Toward a Net-Zero Future

Hamilton Conservation Authority's Corporate Climate Change Strategy

Hamilton Conservation Authority

A Healthy Watershed for Everyone

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1. Executive Summary

Since the industrial revolution, human activities have been increasing greenhouse gas (GHG) emissions in the atmosphere due to burning fossil fuels and land use changes. As a result of these activities, there has been an observed change in the Earth's climate, referred to as anthropogenic climate change. The Hamilton Conservation Authority (HCA) has a role to play in understanding climate change impacts within the conservation boundaries, and the adaptation and mitigation efforts required to help reduce them. The primary objective of this climate change strategy is to identify and provide suggestions for mitigation and adaptation actions were possible in order to reduce overall GHG emissions, resulting in HCA becoming completely net-zero in the future. In order to address climate change within HCA's jurisdiction, this document has compiled previous GHG emissions data from 2015 to present, in order to set benchmarking goals for emissions reductions. Additionally, solutions for carbon storage, energy usage, water management, wetland management, as well as invasive species, natural heritage and wildlife protection are explored. Education and monitoring are a large part of HCA's work, so this plan also sets out ways we can continue education around climate change internally and externally within the community. While this plan is a first step towards the implementation of climate change strategies, HCA will continue to document and monitor all climate change related work within the Conservation Authority. This document will lead further discussion to setting the mentioned climate change goals and benchmarking.

2. Glossary

Definitions obtained from the 2018: Annex I: Glossary report. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_AnnexI_Glossary.pdf

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.

Greenhouse gases: 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 terrestrial radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary GHGs in the earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

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.

Mitigation (of climate change): A human intervention to reduce emissions or enhance the sinks of greenhouse gases.

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.

Carbon sink: A reservoir (natural or human, in soil, ocean, and plants) where a greenhouse gas, an aerosol or a precursor of a greenhouse gas is stored.

Carbon sequestration: The process of storing carbon in a carbon pool.

3. Introduction

In the Province of Ontario, the Hamilton Conservation Authority (HCA) is one of 36 Conservation Authorities whose mandate includes addressing the impacts of flooding and erosion and managing natural resources on a watershed basis in partnership with member municipalities. This work also includes considering and addressing the effects of climate change at the watershed level. The HCA has a strong role to play in addressing these impacts of climate change. This role includes considerations relating to overall operations and how to reduce HCA's carbon footprint. Many of HCA's programs involve issues related to climate change mitigation and adaptation including:

- Flood forecasting and warning
- Dam operations
- Land use planning and regulations
- Aquatic and terrestrial monitoring
- Land stewardship
- Operation of conservation areas and education

The HCA owns over 11,000 acres of land within the watershed. These lands provide valuable functions such as protecting flood and erosion attenuation, water quality, providing habitats for a large variety of species, natural heritage protection, education, and recreation. These lands will need to be continually protected and monitored, as climate change poses threats such as rising temperatures, changing precipitation, extreme weather, and reduced biodiversity. Climate Change is a complex issue, and there will not be an easy solution. The solutions or suggestions in this document are both broad and comprehensive, and touch upon all aspects of the Hamilton Conservation Authority's operations and lands.

4. Background Information

Climate change affects us all and Hamilton is not immune to the effects it will have on the climate, economy, environment, and social issues. Since the Industrial Revolution in the 1800s, the average surface temperatures over Canada has increased at a fast rate, most recently scientists have observed an increase of 1.5°C

from 1950 to 2010.[1] In the same timeframe, the average precipitation across the country has increased by approximately 13%.[2] The key driver of climate change and the temperature increases in parts of the world are greenhouse gases (GHG's). These gases cause what is known as "The Greenhouse Effect." The greenhouse effect is a natural process that occurs near the Earth's surface to help maintain a temperature range that allows for all life to be sustained. The greenhouse effect works by trapping outgoing radiation near the Earth's surface with GHG's.[3] While this is a natural occurrence, increased concentrations of GHG's have been released into the atmosphere since the industrial revolution, creating what is known as the enhanced greenhouse effect, which is the main driver of climate change. The main GHG's driving climate change are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2), and fluorinated gases (HFCs, PFCs, SF_6). Anthropogenic activities such as land use change and burning fossil fuels are the main contributor to the release of these gases.[4] Increased concentrations of GHG emissions are having a significant impact on our climate, evidenced by the extreme weather events that Canada has experienced in the last few years, as record-breaking temperatures across Canada have been accompanied by wildfire seasons and floods.

Figures 1-4 are from an infographic created by the City of Hamilton from their most recent report on future climate projections in Hamilton, 2021. This infographic shows projections including annual mean temperature, seasonal mean temperature, temperature extremes, tropical nights, heatwaves, annual mean precipitation, seasonal mean precipitation, and precipitation events for the City of Hamilton for the years 2021-2050 and 2051-2080. These projections are compared to annual baseline values which is generally measurements from the period between 1975-2005.[5]

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[1] Warren, F.J. and Lemmen, D.S., editors (2014). Canada in a changing climate: Sector perspectives on impacts and adaptation; Government of Canada, Ottawa, ON, p. 7
[2] Warren, F.J. and Lemmen, D.S., editors (2014): Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation; Government of Canada, Ottawa, ON, p.29
[3] NASA. (n.d.). The Cause of Climate Change. Retrieved from https://climate.nasa.gov/causes/
[4] Met Office. (n.d.). Retrieved from https://www.metoffice.gov.uk/weather/climate-change/causes-of-climate-change

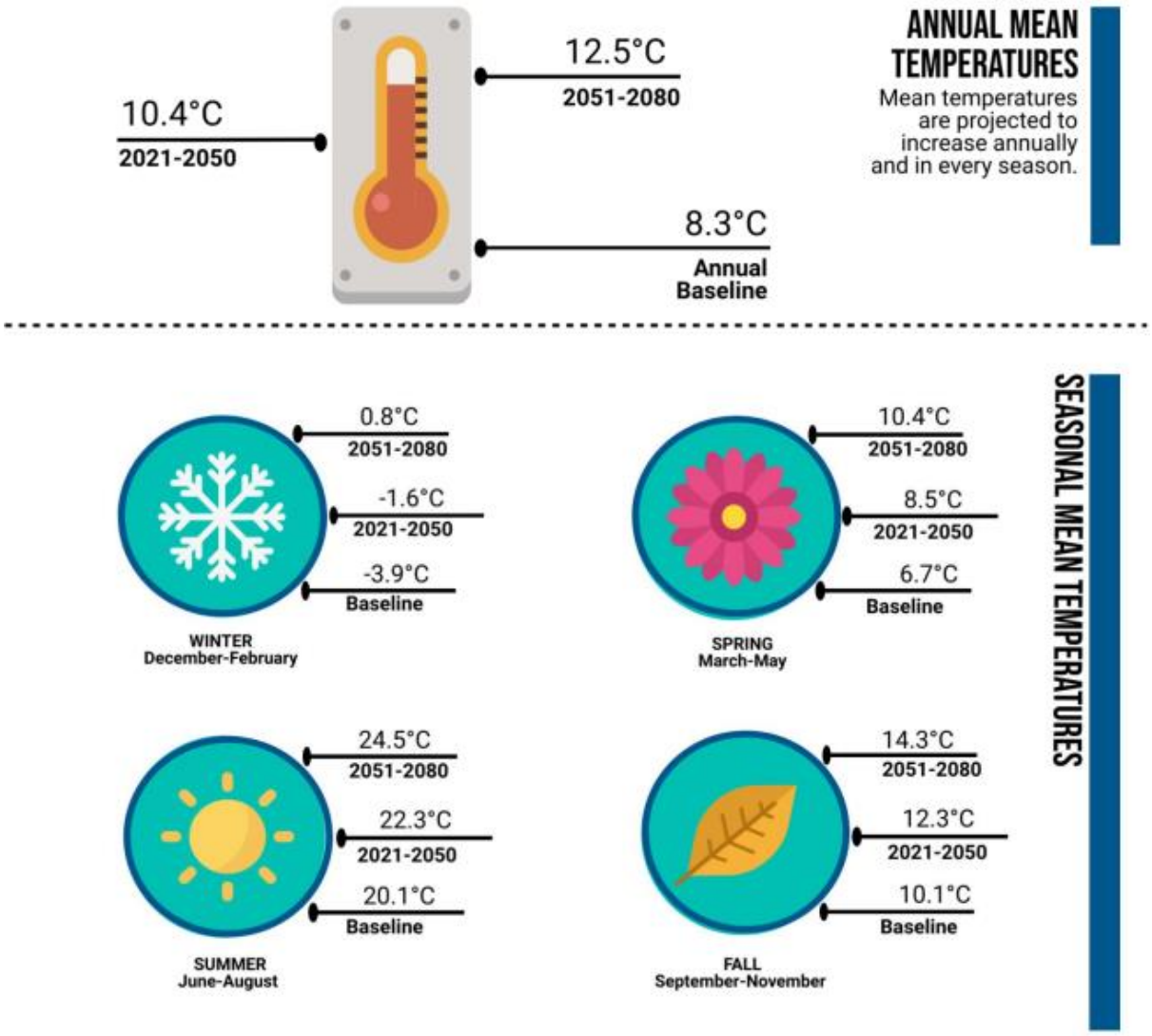

Figure 1: Annual and seasonal mean temperature projections for the City of Hamilton for the years 2021-2050 and 2051-2080, along with the annual baseline.[6]

[6] City of Hamilton. (2021). Future Climate Projections https://engage.hamilton.ca/16238/widgets/94095/documents/58708

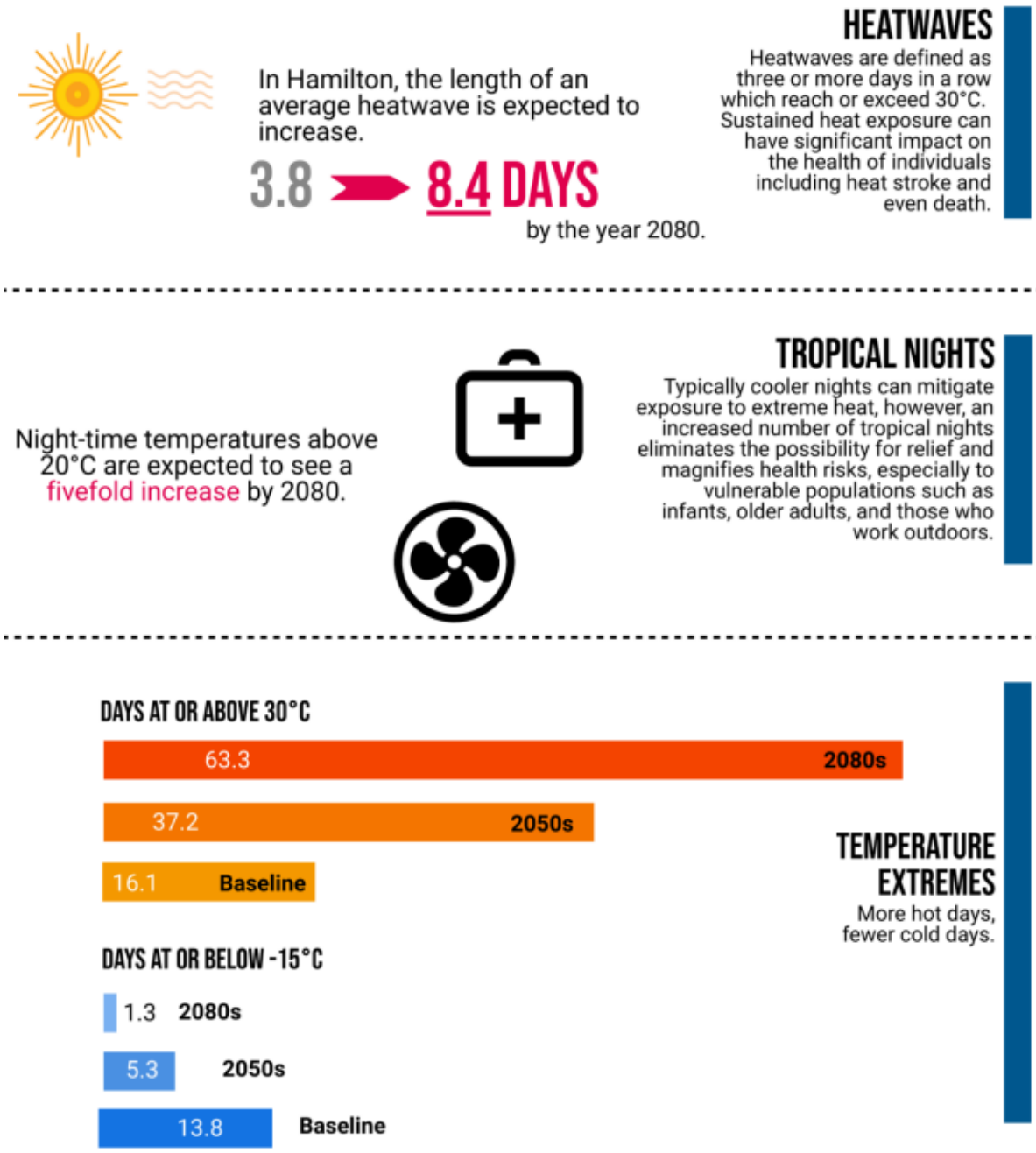

Figure 2: Climate projections for heatwaves, tropical nights, and temperatures extremes in the City of Hamilton for 2050 and 2080.[7]

[7] City of Hamilton. (2021). Future Climate Projections https://engage.hamilton.ca/16238/widgets/94095/documents/58708

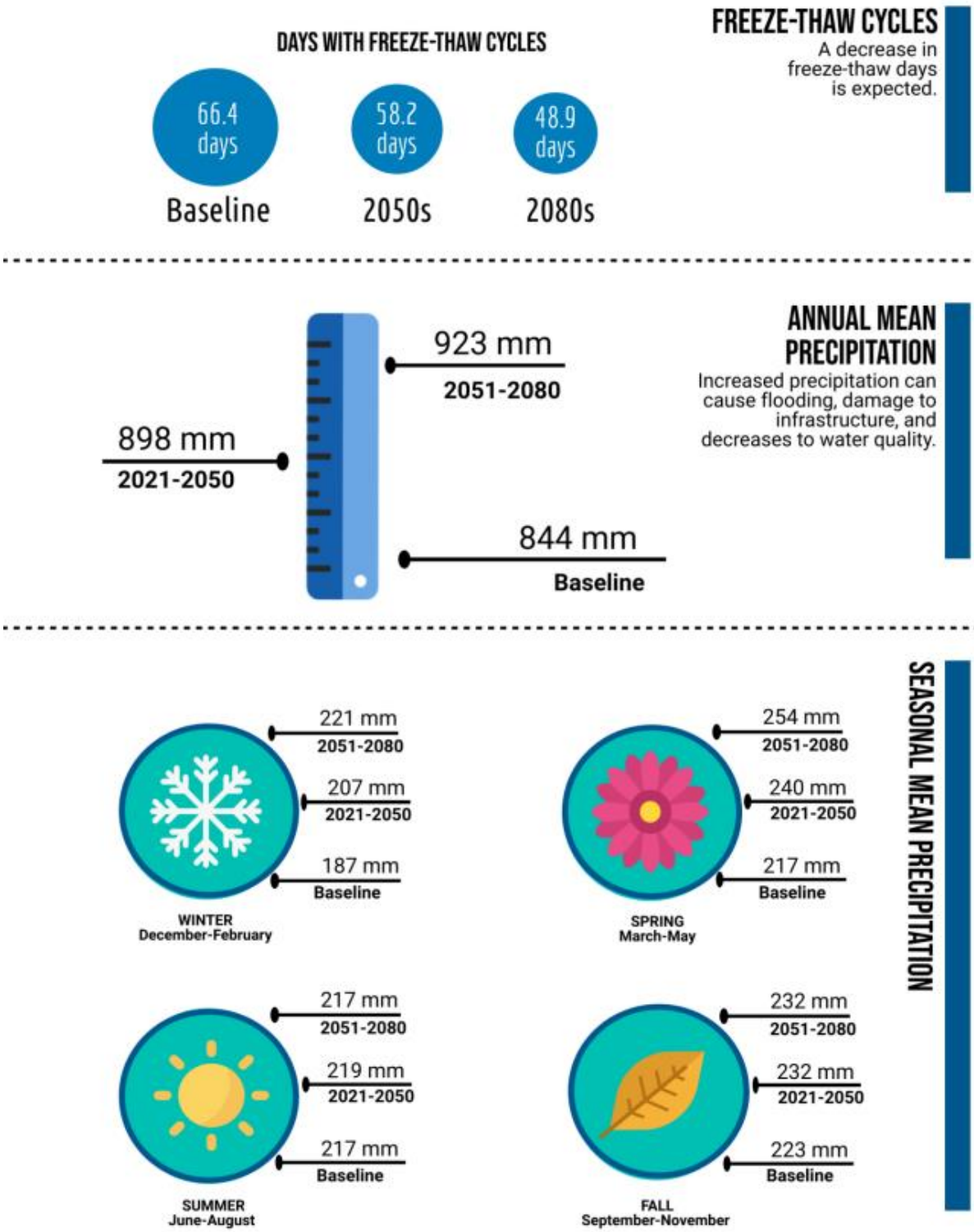

*Figure 3:*Freeze-thaw cycles, annual mean precipitation, and seasonal mean precipitation climate projections for the City of Hamilton. Projections for 2021-2050 and 2051-2080 are included, along with the annual baseline measurements.[8]

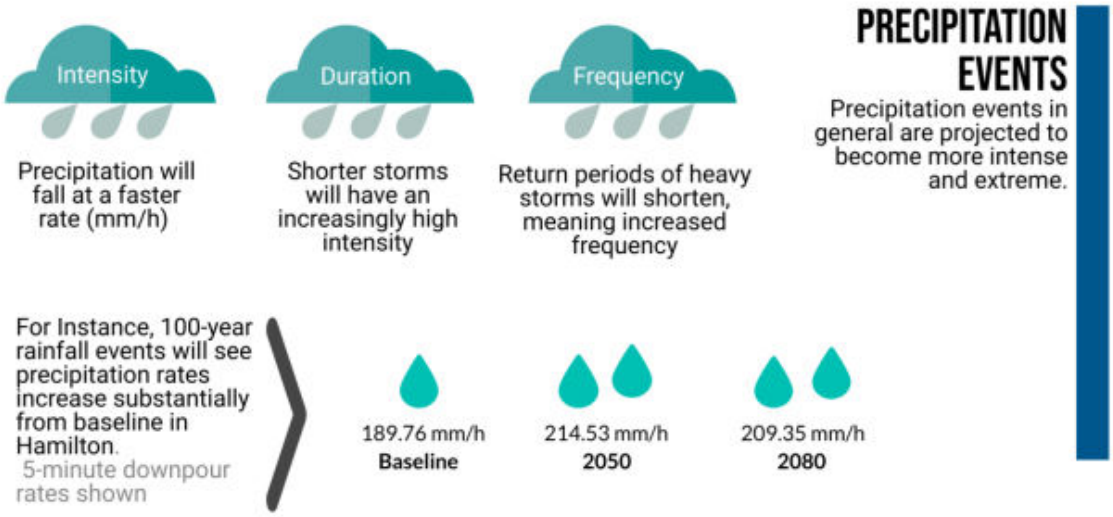

Figure 4: Projected precipitation events for the City of Hamilton for the years 2050 and 2080, compared to the baseline.[9]

The projections show that the annual mean temperature could increase by 4.2°C by 2080, heatwaves will go from being on average 3.8 days in length to 8.4 days, tropical nights are expected to increase by a fivefold, and we will begin to experience more hot days than cold days per year. Climate change in the region is also projected to impact precipitation with an increase in annual mean precipitation by 79 mm, as well as more intense and frequent precipitation events. Additionally, there will be a decrease in the number of days with freeze-thaw cycles. All of these changes will have negative impacts on the region's environment, infrastructure, and society.

The projected scenarios that comes to pass is dependent on our abilities to curb emissions. To achieve climate targets set out by the International Panel on Climate Change (IPCC) this will require significant GHG reductions to achieve net-zero by the year 2050, in order to limit the increase of global temperatures by 1.5°C.[10] Reductions are achievable to meet this transformation, as seen in the past when Ontario's emissions fell approximately 17% between 2007 and 2014, as a

[8] City of Hamilton. (2021). Future Climate Projections https://engage.hamilton.ca/16238/widgets/94095/documents/58708
[9] City of Hamilton. (2021).
[10] IPCC. (2018). Special Report: Global Warming of 1.5°C: Summary for Policymakers. Retrieved from (https://www.ipcc.ch/sr15/chapter/spm/

result of phasing out coal fired electricity generators.[11] Getting to net-zero will require the same level of systems change across all sectors, from retrofitting buildings, to electrifying vehicles, phasing out natural gas, and investing in renewable energy. It is important for local organizations to provide a message of hope and positive action. Local governments and organizations need to begin adapting by taking steps to prepare for the existing and future impacts associated with a changing climate and leading by example.

The HCA recognizes the importance of the organizations mitigation actions to reduce the impacts on the local ecosystem and climate. However, the consequences of climate change are already being seen in Ontario and thus adaptation actions need to be considered and implemented in addition to preventative actions. The difference between climate change mitigation strategies and climate change adaptation is that mitigation is aimed at tackling the causes and minimising the possible impacts of climate change, whereas adaptation looks at how to reduce the negative effects it has and how to take advantage of any opportunities that arise.[12] This report will review HCA's actions for mitigation and adaptation to climate change, and the HCA's role in communicating the need for and taking action on climate change. It does not cover specific instructions on how to implement these actions, rather it outlines potential actions that should be considered.

5. Previous and Continuing Efforts

5.1. 2012 Climate Change Strategy

In 2012 the HCA released their first Climate Change Strategy. This strategy included an overall goal and four major strategic directions (or strategies) that reflect the Authority's mandate and its focus on watershed health. These strategies included: Understand the problem, share information, integrate into existing policies, and develop new policies. The overall goal was "to increase the resiliency of our

[11] Harris, M., Beck, M. & Gerasimchuk, I. (2015). The End of Coal: Ontario's coal phase-out: IISD Report. Retrieved from https://www.iisd.org/system/files/publications/end-of-coal-ontario-coal-phase-out.pdf

[12] Iberdrola. (n.d.) Adapting to climate change: what will the Earth look like in 2030? Retrieved from https://www.iberdrola.com/environment/climate-change-mitigation-and-adaptation

watersheds, systems (natural and man-made) and communities to meet the challenge of climate change." One of the actions was to identify opportunities for HCA to corporately reduce GHG emissions and create a plan. This strategy influenced the HCA to further conduct the 2012 sustainability audit, the 2012 EcoStride Group report, and the 2016 Vulnerability Study.

5.2. Sustainability Audit

In 2012, a Sustainability Audit for the HCA Ancaster main office was conducted in collaboration with McMaster University. This audit identified areas of improvement which focused on four parts: staff transportation, fleet vehicles, redesigned parking lot, and solar panels. The first part involved a transportation survey and potential carpooling opportunities. Due to the isolated nature of the Ancaster office, carpooling would be difficult. Secondly, the cost of purchasing electric vehicles was analysed, and the results showed potential savings of $5,500 a year from the transportation budget. Thirdly, the audit analysed aspects of greening the staff parking lot, including the use of permeable pavement and rain gardens. Lastly, the feasibility and affordability of solar panels were investigated. Some of these aspects were not deemed feasible at the time, however, sustainable technology has improved, and prices have lowered, so similar solutions may be available to be considered currently. Additionally, as the cost of fuel increases and carbon pricing is implemented, renewable energy projects may result in higher saving than what was previously calculated in 2012.

5.3. S-core Report

In 2012, the HCA commissioned the assistance of EcoStride Group, a local consulting firm, to conduct an analysis of HCA's operations and practices with respect to sustainability. Through the resulting report, it was identified that the HCA at the time was engaging in 64 sustainable practices, organized by EcoStride Group into 9 different areas and 29 themes. Under 26 of these themes and in all 9 areas, EcoStride Group submitted 46 Ideas for Action where HCA could improve its practices to move toward greater sustainability. These ideas consisted of suggesting to senior management that the HCA needs to create a strategy, formal policies and structures to embed sustainability in the culture and practices of the organization.

Among sustainability, these categories included energy reduction, waste, office supplies, and transportation, amongst others. Their overall conclusion is that the HCA was only at the starting stage, but needed to build sustainability into the very core of the HCA to move forward and have a concrete plan to lead by example. The recommendations from EcoStride Group were analysed to include applicable recommendations into this strategy.

5.4. Vulnerability Study

The 2016 pilot study named "*Environmental & Infrastructure Vulnerabilities to Climate Change*" was completed by Matrix Solutions Inc. and partners. This study was completed within the Spencer Creek Watershed in Hamilton and focused on an in-depth analysis of the relationship of future climate temperature, precipitation, and hydrology/hydraulic characteristics to potential effects on riverine infrastructure (e.g., bridges) and four environmental features. It recommended adaptation measures to address the risks posed to the watershed by both current and future climate scenarios. It discussed how adaptation measures, such as changes to environmental policy/restoration planning, acceptable risk levels, environmental/infrastructure monitoring, emergency response, design guidelines, and operation and maintenance, may improve the ability of the City of Hamilton and the Conservation Authority in managing and protecting their infrastructure and environmental features. Further studies will need to be conducted to assess species individual resiliency and to collaborate with local organizations to share information. The data presented in that study was analysed to produce some of the recommendations featured in this strategy.

5.5. Sustainability Committee

The HCA has a sustainability committee comprised of staff, in which the purpose of the committee is to "*to promote and ensure that all internal operations and practices are as environmentally sound as possible, recognizing that we must aim to be a leader within our community and watershed."* After the s-core report, the Sustainability Committee developed a work plan, which included an itemized list of HCA's current practices and the 46 Ideas for Action identified through the S-core Report. The Committee then highlighted the current practices and ideas for action

where HCA was identified in the report as being less than 50% toward reaching the industry benchmark for the associated theme. The sustainability committee proved to be a valuable resource in the HCA for implementing sustainability actions, as in the committee's third year of operation, HCA continued to take action on 80% of the recommended Ideas for Action in the Sustainability Committee work plan. The last sustainability monitoring report released by the committee was in 2015, although they continue to meet regularly. The continuation of these reports will be necessary to track the HCA's progress on reducing emissions, as the committee reports investigated utility data and how actions taken changed resource use. Without monitoring the year-to-year changes in data, it will be impossible to track if the HCA is on target to meet goals. One of their suggestions was "to adopt a long-term goal to use more renewable and sustainable fuel sources that can ultimately lead to significant cost advantages (i.e. natural gas, solar, wind, hybrid vehicles, etc.). As technology continues to grow and make alternative fuel sources available, adoption costs to implement them will continue to become more economically feasible. This mindset should be adopted for all HCA activities moving forward in order to achieve positive long term economic and environmental success". The sustainability committee's 2015 goal was to promote reducing the use of resources where possible, while not interfering with necessary activities, and to promote increasing efficiency where possible, in the hope that up to a 10% reduction in overall resource use may be possible. The goal was to reduce resource use by 10% of the baseline 5-year average within this next five-year period, 2015 to 2019. Analysing the utility data for 2005-2009 compared to 2015-2019 determined that there was not a 10% reduction, in fact, GHG emissions rose by 13%. The reasons for not meeting this goal should be analysed to prevent future targets from being missed. It is the intent that after the climate change strategy is completed this goal can be met within the next 5-year period, 2022-2026. The sustainability committee will be reviewing this document as an advisory committee and therefore implementation of the individual action items will be undertaken subject to Executive Team and Board of Directors approvals. The Committee will submit recommendations for ideas for action to be implemented to the Executive Team for consideration.

6. Partnerships

The HCA has long standing relationships with local organizations (Bay Area Restoration Council, Centre for Climate Change Management), conservation authorities, and The City of Hamilton. These relationships ensure that the flow of important information can be accessed and shared, thus ensuring the health of not only the HCA lands but the surrounding areas as well. Invasive species, along with other ecosystem health indicators can begin in other areas and move into HCA lands, which is why the sharing of information is vital so issues can be caught early. HCA should continue to work with stakeholders in regards to climate action within the conservation authority boundaries. It is important reach out to local Indigenous communities to discuss opportunities for knowledge sharing surrounding environmental implications within HCA's watershed.

6.1. The City of Hamilton

In 2019, Hamilton City Council declared a Climate Change Emergency and directed Staff to identify and investigate actions to achieve net-zero carbon emissions by 2050. After the City of Hamilton announced the goal of achieving net zero GHG emissions by 2050, the City released a document in 2020 named "*Low-Carbon Actions Catalogue".* This document, along with their website, detail some plans and actions The City of Hamilton plans to take to reach this goal. Their 9 Corporate Climate Change Goals are as follows:

> Buildings: To increase the number of new and existing high-performance state-of-the-art buildings that improve energy efficiency and adapt to a changing climate.
>
> Active and Sustainable Travel: To change the modal split and investigate strategies so that more trips are taken by active and sustainable transportation than single use occupancy vehicles.
>
> Transportation: To accelerate the uptake of modes of transportation that are low and/or zero emissions.

Planning: To ensure a climate change lens is applied to all planning initiatives to encourage the use of best climate mitigation and adaptation practices.

Procurement: To procure goods, services and construction from vendors who conduct their business in a sustainable and ethical manner that considers equity, diversity and inclusion that contributes to the greater good of the community.

Protect and Restore the Natural Environment: To increase our carbon sinks and local food production through the preservation and enhancement of the natural environment, including local farmland.

Climate Adaptation: To improve Hamilton's climate resiliency by decreasing our vulnerability to extreme weather, minimizing future damages, take advantage of opportunities, and better recover from future damages.

Diversity, Health, and Inclusion: To ensure all our work promotes equity, diversity, health and inclusion and improves collaboration and consultation with all marginalized groups, including local Indigenous Peoples.

Education and Awareness: To increase the knowledge and empower City staff and the Hamilton community including business, non-governmental organizations (NGOs) and individual citizens while advocating to higher levels of government to take action on climate change.

As the City of Hamilton and the HCA work collaboratively, this document will point out where the HCA's actions closely relate to the City of Hamilton's actions and their 9 Corporate Climate Change Goals.[13] The City of Hamilton has also created benchmarking goals to help them ensure they meet their 2050 net-zero target and

[13] City of Hamilton. (2021). Climate Change Action. Retrieved from https://www.hamilton.ca/city-initiatives/strategies-actions/climate-change-action

created a Corporate Climate Change Task Force. The HCA will work within its framework to complete climate change goals and many of these goals will relate to the City of Hamilton's goals and provide a net benefit to the climate and community.

6.2. Bay Area Climate Change Council

The Bay Area Climate Change Council (BACCC) is working with partners to cut carbon emissions in both Bay Area communities by 50% by the year 2030, and reach net-zero by 2050. BACCC has chosen to focus on three main areas: transportation, buildings, and industry. Their goals amongst these areas include improving low carbon modes of transportation like biking, walking, and public transit, supporting the successful implementation of home energy retrofit programs, using net-zero standards for new buildings, and reducing local industrial emissions without carbon leakage. While this is not our focus, the HCA is a member of BACCC, we support their goals and work with the committee to address climate change through our watershed management activities and the management of our conservation areas.

7. What is Net-Zero?

The concept of net-zero is a state in which the amount of GHG's released into the atmosphere is equal to the amount removed from the atmosphere. In the International Panel on Climate Change's report titled *"Climate Change 2021 The Physical Science Basis"* it states: "From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net-zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions." The Canadian Federal Government has pledged to be net-zero by 2050 along with over 120 countries.

To achieve net-zero, benchmarking utilities and GHG emissions in order to understand current usage and create a plan to reduce them is needed. These goals are typically broken into stages, or year goals (5-year, 10-year, 20-years) that focus on achieving small reductions at a time in categories such as transportation emissions, building sustainability, and human behaviour. The climate change opportunities below will help create future goals to reducing these emissions.

8. Benchmarking

Benchmarking is a critical component of any climate change strategy. Benchmarking can define key categories for GHG reductions, with an end goal potentially of net-zero. These benchmarks track key metrics over time, such as hydro, water, and propane use, and help to identify where the usage is coming from and how to reduce the associated GHG emissions. For example, to reduce fleet emissions, vehicle mileage was assessed, and compared with switching to electric. Energy audits will be needed to determine specific actions for utility data and to create specific benchmarking that is attainable.

When measuring and reporting on GHG emissions, the GHG protocol is used. The GHG protocol is a set of standards created for organizations to follow when reporting their GHG emissions. This protocol categorizes emissions into three categories: Scope 1, 2 and 3, also referred to as direct, indirect, and other indirect emissions, respectfully (see Table 1 for specific parameters). Scope 1 emissions are direct emissions that are produced by an organization, this includes building emissions (e.g., furnace, boilers), vehicles, and equipment. Scope 2 emissions are indirect emissions that the organization produces, this includes purchased electricity. Scope 3 emissions are more complex to calculate as they include all other indirect emissions produced by an organization through various types of activities such as the production and transportation of purchased goods, waste disposal, and employee travel.[14] Under the GHG protocol, it is standard to report on Scope 1 and 2 emissions with Scope 3 being optional. However, it is increasingly becoming more important to report on Scope 3 emissions, as often times, they are a large contributor to an organization's total GHG emissions. The HCA will calculate and report on Scope 1 and 2 emissions annually, with the potential to consider reporting on Scope 3 emissions in the future based on the scope of what is to be considered under that approach.

[14] GHG Protocol. (n.d.). A Corporate Accounting and Reporting Standard. Retrieved from https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

Table 1: Reporting Requirements for Scope 1, 2, and 3 under the GHG Protocol.

Scope 1 (Direct)	**Scope 2 (Indirect)**	**Scope 3 (Other Indirect)**
- Company vehicles - Furnaces - Boilers - On-site equipment	- Purchased electricity	- Extraction & production of purchased materials and fuel - Transportation of purchased materials and fuel - Business travel - Employees commute - Waste disposal - Use of sold products and services

Figure 5 displays HCA's emissions from 2005 to 2019, comprised of emissions data (hydro, natural gas, propane, gas, diesel, and furnace oil). While figure 6 shows the breakdown of HCA's emissions by fuel source. The pie graph shows that HCA's GHG emissions come predominately from fuel usage (gasoline and diesel), which is a result of HCA vehicle use and maintenance equipment.

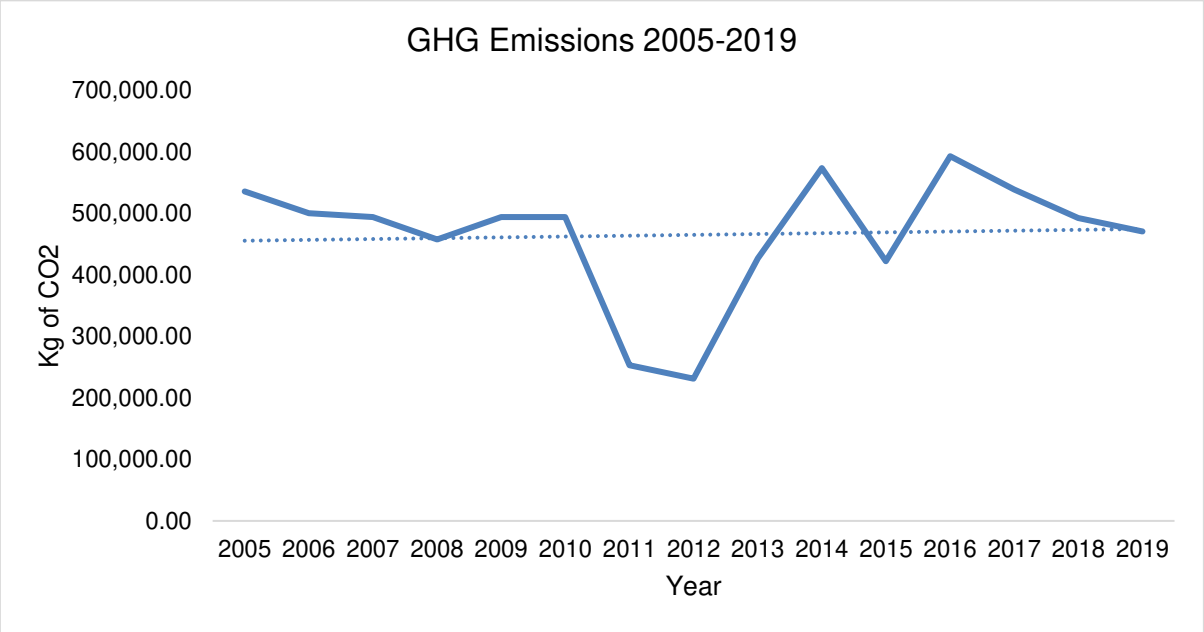

Figure 5: HCA's GHG annual emissions for 2005-2019 in Kg of CO_2.

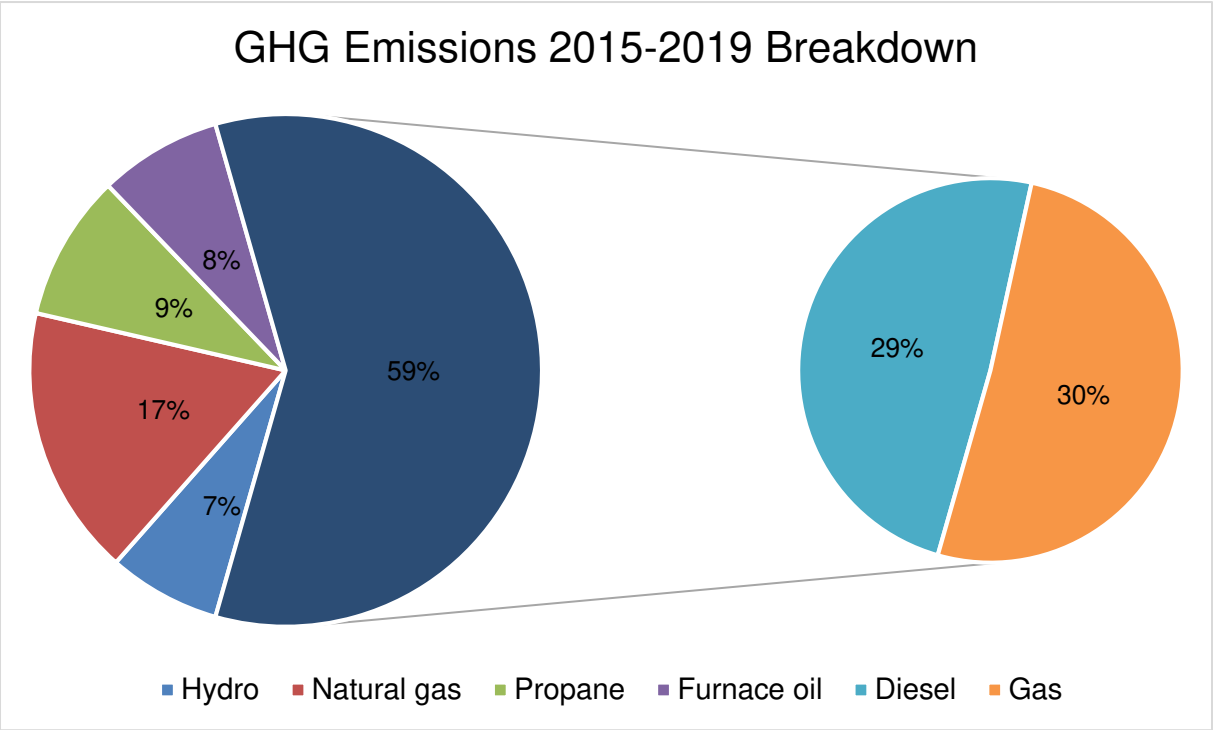

Figure 6: HCA's GHG emissions for 2015-2019 breakdown by fuel type.

Goals will be established following this report to reduce HCA's emissions, based on the benchmarking start point of 2015-2019 (see table 2). The sections of the report that follow are potential actions that can be taken as mitigation and adaptation strategies.

Table 2: HCA's annual benchmarks (data obtained from 2015-2019).

Hydro	Natural Gas	Water	Propane	Diesel	Gas	Furnace Oil
1,295,508kWh	51,919m^3	19,339m^3	34,433L	60,422L	73,758L	17,143L

9. Carbon Storage

One thing that can be considered when looking at benchmarking GHG emissions is offsetting. Offsetting emissions involves using the natural carbon storing properties of forests and natural environments to reduce the net amount of GHG emissions of an organization. The HCA owns lands that act as an important mitigation tool for climate change. By having naturalized lands that are monitored and maintained, they are healthy carbon sequestration tools and wildlife havens.

The HCA aims to minimize the reliance on carbon storage on its lands as they are for the benefit of the community and to move towards net-zero emissions. As it stands currently, the approximate carbon storage of HCA lands exceeds that of its operational GHG emissions. Carbon sequestration rates were calculated by Mohawk Students in 2020. It is estimated that HCA's managed conservation areas have a combined carbon storage of 284,778 tCO_2/year. It is important to note that the carbon sequestration rates used within this project were determined through literature review, so they are not fully accurate for HCA conservation lands, and only provide an estimate for the amount of carbon sequestration. Calculating carbon sequestration of wetlands and forested areas is complex and generally requires field assessments. It is recommended that if HCA intends to use natural areas for carbon off-setting both internally and/or within the community, that a carbon sequestration inventory is conducted.

10. HCA Operations

As climate change is a complex issue, there is no one-size-fits-all approach. There are many categories of change needed to reduce emissions, and the section below will describe these. These are potential opportunities the HCA can undertake in the future, but in some cases more research and information is needed before action can be taken. From completing or investigating these opportunities, such as energy audits, target reductions can be identified and give more direction as more information leads the way to net-zero. This paper is a starting point to meaningful climate action.

The overall important message on climate change is to try and prevent it. The actions needed are called mitigation, which is done by reducing GHG emissions and by enhancing sinks that absorb GHG from the atmosphere. These actions include increasing the use of renewable energy, becoming more energy efficient, and increasing the health and size of natural lands that sequester carbon.

As climate change progresses, impacts will be seen on the natural environment. Climate change adaptation involves actions that help the natural environment adjust and thrive despite these impacts, such as temperature change and extreme weather. Ecosystems can adapt to climate change, a process that can

be supported by human intervention. Protection and restoration of natural and semi-natural areas helps build resilience, making it easier for ecosystems to adapt.

10.1. GHG Emissions

As mentioned previously, GHG emissions are the leading cause for climate change, which is why it is imperative to lessen emissions to reduce climate change impacts. The HCA has completed a review of the current GHG emissions resulting from the HCA's annual operations including hydro, fuel, furnace oil, natural gas, and propane. A plan will be formed to benchmark these emissions and to reduce them over a set amount of time. Data collected for HCA's emissions between 2015-2019 found that the average yearly emissions were equal to 569,262kgCO_2, which is the equivalent to the usage of 68 home's energy for one year.[15] The HCA's top contributor to emissions are from gasoline and diesel. Therefore, an action that should be investigated is electrifying the vehicle fleet, which includes installing chargers for the fleet. There are SUVs in the fleet that would be suitable to switch over to electric, with the potential savings of up to approximately $5,000 on fuel per vehicle per year, as well as the emissions that go along with it (see Appendix A). Installing electric vehicle chargers at the HCA's main office would also allow visitors to charge their electric vehicles while visiting the property. Maintenance equipment such as lawn mowers and trimmers could also be switched over to electric, saving fuel and limiting noise pollution. As natural gas is the second largest emitter in the HCA, all the furnaces should be investigated for age and efficiency, and replaced as needed. If possible, the use of geothermal heat pumps and/or air source heat pumps should be investigated as to completely replace natural gas furnaces.

Sustainable purchasing policies are a great way to help reduce emissions close to the beginning of the products life cycle. Sustainable purchasing policy, also referred to as sustainable procurement, are used to reduce an organizations carbon footprint while purchasing products. Sustainable purchasing ensures that an organization is making informed decisions and purchasing the most eco-friendly

[15] EPA. (n.d.). Greenhouse Gas Equivalencies Calculator. Retrieved from https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

options.[16] HCA should continue to use the sustainable purchasing policy that is in place to reduce supply chain emissions. The current policy states: "Where possible, the HCA will give preference to the purchase of goods, services and contractor/construction projects that minimize adverse environmental impacts and GHG emissions and that promote recycling, re-use and reduction of waste. Authorized Staff will review and modify existing procurement specifications, and create new specifications, to include environmentally and socially responsible options or criteria to be considered along with price and performance."

Mitigation Summary

- Switch from gas/diesel vehicles to electric
- Conduct energy audits for all HCA buildings while investigating furnace age and feasibility to replace with more energy efficient, on demand heating
- Switch over maintenance equipment to electric
- Review HCA's sustainable/environmentally preferable purchasing policy

10.2. Energy Usage

The HCA owns several buildings spread out across all of the conservation areas, including the main office located in Ancaster. While not every location is suitable for solar power or renewable energy, the 2012 Sustainability Study determined that the main office roof would be suitable for solar panels. Further studies should be conducted at each location to determine the suitability and feasibility for solar power, in order to reduce reliance on the Ontario hydro grid, which has non-renewable energy sources (see figure 7[17]). In addition, an energy audit is essential to assessing the following:

- The current electrical and heating/cooling usage at each property
- Identifying conservation actions, such as fixing air drafts, using a more efficient air conditioner/furnace, or improving the insulation
- Retrofit older buildings to meet the more modern standards of sustainability

[16] Green Business Bureau. (2021). What is a Green Procurement Policy? Retrieved from https://greenbusinessbureau.com/blog/what-is-a-green-procurement-policy/
[17] Ontario Energy Board. (n.d.). Overview of energy sector. Retrieved from https://www.oeb.ca/about-us/mission-and-mandate/ontarios-energy-sector

By making each building as efficient as possible, it will reduce the carbon footprint and save on operational costs. One method to consider to reduce building emissions is using LEED building standards. LEED stands for Leadership in Energy and Environmental Design and is the most widely-used green building rating system in the world.[18] The advantage of using LEED is that it provides a method and standardization to sustainable buildings, and is a globally recognized achievement. The HCA could follow the LEED framework as a guide to making their buildings more sustainable. Although the HCA may not construct many buildings in the future, focus for new builds should be on achieving net-zero. Additionally, the BACCC released a Building Retrofitting cost-benefit analysis document that looks at the different forms of retrofits that can be undergone and their GHG emissions potential. It is recommended that HCA references BACCC's documents and suggestions when retrofitting any current and/or future buildings.

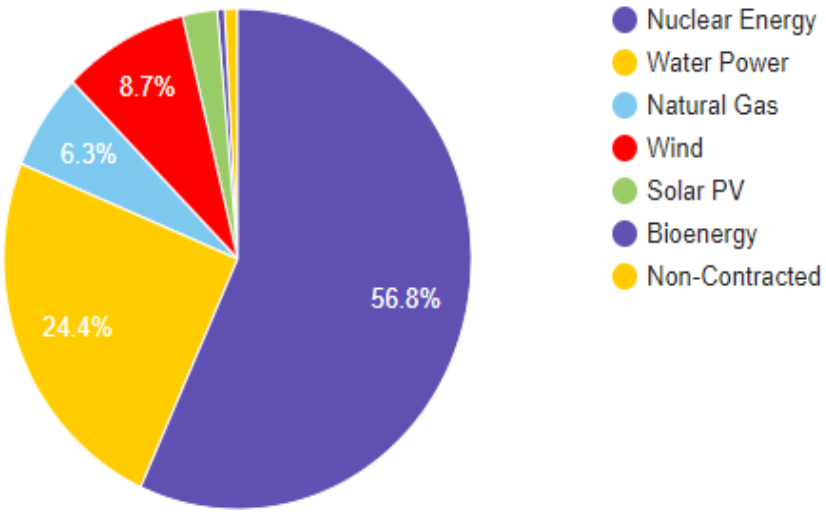

Figure 7: 2020 Electricity Supply Mix for Ontario by fuel type[19].

[18] U.S. Green Building Standard. (n.d.) LEED rating system. Retrieved from https://www.usgbc.org/leed
[19] Ontario Energy Board. (n.d.).

Mitigation Summary

- Conduct energy audits on all HCA buildings
- Retrofit existing buildings (more efficient lighting, heating/cooling systems)
- Examine the feasibility of installing solar panels at the HCA main office
- Use most efficient office equipment
- Consider LEED Standard's for future buildings

11. Environment and Natural Heritage

11.1. Water Management

In Ontario, climate change is anticipated to result in milder, shorter winters with earlier snowmelt, less ice cover on lakes, changing rainfall patterns, and increased evapotranspiration. It is important that the HCA's watershed is protected against the impacts of climate change. Monitoring is important as it can catch impacts before they become severe. Although this report will not have an in-depth climate review, some research has already been completed as to precipitation changes in the HCA watershed. The data presented in Figure 8 shows a slight uptrend in average rainfall, although other graphs such as the amount of rain storms per year > 15 mm has been fairly flat since 1970.

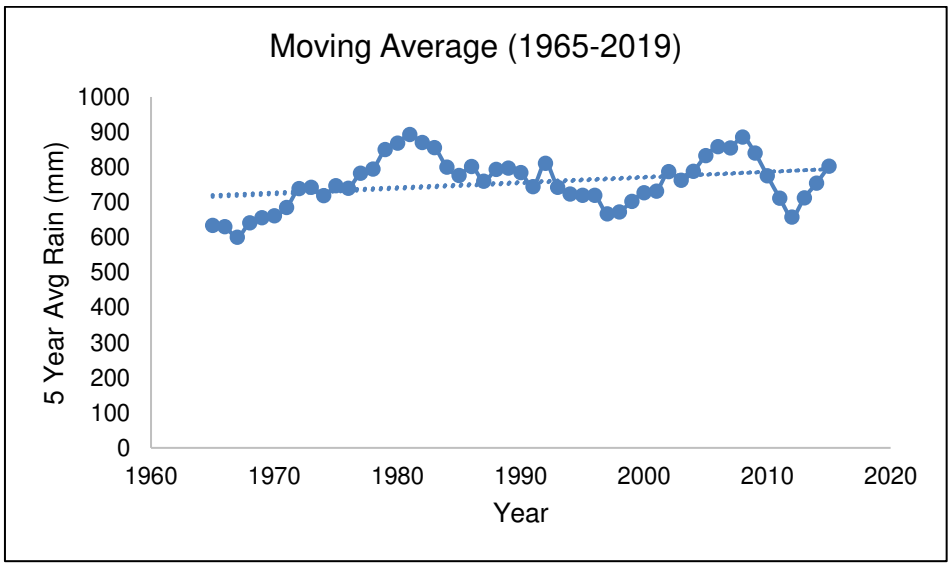

Figure 8: 5-year average rainfall between 1965-2019 within the HCA. Data shows a slight increase in rainfall over the studied time frame.

The HCA has been involved with a water quality monitoring program in partnership with the Hamilton Harbour Remedial Action Plan (HHRAP), Ministry of the Environment, Conservation and Parks (MECP), and the City of Hamilton since the spring of 2014. The monitoring program has been adapted from a previous sampling program undertaken by the Royal Botanical Gardens (RBG) aimed at understanding conditions contributing to Cootes Paradise, which has been identified as an area of concern for the Hamilton Harbour Remedial Action Plan. From 2014 to 2017, the program was expanded further by adding more monitoring sites and automated samplers, along with extending the sampling season to year-round. The additional sampler locations allows HCA to better understand how land uses impact water quality during storm events. In 2018, additional monitoring emphasis along Chedoke Creek began with the addition of 4 new grab sample locations as well as one more on Ancaster Creek above the escarpment. The HCA conducted a vulnerability study of the Spencer Creek watershed and identified areas where it may be vulnerable to climate change effects, and this information was used to identify some mitigation and adaptation actions.

Logging does not take place generally on HCA lands and as such, erosion and runoff from this use is not an issue. However, the HCA has several parking lots and internal road systems that can increase runoff and erosion. These parking lots and roads are non-permeable and not only absorb heat, but can lead to pollution and contaminants flowing into the waterways. The benefits of building low-impact permeable parking lots and roads include water infiltration, flood mitigation, and ground water recharging. A permeable parking lot design for the HCA main office was detailed in the 2012 sustainability audit which included the use of rain gardens and a bioswale on the west side of the parking lot. Additionally, reducing the amount of clean water used for things such as public toilets can be accomplished by using rainwater capture systems in public washrooms.

One of the side effects of human development is ecosystem fragmentation and the creation of barriers to aquatic connectivity. These barriers include structures such as dams, weirs, bridge abutments, pedestrian walkways, roads, and other natural barriers. Investigating potential barriers and their removal increases the resilience of aquatic ecosystems to climate change as barriers change river habitat, reduce habitat and population connectivity, and alter natural flow, temperature,

sediment, and nutrient transport regimes.[20] The HCA could investigate further remediation/restoration projects such as channel reconfiguration and meandering, reach-scale bank restoration, and construction of in-stream habitat structures, on HCA land where applicable.[21]

As climate change progresses, so will the impacts to water and watershed management will have to adapt. These changes will include increased frequency of flooding events, changes in seasonal precipitation patterns, and changes in water chemistry as a result of increased water temperatures and changes in stream flows. All these changes can affect local wildlife and aquatic organisms, certain invasive species will flourish, or local species may decline. To understand how exactly flooding will affect HCA lands, completing more detailed and updated floodplain mapping will help educate property owners that they are on a floodplain and identify steps needed to take to reduce potential damage.

Along with increased flooding, we will see an increase in erosion and impact to stream flows, also referred to as critical flow. Critical flow is the speed of water flow that causes the movement of total suspended solids (TSS). TSS's cause contamination of streams/creeks/rivers and usually include silt, sand, microorganisms, plant or animal matter, and industrial wastes that remain suspended in the water column. Excessive amounts of TSS can negatively impact streams and rivers as it can transport phosphorus, decrease light penetration, and alter aquatic habitats. Increased TSS's will also be seen as a result of increased intense rain events.

As the global average temperature continues to increase, we will begin to see decreasing water levels in aquatic environments. Additionally, the average water temperature will increase resulting in unfavourable conditions for a variety of species, while welcoming new species. This includes an increase in algal production, which impacts the water chemistry similarly to TSS's, by altering sunlight and

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[20] Wilkinson, J. et al. (2017). Environmental Markets and Stream Barrier Removal: An Exploration of Opportunities to Restore Freshwater Connectivity Through Existing Mitigation Programs. The Nature Conservancy.: Arlington, Va. Retrieved from https://www.nature.org/content/dam/tnc/nature/en/documents/2017_Stream_Barrier_Removal_and_Mitigation_Report.pdf

[21] Wilkinson, J. et al. (2017).

phosphorous levels within the water.[22] It is projected that water temperatures will increase in the spring and fall, which poses a threat to cold water species (e.g., Brooke Trout).[23] Longer periods of warm water in lakes can result in longer periods of stratification in lakes. Lakes stratify when the warmer water stays near the top of the lake and the colder water stays near the bottom, resulting in less oxygen availability lower in the lake.[24] Increasing water temperatures will also have negative impacts on streams and other aquatic ecosystems. Monitoring will have to continue watching for these levels to understand the impacts and research will have to be done to understand how to adapt.

When planning for future development, focus should be directed towards low-impact development which mimic natural water flow and reduce flooding. Additionally, continued efforts to educate property owners with riverbanks on their property about how they can play a part in reducing erosion is important.

Water Management Summary

- Continue monitoring efforts to catch climate change impacts proactively
- Consider the use of permeable parking lots
- Rainwater capture systems for public washrooms, rain gardens
- Investigate removing/assessing barriers to aquatic connectivity
- Assess impacts from previous floods and how to mitigate damage
- Use floodplain mapping (continue to finalize flood plain mapping for coverage throughout watershed) to educate homeowners they are on a floodplain and the steps they can take to reduce damage.
- Investigate ways to increase infiltration and reduce flow as a means to improve erosion, water quality, increased TSS, and increased levels of phosphorous as a result of climate change impacts.
- Continue to focus on utilizing the Permitting and Planning responsibilities to limit development within the floodplain.

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[22] Tomalty, R & Komorowski, B. (2011). Climate Change Adaptation: Ontario's Resilient Greenbelt. Retrieved from http://d3n8a8pro7vhmx.cloudfront.net/greenbelt/pages/41/attachments/original/1376571502/Climate_Change_Adaption_Ontario's_Resilient_Greenbelt.pdf?1376571502

[23] Tomalty, R & Komorowski, B. (2011).

[24] Tomalty, R & Komorowski, B. (2011).

- Encourage storm water management designs that account for climate change-influenced runoff.
- Encourage low impact development
- Periodic reviews of operational strategies for Christie Lake dam (both for storm events and low water conditions).
- Periodic reviews of the precipitation thresholds expected to result in High Water or Significant Flooding (as required due to future changes in general rainfall intensities).

11.2. Wetland Management

Mitigation

Wetlands are important ecosystems for combating climate change, but also one of the most vulnerable. Wetlands are particularly vulnerable to changes in hydrology as they exist between fully aquatic and fully terrestrial ecosystems. Intermittent streams and small, isolated wetlands are likely to be particularly vulnerable due to changes in the timing and volumes of spring peak flows.[25] As temperatures increase, wetlands will decrease in size, or dry up altogether. As storms increase and wetlands experience increased runoff, the ecosystem will be altered and so will the relationship between these wetlands and their plant and animal species. Without wetlands operating at full health, they cannot provide natural services like maintaining shoreline integrity, reducing erosion, filtering contaminants, and providing fish and wildlife habitats.[26] Keeping wetland areas healthy helps mitigate climate change by acting as a carbon sink (reduces GHG concentrations), regulating temperature, slowing the impacts of drought, and reducing flood risks (water permeation). In addition to acting as a carbon store, wetlands contain a large amount of methane gas, which is a potent GHG. The loss of wetlands result in the release of stored methane, thus contributing to increased concentrations in the atmosphere.

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[25] Wisconsin wetlands Association. (2018). How will wetlands be affected by climate change? Retrieved from https://www.wisconsinwetlands.org/updates/how-will-wetlands-be-affected-by-climate-change/

[26] Natural Resources Conservation Policy Branch. (2017). Archived – Wetland conservation strategy. Retrieved from https://www.ontario.ca/page/wetland-conservation-strategy

Losses of native species, particularly at the southern end of their ranges, and increases in species at the northern end of their ranges, may be common. Opportunistic, easily adaptable, and invasive species, pests, and diseases will take advantage of these changes and will increase. Addressing and identifying these threats as changes occur will be key to improving wetland health. While wetlands cover only 6% of the world's land surface, they store approximately 20-30% of the global soil carbon.[27] As many wetlands in Ontario have been drained historically for farmland, more wetlands should be created and existing ones protected. Ongoing monitoring and research will have to be done to assess threats to wetlands and effective strategies to mitigate these impacts.

Mitigation Summary

- Investigate opportunities for new development to integrate measures to enhance, reclaim, or create wetlands.
- Identify resilient, native species to target for restoration, address fragmented corridors, consider how ecosystems will move, and restore floodplain natural areas.
- Continue to investigate current and emerging threats to wetland
- Use lessons learned from Saltfleet Conservation Authority to create new wetland areas.

Adaptation

The question is, as the climate changes, how can we help wetlands adapt? There is no one-size-fits-all approach, as each local climate and ecosystem varies, and even factors such as land-use changes over time will have a significant effect on the way the carbon is stored and the wetland functions. Impaired wetland function will negatively affect critical functions and ecosystem services such as carbon storage, biodiversity support, wildlife habitat, and water quality.[28] The key for wetland climate change adaptation is understanding how climate change will impact wetlands

[27] Nahlik, A., & Fennessy, M. (2016). Carbon storage in US wetlands. *Nat Commun* 7**,** 13835. https://doi.org/10.1038/ncomms13835

[28] Moomaw, W.R., Chmura, G.L., Davies, G.T. *et al.* (2018). Wetlands in a Changing Climate: Science, Policy and Management. *Wetlands* 38, 183–205. https://doi.org/10.1007/s13157-018-1023-8

and tailoring the solutions to each location. As they are such an important carbon store, it is important to prevent them from drying and releasing their carbon to the atmosphere. The best way to do this is monitoring and research, which is covered in the sections below.

Wetlands also aid in reducing urban flooding during increased rain and ice melting events. It is important to maintain the integrity of wetland health to help aid in flood reduction within the watershed. HCA has begun construction on the Saltfleet Conservation Area, which will consist of four man-made wetlands. This project was created to help manage urban flooding within the area, as well as provide habitat for wildlife and recreational use for the community. The Saltfleet project is a great example of how creating wetlands can be used to adapt to increased urban flooding, while also helping to promote and protect biodiversity.

Adaptation Summary

- Control drainage of wetlands to prevent oxidation of wetland soils and the resulting releases of carbon into the atmosphere.
- Gather and summarize research information and potential options to minimize impacts of climate change on wetlands.
- Encourage integration of wetland restoration/creation/management into local adaptation plans. Collaborate with local planners to provide information regarding the importance of wetland systems, and potential for no-regrets wetland strategies for nonpoint source and climate management.
- Use Saltfleet Conservation Area as an example of how man-made wetlands can be used as an adaptation strategy for flood management.

11.3. Carbon Sequestration

Mitigation

As stated previously, in order for an organization to become net-zero, the amount of GHG's emitted by such an organization must equal the amount that is being sequestered and/or off-set. Although offsetting and tree planting is beneficial, reducing the GHG's emitted should take a higher priority. The HCA owns 5,200 acres of forests, 2,940 acres of wetlands, and 3,000 acres of other types of land. All

these lands act as carbon stores, which help remove excess CO_2 from the atmosphere. Future work should continue to maintain the health of these lands, and to look for opportunities to purchase more land and create/restore wetlands. Maintaining and enhancing the forests by promoting management techniques that create a sustainable healthy forest that will be resilient to potential impacts from climate change.

Mitigation Summary

- Create more wetlands to act as carbon sinks
- Increase forest and prairie cover (also reduces erosion, moderate water flow)

11.4. Invasive Species

Adaptation

The HCA has always been a champion of monitoring and controlling invasive species, while also collaborating with local organizations to ensure information sharing. The HCA released an invasive species strategy in 2016 which outlines HCA's seven strategies, which are focused on prevention, communication, best management practices, prioritization, implementation, collaboration and research and monitoring. Additionally, the HCA's strategic plan for 2019-2023 outlines actions for natural heritage preservation which includes "[implementing] the approved Invasive Species Strategy and natural heritage plans as detailed in HCA master plans". These master plans are specific for conservation lands and underline the Natural Areas Inventories which include all the flora/fauna/aquatic life, and conservation area management such as land and water management. As previous and continuing efforts to control and manage invasive species are extensive, recommendations include continuing these efforts, and monitoring for climate change related impacts. Species like phragmites are disrupting Ontario's sensitive wetland ecosystems and impacting at least 25 percent of Ontario's species at risk. If monitoring continues and expands, any invasive species that migrate due to climate change can hopefully be mitigated and caught early.

One challenge of climate change adaptation is knowing in advance what changes will happen before they happen. Each conservation area can have unique

plant and animal species that each react differently to climate change. A 2020 study that looked at the projection of alien species talks about these challenges, stating "Biological invasions have steadily increased over recent centuries."[29] However, we still lack a clear expectation about future trends in alien species numbers. In particular, we do not know whether alien species will continue to accumulate in regional floras and faunas, or whether the pace of accumulation will decrease due to the depletion of native source pools. This study predicts that the number of established alien species will increase by 36% between 2005 and 2050.[30] The HCA is already doing monitoring and identifying, and needs to continue to maintain these as high priorities. Conservation areas will need to be prioritized based on their vulnerability and invasive species, and proactive measures that support early warning and eliminating alien species before they become invasive.

Adaptation Summary

- Continue phragmites control and boost efforts to eradicate
- Continue HCA efforts to create action plan for each HCA conservation area
- Continue efforts to complete invasive species mapping and implement an updating schedule to ensure mapping is current and accurate.
- Research into preventative invasive species actions (e.g., install wash stations, boot stations)
- Conduct regular invasive species monitoring to assess species movement due to climate change.
- Add more ecological monitoring and assessment network (EMAN) plots to cover a wider area
- Assess all new land purchases for invasive species
- Use Natural Areas Inventories results to understand how the invasive species will react to climate change and how their territory will move or expand (e.g., Spongey Moths, Beech Scale).

[29] Seebens, H, Bacher, S, Blackburn, TM, et al. (2021). Projecting the continental accumulation of alien species through to 2050. *Glob Change Biol*. 27: 970– 982. https://doi.org/10.1111/gcb.15333
[30] Seebens, H, Bacher, S, Blackburn, TM, et al. (2021).

- Continue actions under the invasive species strategy
- Increase educational signage about invasive species in parks

11.5. Protection of Wildlife

Adaptation

With climate change, comes a threat to species biodiversity. In fact, the HCA falls within the Lake Erie Lowlands ecoregion, which was identified as a "crisis ecoregion" by a 2020 study that examined each ecoregion in Southern Canada based on their biodiversity and threat level.[31] It was found that the land within the Lake Erie Lowlands has a high level of biodiversity, but a low level of conservation efforts, thus having a high level of threat for biodiversity loss.[32] Mitigating these threats will have to become the heart of environmental management strategies, along with utilizing the most up to date science and technology. Understanding the precise actions to take will be difficult, in which it is vital to collaborate with local partners to share information and techniques to ensure thoroughness. Previous studies have been done by the HCA (The Vulnerability Study) which assessed which species in the HCA lands will be most susceptible to climate change. However, the individual resilience of these species cannot be fully understood and repeating this study in the future will ensure this list is up to date. Strengthening the habitats of the species and eliminating potential points of vulnerability will assist species in becoming more resilient to climate change. For example, creating more pollinator gardens and adding beehives on HCA property will help essential pollinator health. Mohawk College and The City of Hamilton have both implemented beehives. Over one third of the human diet comes directly or indirectly from insect-pollinated plants, and about 80 percent of wild, flowering plant species would not exist without pollination. Climate Change may affect the foraging behaviour of pollinators as well as the attractiveness of plants. Upon further monitoring, other specific species actions will become apparent, both for mitigation and adaptation. Species most

[31] Kraus, D. & Hebb, A. (2020). Southern Canada's crisis ecoregions: identifying the most significant and threated places for biodiversity and conservation. *Biodivers Cobserv 29,* 3573-3590. https://doi.org/10.1007/s10531-020-02038-x
[32] Kraus, D. & Hebb, A. (2020).

vulnerable to climate change usually have small ranges and population sizes and live in areas that are isolated. If Hamilton undergoes severe warming, the risk of wildfires may increase. Additionally, as climate change shifts the ranges of ecological zones, planting species that are already adapted to a warmer climate will be beneficial to a thriving ecosystem.

Living species have a remarkable ability to adapt to change. However, as we continue to see record breaking temperatures, evolution and resiliency may not be able to keep up, and human intervention may be needed. This help may be in the form of assisted migration, as suitable habitats and ecosystems shift with changing conditions. For example, terrestrial ecologists will want to plant what will be able to survive under future conditions. Assisted migration projects are occurring across Ontario by different organizations including the planting of six different hardwood species from varying distances in Claremont, Ontario, lead by Natural Resources Canada.[33] The Upper Thames River Conservation Authority is also using assisted migration of Bur Oak trees.[34] Many of the assisted migration projections being undergone in Ontario are for research purposes in order to better understand how this technique can be used as an adaptation measure in the future.

As current habitats become unsuitable for some species, it is important to maintain habitat connectivity to facilitate movement between climate refuges to allow them to colonize new areas. Protecting and enhancing ecological connectivity will become increasingly important as the climate continues to change. The northern portion of Beverly Swamp consists primarily of white cedar and tamarack coniferous swamp, whereas the southern portion consists primarily of silver maple deciduous swamp. The predicted climate change impacts may induce a shift in the boundary between these life zones, as conditions would be preferable for the deciduous region to expand to the north potentially constricting the extent of the coniferous forest zone.

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[33] Natural Resources Canada. (2020). Assisted Migration. Retrieved from https://www.nrcan.gc.ca/climate-change-adapting-impacts-and-reducing-emissions/climate-change-impacts-forests/adaptation/assisted-migration/13121

[34] Forest Gene Conservation Association. (n.d.). Assisted Migration. Retrieved from https://fgca.net/climate-change/assisted-migration/

Adaptation Summary

- Increase pollinator gardens, add beehives
- Assess conservation actions of vulnerable species identified in HCA Vulnerability Study [Limit sportfishing of vulnerable species (e.g., northern pike, largemouth bass) and encourage fishing/removal of invasive species (e.g., Asian carp)].
- Redo vulnerability study in the future to re-assess.
- Follow the 50-year plan recommendations and take conservation actions in Dundas Valley to protect against climate change impacts.
- Protect and enhance the Valley's Ecology and Natural Areas
- Maintain and protect the Valley's cultural heritage and historical features
- Promote sustainable passive recreational opportunities within the Valley's Green Spaces
- Ensure conservation area facilities are accessible and convenient
- Consider the use of assisted migration of plant species as temperatures increase
- Understand how tree and plant species will react to climate change, how can we react and help?
- Understand how animal and aquatic species will react to climate change
- Work with partners to increase the biodiversity of urban/rural wildlife habitats to adapt to shifts in the timing of life cycle events and other climate impacts.

11.6. Monitoring Programs

In the 2012 Hamilton Conservation Authority's Climate Change Strategy, it discusses future climate change impacts; "To adapt to these changes, we need first to recognize when they are occurring or are likely to occur and what the magnitude of the changes will be. This requires a robust water and climate change monitoring network and up-to-date forecasting tools." The HCA throughout its history has always made monitoring a priority. Additionally, the HCA practices the principle of adaptive management, which will allow plans and actions to be guided by information obtained over time through environmental monitoring. This is key to climate change monitoring and subsequent actions, as ecosystems and their constituents slowly experience climate change impacts over the upcoming decades.

The types of monitoring and the depth involved will change. Additional new types of monitoring may have to be considered, such as soil moisture monitoring. Important applications of soil moisture information include forecasting of weather and climate variability, projection and monitoring of drought conditions, management and allocation of water resources, or monitoring of ecosystem response to climate change, to name just a few. As increased rainfall is possible in the Hamilton area, erosion monitoring will have to be undertaken or continued (done by The City of Hamilton in cooperation with HCA) to assess the impacts and how to mitigate them. Long term monitoring programs should continue and expand to cover more HCA land, and the monitoring results will have to be carefully examined so as to not miss any impacts of climate change.

Monitoring Programs Summary

- Need to maintain HCA regulations and planning program as it relates to natural hazards and the impact of climate change
- City of Hamilton erosion monitoring: assess where it is getting worse and what can be done.
- Enhance HCA erosion and sediment control initiatives to consider climate impacts
- Soil moisture monitoring
- How will increased CO_2 levels affect local species and water bodies (Undertake research to further understand the impacts of climate change on aquatic communities).
- Monitor the spread of damaging pests and species
- Increasing temperatures and drought can cause gaps in the forest canopy, impacting soil conditions, and potentially moving in invasive species there that can survive. Create monitoring program to assess forest health continually and plant to fill in these gaps.
- Enhanced long-term water resources and environmental monitoring programs will allow for hydrologic and environmental changes to be observed and identified as they occur.
- Enhanced predictive modelling for species vulnerability

12. Experience, Education and Awareness

12.1. Conservation Area Experience

Tourism season may be prolonged as the spring and fall seasons become milder, and with that comes different management expectations of both the environment and people. Increased frequency, duration, and intensity of rainfall events will influence trail erosion on HCA lands and will impact trail maintenance. Trails will need to be evaluated to determine what best management practice should be used, including possible trail closures. Predicted lower spring and summer flows and warmer temperatures during the summer months have the potential to affect recreational activities at Christie Reservoir. While less ice cover on lakes[35] during the winter months may impact winter tourism at Valen's Lake. Nutrient loading in lower flow conditions and warmer water temperatures may create conditions favourable for bacterial and algal growth that could result in swimming restrictions and beach closures. The maintenance of sufficient water levels for swimming and boating activities may also be affected by greater requirements for the reservoir to increasingly augment downstream flows.

Conservation Area Experience Summary

- Plan for a longer tourist season, due to longer warm periods (may have to keep water at recreational levels longer, longer camping season, etc.).
- Increased staff resources may be required to address clean-up from damaging storms, fire or insect and disease damage, an extended growing season (e.g., additional grass cutting), and invasive species control.
- Enhanced Marketing and communications to alert of impacts for closed areas following storm damage, fire bans, low reservoir water levels for recreation use, closed beaches due to poor water quality, unsafe ice conditions etc.
- Increased capital resources may be required to address storm and erosion damage to trails, bridges, parking lots, roads and other infrastructure and facilities.

[35] Woolway, R., Sharma, S., & Smol, J. (2022). Lakes in Hot Water: The Impacts of a Changing Climate on Aquatic Ecosystems. *BioScience.* https://doi.org/10.1093/biosci/biac052

- Update and revise safe working procedures for staff to address working in heat, tick safety, inclement weather and any other climate change risks identified.

12.2. Education and Awareness

Although the HCA does not conduct in-depth science research itself on climate change impacts, conducting regular review of other's research will ensure that their information is up to date. Educating visitors to HCA lands will become more important as climate change impacts become visible. Education can be done through increased signage about invasive species and ecology changes in the parks, or through social media campaigns. This is the role of the stewardship program and HCA education program.

With changes in the local climate, the HCA may begin to see increased vector-borne diseases and threats to human health. The HCA works to spread awareness within the community and to conservation land users about ticks and mosquitoes and how to best protect yourself from these risks. It is important that the HCA continues to make use of educational mediums including blog posts and effective signage throughout the conservation areas.

Education and Awareness Summary

- Identify opportunities for using nature-based solutions for climate adaptation and GHG reductions, in collaboration with partners.
- Increase signage to educate visitors on invasive species and ecological changes in parks
- Use social media campaigns to educate the public

13. Measuring Success and Continual Learning

In order to ensure climate change goals are being met, milestone goals should be created. These goals can be on time frames of 1, 5 or 10 years, and mark specific goals to be accomplished, such as GHG reductions or renewable energy targets. These goals should be built into the next strategic plan for the HCA. Along with creating benchmark goals, policy and monitoring programs should also have a timeline for review, as new information is discovered. Additionally, climate change

policy and reports should be a priority for the HCA, so all departments are a part of the plan and knowledge. Along with involving all aspects of the HCA and departments, regular meetings and workshops should be held for staff to obtain feedback and educate staff on impacts of climate change on HCA lands.

Measuring Success and Continual Learning Summary

- Review policies, guidelines, programs and strategies on a five-year basis to incorporate new climate change science and information to reduce risk and liability
    - Energy and waste audits will be conducted to identify potential efficiencies, justify improvements and measure effectiveness of policies and practices. These audits will also determine a baseline to measure against and timelines in which changes are to be made. The audits could be part of an HCA Climate Change Strategy annual report.
- Develop and implement tools and approaches for integrating climate change knowledge into the assessment, stewardship and management of species, ecosystems, and natural resources.
- Work towards net-zero carbon emissions over a specific timeframe that will be determined based on further data collection and benchmarking.
- Create cross-jurisdictional partnerships to identify emerging trends requiring proactive adaptation action.
- Develop and report performance measures for climate change programs recognizing that environmental action today translates to long-term benefits.
- Set ongoing targets for energy and GHG emission reductions
- Undergo annual review of new research, biodiversity reports, invasive species, and climate change reports.
- Create a template for annual sustainability reports, measuring effort and giving suggestions for future effort
- Create staff feedback form for adopting programs to climate change

14. Conclusion

As humans continue to burn fossil fuels and make land use change, climate change is worsening and impacting communities all over the world, including Hamilton, Ontario. As an active member in the community, HCA has a responsibility to address climate change impacts within the conservation boundaries, and take action in order to help mitigate and adapt to these impacts. This Climate Change Strategy has highlighted the work that HCA has done thus far, while also highlighting recommendations for work that can be done going forward to help get HCA properties to net-zero. Recommendations in this report look at mitigation and adaptation opportunities for HCA's energy usage, water management, wetland management, invasive species, carbon sequestration, and the protection of wildlife. Additionally, ways in which HCA can continue to use pre-existing monitoring programs partnerships and educational programs to help work together on tackling climate change. It is more important than ever to implement climate action into our everyday lives and organizations, and if we all work together, GHG emissions reductions can be achieved.

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16. Appendices

16.1. Appendix A – 2018 Data for Kms and fuel for HCA Vehicles

Sample Calculations down below, GHG % reductions are based on the 2015-2019 yearly baseline for GAS emissions only. Note that Km and fuel data does not exist prior to 2018.

Vehicle	Designed Fuel Economy	Actual Fuel Economy	Km and Fuel (L) for 2018	Fuel costs ($1.20/L)	Annual Electricity cost*	Money and GHG saved if electric (per year)
Chevrolet Silverado (E417) 2011	18.8L/ 100km	21.02L/100km	22,645km with 4762L	$5,714	$667	$5,047 on fuel 12,857kg of CO_2 (109.95kg of CO_2 from electric) 6.4% gas GHG
Chevrolet EXP (E430) 2003	16.7L/100km	20.4L/100 km	5,465km, 1115L	$1,338	$161	$1,177 on fuel 3,010kg of CO_2 (26.53kg of CO_2 from electric) 1.41% GHG from gas
Ford Escape (E403) 2014	6.2L/100 km	9.57L/100 km	15,412km, 1,476L	$1,771	$454	$1,317 on fuel 3,985kg of CO_2 (74.83kg of CO_2 from electric) 1.86% GHG from gas
Chevrolet Silverado (E434) 2012	13.84L/ 100km	15.3L/100 km	18,745km, 2,866L	$3,439	$552	$2,887 on fuel, 7,738kg of CO_2, (91.01kg of CO_2 from electric) 3.6% on GHG from gas
GMC Sierra (E411) 2012	13.84L/ 100km	16.6L/100 km	16,798km, 2,784L	$3,340	$495	$2,845 on fuel, 75,16kg of CO_2, (81.56kg of CO_2 from electric) 3.5% on GHG from gas

Vehicle	Designed Fuel Economy	Actual Fuel Economy	Km and Fuel (L) for 2018	Fuel costs ($1.20/L)	Annual Electricity cost*	Money and GHG saved if electric (per year)
Chevrolet Colorado (E421) 2011	13L/100km	12.3L/100 km	1,3511km, 1,674L	$2,008	$398	$1,610 on fuel, 4,519kg of CO_2, (65.60kg of CO_2 from electric) 2.1% on GHG from gas

* Based on the assumption that an electric vehicle has a range of 415km/charge