identified in impact statements
- **Sensitivity** = the degree to which a system is impacted by a climatic threat
- **Adaptive Capacity** = the ability to easily adjust to climate change, including how to respond to and prepare for climatic threats

1. **Sensitivity Assessment:** The impact statements were assessed by the ASC and the Adaptation Team. The working group determined the sensitivity i.e. if the impact occurs, will it affect the functionality of the department for each impact statement.
2. **Adaptive capacity:** Adaptive capacity refers to the ability of built, natural, or human systems to accommodate changes in climate (including climate variability and climate extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The ASC determined Adaptive Capacity i.e. can the department adjust to the projected impact with minimal cost and disruption for each of the impact statements.

A total of **53 impact statements** were assessed through a vulnerability assessment. Based on the vulnerability assessment matrix (**Appendix D**), the 53 impacts showed the following results:

- 7 impacts rank **high** in vulnerability (V4 & V5), meaning the Town's adaptive capacity to adapt to the proposed climatic threats is low and the sensitivity is high.
- 23 impacts rank **medium** in vulnerability (V3), meaning the Town has a moderate adaptive capacity and sensitivity to these impacts
- 23 impacts rank **low** in vulnerability (V2 & V1), meaning the Town's adaptive capacity to adapt to the proposed climatic threats is high and the sensitivity is low.

The ASC reviewed the impacts after having been revised by the SAG, along with the vulnerability report provided by Brock, and further conducted a risk assessment.

*Note(s): More information on Town's Vulnerability Assessment can be found in **Appendix D**.*

Risk Assessment

Risk is a function of the consequence of an impact and the likelihood of its occurrence or more simply:

$$\text{Risk} = \text{Likelihood} \times \text{Consequence}$$

Based on the 53 impact statements that were evaluated through a vulnerability assessment, 30 impacts were further investigated through a risk analysis. These 30 impacts were further assessed because they ranked medium to high (V3, V4 or V5) in vulnerability.

1. **Likelihood** is determined by considering the frequency of the impact, i.e., whether the impact is likely to reoccur or is a single event. It considers the both likelihood of impact occurring and the outcome of the impact. Likelihood is the probability of the projected impact occurring and is scored on a scale of L1 to L5 with L1 being 'Rare' and L5 being 'Almost Certain'.
2. **Consequence** is defined as known or estimated consequences (to Environment, Public Administration, Public Safety, Economy, and Community Services) of a particular impact. It caters to the known or estimated consequences (economic, ecological, social, and legal) of a particular climate change impact. A Consequence rating is based on a scale of C1 to C5 where C1 is 'Negligible' and C5 is 'Catastrophic'.

To calculate the risk ratings, likelihood scores were multiplied with consequence scores. Of the 30 statements that were assessed:

- 1 impact statement was categorized as a **high** risk
- 1 impact statement was categorized as a **medium-high** risk
- 14 impact statements were categorized as a **medium** risk
- 11 impact statements were categorized as a **medium-low** risk
- 3 impact statements were categorized as a **low** risk

The statements that indicated high risk, medium-high risk and medium risk were identified as priority impacts. A total of **16 impact statements** were identified as priority impacts which were then used to develop adaptation goals and actions. This ensured that the selected impacts were a priority to the Town as they posed a high risk to a particular municipal component (i.e. Town-owned building, asset, day to day operations, services, etc.).

*Note(s): More information on Town's Risk Assessment can be found in **Appendix D**.*

6. Community Engagement

The Town of Pelham is a dynamic and growing community. The planning team supported the importance of community/stakeholder engagement in building the climate change adaptation plan. As mentioned in the Town's 2019 Strategic Plan, Council's vision is to "work together with the community to strengthen trust, enhance the quality of life and economic well-being for today and for the future". In addition to engaging the interdisciplinary team that was formed at the beginning of the planning process, the Town engaged the community members at two stages of building the plan.

Vulnerability Assessment



The Niagara Adapts Team identified indicators for exposure, sensitivity, and adaptive capacity (which determine vulnerability) through a scholarly literature review and consultation with experts in the field and selected 50 indicators. To ensure that the 50 indicators were highly relevant to Pelham, municipal partner(s) from Pelham prioritized the indicators, from most to least important.

To capture potential vulnerabilities at both the municipal scale and at the household scale, two survey instruments were implemented at the respective scales. At the municipal scale, partners collected relevant materials and consulted members of municipal staff to collect information on specific indicators. Data at the household scale was collected through a public survey. In Pelham, 147 residents participated. The results from the survey provide critical insight into how people in the region are experiencing climate change as well as their potential capacity to adapt.

Stakeholder Engagement Survey on Vision and Goals



A stakeholder engagement survey was conducted in Pelham to generate feedback on the municipality's draft vision and goals for the climate change adaptation plan. The survey received a total of 41 responses from community stakeholders. The feedback played an instrumental role in defining the adaptation vision and goals and contributed to the iterative nature of designing the adaptation plan.

Note(s): More information is located in [Appendix E](#).

7. Vision



The Town of Pelham will reduce, respond to, and recover from, the unique climatic threats posed by climate change, and will embrace the opportunities that position the Town to support sustainable development by promoting cultural assets while protecting our environmental assets



Note(s): More information on the process of identification, modification, and community involvement in shaping the vision can be found in [Appendix E](#).

8. Goals and Actions

Goals

The Town of Pelham identified 8 Goals which can be traced back to the priority impacts identified by the Planning Team. The ASC provided their feedback on the goals which were then circulated to the municipality as a part of community engagement. The overarching goals serve as the guiding principles which aim to connect the broader adaptation Vision to the actual adaptation Actions that the Town will undertake to fulfil its aim of becoming a more climate-resilient community.



Goal 1. Protect community members and outdoor workers from potential health risks related to climate change



Goal 2. Build awareness of climate change impacts and risks among Town's staff and community members



Goal 3. Develop a comprehensive strategy to manage extreme weather events and emergencies



Goal 4. Foster adaptive capacity in the design, construction, and maintenance of Town-owned infrastructure



Goal 5. Preserve, protect, and restore Town's urban and rural forests



Goal 6. Cultivate resiliency to heavy rainfall and flooding events



Goal 7. Streamline Town services to provide sustained support to Pelham community



Goal 8. Mainstream climate change information into Town's planning, policy, and decision-making processes

Note(s): More information on the process of identification, modification, and community involvement in shaping the goals can be found in [Appendix E](#).

Actions

The Town identified 45 adaptation actions which are distributed among the 8 above-mentioned goals. The actions were identified while tracking the priority impacts that are most likely to affect the community. The ASC provided their feedback on the actions and, subsequently, actions were prioritized based on the urgency, importance, environmental, social & economic consequences as well as feasibility criteria. The actions were then categorized under 3 categories. These can be viewed for each action in the implementation schedule under [Appendix F](#).

- Short-term – implementation within 0-3 yrs.
- Medium-term – implementation within 4-7 yrs.
- Long-term – Implementation within 8-10 yrs.

Most of the actions fall under 5 categories:

- Increasing public awareness of the changing climate and its projected impacts
- Increasing technical capacity to better manage the impacts
- Mainstreaming climate change planning in policy and investment decisions
- Increasing the adaptive capacity of built, natural and human systems
- Strengthening community partnerships to increase resiliency in the community

It is also important to highlight that the Planning Team recognized the efforts that are already being made and the actions that are in progress to increase climate resiliency. That said, some of these actions have been included in the plan to strengthen the ongoing implementation along with newly developed actions. The identified and prioritized actions also include both anticipatory (i.e. actions taken before impacts are observed) and reactive (i.e. actions after impacts have been felt) activities.



Goal 1. Protect community members and outdoor workers from potential health risks related to climate change

- 1.1 Create an extreme weather policy to minimize risks to vulnerable populations during extreme events including heavy rainfall, extreme heat, and extreme cold*
- 1.2 Develop a communication strategy to inform the Town residents and staff on road conditions during extreme weather events*
- 1.3 Foster emergency preparedness among Town's staff and community members (e.g. mainstream the 72-hour emergency preparedness guide)*
- 1.4 Design educational and training content to support community members and outdoor staff during extreme weather events*
- 1.5 Increase relief measures for extreme events of heatwaves through providing indoor activities for community members (e.g. pool facilities, cooling centres, recreational facilities)*
- 1.6 Increase operating hours of current facilities available to the residents during extreme heat and extreme cold*
- 1.7 Review (and revise if necessary) the Town's Winter Operations Plan to accommodate the effects of climate change*





Goal 2. Build awareness of climate change impacts and risks among Town's staff and community members

2.1 Review current communication relative to climate change and extreme weather events and incorporate new strategies to benefit the Town's emergency response communication

2.2 Develop educational initiatives that raise awareness on climate change for Pelham residents, businesses, and Town staff, and integrate these initiatives into existing programs, activities, and communications (where possible)

2.3 Enlist the help of community groups and young students in spreading climate literacy through educational campaigns at schools and in the local community

2.4 Create resources for the community to underscore the importance of Low Impact Development, green roofs, creating green spaces (trees and shrubs) and maintaining natural heritage in adapting to climate change impacts

2.5 Foster partnerships with like-minded local organizations to spread awareness on climate change and its impacts to promote adoption of climate change adaptation strategies





Goal 3. Develop a comprehensive strategy to manage extreme weather events and emergencies

3.1 Create and implement robust training strategies for Town staff to deliver an efficient and quick response to extreme weather events

3.2 Prepare for the spike in demand for emergency services during extreme weather events including heavy rainfall, extreme heat, and extreme cold events

3.3 Design an opt-in communication (email, text) alert system to provide extreme weather and climate change updates to the Town residents

3.4 Integrate climate change projections, impacts and actions into emergency response planning and existing training guides





Goal 4. Foster adaptive capacity in the design, construction, and maintenance of Town-owned infrastructure

- 4.1 *Assess the condition of the Town's stormwater management infrastructure and explore opportunities for upgrading or reinstalling infrastructure*
- 4.2 *Incorporate drought-tolerant landscaping design on Town properties*
- 4.3 *Investigate the use of reflective surfaces, cool paving, green facades, and green roofs to minimize the effects of heat on built infrastructure*
- 4.4 *Update the Engineering Design Guide to incorporate projections, impacts and risks of climate change and relevant adaptation strategies*
- 4.5 *Integrate climate change considerations in Capital Asset Management Policy and the development of Capital Asset Management Plan*
- 4.6 *Explore opportunities to integrate Low Impact Development and green technologies in the Town's approach to designing, construction, and maintenance of infrastructure*
- 4.7 *Support the updates to by-laws, zoning regulations, and building codes to accommodate climate change adaptation options*
- 4.8 *Legitimize the use of green infrastructure by incorporating the same in Capital Asset Management Plan and training the staff on the utility and benefits of green infrastructure*





Goal 5. Preserve, protect, and restore Town's urban and rural forests

5.1 Map Town's tree cover to understand the spread of existing tree canopy and develop strategies for expanding the municipal tree canopy target

5.2 Create a combined Forest Strategy and an Emergency Response Strategy to address the impacts of climate change on tree canopy cover and respond to such impacts (e.g. attack of invasive species like Gypsy Moth)

5.3 Conduct analysis for areas under heat stress and use the information to assign new tree plantation sites

5.4 Support partnerships with local/national organizations to enhance preservation, protection and restoration of tree canopy cover and biodiversity

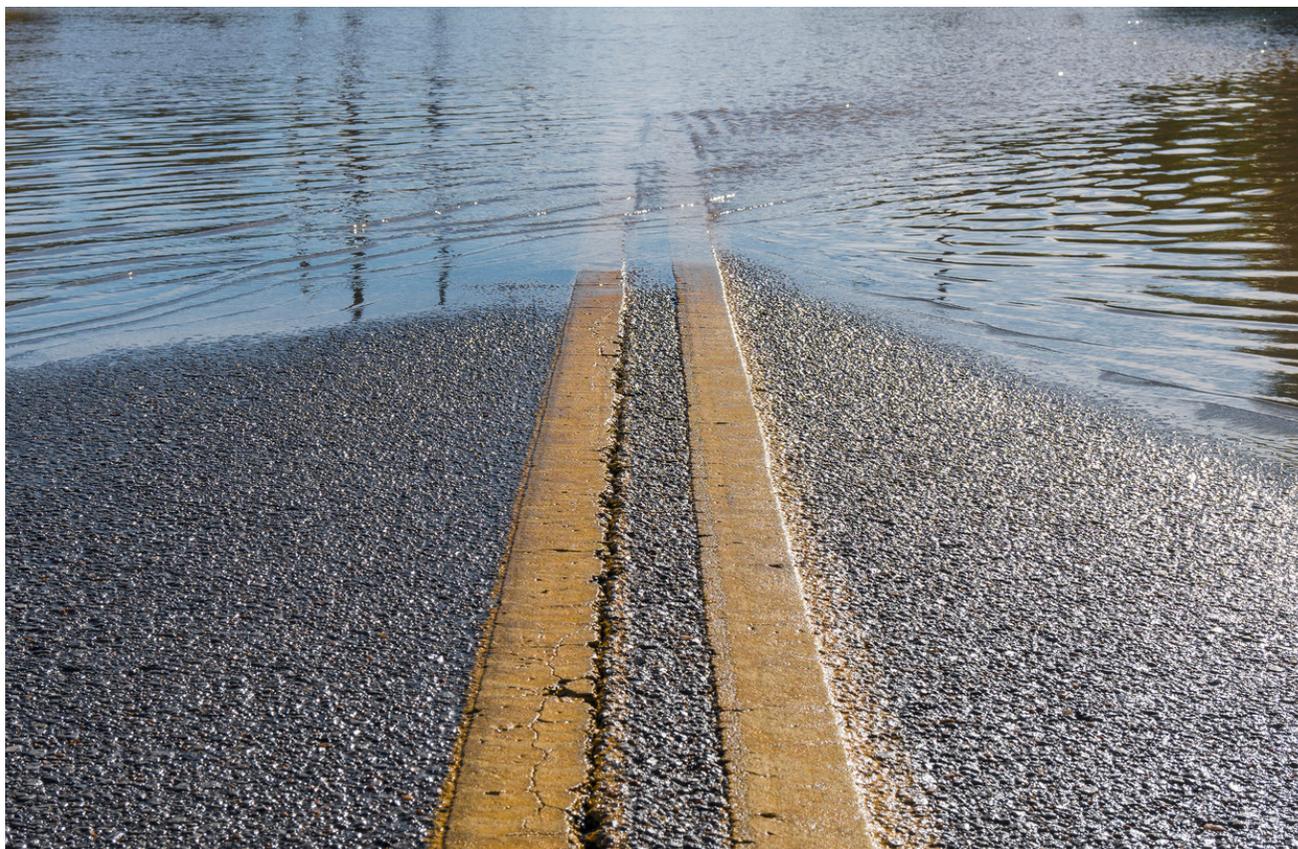
5.5 Focus on Town's green infrastructure of parks and open spaces, green spaces, urban forests, natural heritage areas to explore opportunities to expand the use of similar nature-based solutions to adapt to climate change impacts (e.g. heat stress)





Goal 6. Cultivate resiliency to heavy rainfall and flooding events

- 6.1 *Collect baseline information on areas prone to flooding and implement floodproofing measures proactively depending on feasibility and requirement*
- 6.2 *Promote the use of green infrastructure tailored to minimize the effects of flooding*
- 6.3 *Build on existing strategies to educate the residents on flood preparedness and develop emergency flood relief measures to be deployed in case of extreme flooding*
- 6.4 *Re-investigate the feasibility of Town's Sanitary Sewer Backflow Prevention Incentive Program*
- 6.5 *Conduct a feasibility study of a downspout and sump pump disconnection program*
- 6.6 *Include stormwater mitigation and adaptation strategies in the Engineering Design Guide to support flood management interventions*
- 6.7 *Assess, implement and revise (if needed) floodproofing mechanisms employed at Town-owned buildings*





Goal 7. Streamline Town services to provide sustained support to Pelham community

- 7.1 *Develop a plan (e.g. COVID-19 Recovery framework) and train the staff to ensure Town's services are sustainably supported*
- 7.2 *Provide training to entire staff on climate change and climate change adaptation*
- 7.3 *Invest in new power support systems (e.g. generator for MCC) for Town's built infrastructure to support seamless services during extreme events*
- 7.4 *Prepare to accommodate the increase in public service requests for the maintenance of infrastructure after extreme weather events, floods, heat stress, and cold stress*





Goal 8. Mainstream climate change information into Town's planning, policy, and decision-making processes

8.1 *Declare a climate emergency*

8.2 *Develop and implement a Green Procurement Policy that would establish guidelines for all Township employees to ensure staff are purchasing products that minimize consumption of energy and water and are more environmentally appropriate*

8.3 *Develop and implement a corporate Policy on Climate Change Adaptation*

8.4 *Continue to monitor climate change projections annually and collect data from other sources that can aid in the implementation of climate change adaptation solutions (e.g. GIS, citizen scientists)*

8.5 *Incorporate climate change projections and adaptation options in the Town's policies and practices to standardize response on addressing climate change impacts (i.e. Strategic Plan, Community Improvement Plan, Communications Plan, Cultural Master Plan, Engineering Design Guide, Human Resource Policy, Winter Operations Plan etc.)*



9. Implementation

The adaptation planning process emphasizes creating a robust implementation strategy (Guyadeen et al., 2019; ICLEI). According to the Adaptation Gap Report 2020 (UNEP, 2021), scaling up implementation is needed to manage climate risk. The report emphasizes closing the adaptation financing gap, i.e., adaptation costs are currently higher than adaptation financing. The Town has a two-fold implementation strategy that addresses some of the above-mentioned concerns. Successful implementation strategy requires a comprehensive schedule and implementation tools. The implementation strategy mobilizes the knowledge accumulated through previous steps and brings the plan from theory to practice. The Town of Pelham's approach to implementation involves two key elements:



Implementation Schedule

Implementation Schedule is a comprehensive strategy to move the decided actions into the execution phase. The schedule is deemed as the 'backbone' of implementation (ICLEI). See [Appendix F](#) for the full Implementation Schedule. It requires certain elements which are described below:

Action: Highlights a particular action under each goal

Description/Scope: Briefly discusses the opportunities, challenges & bandwidth/range of each adaptation option

Lead Department(s): Department(s) leading the adaptation action implementation

Relevant Department(s): Department(s) responsible for supporting the lead department for implementation

Implementation Term: Action to be implemented within short (0-3 yrs.), medium (4-7 yrs.) or long (8-10 yrs.) term

Resource Requirement: Reflects upon anticipated staff requirement (low, medium, high) and budget allocations (\$ -Low, \$\$ - Medium, \$\$\$ - High) required for the action

Implementation Tools

Implementation tools are adopted to align the adaptation planning process with long-term sustainability goals. In essence, the tools help in driving the implementation process (ICLEI). Some of the significant implementation tools that are relevant to the Town's planning are identified below.

- **Stakeholder Engagement:** The plan identified stakeholder engagement as one of the most efficient implementation tools. Pelham is a dynamic community. While the pace of development in the Town is increasing, it also opens a window of opportunity to involve the community members, staff, policymakers, local organizations etc. in adaptation planning. The planning process ensures that community support is both provided and elicited at various points in the implementation process. adaptation vision and goals

- **Fundraising:** Implementation is contingent upon the availability of funds. However, it is not always possible to secure funding from internal budgets. The planning team proposes to include other sources of funding which may include but are not limited to FCM's Green Municipal Funds, partnerships with local universities and NGOs, Federal and Provincial Grants etc.
- **Pilot Projects:** While certain small-scale projects can be implemented without pilot planning, large-scale projects are not as easy to implement. Therefore, pilot projects can be useful in projecting the long-term utility of the action implemented. It also ensures quick support from public and private authorities, budget approvals and resource allocation as the scale and the timeline of the project are pre-determined as opposed to investing in long-term projects with open resource requirements.
- **Communication:** The Plan identifies communication as the cornerstone of adaptation planning. As Pelham ventures into adapting to and mitigating the impacts of climate change, it is of utmost importance to communicate the adaptation planning process, and more broadly cultivate an understanding of climate change and its impacts. Furthermore, it fosters transparency and trust within the community which aids in adaptation planning and implementation. The Plan employs various strategies such as print media (reports, guides etc.), social media (Town's official channels), in-person collaborations (workshops, training etc.) to create more awareness among staff and residents.
- **Integration in Current Plans:** The Town of Pelham has existing plans and guides (Strategic Plan, Natural Heritage Plan, Engineering Design Guide etc.) that could be linked to the climate change adaptation planning process. This may include the integration of relevant adaptation actions and planning processes in the existing documents to maintain seamless implementation planning.
- **Interdepartmental Coordination:** The coordination between various departments is important in adaptation planning (Guyadeen et al., 2019) to align different yet connected practices within the municipality. However, it is challenging to bring different departments on the same page in the context of adaptation planning. Therefore, this Plan encourages interdepartmental cooperation wherever possible.

It is important to highlight that the implementation is meant to be a dynamic process, i.e., it supports continuous updates and additions to the plan based on the progress that has been made in the implementation of the actions. The main advantage of dynamic implementation planning is that it not only serves as a blueprint for current and future action, it also recalibrates itself based on the updated information. In that sense, implementation planning is closely linked to monitoring and evaluation processes which are discussed in the next section.

10. Monitoring and Review

Monitoring the implementation of actions provides further viability to the adaptation planning process. In essence, M&E provides an update on the effectiveness of the implementation plan which is intricately linked to the implementation plan's dynamic nature. Over the years, implementation plans can undergo drastic morphosis based on the information collected and applied through the indicators. Research indicates that monitoring indicators and evaluating outcomes are one of the strongest pillars of adaptation and climate change planning at large (Guyadeen et al., 2020; Meerow & Woodruff, 2020). This is because the climate is constantly changing, and the ability to project climate change impacts is becoming more precise. Moreover, institutional and funding changes can impact the progress of the plan. The COVID-19 pandemic is one of the examples of an external event that can impact the implementation of the climate change plan. Closely associated with M&E is long-term strategic planning to accommodate for uncertainty (Meerow & Woodruff, 2020).

Furthermore, evidence suggests there is a lack of integrating M&E mechanisms in adaptation planning (Adaptation Gap Report 2020, UNEP, 2021). Therefore, engaging in M&E practices periodically ensures that the required changes are made to the implementation plan and it is in alignment with best practices for adaptation planning. For successful implementation over the years, the Town has integrated an M&E plan (Appendix G) as a living document within the adaptation plan.

The plan provides the following information:

Action: Highlights a particular action under each goal

Indicator(s): Indicators selected to monitor the progress of each adaptation action

Lead Department(s): Department(s) involved in collecting the data based on the indicators

Duration: Highlights the time frame for collection and measurement of the indicator (Short-Term: 0-2 yrs., Medium-Term: 2-4 yrs., Long-Term: 4-6 yrs.)

Resource Requirement: Staff requirement (low, medium, high) and budget allocations (\$ -Low, \$\$ - Medium, \$\$\$ - High)

The process followed to select indicators was based on the application of the SMART framework. The indicator(s) selected for each action represent Specific, Measurable, Achievable, Relevant & Time-Bound (SMART) characteristics. Other criteria employed in the selection of indicators involved:

- Process indicators i.e. indicators that monitor the progress of the plan, and outcome indicators evaluate the success of the plan
- Quantitative indicators which are often numerical, ratio or percentage-based and qualitative indicators describe the quality based on opinions or simply yes/no answers

Essentially, the M&E process ensures tracking of adaptive capacity and the achievement of climate change adaptation goals. The review of CCCAP is dependent on the reports provided to the council (i.e. yearly, bi-annually etc.) and on a reassessment of the plan based on new climate science data and the Town's growth and development. It is suggested to reassess the plan in the next 5 years.



Appendices

Appendix A – Timeline of the Project

| 2019 | | | 2020 | | | | 2021 |
|--|--|---|---|---|---|---|---|
| Apr May Jun Q2 | Jul Aug Sep Q3 | Oct Nov Dec Q4 | Jan Feb Mar Q1 | Apr May Jun Q2 | Jul Aug Sep Q3 | Oct Nov Dec Q4 | Jan Feb Q1 |
| <ul style="list-style-type: none"> Establish Climate Adaptation Team Identification of project stakeholders Gather baseline data on the current state of the municipality | <ul style="list-style-type: none"> Develop Climate Adaptation Steering Committee (ASC) Council resolution to support climate adaptation pledge Climate change impact analysis | <ul style="list-style-type: none"> Identify Stakeholder Advisory Committee (SAG) Define technical gaps and data Community engagement | <ul style="list-style-type: none"> Consultation with stakeholders Vulnerability adaptive capacity assessment and report | <ul style="list-style-type: none"> Identify and prioritize adaptation options Initiate a draft for CCCAP Vulnerability and Risk Assessment | <ul style="list-style-type: none"> Design and implementation of adaptive management Develop draft low impact guidelines for Engineering Design Manual | <ul style="list-style-type: none"> Stakeholder engagement for adaptation Review implementation strategy formulation Create an implementation and M&E strategy/plan | <ul style="list-style-type: none"> Finalize the CCCAP and present it to the council for approval Implementation and Knowledge Mobilization Finalize changes to the Engineering Design Manual |

Table 1: Timeline of the Project

Appendix B – Climate Change Projections

Table 2 represents climate change projections for the Town of Pelham with RCP8.5 which indicates a business-as-usual scenario i.e. the assumption that no mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted (IPCC, 2018).

According to IPCC, Representative Concentration Pathways (RCPs) are the scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long-term concentration levels but also the trajectory taken over time to reach that outcome are of interest.

- RCP2.6: One pathway where radiative forcing peaks at approximately 3 W m^{-2} and then declines to be limited at 2.6 W m^{-2} in 2100 (the corresponding Extended Concentration Pathway, or ECP, has constant emissions after 2100).
- RCP4.5 and RCP6.0: Two intermediate stabilization pathways in which radiative forcing is limited at approximately 4.5 W m^{-2} and 6.0 W m^{-2} in 2100 (the corresponding ECPs have constant concentrations after 2150).
- RCP8.5: One high pathway which leads to $>8.5 \text{ W m}^{-2}$ in 2100 (the corresponding ECP has constant emissions after 2100 until 2150 and constant concentrations after 2250).

Even though the models utilize precision in their calculations, there is inherent uncertainty in climatology. The town has fetched data from reliant resources, but it is important to note that there are limitations in the parameters, structures of the models, the future climate projections/trajectories and even the tools embedded in weather observation instruments.

The Town collected data from climateatlas.ca and climatedata.ca. The data was also drawn from Canadian Centre for Climate Services. In cases where data wasn't available for Pelham, the data for the neighbouring municipality of Welland was considered.

| Climate Variable | | 1976-2005 | 2021-2050 Projection | 2100 Projection |
|----------------------------------|---|------------|-------------------------|--------------------|
| Temperature (°C) | Average/Yr | 9°C | 12°C | ↑ 15°C |
| | Spring | 7°C | 8.8°C | ↑ 10.7°C |
| | Summer | 20.5°C | 22.6°C | ↑ 24.8°C |
| | Fall | 10.8°C | 13°C | ↑ 15°C |
| | Winter | -3.1°C | -0.8°C | ↑ 1.5°C |
| Extremes (°C) | Heat (max) | 33°C | 36°C | ↑ 39°C |
| | Cold (min) | -20°C | -13°C | ↑ -8°C |
| | Days/Yr +30°C | 8 | 43 | ↑ 93 |
| Indices | Cooling Degree Days (CDD) | 321 | 667 | ↑ 1192 |
| | Heating Degree Days (HDD) | 3399 | 2667 | ↓ 2022 |
| | Freeze-Free Days (>0°C) | 3658 | 4489 | ↑ 5520 |
| Precipitation (mm) | Total Annual | 884 mm | 1046 mm | ↓ 983 mm |
| | Average Spring | 224 mm | 247 mm | ↑ 260 mm |
| | Average Summer | 221 mm | 224 mm | ↓ 222 mm |
| | Average Fall | 239 mm | 246 mm | 246 mm |
| | Average Winter | 208 mm | 230 mm | ↑ 246 mm |
| Extreme Precipitation (mm) | Average Annual # of Wet Days (>10mm) / Yr | 7 days/yr | 9 days/yr | 9 days/yr |
| | Average Annual # of Wet Days (>20mm) / Yr | 7 days/yr | 9 days/yr | 9 days/yr |
| | Maximum Precipitation on a Single Day / Yr | 38 mm | 40 mm | 40 mm |
| Frost (days) | Frost-Free Season (days) | 168 days | 207 days | ↑ 229 days |
| | Date of Last Spring Frost | April 21 | April 12 | ↓ April 3 |
| | Date of First Fall Frost | Oct 29 | Nov 8 | ↑ Nov 21 |
| | Average Annual # of Ice Days (below 0°C) | 48 days/yr | 26 days/yr | ↓ 6 days/yr |
| Tropical Nights | Average Annual # of Tropical Nights (>18°C) | 27 days/yr | 64 days/yr | ↑ 106 days/yr |
| | Average Annual # of Tropical Nights (>20°C) | 10 days/yr | 40 days/yr | ↑ 85 days/yr |
| | Average Annual # of Tropical Nights (>22°C) | 1 days/yr | 18 days/yr | ↑ 60 days/yr |

Table 2: Climate Change Projections for the Town of Pelham with RCP8.5

Appendix C – Climate Impact Statements

After discussing the climate change projections and the associated impacts, 53 impact statements were identified with associated climatic threat, theme and the departments that were affected by the impact.

| ID# | Climatic Threat | Theme | Impact Statement | Department | | | | | | | | |
|-----|--|---------------------------------------|--|-------------------------|-----------------------------------|--------------------|------------------------|----------------------------|-------------------------------------|----------------------|------------------------|--------------------------------|
| | | | | Administration Services | Community, Planning & Development | Corporate Services | Fire & By-Law Services | Public Works - Engineering | Public Works - Parks/Beautification | Public Works - Roads | Public Works - General | Recreation, Culture & Wellness |
| 1 | <i>Increase in Precipitation in Winter</i> | Natural Resources and the Environment | An increase in winter precipitation (i.e. freezing rain) can lead to increased exposure to salt on roads, causing adverse effects on tree, plant, and aquatic species | | | | | | X | O | | |
| 2 | <i>Increased Heavy Rainfall Events</i> | | An increase in heavy rainfall events (i.e.+ >50 mm/hr) can have adverse impacts (i.e. washouts, erosions, floods, etc.) on Town-owned infrastructure and assets (i.e. roads, creeks, curbs and sidewalks, storm sewers, storm ponds, channels, etc.) | | O | | | X | X | X | | |
| 3 | <i>Increase in Intensity/Frequency of Drought</i> | | An increase in intensity/frequency of summer droughts may add additional stress to local watercourses (i.e. surface water levels and temperature), which can pose adverse impacts on particular ecosystem services and biodiversity | | | | | X | X | O | | |
| 4 | <i>Increase in Annual Temperatures</i> | | An increase in annual temperatures can lead to large infestations of invasive species, as minimum temperature increases and the survival rate for native tree species decline | | O | | | | | X | | |
| 5 | | | An increase in annual temperatures may present altered agricultural zones and seasons (i.e. reproductive patterns) for native flora due to a changing climate | | X | | | | | X | | |
| 6 | <i>Increase in Temperature Variability in Shoulder Seasons</i> | | An increase in temperature variability during shoulder seasons may prolong the time of year in which plant and tree maintenance (i.e. leaf and grass clean up, watering, pruning, etc.) is required | | | | | | | X | | |
| 7 | <i>More Frequent Events of Extreme Weather</i> | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to a higher likelihood of tree mortality, affecting the Town's total urban forest canopy | | | O | | | | X | | |

| | |
|----------------------|---|
| Directly Impacted | X |
| In-directly Impacted | O |
| Opportunity | W |

| | | | | | | | | | | | | | | |
|----|---|-----------------------|--|--|---|---|---|---|---|---|---|---|---|--|
| 8 | <i>Increase in Precipitation in Winter</i> | Public Administration | An increase in winter precipitation (i.e. freezing rain) can increase emergency services costs due to increased demand in emergency response time as well as additional training to the Town's emergency response team | | | X | X | | | | | | | |
| 9 | <i>Increase in Precipitation in Winter</i> | | An increase in winter precipitation (i.e. freezing rain and/or freeze-thaw cycles) may present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets | | | X | | | O | O | O | X | | |
| 10 | | | An increase in winter precipitation (i.e. freezing rain) can lead to the closure of Town facilities (i.e. Town Hall, the MCC, public libraries, etc.) and additional costs to the Town due to public safety concerns | | O | X | O | | | | | O | O | |
| 11 | <i>Increased Heavy Rainfall Events</i> | | An increase in heavy rainfall events (i.e.+ >50 mm/hr) can increase capital and/or operational costs to the Town due to delays in construction for municipal projects | | | X | | O | | | | O | | |
| 12 | | | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets | | O | X | | X | X | X | O | O | | |
| 13 | | | An increase in heavy rainfall events (i.e.+ >50 mm/hr) can lead to altered environmental protection zones and increased demand for new and/or altered permits for particular projects | | X | X | O | O | | | | | | |
| 14 | <i>Increase in Annual Precipitation</i> | | An increase in annual precipitation may present additional costs for Town-related capital projects due to higher ground water tables | | | X | | O | | | | | | |
| 15 | <i>Increase in Intensity/Frequency of Drought</i> | | An increase in intensity/frequency of summer droughts may present unexpected maintenance costs and stress to the Town's green infrastructure (i.e. public spaces and local neighbourhoods) | | O | X | | O | X | | | | | |
| 16 | <i>Increased Summer Temperatures</i> | | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may increase the demand to cool Town-owned facilities, which can subsequently increase energy consumption costs (i.e. hydro and natural gas) | | O | X | | | | | | | O | |
| 17 | | | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may present additional health and safety-related cases (i.e. heatstroke, renal/cardiovascular/skin issues, mental health, etc.) and costs to the Town, subsequently leading to less time for daily projects and/or tasks to be completed | | | X | | | X | X | | | X | |
| 18 | <i>Milder Winter Temperatures</i> | | An increase in milder winter temperatures may present unexpected costs to the Town due to a higher demand in invasive species management (i.e. maintain and/or respond to particular infestations) | | | X | | | X | | | | | |
| 19 | | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to a surplus of public service requests (i.e. requests for Town staff to maintain or replace Town property as well as provide required services to residents, etc.) and will thereby require more time from, and additional funds for, Town staff to service such requests | | | X | | | | | | X | | |

| | | | | | | | | | | | | | |
|----|---|--|---|---|--|---|---|---|---|---|---|---|---|
| 20 | More Frequent Events of Extreme Weather | Public Administration | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may in-directly cause harm (i.e. weather-related car accidents or traumatic injuries such as bruises, cuts, bone fractures, etc.) to Town staff that primarily work outdoors, leading to additional health and safety-related costs and overtime pay | | | X | O | | O | O | | O | |
| 21 | | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may inflict damage upon Town-owned infrastructure and assets, leading to possible increased replacement and/or maintenance costs | | | X | | | | | | O | |
| 22 | Increase in Precipitation in Winter | Public Health and Safety | An increase in winter precipitation (i.e. freezing rain) can increase the response time for emergency storm clean-up (i.e. removing debris from roads), limit road access and major routes for public use | | | | X | O | | X | | | |
| 23 | | | Although winter precipitation (i.e. freezing rain) raises the demand for road salts, the increase in intensity and frequency of rain can dilute the salt, thereby creating more health and safety hazards to road users (i.e. Town staff and the public) | | | | X | | | O | | | |
| 24 | | | An increase in winter precipitation (i.e. freezing rain) can lead to an increased demand for Town staff to provide extreme weather alerts, along with any additional public health and safety information to the public (i.e. no parking on Town streets anytime during winter events when plows and sanders are in operation) | X | | | X | | | O | | | |
| 25 | | | An increase in the frequency of winter precipitation (i.e. freezing rain) can increase the demand for, and "wear and tear" on, Town equipment (i.e. PPE, light and heavy-duty trucks, equipment, etc.) to meet the current demand for Town services (i.e. emergency) and use of assets (i.e. roads, parks, trails, etc.) | | | | X | | X | X | | | |
| 26 | | | An increase in winter precipitation (i.e. freezing rain) can quantify the number of reported workplace injuries (i.e. weather-related car accidents or traumatic injuries such as bruises, cuts, bone fractures, etc.) due to unsafe work conditions | | | | X | | | | | O | O |
| 27 | | | An increase in winter precipitation (i.e. freezing rain) can create potential health and safety hazards to Town staff and residents who use Town roads, trails, sidewalks, or parking lots | | | | X | | | | | | O |
| 28 | | | An increase in winter precipitation (i.e. freezing rain) may increase the likelihood of more intense and frequent blackout and/or brownout incidents, due to possible damage to power lines | | | | X | | | | | X | O |
| 29 | | | Increased Heavy Rainfall Events | An increase in heavy rainfall events (i.e. + >50 mm/hr) may lead to local flooding, which can increase the demand for the Town's emergency response services (i.e. emergency evacuations and/or response time to accidents) | | | | X | O | | O | | O |
| 30 | | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may lead to overflow of the Town's greywater systems, particularly in rural areas, posing several health and safety hazards | | O | | | X | | | | | | |

| | | | | | | | | | | | | | |
|----|--|---------------------------------|--|---|---|---|---|---|---|---|---|---|---|
| 31 | <i>Increased Summer Temperatures</i> | Public Health and Safety | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may present additional health and safety risks (i.e. heatstroke, renal/cardiovascular/skin issues, mental health, etc.) to vulnerable populations (i.e. seniors, children (<5 yrs., individuals with pre-existing health conditions, etc.) along with Town staff that operate in an outdoor setting | | | | X | | X | X | | X | |
| 32 | | | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may lead to an increased demand for Town staff to provide extreme temperature alerts, along with any additional health and safety information to the public | X | | | | | | | | O | |
| 33 | <i>Extreme Cold Temperatures</i> | | An increase in extremely cold temperatures (i.e. > -30°C) may lead to an increased demand for Town staff to provide extreme temperature alerts to the public, along with any additional health and safety information to the public | X | | | | | | | | O | |
| 34 | <i>More Frequent Events of Extreme Weather</i> | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to an increase in the Town's emergency response services, particularly for emergency evacuations | | | | X | | | | | O | O |
| 35 | | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may increase the likelihood of emergency-related scenarios (i.e. car accidents, flooding, prolonged power outages, etc.), resulting in an increase in emergency response time for emergency purposes | | | | X | | | | | O | O |
| 36 | | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may cause service disruptions (i.e. power outages and electrical surges) to Town residents, thereby worsening crises to vulnerable populations (i.e. seniors, children < 5yrs, or individuals with pre-existing health conditions) | | | | X | | | | | O | |
| 37 | | | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may increase the likelihood of flooding, leading to health and safety implications for the public | | | | X | | | | | | |
| 38 | <i>Increase in Precipitation in Winter</i> | Local Economy | An increase in winter precipitation (i.e. freezing rain) may cause failure to power lines and transmission structures, which may cause severe implications to Town staff and vulnerable populations (i.e. seniors, children (<5yrs), or individuals with pre-existing health conditions) | | | O | X | O | | | | | |
| 39 | <i>Increased Heavy Rainfall Events</i> | | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may increase the likelihood of overland flooding, causing damage to Town-infrastructure (i.e. roads, buildings, stormwater ponds, culverts, etc.) as well as increasing the rate of exposure to vulnerable areas (i.e. rural areas) | | X | O | | | | | O | | |
| 40 | <i>Increase in Annual Precipitation</i> | | An increase in annual precipitation may increase the demand for water and sewage networks to accommodate more intense precipitation | | X | | | X | | | | | |

Appendix D – Vulnerability and Risk Assessment

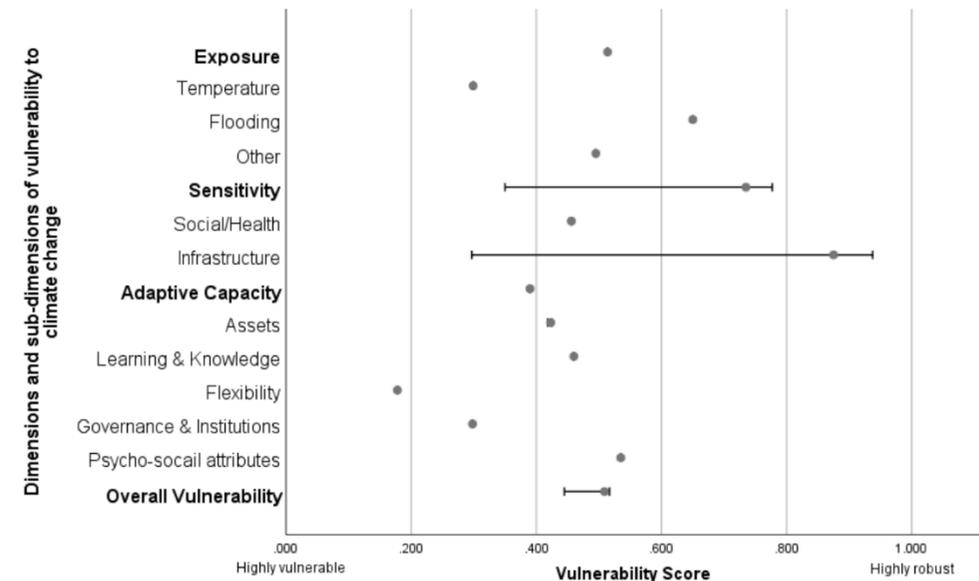
Vulnerability Assessment

Niagara Adapts at Brock University conducted a thorough vulnerability assessment for the Town of Pelham in Fall 2019. Through an extensive literature review and input from the experts, the NA team identified 50 indicators for the Niagara Region which were further ranked in importance (least to most important via a Q-sort) by the municipal staff according to relevance for Pelham.

Vulnerability assessments involve the systematic collection and analysis of information about exposure, sensitivity, and adaptive capacity relevant to a system of interest. A climate vulnerability index is a metric that is derived by combining, with or without weighting, several indicators assumed to represent a vulnerability. A vulnerability index can also identify which dimensions (e.g. exposure, sensitivity, and adaptive capacity) and sub-dimensions of a particular system are the most vulnerable. Data were collected from both primary and secondary sources. Secondary data was collected from sources including Statistics Canada, Environment Canada, climatedata.ca, Niagara Region Public Health, and others. To ensure maximum accuracy in the determination of vulnerability, survey instruments were implemented at both municipal and household scales.

For the analysis process, the data was normalized. Following the normalization process, data were aggregated to create the composite index. Weighted averages were used as a method of data aggregation. Weighting can reflect the local context and importance of certain indicators. Critical values were also taken into consideration. Critical values are indicators that are below a threshold, indicating moderate or greater vulnerability. Finally, it is common that data is unavailable for certain indicators. In instances where data was missing, the vulnerability index was also calculated assuming a pessimistic scenario (in which case, missing indicators were assigned the lowest possible vulnerability rating) and an optimistic scenario (in

which case missing indicators were assigned the highest possible vulnerability rating).



Dimensions and sub-dimensions of vulnerability to climate change across dimensions and ten sub-dimensions for Pelham. The grey dots represent the baseline scenarios. The confidence intervals represent the possible range from pessimistic to optimistic in cases where there is missing data.

For the Town, the overall vulnerability index value for Pelham is 0.509, on a scale from 0 (highly vulnerable) to 1 (highly robust). Exposure and sensitivity indicators from the assessment determined that extreme heat and cold temperatures, along with senior residents and/or individuals with pre-existing health conditions within Pelham are highly vulnerable to climate change. Adaptive capacity indicators determined that parks and forests and wetlands ranked high in vulnerability, along with political leadership, climate action, flexibility in institutional decision-making, and the level of community participation in decision-making processes.

The results provide data on the current state of vulnerability in Pelham, highlight potential opportunities to build adaptive capacity, and shed light on areas of missing data that may be useful to collect in the future. These findings provide critical data to inform the ongoing climate change adaptation planning process.

These results, in partnership with the results from Brock University's Niagara Adapts survey, collectively determined the set of impacts that were prioritized into "items of action" for the adaptation plan.

Note (s):

- **Results of the Household Survey can be found in Appendix E**
- **The complete vulnerability assessment report can be accessed through <https://www.pelham.ca/en/living-here/resources/Documents/NA-Vulnerability-Report---May-20th.pdf>**

53 Impact statements were further analyzed by the ASC for vulnerability.

The breakdown of vulnerability score is as follows:

- 7 impacts rank **high** in vulnerability (V4 & V5), meaning the Town's adaptive capacity to adapt to the proposed climatic threats is low and the sensitivity is high
- 23 impacts rank **medium** in vulnerability (V3), meaning the Town has a moderate adaptive capacity and sensitivity to these impacts
- 23 impacts rank **low** in vulnerability (V2 & V1), meaning the Town's adaptive capacity to adapt to the proposed climatic threats is high and the sensitivity is low

Vulnerability is defined as the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. The assessments collect information on **the exposure, sensitivity, and adaptive capacity** of a given service area. In the Town's case, a vulnerability assessment can be used, at any scale, to distinguish how vulnerable a sector, service, and/or system is within a municipal department. Once complete, the Town had a better understanding of each municipal department's level of vulnerability to the existing climate change impact caused by a particular climatic threat.

The components and given formula of a vulnerability assessment can be found below:

$$\text{Vulnerability} = \frac{\text{Exposure} \times \text{Sensitivity}}{\text{Adaptive Capacity}}$$

Exposure = the degree to which a system is exposed to a climatic threat (i.e. floods, ice storms, extreme winds, etc.) which was identified with impact statements

Sensitivity = the degree to which a system is impacted by a climatic threat

Adaptive Capacity = the ability to easily adjust to climate change, including how to respond to and prepare for climatic threats

1. In **Step A**, the ASC identified the sensitivity of each department/service area to understand if the functionality of the service area will be impacted or not. The team used a sensitivity scale to assign values from S1 to S5 based on the scale below. Following themes were followed to assess the sensitivity.
 - How exposed is the service area to the impacts of climate change?
 - Is the service area subject to existing stresses?
 - Will climate change cause the demand for a resource or service to exceed its supply or current abilities?
 - Does the service area have limiting factors that may be affected by climate change?
 - Are there measures that are presently in place that can provide a buffer against expected future changes

A. Sensitivity Scale

| If the impact occurs, will it affect the functionality of the service area? | | | | |
|---|---|---|---|---|
| No – Functionality will stay the same (S1) | Unlikely – Functionality will likely stay the same (S2) | Yes – Functionality is likely to get worse (S3) | Yes – Functionality will get worse (S4) | Yes – Functionality will become unmanageable (S5) |

2. In the following **Step B**, the ASC assessed the ability of the department to adapt to climate change impacts. The determining factors and the themes engaged for adaptive capacity include economic resources, technology, information and skills, social capital, institutions, and equity. Each department was assessed for its adaptive capacity and was assigned a score from AC1 to AC5 as seen in the Adaptive Capacity Scale below.

B. Adaptive Capacity Scale

| Can the service area adjust to the projected impact with minimal cost and disruption? | | | | |
|---|---|--|--|--|
| No – Will require substantial costs (\$\$\$\$\$) and staff intervention (AC1) | No – Will require significant costs (\$\$\$\$) and staff intervention (AC2) | Maybe – Will require some costs (\$\$\$) and staff interventions (AC3) | Yes – But will require some slight costs (\$\$) and staff intervention (AC4) | Yes – No to little costs (\$) and staff intervention are necessary (AC5) |

3. In the final **Step C**, using the sensitivity, adaptive capacity and exposure values, vulnerability score is assigned to each impact and the department.

C. Sensitivity and Adaptive Capacity Matrix

| | S1 | S2 | S3 | S4 | S5 |
|-----|----|----|----|----|----|
| AC1 | V2 | V2 | V4 | V5 | V5 |
| AC2 | V2 | V2 | V3 | V4 | V5 |
| AC3 | V2 | V2 | V3 | V4 | V4 |
| AC4 | V1 | V2 | V2 | V3 | V3 |
| AC5 | V1 | V1 | V2 | V3 | V3 |

V1 = Low Vulnerability

V2 = Medium-Low Vulnerability

V3 = Medium Vulnerability

V4 = Medium-High Vulnerability

V5 = High Vulnerability

Risk Assessment

Based on the 53 impact statements that were evaluated through a vulnerability assessment, 30 impacts were further investigated through a risk analysis as they ranked medium to high (V3, V4 or V5) in vulnerability. Of those 30 statements, the following risk scores were observed:

- 1 impact statement was categorized as a **high** risk
- 1 impact statement was categorized as a **medium-high** risk
- 14 impact statements were categorized as a **medium** risk
- 11 impacts were categorized as a **medium-low** risk
- 3 impacts were categorized as a **low** risk

Risk is simply calculated as a cross between likelihood and consequence. It is a function of the consequence of an impact and the likelihood of its occurrence. Risk assessment is done in three steps.

1. In **Step A**, the likelihood of the impact is determined. The underlying theme considered to determine likelihood meant that the ASC considered whether the impact is recurring or a single event. Following the logic, a likelihood rating was assigned from L1 which was *Rare* to L5 which reflected *Almost Certain*.

A. Likelihood Rating

| <i>What is the probability of the climate impact occurring?</i> |
|---|
| L1- Rare, unlikely during the next 25 years |
| L2- Unlikely, may arise once in 10-25 years |
| L3- Possible, may arise once in 10 years |
| L4- Likely, may arise about once per year |
| L5- Almost Certain, could occur several times per year |

2. In the next **Step B**, the ASC determined a consequence rating for each of the 30 impacts. Consequence is the known or estimated consequences (to public safety, local economy & growth, community & lifestyle, environment & sustainability, and public administration) of a particular impact. Using the criteria in the table below, the ASC determined a score of C1 which indicated a *negligible* consequence rating to C5 which indicates *catastrophic* consequence rating for each of the 5 themes of Environment, Public Administration, Public Safety, Economy, and Community Services. The scores from each category were used to determine a consequence rating for each impact.

B. Consequence Criteria

| Theme 1: Environment | Theme 2: Public Administration | Theme 3: Public Safety | Theme 4: Economy | Theme 5: Community Services |
|---|---|---|--|--|
| What are the known or estimated consequences of the climatic threat to the respective theme? | | | | |
| C1- Negligible, no environmental damage | C1- Negligible, minor instances where public administration would be under stress | C1- Negligible, appearance of a threat but not actual harm | C1- Negligible, minor shortfall relative to current forecasts | C1- Negligible, minor areas in which the Town was unable to maintain current services |
| C2- Minor, minor instances of environmental damage that could be reversed | C2- Minor, isolated instances of public administration being under severe pressure | C2- Minor, serious near misses or minor injuries | C2- Minor, individually significant but isolated areas of reduction in economic performance relative to current forecasts | C2- Minor, isolated but noticeable examples of decline in services |
| C3- Moderate, isolated but significant instances of environmental damage that might be reversed with intensive efforts | C3- Moderate, public administration would be under pressure on several fronts | C3- Moderate, small number of injuries | C3- Moderate, significant general reduction in economic performance relative to current forecasts | C3- moderate, general appreciable decline in services |
| C4- Major, severe loss of environmental amenity and a danger of continuing environmental damage | C4- Major, public administration would struggle to remain effective and would seem to be in danger of failing completely | C4- Major, isolated instances of serious injuries or loss of life | C4- Major, regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth | C4- Major, severe and widespread decline in services and quality of life within the community |
| C5- Catastrophic, major widespread loss of environmental amenity and progressive irrecoverable environmental damage | C5- Catastrophic, public administration would fall into decay and cease to be effective | C5- Catastrophic, large numbers of serious injuries or loss of lives | C5- Catastrophic, regional decline leading to widespread business failure, loss of employment and hardship | C5- Catastrophic, the Town would be seen as very unattractive, moribund and unable to support its community |

- In the final **Step C**, the likelihood rating and the consequence rating were used to assign a risk score to the impact. The risk scores were interpreted using the risk spectrum mention below.

C. Risk Spectrum



The extreme, very-high, and high-risk impacts demand the most attention even if they can be accommodated as a part of routine operations. Medium spectrum risks are assigned to various managers and are reviewed constantly. As such, **16 impacts** were considered as high to medium risk and required the most attention while building the goals and actions of the adaptation strategy.

Lastly, it is important to reiterate that the vulnerability and risk assessments from the ASC were calculated using a weighted average. The departments that were directly impacted by the impact held a greater weight compared to those who were in-directly impacted.

Below is a consolidated list of Vulnerability & Risk Assessments for the 53 and 30 impacts, respectively.

Vulnerability Assessment

Natural Resources and the Environment

| ID# | Impact Statement | <table border="1"> <tr> <td>Directly Impacted</td> <td>X</td> </tr> <tr> <td>In-directly Impacted</td> <td>O</td> </tr> <tr> <td>Opportunity</td> <td>W</td> </tr> </table> | | Directly Impacted | X | In-directly Impacted | O | Opportunity | W | Department | | | | | | | | Vulnerability Score |
|-------------------------|--|---|------------------------|----------------------------|------------------------------------|----------------------|------------------------|--------------------------------|---|------------|----|--|--|--|--|--|--|---------------------|
| | | Directly Impacted | X | | | | | | | | | | | | | | | |
| In-directly Impacted | O | | | | | | | | | | | | | | | | | |
| Opportunity | W | | | | | | | | | | | | | | | | | |
| Administration Services | Community, Planning & Development | Corporate Services | Fire & By-Law Services | Public Works - Engineering | Public Works- Parks/beautification | Public Works - Roads | Public Works - General | Recreation, Culture & Wellness | | | | | | | | | | |
| 2 | An increase in heavy rainfall events (i.e.+ >50 mm/hr) can have adverse impacts (i.e. washouts, erosions, floods, etc.) on Town-owned infrastructure and assets (i.e. roads, creeks, curbs and sidewalks, storm sewers, storm ponds, channels, etc.) | | O | | | X | X | X | | | V4 | | | | | | | |
| 3 | An increase in intensity/frequency of summer droughts may add additional stress to local watercourses (i.e. surface water levels and temperature), which can pose adverse impacts on particular ecosystem services and biodiversity | | | | | X | X | O | | | V4 | | | | | | | |
| 4 | An increase in annual temperatures can lead to large infestations of invasive species, as minimum temperature increases and the survival rate for native tree species decline | | O | | | | X | | | | V3 | | | | | | | |
| 7 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to a higher likelihood of tree mortality, affecting the Town's total urban forest canopy | | | O | | | X | | | | V3 | | | | | | | |
| 1 | An increase in winter precipitation (i.e. freezing rain) can lead to increased exposure to salt on roads, causing adverse effects on tree, plant, and aquatic species | | | | | | X | O | | | V3 | | | | | | | |
| 5 | An increase in annual temperatures may present altered agricultural zones and seasons (i.e. reproductive patterns) for native flora due to a changing climate | | X | | | | X | | | | V2 | | | | | | | |
| 6 | An increase in temperature variability during shoulder seasons may prolong the time of year in which plant and tree maintenance (i.e. leaf and grass clean up, watering, pruning, etc.) is required | | | | | | X | | | | V2 | | | | | | | |

Table 4: Vulnerability Score for Impact Statements under Natural Resources and the Environment Category

Public Administration

| ID# | Impact Statement | Department | | | | | | | | Vulnerability Score | |
|-----|--|-------------------------|-----------------------------------|--------------------|------------------------|----------------------------|-------------------------------------|----------------------|------------------------|---------------------|--------------------------------|
| | | Administration Services | Community, Planning & Development | Corporate Services | Fire & By-Law Services | Public Works - Engineering | Public Works - Parks/Beautification | Public Works - Roads | Public Works - General | | Recreation, Culture & Wellness |
| 17 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may present additional health and safety-related cases (i.e. heatstroke, renal/cardiovascular/skin issues, mental health, etc.) and costs to the Town, subsequently leading to less time for daily projects and/or tasks to be completed | | | X | | | X | X | | X | V3 |
| 12 | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets | | O | X | | X | X | X | O | O | V3 |
| 9 | An increase in winter precipitation (i.e. freezing rain and/or freeze-thaw cycles) may present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets | | | X | | O | O | O | X | | V3 |
| 19 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to a surplus of public service requests (i.e. requests for Town staff to maintain or replace Town property as well as provide required services to residents, etc.) and will thereby require more time from, and additional funds for, Town staff to service such requests | | | X | | | | | X | | V3 |
| 18 | An increase in milder winter temperatures may present unexpected costs to the Town due to a higher demand in invasive species management (i.e. maintain and/or respond to particular infestations) | | | X | | | X | | | | V3 |
| 21 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may inflict damage upon Town-owned infrastructure and assets, leading to possible increased replacement and/or maintenance costs | | | X | | | | | O | | V3 |
| 8 | An increase in winter precipitation (i.e. freezing rain) can increase emergency services costs due to increased demand in emergency response time as well as additional training to the Town's emergency response team | | | X | X | | | | | | V2 |
| 10 | An increase in winter precipitation (i.e. freezing rain) can lead to the closure of Town facilities (i.e. Town Hall, the MCC, public libraries, etc.) and additional costs to the Town due to public safety concerns | | O | X | O | | | | O | O | V2 |
| 20 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may in-directly cause harm (i.e. weather-related car accidents or traumatic injuries such as bruises, cuts, bone fractures, etc.) to Town staff that primarily work outdoors, leading to additional health and safety-related costs and overtime pay | | | X | O | | O | O | | O | V2 |

| | |
|----------------------|---|
| Directly Impacted | X |
| In-directly Impacted | O |
| Opportunity | W |

| | | | | | | | | | | | | |
|----|---|---|--|---|---|--|---|---|---|---|---|----|
| | seniors, children <5 yrs., individuals with pre-existing health conditions, etc.) along with Town staff that operate in an outdoor setting | | | | | | | | | | | |
| 28 | An increase in winter precipitation (i.e. freezing rain) may increase the likelihood of more intense and frequent blackout and/or brownout incidents, due to possible damage to power lines | | | | X | | | | X | O | | V3 |
| 25 | An increase in the frequency of winter precipitation (i.e. freezing rain) can increase the demand for, and "wear and tear" on, Town equipment (i.e. PPE, light and heavy-duty trucks, equipment, etc.) to meet the current demand for Town services (i.e. emergency) and use of assets (i.e. roads, parks, trails, etc.) | | | | X | | X | X | | | | V3 |
| 35 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may increase the likelihood of emergency-related scenarios (i.e. car accidents, flooding, prolonged power outages, etc.), resulting in an increase in emergency response time for emergency purposes | | | | X | | | | | O | O | V3 |
| 36 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may cause service disruptions (i.e. power outages and electrical surges) to Town residents, thereby worsening crises to vulnerable populations (i.e. seniors, children < 5yrs, or individuals with pre-existing health conditions) | | | | X | | | | | O | | V3 |
| 26 | An increase in winter precipitation (i.e. freezing rain) can quantify the number of reported workplace injuries (i.e. weather-related car accidents or traumatic injuries such as bruises, cuts, bone fractures, etc.) due to unsafe work conditions | | | | X | | | | | O | O | V3 |
| 23 | Although winter precipitation (i.e. freezing rain) raises the demand for road salts, the increase in intensity and frequency of rain can dilute the salt, thereby creating more health and safety hazards to road users (i.e. Town staff and the public) | | | | X | | | | | O | | V2 |
| 27 | An increase in winter precipitation (i.e. freezing rain) can create potential health and safety hazards to Town staff and residents who use Town roads, trails, sidewalks, or parking lots | | | | X | | | | | | O | V2 |
| 34 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to an increase in the Town's emergency response services, particularly for emergency evacuations | | | | X | | | | | O | O | V2 |
| 30 | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may lead to overflow of the Town's greywater systems, particularly in rural areas, posing several health and safety hazards | | | O | | | X | | | | | V2 |
| 24 | An increase in winter precipitation (i.e. freezing rain) can lead to an increased demand for Town staff to provide extreme weather alerts, along with any additional public health and safety information to the public (i.e. no parking on Town streets anytime during winter events when plows and sanders are in operation) | X | | | X | | | | | O | | V2 |
| 33 | An increase in extremely cold temperatures (i.e. > -30°C) may lead to an increased demand for Town staff to provide extreme temperature alerts to the public, along with any additional health and safety information to the public | X | | | | | | | | | O | V1 |
| 32 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may lead to an increased demand for Town staff to provide extreme temperature alerts, along with any additional health and safety information to the public | X | | | | | | | | | O | V1 |

Table 6: Vulnerability Score for Impact Statements under Public Health and Safety Category

Local Economy

| ID# | Impact Statement | <table border="1"> <tr> <td>Directly Impacted</td> <td>X</td> </tr> <tr> <td>In-directly Impacted</td> <td>O</td> </tr> <tr> <td>Opportunity</td> <td>W</td> </tr> </table> | | Directly Impacted | X | In-directly Impacted | O | Opportunity | W | Department | | | | | | | | Vulnerability Score |
|-------------------------|---|---|------------------------|----------------------------|------------------------------------|----------------------|------------------------|--------------------------------|---|------------|--|--|--|--|--|--|--|---------------------|
| | | Directly Impacted | X | | | | | | | | | | | | | | | |
| In-directly Impacted | O | | | | | | | | | | | | | | | | | |
| Opportunity | W | | | | | | | | | | | | | | | | | |
| Administration Services | Community, Planning & Development | Corporate Services | Fire & By-Law Services | Public Works - Engineering | Public Works- Parks/Beautification | Public Works - Roads | Public Works - General | Recreation, Culture & Wellness | | | | | | | | | | |
| 45 | An increase in milder winter temperatures may overburden storm sewer systems resulting in surcharge and runoff from rapid snow melts | | | | | X | | | | V4 | | | | | | | | |
| 39 | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may increase the likelihood of overland flooding, causing damage to Town-infrastructure (i.e. roads, buildings, stormwater ponds, culverts, etc.) as well as increasing the rate of exposure to vulnerable areas (i.e. rural areas) | | X | O | | | | | O | V3 | | | | | | | | |
| 42 | An increase in extremely cold temperatures (i.e. > -30°C) and rainfall intensity can freeze the ground, subsequently leading to flash flooding | | X | | | X | | | | V3 | | | | | | | | |
| 40 | An increase in annual precipitation may increase the demand for water and sewage networks to accommodate more intense precipitation | | X | | | X | | | | V3 | | | | | | | | |
| 38 | An increase in winter precipitation (i.e. freezing rain) may cause failure to power lines and transmission structures, which may cause severe implications to Town staff and vulnerable populations (i.e. seniors, children (<5yrs), or individuals with pre-existing health conditions) | | | O | X | O | | | | V3 | | | | | | | | |
| 46 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may present additional damage to Town-owned infrastructure (i.e. roads, sidewalks, buildings, parks, trails, signs, street signs, small equipment, etc.), which will lead to an increase in maintenance and replacement costs | | | X | | | | X | O | V3 | | | | | | | | |
| 43 | More volatile winter temperatures will increase the frequency of freeze-thaw events, which may present additional implications for Town-owned infrastructure (i.e. roads, stormwater ponds, sidewalks, parks, trails, water mains, culverts, etc.) and buildings (i.e. roofs and foundation), leading to an increase in maintenance and replacement costs | | O | X | | | | | O | V2 | | | | | | | | |
| 41 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may present additional damage to Town assets (i.e. roads, sidewalks, parking lots, culverts, etc.), as well as outdoor recreational facilities (i.e. playgrounds and parks), which will lead to an increase in maintenance and/or replacement costs | | O | X | | | | O | O | V2 | | | | | | | | |
| 44 | An increase in milder winter temperatures may present additional damage to Town assets (i.e. green infrastructure) and will result in ongoing maintenance to respective assets (i.e. invasive species) | | | X | | | X | | | V2 | | | | | | | | |

Table 7: Vulnerability Score for Impact Statements under Local Economy Category

Community Services

| ID# | Impact Statement | <table border="1"> <tr> <td>Directly Impacted</td> <td>X</td> </tr> <tr> <td>In-directly Impacted</td> <td>O</td> </tr> <tr> <td>Opportunity</td> <td>W</td> </tr> </table> | | Directly Impacted | X | In-directly Impacted | O | Opportunity | W | Department | | | | | | | | Vulnerability Score |
|-------------------------|---|---|------------------------|----------------------------|------------------------------------|----------------------|------------------------|--------------------------------|---|------------|--|--|--|--|--|--|--|---------------------|
| | | Directly Impacted | X | | | | | | | | | | | | | | | |
| In-directly Impacted | O | | | | | | | | | | | | | | | | | |
| Opportunity | W | | | | | | | | | | | | | | | | | |
| Administration Services | Community, Planning & Development | Corporate Services | Fire & By-Law Services | Public Works - Engineering | Public Works- Parks/Beautification | Public Works - Roads | Public Works - General | Recreation, Culture & Wellness | | | | | | | | | | |
| 53 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to an increase in cancellations or possible delays to outdoor Town events | | | | | | | | X | V5 | | | | | | | | |
| 47 | An increase in precipitation during the winter season (i.e. freezing rain) may increase the likelihood of delays or possible cancellations of sport, community and/or private events serviced by Town facilities (i.e. MCC, OPTH) | | | | | | | | X | V4 | | | | | | | | |
| 48 | An increase in the duration of heavy rainfall events (i.e.+ >50 mm/hr) may manipulate the grounds (i.e. flooding) at public parks and/or trails, which can lead to delays or possible cancellations for Town events | | | O | | O | | | X | V4 | | | | | | | | |
| 51 | Vulnerable or immuno-compromised individuals (i.e. seniors, children (< 5yrs), or individuals with pre-existing health conditions) that actively participate in Town programs and/or events may become more vulnerable to heat stress due to increased summer temperatures (i.e. >30°C) | | | | | | | | X | V3 | | | | | | | | |
| 52 | An increase in extremely cold temperatures (i.e. > -30°C) may lead to a higher demand for public participation in indoor recreational activities | | | | | | | | X | V2 | | | | | | | | |
| 50 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may result in an increased demand for the Town's outdoor pool facilities and aquatic activities | | | | | | | | X | V2 | | | | | | | | |
| 49 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may result in less demand in outdoor recreational activities (such as playgrounds and parks) and increase demand for indoor facilities | | | | | | | | X | V2 | | | | | | | | |

Table 8: Vulnerability Score for Impact Statements under Community Services Category

Risk Assessment

| ID# | Impact Statement | <table border="1"> <tr> <td>Directly Impacted</td> <td>X</td> </tr> <tr> <td>In-directly Impacted</td> <td>O</td> </tr> <tr> <td>Opportunity</td> <td>W</td> </tr> </table> | | Directly Impacted | X | In-directly Impacted | O | Opportunity | W | Department | | | | | | | | Overall Risk Score | Overall Risk Ranking |
|-------------------------|--|---|------------------------|----------------------------|-------------------------------------|----------------------|------------------------|--------------------------------|---|------------|----|-------------|--|--|--|--|--|--------------------|----------------------|
| | | Directly Impacted | X | | | | | | | | | | | | | | | | |
| In-directly Impacted | O | | | | | | | | | | | | | | | | | | |
| Opportunity | W | | | | | | | | | | | | | | | | | | |
| Administration Services | Community, Planning & Development | Corporate Services | Fire & By-Law Services | Public Works - Engineering | Public Works - Parks/Beautification | Public Works - Roads | Public Works - General | Recreation, Culture & Wellness | | | | | | | | | | | |
| 39 | An increase in heavy rainfall events (i.e. + >50 mm/hr) may increase the likelihood of overland flooding, causing damage to Town-infrastructure (i.e. roads, buildings, stormwater ponds, culverts, etc.) as well as increasing the rate of exposure to vulnerable areas (i.e. rural areas) | | X | O | | | | | O | | 86 | High | | | | | | | |
| 22 | An increase in winter precipitation (i.e. freezing rain) can increase the response time for emergency storm clean-up (i.e. removing debris from roads), limit road access and major routes for public use | | | | X | O | | X | | | 69 | Medium-High | | | | | | | |
| 29 | An increase in heavy rainfall events (i.e. + >50 mm/hr) may lead to local flooding, which can increase the demand for the Town's emergency response services (i.e. emergency evacuations and/or response time to accidents) | | | | X | O | | O | | O | 65 | Medium | | | | | | | |
| 31 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may present additional health and safety risks (i.e. heatstroke, renal/cardiovascular/skin issues, mental health, etc.) to vulnerable populations (i.e. seniors, children (<5 yrs., individuals with pre-existing health conditions, etc.) along with Town staff that operate in an outdoor setting | | | | X | | X | X | | X | 64 | Medium | | | | | | | |
| 2 | An increase in heavy rainfall events (i.e. + >50 mm/hr) can have adverse impacts (i.e. washouts, erosions, floods, etc.) on Town-owned infrastructure and assets (i.e. roads, creeks, curbs and sidewalks, storm sewers, storm ponds, channels, etc.) | | O | | | X | X | X | | | 63 | Medium | | | | | | | |
| 28 | An increase in winter precipitation (i.e. freezing rain) may increase the likelihood of more intense and frequent blackout and/or brownout incidents, due to possible damage to power lines | | | | X | | | | X | O | 60 | Medium | | | | | | | |
| 42 | An increase in extremely cold temperatures (i.e. > -30°C) and rainfall intensity can freeze the ground, subsequently leading to flash flooding | | X | | | X | | | | | 57 | Medium | | | | | | | |
| 7 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to a higher likelihood of tree mortality, affecting the Town's total urban forest canopy | | | O | | | X | | | | 57 | Medium | | | | | | | |
| 53 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to an increase in cancellations or possible delays to outdoor Town events | | | | | | | | | X | 55 | Medium | | | | | | | |

| | | | | | | | | | | | | |
|----|--|--|---|---|---|---|---|---|---|---|----|------------|
| 47 | An increase in precipitation during the winter season (i.e. freezing rain) may increase the likelihood of delays or possible cancellations of sport, community and/or private events serviced by Town facilities (i.e. MCC, OPTH) | | | | | | | | | X | 55 | Medium |
| 25 | An increase in the frequency of winter precipitation (i.e. freezing rain) can increase the demand for, and "wear and tear" on, Town equipment (i.e. PPE, light and heavy-duty trucks, equipment, etc.) to meet the current demand for Town services (i.e. emergency) and use of assets (i.e. roads, parks, trails, etc.) | | | X | | X | X | | | | 55 | Medium |
| 4 | An increase in annual temperatures can lead to large infestations of invasive species, as minimum temperature increases and the survival rate for native tree species decline | | O | | | X | | | | | 53 | Medium |
| 40 | An increase in annual precipitation may increase the demand for water and sewage networks to accommodate more intense precipitation | | X | | X | | | | | | 53 | Medium |
| 35 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may increase the likelihood of emergency-related scenarios (i.e. car accidents, flooding, prolonged power outages, etc.), resulting in an increase in emergency response time for emergency purposes | | | | X | | | | O | O | 53 | Medium |
| 36 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may cause service disruptions (i.e. power outages and electrical surges) to Town residents, thereby worsening crises to vulnerable populations (i.e. seniors, children < 5yrs, or individuals with pre-existing health conditions) | | | | X | | | | O | | 53 | Medium |
| 37 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may increase the likelihood of flooding, leading to health and safety implications for the public | | | | X | | | | | | 51 | Medium |
| 17 | An increase in duration and frequency of extreme temperatures (i.e. >30°C) may present additional health and safety-related cases (i.e. heatstroke, renal/cardiovascular/skin issues, mental health, etc.) and costs to the Town, subsequently leading to less time for daily projects and/or tasks to be completed | | | X | | | X | X | | X | 50 | Medium-Low |
| 45 | An increase in milder winter temperatures may overburden storm sewer systems resulting in surcharge and runoff from rapid snow melts | | | | | X | | | | | 49 | Medium-Low |
| 12 | An increase in heavy rainfall events (i.e.+ >50 mm/hr) may present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets | | O | X | | X | X | X | O | O | 49 | Medium-Low |
| 38 | An increase in winter precipitation (i.e. freezing rain) may cause failure to power lines and transmission structures, which may cause severe implications to Town staff and vulnerable populations (i.e. seniors, children (<5yrs), or individuals with pre-existing health conditions) | | | O | X | O | | | | | 48 | Medium-Low |
| 9 | An increase in winter precipitation (i.e. freezing rain and/or freeze-thaw cycles) may present additional maintenance, insurance and/or replacement costs to Town-owned infrastructure and assets | | | X | | O | O | O | | X | 47 | Medium-Low |
| 48 | An increase in the duration of heavy rainfall events (i.e.+ >50 mm/hr) may manipulate the grounds (i.e. flooding) at public parks and/or trails, which can lead to delays or possible cancellations for Town events | | | O | | | O | | | X | 46 | Medium-Low |
| 26 | An increase in winter precipitation (i.e. freezing rain) can quantify the number of reported workplace injuries (i.e. weather-related car accidents or traumatic injuries such as bruises, cuts, bone fractures, etc.) due to unsafe work conditions | | | | X | | | | O | O | 44 | Medium-Low |

| | | | | | | | | | | | | |
|----|--|--|--|---|--|---|---|---|---|---|----|------------|
| 46 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may present additional damage to Town-owned infrastructure (i.e. roads, sidewalks, buildings, parks, trails, signs, street signs, small equipment, etc.), which will lead to an increase in maintenance and replacement costs | | | X | | | | | X | O | 43 | Medium-Low |
| 19 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may lead to a surplus of public service requests (i.e. requests for Town staff to maintain or replace Town property as well as provide required services to residents, etc.) and will thereby require more time from, and additional funds for, Town staff to service such requests | | | X | | | | | X | | 40 | Medium-Low |
| 1 | An increase in winter precipitation (i.e. freezing rain) can lead to increased exposure to salt on roads, causing adverse effects on tree, plant, and aquatic species | | | | | | X | O | | | 37 | Medium-Low |
| 18 | An increase in milder winter temperatures may present unexpected costs to the Town due to a higher demand in invasive species management (i.e. maintain and/or respond to particular infestations) | | | X | | | X | | | | 36 | Medium-Low |
| 21 | More frequent events of extreme weather (i.e. thunder, hail, and/or wind storms) may inflict damage upon Town-owned infrastructure and assets, leading to possible increased replacement and/or maintenance costs | | | X | | | | | O | | 35 | Low |
| 3 | An increase in intensity/frequency of summer droughts may add additional stress to local watercourses (i.e. surface water levels and temperature), which can pose adverse impacts on particular ecosystem services and biodiversity | | | | | X | X | O | | | 34 | Low |
| 51 | Vulnerable or immuno-compromised individuals (i.e. seniors, children (< 5yrs), or individuals with pre-existing health conditions) that actively participate in Town programs and/or events may become more vulnerable to heat stress due to increased summer temperatures (i.e. >30°C) | | | | | | | | | X | 29 | Low |

Table 9: Risk Scores for Impact Statements

Appendix E – Community Engagement

As a part of Town’s Adaptation Planning Strategy, community engagement was given intense weightage while finalizing the CCCAP. The engagement included members from the Planning Team, Municipal Staff and Residents and Public at large. The stakeholder engagement was undertaken at two stages of building the plan.

Vulnerability Assessment

The Niagara Adapts Team conducted a thorough vulnerability assessment for the Town of Pelham. The idea was to conduct a vulnerability assessment that captured a range of relevant systems and scales for Pelham. The Niagara Adapts team identified indicators for exposure, sensitivity, and adaptive capacity which determine vulnerability through a scholarly literature review and consultation with experts in the field and selected 50 indicators. These indicators gauged both the social and the biophysical elements of vulnerability to climate change. To ensure that the 50 indicators were highly relevant to Pelham, municipal partner(s) from Pelham prioritized the indicators, from most to least important. Using the Q sort method, the Town ranked 50 indicators based on their importance and relevance. The yellow indicators represented adaptive capacity, whereas the blue was exposure and the green were sensitivity



Photo: 50 indicators ranked based on importance and relevance

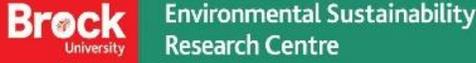
Data for vulnerability assessments included primary as well as secondary data. Secondary data was collected from sources including Statistics Canada, Environment Canada, climatedata.ca, Niagara Region Public Health, and others. To capture potential vulnerabilities at both the municipal scale and at the household scale, two survey instruments were implemented at the respective scales.

- At the municipal scale, partners collected relevant materials and consulted members of municipal staff to collect information on specific indicators.
- Data at the household scale was collected through a public survey. The survey asked questions relative to how the impacts of climate change affect local communities and how people respond to those impacts. Surveys were completed online and in person. In Pelham, 147 residents participated. Niagara Adapts' Climate Change Adaptation Survey, which was readily available on the Town's website and social media platforms (i.e. Instagram, Twitter, and Facebook), emails were sent to Town staff and members on Town-related committees, and advertisements from local newspapers (i.e. the Voice and Niagara this Week) to gain additional numbers for the survey.

The Household Survey results revealed critical information on the respondents' experience with climate change impacts and their opinions on climate change adaptation. Respondents of the household survey were 36% male and 64% female. 57% were between the ages of 18 and 54, and 43% above the age of 55. Some of the critical aspects of the results are outlined in the [fact sheets](#) below.

For the complete report on vulnerability analysis, please visit <https://www.pelham.ca/en/living-here/resources/Documents/NA-Vulnerability-Report---May-20th.pdf>

Assessment of Vulnerability – Fact Sheet



Niagara Adapts

Climate Vulnerability Fact Sheet

Niagara Adapts Partnership Overview

The impacts of climate change are already being experienced in Niagara and will only intensify in the future. In response, seven municipalities in the region have partnered with Brock University to develop and implement climate adaptation plans. Understanding vulnerability to climate change is a critical component of effective climate adaptation planning.



We asked representatives from each participating municipality what 'adaptation to climate change' means to them. This word cloud summarized their responses.

Vulnerability Assessment

Vulnerability is defined as susceptibility to harm arising from climate change impacts. This factsheet highlights the results from a baseline climate vulnerability survey conducted in the fall 2019.



Surveys were conducted face-to-face and online.

Respondents

1087 people completed the survey

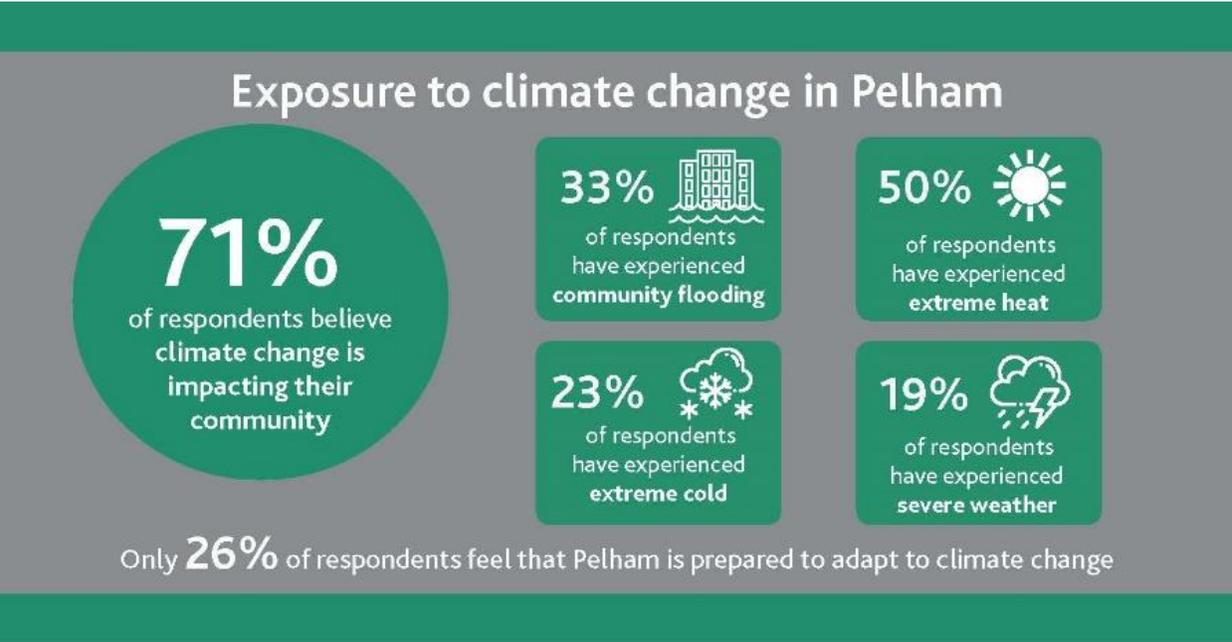


| | | |
|-----|--------|---|
| 63% | female |  |
| 37% | male |  |

Municipal Partners



| | |
|--|--|
| <p>CONTACT US t 905-688-5550 x5772 e esrc@brocku.ca w brocku.ca/niagara-adapts</p> | <p>FOR FURTHER INFORMATION Dr. Jessica Blythe, Niagara Adapts Faculty Lead e jblythe2@brocku.ca w brocku.ca/esrc/jessica-blythe</p> |
|--|--|



Opportunities for adaptation



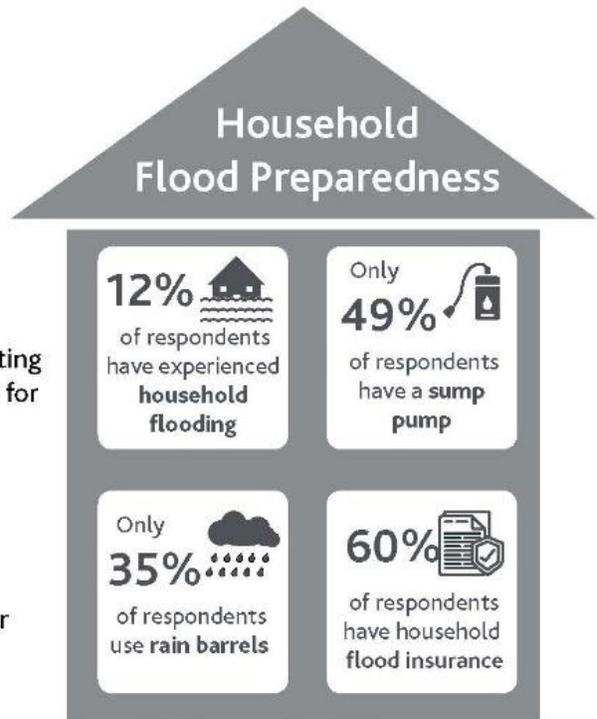
86% of respondents believe humans have the capacity to address climate change



For **48%** of respondents, adapting to climate change is a top priority for their households



82% of respondents support municipal resources being used for climate change adaptation



Note: Percentages reported on this page reflect the 147 people who completed surveys from Pelham.

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This publication should be cited as:
 Blythe J, Mallette A, Smits A, Daly E, Plummer R, 2020.
 Climate vulnerability fact sheet – Pelham.
 Niagara Adapts Program Brief: 2020-05.

Stakeholder Engagement Survey on Vision and Goals

In November and December 2020, a stakeholder engagement survey was conducted in Pelham to generate feedback on the municipality's draft vision and goals for their climate change adaptation plan. The survey was created and distributed using Qualtrics, an online survey platform. Surveys were distributed by Niagara Adapts partners through online advertisements, social media channels, and municipal channels.

The survey provided an opportunity for stakeholders to provide feedback on the draft vision and goals for the final plan. The survey received a total of **41** responses from community stakeholders. The responses and the results are presented in this report to help inform the collaborative planning process.

Demographics

Participants were asked to identify their role in Pelham. These data provide an opportunity to understand which stakeholders are providing feedback in the planning process.

Survey respondents' demographics.

| | Number of responses | % |
|-----------------|---------------------|---------|
| Municipal staff | 22 | 57.89 % |
| Council member | 4 | 10.58 % |
| Resident | 12 | 31.58 % |
| Other | 0 | 0 % |

Draft Vision

The draft vision for the Town of Pelham's climate adaptation plan is:

The Town of Pelham will reduce, respond to, and recover from, the unique climatic threats posed by climate change, and will embrace the opportunities that position the Town to grow revenue by promoting cultural assets while protecting our environmental assets.

Stakeholders were asked to rank their level of support for the draft vision and provide qualitative feedback on the draft vision.

Stakeholders' levels of support for the Town of Pelham's draft vision for their climate adaptation plan ($n=35$).

| | Number of responses | % |
|-------------------------------|---------------------|---------|
| Strongly disapprove | 1 | 2.86 % |
| Disapprove | 3 | 8.57 % |
| Neither support or disapprove | 5 | 14.29 % |
| Support | 15 | 42.86 % |
| Strongly Support | 11 | 31.43 % |

Some of the comments provided include:

- *No more houses and definitely do not tamper with forested areas*
- *The wording “will embrace opportunities that position the Town to grow revenue by promoting cultural assets” is quite objective to whomever is reading it – where does growing revenue for the Town fit in with protecting the environment and reducing climate change? This could loosely be interpreted by decision makers and may lean towards growing revenue over protecting the environment*
- *We should be protecting our environmental assets. Period. Not just embracing opportunities to grow revenue??*
- *This should refer to protect of grey and green infrastructure and protection of the residents and the natural systems. Grow revenue???*
- *Would like enhancement of environmental assets*

Draft Goals

This section outlines the results from the survey for the draft goals for the climate adaptation plan. Stakeholders were asked to rank their level of support for the draft goals and provide qualitative feedback. Their responses are found in this section.

In the draft, there were 9 goals presented to the community for their feedback. The goals are outlined below:

Goal 1: Create and support innovative solutions that help minimize health and safety risks to outdoor workers and community members.

Goal 2: Educate and create community awareness of changing climate conditions and environmental assets with Town staff and the community.

Goal 3: Ensure the Town has a universal response to and recovery from extreme weather events and emergencies.

Goal 4: Increase adaptive capacity in the design, construction, and maintenance of built, natural, and human systems within our municipality.

Goal 5: Cultivate resiliency within the Town’s urban and rural forests and natural landscapes.

Goal 6: Reduce risks relative to heavy rainfall and flooding events.

Goal 7: Diminishing disruption to Town services.

Goal 8: Minimize risks to Town-owned buildings and properties.

Goal 9: Incorporate climate change adaptation into the Town’s policies, plans, procedures, day-to-day operations, and services.

The response rate for each of the goals is summarized in the matrix below:

| Goal | No. of votes | Support (%) | Neither support or disapprove (%) | Disapproval (%) |
|--------|--------------|-------------|-----------------------------------|-----------------|
| Goal 1 | 31 | 90.32 | 6.45 | 3.23 |
| Goal 2 | 31 | 87.1 | 12.90 | 0 |
| Goal 3 | 31 | 93.54 | 6.45 | 0 |
| Goal 4 | 31 | 80.65 | 19.35 | 0 |
| Goal 5 | 31 | 87.1 | 12.90 | 0 |
| Goal 6 | 31 | 96.77 | 3.23 | 0 |
| Goal 7 | 33 | 90.33 | 9.68 | 0 |
| Goal 8 | 31 | 93.55 | 6.45 | 0 |
| Goal 9 | 31 | 90.33 | 9.68 | 0 |

Some of the final feedback and concerns received are highlighted in the following comments:

- *I find the objectives and goals to be overly simplistic. The focus of revenue generation is misguided. None of the goals provides an opportunity for revenue. Addressing climate change is a costly venture and a truthful statement addressing that reality would be fitting.*
- *This is so important STOP THE BUILDING for the sake of tax revenue*
- *Environmental protection needs to be at the forefront of any plans- this might mean at the financial risk to the Town- we need to protect the environment at any cost at this point, and it would be nice to see the Town of Pelham leading this initiative to ensure that environmental protection is above financial, political and personal agendas.*
- *I have not seen any of this circulate previously, if it was made available then perhaps distribution methods should be revisited.*
- *Excellent goals and vision*
- *I 100 % support this initiative and hopefully it will come into reality without creating a lot of red tape through the approval process. This cannot cost money, but delay moving forward.*

Overall, Vision received positive feedback and some of the concerns about 'growing revenue' were addressed. For the goals, synergies within the goals were further identified and based on the feedback received, the plan settled for 8 most suitable goals that reflect Town's most urgent and focussed priorities to make Pelham more resilient to the changing climate.

Appendix F – Implementation Schedule

| Options | Description/Scope | Lead Department(s) | Relevant Department(s) | Implementation Term | Resource Requirement |
|--|--|--|--|---------------------|-------------------------------------|
| <p>1.1 Create an extreme weather policy to minimize risks to vulnerable populations during extreme events including heavy rainfall, extreme heat, and extreme cold</p> | <p>Vulnerable populations (i.e. seniors, children (<5yrs), or individuals with pre-existing health conditions) are prone to extreme distress in conditions of extreme weather events (thunder, hail, storms, heavy rainfall, heatwaves, and cold stress). These events may cause distresses such as (but not limited to) heatstroke, renal/cardiovascular/skin issues, mental health, etc. and place excessive demands on caretakers and health care facilities. The policy may cover the following grounds:</p> <ul style="list-style-type: none"> • Collection of baseline information on the leverage points for intervention for the benefits of vulnerable populations • Create support systems for an immediate effect (e.g. buddy systems, dedicated emergency helplines etc.) during and after an emergency event • Create protocols to deal with extreme scenarios such as power outages etc. (e.g. arrange transport to designated refuge buildings) • Train caretakers and staff to deliver targeted response to the needs of vulnerable population during emergency events | <ul style="list-style-type: none"> • Fire & By-Law Services • Recreation, Culture & Wellness | <ul style="list-style-type: none"> • Administration Services • Communications and Public Relations | <p>Medium-term</p> | <p>Staff: Medium Budget: \$</p> |

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| <p>1.2 Develop a communication strategy to inform the Town residents and staff on road conditions during extreme weather events</p> | <p>Extreme weather events (hail, storms, winds), heavy rainfall, freezing rain and extreme temperatures can affect the conditions of the roads and therefore cause distress to the residents and staff working outdoors. Effective and repetitive communication is like to mitigate any negative impacts of road damages. Communication could likely involve:</p> <ul style="list-style-type: none"> • Road closures due to damage caused by extreme events • Road repair work after the damage caused by an extreme event • Quick and effective mode of communication (e.g. social media, opt-in text/call system as pointed in 3.3) | <ul style="list-style-type: none"> • Public Works - Roads | <ul style="list-style-type: none"> • Communications and Public Relations | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>1.3 Foster emergency preparedness among Town's staff and community members (e.g. mainstream the 72-hour emergency preparedness guide)</p> | <p>Fostering responsibility among the residents and proper training to the staff can help in fostering emergency preparedness. Community outreach activities centred around emergency event response can help in ensuring collective responsibility during and after emergency events. This could involve multiple levels:</p> <ul style="list-style-type: none"> • Communication on the importance of emergency preparedness to staff and community members can help in increasing effective response • Workshops/events among the residents can bring awareness both about climate change and its impacts along-term with the effective response to such events at the household and neighbourhood scale (e.g. actions to implement 72-hour emergency preparedness guide) • Train the staff to relay knowledge and skills to the residents through the above-mentioned workshops | <ul style="list-style-type: none"> • Fire & By-Law Services • Recreation, Culture & Wellness | <ul style="list-style-type: none"> • Communications and Public Relations • Administration Services | <p>Short-term</p> | <p>Staff: Low Budget: \$\$</p> |

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| <p>1.4 Design educational and training content to support community members and outdoor staff during extreme weather events</p> | <p>The creation of Short-term yet effective educational content that can deliver messages of safety and response during and after an extreme event can resonate with staff and residents alike and can help in supporting the Pelham community</p> <ul style="list-style-type: none"> • Short-term training videos and printed guides • Use of social media to spread awareness among the community | <ul style="list-style-type: none"> • Fire & By-Law Services • Communications and Public Relations | <ul style="list-style-type: none"> • Recreation, Culture & Wellness • Administration Services | <p>Medium-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>1.5 Increase relief measures for extreme events of heatwaves through providing indoor activities for community members (e.g. pool facilities, cooling centres, recreational facilities)</p> | <p>The increase in temperature leads to an increased requirement of indoor services for the community members. The interventions could include:</p> <ul style="list-style-type: none"> • Increase in indoor recreational facilities • Designating cooling centres to provide heat relief • Increased access to indoor pool facilities • Partner with schools/NGOs interested in providing heat relief support to the Town | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | <ul style="list-style-type: none"> • Public Works - General • Corporate Services | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>1.6 Increase operating hours of current facilities available to the residents during extreme heat and extreme cold</p> | <p>Town buildings can serve as an excellent refuge from extreme heat and cold events. It can also provide refuge in case of power outages during extreme events due to the availability of backup power. An increase in operating hours of these facilities can provide relief to community members to tackle extreme heat and cold waves.</p> | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | <ul style="list-style-type: none"> • Community, Planning & Development • Corporate Services | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |

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| <p>1.7 Review (and revise if necessary) the Town's Winter Operations Plan to accommodate the effects of climate change</p> | <p>Freezing rain and extremely cold temperatures may affect the Town's Winter Control Operations. Considering climate change impacts while planning Town's winter operations can provide effective pre-emptive and responsive services to manage the impact of sudden and harsh winter conditions. This could include:</p> <ul style="list-style-type: none">• Integrating climate change projections• Assessing staff requirements and training• Vulnerable area assessments and preparation of a response• Reviewing the use of Salts on the roads as it impacts the safety of both human and natural systems | <ul style="list-style-type: none">• Public Works - Roads | <ul style="list-style-type: none">• Public Works - General | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
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| <p>2.1 Review current communication relative to climate change and extreme weather events and incorporate new strategies to benefit the Town's emergency response communication</p> | <p>Prior communication and awareness of climate change impacts play an important role in ensuring effective delivery of emergency response during and after the emergency event. The following two levels can be explored:</p> <ul style="list-style-type: none"> • Considering an interdepartmental study to understand the services that are most impacted by the changing climate can help in formulating a uniform response to climate change at the community scale. The Climate change Adaptation Plan is a head start. However, to promote widespread adoption of climate change impacts and its solutions in the strategy of the Town, each department at their micro-level can contribute to areas that can most benefit from such interventions • From a different lens of residents and community members, the communication delivered by the Town on climate change and its impacts plays an important role in legitimizing the adoption of best practices that ensure safety and preparation as well as mitigation of severe impacts of climate change. Reviewing current communication on climate change can provide an insight into areas of improvement for communication | <ul style="list-style-type: none"> • Fire & By-Law Services | <ul style="list-style-type: none"> • Administration Services • Communications and Public Relations | <p>Medium-term</p> | <p>Staff: Low Budget: \$</p> |
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| <p>2.2 Develop educational initiatives that raise awareness on climate change for Pelham residents, businesses, and Town staff, and integrate these initiatives into existing programs, activities, and communications (where possible)</p> | <p>Education of climate change, vulnerability, risks and exposure can impact the way Pelham responds to the impacts of climate change. Designing and delivering educational campaigns and initiatives promote climate literacy among the population and capitalizes on the potential of each household in adapting to and mitigating climate change impacts. They could be further explored through:</p> <ul style="list-style-type: none"> • Creating interactive content on climate change • Delivering educational workshops on climate change to various groups (residents, businesses, Town staff) | <ul style="list-style-type: none"> • Administration Services • Recreation, Culture & Wellness | <ul style="list-style-type: none"> • Communications and Public Relations | <p>Medium-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>2.3 Enlist the help of community groups and young students in spreading climate literacy through educational campaigns at schools and in the local community</p> | <p>Students and community groups already engaged in spreading climate change awareness can get more exposure through the Town's platform. Partnering with schools and these groups can enhance their visibility through:</p> <ul style="list-style-type: none"> • Town can provide resources (e.g. venues/social media space/funds) to community groups required to mainstream their campaigns • At schools, Town can partner with administration/teachers to engage the students via organizing competitions/prizes/poster competitions/workshops focussed on climate change | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | <ul style="list-style-type: none"> • Administration Services | <p>Short-term</p> | <p>Staff: Low Budget: \$\$</p> |

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| <p>2.4 Create resources for the community to underscore the importance of Low Impact Development, green roofs, creating green spaces (trees and shrubs) and maintaining natural heritage in adapting to climate change impacts</p> | <p>Green infrastructure is an extremely valuable resource in adapting to climate change. These solutions are often flexible in terms of cost, availability, and usage. The Town can invest in creating resources to spread the awareness of such interventions and other green technologies that may provide social, environmental, and economic benefits. It also promotes support for the Town's projects that involve green infrastructure interventions from the public. The typical green infrastructure includes:</p> <ul style="list-style-type: none"> • Urban forests • Low Impact Development (LID) • Urban Agriculture • Green Spaces (Parks/Open Spaces) • Green Roofs | <ul style="list-style-type: none"> • Public Works - Engineering • Corporate Services | | Short-term | Staff: Low Budget: \$ |
| <p>2.5 Foster partnerships with like-minded local organizations to spread awareness on climate change and its impacts to promote adoption of climate change adaptation strategies</p> | <p>Support from like-minded organizations can benefit Town's strategy to spread awareness on climate change impacts. This could involve:</p> <ul style="list-style-type: none"> • Support from universities and schools can positively impact the spread of messaging around climate change. Niagara Adapts is one of the ways through which the Town has received support for Climate Change Adaptation Planning. • Similarly, engaging local organizations and Niagara-based groups can help in building awareness for climate change and its impacts in Niagara Region • Importantly, Town can integrate the voices and stories of Indigenous Communities in understanding the role of nature and its integral impact on our lives | <ul style="list-style-type: none"> • All Departments | | Short-term | Staff: Low Budget: \$ |

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| <p>3.1 Create and implement robust training strategies for Town staff to deliver an efficient and quick response to extreme weather events</p> | <p>Understanding climate change impacts and accordingly responding to these impacts can help in the delivery of quick and efficient responses. It may include:</p> <ul style="list-style-type: none"> • Gather data (e.g. through Corporate Climate Change Plan) to assess more vulnerable areas that might require more intervention during and after emergency events • Integrate data-based responses into current training guides and training delivery • Add more sections and drills to accommodate for targeted emergency responses (e.g. vulnerable populations as mentioned in 1.1) | <ul style="list-style-type: none"> • Fire & By-Law Services | <ul style="list-style-type: none"> • Administration Services | <p>Medium-term</p> | <p>Staff: Medium Budget: \$</p> |
| <p>3.2 Prepare for the spike in demand for emergency services during extreme weather events including heavy rainfall, extreme heat, and extreme cold events</p> | <p>Frequent extreme events can generate more demand for emergency services. Coupled with damage to infrastructure (such as roads, culverts, sidewalks etc.), it might prove challenging to deliver emergency services to the residents in need. To address such challenges, the Town may explore:</p> <ul style="list-style-type: none"> • Securing back-up funds to support the demand • Staff on standby to attend to increased demand • Inventory the equipment (e.g. PPE etc.) to understand the purchasing and maintenance requirement | <ul style="list-style-type: none"> • Fire & By-Law Services | <ul style="list-style-type: none"> • Public Works - General | <p>Medium-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>3.3 Design an opt-in communication (email, text) alert system to provide extreme weather and climate change updates to the Town residents</p> | <p>An emergency alert system can be effective in keeping the residents and the staff up to date on weather events and emergency responses. Developing such a system will complement the emergency response efforts.</p> | <ul style="list-style-type: none"> • IT Support • Fire & By-Law Services | | <p>Short-term</p> | <p>Staff: Medium Budget: \$\$</p> |

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| <p>3.4 Integrate climate change projections, impacts and actions into emergency response planning and existing training guides</p> | <p>Including climate change impacts and adaptation options in training guides and emergency response planning can standardize the response to these events. The following points can be explored to achieve maximum benefits:</p> <ul style="list-style-type: none"> • Support inter-departmental coordination to increase the uniformity of the response (related to 2.1) • The Corporate Climate Change Adaptation Plan can provide a baseline document to understand climate change projections that can be subsequently incorporated into other guides • The Human Resource Department can ensure uniform implementation of climate change considerations in existing policies and any new policies in the future | <ul style="list-style-type: none"> • All Departments | | <p>Long-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>4.1 Assess the condition of the Town's stormwater management infrastructure and explore opportunities for upgrading or reinstalling infrastructure</p> | <p>High functioning stormwater management infrastructure is crucial in preventing the increased risk of floods, stream erosion and maintaining water quality. An investigation into the Town's current infrastructure can help in understanding areas of improvement. The following steps could be initiated:</p> <ul style="list-style-type: none"> • Assess stormwater infrastructure for its functionality • Explore opportunities for the upgrading or reinstalling infrastructure while incorporating stormwater management adaptation options • Stormwater infrastructure design can be updated based on recent policy suggestions in Ontario • Focus on securing funding for the undertaking the project | <ul style="list-style-type: none"> • Public Works - Engineering • Community, Planning & Development | | <p>Long-term</p> | <p>Staff: Medium Budget: \$\$\$</p> |

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| <p>4.2 Incorporate drought-tolerant landscaping design on Town properties</p> | <p>In the city of Toronto, native plant species and drought-tolerant plants are used for landscaping purposes. Such plants reduce the demand for water consumption during summer months, require lower maintenance and promote ecological diversity. Opportunities for implementing such strategies will prove beneficial. It could include:</p> <ul style="list-style-type: none"> • Spreading awareness in the community on drought-tolerant plant species and their benefits • Purposeful selection of native/drought-tolerant species for landscaping purposes by the Town | <ul style="list-style-type: none"> • Public Works - Engineering • Community, Planning & Development | | <p>Medium-term</p> | <p>Staff: Low Budget: \$\$</p> |
| <p>4.3 Investigate the use of reflective surfaces, cool paving, green facades, and green roofs to minimize the effects of heat on built infrastructure</p> | <p>Use of reflective surfaces, cool paving and 'greening' are some of the ways to prevent overheating of the buildings during high-temperature months. The use of green roofs helps in decreasing energy consumption all year round. Green roofs are especially useful in mitigating the urban heat effect, lowering air temperatures, and storing rainwater. This may include:</p> <ul style="list-style-type: none"> • Conducting a research-based study on the benefits of built infrastructure • Explore opportunities and challenges for the adoption of these pathways | <ul style="list-style-type: none"> • Public Works - Engineering • Community, Planning & Development | <ul style="list-style-type: none"> • Corporate Services | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |

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| <p>4.4 Update the Engineering Design Guide to incorporate projections, impacts and risks of climate change and relevant adaptation strategies</p> | <p>Integrating climate change projections, impacts and suggested adaptation solutions in the Engineering Design Guide is essential in ensuring the uptake and widespread implementation of adaptation options. It is an important first step in knowledge mobilization. The idea is to translate the adaptation options and the underlying scientific information into actionable items that could be adopted by a wide range of stakeholders involved in designing and maintaining the municipal infrastructure.</p> | <ul style="list-style-type: none"> • Public Works - Engineering | | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>4.5 Integrate climate change considerations in Capital Asset Management Policy and the development of Capital Asset Management Plan</p> | <p>Climate Change impacts are associated with infrastructure design and maintenance and therefore impact sustainable service delivery which is closely associated with asset management. Having these projections and impacts integrated into asset management planning can increase the ability to manage asset failure or reduced asset life, reduced services provided by current assets as well and increase the cost of delivering these services. It also provides an opportunity to impact climate change mitigation decisions like the reduction of greenhouse gases. The stages of integration could include:</p> <ul style="list-style-type: none"> • Taking an inventory i.e. assessment of infrastructure and associated service delivery • Taking stock of local climate change projections • Assessing the vulnerability of assets to climate change • Integrating climate change adaptation and mitigation in financial planning • Implement and monitor the updated asset management practices | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | | <p>Short-term</p> | <p>Staff: Medium Budget: \$\$</p> |

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| <p>4.6 Explore opportunities to integrate Low Impact Development and green technologies in the Town's approach to designing, construction, and maintenance of infrastructure</p> | <p>Low Impact Development and other green technologies have several advantages in adapting to climate change. These solutions provide multiple societal, economic, and environmental benefits. There are multiple examples of green technologies (mentioned in 2.4). Creating such opportunities is essential in moving towards the adoption of these practices. Moreover, another area of improvement is securing funding and policy support for integrating such practices in infrastructure design.</p> | <ul style="list-style-type: none"> • Public Works - Engineering | | <p>Short-term</p> | <p>Staff: Medium Budget: \$\$\$</p> |
| <p>4.7 Support the updates to by-laws, zoning regulations, and building codes to accommodate climate change adaptation options</p> | <p>Climate Change Adaptation Options in some cases will require supporting the updates to by-laws, zoning regulations and upgrading building codes. This is crucial to ensure fast uptake of these options.</p> | <ul style="list-style-type: none"> • Public Works - Engineering • Fire & By-Law Services | <ul style="list-style-type: none"> • Community, Planning & Development | <p>Long-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>4.8 Legitimize the use of green infrastructure by incorporating the same in Capital Asset Management Plan and training the staff on the utility and benefits of green infrastructure</p> | <p>Green infrastructure can be supported by integrating the same in Capital Asset Management Plan. Understanding green infrastructure and ecosystem services and their relationship to asset management planning will provide much-needed clarity on the subject. This would need inventorying and valuing municipal green infrastructure and understanding asset classification schemes. Training the staff on green infrastructure can impact the uptake and understanding of such approaches in climate change adaptation management. Conducting a cost-benefit analysis of green infrastructure can help in making better investment decisions.</p> | <ul style="list-style-type: none"> • Community, Planning & Development • Corporate Services | <ul style="list-style-type: none"> • Public Works - Engineering | <p>Medium-term</p> | <p>Staff: Medium Budget: \$\$\$</p> |

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| <p>5.1 Map Town's tree cover to understand the spread of existing tree canopy and develop strategies for expanding the municipal tree canopy target</p> | <p>Public trees i.e. in parks and streets as well as municipally managed forest areas can be extremely helpful in mitigating and adapting to climate change. In addition to providing relief from the urban heat island effect and absorption of greenhouse gases, these plantations can help in the absorption of urban stormwater and reduce flooding. It is important to look for opportunities for expansion of tree cover which benefits multiple adaptation strategies and to avoid maladaptation. In effect, mapping the current areas with tree cover and spaces that could be used as future plantation sites can provide baseline information. It could also be useful to have a percentage target to meet the expectations at the end of a certain set time for forest policy.</p> | <ul style="list-style-type: none"> • Public Works - Engineering • Corporate Services | | <p>Medium-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>5.2 Create a combined Forest Strategy and an Emergency Response Strategy to address the impacts of climate change on tree canopy cover and respond to such impacts (e.g. attack of invasive species like Gypsy Moth)</p> | <p>To sustainably manage the forests as well as supporting the emergency response to events such as fires and invasive species manifestation, a comprehensive forest management plan which could include both Forest Strategy and Forest Emergency Response Strategy can be very useful. Climate Change affects the health of forests in various ways especially milder winter temperatures that affect invasive species infestations. A Plan of Action to prevent damage and to prepare for further impacts of higher temperatures on urban and rural forests can be highly beneficial in adapting to these changes.</p> | <ul style="list-style-type: none"> • Public Works - Engineering • Fire & By-Law Services | <ul style="list-style-type: none"> • Corporate Services | <p>Medium-term</p> | <p>Staff: Low Budget: \$</p> |

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| 5.3 Conduct analysis for areas under heat stress and use the information to assign new tree plantation sites | Using technology to assess areas under higher heat stress can impact decision making for assigning tree plantation sites. This is crucial in adapting to the urban heat island effect. It can also affect the planning of community events based on information gathered on areas under high heat stress as well as influencing policy decisions. | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering • Public Works - Parks/Beautification | | Short-term | Staff: Low Budget: \$ |
| 5.4 Support partnerships with local/national organizations to enhance preservation, protection and restoration of tree canopy cover and biodiversity | Community partnerships can aid the efforts being undertaken by the municipality to protect the tree canopy. Organizations working at the grassroots level can be supported in various ways by the municipalities, one of them being recognizing their efforts in supporting Pelham urban and rural forests. The resources and expertise available at the organizations (e.g. NPCA) can be of immense benefit to the municipality in achieving the adaptation goals. | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | Medium-term | Staff: Low Budget: \$ |
| 5.5 Focus on Town's green infrastructure of parks and open spaces, green spaces, urban forests, natural heritage areas to explore opportunities to expand the use of similar nature-based solutions to adapt to climate change impacts (e.g. heat stress) | Emphasizing green infrastructure as a part of the Town's management of green spaces, parks, urban forests can foster the uptake of these nature-based solutions in managing rural and urban forests. | <ul style="list-style-type: none"> • Public Works - Parks/Beautification • Community, Planning & Development | <ul style="list-style-type: none"> • Public Works - Engineering | Short-term | Staff: Low Budget: \$\$ |

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| <p>6.1 Collect baseline information on areas prone to flooding and implement floodproofing measures proactively depending on feasibility and requirement</p> | <p>Flooding is a major problem in Niagara Region. As the temperature changes, heavy precipitation dominates weather patterns. As a result, floods are becoming more common and interfering with population safety and infrastructure management. Mapping areas prone to flooding will provide ample opportunity to foster flood preparedness (i.e. ensuring transparent communication to the community, reduce vulnerability by provisions such as sandbags etc.) among the departments at the Town. It requires cooperation from all levels of operation to take stock of their responsibility in proactively managing the flood. Flood preparedness training and planning can prove beneficial in cultivating awareness among the Town staff.</p> | <ul style="list-style-type: none"> • Public Works - Engineering • Public Works - Parks/Beautification | <ul style="list-style-type: none"> • Community, Planning & Development • Fire & By-Law Services | <p>Short-term</p> | <p>Staff: Medium Budget: \$</p> |
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| <p>6.2 Promote the use of green infrastructure tailored to minimize the effects of flooding</p> | <p>Green infrastructure is an opportunity that provides a different, nature-based set of solutions for the municipality to adapt to flood events caused by climate change. These include:</p> <ul style="list-style-type: none"> • Downspout Disconnection • Rainwater Harvesting • Rain Gardens • Bioswales • Permeable Pavements • Green Roofs <p>One specific example is stormwater ponds (traditional stormwater management systems, also classified in gray infrastructure as they can be built for stormwater management) which are beneficial as they not only absorb the runoff rain and snowmelt water and therefore reduce flooding, they also control erosion by checking the amount of water that flows into creeks. However, they require maintenance and supervision from the municipality</p> | <ul style="list-style-type: none"> • Community, Planning & Development • Public Works - Engineering | | Short-term | Staff: Medium Budget: \$\$ |
| <p>6.3 Build on existing strategies to educate the residents on flood preparedness and develop emergency flood relief measures to be deployed in case of extreme flooding</p> | <p>As much as the Town can play an important role in preparing and increasing staff's awareness of flooding events, the community also plays a significant role. There are existing strategies that help the residents to foster flood preparedness. Building on such strategies can aid in the adoption of flood preparedness measures and increased awareness among the residents.</p> | <ul style="list-style-type: none"> • Fire & By-Law Services • Administrative Services | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | Short-term | Staff: Medium Budget: \$\$ |

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| <p>6.4 Re-investigate the feasibility of Town's Sanitary Sewer Backflow Prevention Incentive Program</p> | <p>Conducting a feasibility study of the Town's Sanitary Sewer Backflow Prevention Incentive Program can help in making informed decisions on the program's feasibility, utility, and implementation. The Town has gone through the program cycle. However, it will be useful to understand the outcomes of the program and finding avenues for tangential programs or simply repeating the program to account for the gaps associated with accomplishing the targets.</p> | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>6.5 Conduct a feasibility study of a downspout and sump pump disconnection program</p> | <p>Downspout and sump pump disconnection is a part of green infrastructure to manage stormwater runoff. Even though the Town encourages downspout and sump pump disconnections, evaluating the scope of running a program could prove quite beneficial. During a flooding event, diverting the runoff water to the property instead of sewers can help in the elimination of sewer overloads. Also, it can reduce pollution of local water bodies and reduce the risk of basement flooding. Accounting for these benefits, a disconnection program would be a solid approach to minimizing sewer overflows and basement flooding.</p> | <ul style="list-style-type: none"> • Public Works - Engineering | <ul style="list-style-type: none"> • Corporate Services | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>6.6 Include stormwater mitigation and adaptation strategies in the Engineering Design Guide to support flood management interventions</p> | <p>Flood management includes various green and gray infrastructure strategies that can be taken into consideration while designing, constructing, and maintaining municipal infrastructure. This practice could be useful in increasing the uptake of solutions, building on existing solutions in the Design Guide and therefore to be better prepared to manage floods.</p> | <ul style="list-style-type: none"> • Public Works - Engineering | | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |

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| 6.7 Assess, implement and revise (if needed) floodproofing mechanisms employed at Town-owned buildings | Floodproofing measures for Town-owned buildings can be beneficial in protecting them from the damage caused by floods. Assessing the existing measures and implementing new measures can save cost incurred later for repair and maintenance. | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | | Short-term | Staff: Low Budget: \$\$ |
| 7.1 Develop a plan (e.g. COVID-19 Recovery framework) and train the staff to ensure Town's services are sustainably supported | Planning for recovery from extreme weather events, heavy rainfall and winter precipitation can help in adapting to the negative impacts of these events. A recovery module can help in adhering to best practices for handling extreme events during and after the event. Climate change can manifest slowly in some cases such as invasive species and agricultural changes, therefore having a plan that addresses recovery from slow and fast-paced events can be beneficial for the Town and the residents. The training can ensure that the staff is on the same page to deliver seamless services. | <ul style="list-style-type: none"> • All Departments | | Medium-term | Staff: Medium Budget: \$ |
| 7.2 Provide training to entire staff on climate change and climate change adaptation | Integrating climate change risks, projections, impacts and adaptation solutions in the management of the Town's policies can help, but educating the staff on the basics of climate change and adaptation can increase their understanding of the science and impacts of the changing climate. | <ul style="list-style-type: none"> • Public Works - Engineering | <ul style="list-style-type: none"> • Administration Services | Medium-term | Staff: Medium Budget: \$ |

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| <p>7.3 Invest in new power support systems (e.g. generator for MCC) for Town's built infrastructure to support seamless services during extreme events</p> | <p>Power back-up systems are crucial in providing seamless service during extreme events. These building can be used as supporting centres for vulnerable populations and/or emergency operations in cases of blackouts due to extreme weather events.</p> | <ul style="list-style-type: none"> • Corporate Services | | <p>Short-term</p> | <p>Staff: Low Budget: \$\$\$</p> |
| <p>7.4 Prepare to accommodate an increase in public service requests for the maintenance of infrastructure after extreme weather events, floods, heat stress, and cold stress</p> | <p>Public service requests for repair and maintenance of infrastructure can increase in the aftermath of extreme events. Accommodating such requests can be overwhelming and cost inducing for the Town staff. However, preparing in advance can mitigate some of the pressures of such requests. It could include:</p> <ul style="list-style-type: none"> • Preparing for increased staff requirements • Securing extra budget for accommodating the costs incurred | <ul style="list-style-type: none"> • Public Works - Engineering | <ul style="list-style-type: none"> • Public Works - General | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |
| <p>8.1 Declare a climate emergency</p> | <p>Declaring a climate emergency can benefit the Town's stance and action strategy on climate change as follows:</p> <ul style="list-style-type: none"> • Fosters mobilizing funds, technical resources and grants from organizations • Promotes both climate change mitigation and adaptation options • Supports green jobs, green infrastructure, better environmental practices and community support to increase resilience to climate change | <ul style="list-style-type: none"> • All Departments | | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |

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| <p>8.2 Develop and implement a Green Procurement Policy that would establish guidelines for all Township employees to ensure staff are purchasing products that minimize consumption of energy and water and are more environmentally appropriate</p> | <p>Increasing environmental sustainability consideration in the procurement of goods and services presents a significant window of opportunity to adapt to changing climate and reduce the Town's environmental footprint. The Town is utilizing goods and services at a significant scale, and therefore holds the power to foster environmental stewardship by developing and enforcing a green procurement policy that includes the following facets:</p> <ul style="list-style-type: none"> • Consider environmental processes in the procurement cycle while maintaining value for money • Support local/national goods that are promoting environmentally sound practices • Understanding the lifecycle of goods and services provided from manufacturing to acquiring to disposal • Training staff and administration to move towards making such choices • Cost-benefit analysis of goods and services currently used vs. switching to environmentally preferable goods and services | <ul style="list-style-type: none"> • Corporate Services | <ul style="list-style-type: none"> • Public Works - Engineering | <p>Medium-term</p> | <p>Staff: Medium Budget: \$</p> |
| <p>8.3 Develop and implement a corporate policy on Climate Change Adaptation</p> | <p>The ongoing implementation of the Corporate Climate change Adaptation Plan provides a head start and a window of opportunity to cement the Town's role in climate change mitigation and adaptation. It is an essential step in ensuring that the Town and its residents are supported through and protected from the impacts of climate change. Continued implementation of the Climate Change Adaptation Plan is essential to make Pelham climate resilient.</p> | <ul style="list-style-type: none"> • Public Works - Engineering | | <p>Short-term</p> | <p>Staff: Low Budget: \$</p> |

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| <p>8.4 Continue to monitor climate change projections annually and collect data from other sources that can aid in the implementation of climate change adaptation solutions (e.g. GIS, citizen scientists)</p> | <p>Data play a major role in defining and delivering the response to climate change. With the latest information on climate change, the Town can ensure that the subsequent responses are efficient and tailored to the needs of the area, extreme event or age group. Therefore, collaborating with other departments to obtain data that can aid in the implementation of climate change adaptation solutions can prove to be highly beneficial. In terms of monitoring and evaluation, engaged citizen scientists in outdoor settings (e.g. forests and/or biodiversity) can help in providing data that can also be beneficial to the ongoing monitoring of the implementation of adaptation options. Certain websites such as NPCA GIS Open Data Portal can provide data required for the adaptation planning process.</p> | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | <p>Medium-term</p> | <p>Staff: Low Budget: \$\$</p> |
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| <p>8.5 Incorporate climate change projections and adaptation options in the Town's policies and practices to standardize response on addressing climate change impacts (i.e. Strategic Plan, Official Plan, Community Improvement Plan, Communications Plan, Cultural Master Plan, Engineering Design Guide, Human Resource Policy, Winter Operations Plan etc.)</p> | <p>The aim of incorporating climate change considerations into the Town's response is directly correlated with integrating information in all of the Town's policies and creating new policies that promote environmental stewardship. As daunting as it seems, the implementation of the above-mentioned adaptation options can provide a starting point to achieve such a goal. It also calls for interdepartmental cooperation to ensure a cohesive response to climate change rather than a fragmented departmental level response. The department level response is great but to achieve a standardized response on Town's behalf, the ability to integrate climate change in all policies and plans is essential and depends on cooperation and consistency of action.</p> | <ul style="list-style-type: none"> • Administration Services | <ul style="list-style-type: none"> • All Departments | <p>Long-term</p> | <p>Staff: Low Budget: \$\$</p> |
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Table 10: Implementation Schedule

Appendix G – M&E Plan

| Options | Indicator(s) | Lead Department(s) | Duration | Resource Requirement |
|---|---|---|------------|----------------------------|
| 1.1 Create an extreme weather policy to minimize risks to vulnerable populations during extreme events including heavy rainfall, extreme heat, and extreme cold | 1.1.1 Progress on extreme weather policy 1.1.2 Number of data points/baseline information collected | <ul style="list-style-type: none"> • Fire & By-Law Services • Recreation, Culture & Wellness | Short-Term | Staff: Low Budget: \$ |
| 1.2 Develop a communication strategy to inform the Town residents and staff on road conditions during extreme weather events | 1.2.1 Progress on communication strategy 1.2.2 Number of times communication alerts issued to inform the residents | <ul style="list-style-type: none"> • Public Works - Roads | Short-term | Staff: Low Budget: \$ |
| 1.3 Foster emergency preparedness among Town's staff and community members (e.g. mainstream the 72-hour emergency preparedness guide) | 1.3.1 Number of workshops conducted for the staff and residents 1.3.2 Number of communication strategies carried out 1.3.3 Number of areas that showed successful flood preparation and management | <ul style="list-style-type: none"> • Fire & By-Law Services • Recreation, Culture & Wellness | Short-term | Staff: Low Budget: \$\$ |
| 1.4 Design educational and training content to support community members and outdoor staff during extreme weather events | 1.4.1 Number of social media posts published to raise awareness on best practices 1.4.2 Number of printed material and videos generated | <ul style="list-style-type: none"> • Fire & By-Law Services • Communications and Public Relations | Short-Term | Staff: Low Budget: \$ |
| 1.5 Increase relief measures for extreme events of heatwaves through providing indoor activities for community members (e.g. pool facilities, cooling centres, recreational facilities) | 1.5.1 Number of cooling centres and recreational facilities designated 1.5.2 Number of partnerships forged to provide heat relief programs 1.5.3 Percentage increase in the use of heat relief programs | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | Short-term | Staff: Low Budget: \$ |
| 1.6 Increase operating hours of current facilities available to the residents during extreme heat and extreme cold | 1.6.1 Changes in operating hours of Town facilities 1.6.2 Percentage increase in the use of facilities outside business hours during extreme heat and cold | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | Short-term | Staff: Low Budget: \$ |
| 1.7 Review (and revise if necessary) the Town's Winter Operations Plan to accommodate the effects of climate change | 1.7.1 Progress on Winter Operation Plans review in the context of climate change projections 1.7.2 Number of updates in the plan | <ul style="list-style-type: none"> • Public Works - Roads | Short-term | Staff: Low Budget: \$ |

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| 2.1 Review current communication relative to climate change and extreme weather events and incorporate new strategies to benefit the Town's emergency response communication | 2.1.1 Study on intra- and inter-departmental responsibility of climate change communication completed 2.1.2 Number of updates generated for climate change communication response | <ul style="list-style-type: none"> • Fire & By-Law Services | Medium-term | Staff: Medium Budget: \$\$ |
| 2.2 Develop educational initiatives that raise awareness on climate change for Pelham residents, businesses, and Town staff, and integrate these initiatives into existing programs, activities, and communications (where possible) | 2.2.1 Number of workshops/initiatives designed 2.2.2 Number of workshops/initiatives executed | <ul style="list-style-type: none"> • Administration Services • Recreation, Culture & Wellness | Medium-term | Staff: Low Budget: \$ |
| 2.3 Enlist the help of community groups and young students in spreading climate literacy through educational campaigns at schools and in the local community | 2.3.2 Number of partnerships/campaigns supported 2.3.2 Number of schools engaged in raising climate change awareness | <ul style="list-style-type: none"> • Recreation, Culture & Wellness | Short-term | Staff: Low Budget: \$\$ |
| 2.4 Create resources for the community to underscore the importance of Low Impact Development, green roofs, creating green spaces (trees and shrubs) and maintaining natural heritage in adapting to climate change impacts | 2.4.1 Number of resources created to understand LID, green technologies, and natural heritage 2.4.2 Number of times resources was shared/downloaded | <ul style="list-style-type: none"> • Public Works - Engineering • Corporate Services | Short-term | Staff: Low Budget: \$ |
| 2.5 Foster partnerships with like-minded local organizations to spread awareness on climate change and its impacts to promote adoption of climate change adaptation strategies | 2.5.1 Number of new partnerships created/old partnerships maintained with educational institutions 2.5.2 Number of Indigenous communities/members involved in climate change planning and execution 2.5.3 Number of local organizations i.e. businesses, NGOs, agriculture-based organizations/farmlands engaged | <ul style="list-style-type: none"> • All Departments | Short-term | Staff: Low Budget: \$ |
| 3.1 Create and implement robust training strategies for Town staff to deliver an efficient and quick response to extreme weather events | 3.1.1 Updates to current guides and training courses completed 3.1.2 Number of trainings conducted based on newly developed guidelines | <ul style="list-style-type: none"> • Fire & By-Law Services | Short-Term | Staff: Low Budget: \$ |
| 3.2 Prepare for the spike in demand for emergency services during extreme weather events including heavy rainfall, extreme heat, and extreme cold events | 3.2.1 Extra budget secured for emergency service response 3.2.1 Extra staff and equipment designated for emergency response | <ul style="list-style-type: none"> • Fire & By-Law Services | Short-Term | Staff: Low Budget: \$ |

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| 3.3 Design an opt-in communication (email, text) alert system to provide extreme weather and climate change updates to the Town residents | 3.3.1 Opt-in alert system developed 3.3.2 Number of alerts issued to Town residents | <ul style="list-style-type: none"> IT Support Fire & By-Law Services | Short-term | Staff: Low Budget: \$ |
| 3.4 Integrate climate change projections, impacts and actions into emergency response planning and existing training guides | 3.4.1 Review of emergency response policies in the context of climate change completed 3.4.2 Number of changes accommodated in planning and execution | <ul style="list-style-type: none"> All Departments Fire & By-Law Services | Medium-term | Staff: Low Budget: \$ |
| 4.1 Assess the condition of the Town's stormwater management infrastructure and explore opportunities for upgrading or reinstalling infrastructure | 4.1.1 Percentage of stormwater infrastructure assessed 4.1.2 Number of upgrades and reinstallations made to the infrastructure | <ul style="list-style-type: none"> Public Works - Engineering Community, Planning & Development | Medium-term | Staff: Medium Budget: \$\$ |
| 4.2 Incorporate drought tolerant landscaping design on Town properties | 4.2.1 Number of drought-tolerant landscaping designs accomplished 4.2.2 Number of educational resources generated on benefits of drought-tolerant landscaping design | <ul style="list-style-type: none"> Public Works - Engineering Community, Planning & Development | Short-Term | Staff: Low Budget: \$ |
| 4.3 Investigate the use of reflective surfaces, cool paving, green facades, and green roofs to minimize the effects of heat on built infrastructure | 4.3.1 Percentage of a cost-benefit analysis for the mentioned tools completed 4.3.2 Number of opportunities and challenges identified for the uptake of these tools | <ul style="list-style-type: none"> Public Works - Engineering Community, Planning & Development | Short-term | Staff: Low Budget: \$ |
| 4.4 Update the Engineering Design Guide to incorporate projections, impacts and risks of climate change and relevant adaptation strategies | 4.4.1 Number of changes made to the Engineering Design Guide 4.4.2 Percentage of the update process completed | <ul style="list-style-type: none"> Public Works - Engineering | Short-term | Staff: Low Budget: \$ |
| 4.5 Integrate climate change considerations in Capital Asset Management Policy and the development of Capital Asset Management Plan | 4.5.1 Number of climate change projections identified to be included in Capital Asset Management Policy 4.5.2 Percent of the integration of climate change projections in Capital Asset Management Policy completed | <ul style="list-style-type: none"> Corporate Services Public Works - Engineering | Short-term | Staff: Medium Budget: \$ |
| 4.6 Explore opportunities to integrate Low Impact Development and green technologies in the Town's approach to designing, construction, and maintenance of infrastructure | 4.6.1 Study of opportunities available for integrating LID and green technologies conducted 4.6.2 Changes made in the policy process and budget allocations to accommodate LID and green technologies 4.6.3 Number of LID and green technology projects adopted and implemented | <ul style="list-style-type: none"> Public Works - Engineering | Short-term | Staff: Medium Budget: \$ |

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| 4.7 Support the updates to by-laws, zoning regulations, and building codes to accommodate climate change adaptation options | 4.7.1 Number of by-laws/regulations/building codes updated to accommodate climate change adaptation options 4.7.2 Number of changes to by-laws/regulations/building codes in progress | <ul style="list-style-type: none"> Public Works - Engineering Fire & By-Law Services | Medium-term | Staff: Medium Budget: \$ |
| 4.8 Legitimize the use of green infrastructure by incorporating the same in Capital Asset Management Plan and training the staff on the utility and benefits of green infrastructure | 4.8.1 Percentage incorporation of green infrastructure in Capital Asset Management Plan completed 4.8.2 Number of staff training workshops conducted | <ul style="list-style-type: none"> Community, Planning & Development Corporate Services | Medium-term | Staff: Medium Budget: \$\$\$ |
| 5.1 Map Town's tree cover to understand the spread of existing tree canopy and develop strategies for expanding the municipal tree canopy target | 5.1.1 Assessment of Town's tree canopy cover completed 5.1.2 Percentage expansion target designated for tree canopy cover | <ul style="list-style-type: none"> Public Works - Engineering Corporate Services | Medium-term | Staff: Low Budget: \$ |
| 5.2 Create a combined Forest Strategy and an Emergency Response Strategy to address the impacts of climate change on tree canopy cover and respond to such impacts (e.g. attack of invasive species like Gypsy Moth) | 5.2.1 Combined Forest Management Plan completed 5.2.2 Percentage reduction in Gypsy Moth infestation | <ul style="list-style-type: none"> Public Works - Engineering Fire & By-Law Services | Short-Term | Staff: Medium Budget: \$\$ |
| 5.3 Conduct analysis for areas under heat stress and use the information to assign new tree plantation sites | 5.3.1 Baseline information collected on areas under heat stress 5.3.2 Number/area of new plantation sites designated | <ul style="list-style-type: none"> Corporate Services Public Works - Engineering Public Works - Parks/Beautification | Short-term | Staff: Medium Budget: \$ |
| 5.4 Support partnerships with local/national organizations to enhance preservation, protection and restoration of tree canopy cover and biodiversity | 5.4.1 Number of new partnerships formed/old partnerships sustained with organizations/individuals 5.4.2 Number of habitat restoration, protection and preservations projects delivered in consultation with the partners | <ul style="list-style-type: none"> Corporate Services Public Works - Engineering | Short-Term | Staff: Medium Budget: \$ |
| 5.5 Focus on Town's green infrastructure of parks and open spaces, green spaces, urban forests, natural heritage areas to explore opportunities to expand the use of similar nature-based solutions to adapt to climate change impacts (e.g. heat stress) | 5.5.1 Number of new green infrastructure solutions implemented (e.g. new parks, open spaces) 5.5.2 Percentage budget allocated for green infrastructure investments | <ul style="list-style-type: none"> Public Works - Parks/Beautification Community, Planning & Development | Short-term | Staff: Medium Budget: \$ |
| 6.1 Collect baseline information on areas prone to flooding and implement floodproofing measures proactively depending on feasibility and requirement | 6.1.1 Baseline information (risk to properties, vulnerable communities etc.) on flood-prone areas collected 6.1.2 Number of floodproofing measures designated and implemented in these areas | <ul style="list-style-type: none"> Public Works - Engineering Public Works - Parks/Beautification | Short-term | Staff: Medium Budget: \$ |

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| 6.2 Promote the use of green infrastructure tailored to minimize the effects of flooding | 6.2.1 Number of new green infrastructure solutions researched and designated specifically to manage floods 6.2.2 Percentage of the budget allocated for flood management with a focus on green infrastructure | <ul style="list-style-type: none"> • Community, Planning & Development • Public Works - Engineering | Short-term | Staff: Medium Budget: \$ |
| 6.3 Build on existing strategies to educate the residents on flood preparedness and develop emergency flood relief measures to be deployed in case of extreme flooding | 6.3.1 Number of educational initiatives on flood preparedness organized 6.3.2 Number of times emergency relief measures implemented during extreme flooding | <ul style="list-style-type: none"> • Fire & By-Law Services • Administrative Services | Short-term | Staff: Medium Budget: \$ |
| 6.4 Re-investigate the feasibility of Town's Sanitary Sewer Backflow Prevention Incentive Program | 6.4.1 A study on the outcomes of Town's Sanitary Sewer Backflow Prevention Incentive Program completed 6.4.2 Number of new feasible and tangential projects generated | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | Short-term | Staff: Low Budget: \$ |
| 6.5 Conduct a feasibility study of a downspout and sump pump disconnection program | 6.5.1 An in-depth cost-benefit analysis of downspout and sump pump disconnection program completed 6.5.2 Number of downspouts and sump pump disconnected with or without program implementation | <ul style="list-style-type: none"> • Public Works - Engineering | Short-term | Staff: Medium Budget: \$ |
| 6.6 Include stormwater mitigation and adaptation strategies in the Engineering Design Guide to support flood management interventions | 6.6.1 Changes made to the Engineering Design Guide for flood management 6.6.2 Number of interventions added to the Engineering Design Guide to support flood management | <ul style="list-style-type: none"> • Public Works - Engineering | Short-term | Staff: Low Budget: \$ |
| 6.7 Assess, implement and revise (if needed) floodproofing mechanisms employed at Town-owned buildings | 6.7.1 Number of Town-owned buildings assessed for floodproofing 6.7.2 Number of interventions implemented for floodproofing the buildings | <ul style="list-style-type: none"> • Corporate Services • Public Works - Engineering | Short-term | Staff: Low Budget: \$ |
| 7.1 Develop a plan (e.g. COVID-19 Recovery framework) and train the staff to ensure Town's services are sustainably supported | 7.1.1 A generic recovery plan developed to minimize disruption to Town services 7.1.2 Number of trainings/modules developed to respond to the short-term, medium-term, and long-term consequences of extreme events | <ul style="list-style-type: none"> • All Departments | Medium-term | Staff: Medium Budget: \$ |

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| 7.3 Invest in new power support systems (e.g. generator for MCC) for Town's built infrastructure to support seamless services during extreme events | 7.3.1 Budget allocated for new power support systems 7.3.2 Number of power support systems installed | • Corporate Services | Short-term | Staff: Low Budget: \$ |
| 7.4 Prepare to accommodate an increase in public service requests for the maintenance of infrastructure after extreme weather events, floods, heat stress, and cold stress | 7.4.1 Number of public service requests generated and responded 7.4.2 Number of staff and budget allocated for maintenance of infrastructure after extreme events | • Public Works - Engineering | Short-term | Staff: Medium Budget: \$ |
| 8.1 Declare a climate emergency | 8.1.1 Official Climate Emergency declared | • All Departments | Short-term | Staff: Low Budget: \$ |
| 8.2 Develop and implement a Green Procurement Policy that would establish guidelines for all Township employees to ensure staff are purchasing products that minimize consumption of energy and water and are more environmentally appropriate | 8.2.1 Green Procurement Policy completed 8.2.2 Number of times products aligned with the policy purchased | • Corporate Services | Short-Term | Staff: Low Budget: \$ |
| 8.3 Develop and implement a corporate policy on Climate Change Adaptation | 8.3.1 Corporate Climate Change Adaptation Plan created and approved 8.3.2 Climate Change coordinator/champion identified for continued implementation and monitoring of the plan | • Public Works - Engineering | Short-term | Staff: Low Budget: \$ |
| 8.4 Continue to monitor climate change projections annually and collect data from other sources that can aid in the implementation of climate change adaptation solutions (e.g. GIS, citizen scientists) | 8.4.1 Climate change projections assessed annually 8.4.2 Number of data sources designated and utilized for collection of baseline information and mentoring data | • Corporate Services • Public Works - Engineering | Short-Term | Staff: Medium Budget: \$ |
| 8.5 Incorporate climate change projections and adaptation options in the Town's policies and practices to standardize response on addressing climate change impacts (i.e. Strategic Plan, Community Improvement Plan, Communications Plan, Cultural Master Plan, Engineering Design Guide, Human Resource Policy, Winter Operations Plan etc.) | 8.5.1 Number of plans that include climate change considerations and adaptation options 8.5.2 Number of interdepartmental adaptation options identified and integrated across the plans | • Administration Services | Medium-term | Staff: High Budget: \$\$ |

Table 11: M&E Plan

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