

City of Windsor

DEGREES OF CHANGE

Climate Change Adaptation Plan

Acknowledgements

This Plan was developed by City of Windsor and ICLEI Canada Project Staff working closely with the Community Task Force as well as all City of Windsor departments. The following individuals contributed their valuable knowledge and expertise to the development of *Degrees of Change – Windsor’s Climate Change Adaptation Plan*.

City of Windsor Project Staff

Karina Richters, Supervisor, Environmental Sustainability and Climate Change
Averil Parent, Environment and Sustainability Coordinator
Kyle Bassett, Community Energy Plan Administrator

ICLEI Canada Project Staff

Christina Schwantes, Climate Change Project Coordinator, ICLEI Canada

FCM funding statement

The Adaptation Changemakers project was delivered by ICLEI Canada and funded through the Federation of Canadian Municipalities’ Climate Adaptation Partner Grants available through FCMs Municipalities for Climate Innovation Program (MCIP). MCIP, delivered by FCM and funded by the Government of Canada, is a five-year, \$75-million program designed to support and encourage municipalities to reduce greenhouse gas emissions and adapt to climate change.

Table of Contents

Executive Summary	2
Message from the Community Task Force	4
Glossary of Terms	5
Introduction	7
Plan Development	10
Climate Science	14
Windsor's Climate Projections	19
Climate Change Impacts and Issues	22
The Cost of Doing Nothing	29
Future Directions	32
Objectives	32
Implementation and Governance	53
Communication, Education and Outreach	55
Funding	56
Monitoring and Review	58
Appendix A Detailed Climate Projections	59
Appendix B Implementation Table	65
Appendix C Indicators	84
References	87

Executive Summary

Purpose of this Climate Change Adaptation Plan

There is a quantifiable history of Climate Change in Windsor. The 30-year mean temperature in Windsor has increased from 9.1°C in 1960-1989 to 10.1°C in 1990-2019, representing a 1°C increase in our average annual temperature. The 30-year mean annual rainfall has increased from 840mm in 1941-1969 to 955mm in 1990-2019, an increase of approximately 7%. In the last decade alone (2010-2019), the mean annual rainfall has been measured at 995mm.

Projections show that the average number of days above 30°C will more than double by 2050s and more than triple by 2080s. An increase in average precipitation is expected, particularly in winter and spring, while summer may eventually see a slight decrease in precipitation coupled with increasingly warm seasonal temperatures. More events of extreme precipitation are expected. Water temperature of the Erie basin continues to increase, negatively impacting wetlands, habitats and biodiversity. In addition, water levels have been above average since 2013.

In keeping with the Strategic Direction laid out in the original Environmental Master Plan (2007), *The City of Windsor is committed to being a leader through its daily actions and services to enhance the environment for present and future generations*, the Climate Change Adaptation Plan (2012) was developed. To build upon the success of the 2012 Climate Change Adaptation Plan, this update was developed.

Recognizing the importance of immediate action, the City of Windsor declared a Climate Change Emergency on November 18, 2019. To help combat the impacts of Climate Change that we are currently experiencing, and that which we are projected to experience, this plan aims to address the physical, social, economic and ecological health impacts of Climate Change and the adaptation actions that could help diminish them.

In 2017, the City of Windsor approved the City's 1st Community Energy Plan and Corporate Climate Action Plan developing a pathway to reduce greenhouse gas emissions and energy consumption. The implementation of the CEP is important to reduce the extent of climate change.

How was this Plan Developed?

This update to the plan was developed based on ICLEI Canada's Building Adaptive and Resilient Communities Program (BARC), supported by the ICLEI Adaptation Changemakers Project. Funded by FCM's Adaptation Partner Grants and delivered through their Municipalities for Climate Innovation Program, it is a \$75-million program designed to support and encourage municipalities to reduce greenhouse gas emissions and adapt to climate change. ICLEI provided the City of Windsor the opportunity to participate in this project with seven other municipalities, allowing Windsor to network, learn and share experiences about the adaptation planning process. This encouraged the development of a community-wide adaptation strategy that includes actionable elements for all participating organizations (municipality, university, public health, etc.)

To support the community-wide adaptation strategy, a Community Task Force (CTF) was developed and consulted in parallel to the consultation of all City of Windsor departments. The CTF and City staff used their knowledge and experience to identify locally relevant climate change

impacts, complete organizational vulnerability and risk assessments, establish a long-term adaptation vision and goals, identify relevant adaptation and implementation actions, and support a monitoring and review process.

Climate Change Adaptation Plan Vision:

Based on the results of vulnerability and risk assessments a list of local climate change impacts identified by the Community Task Force and City of Windsor Administration were prioritized. These impacts were categorized under the following themes: Impacts to Community Health and Safety; Impacts to Building and Property Damage; Impacts to Infrastructure Services; Impacts to Ecosystem Function; Impacts to Community Services; and Impacts to Quality of Life. Also considered was the impact of inaction, the Cost of Doing Nothing and the escalation in Climate Change costs depending on the combination of global emissions growth as well as local economic and population growth. Public Safety Canada estimates that every dollar invested in climate change adaptation saves \$3 to \$5 in recovery costs. In the past 4 years, the Corporation of the City of Windsor has spent over \$8 million on emergency response and unplanned capital investments and the Windsor community experienced \$232 million in insured losses as a result of the 2016 and 2017 flood events.

Targets and Actions

Windsor will continue to prepare for our climate future by creating a more resilient city to the effects of a changing climate by implementing a series of actions to reach seven key objectives. Those objectives are:

1. Integrate Climate Change Thinking and Response
2. Protect Public Health and Safety
3. Reduce Risk to Buildings and Property
4. Strengthen Infrastructure Resilience
5. Protect Biodiversity and Enhance Ecosystem Functions
6. Reduce Community Service Disruptions
7. Build Community Resilience

Implementation:

To achieve goals of this plan, the City will require multiple streams of support including the Environmental Sustainability and Climate Change Office, City Administration, the Community Task Force, Community Partners (including external agencies, school boards, the private sector, developers, post-secondary institutions, etc.). A fundamental part of this plan is Communication, Education and Outreach, as many actions within call for community involvement and participation. Funding is key, a financial commitment is necessary to help protect the Windsor community from the effects of a changing climate. Tracking progress of a series of high-level indicators allows for plan success and longevity – reviewing vulnerabilities and risk assessment every 5 years at minimum. An Implementation update to Windsor City Council and Community Task force is to occur on biennial basis.

Message from the Community Task Force

'Business as usual isn't an option-we only have one planet' was the guiding principle for the Community Task force, in its endeavor to come up with a *forward thinking, systematic, holistic* Climate Change Adaptation Plan for the City of Windsor.

As integral components of the Climate Change Adaptation Planning process, the Community Task Force members are dedicated to the pursuit of environmentally sustainable goals and building a climate resilient community as outlined in the Climate Change Adaptation Plan. Task force members are in a unique position to identify future vulnerabilities and risks to the Community as a result of our changing climate. Together, task force members can provide significant support to all levels of government with regards to community-wide implementation of climate change adaptation efforts. It is the Task Force's long-term strategic commitment to work alongside the City of Windsor to achieve the Climate Change Adaptation Plan's vision.

The vision: Windsor will continue to prepare for our climate future by creating a more resilient city to the effects of a changing climate. We will minimize climate change risks to our community through the advancement of sustainable policies, infrastructure investment and public education. Forward thinking and proactive actions will benefit our community health, environment and economy.

Task Force Members:

- The University of Windsor
- County of Essex
- Enbridge (formally Union Gas)
- St. Clair College
- Windsor Essex Community Housing Corporation
- Windsor Essex County Health Unit
- Windsor Essex Local Immigration Partnership
- Greater Essex County District School Board
- Windsor Essex Catholic District School Board
- Detroit River Canadian Cleanup
- Downtown Mission
- Friends of Ojibway Prairie
- Great Lakes Institute for Environmental Research
- Essex Region Conservation Authority
- Citizens Environment Alliance
- Windsor Regional Hospital
- Windsor Essex County District School Board
- Windsor Women Working with Immigrant Women
- Enwin
- Windsor Port Authority
- Walpole First Nations
- Essex County Field Naturalists' Club
- Hotel-Dieu Grace Healthcare
- Canadian Red Cross

Glossary of Terms

Adaptation: Includes any initiatives or actions in response to actual or projected climate change impacts and which reduce the effects of climate change on built, natural and social systems.

Adaptive Capacity: The ability of built, natural and social systems to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities, or to cope with the consequences.

Climate: The weather of a place averaged over a period of time, often 30 years. Climate information includes the statistical weather information that tells us about the normal weather, as well as the range of weather extremes for a location.

Climate Change: Climate change refers to changes in long-term weather patterns caused by natural phenomena and human activities that alter the chemical composition of the atmosphere through the build-up of greenhouse gases which trap heat and reflect it back to the earth's surface.

Climate Projections: Climate projections are a projection of the response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols. These projections depend upon the climate change (or emission) scenario used, which are based on assumptions concerning future socioeconomic and technological developments that may or may not be realized and are therefore subject to uncertainty.

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 (H₂O), carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), ozone (O₃), and chlorofluorocarbons (CFCs) are the six primary greenhouse gases in the Earth's atmosphere in order of abundance.

Climate Impact: The effects of existing or forecast changes in climate on built, natural, and human systems. One can distinguish between potential impacts (impacts that may occur given a projected change in climate, without considering adaptation) and residual impacts (impacts of climate change that would occur after adaptation)

Impact Statement: Climate-related impact statements are concise statements that outline locally-relevant projected threats and how those changes are expected to affect the built, natural, social, and economic systems of the municipality.

Mitigation: The promotion of policy, regulatory and project-based measures that contribute to the stabilization or reduction of greenhouse gas concentrations in the atmosphere. Renewable energy programs, energy efficiency frameworks and substitution of fossil fuels are examples of climate change mitigation measures.

Resilience: The capacity of a system, community or society exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.

Risk: The combination of the likelihood of an event occurring and its negative consequences. Risk can be expressed as a function where $\text{risk} = \text{likelihood} \times \text{consequence}$. In this case, *likelihood* refers to the probability of a projected impact occurring, and *consequence* refers to the known or estimated outcomes of a particular climate change impact.

Sensitivity: Measures the degree to which the community will be affected when exposed to a climate related impact. Sensitivity reflects the ability of the community to function (*functionality*) as normal when an impact occurs.

Vulnerability: Vulnerability refers to the susceptibility of the community to harm arising from climate change impacts. It is a function of a community's sensitivity to climate change and its capacity to adapt to climate change impacts.

Weather: The day-to-day state of the atmosphere, and its short-term variation in minutes to weeks.

Acronyms

BARC – Building Adaptive and Resilient Communities

BFSP – Basement Flooding Subsidy Program

CDHS – Community Development & Health Services

CFIA – Canadian Food Inspection Agency

DRCC – Detroit River Canadian Cleanup

EMS – Emergency Medical Service

ESCC – Environment, Sustainability & Climate Change Office, City of Windsor

ERCA – Essex Region Conservation Authority

GLIER – Great Lakes Institute for Environmental Research

LHIN – Local Health Integration Network

MNRF – Ministry of Natural Resources and Forestry

MOECP – Ministry of the Environment, Conservation and Parks

MTO – Ministry of Transportation

WDBA – Windsor-Detroit Bridge Authority

Introduction

The City of Windsor has a long-standing commitment to both Climate Change Mitigation and Adaptation Planning. A corporate environmental commitment was made through the development of our original Environmental Master Plan (2007). This document provided the following Strategic Direction:

The City of Windsor is committed to being a leader through its daily actions and services to enhance the environment for present and future generations.

As a result of this direction, the Environmental Sustainability and Climate Change Office has been working on climate change mitigation and adaptation for nearly a decade. Our 2012 Climate Change Adaptation Plan was one of the first of its kind in Canada outlining recommendations to make Windsor a more climate resilient city. In 2017 the City of Windsor adopted a Community Energy Plan, which aims to reduce greenhouse gas emissions and energy consumption, decreasing further contributions to climate change.

Although reducing greenhouse gas emissions is vital to limiting the rate and amount of future climate change, the reality is that climate change impacts are happening now and are unavoidable in the near future. The impacts of climate change are already widespread and have been felt in Windsor-Essex. These impacts include but are not limited to overland flooding, heavy rain event flooding, emergence of invasive species, increased number of high heat days, the rise of vector borne diseases and the re-emergence of blue-green algae and harmful algal blooms in our lakes and rivers.

Windsor on alert for potential overland flooding in east Windsor



CTV Windsor. May 3, 2019

In the past 4 years the Corporation of the City of Windsor has spent over \$8 million on emergency response and unplanned capital investments and the Windsor community experienced \$232 million in insured losses as a result of the 2016 and 2017 flood events.

The increasing impacts and costs associated with climate change have made community action on adaptation and mitigation more urgent than ever before.

Lyme Disease risk areas are up from last year:



Public Health Ontario says tick populations are continuing to expand — and climate change is part of the reason

CBC News. May 06, 2019

Adaptation Changemakers

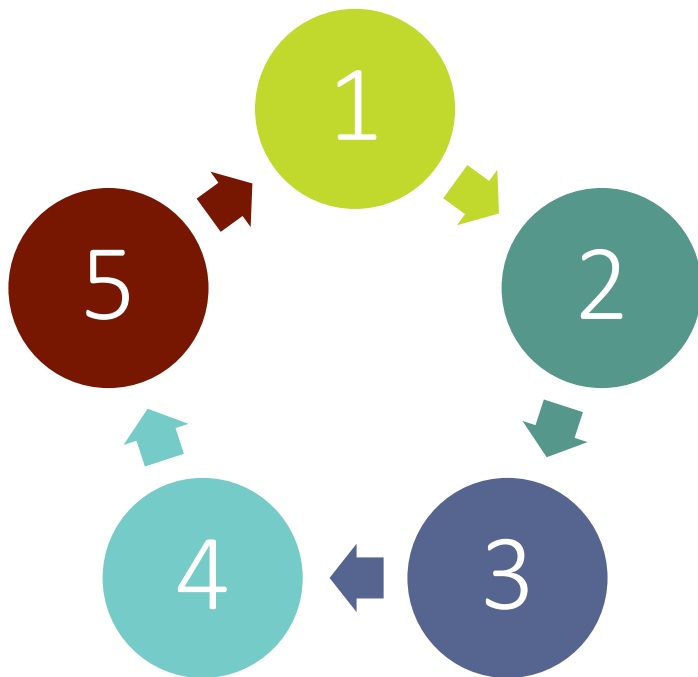
Accordingly, the Windsor community must continue to build upon the success of the 2012 Climate Change Adaptation Plan. The update to the Plan involved a robust process with the support of the ICLEI Adaptation Changemaker Project. *Based on ICLEI Canada's Building Adaptive and Resilient Communities Program (BARC)*, the goal of the project was to build capacity for community climate change resilience across Canada. Eight municipalities participated from across Canada. Each community assessed localized climate risks and identified community adaptation actions. The Adaptation Changemakers project's cohort structure brought the eight participating communities together multiple times over the course of two years, gathering at three national workshops across Canada to network, learn, and share experiences about the adaptation planning process.

The adaptation planning process was community-focused, and each participating municipality convened a wide range of community stakeholders, allowing for collaborative co-development of adaptation plans that address climate risks across multiple sectors and systems. The community-focused process has helped establish an engaged group of community stakeholders who co-developed the plan and will support implementation locally. The breadth of community impacts and stakeholders engaged throughout the process *represents a significant advancement in the state of resilience in Windsor.*

Guided by the BARC methodology, the Adaptation Plan was developed through extensive collaboration with City departments and community stakeholders. An overview of the BARC methodology can be found in the Figure 1.



Figure 1: ICLEI Canada’s Building Adaptive and Resilient Communities Framework



MILESTONE ONE – INITIATE

Within this milestone, communities identify stakeholders to review and understand existing knowledge on how the regional climate is changing, followed by a brainstorming exercise to identify potential climate change impacts.

MILESTONE TWO – RESEARCH

The second milestone is meant to further develop a community’s understanding of climate change impacts and the major service areas which are likely to feel these impacts most acutely. Within this milestone, a municipality will scope the climate change impacts for the region and conduct both a vulnerability and risk assessment.

MILESTONE THREE – PLAN

The third milestone provides guidance on how to establish a vision, set adaptation goals and objectives, identify adaptation options, and examine possible constraints and drivers to various actions. From there, a community will draft a Local Adaptation Strategy. Baseline data is collected and recorded, financing and budget issues are addressed, an implementation schedule is drafted, implementation responsibilities are determined, and progress and effectiveness indicators are identified in the Plan.

MILESTONE FOUR – IMPLEMENT

In the fourth milestone, communities work to ensure that they have the approval and support of council, municipal staff and the community in order to move forward on implementation. Communities will also make sure they have the appropriate implementation tools to ensure the ongoing success of the Strategy.

MILESTONE FIVE – MONITOR & REVIEW

The fifth and final milestone serves to assess whether the goals and objectives of the Strategy have been achieved, and helps communities identify any problems that have been encountered and develop solutions. Additionally, the fifth milestone helps communities communicate their progress to council and the general public.

Plan Development

Community Scope and Intention of Plan

This Plan represents an update to the City of Windsor's 2012 Climate Change Adaptation Plan. Updating the adaptation plan allows the City to identify and build on work already completed, check in on existing stressors, risks, and implementation progress, and advance the community further toward climate resilience of its social, economic, built and natural systems.

This update to the 2012 Climate Change Adaptation Plan took a broad approach that involved the Windsor community as well as municipal administration. The intent of this plan is to help organizations, institutions, businesses, vulnerable populations, and individuals of all ages adapt to current and future climate-related risks and opportunities. Although City administration has a primary role for most actions outlined in the Plan, working with various stakeholders in the community is necessary to further educate and implement climate change adaptation measures in the broader community.

To ensure that the voices and values of our community were incorporated into *Degrees of Change*, a Community Task Force was created. The Task Force included representation from many community groups and organizations.

Community Task Force

- The University of Windsor
- County of Essex
- Enbridge (formally Union Gas)
- St. Clair College
- Windsor Essex Community Housing Corporation
- Windsor Essex County Health Unit
- Windsor Essex Local Immigration Partnership
- Greater Essex County District School Board
- Windsor Essex Catholic District School Board
- Detroit River Canadian Cleanup
- Downtown Mission
- Friends of Ojibway Prairie
- Great Lakes Institute for Environmental Research
- Essex Region Conservation Authority
- Citizens Environment Alliance
- Windsor Regional Hospital
- Windsor Essex County District School Board
- Windsor Women Working with Immigrant Women
- Enwin
- Windsor Port Authority
- Walpole First Nations
- Essex County Field Naturalists' Club
- Hotel-Dieu Grace Healthcare
- Canadian Red Cross



The Task Force participated in localized workshops and meetings delivered as part of ICLEI Canada's Adaptation Changemakers Project, structured around the Building Adaptive and Resilient Communities (BARC) Framework (p.9 Figure 1). Simultaneously, City of Windsor Administration followed a parallel process with all departments. Both groups were presented with the latest climate projection data for Windsor Essex and asked to identify how climate change is currently affecting their department and/or organization as well as look forward to how they might be impacted under our projected future climate conditions. After participating in vulnerability and risk assessments to prioritize impacts, both administration and the community groups were asked to outline strategies and action items that would help the Windsor community as a whole improve its climate resilience.

Simultaneously, multiple community stakeholders such as ERCA and the Windsor-Essex County Health Unit are completing corporate and organizational climate change vulnerability and adaptation planning processes to prepare their organizations for climate change. We have an opportunity to bring together County, City and Town governments as well as regional stakeholders to work together on climate change planning and implementation with the aim of protecting our region and contributing to greater national and global climate change response.

Adaptation vs. Mitigation

Climate change adaptation refers to any initiative or action that seeks to reduce the vulnerability of social, economic, built, and natural systems to changing climate conditions. Adaptation efforts may focus on changing individual behaviour, updating municipal by-laws and policies, enhancing the capacity of physical infrastructure, and improving ecological services.

Climate Change mitigation refers to the implementation of policy, regulatory and project-based measures that contribute to the stabilization or reduction of greenhouse gas concentrations in the atmosphere. These include anti-idling by-laws, building retrofits to conserve energy, and transitioning to low-carbon energy sources. While mitigation efforts work to contain the long-term impacts of climate change, adaptation measures are needed to address the impacts that are already happening. Possible action items to address climate change adaptation and mitigation are shown in Figure 2.

ADAPTATION = managing the unavoidable

MITIGATION = avoiding the unmanageable

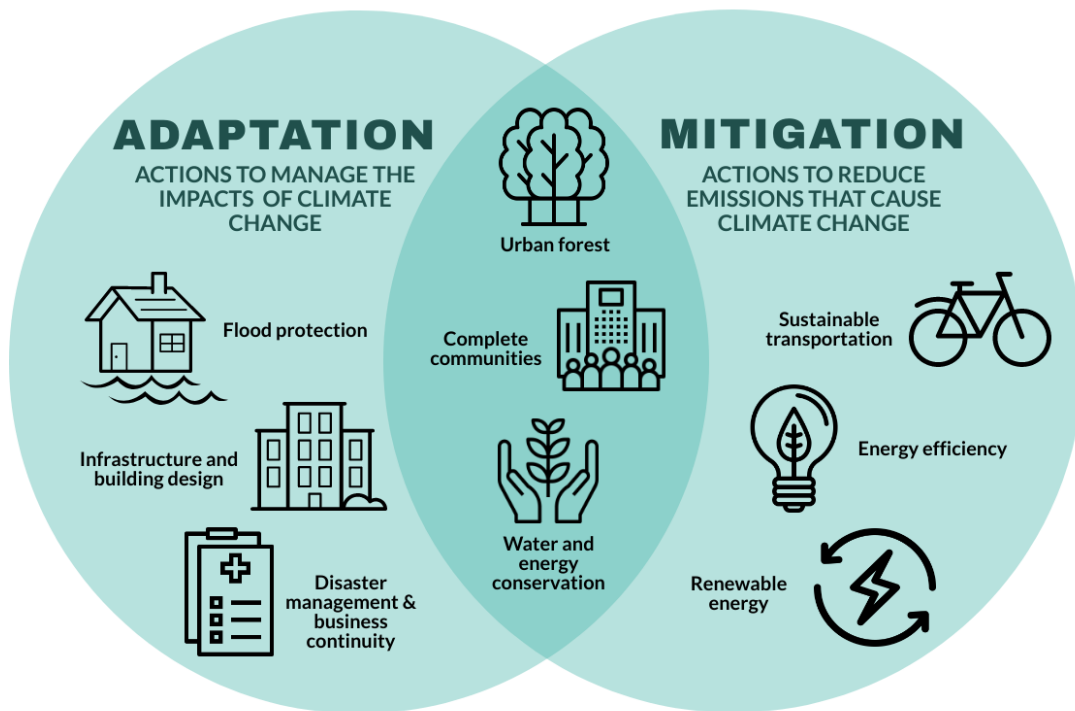


Figure 2: Actions to address Climate Change Adaptation and Mitigation

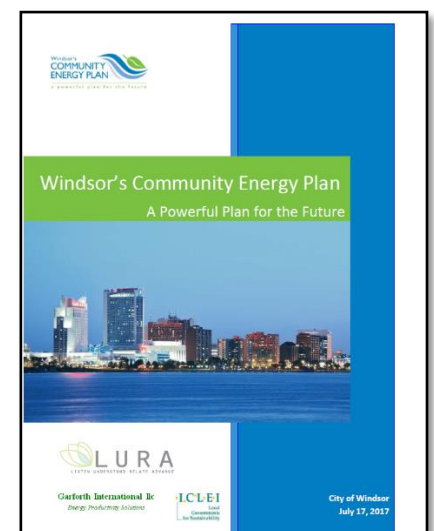


Climate Inertia: The Need for Immediate Action and Long-term Planning

One of the major challenges to climate change adaptation planning is the time delay between the release of greenhouse gas emissions and the resulting climate change impacts. When greenhouse gases are emitted into the atmosphere they can remain in the environment for decades before they impact our climate and often this impact does not occur in the same location as the emissions. This phenomenon is commonly referred to as “Climate Inertia” and it is an extremely important area of climate science currently being studied (Hansen *et al.* 2013). Research into this area is ongoing and there is no unanimous consensus on exactly the time delay, but current literature suggests a delay of 20 to 40 years (Tebaldi & Friedlingstein 2013). What this means for governments, municipalities, businesses and citizens looking to combat climate change is that we cannot expect to see the benefits of mitigation efforts immediately. A reduction in emissions in a certain location will not result in decreased climate impacts the following year, or even the following decade.

Based on the climate inertia delay of 40 years, Windsor is currently experiencing climate impacts from greenhouse gasses emitted in the late 1970s and early 1980s (Boden *et al.* 2009). On all local, provincial, national, and international scales emissions have drastically increased between the 1970s and present day, in fact, total global emissions have doubled since 1980. This means that we are only beginning to see the full affects of climate change and we can expect it to worsen and intensify drastically for at least the next 40 years, even if emissions were reduced to zero today. Climate change mitigation efforts undertaken now are working to reduce climate impacts for 2060. This is why climate change mitigation and adaptation planning are so important and must be done in partnership.

The Objectives and action items developed in *Degrees of Change* refer to Climate Change Adaptation. Work continues to mitigate climate change by reducing the greenhouse gas (GHG) emissions in the City of Windsor through the implementation of the *Community Energy Plan*. This Plan involves Community-level work and is lead by City of Windsor Administration as well as the Community Energy Plan Community Task Force.



Global and National Climate Change

Since the late 1800s, the Earth's temperature has risen by 1°C largely due to human activities (IPCC, 2014). As fossil fuels continue to be burned around the world, the warming is accelerating faster than before. Earth's average surface temperature in 2018 was the fourth hottest year on record since record-keeping began in the 1880s (NASA, 2019). As of 2019, the five warmest recorded years have occurred during the past five years, and the 20 warmest years on record have occurred over the past 22 years (NASA, 2019).

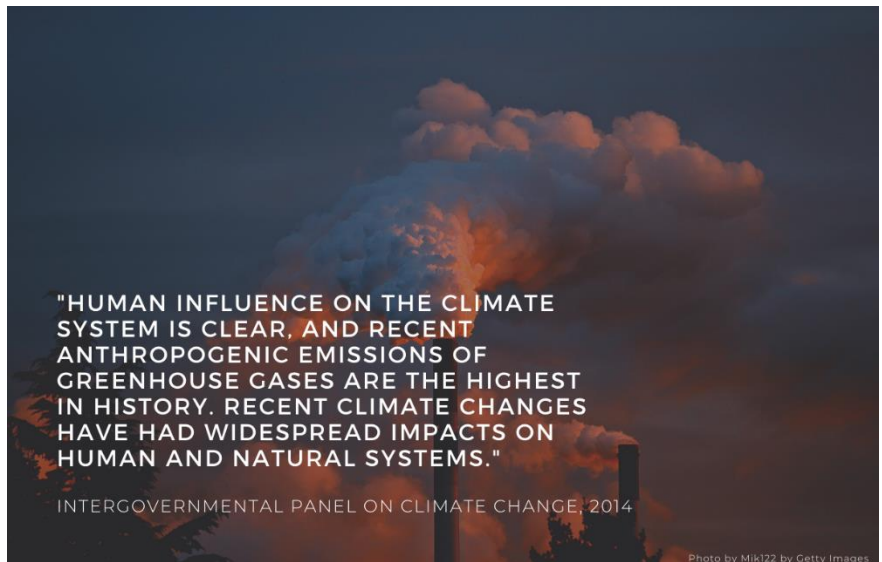
Since 1950, the overland temperature in Canada has increased by 1.5°C. This rate of warming is almost double the global average reported over the same period. The years 2011 and 2012 were 1.5°C and 1.9°C warmer than the 1961-1990 average in Canada, with 2016 now standing as the warmest year on record globally. Canada has also become wetter during the past half century, with average precipitation across the country increasing by approximately 13%. We have also seen more frequent and intense extreme events over the last 50-60 years than ever before. These events come in the form of extreme heat days, more instances of extreme precipitation and flooding, wind storms, and ice storms. In Canada, models show shorter return periods of extreme events into the future (McBean and Henstra, 2009).

Climate Science

The UN Intergovernmental Panel on Climate Change (IPCC) is the UN body tasked with assessing the science related to climate change, its impacts and potential future risks, and possible response options. In its Fifth Assessment report, the IPCC declared with certainty the widespread impact of human-caused climatic changes. The report stated: "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems" (IPCC, 2014).

At the 2015 United Nations Climate Change Conference (COP 21), 195 countries including Canada reached the Paris Agreement, an attempt to limit the global average temperature rise to "well below" 2°C from preindustrial levels, and pursue efforts to limit the

increase to 1.5°C. According to the IPCC, the 1°C of warming already experienced will have a long-lasting consequences for human and natural systems, and limiting global warming to 1.5°C (as opposed to 2°C) would allow more time to adapt to climatic changes such as sea level rise and ocean acidification (IPCC, 2018).



To limit warming, there must be “rapid and far-reaching” transitions in how we use our lands, energy, industry, buildings, transportation and design our cities (IPCC, 2018). In order to stay on track for 1.5°C of warming, emissions would need to drop to roughly half of 2010 levels by 2030, nearing zero by 2050 (IPCC, 2018). As such, the Government of Canada’s current emissions reduction target is 30 per cent below 2005 levels by 2030. However, a UN Environment report published in 2018 found that emissions pathways reflecting the commitments from the Paris Agreement would still constitute warming of 3°C by 2100 (UNEP, 2018). If the emissions gap is not closed by 2030, it is very plausible that the goal of a well-below 2°C temperature increase is also out of reach (UNEP, 2018).

Now more than ever, it is crucial that cities adapt to help community members prepare for increasing intensity of climate-related risks. The IPCC recommends a mix of adaptation and mitigation options to limit global warming to 1.5°C, implemented in a participatory and integrated manner (IPCC, 2018).

Policy direction on Adaptation

In addition to signing onto the Paris Climate Agreement, the Government of Canada has produced several reports that inform and guide decision-makers on climate change adaptation. In 2016, it released its Pan Canadian Framework on Clean Growth and Climate Change, which includes adaptation considerations and actions to improve climate resiliency. Major focus areas include building climate resilience through infrastructure, protecting and improving human health and well-being, and reducing climate-related hazards and disaster risks. The framework recognizes the important role that municipalities will play in implementing climate solutions locally.

While Federal and Provincial governments provide strategic focus, standards, and potential funding streams for adaptation, it will be up to local governments to tailor climate change adaptation strategies to their local circumstances and to the unique set of climate change impacts they expect to face.

Adaptation in Windsor

The City of Windsor has been working on climate change adaptation for nearly a decade. Faced with several extreme temperature and precipitation events, the City has undertaken multiple initiatives to better understand and plan for localized risks.

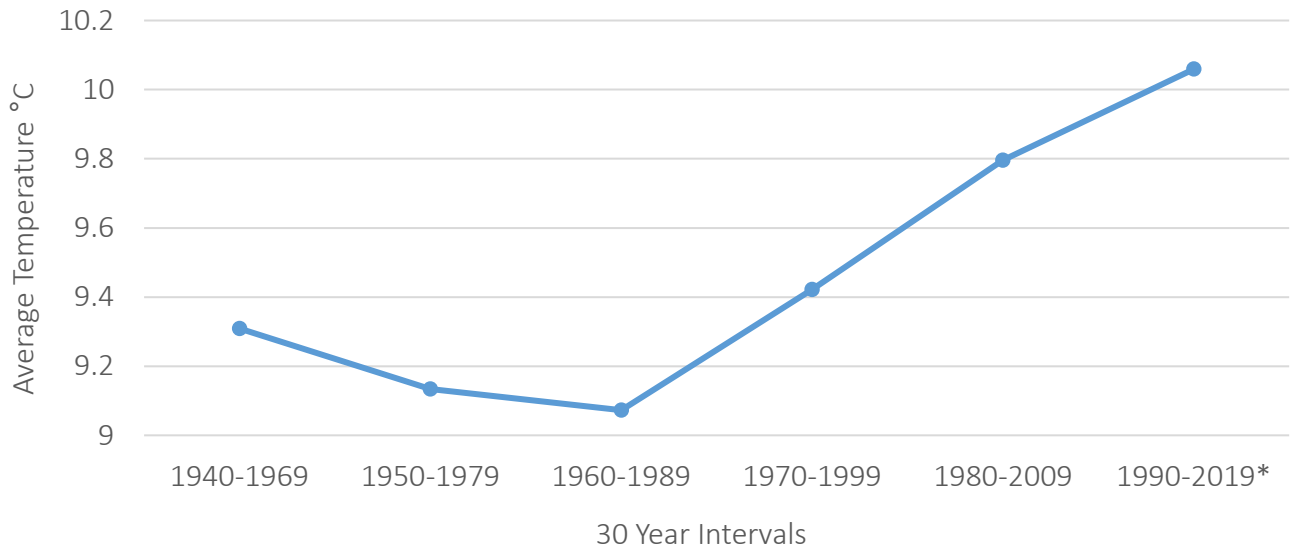
This Plan represents an opportunity to build upon work completed to date, and integrate lessons learned from Windsor’s work on adaptation in the community.

Table 1: City of Windsor Climate Change Activities		
Mitigation		
✓ Active Transportation Master Plan (2019)	✓ Corporate Climate Action Plan (2017)	✓ Increased public education
✓ LED streetlight conversion	✓ Energy efficiency upgrades to buildings	✓ Tree planting programs
✓ Urban Forest Canopy Cover & Benefits Assessment		

Windsor's Historical Climate

Temperature

Environment Canada has maintained a weather station at the Windsor airport since the 1940s. Figure 3 below illustrates that the 30-year mean temperature in Windsor has increased from 9.1°C in 1960-1989 to 10.1°C in 1990-2019, representing a 1°C increase in our average annual temperature.



Notes: * includes data until August 2019

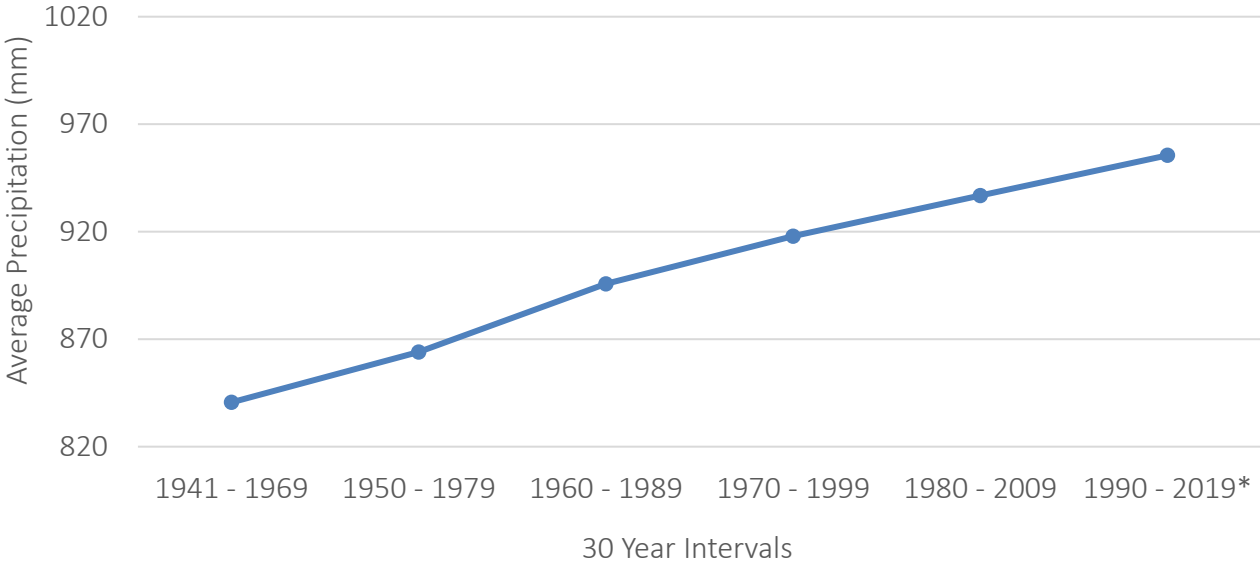
Figure 3: Windsor's Historical 30 Year Mean Annual Temperatures





Precipitation

Figure 4 below shows that Windsor’s 30-year mean annual rainfall has increased from 840mm in 1941- 1969 to 955mm in 1990-2019 representing an increase of approximately 7%. In the last decade, 2010 – 2019, not shown on the figure, it is interesting to note that the mean annual rainfall has been measured at 995mm.



Notes: * includes data until August 2019

Figure 4: Windsor’s Historical 30 Year Mean Annual Precipitation

Windsor's Climate Projections

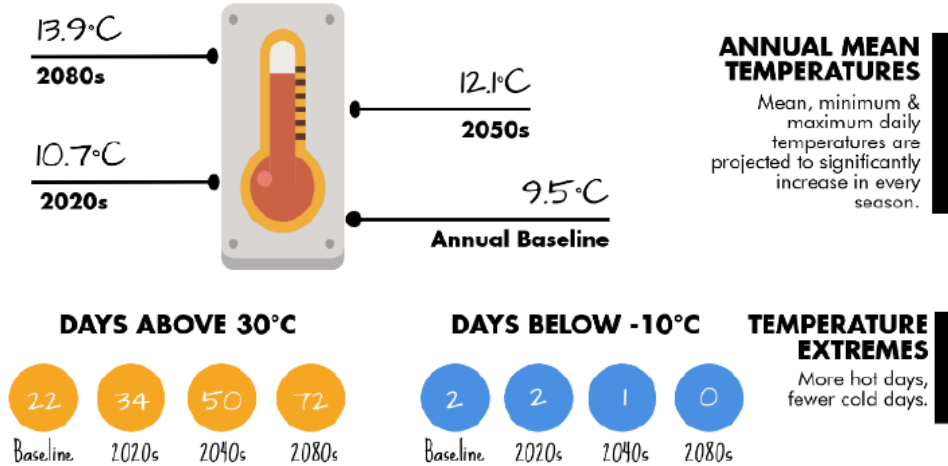
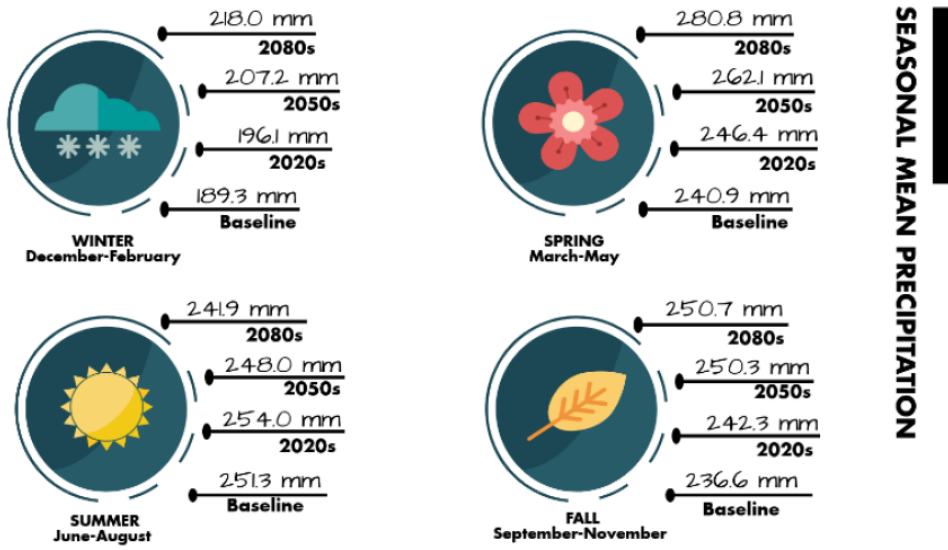
Projecting future climate conditions requires historical weather station data from the City of Windsor as well as an ensemble of global climate models, which provide the best available scientific assessment of how future social and economic conditions will influence the climate system. Future conditions are modeled on future climate "scenarios," which are assumptions of future atmospheric composition and an understanding of the effects of increased atmospheric concentrations of greenhouse gases (GHG), particulates, and other pollutants. Producing scenarios requires estimates of future population levels, economic activity, structure of governance, social values, and patterns of technological change.

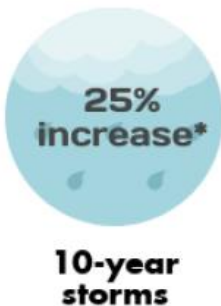
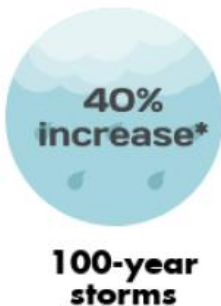
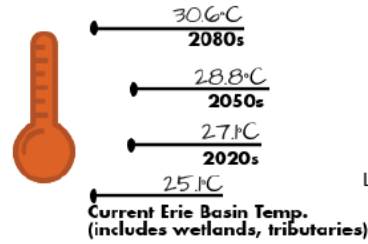



The climate data gathered for the City of Windsor is based on global climate models and emission scenarios defined by the Intergovernmental Panel on Climate Change (IPCC), drawing from both the Fourth Assessment Report (AR4) for temperature and precipitation data and the Fifth Assessment Report (AR5) for extreme weather data. Localized climate projections were retrieved from the Canadian Climate Data and Scenarios Network. A summary table of the climate projections for Windsor can be found in Table 2. Please see Appendix A for more detailed climate projections.

While it is not possible to anticipate future climate changes with absolute certainty, climate change scenarios create plausible representations of future climate conditions. Uncertainty is factored into climate change scenarios, models, and data, and reflects the complex reality of environmental change and the evolving relationship between humans and the planet.



Table 2: Summary Table - Windsor's Climate Projections

<p>Temperature</p>	 <p>ANNUAL MEAN TEMPERATURES Mean, minimum & maximum daily temperatures are projected to significantly increase in every season.</p> <p>DAYS ABOVE 30°C</p> <table border="1"> <tr> <td>2.2</td> <td>34</td> <td>50</td> <td>72</td> </tr> <tr> <td>Baseline</td> <td>2020s</td> <td>2040s</td> <td>2080s</td> </tr> </table> <p>DAYS BELOW -10°C</p> <table border="1"> <tr> <td>2</td> <td>2</td> <td>1</td> <td>0</td> </tr> <tr> <td>Baseline</td> <td>2020s</td> <td>2040s</td> <td>2080s</td> </tr> </table> <p>TEMPERATURE EXTREMES More hot days, fewer cold days.</p> <ul style="list-style-type: none"> • Average annual temperature increasing by up to 4.4°C by the 2080s; • Average number of days above 30°C will more than double by the 2050s and more than triple by the 2080s. 	2.2	34	50	72	Baseline	2020s	2040s	2080s	2	2	1	0	Baseline	2020s	2040s	2080s																
2.2	34	50	72																														
Baseline	2020s	2040s	2080s																														
2	2	1	0																														
Baseline	2020s	2040s	2080s																														
<p>Precipitation</p>	 <p>SEASONAL MEAN PRECIPITATION</p> <p>WINTER (December-February)</p> <table border="1"> <tr> <td>218.0 mm</td> <td>2080s</td> </tr> <tr> <td>207.2 mm</td> <td>2050s</td> </tr> <tr> <td>196.1 mm</td> <td>2020s</td> </tr> <tr> <td>189.3 mm</td> <td>Baseline</td> </tr> </table> <p>SPRING (March-May)</p> <table border="1"> <tr> <td>280.8 mm</td> <td>2080s</td> </tr> <tr> <td>262.1 mm</td> <td>2050s</td> </tr> <tr> <td>246.4 mm</td> <td>2020s</td> </tr> <tr> <td>240.9 mm</td> <td>Baseline</td> </tr> </table> <p>SUMMER (June-August)</p> <table border="1"> <tr> <td>241.9 mm</td> <td>2080s</td> </tr> <tr> <td>248.0 mm</td> <td>2050s</td> </tr> <tr> <td>254.0 mm</td> <td>2020s</td> </tr> <tr> <td>251.3 mm</td> <td>Baseline</td> </tr> </table> <p>FALL (September-November)</p> <table border="1"> <tr> <td>250.7 mm</td> <td>2080s</td> </tr> <tr> <td>250.3 mm</td> <td>2050s</td> </tr> <tr> <td>242.3 mm</td> <td>2020s</td> </tr> <tr> <td>236.6 mm</td> <td>Baseline</td> </tr> </table> <ul style="list-style-type: none"> • Average precipitation expected to increase, particularly in winter and spring; • Summer may eventually see a slight decrease in precipitation, coupled with increasingly warm seasonal temperatures. 	218.0 mm	2080s	207.2 mm	2050s	196.1 mm	2020s	189.3 mm	Baseline	280.8 mm	2080s	262.1 mm	2050s	246.4 mm	2020s	240.9 mm	Baseline	241.9 mm	2080s	248.0 mm	2050s	254.0 mm	2020s	251.3 mm	Baseline	250.7 mm	2080s	250.3 mm	2050s	242.3 mm	2020s	236.6 mm	Baseline
218.0 mm	2080s																																
207.2 mm	2050s																																
196.1 mm	2020s																																
189.3 mm	Baseline																																
280.8 mm	2080s																																
262.1 mm	2050s																																
246.4 mm	2020s																																
240.9 mm	Baseline																																
241.9 mm	2080s																																
248.0 mm	2050s																																
254.0 mm	2020s																																
251.3 mm	Baseline																																
250.7 mm	2080s																																
250.3 mm	2050s																																
242.3 mm	2020s																																
236.6 mm	Baseline																																

<p>Extreme Precipitation</p>	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>25% increase*</p> <p>10-year storms</p> </div> <div style="text-align: center;">  <p>40% increase*</p> <p>100-year storms</p> </div> </div> <p style="text-align: center; font-size: small;">*Storm intensity may increase in by the above percentages (50th percentile, 10%-90% range)</p> <ul style="list-style-type: none"> • More intense precipitation events are expected to occur more frequently; • 25% increase in 10-year storms; • 40% increase in 100-year storms (Windsor has already experienced two in the last three years); • On average, more rain is expected to fall (in mm/h) during periods of precipitation.
<p>Water Temperature</p>	<div style="display: flex; align-items: center;"> <div style="flex: 1;">  <p style="font-size: x-small;">30.6°C 2080s</p> <p style="font-size: x-small;">28.8°C 2050s</p> <p style="font-size: x-small;">27.1°C 2020s</p> <p style="font-size: x-small;">25.1°C Current Erie Basin Temp. (includes wetlands, tributaries)</p> </div> <div style="flex: 1; text-align: center;">  <p>33%</p> <p style="font-size: x-small;">Loss of coldwater (<19°C) stream habitat</p> </div> <div style="flex: 1;"> <p>WATER TEMPERATURES</p> <p style="font-size: x-small;">Erie basin temperatures will increase. This can negatively impact wetlands, habitats, and biodiversity.</p> </div> </div> <ul style="list-style-type: none"> • Temperature of Erie basin (includes wetlands and tributaries) continues to increase.
<p>Water Levels</p>	<p>WATER LEVELS</p> <p>Water levels in Lake Erie and Lake St. Clair were at record lows until 2013, but have since been increasing to above-average levels. This is caused by increased precipitation and decreased evaporation and is expected to continue through 2018.</p> <div style="display: flex; align-items: center; margin-top: 20px;"> <div style="flex: 1; font-size: x-small;"> <p>In the long term, projections of warmer temperatures translate into expectations of lower water levels in the Great Lakes system</p> </div> <div style="flex: 1; text-align: center;">  <p style="font-size: x-small;">Loss of wetland water budget and abundance of wetland vegetation, birds, and fish communities</p> </div> <div style="flex: 1; text-align: center;">  </div> </div> <ul style="list-style-type: none"> • Water levels have been above average since 2013; • In 2019 the Detroit River reached a high water level of 176.08 meters; • In the near climate future water levels are expected to continue to be high; • In the distant climate future, water levels are projected to decrease in Great Lakes partially due to warmer temperatures (i.e. more evaporation) and changing precipitation patterns.

Climate Change Impacts and Issues



The physical, social, economic and ecological health of Windsor is influenced by our changing climate in a variety of complex and interdependent ways. This Adaptation Plan addresses a wide range of climate impacts that may pose risks to systems and sectors across the community.

Physical Impacts

Climate change impacts will affect the built infrastructure in Windsor, from roads and bridges, to buildings, transportation systems, energy systems, parks, and public spaces. More frequent and extreme temperatures and precipitation events will increase maintenance requirements, replacements costs, and increase potential for the loss of assets throughout the community. Increased precipitation will have a direct impact on stormwater (e.g. stormwater pond capacity) and transportation infrastructure (e.g. road flooding).

Public health and safety can also be threatened when extreme weather causes dangerous conditions in public places or in the transportation system. Cultural sites, parks, and community spaces such as rinks, pools, soccer fields and trails are also at risk of damage or closure due to temperature and precipitation changes. It is crucial to ensure that risks to Windsor's built infrastructure are measured thoroughly and adaptive measures are put in place to protect these valuable resources and those who use them.

Social Impacts

Climate and weather-related impacts have both direct and indirect effects on the complex social systems in Windsor. Changing temperature and precipitation patterns have been linked to an increased spread of vector-borne diseases, food insecurity, and human health implications such as illness, injury and/or stress. Hot days can cause respiratory issues and heat stress in the elderly, children, and vulnerable populations. Extreme precipitation creates dangerous conditions at home, in workplaces and schools, and outdoors on roads and sidewalks. Power outages can occur as a result of extreme weather-related events, which can affect our ability to communicate during emergencies. In addition, climate change and weather-related disasters has been linked to increasing mental health challenges and physiological stress in community members. As a result, extra pressure is placed on Health care services to care for these individuals. To mitigate social risks associated with climate change, communities need to prepare for the human vulnerability to climate-related impacts (United Way, 2013).

It is critical for communities to understand that climate change does not affect all social systems equally. Those most vulnerable may include community members who are low income, chronically ill, lack a social network, elderly, those living in isolated dwellings, or facing other systematic barriers (Health Canada, 2018). These groups are typically vulnerable to harm from climate impacts as they have fewer resources to prepare for changing conditions or to offer help when needed. Each community is unique, and effort is required to identify and support those who are most vulnerable to climate-related risks.





Economic Impacts

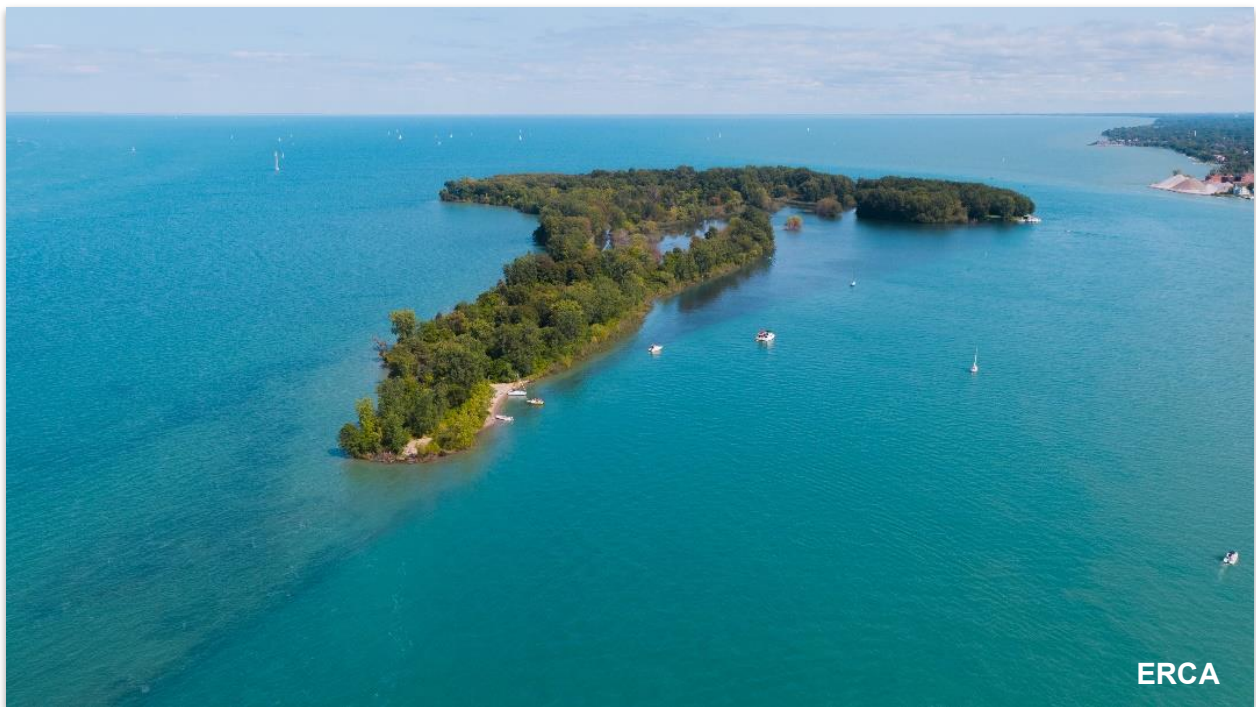
Multitudes of studies have determined that the net damage costs of climate change are likely to be significant and will increase over time (IPCC, 2014). As such, climate impacts will have both immediate and long-lasting impacts on the flow of goods and services through the community in Windsor. Changes to the production, price, and demand for goods and services can have an adverse effect on the local economy, and produce economic losses as have already been experienced in the community. Local businesses may experience operational losses, business continuity issues, and disruptions to essential services (e.g. power, telecommunications) which are relied upon to deliver products and services. Climate change is also impacting several local revenue sources such as energy, tourism, recreation, freshwater fisheries and transportation, generating losses that are likely to be felt within the short and medium term (Warren and Egginton, 2008). The economic and recreational benefits of seasonal amenities such as outdoor skating rinks and marinas are already challenged by rising temperatures and an increase in extreme weather. Residents will also be impacted as insurance premiums rise and potential damage to properties increases as a result of extreme weather events.

It is important to understand the impacts of climate change on the local economy in order to build awareness and engagement from the business community and to enhance resilience within local economic sectors. While there may be certain opportunities that could arise, particularly in tourism related industries, it is important to proactively plan for the impacts (and opportunities) of climate change. To enable action, governments and business alike must embed adaptation within existing risk-management mechanisms and processes and work collectively to improve the adaptive capacity of the local economic sectors in Windsor (NRTEE, 2012).

Ecological/Natural Impacts

Ecological systems have a significant influence on Windsor's natural capital and its ability to deliver services which in turn contribute to human health and well-being as well as the productivity of a wide range of economic sectors (Nantel et al., 2014). Windsor's natural areas and the services they provide to the community are already under stress as a result of human activities such as development and pollution. Climate change creates opportune conditions for habitat loss, forest fires, invasive species, and the spread of insects and disease.

Impacts on ecological systems often cascade into socioeconomic and built systems wherein the consequences will be felt across the community for the long term. For example, warmer temperatures and lower summer precipitation can cause low water levels leading to reduced soil moisture for ecosystems, forests and agricultural land. This can introduce a wide range of concerns such as a loss of ecosystem function, biodiversity, natural shading, carbon sequestration, as well as damage to crops and the livelihood of the agricultural community. Ecological impacts should be of concern to communities as ultimately the risk of ecosystem damage and loss of biodiversity will diminish the ecosystem services and socioeconomic benefits provided to the community (Chiotti and Lavendar, 2008).

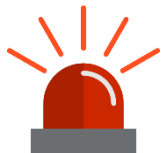


Priority Climate Change Impacts

The Community Task Force and City of Windsor Administration concurrently worked to develop a list of local climate change impacts to their organizations and departments. The climate change impacts were based on subject matter expertise of each stakeholder involved, who considered what climate-related impacts the community has already experienced and what impacts may occur given future climate projections.

The community and corporate climate impacts were then prioritized based on Vulnerability and Risk Assessments conducted the Community Task Force as well as by Administration. Based on the results of the Vulnerability and Risk Assessments, a number of impacts were identified as priorities. Impacts were prioritized based on the total social, economic, and environmental consequence scores, the cumulative risk ranking and the vulnerability scores.

The priority community and corporate climate impacts have been combined as summarized below. For a detailed analysis of the risk and vulnerability assessment completed for each corporate impact, please consult *Climate Change Impacts in Windsor – A Technical Analysis*.



Impacts to Community Health and Safety

An increase in extreme weather events increasing the health and safety risk to the community.

An increase in extreme weather events causing strain on emergency response and community service providers.

An increase in extreme weather events leading to basement flooding, and without proper restoration allowing mold growth.

An increase in extreme heat causing potential heat-related health issues at facilities servicing vulnerable populations including schools, homes for the aged and medically compromised individuals.

Increasing summer temperatures causing a decrease in air quality.

Increasing annual temperatures leading to an increased risk for vector borne disease and new infectious diseases.

Increasing winter precipitation leading to an increased risk of ice conditions.

An increase in rainfall and temperature causing increased algae growth in our water bodies.



Impacts to Building and Property Damage

An increase in extreme precipitation leading to basement flooding.

An increase in surface water levels leading to overland flooding from the Detroit River, Little River, Lake St. Clair and Lake Erie.

An increase in winter and spring temperatures leading to quicker thawing and snowmelt contributing to overland flooding.



Impacts to Infrastructure Services

An Increase in extreme precipitation leading to an overwhelming of City infrastructure.

An increase in extreme weather response needed causing a diversion of financial and human resources.

Increasing intensity of storms leading to damage to infrastructure, power outages, safety and additional clean-up costs.

An increase in extreme hot days leading to infrastructure wear and tear.

An increase in extreme hot days leading to more frequent buckling of roads leading to failure.



Impacts to Ecosystem Function

Increasing intense storms impacting the tree canopy through stress and damage.

An increase in annual temperature causing an increase in plant pests, disease and invasive species.

Increased temperatures and precipitation causing damage to trees and natural features, leading to loss of ecosystem goods and services.

Increased annual temperature and a shift in ecoregions causing inhospitable habitat for sensitive plant and animal species, changing the community's biodiversity.



Impacts to Community Services

An increase in winter temperatures resulting in a reduced length of time outdoor rinks can operate.

An increase in extreme weather events leading to increased damage to nature trails, parks, and green spaces causing temporary or permanent closures of outdoor public spaces.

An increase of surface water levels leading to overland flooding causing closures of businesses and schools, and disruptions to community services.

Increased temperatures and precipitation causing an increase in health risks and discomfort leading to decreased use of public transit.



Impacts Quality of Life

An increase in summer temperatures causing an increase in energy demand.

Increasing summer temperatures causing stress on landscaping and park lands.

An increase in extreme precipitation causing basement flooding and resulting in personal financial strain due to personal property loss and high replacement costs.

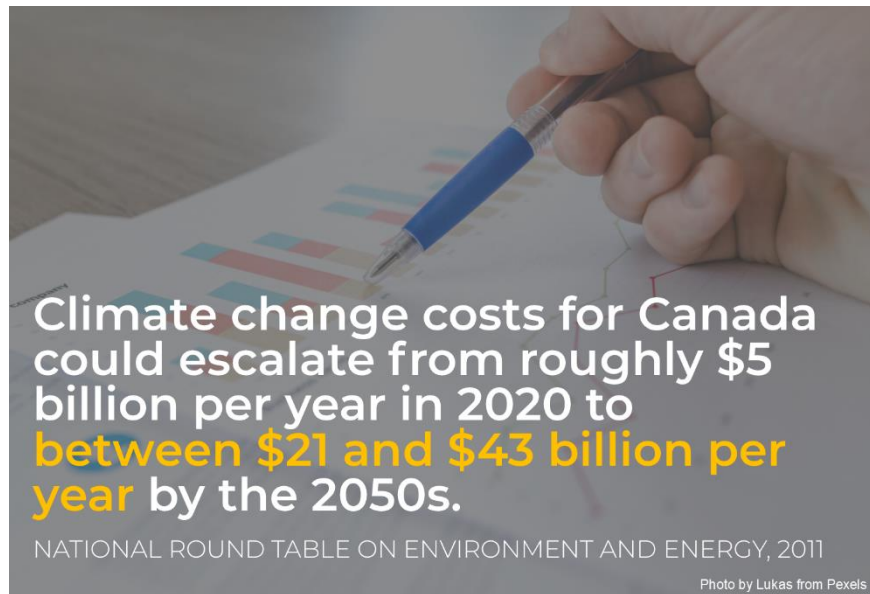
Increasing summer temperatures leading to decreased air quality may result in fewer opportunities for active transportation and outdoor recreation.

An increase in annual temperatures and extreme precipitation leading to more heat and water stress on crops and livestock.

An increase in extreme weather causing damage to Windsor's natural land, water features and recreational facilities leading to decreased summer tourism.

The Cost of Doing Nothing

A 2011 report by the National Round Table on the Environment and Energy estimated that climate change costs for Canada could escalate from roughly \$5 billion per year in 2020 to between \$21 and \$43 billion per year by the 2050s (NRTEE, 2011). The magnitude of costs depends upon a combination of two factors: global emissions growth as well as the economic growth and



population growth in Canada during that time. The modelling shows there is a risk that these costs could be significantly higher than those stated. In the 2050s, where climate change costs are estimated at \$21 billion per year in the low climate change/slow growth scenario, there is a 5% chance that the costs could actually be at least \$44 billion per year. In the high climate change/rapid growth scenario, climate-related costs are estimated that \$43 billion per year by the 2050s, but there is a 5% chance that costs could be at least \$91 billion (NRTEE, 2011)

In 2016, the Office of the Auditor General of Canada published a report by the Commissioner of Environment and Sustainable Development titled "*Mitigating the Impacts of Severe Weather*". The report states that from 2009 through 2015, the federal government spent more on recovering from large-scale natural disasters than in the previous 39 years combined through Disaster Financial Assistance Arrangements (Figure 5) (Auditor General, 2016). The report goes on to highlight that disaster mitigation measures (climate change adaptation) can be very cost effective for government and society. For example, the estimated \$63 million invested in disaster mitigation measures to build the Manitoba Red River Floodway in 1960 saved \$8 billion by 2008 in avoided recovery costs. In addition, such foresight can reduce disruption of local economies and communities.

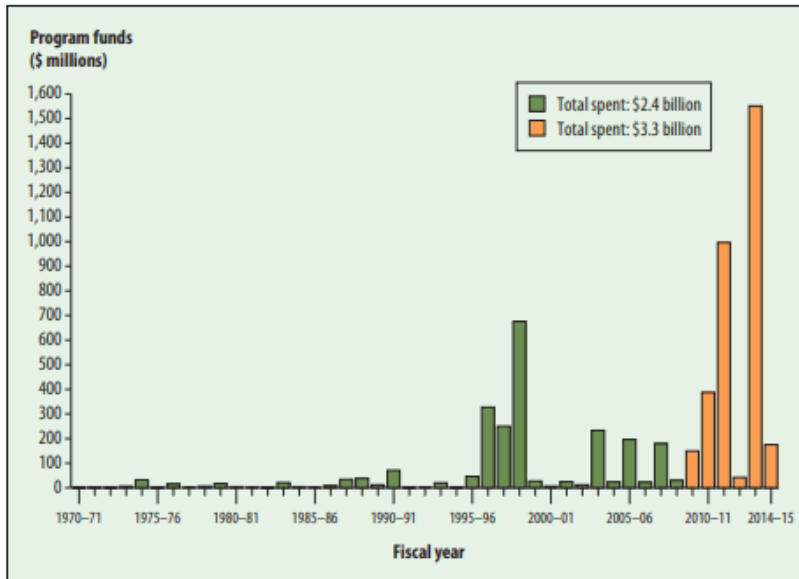


Figure 5: Disaster Financial Assistance Arrangements Costs from 1970 to 2015

For more than a decade, the Insurance Bureau of Canada (IBC) has been reporting a rise in claims as a result of the increase in severe weather events related to climate change. Specifically, the IBC notes that catastrophic losses (insured losses of \$25 million or more from natural disasters) have increased dramatically over the last decade (IBC, 2016). IBC’s 2016 statistics (in 2015 dollars) illustrate this pattern. Over the 21-year period from 1983 to 2004, insured losses averaged \$373 million a year. In the decade from 2005 to 2015, the annual average loss more than tripled, growing to \$1.2 billion a year. In 2018 alone, insured damage for severe weather events across Canada reached \$1.9 billion. Notably, 2018 has the fourth-highest amount of losses on record. However, unlike other years where single significant events such as the Quebec ice storm in 1998, the Calgary floods in 2013 or the Fort McMurray wildfire in 2016 contributed drastically to insured losses, in 2018 no single event caused the high amount paid out for losses. Instead the substantial amount of insured losses were cumulative from numerous severe storms and flooding across the country.



The 2016 and 2017 rain events resulted in **over \$200 million each** in economic losses to the Windsor community.

Photo from WindsorDOTca

In recent history, IBC has reported two catastrophic losses for the Windsor Community. Extreme precipitation events in 2016 and 2017 leading to massive flooding reported insured losses of \$108 million and \$124 million, respectively. Based on the results of a Partners for Action survey completed after the flooding events, approximately 44% of Windsorites paid for flooding damages through insurance and only 0.5%

received government disaster assistance. The rest of the homeowners who had flooded self financed their restoration through personal savings, loans, RRSPs or other means. Therefore, it is assumed that both the 2016 and 2017 rain events actually resulted in well over \$200 million each in economic losses to the Windsor community. It is important to note that this does not factor in costs such as lost wages, loss of irreplaceable items, as well as emotional and physical toll on homeowners during and after flood recovery.

Public Safety Canada estimates that for every dollar invested in climate change adaptation \$3 to \$5 is saved in recovery costs (Auditor General, 2016). Similarly, an independent study commissioned by the U.S. Federal Emergency Management Agency found that the return on investment in the United States was \$4 in cost savings for every \$1 spent on disaster mitigation (adaptation). Studies in Australia have found a return of 3:1, while in the United Kingdom, 5:1 (Ontario, 2019).



Photo by Pixabay from Pexels

For more information, refer to the *Climate Change Impacts in Windsor – A Technical Analysis* document which includes further estimates of the “cost of doing nothing” for each identified impact, where enough data was available.

Future Directions

The Vision, Objectives and Actions presented in this Plan are a combination of City administration and community-led measures that have been developed by the Community Task Force and City Administration to address Windsor's priority climate impacts and risks.

A detailed implementation table outlining for each action the lead and supporting roles, associated Municipal Plans and Policies, timeline, estimated costs and level of effort can be found in Appendix B.

Monitoring metrics for the main actions can be found in the "Indicators" section of this document.



Vision

Windsor will continue to prepare for our climate future by creating a more resilient city to the effects of a changing climate. We will minimize climate change risks to our community through the advancement of sustainable policies, infrastructure investment and public education. Forward thinking and proactive actions will benefit our community health, environment and economy.

Objectives

1. Integrate Climate Change Thinking and Response
2. Protect Public Health and Safety
3. Reduce Risk to Buildings and Property
4. Strengthen Infrastructure Resilience
5. Protect Biodiversity and Enhance Ecosystem Functions
6. Reduce Community Service Disruptions
7. Build Community Resilience



Denotes Actions where community involvement and participation is needed.



1 Integrate Climate Change Thinking and Response

Photo by liam ortiz from Pexels

A knowledgeable, involved community is critical in the fight for climate change adaptation. Both the Corporation of the City of Windsor as well as the broader community as a whole will benefit greatly from a better understanding of how to prepare for our climate future as well as how to decrease our energy consumption and greenhouse gas emissions.

Objective 1 actions address many of the impacts facing the Windsor community that require a broad, integrated approach across sectors to implement. These actions work to integrate climate change considerations into decision making at the City of Windsor, as well as push our residents and community partners to be knowledgeable about climate change and act to adapt to the impacts and risks of our climate future.

Action 1.1 Incorporate climate change considerations into Municipal Decision Making.

- Incorporate climate change language into the City's Official Plan, Zoning By-Law, and any implementation guidelines;
- Integrate climate change considerations into Windsor's new and existing Plans and Policies, as well as Administrative and Consultant reports.

Action 1.2 Increase community level of knowledge on Climate Change.



- Enhance climate change education and awareness initiatives for Windsor residents and City staff;
- Collaborate with the University, College and local school boards to enhance climate change training and development;
- Continue to consult and engage local First Nations to further climate action based on traditional knowledge, insights and experience;
- Engage with professional agencies to develop and enhance local climate change knowledge and experience;
- Continue to share relevant climate change data on Open Data Catalogue
- Investigate the creation of a City Lab in Windsor - an innovation hub bringing together students, academia and civic leaders to work towards climate action.

Action 1.3 Build financial support for unforeseen impacts of climate change

- Develop a Municipal severe weather reserve fund to address funding deficits due to emergency response.

Action 1.4 Enhance the ability to collect and share climate change related data

- Leverage climate change data to be included in municipal decision making;
- Automate notifications and triggers to assist with adaptation actions;
- Use data to monitor the implementation of *Degrees of Change*;
- Share data to empower the community to support climate change planning;
- Use data to inform education campaigns.



Climate change poses numerous, complex health and safety concerns for our community. Over the coming decades, Windsor will see an increase in extreme weather events, temperatures and precipitation including freezing rain. Losses from catastrophic weather events as well as heat health issues and an increase in vector borne diseases pose health implications that are the responsibility of the City as well as the community.

Protecting our vulnerable communities against the impacts of climate change is a major theme in this objective. These populations include people with low income, children, seniors, those who are socially isolated, people experiencing homelessness and those with special existing health conditions.

Action 2.1 Update Community Development and Health Services (CDHS) Emergency Response Plan

- Consult with County stakeholders to discuss regional approaches;
- City of Windsor staff training for emergency response;
- Conduct exercises to test opening emergency shelters in times of crisis;
- Develop a notification system for the public on what to do and where to go in an emergency.



Action 2.2 Develop an emergency response procedure for extreme flooding events

- Ensure open communication among City of Windsor staff and first responders before, during and after the event;
- Identify vulnerable roads and areas prone to overland and extreme rain event flooding and have appropriate plans in place to address them;
- Consult and collaborate with first responders to prepare road closure protocols;
- Develop a safe access standard for road evaluations;
- Continue to coordinate emergency response with the Local Health Integration Network (LHIN) to decrease risk to vulnerable populations.

Action 2.3 Enhance public education to increase personal preparedness & reduce health risks associated with extreme weather



- Produce targeted messaging for at risk populations including seniors and persons with limited mobility as well as their caregivers;
- Enhance supports for Community Development and Health Services clients;
- Educate the public on when to call 911 or 311.

Action 2.4 Review the 2011 Heat Alert and Response Plan and Update as required

- Determine emergency conditions that require opening community reception centres or emergency shelters;
- Ensure all public facilities have access to an air conditioned space;
- Encourage the public to seek relief from extreme heat in public spaces;
- Identify privately owned places that could be used as cooling centres during Heat Alerts;
- Promote access to free tap water through programs such as Blue W or the Windsor Essex County Health Units Water app;
- Increase access to water bottle re-fill stations at public buildings;
- Review the 2011 Vulnerability to Extreme Heat in Windsor report and update where possible.

Action 2.5 Enhance protection of outside workers during extreme heat conditions



- Identify opportunities for targeted education to at risk workers and their employers (e.g. Factory and greenhouse workers, farmers, roofers, landscapers and construction workers);
- Identify options to modify outdoor staff work schedules and/or tasks to earlier in the day, or in shaded or indoor areas;
- Investigate alternatives for cooler clothing options and hats for outside workers;
- Provide sun protection options such as sunscreen or hats to staff;
- Promote the importance of hydration to staff.

Action 2.6 Continue to protect indoor air quality



- Continue to monitor the indoor air quality of corporate work places and public places;
- Encourage residential and business property owners to monitor air quality.

Action 2.7 Develop an Air Quality Health Index (AQHI) Response Plan

- Communicate AQHI warnings via email and a website link to the public as well as community partners (e.g. Windsor- Essex Housing Connections WEHC);
- Identify actions to limit pollution produced during AQHI warnings as well and limit staff and community exposure to poor air quality;
- In collaboration with the Windsor-Essex County Health Unit increase education about the Air Quality Heat Index (AQHI).

Action 2.8 Decrease public and private contributions to air quality contaminants



- Improve education and awareness of the Anti-Idling Bylaw;
- Enhance the City of Windsor's Anti-Idling Bylaw and increase enforcement;
- Investigate the feasibility of replacing gas and diesel burning equipment with cleaner technologies such as electric powered equipment;
- Promote the benefits of public and private trees including carbon dioxide capture and improved air quality.

Action 2.9 Enhance monitoring for vector borne diseases and new infectious diseases

- Continue to work in collaboration with the Windsor-Essex County Health Unit (WECHU) to undertake tick and mosquito surveillance programs;
- Promote the WECHU Fight the Bite public awareness campaign;
- Continue to participate in larviciding programs to decrease the spread of vector borne diseases;
- Provide personal protection for outside workers against vector borne disease;
- Enhance Bylaw Enforcement and response to standing water complaints.

Action 2.10 Enhance community safety during icy conditions



- Enhance winter maintenance and snow ploughing of sidewalks and public spaces;
- Enhance Bylaw Enforcement and response to public and private snow and ice complaints;
- Identify and address areas where snow melt water accumulates and increases the likelihood of ice formation;
- Review and update the City's salt management plan;
- Enhance education to the public about ice and snow hazards;
- Improve communications to private businesses and landowners on their roles and responsibilities for the maintenance of sidewalks during freezing rain or snow events.

Action 2.11 Enhance surveillance for blue-green algae in our surface water bodies

- In collaboration with the Windsor-Essex County Health Unit enhance education about the dangers of blue-green algae for water users;
- Develop an education campaign targeting fertilizer use and washing cars around storm water ponds;
- Develop a regional plan to reduce phosphorus levels in our environment.



3 Reduce Risk to Buildings and Property

Photo by Vlad Chetan from Pexels

In recent years the Windsor community has felt the devastating effects of property damage due to flooding as a result of extreme rain events. This damage can threaten our quality of life, financial well being as well as our emotional state. With our climate projections predicting an increase in the frequency of extreme rain events we need to act now to protect our building and property investments.

Many actions in this objective require direct involvement and investment from our residents. Strengthening community knowledge and helping residents be proactive is crucial to the success of this objective.

Action 3.1 Increase education to the public on how to reduce their personal risk of basement flooding



- Hire a coordinator to conduct public education and outreach to highlight responsibilities of the property owner and promote lot level storm water controls. These include but are not limited to rainbarrels, rain gardens and down spout disconnections;
- Develop outreach programs to teach residents what they can do to reduce snowmelt flooding on their property;
- Provide education to private market and social housing landlords and business owners outlining precautions, insurance options and responsibilities for tenants and landlords;
- Provide education on cleaning and fixing damaged property after a flooding event to prevent mould growth.

Action 3.2 Develop a media notification system to prepare residents for large storm events

- Provide information on what to do before, during and after extreme rain events in real time.

Action 3.3 Continue and enhance the Basement Flooding Subsidy Program and incentivize other methods of protecting property

- Include a subsidy for sewer lateral video surveillance and subsequent repair or replacement as part of the Basement Flooding Subsidy Program;
- Continue to subsidize rainbarrels.

Action 3.4 Continue and enhance tree pruning programs to develop proper tree health and limit future damage



- Enhance tree pruning and maintenance programs on City of Windsor trees using the City's updated Tree Inventory;
- Implement an outreach program for private tree care and maintenance.

Action 3.5 Review and improve policies and procedures to prepare for overland flooding

- Identify vulnerable roads and areas prone to overland flooding and have appropriate plans in place to address them;
- Continue to provide sandbags to vulnerable properties when required;
- Continue to sandbag critical infrastructure when required;
- Install high water detection equipment at critical infrastructure to monitor surface water levels.

Action 3.6 Promote public and private building standards and maintenance practices which protect buildings and HVAC units from damage due to increased cooling demand



- Consider new design and replacement standards for building Heating, Ventilation and Air Conditioning (HVAC) units;
- Enhance preventative maintenance for building HVAC units;



Mitigating the risks and impacts of climate change on our community requires continual investments in Windsor’s infrastructure. Increased intensity of rainfall, runoff and erosion require us to think differently about traditional grey infrastructure and begin to see the benefits of constructed or natural green infrastructure. Climate resilient cities think about infrastructure in these non-traditional ways. Temporarily storing or slowing down rainwater runoff in order to ease the burden on our traditional infrastructure as well as updating current and proposed infrastructure to meet future climate projections is something the City of Windsor is committed to.

Action 4.1 Implement the Sewer Master Plan overall recommendations (including but not limited to)

- Identify infrastructure most at risk for extreme weather impacts;
- Continue to implement sewer infrastructure replacement and improvements;
- Install rain guards in sanitary manholes;
- Design and installation of curb inlet flow restrictors;
- Introduce city-wide mandatory downspout disconnection;
- Explore feasibility of a retention treatment basin (RTB) on the riverfront trunk sewer near the Lou Romano Water Reclamation Plant;
- Explore opportunities for stormwater storage near the Little River Pollution Control Plant.

Action 4.2 Increase City of Windsor staff resources to respond to infrastructure issues during extreme weather

- Review staff resources required for flooded infrastructure response during extreme rain events;
- Promote skilled trades as an important and rewarding career to address future gaps in trained personnel.

Action 4.3 Incorporate climate change considerations into infrastructure design, development, maintenance and renewal

- Continue to consider climate change when implementing the City of Windsor's Asset Management Plan;
- Continue to implement the Triple Bottom Line approach considering financial, social and environmental costs and benefits when making infrastructure decisions.

Action 4.4 Implement the recommendations of the East Riverside Flood Risk study to reduce overland flooding risk

- Assess vulnerable areas and properties along the Detroit River;
- Share the findings with the public and conduct public education on flooding risks, responsibilities and emergency response;
- Enhance the barrier landform where required;
- Ensure protection of the St. Paul Pump Station.

Action 4.5 Continue to monitor Little River overland flooding risk

- Inspect the landform along the Little River channel and provide enhancements as required;
- Enhance the berm around the Little River Pollution Control Plant to protect critical infrastructure

Action 4.6 Complete infrastructure projects that received funding as part of the Disaster Mitigation & Adaptation Fund grant

- Implement the Pontiac/St. Paul pump station study;
- Implement stormwater management improvements to Tranby Park;
- Complete the Upper/Lower Little River Flood Plain mapping study

Action 4.7 Continue to invest in stormwater and sewer infrastructure

- Conduct vulnerability and risk assessments for critical infrastructure including pump stations;
- Invest in municipal drain and stormwater pond improvements;
- Where warranted, enhance stormwater infrastructure operations and maintenance;
- Increase drawdown rates for storm water ponds;
- Enhance phragmites control to maintain capacity of drains and ponds.

Action 4.8 Protect and improve roads from flooding damage

- Assess frequently flooded roads and consider road improvements

Action 4.9 Promote green infrastructure options for drainage issues on public and private property

- Research and implement the use of green infrastructure as part of municipal projects;
- Encourage the use of French drains, dry wells, bioretention stormwater ponds or raingardens to enhance rear yard drainage as opposed to connecting to a storm sewer;
- Promote, encourage and protect the use of urban forests as Green Infrastructure for rainwater interception and erosion control benefits.



Action 4.10 Review design standards and maintenance practices as they relate to newest climate projections

- Review engineering design, construction and maintenance for surface pavements;
- Review engineering design, construction and maintenance for sewer and stormwater management infrastructure;
- Enhance preventative maintenance for HVAC units;
- Identify cooling options for electrical and mechanical components susceptible to high heat and equipment wear and tear.

Action 4.11 Explore options for increased electrical power generation from City of Windsor infrastructure (generators) to supplement Ontario's electrical grid as warranted



Windsor residents are very passionate about our natural areas. We have some of the highest biodiversity rates and number of species at risk in Canada, generally concentrated within the Ojibway Prairie Complex. Our natural areas absorb greenhouse gas emissions, clean our air, clean and absorb rainwater, and allow our community to explore nature.

Ecosystems are under threat due to climate change. Windsor's climate projections predict an increase in favourable conditions for the spread of invasive species, potential loss of species at risk and environmental damages due to extreme weather. These as well as other factors and human stressors put these valuable resources in jeopardy. We need the services natural areas provide to both mitigate and adapt to climate change. Protecting and enhancing these natural assets is vital to becoming a more resilient city to the affects of climate change.

Action 5.1 Protect and enhance the management of natural areas to improve climate change resilience



- Evaluate and prioritize natural areas restoration opportunities;
- Develop high level policies to inform the development of Natural Areas Management Plans;
- Develop Natural Areas Management Plans;
- Prioritize the preservation of unprotected natural properties especially for consolidation of existing natural areas;
- Increase implementation of natural areas restoration and maintenance;
- Conduct restoration using appropriate zone specific plants focusing on those identified to be able to withstand extreme weather events;
- Monitor, protect and advocate for species at risk;
- Enhance communication and coordination with other agencies;
- Enhance recognition of Trees as assets in all rehabilitation, development and remediation issues.

Action 5.2 Investigate the potential for natural areas to enhance flood attenuation

- Identify where flood attenuation is needed within the City of Windsor;
- Review water retention possibilities in natural areas including lands adjacent to Provincially Significant Wetlands and other wetland associated habitats (e.g. swamp forest, wet prairie, meadow marsh).

Action 5.3 Enhance linkages between and among natural heritage features

- Ensure land retention of natural heritage linkages;
- Investigate increased land connectivity options including land acquisition and landscaped or below grade Eco passages to enhance natural areas linkages.

Action 5.4 Implement an Invasive Species Program



- Hire an invasive species coordinator for the City of Windsor;
- Monitor Windsor's natural areas for invasive species such as Phragmites, Oak Wilt, the Asian long horned beetle etc.;
- Increase invasive and woody species control measures such as prescribed burns, cutting and physical removal;
- Enhance targeted education to the public regarding best management practices for protecting private trees from invasive species.

Action 5.5 Complete an Urban Forest Management Plan

- Complete the City of Windsor Street Tree and Park Tree Inventories;
- Complete a Canopy Cover Study & Benefits Assessment and develop a Tree Canopy Cover goal for the Windsor community to benefit the environment and human health;
- Work towards achieving the Tree Canopy Cover goal through increased quality tree planting, maintenance and replacement;
- Continue to protect the urban forest through enforcement of the public tree by-law (By-law 135-04);
- Explore additional tree protection measures to limit the removal of trees in Windsor;
- Increase awareness of the air pollution and greenhouse gas reduction benefits provided by trees.

Action 5.6 Improve climate resilience of trees in urban forests, parks and in the public right-of-way

- Ensure tree and plant species established are native where possible, diverse, disease resistant and have high climate adaptability;
- Where appropriate, identify safe opportunities for assisted tree migration from more southern regions;
- Use an integrated pest management approach to park and urban forest maintenance;
- Enhance tree maintenance programs to mitigate damage due to heat and extreme events;
- Review and update new tree irrigation procedures to improve establishment success and therefor long-term survival and performance of trees.

Action 5.7 Enhance Detroit River shoreline protection measures along Windsor's riverfront and Peche Island

Action 5.8 Increase community level of knowledge on the benefits of natural areas

- Enhance support for the Ojibway Nature Center;
- Continue to provide education to the public about the importance of natural areas, invasive species and endangered species;
- Utilize Citizen Science Programs such as iNaturalist to help monitor and collect information on species at risk and invasive species.





The projected increase in extreme weather events in Windsor creates the potential for more frequent disruptions to community services. Services such as transportation, community centres and outdoor recreation provide a multitude of benefits to the community as well as help our economy to function. These services affect the day-to-day lives of Windsorites and therefore the City of Windsor will take measures to ensure that the needs of the community are met, and any disruption to core services are minimized.

Action 6.1 Improve communications from Transit Windsor to the public

- Hire a social media/communications coordinator for Transit Windsor;
- Develop a social media presence for Transit Windsor and use this to alert riders of changes to routes due to extreme weather events.

Action 6.2 Develop extreme weather contingency plans for Transit Windsor

- Identify priority risk areas and develop a Plan to respond to flooding of transit infrastructure, disruption of service and infrastructure damage to terminals, shelters, benches, bus stop pads etc.;
- Invest in back up power sources for all key Transit Windsor infrastructure including fuel pumps;
- Explore storing Transit Windsor buses in more than one location

Action 6.3 Improve design standards for new recreational facilities to ensure they are more climate resilient

- Ensure any future outdoor rinks developed consider warmer winter temperature protection measures which may include a full cover and extra cooling capacity;
- Ensure all new sports fields developed have sufficient shade amenities and additional drainage designed to reflect Windsor's climate projections;
- Ensure any new indoor recreational facilities are designed to withstand Windsor's climate projections

Action 6.4 Identify strategies to minimize cancellations of recreational rentals at existing recreation facilities

- Investigate modifying season start, end and duration dates as well as general schedules for recreational programming to try to avoid spring flooding and summer heat;
- Identify recreational facilities such as trails and sports fields at risk of flooding and prioritize additional drainage measures where possible;
- Continue to add air conditioning and dehumidifiers to indoor arenas as necessary
- Investigate developing service agreements with private facilities or neighbouring towns to share recreational facilities in the event of flooding

Action 6.5 Enhance inspections of Special Events Facilities and roads to identify infrastructure deficiencies for upcoming events

Action 6.6 Evaluate and enhance recreational uses along Windsor's shoreline

- Enhance shoreline protection for Sandpoint Beach;
- Enhance shoreline protection for Peche Island;
- Evaluate where pathways and trails should be set back from surface water bodies to protect public safety and limit closures when water levels are high.

Action 6.7 Replace Lakeview Marina docks with floating docks that are more resilient to varying water levels



Climate Change has already affected the community of Windsor in many ways – from flooding, to extreme heat, to habitat and species loss and property damage. These losses effect public safety, the economy, our social well being and our environment. Building community resilience is about increasing our ability to withstand and recover from the impacts of climate change.

The actions in this Objective stress community collaboration and participation. We need our community to be supportive as the City of Windsor strives to move our City forward with the goal of improving local adaptive capacity and reducing risk to the community.

Action 7.1 Improve stormwater design standards for future climate change precipitation projections

- Require new developments to follow the new Windsor Essex Region Stormwater Management Standards Manual including climate change considerations;
- Design new public areas to accommodate future rainfall intensity and increased stormwater demand and where possible consider providing additional resiliency to neighbouring areas;
- Investigate changes to new building structures in flood prone areas such as limiting basement depth, enhancing lot grading and building elevation requirements;
- Use the City's Zoning By-law and Site Plan Control process to limit hard surface areas in new developments;
- Re-evaluate the defined flood plains in Windsor considering climate change and restrict development in those areas to low population and recreational uses.

Action 7.2 Explore options to implement stormwater financing mechanisms

- Complete the Stormwater Financing Study
- Effectively communicate and educate the public of any stormwater financing implementation decisions

Action 7.3 Enhance the use of low impact development in both private and public areas to reduce storm water impacts



- Develop opportunities for increased stormwater management in parks.
- Incorporate low impact development into infrastructure projects such as roads, sewers and public spaces development.
- Continue to monitor and showcase current City of Windsor low impact development projects.
- Promote and incentivize the use of low impact development to developers, private landowners and the community.

Action 7.4 Enhance education to the public about the risk of high surface water levels



- Communicate with the media and use social media to update the public on current or changing conditions;
- Collaborate with other organizations such as ERCA to help spread similar messaging;
- Use various educational tools and resources to help illustrate overland flooding to the public;
- Provide door-to-door visits to vulnerable properties as required;
- Educate the public on the risks of driving on flooded roads

Action 7.5 Develop communications campaign with messaging to residents on lot-level resiliency actions

- Including but not limited to green and cool roofs, rain gardens, native plants, rainbarrels etc.

Action 7.6 Consider Thermal Comfort and the Urban Heat Island effect in development project design

- Encourage and implement more natural surface low impact development treatments instead of hard surfaces;
- Enhance landscaping and tree coverage in new public space and public right-of-way development;
- Continue to consider thermal comfort in park design and incorporate shade sails, tree planting, shade structures, splash pads etc.
- Use cooler and lighter hard surfaces in parks and public spaces;
- Include requirements for Urban Heat Island and Thermal Comfort considerations in Requests for Proposals for road class environmental assessments

Action 7.7 Enhance protections from heat and UV rays at sport fields and outdoor pools

- Increase shade options for all users and spectators at sports fields as well as outdoor pools by using trees, shade structures, shade sails etc.;
- Explore a field closure policy during extreme heat events;
- Explore rearranging outdoor swimming schedules to avoid peak heat times of day;
- Investigate installing stadium lighting for sports fields so usage can shift to cooler parts of the day;
- Increase education with recreation user groups about the risks of extreme heat

Action 7.8 Provide UV Protection in public spaces and at public events



- Locate public transportation bus stops where shade is available;
- Consider installation of sunscreen dispensers in washroom facilities in public spaces and public pools, Sandpoint beach and the Marina;
- Promote cooling options for festival organizers such as temporary shade sails, misting stations, the Hydration Station etc.;
- Provide and promote education about the risks of extreme heat

Action 7.9 Enhance communication and education around the impacts of extreme heat on human health



- Increase community understanding of heat illness signs and symptoms and associated health risks;
- Collaborate with the Windsor-Essex County Health Unit to communicate heat warnings via email, website, social media, text, app etc.;
- Collaborate with partners to produce and implement a targeted heat education program for vulnerable populations including migrant workers, international students and new Canadians

Action 7.10 Implement the Community Energy Plan (including but not limited to the following)

- Develop and implement home and building retro fit programs;
- Encourage a modal shift towards Public Transit and Active Transportation;
- Foster the adoption of electric vehicles;
- Continue to retrofit City of Windsor buildings to increase energy efficiency;
- Incentivize the use of energy efficiency technologies to decrease building energy demand;
- Designate and plan district energy areas;
- Promote and implement renewable energy generation such as solar photovoltaic energy systems



Action 7.11 Incorporate native and/or drought tolerant plants into public and private landscaping

- Educate the public about the benefits of native plants including drought tolerance; water retention attracting pollinators etc.
- Review and encourage the selection of species more resilient to a changing climate;
- Encourage the selection of plants that are more mature and larger with deeper root systems;
- Explore native plant demonstration gardens in public spaces



Action 7.12 Collaborate with the Essex Region Conservation Authority and the Windsor-Essex County Health Unit on their climate change mitigation and adaptation planning

- Provide data, resources and support for regional climate change planning as needed;
- Encourage and support the completion of floodplain mapping for our regional watersheds;
- Incorporate climate change considerations in food security communications and programming;
- Support the work of the Windsor Essex Food Policy Council

Action 7.13 Assess new opportunities for different forms of business and tourism as a result of a changing climate

- Educate and encourage local businesses and the tourism industry to implement adaptation actions to prepare for our climate future (e.g. cooling options for outdoor patios);
- Promote "shoulder seasons" as a great time for tourism in Windsor Essex;
- Work with businesses to encourage climate resilience and tourism related services



Implementation and Governance

Creating an implementation and governance structure is essential to achieving the community adaptation actions outlined in this Plan. Planning for implementation improves the likelihood of effective adaptation, provides new opportunities for outreach and engagement, and fosters long-term sustainability of the action by integrating multiple streams of support.

Environmental Sustainability and Climate Change Office

The Environmental Sustainability and Climate Change Office will be responsible for monitoring and tracking of *Degrees of Change*. This includes the monitoring of climate change projections for the City and identifying when broad cross corporate and community vulnerability and risks assessments may be required to ensure that the City of Windsor is aware of possible impacts from a changing climate. In most cases, this team will work with the Community to build resiliency. This office is also available to provide technical support to various corporate departments.

City Administration Responsibility

Canadians count on local governments for good roads and bridges, efficient public transit, reliable water and waste water systems, storm water management, quality recreational facilities and so much more. In fact, municipalities build and maintain approximately 60 percent of the public infrastructure in Canada (FCM, 2019).

The City of Windsor will lead by example through the implementation of the plan but as noted throughout this plan, the City can not do it alone. The Community has a role to plan if we are going to build a resilient Windsor.

Community Task Force Responsibility

The Community Task Force will continue to meet regularly to review progress on *Degrees of Change*. Meetings will likely take place at least annually, with additional meeting being held as required. New information such as updated climate projections or new identified risks will be brought forward to the Community Task Force by City administration.

The Community Task Force will advocate for this Plan by bringing relevant information and new ideas back to respective organizations and businesses represented. Members of the task force shall use their influence and reach within the community to educate and advocate for climate change adaptation actions as identified in the Plan.

Community Partnerships

Building a more resilient community will not be achieved through municipal actions alone. Strengthening community partnerships will ensure climate change adaptation considerations are embedded across the community. Below are some examples where developing partnerships will enhance or expand beyond the actions called for in this Plan.

- External agencies: The Essex Region Conservation Authority and Windsor Essex County Health Unit are both looking at developing regional strategies to address a changing climate. Many of the climate change impacts identified within this plan (e.g. flooding, health issues) will also be considered in these regional strategies providing opportunities for coordination and collaboration.
- School Boards: Schools provide a perfect environment to educate and engage youth. Transferring knowledge to students about the local impacts of climate change can empower them to create action within the school community, their personal activities as well as in their homes. A good example of schools supporting environmental action was the education around recycling provided to youth in the 1980s. The youth of today will be the leaders of tomorrow but they are also the lines of communication into many Windsor homes.
- Private Sector: Extreme weather events are already impacting the private sector (e.g. businesses have flooded and restaurant patios have lower use during hot days). Partnerships with the private sector can provide opportunities for adaptation outside the public space.
- Developers: The City should explore opportunities for infrastructure enhancements to address climate change as development occurs. This process could be formalized through an update to the Official Plan, development charges, site plan control, community improvement plans or through individual negotiations.
- Post secondary institutions: Windsor's Post secondary institutions can be involved through initiatives such as a City Lab - an innovation hub bringing together students, academia and civic leaders to work towards climate action. The City should look for opportunities to involve students and student-led research where appropriate. Post secondary institutions can take actions identified within the Plan to become more resilient to climate change.





Communication, Education and Outreach

Degrees of Change and all supporting Plans will be posted on-line on the City of Windsor webpage along with the climate projections for Windsor Essex County.

Many actions within this Plan call for expansion of the engagement and education currently underway. The City of Windsor will continue to work with community stakeholders to ensure the most relevant information is available. As in the past, this engagement may take many forms including: formal presentations; public open houses; special events; workshops; on-line engagement; advertisements and other forms of communication. The City of Windsor is open to new ideas to bolster community engagement and education.

Funding

Most of the climate change adaptation strategies outlined in *Degrees of Change* will require funding. As mentioned previously Public Safety Canada estimates that for every dollar invested in climate change adaptation \$3 to \$5 is saved in recovery costs (Auditor General, 2016). In addition, outlining the costs of doing nothing in *Climate Change Impacts in Windsor – A Technical Analysis* supports that a financial commitment is necessary to help protect the Windsor community from the effects of a changing climate.

The following sections outline several strategies available to fund climate change adaptation actions.

Integration

The best opportunities to improve the climate resiliency of our community is to include climate change considerations during the initial planning, design and funding of infrastructure projects, into Master Plan documents as well as into program and policy development. Recently, several initiatives were undertaken at the City of Windsor that included considerations for climate change adaptation including: Class Environmental Assessments (e.g. the Sewer Master Plan); Master Planning documents (e.g. Parks Master Plan); and Capital projects (e.g. the Disaster Mitigation and Adaptation Fund application). Wherever possible City of Windsor administration and Council should continue to seek out opportunities to integrate climate change adaptation when making corporate decisions.

Asset Management and Capital Planning

The 2018 Asset Management Plan includes climate change planning considerations. In terms of preparing for a changing climate, the asset planning process can be used to ensure capital infrastructure includes adaptation and resiliency considerations through a life cycle cost analysis and review of level of service. The asset planning process should include safeguards to ensure infrastructure built today will last for the intended life span even under a changing climate.

Many of the larger adaptation actions identified (e.g. implementation of the Sewer Master Plan and the East Riverside Flood Risk Assessment) are expected to be included in the City's Capital Budget starting as early as 2020 and continuing for decades. Additional capital funding will be required to further other adaptation actions identified in this Plan.

Incremental Operational Budgets

Many of the adaptation actions proposed will not require capital investment but instead will involve reconsideration or enhancements in day to day City of Windsor operations (e.g. sewer maintenance programs).

This Plan highlights the importance of action on the part of the Community. In order to achieve the required level of involvement, community engagement and education conducted by City of Windsor staff will need to increase.

External Funding Sources

The costs of implementing many of the adaptation actions identified may be reduced by pursuing external funding sources. The City should pursue all available sources of funding to advance climate change resiliency as quickly as possible. This section outlines some funding strategies that the City has already benefited from:

- Federal Disaster Mitigation and Adaptation Fund – In response to the wide variety of climate change impacts across the County, the Government of Canada has developed this fund to invest in public infrastructure needed to mitigate the potential economic, environmental and social impacts of climate change, and strengthen our resilience to disasters triggered by natural hazards and extreme weather event. The City of Windsor has received approval for over \$32 million dollars under this fund.
- Municipal Climate Innovation Program (MCIP) – The Federation of Canadian Municipalities (FCM) created funding, resources and training to help municipalities respond to climate change (mitigation and adaptation). Through the MCIP program the City of Windsor received funding for a number of mitigation projects but also to complete the East Riverside Flood Risk Assessment. In addition, the City of Windsor also received support through the MCIP Climate Adaptation Partner grants to participate in ICLEI’s Adaptation Changemakers project and complete *Degrees of Change*.
- Green Municipal Fund – FCM’s Green Municipal Fund provided funding to 12 municipalities across Canada, including Windsor, to participate in the Leadership in Asset Management Program (LAMP). This program was developed as a peer-learning initiative allowing municipalities to collaborate on the development of asset management practices to overcome economic, social and environmental challenges and sustainably deliver services to residents today and in the future. The City of Windsor leveraged this program to include climate change considerations in our Asset Management Plan.



Monitoring and Review

Tracking progress is an important part of the monitoring and review process as it enables the City and Community to assess whether the actions outlined in this Plan are producing the desired results. It sets the stage for Plan longevity, as it allows the City and the community to build upon the networks created and lessons learned throughout plan development. Since adaptation is a moving target, a monitoring framework also ensures that the community can assess whether local risks and vulnerabilities are changing and make required adjustments to the adaptation actions.

At a minimum the climate change projections as well as the corporate and community vulnerability and risk assessment will be reviewed every 5 years. In the event that new impacts, vulnerabilities or risks are identified a formal review of the Climate Change Adaptation Plan will occur.

An implementation update report to Windsor City Council and the Community Task Force will occur on a biennial basis.

Indicators

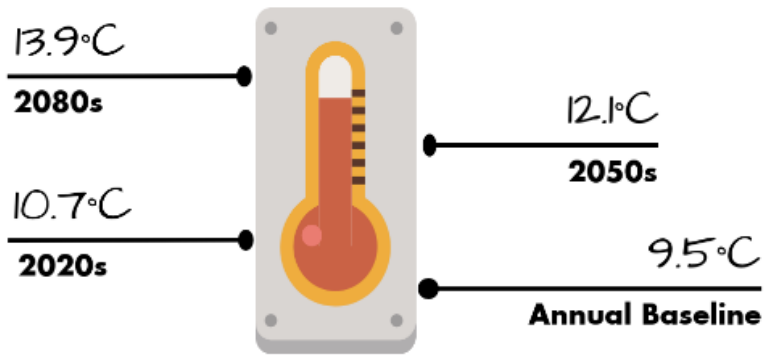
To ensure the successful implementation of *Degrees of Change* a series of high level indicators have been recommended to track progress over time. These indicators are outlined in Appendix C and are meant to measure the success of the overall Climate Change Adaptation Plan and provide insights into how the City is preparing for, and responding to the impacts of a changing climate.

Appendix A

Detailed Climate Projections

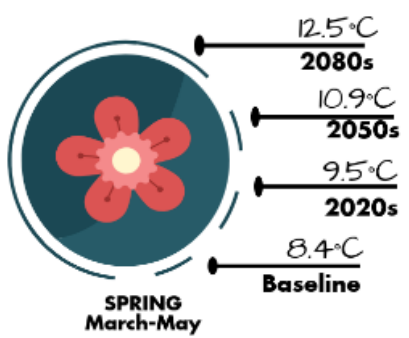
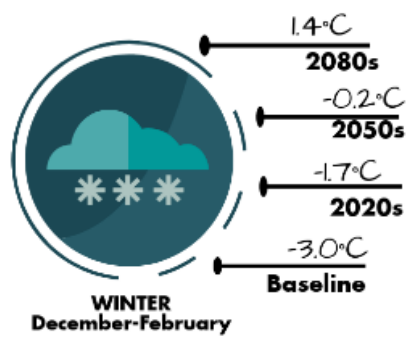
Future Climatic Projections

For: The City of Windsor | Created: June, 2018

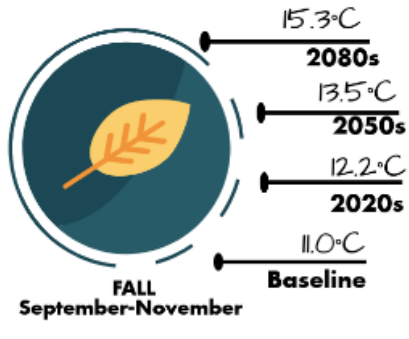
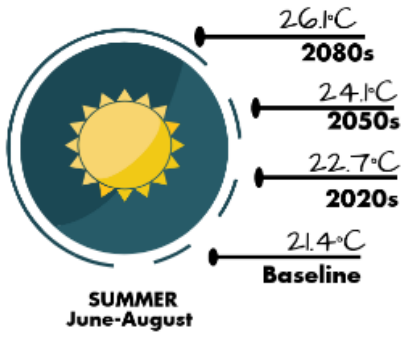


ANNUAL MEAN TEMPERATURES

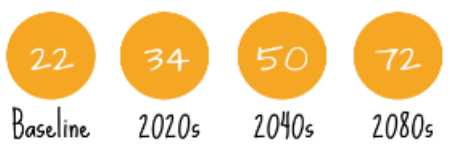
Mean, minimum & maximum daily temperatures are projected to significantly increase in every season.



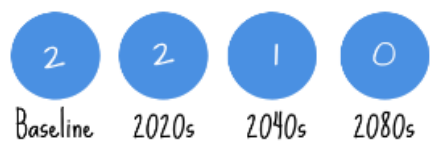
SEASONAL MEAN TEMPERATURES



DAYS ABOVE 30°C



DAYS BELOW -10°C



TEMPERATURE EXTREMES

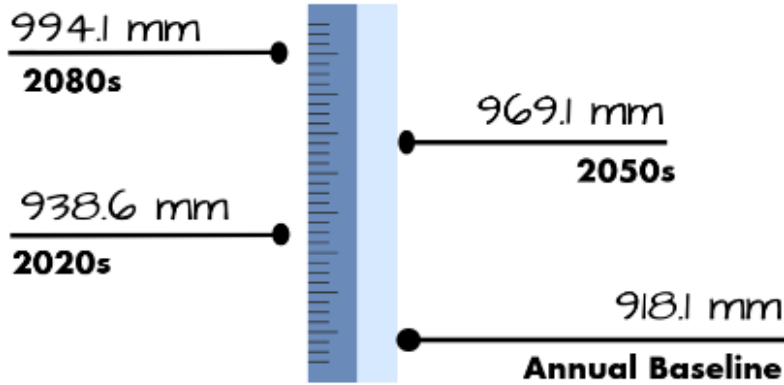
More hot days, fewer cold days.

DAYS WITH FREEZE-THAW CYCLES



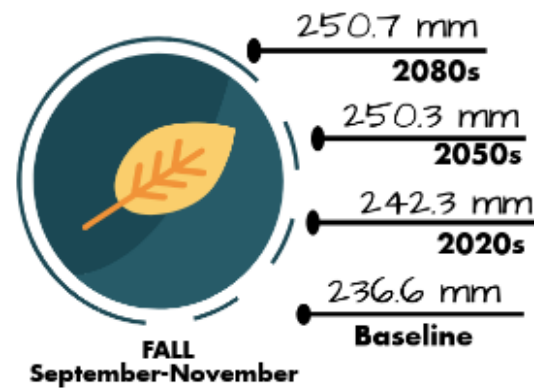
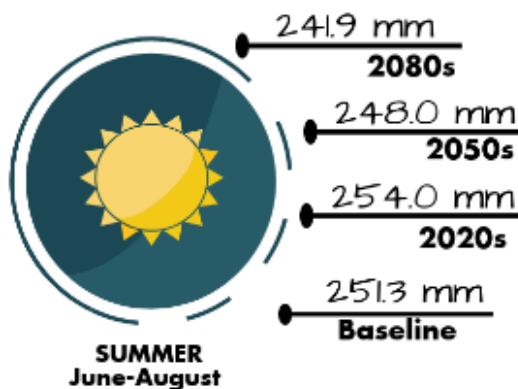
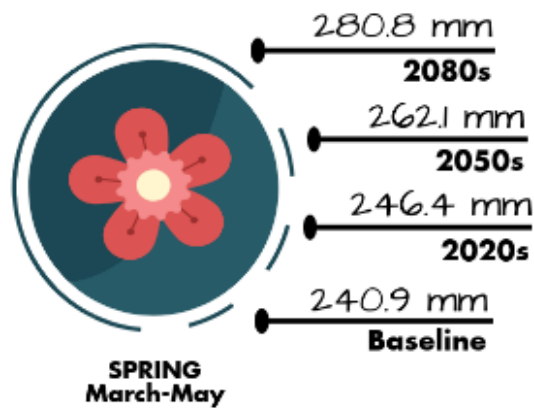
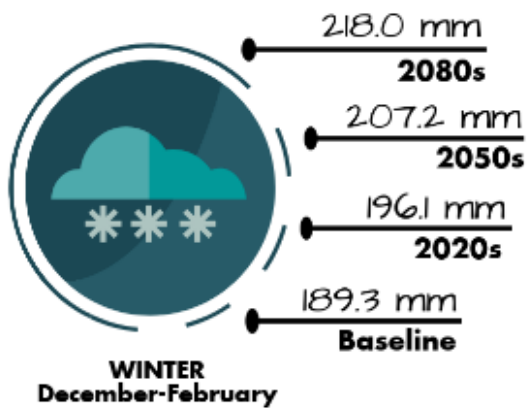
FREEZE-THAW CYCLES

A decrease in freeze-thaw days is expected.



ANNUAL MEAN PRECIPITATION

Annual precipitation is expected to increase. Winter and Spring are projected to get significantly wetter, with a slight decline in the Summer.



SEASONAL MEAN PRECIPITATION



Intensity
Precipitation will fall at a faster rate (mm/h)



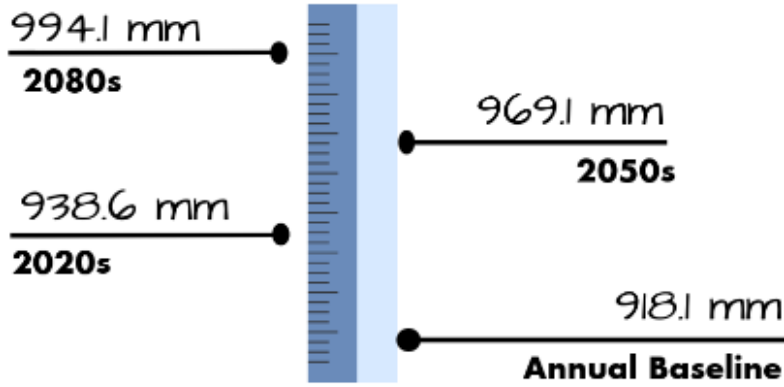
Duration
Shorter storms will have an increasingly high intensity



Frequency
Return periods of heavy storms will shorten, meaning increased frequency

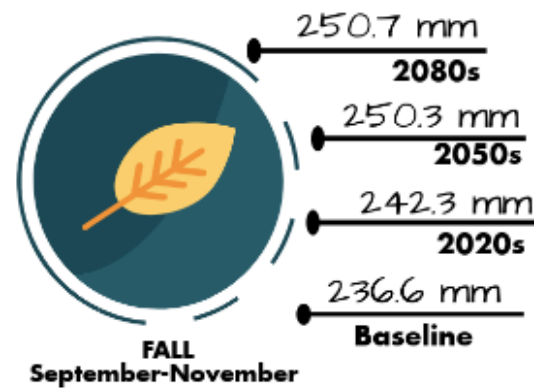
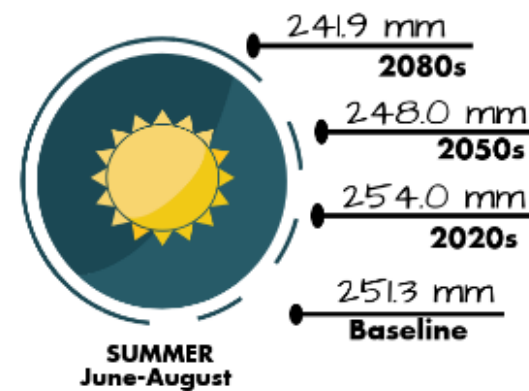
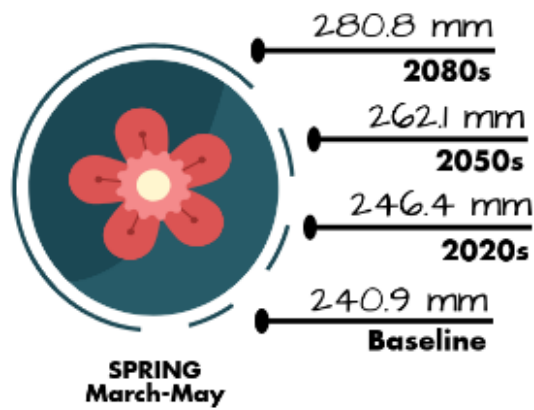
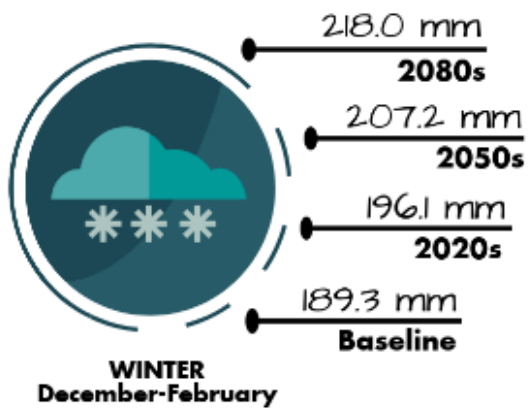
PRECIPITATION EVENTS

Precipitation events in general are projected to become more intense and extreme.



ANNUAL MEAN PRECIPITATION

Annual precipitation is expected to increase. Winter and Spring are projected to get significantly wetter, with a slight decline in the Summer.



SEASONAL MEAN PRECIPITATION



Intensity
Precipitation will fall at a faster rate (mm/h)



Duration
Shorter storms will have an increasingly high intensity



Frequency
Return periods of heavy storms will shorten, meaning increased frequency

PRECIPITATION EVENTS

Precipitation events in general are projected to become more intense and extreme.

Climate Atlas Report

Municipality: Windsor



RCP 8.5: High Carbon climate future

GHG emissions continue to increase at current rates

Variable	Period	1976-2005	2021-2050			2051-2080		
		Mean	Low	Mean	High	Low	Mean	High
Precipitation (mm)	annual	1256	1125	1330	1557	1164	1380	1621
Precipitation (mm)	spring	301	230	323	431	232	338	448
Precipitation (mm)	summer	240	165	253	359	160	258	382
Precipitation (mm)	fall	340	236	351	473	244	358	484
Precipitation (mm)	winter	375	296	403	518	310	425	556
Mean Temperature (°C)	annual	7.1	7.9	9	10.3	9.6	11	12.5
Mean Temperature (°C)	spring	4.8	4.8	6.5	8.4	6.3	8.4	10.5
Mean Temperature (°C)	summer	18	18.4	19.9	21.4	20.1	21.9	23.8
Mean Temperature (°C)	fall	9.3	9.8	11.3	12.8	11.5	13.2	14.8
Mean Temperature (°C)	winter	-4	-4	-1.9	0.2	-1.9	0.3	2.3
Tropical Nights	annual	1	0	4	10	4	15	32
Very hot days (+30°C)	annual	4	4	14	26	14	32	54
Very cold days (-30°C)	annual	0	0	0	0	0	0	0
Date of Last Spring Frost	annual	May 6	April 9	April 27	May 12	March 28	April 14	May 4
Date of First Fall Frost	annual	Oct. 14	Oct. 12	Oct. 28	Nov. 18	Oct. 22	Nov. 11	Dec. 2
Frost-Free Season (days)	annual	159	156	181	209	178	207	236

RCP 4.5: Low Carbon climate future

GHG emissions much reduced

Variable	Period	1976-2005	2021-2050			2051-2080		
		Mean	Low	Mean	High	Low	Mean	High
Precipitation (mm)	annual	1258	1104	1325	1544	1131	1355	1602
Precipitation (mm)	spring	301	229	318	417	232	328	432
Precipitation (mm)	summer	241	156	253	361	164	256	370
Precipitation (mm)	fall	341	236	353	479	248	366	498
Precipitation (mm)	winter	375	295	401	518	303	406	521
Mean Temperature (°C)	annual	7.1	7.7	8.8	10.1	8.4	9.7	11.2
Mean Temperature (°C)	spring	4.8	4.6	6.4	8.3	5.4	7.3	9.4
Mean Temperature (°C)	summer	18	18.1	19.7	21.3	18.8	20.6	22.4
Mean Temperature (°C)	fall	9.3	9.6	11	12.4	10.2	11.9	13.5
Mean Temperature (°C)	winter	-4	-4.2	-2	0.2	-3.2	-1.1	1.2
Tropical Nights	annual	1	0	3	9	1	7	17
Very hot days (+30°C)	annual	4	3	13	25	6	20	37
Very cold days (-30°C)	annual	0	0	0	0	0	0	0
Date of Last Spring Frost	annual	May 6	April 9	April 27	May 12	April 4	April 22	May 10
Date of First Fall Frost	annual	Oct. 14	Oct. 10	Oct. 25	Nov. 14	Oct. 15	Nov. 1	Nov. 22
Frost-Free Season (days)	annual	159	155	179	204	163	190	220

Where did this data come from?

Global Climate Models (GCMs) are used to depict how the climate is likely to change in the future. Since no one climate model can be considered 'correct', it is important to use many GCMs to capture a range of possible conditions. The GCM data we used were obtained from the Pacific Climate Impacts Consortium (PCIC). PCIC collected temperature and precipitation data produced by 24 different models and used advanced statistical techniques to create high-resolution (daily, 10km) versions of the data for all of Canada (for more information visit pacificclimate.org).

What are the RCP 8.5 and RCP 4.5 future climate scenarios?

One of the most important inputs into GCM simulations of the future climate is the expected concentration of greenhouse gases (GHGs; especially carbon dioxide) in the atmosphere as a result of human activity. In the scientific literature these future GHG concentrations are used to calculate Representative Concentration Pathways (RCPs). The High Carbon scenario (RCP8.5) assumes that we continue to emit very large amounts of carbon dioxide from the burning of fossil fuels; the Low Carbon scenario (RCP4.5) assumes that drastic reductions of emissions in the coming decades will stabilize the concentration of GHGs in the atmosphere by the end of this century. We did not use RCP2.6, an even lower emissions scenario.

How are the minimum, mean, and maximum calculated?

We used an ensemble of 24 different GCMs to analyze the future climate. The mean values are the average values of this ensemble over the 1976-2005, 2021-2050 and 2051-2080 periods. The range of values in each time period is indicated by the High (90th percentile) and Low (10th percentile) values in the tables. This means about 10% of the predicted values are above the "High" value, and 10% are lower than the "Low" value.

The Climate Atlas of Canada

The Climate Atlas of Canada (climateatlas.ca) is an interactive tool for citizens, researchers, businesses, and community and political leaders to learn about climate change in Canada. It combines climate science, mapping and storytelling to bring the global issue of climate change closer to home, and is designed to inspire local, regional, and national action and solutions.

Source

Prairie Climate Centre (2019). Climate Atlas of Canada, version 2 (July 10, 2019). <https://climateatlas.ca>

Disclaimer

The information disseminated by the Prairie Climate Centre -- including but not restricted to maps, tables, statistics and interpretations -- is provided as a public service. It is provided without any warranty or representation, express or implied, as to its accuracy or completeness. Any reliance you place upon the information contained here is your sole responsibility and strictly at your own risk. In no event will the Prairie Climate Centre be liable for any loss or damage whatsoever, including without limitation, indirect or consequential loss or damage, arising from reliance upon the data or derived information.

Appendix B

Implementation Table

	Action & Supporting Actions	Associated Municipal Plan/Policies	Timelines	Estimated Costs	Level of Effort
1.1	<p>Incorporate climate change considerations into Municipal Decision Making - Incorporate climate change into the City's Official Plan; Integrate climate change considerations into Windsor's new and existing Plans and Policies, as well as Administrative and Consultant reports.</p> <p>Lead: ESCC. Supporting Role: All Departments.</p>	All municipal Plans and Policies	On-going	\$	Low
1.2	<p>Increase community level of knowledge on Climate Change - Enhance climate change education and awareness initiatives for Windsor residents and City staff; Collaborate with the University, College and local school boards to enhance climate change training and development, Engage with professional agencies to develop and enhance local climate change knowledge and experience; Continue to share relevant climate change data on Open Data Catalogue; Investigate the creation of a City Lab in Windsor - an innovation hub bringing together students, academia and civic leaders to work towards climate action.</p> <p>Lead: ESCC. Supporting Role: Communications; IT; All departments; WEC Health Unit; ERCA; Citizen Environment Alliance.</p>	Environmental Master Plan, Parks Master Plan, Active Transportation Master Plan, Landscape Manual, Official Plan	On-going	\$	Medium
1.3	<p>Build financial support for unforeseen impacts of climate change - Develop a Municipal severe weather reserve fund to address funding deficits due to emergency response.</p> <p>Lead: Finance.</p>	Capital Budget/Asset Management Plan	Short-Term with annual contributions	\$-\$\$\$	Low
1.4	<p>Enhance the ability to collect and share climate change related data; Leverage climate change data to be included in municipal decision making; Automate notifications and triggers to assist with adaptation actions; Use data to monitor the implementation of <i>Degrees of Change</i>; Share data to empower the community to support the plan; Use data to inform education campaigns.</p> <p>Lead: IT. Supporting Role: All Departments.</p>	Information Management Policy	On-going	\$-\$\$\$	Medium

2.1	<p>Update Community Development and Health Services (CDHS) Emergency Response Plan - Consult with County stakeholders to discuss regional approaches; City of Windsor staff training for emergency response; Conduct exercises to test opening emergency shelters; Develop a notification system for the public on what to do and where to go in an emergency.</p> <p>Lead: CDHS, Fire. Supporting Role: Fire; Recreation; Communications; ERCA.</p>	CDHS Emergency Response Plan	Short-Term	\$	Low
2.2	<p>Develop an emergency response procedure for extreme flooding events - Ensure open communication among City of Windsor staff and first responders before, during and after the event; Identify vulnerable roads and areas prone to overland and extreme rain event flooding and have appropriate plans in place to address them; Consult and collaborate with first responders to prepare road closure protocols; Develop a safe access standard for road evaluations; Continue to coordinate emergency response with the LHIN to decrease risk to vulnerable populations.</p> <p>Lead: Fire. Supporting Role: Operations; IT; Police; Communications; Pollution Control; Planning; ERCA; EMS; LHIN.</p>	City of Windsor Emergency Response Plan	Short-Term	\$	Low
2.3	<p>Enhance public education to increase personal preparedness & reduce health risks associated with extreme weather - Produce targeted messaging for at risk populations including seniors and persons with limited mobility as well as their caregivers; Enhance supports for CDHS clients; Educate the public on when to call 911 or 311.</p> <p>Lead: Fire. Supporting Role: CDHS; Communications; WEC Health Unit; Community groups; Windsor-Essex County Extreme Temperatures Committee.</p>	Emergency Management Plan; Heat Alert and Response Plan	Short-Term	\$	Medium

2.4	<p>Review the 2011 Heat Alert and Response Plan and Update as required - Determine emergency conditions that require opening community reception centres or emergency shelters; Ensure all public facilities have access to an A/C space; Encourage the people to seek relief from extreme heat in public places; Identify privately owned places that could be used as cooling centres during Heat Alerts; Promote access to free tap water through programs such as Blue W or the WECHU Water app; Increase access to water bottle re-fill stations in public washrooms; Review the 2011 Vulnerability to Extreme Heat in Windsor report and update where possible.</p> <p>Lead: WEC Health Unit. Supporting Role: Communications; Recreation; Fire; ESCC; Parks; Community Groups.</p>	Heat Alert and Response Plan	Short-Term	\$	Medium
2.5	<p>Enhance protection of outside workers during extreme heat conditions - Identify opportunities for targeted education to at risk workers and their employers (e.g. Factory and greenhouse workers, farmers, roofers, landscapers and construction workers); Identify options to modify outdoor staff work schedules and/or tasks under to earlier in the day, or in shaded or indoor areas; Investigate alternatives for cooler clothing options and hats for outside workers; Provide sun protection options such as sunscreen or hats to staff; Promote the importance of hydration to staff.</p> <p>Lead: Human Resources; WEC Health Unit; Local Employers. Supporting Role: City Departments with outdoor workers.</p>		Short-Term	\$	Low
2.6	<p>Continue to protect indoor air quality - Continue to monitor the indoor air quality of corporate work places and public places; Encourage residential and business property owners to monitor air quality.</p> <p>Lead: Human Resources. Supporting Role: Facilities.</p>		On-going	\$	Low

2.7	<p>Develop an Air Quality Health Index (AQHI) Response Plan - Communicate AQHI warnings via email and a website link to the public as well as community partners (ex. Windsor- Essex Housing Connections WEHCI); Identify actions to limit pollution produced during AQHI warnings as well as limit staff and community exposure to poor air quality; In collaboration with the Windsor-Essex County Health Unit increase education about the air quality heat index (AQHI).</p> <p>Lead: ESCC; WEC Health Unit. Supporting Role: Communications; Parks; Fleet; Human Resources; Transit Windsor; School Boards; Hospitals; Canadian Red Cross; Heart and Stroke Foundation; EMS; Unions; Environment Canada.</p>		Short-Term	\$	Low
2.8	<p>Decrease public and private contributions to air quality contaminants - Enhance the City of Windsor's Anti-Idling Bylaw; Improve education and awareness of the Anti-Idling Bylaw; Investigate the feasibility of replacing gas and diesel burning equipment with cleaner technologies such as electric powered equipment; Promote the benefits of public and private trees including carbon dioxide capture and improved air quality.</p> <p>Lead: Parking Enforcement; Windsor Police Services. Supporting Role: Parks; Fleet.</p>	Greening the Fleet Plan	On-going	\$-\$-\$	Low
2.9	<p>Enhance monitoring for vector borne diseases and new infections diseases - Continue to work in collaboration with the Windsor-Essex County Health Unit to undertake tick and mosquito surveillance programs; Promote the WECHU Fight the Bite public awareness campaign; Continue to participate in larviciding programs to decrease the spread of vector borne diseases; Provide personal protection for outside workers against vector borne disease; Enhance Bylaw Enforcement and response to standing water complaints.</p> <p>Lead: WEC Health Unit. Supporting Role: ESCC; By-law Enforcement; Public Health Ontario; Regional Communications Group</p>		On-going	\$-\$	Medium

2.10	<p>Enhance community safety during icy conditions - Investigate enhancement to winter maintenance and snow ploughing of sidewalks and public spaces; Enhance Bylaw Enforcement and response to public and private snow and ice complaints; Identify and address areas where snow melt water accumulates and increases the likelihood of ice formation; Enhance education to the public about ice and snow hazards; Improve communications to private businesses and landowners on their roles and responsibilities for the maintenance of sidewalks during freezing rain or snow events.</p> <p>Lead: Operations. Supporting Role: By-Law Enforcement; Parks & Facilities; Communications; Private Building Owners/Operators; Residents.</p>		On-going	\$\$-\$\$\$\$	Medium
2.11	<p>Enhance Surveillance for blue-green algae in our surface water bodies - In collaboration with the WECHU enhance education about the dangers of blue-green algae for water users; Develop and education campaign targeting fertilizer use and washing cars around storm water ponds; Develop a regional plan to reduce phosphorus levels in our environment.</p> <p>Lead: WEC Health Unit; ERCA. Supporting Role: Pollution Control; Recreation; GLIER; WUC.</p>		On-going	\$	Low
3.1	<p>Increase the education to the public on how to reduce their personal risk of basement flooding - Hire a coordinator to conduct public education and outreach to highlight responsibilities of the property owner and promote lot level storm water controls (rainbarrels, rain gardens, down spout disconnections etc.); Develop outreach programs to teach residents what they can do to reduce snowmelt flooding on their property; Provide education to private market and social housing landlords and business owners outlining precautions, insurance options and responsibilities for tenants and landlords; Provide education on cleaning and fixing damaged property after a flooding event to prevent mould growth.</p> <p>Lead: ESCC. Supporting Role: Engineering; Operations; Communications; Drainage Contractors; Plumbers; Insurance Agencies; Business associations.</p>	Sewer Master Plan	Short-Term	\$	Low

3.2	<p>Develop a media notification system to prepare residents for large storm events - Provide information on what to do before, during and after extreme rain events in real time.</p> <p>Lead: ESCC; Communications. Supporting Role: Operations; Engineering.</p>		Short-Term	\$	Low
3.3	<p>Continue and enhance the basement flooding subsidy program and other methods of protecting property - Include a subsidy for sewer lateral video surveillance and subsequent repair or replacement as part of the basement flooding subsidy program; Continue to subsidize rainbarrels.</p> <p>Lead: Engineering. Supporting Role: Operations; ESCC.</p>	Sewer Master Plan	Short-Term	\$\$-\$\$\$\$	Medium
3.4	<p>Continue and enhance tree pruning programs to develop proper tree health and limit future damage - Enhance tree pruning and maintenance programs on City of Windsor trees using the City's updated Tree Inventory; Implement an outreach program for private tree care and maintenance.</p> <p>Lead: Forestry.</p>		Short-Term	\$\$	Medium
3.5	<p>Review and improve policies and procedures to prepare for overland flooding - Identify vulnerable roads and areas prone to overland flooding and have appropriate plans in place to address them; Continue to provide sandbags to vulnerable properties when required; Continue to sandbag critical infrastructure when required; Install high water detection equipment at critical infrastructure to monitor surface water levels.</p> <p>Lead: Community Control Group. Supporting Role: Engineering; Operations; Pollution Control; ERCA.</p>	Emergency Response Plan	Short-Term	\$\$-	Medium
3.6	<p>Promote public and private building standards and maintenance practices which protect buildings and HVAC units from damage due to increased cooling demand - Consider new design and replacement standards for building Heating, Ventilation and Air Conditioning (HVAC) units; Enhance preventative maintenance for building HVAC units.</p> <p>Lead: Facilities; Corporate Projects. Supporting Role: Planning and Building; Private Building Owners; School boards.</p>		Short-Term	\$	Low

4.1	<p>Implement the Sewer Master Plan overall recommendations (including but not limited to) - Identify infrastructure most at risk for extreme weather impacts; Continue to implement sewer infrastructure replacement and improvements; Install rain guards in sanitary manholes; Design and installation of curb inlet flow restrictors; Introduce city-wide mandatory downspout disconnection; Explore feasibility of a retention treatment basin (RTB) on the riverfront trunk sewer near the Lou Romano Water Reclamation Plant; Explore opportunities for stormwater storage near the Little River Pollution Control Plant.</p> <p>Lead: Engineering. Supporting Role: Pollution Control; Operations; ESCC; Asset Planning.</p>	Sewer Master Plan	Long-Term	\$\$\$\$	High
4.2	<p>Increase City of Windsor staff resources to address future gap in trained personnel - Review staff resources required for flooded infrastructure response during extreme rain events; Promote skilled trades as an important, rewarding career to address future gaps in trained personnel.</p> <p>Lead: Pollution Control. Supporting Role: HR; School Boards; St. Clair College.</p>		On-going	\$	Medium
4.3	<p>Incorporate climate change considerations into infrastructure design, development, maintenance and renewal - Continue to consider climate change when implementing the City of Windsor's Asset Management Plan; Continue to implement the Triple Bottom Line approach considering financial, social and environmental costs and benefits when making infrastructure decisions</p> <p>Lead: Asset Planning. Supporting Role: Engineering, Operations; Pollution Control; ESCC; Parks.</p>	Asset Management Plan	Short-Term	\$\$	Medium

4.4	<p>Implement the recommendations of the East Riverside Flood Risk study to reduce overland flooding risk - Assess vulnerable areas and properties along the Detroit River; Share the findings with the public and conduct public education on flooding risks, responsibilities and emergency response; Enhance the barrier landform where required; Ensure protection of the St. Paul Pump Station.</p> <p>Lead: Engineering. Supporting Role: Operations; Pollution Control; ERCA.</p>		Medium-Term	\$\$\$\$	High
4.5	<p>Continue to monitor Little River overland flooding risk - Inspect the landform along the Little River channel and provide enhancements as required; Enhance the berm around the Little River Pollution Control Plant to protect critical infrastructure.</p> <p>Lead: Operations. Supporting Role: Engineering; ERCA.</p>		Short-Term	\$\$\$	High
4.6	<p>Complete infrastructure projects that received funding as part of the Disaster Mitigation & Adaptation Fund grant - Implement the Pontiac/St. Paul pump station study; Implement stormwater management improvements to Tranby Park; Complete the Upper/Lower Little River Flood Plain Mapping Study.</p> <p>Lead: Engineering; Pollution Control; Parks. Supporting Role: Asset Planning; ESCC; ERCA.</p>		Medium-Term	\$\$\$\$	High
4.7	<p>Continue to invest in stormwater and sewer infrastructure - Conduct vulnerability and risk assessments for critical infrastructure including pump stations (ex: Clairview, East Marsh, Riverdale, Ford, Buckingham and Woods); Invest in municipal drain (ex: 6th concession drain along Baseline) and stormwater pond improvements; Where warranted, enhance stormwater infrastructure operations and maintenance; Increase drawdown rates for stormwater ponds; Enhance phragmites control to maintain capacity of drains and ponds.</p> <p>Lead: Pollution Control; Engineering. Supporting Role: Operations.</p>		Medium-Term	\$\$\$	Medium

4.8	<p>Protect and improve roads from flooding damage - Assess frequently flooded roads and consider road improvements (ex. Prospect).</p> <p>Lead: Engineering. Supporting Role: Operations.</p>		Medium-Term	\$\$\$	Medium
4.9	<p>Promote green infrastructure options for drainage issues on public and private property - Research and implement the use of green infrastructure as part of municipal projects; Encourage the use of French drains, dry wells, bioretention stormwater ponds or raingardens to enhance rear yard drainage as opposed to connecting to a storm sewer; Promote, encourage and protect the use of urban forests as Green Infrastructure for rainwater interception and erosion control benefits.</p> <p>Lead: Engineering. Supporting Role: Planning & Building.</p>	Sewer Master Plan, Landscape Plan	Short-Term	\$	Low
4.10	<p>Review design standards and maintenance practices as they relate to newest climate projections - Review engineering, construction and maintenance for surface pavements; Review engineering design, construction and maintenance for sewer and stormwater management infrastructure; Enhance preventative maintenance for HVAC units; Identify cooling options for electrical and mechanical components susceptible to high heat and equipment wear and tear.</p> <p>Lead: Operations; Pollution Control. Supporting Role: Engineering.</p>		Short-Term	\$\$-\$\$\$	Medium
4.11	<p>Explore options for increased electrical power generation from City of Windsor infrastructure (generators) to supplement Ontario's electrical grid as warranted.</p> <p>Lead: Asset Planning. Supporting Role: Pollution Control.</p>		Short-Term	\$	Medium

5.1	<p>Protect and enhance the management of natural areas to improve climate change resilience - Evaluate and prioritize natural areas restoration opportunities; Develop high level policies to inform the development of Natural Areas Management Plans; Develop Natural Areas Management Plans; Prioritize the preservation of unprotected natural properties especially for consolidation of existing natural areas; Increase implementation of natural areas restoration and maintenance; Conduct restoration using appropriate zone specific plants focusing on those identified to be able to withstand extreme weather events; Monitor, protect and advocate for species at risk; Enhance communication and coordination with other agencies; Enhance recognition of Trees as assets in all rehabilitation, development and remediation issues.</p> <p>Lead: Parks; Planning. Supporting Role: ERCA; Friends of Ojibway Prairie; Essex County Field Naturalists; Tallgrass Ontario; Ontario Parks; MNRF; MOECP; Point Pelee National Park; Private Landowners; Erie Wildlife Rescue; Humane Society; Wings Avian Rehabilitation.</p>	Parks Master Plan, Environmental Master Plan, Landscape Plan, Official Plan, Black Oak Management Plan	Medium-Term	\$\$	Medium
5.2	<p>Investigate the potential for natural areas to enhance flood attenuation - Identify where flood attenuation is needed within the City of Windsor; Review water retention possibilities in natural areas including lands adjacent to Provincially Significant Wetlands and other wetland associated habitats (e.g.. swamp forest, wet prairie, meadow marsh).</p> <p>Lead: Planning; Parks; ERCA. Supporting Role: Private landowners.</p>		Medium-Term	\$\$	Medium

5.3	<p>Enhance linkages between and among natural heritage features - Evaluate and prioritize natural heritage restoration opportunities; Increase implementation of natural heritage restoration and maintenance; Ensure land retention of natural heritage linkages, Investigate increased land connectivity options including land acquisition and landscaped or below grade Eco passages to enhance natural areas linkages.</p> <p>Lead: Parks; Planning. Supporting Role: Legal; ERCA; Ontario Parks; Friends of Ojibway Prairie; Tallgrass Ontario; WDBA; MTO-Herb Gray Parkway; Wildlife Preservation Canada.</p>	Official Plan, Parks Master Plan	Medium-Term	\$\$\$\$	High
5.4	<p>Implement an Invasive Species Program - Hire an invasive species coordinator for the City of Windsor; Monitor Windsor's natural areas for invasive species species such as Phragmites, Oak Wilt, the Asian long horned beetle etc.; Increase invasive and woody species control measures such as prescribed burns cutting and physical removal; Enhance targeted education to the public regarding best management practices for protecting private trees from invasive species.</p> <p>Lead: Parks. Supporting Role: CFIA; WEC Health Unit; Essex County Field Naturalists; Friends of Ojibway Prairie; Tallgrass Ontario; Ontario Parks; MNR; MOECP; ERCA; DRCC; Carolinian Canada; St. Clair Horticultural; U Windsor; Point Pelee National Park.</p>		Short-Term	\$\$	Medium
5.5	<p>Complete an Urban Forest Management Plan - Complete the City of Windsor Street Tree and Park Tree Inventories; Complete a Canopy Cover Study & Benefits Assessment and develop a Tree Canopy Cover goal for the Windsor community to benefit the environment and human health; Work towards achieving the Tree Canopy Cover goal through increased quality tree planting, maintenance and replacement; Continue to protect the urban forest through enforcement of the public tree by-law (By-law 135-04); Explore additional measures to limit the removal of trees in Windsor; Increase awareness of the air pollution and greenhouse gas reduction benefits provided by trees.</p> <p>Lead: Parks. Supporting Role: ERCA; DRCC.</p>	Environmental Master Plan	Short-Term	\$\$	Medium

5.6	<p>Improve climate resilience of trees in urban forests, parks and in the public right-of-way - Ensure tree and plant species established are native where possible, diverse, disease resistant and have high climate adaptability; Where appropriate, identify safe opportunities for assisted tree migration from more southern regions; Use an integrated pest management approach to park and urban forest maintenance; Enhance tree maintenance programs to mitigate damage due to heat and extreme events; Review and update new tree irrigation procedures to improve establishment success and therefor long-term survival and performance of trees.</p> <p>Lead: Parks. Supporting Role: Planning.</p>	Parks Master Plan, Environmental Master Plan, Landscape Manual, Urban Tree Inventory	Short-Term	\$	Low
5.7	<p>Enhance Detroit River shoreline protection measures along Windsor's riverfront and Peche Island.</p> <p>Lead: Parks. Supporting Role: ERCA.</p>		Short-Term	\$\$\$	Medium
5.8	<p>Increase community level of knowledge on the benefits of natural areas - Enhance support for the Ojibway Nature Centre; Continue to provide education to the public about the importance of natural areas, invasive species and endangered species; Utilize Citizen Science Programs such as iNaturalist to help monitor and collect information on species at risk and invasive species.</p> <p>Lead: Parks. Supporting Role: ERCA; Essex County Field Naturalists; Friends of Ojibway Prairie; Tallgrass Ontario.</p>		Short-Term	\$	Low
6.1	<p>Improve communications from Transit Windsor to the public - Hire a social media/communications coordinator for Transit Windsor; Develop a social media presence for Transit Windsor and use this to alert riders of changes to routes due to extreme weather events.</p> <p>Lead: Transit Windsor.</p>	Transit Service Delivery Review	Short-Term	\$	Low

6.2	<p>Develop extreme weather contingency plans for Transit Windsor - Identify priority risk areas and develop a Plan to respond to flooding of transit infrastructure, disruption of service and infrastructure damage to terminals, shelters, benches, bus stop pads etc.; Invest in back up power sources for all key Transit Windsor infrastructure including fuel pumps; Explore storing Transit Windsor buses in more than one location.</p> <p>Lead: Transit Windsor.</p>		Short-Term	\$\$	Medium
6.3	<p>Improve design standards for new recreational facilities to ensure they are more climate resilient - Ensure any future outdoor rinks developed consider warmer winter temperature protection measures which may include a full cover and extra cooling capacity; Ensure all new sports fields developed have sufficient shade amenities and additional drainage designed to reflect Windsor's climate projections; Ensure any new indoor recreational facilities are designed to withstand Windsor's climate projections.</p> <p>Lead: Facilities. Supporting Role: Recreation.</p>		Short-Term	\$\$\$\$	Medium
6.4	<p>Identify strategies to minimize cancellations of recreational rentals at existing recreation facilities - Investigate modifying season start, end and duration dates as well as general schedules for recreational programming to try to avoid spring flooding and summer heat; Identify recreational facilities such as trails and sports fields at risk of flooding and prioritize additional drainage measures where possible; Investigate developing service agreements with private facilities or neighbouring towns to share recreational facilities in the event of flooding.</p> <p>Lead: Parks; Recreation; Facilities. Supporting Role: School Boards; St. Clair College; University of Windsor; Private recreational facilities.</p>		Medium-Term	\$\$\$	Medium
6.5	<p>Enhance inspections of Special Events Facilities and roads to identify infrastructure deficiencies for upcoming events.</p> <p>Lead: Recreation; Parks; Facilities; Operations. Supporting Role: Legal; Risk Management; Event Coordinators.</p>		Short-Term	\$	Low

6.6	<p>Evaluate and enhance recreational uses along Windsor's shoreline - Enhance shoreline protection for Sandpoint Beach; Enhance shoreline protection for Peche Island; Evaluate where pathways and trails should be set back from surface water bodies to protect public safety and limit closures when water levels are high.</p> <p>Lead: Parks. Supporting Role: Recreation; Operations; ERCA.</p>		Short-Term	\$\$	Medium
6.7	<p>Replace Lakeview Marina docks with floating docks that are more resilient to varying water levels.</p> <p>Lead: Facilities. Supporting Role: Recreation.</p>		Short-Term	\$\$\$\$	Medium
7.1	<p>Improve stormwater design standards for future climate change precipitation projections - Require new developments follow the new Windsor Essex Regional Stormwater Management Standards Manual including climate change considerations; Design new public areas to accommodate future rainfall intensity and increased stormwater demand and where possible consider providing additional resiliency to neighbouring areas; Investigate changes to new building structures in flood prone areas such as limiting basement depth, enhancing lot grading and building elevation requirements; Use the City's Zoning By-law and Site Plan Control process to limit hard surface areas in new developments; Re-evaluate the defined flood plains in Windsor considering climate change and restrict development in those areas to low population and recreational uses.</p> <p>Lead: Engineering; ERCA. Supporting Role: Planning and Building; Parks.</p>	Zoning By-law, Development Manual, Engineering Standards, Landscape Manual	Short-Term	\$\$	Medium-High
7.2	<p>Explore options to implement stormwater financing mechanisms - Complete the Stormwater Financing Study and recommend implementation; Effectively communicate and educate the public of any stormwater financing implementation decisions.</p> <p>Lead: Engineering. Supporting Role: Finance.</p>		Short-Term	\$\$	Medium

7.3	<p>Enhance the use of low impact development in both private and public areas to reduce storm water impacts - Develop opportunities for increased stormwater management in parks; Incorporate low impact development into infrastructure projects such as roads, sewers and public spaces development; Continue to monitor and showcase current City of Windsor low impact development projects; Promote and incentivize the use of low impact development to developers, private landowners and the community.</p> <p>Lead: Engineering; Planning; Parks; ESCC. Supporting Role: Operations; ERCA; Private landowners; Home Builders Association.</p>	Official Plan, Environmental Master Plan, Landscape Manual, Community Improvement Plans	Short-Term	\$\$-\$\$\$	Medium
7.4	<p>Enhance education to the public about the risk of high surface water levels - Communicate with the media and use social media to update the public on current or changing conditions; Collaborate with other organizations such as ERCA to help spread similar messaging; Use various educational tools and resources to help illustrate overland flooding to the public; Provide door-to-door visits to vulnerable properties as required; Educate the public on the risks of driving on flooded roads.</p> <p>Lead: Fire; ERCA. Supporting Role: Operations; Communications.</p>	Sewer Master Plan	Short-Term	\$	Low
7.5	<p>Develop communications campaign with messaging to residents on lot-level resiliency actions - Including but not limited to green and cool roofs, rain gardens, native plants, rainbarrels etc.</p> <p>Lead: ESCC. Supporting Role: Planning; Engineering; Communications.</p>	Environmental Master Plan, Landscape Plan, Site Plan Control Manual	Short-Term	\$	Medium

7.6	<p>Consider Thermal Comfort and the Urban Heat Island effect in development project design - Encourage and implement more natural surface low impact development treatments instead of hard surfaces; Enhance landscaping and tree coverage in new public space and public right-of-way development; Continue to consider thermal comfort in park design and incorporate shade sails, tree planting, shade structures, splash pads etc. Use cooler and lighter hard surfaces in parks and public spaces; Include requirements for Urban Heat Island and Thermal Comfort considerations in Requests For Proposals for road class environmental assessments.</p> <p>Lead: Planning; Parks; Transportation Planning; Engineering; Corporate Projects. Supporting Role: Purchasing.</p>	Environmental Master Plan, Parks Master Plan, Landscape Manual	Medium-Term	\$\$\$	Medium
7.7	<p>Enhance protections from heat and UV rays at sport fields and outdoor pools - Increase shade options for all users and spectators at sports fields as well as outdoor pools by using trees, shade structures, shade sails etc.; Explore a field closure policy during extreme heat events; Explore rearranging outdoor swimming schedules to avoid peak heat times of day; Investigate installing stadium lighting for sports fields so usage can shift to cooler parts of the day; Increase education with recreation user groups about the risks of extreme heat.</p> <p>Lead: Parks; Recreation.</p>	Parks Master Plan, Environmental Master Plan	Medium-Term	\$\$\$-\$\$\$\$	Medium
7.8	<p>Provide UV Protection in public spaces and at public events - Locate public transportation bus stops where shade is available; Consider installation of sunscreen dispensers in washroom facilities in public spaces and public pools, Sandpoint beach and the Marina; Promote cooling options for festival organizers such as temporary shade sails, misting stations, the Hydration Station etc.; Provide and promote education about the risks of extreme heat.</p> <p>Lead: Recreation; Transit Windsor. Supporting Role: Parks; Operations; WEC Health Unit.</p>		Short-Term	\$	Low

7.9	<p>Enhance communication and education around the impacts of extreme heat on human health - Increase community understanding of heat illness signs and symptoms and associated health risks; Collaborate with the Windsor-Essex County Health Unit to communicate heat warnings via email, website, social media, text, app etc.; Collaborate with partners to produce and implement a targeted heat education program for vulnerable populations including migrant workers, international students and new Canadians.</p> <p>Lead: WEC Health Unit. Supporting Role: Communications; ESCC; Emergency Services; School Boards; Canadian Red Cross; Heart & Stroke Foundation; EMS; Unions; Environment Canada.</p>	Heat Alert and Response Plan	Short-Term	\$	Low
7.10	<p>Implement the Community Energy Plan (including but not limited to the following) - Develop and implement home and building retro fit programs; Encourage a modal shift towards Public Transit and Active Transportation; Foster the adoption of electric vehicles; Continue to retrofit City of Windsor buildings to increase energy efficiency; Incentivize the use of energy efficiency technologies to decrease building energy demand. Designate and plan district energy areas; Promote and implement renewable energy generation such as solar photovoltaic energy systems.</p> <p>Lead: ESCC. Supporting Role: Planning; Facilities; Engineering; Asset Planning; Community Energy Plan Task Force; Transit Windsor; School Boards; Private building owners.</p>	Community Energy Plan, Corporate Climate Action Plan, Community Improvement Plans	Short-Term	\$\$\$\$	High
7.11	<p>Incorporate native and/or drought tolerant plants into public and private landscaping - Educate the public about the benefits of native plants including drought tolerance, water retention attracting pollinators etc.; Review and encourage the selection of species more resilient to a changing climate; Encourage the selection of plants that are more mature and larger with deeper root systems; Explore native plant demonstration gardens in public spaces.</p> <p>Lead: Parks; ESCC. Supporting Role: Essex County Field Naturalists; Friends of Ojibway Prairie; ERCA; DRCC; Private Landowners; Nurseries; Carolinian Canada; St. Clair Horticultural; CEA.</p>	Parks Master Plan, Environmental Master Plan, Landscape Manual	Short-Term	\$	Low

7.12	<p>Collaborate with the Essex Region Conservation Authority and the Windsor-Essex County Health Unit on their climate change mitigation and adaptation planning - Provide data, resources and support for regional climate change planning as needed; Encourage and support the completion of floodplain mapping for our regional watersheds; Incorporate climate change considerations in food security communications and programming; Support the work of the Windsor Essex Food Policy Council.</p> <p>Lead: ESCC; ERCA; WEC Health Unit; Essex County Federation of Agriculture. Supporting Role: CDHS.</p>		Short-Term	\$	Low
7.13	<p>Assess new opportunities for different forms of business and tourism as a result of a changing climate - Educate and encourage local businesses and the tourism industry to implement adaptation actions to prepare for our climate future (e.g. cooling options for outdoor patios); Promote "shoulder seasons" as a great time for tourism in Windsor Essex; Work with businesses to encourage climate resilience and tourism related services.</p> <p>Lead: Tourism Windsor Essex. Supporting Role: Parks; ERCA; Point Pelee National Park.</p>		Short-Term	\$	Low

Timelines

- Short-Term: < 5 years
- Medium Term: 5-10 years
- Long Term: > 10 years

Estimated Costs

- \$ = <\$100,000
- \$\$ = \$100,000-\$500,000
- \$\$\$ = \$500,000-\$1,000,000
- \$\$\$\$ = >\$1,000,000

Appendix C

Indicators

Indicators

Indicators have been developed for each action, where feasible. Effort was taken to identify indicators that already exist or that are already being tracked. In cases where indicators exist, City departments and/or organizations with access to the information are identified. An organizational lead was also assigned for tracking progress for each indicator. For some actions, indicators will be identified as implementation progresses.

Objective 1: Integrate Climate Change Thinking and Response

- Climate Change inclusion in Official Plan (Planning)
- Number of plans and policies including climate change considerations (ESCC)
- Number of engagement activities (ESCC leading, all departments)
- Number of people reached through engagement activities (ESCC, IT, all departments)
- Costs of response to natural disasters (Finance)
- Number of Partnerships Formed (ESCC)

Objective 2: Protect Public Health and Safety

- Updated Community Development and Health Services Emergency Response Plan (CDHS)
- Number of times Emergency Response Plans have been implemented (Emergency Management)
- Number of sites offering free tap water (ESCC, Windsor Essex County Health Unit)
- Number of AQHI alerts (ESCC)
- Number of human cases of vector borne diseases (Windsor Essex County Health Unit)
- Heat related emergency room visits (Windsor Essex County Health Unit)

Objective 3: Reduce Risk to Building and Property

- Number of People taking advantage of the Basement Flooding Subsidy Program (Engineering)
- Number of rainbarrel sales (ESCC)
- Number of downspouts disconnected (Field Services)

Objective 4: Strengthen Infrastructure Resiliency

- Sewer Master Plan completed (Engineering)
- Number of recommendations in the Sewer Master Plan underway or completed (Engineering)
- Number of rain guards installed (Operations)
- Number of projects using the Triple Bottom Line approach (Asset Planning)
- Completion of Flood Plain Mapping (Engineering)
- Number of vulnerability and risk assessments completed for individual City assets (ESCC, Engineering)

- Number of recommendations ongoing or completed in the East Riverside Flood Study (Engineering)
- Number of infrastructure failures due to extreme temperatures (Operations)

Objective 5: Protect Biodiversity and Enhance Ecosystem Functions

- Number and local status of species at risk in Windsor (Forestry and Natural Areas)
- Number and local status of invasive species types identified (Forestry and Natural Areas)
- Costs per year for invasive species management control (Forestry and Natural Areas)
- Percentage of tree canopy cover achieved (Forestry and Natural Areas)
- Total land area of Natural Areas in Windsor (Forestry and Natural Areas)
- Number of Citizen Science programs conducted (ESCC, Forestry and Natural Areas)
- Number of Street, Park and Natural Area Trees (Forestry and Natural Areas)
- Urban Forestry Management Plan completed (Forestry and Natural Areas)

Objective 6: Reduce Community Service Disruptions

- Days outdoor rinks operate (Recreations)
- Number of closures of sports fields due to precipitation (Recreation)
- Number of shade amenities at sports fields (Parks)
- Number of facilities/paths closed due to extreme weather (Facilities, Forestry, Parks)
- Number of beach closures (Windsor Essex County Health Unit)

Objective 7: Build Community Resilience

- Number of Low Impact Development features on City Property (Asset Planning)
- Number of Low Impact Development features on Private Property (ESCC, R.O.W. Development)
- Tonnes of Greenhouse Gas Emissions – Community (ESCC)
- Number of artificial shade structures (Parks)
- Amount of money invested in energy retrofit projects by School Boards and Institutions (Various School Boards and Institutions)

References

Boden, Tom A., Gregg Marland, and Robert J. Andres. "Global, regional, and national fossil-fuel CO₂ emissions." Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of Energy, Oak Ridge, Tenn., USA doi 10 (2009).

Canada. National Round Table on the Environment and the Economy. (2011). *Paying the Price: The Economic Impacts of Climate Change for Canada*.

Canada. National Round Table on the Environment and the Economy. (2012). *Facing the Elements: Building Business Resilience in a Changing Climate (Advisory Report)* Accessed from <http://collectionsCanada.gc.ca/webarchives2/20130322175153/http://nrtee-trnee.ca/wp-content/uploads/2012/04/cp5-advisory-report.pdf>

Chiotti, Q. and Lavender, B. (2008): Ontario; *in* From Impacts to Adaptation: Canada in a Changing Climate, 2007, *edited by* D.S. Lemmen, F.J. Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 227-274

Federation of Canadian Municipalities, 2019: online at <https://fcm.ca/en/focus-areas/infrastructure>.

Hansen, James; Kharecha, Pushker; Sato, Makiko; Masson-Delmotte, Valerie; Ackerman, Frank; Beerling, David J.; Hearty, Paul J.; Hoegh-Guldberg, Ove; Hsu, Shi-Ling; Parmesan, Camille; Rockstrom, Johan; Rohling, Eelco J.; Sachs, Jeffrey; Smith, Pete; Steffen, Konrad; Van Susteren, Lise; von Schuckmann, Karina; Zachos, James C. (3 December 2013). "Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature". PLOS ONE. 8: e81648. Bibcode:2013PLoSO...881648H. doi:10.1371/journal.pone.0081648. PMC 3849278. PMID 24312568.

Health Canada, 2018: Climate Change and Health: Populations at Risk. <https://www.canada.ca/en/health-canada/services/climate-change-health/populations-risk.html>

Her Majesty the Queen in Right of Canada, as represented by the Auditor General of Canada, 2016. Commissioner of Environment and Sustainable Development *Mitigating the Impacts of Severe Weather* online http://www.oag-bvg.gc.ca/internet/docs/parl_cesd_201605_02_e.pdf

IDF Curve. The Climate Workspace. Accessed from: <http://www.glisacclimate.org/node/2341>

Insurance Bureau of Canada. 2016. Facts of the Property and Casualty Insurance Industry in Canada 2016 online http://assets.ibc.ca/Documents/Facts%20Book/Facts_Book/2016/Facts-Book-2016.pdf

IPCC, 2014: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-

Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.]. *World Meteorological Organization, Geneva, Switzerland, 32 pp.*

McBean, G. and Henstra, D. (2009). Background Report: Climate Change and Extreme Weather: Designing Adaptation Policy.

McDermid, J., Fera, S., and Hogg, A. (2015). Climate Change Projections for Ontario: An Updated Synthesis for Policymakers and Planners. Queen's Printer for Ontario. Ontario Ministry of Natural Resources and Forestry, Science and Research Branch, Peterborough, Ontario. Climate Change Research Report CCRR-44.

NASA (2019). 2018 fourth warmest year in continued warming trend, according to NASA, NOAA.

Nantel, P., Pellatt, M.G., Keenleyside, K. and Gray, P.A. (2014): Biodiversity and Protected Areas; in *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, (ed.) F.J. Warren and D.S. Lemmen; Government of Canada, Ottawa, ON, p. 159-190.

Ontario, 2019 online <https://www.ontario.ca/page/how-were-adapting-climate-change>

Tebaldi, Claudia, and Pierre Friedlingstein. "Delayed detection of climate mitigation benefits due to climate inertia and variability." *Proceedings of the National Academy of Sciences* 110.43 (2013): 17229-17234.

UNEP (2018). The Emissions Gap Report 2018.

United Way (2013) From Crisis to Resiliency: A guide for partners in flood recovery. Accessed from <http://www.calgaryunitedway.org/images/uwca/our-work/communities/public-policy-research/flood-report/from-crisis-to-resiliency-flood-report-full-report.pdf>

Warren, F.J., and Egginton, P.A. (2008) Background Information; *in* From Impacts to Adaptation: Canada in a Changing Climate 2007, *edited* by D.S. Lemmen, F.J. Warren, J. Lacroix and E. Bush; Government of Canada, Ottawa, ON, p. 27-56