

July 2024

DISCUSSION PRIMER

Developing London's Climate Change Adaptation
Framework as part of the Climate Emergency Action Plan



#LdnOnt
ClimateAction



London
CANADA

Land Acknowledgement

We acknowledge that we are gathered today on the traditional lands of the Anishinaabek, Haudenosaunee, Lūnaapéewak and Attawandaron. We acknowledge all the treaties that are specific to this area: the Two Row Wampum Belt Treaty of the Haudenosaunee Confederacy/ Silver Covenant Chain; the Beaver Hunting Grounds of the Haudenosaunee NANFAN Treaty of 1701; the McKee Treaty of 1790, the London Township Treaty of 1796, the Huron Tract Treaty of 1827, with the Anishinaabeg, and the Dish with One Spoon Covenant Wampum of the Anishnaabek and Haudenosaunee.

This land continues to be home to diverse Indigenous people (First Nations, Métis and Inuit) whom we recognize as contemporary stewards of the land and vital contributors to society. We hold all that is in the natural world in our highest esteem and give honor to the wonderment of all things within Creation. We bring our minds together as one to share good words, thoughts, feelings and sincerely send them out to each other and to all parts of creation. We are grateful for the natural gifts in our world, and we encourage everyone to be faithful to the natural laws of Creation.

The three Indigenous Nations that are neighbours to London are the Chippewas of the Thames First Nation; Oneida Nation of the Thames; and the Munsee-Delaware Nation who all continue to live as sovereign Nations with individual and unique languages, cultures and customs.

This Land Acknowledgement is a first step towards reconciliation. Awareness means nothing without action. It is important that everyone takes the necessary steps towards decolonizing practices. We encourage everyone to be informed about the traditional lands, Treaties, history, and cultures of the Indigenous people local to their region.



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.

Baseline: A climatological baseline is a reference period, typically 30 years, that is used to compare fluctuations of climate between one period and another. Baselines can also be called references or reference periods.

Climate: The weather of a place averaged over a period, often 30 years. Climate information includes the statistical weather information describes 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 Atlas of Canada: The Climate Atlas of Canada is an interactive tool that combines climate science, mapping, and storytelling to depict expected climatic changes across Canada to the end of the century. The 250-layer map is based on data from 12 global climate models. Users are shown a baseline period of warming trends by region that spans from 1950 to 2005 and can toggle between two future projection periods, 2021 to 2050 and 2051 to 2080.

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.



Climate Change Scenario: A climate change scenario is the difference between a future climate scenario and the current climate. It is a simplified representation of future climate based on comprehensive scientific analyses of the potential consequences of anthropogenic climate change. It is meant to be a plausible representation of the future emission amounts based on a coherent and consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships.

Extreme Weather Event: A meteorological event that is rare at a place and time of year, such as an intense storm, tornado, hailstorm, flood or heat wave, and is beyond the normal range of activity. An extreme weather event would normally occur very rarely or fall into the tenth percentile of probability.

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.



Representative Concentration Pathways (RCPs): Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5) in 2014. It supersedes the Special Report on Emissions Scenarios (SRES) projections published in 2000.

Resilience: The capacity of a system, community or society exposed to hazards to adapt, by resisting or changing 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.

Vulnerable Populations: The portion of the population facing greater vulnerability to the effects of climate change. In the context of London, this group may encompass seniors, youth, children, Indigenous Peoples, racialized communities, individuals with disabilities, pregnant individuals, frontline emergency responders, socially and economically marginalized individuals, immunocompromised individuals, and those with pre-existing health conditions.

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

(Note: The Glossary of Terms and definitions have been compiled from various published sources dealing with climate change adaptation. These are not City of London definitions)



Acronyms

BARC – Building Adaptive and Resilient Communities

CCAP – Community Climate Adaptation Plan

CEAP – Climate Emergency Action Plan

ICLEI Canada – Local Governments for Sustainability

IPCC – Intergovernmental Panel on Climate Change

LID – Low Impact Development

MLHU – Middlesex London Health Unit

NBS – Nature-based Solutions

RCP – Representative Concentration Pathways

UTRCA – Upper Thames River Conservation Authority



Table of Contents

Land Acknowledgement

Glossary of Terms

Acronyms

1. Purpose and How to Participate	1
2. Acknowledgements	3
3. Background	4
3.1 Climate Change Science.....	4
3.2 Observed Climate Change in London	4
3.3 Adaptation vs. Mitigation	6
3.4 Why Do We Need Adaptation?	7
3.4.1 IPCC Direction	8
3.4.2 Federal Policy Direction on Climate Adaptation.....	8
3.4.3 Provincial Policy Direction on Climate Adaptation	9
3.4.4 The Cost of Doing Nothing.....	10
3.5 London's Commitment to Climate Change.....	11
3.6 London's Current Adaptation Actions.....	12
4. Climate Change Projections for London.....	14
4.1 Temperature	15
4.2 Hot Days	15
4.3 Freeze Thaw	16
4.4 Precipitation	16
4.5 Heavy or Extreme Precipitation.....	16
5. Adaptation Plan Development.....	18



5.1 BARC Program	19
5.2 Vulnerability and Risk Assessment	20
5.3 Priority Impacts and Issues for London	20
5.4 Adaptation Planning	24
6. Themes, Objectives and Actions	25
6.1 Theme 1: Built Environment.....	25
6.2 Theme 2: Natural Environment	27
6.3 Theme 3: People.....	30
6.4 Theme 4: Engagement and Partnerships.....	32
7. Plan Implementation, Monitoring and Governance.....	34
7.1 Implementation and Governance	34
7.2 Monitoring and Evaluation.....	34
7.3 Funding.....	34
7.4 Communication, Education and Outreach.....	35
8. Adaptation Planning Resources	36
9. Next Steps.....	37
References.....	38
Appendix 1 – Adaptation Summary for Peer Ontario Municipalities	39
Appendix 2 – Examples of London's Adaptation Actions	48
Appendix 3 – London's Urban Heat Island	58
Appendix 4 – Review of London's Urban Forest from a Wildfire Perspective.....	60
Appendix 5 – 2014 Risk Assessment Considerations and Recommendations	62
Appendix 6 – Risk/Vulnerability Assessment Outcomes	64



1. Purpose and How to Participate

Purpose and Brief Background

The purpose of this Discussion Primer is to help develop London's Climate Change Adaptation Framework (hereafter referred to as the 'Discussion Primer') and to build upon the existing and past actions taken by the City of London and many other businesses, institutions, agencies and interested parties to prepare for and respond to the impacts of a changing climate.

London and area have been experiencing more severe weather (e.g., flooding, windstorms, heat waves, draught conditions) in recent years and it is anticipated that this trend will increase.

The Discussion Primer is not about reducing greenhouse gas emissions which is covered in many Areas of Focus of the Climate Emergency Action Plan (CEAP). However, a number of adaptation actions do have the potential to also reduce greenhouse gas emissions.

This document provides background information and proposes an initial set of actions spanning the community that are intended to address the climate risks identified for London and improve the City's resilience as outlined in Area of Focus #8, "Adapting and Making London More Resilient" from London's Climate Emergency Action Plan (CEAP).

The development of this Discussion Primer had its initial foundation developed as far back as the 2014 *City of London Climate Change Adaptation Risk Assessment Report* (herein referred to as the Risk Assessment Report) prepared by a committee comprised of City staff from a cross-section of departments in addition to staff from the Middlesex-London Health Unit (MLHU) and with input from staff from the Upper Thames River Conservation Authority (UTRCA). This was the same year that the Middlesex-London Health Unit (MLHU) released a report entitled the Assessment of Vulnerability to the Health Impacts of Climate Change in Middlesex-London.

Prior to 2014, plans, programs and projects existed across London; however, the linkages and relationships between climate change, resiliency, mitigation and adaptation were not as strong locally as they are today.

Since 2014, climate change adaptation actions became increasingly more important in the design and maintenance of City infrastructure. Numerous projects were undertaken and the range of organizations becoming involved with adaptation and resiliency actions increased. Additional important local time periods included the declaration of a climate emergency by London City Council in 2019 and the development and approval of a London Climate Emergency Action Plan (CEAP - between 2019 and 2022) including processes to further embed adaptation actions into existing and new projects and program (e.g., Corporate Asset Management Plan).

Proposed objectives and actions in the Discussion Primer are provided for discussion and for further refinement by partners, collaborators, interested parties and community members. They respond to the climate change adaptation goals and objectives identified with the help of staff from the International Council for Local Environmental Initiatives (ICLEI Canada) and by using the "Building

Adaptative and Resilient Communities” (BARC) program. The actions are based on a preliminary Risk Assessment in 2014 (updated in 2021), on two workshops with City staff and community environmental partners in 2022, and on the results of shared experiences with peer municipalities and climate experts.

This Discussion Primer has benefited from recent research and actions from several local organizations plus several outside London including Green Communities Canada, the Climate Risk Institute (CRI), and Regional Public Works Commissioners of Ontario (RPWCO).

In summary, this Discussion Primer is intended to generate feedback that will assist in the final steps to prepare London’s Climate Change Adaptation Framework as part of the overall CEAP.

How to Participate

Opportunities to provide feedback on all content provided in this Discussion Primer will be available primarily through London’s digital engagement tool called Get Involved, available at getInvolved.london.ca.

Throughout the summer and fall of 2024 a series of opportunities and questions will be initiated, organized around the themes of built environment, natural environment, people, and engagement and partnerships, to gather information from Londoners and other interested parties.

In addition, general or more targeted input on the developing plan and/or the plan’s implementation can be provided through Get Involved’s general input opportunities, or information can be emailed to the City project team at ClimateAction@london.ca.

If there are any special requirements or accessibility limitations preventing you from providing feedback through the means available, accommodations can be explored by contacting London’s Accessibility and Inclusion team via accessibility@london.ca or calling 519-661-2489, extension 2425.

2. Acknowledgements

This initial work could not have been accomplished without the assistance advice and guidance provided by the following groups and individuals:

Project Team:

- City of London (staff from all City Service Areas)
- ICLEI Canada staff (5 staff participated)

Contributors to the development of this Discussion Primer included:

- Upper Thames River Conservation Authority (UTRCA)
- London Environmental Network (LEN)
- ReForest London
- Thames Talbot Land Trust (TTLT)
- Carolinian Canada
- Middlesex – London Health Unit (MLHU)

Project funding statement:

Advice, guidance, and support on the development towards London's Climate Change Adaptation Framework was delivered by ICLEI Canada through the Planning cohort of the Advancing Adaptation: Train the Trainer project, funded through the Ministry of Environment, Conservation and Parks alongside support from Environment and Climate Change Canada.

3. Background

3.1 Climate Change Science

Since the late 1800s, the Earth's temperature has risen by 1°C per century (NOAA 2021 Annual Climate Report) largely due to human activities. As fossil fuel extraction and consumption continues around the world, warming is accelerating at a faster rate. Earth's average surface temperature in 2020 tied 2016 for the hottest year since record-keeping began in the 1880s, a record that is now held by the year 2023. The nine warmest years have taken place consecutively since 2015, and the 22 warmest years on record have occurred over the past 24 years. July 2023 was the hottest month ever recorded, shrinking Arctic and Antarctic sea ice to historic lows 19.8 per cent below average. September 2023 was also the hottest month of September globally on record (European Union's Copernicus Climate Change Service, 2023).

Similar to global trends, Canada has been warming over the last six decades, with annual average surface air temperatures over land warming by 1.7°C since 1948, and even greater increases observed in the North, the Prairies, and northern British Columbia. This rate of warming is almost double the global average reported over the same period, meaning an increase of 2°C globally could result in a 3 to 4°C change in Canada. The record setting 2021 summer heatwave in British Columbia saw temperatures reach 49.6°C and resulting in over 500 heat-related deaths and contributed to the destruction of the Town of Lytton, B.C. by fire.

Canada has also generally become wetter over the past several decades, with average annual precipitation across the country increasing by approximately 16 per cent between 1950-2010. This increase is dominated by large changes in British Columbia and Atlantic Canada. Extreme precipitation events are also likely to become more intense and more frequent. Recent studies show that a 1-in-20-year storm event are likely to become 1-in-10-year storm events by the 2050s.

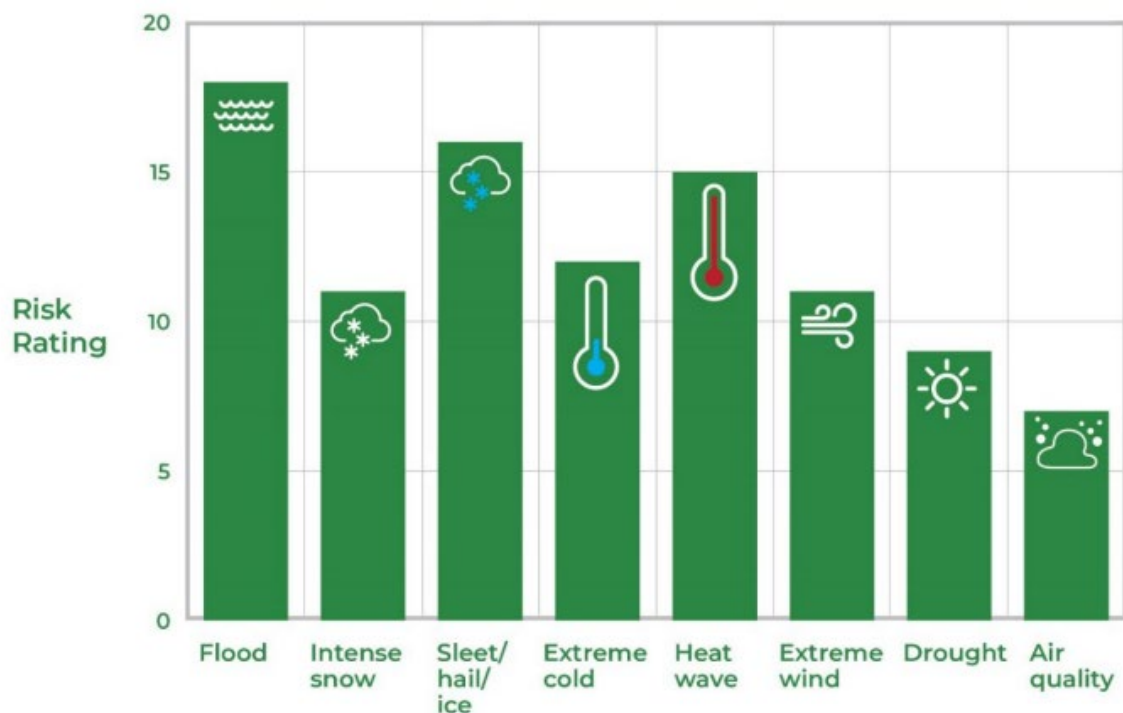
3.2 Observed Climate Change in London

Warmer, wetter, and wilder weather events have already impacted London, and are projected to become more frequent and intense. These events include flooding, heat waves, damaging winds, possible tornados, snow squalls, and ice storms. Additionally, slow onset climate changes (i.e., longer frost-free seasons, hotter summer temperatures) will continue to affect the environment. All aspects of life in London including its citizens, communities, infrastructure, and the natural environment will be impacted by these changes. Increasing resilience in the community and in London's infrastructure and buildings is essential in creating a more sustainable and livable London.

Research completed in 2014 was used to develop a Climate Risk Rating of extreme weather events for London which was further refined and confirmed in 2020 using climate, web-based data obtained from Climateatlas.ca and Climatedata.ca. That analysis identified eight weather impacts or events of concern (see Figure A). The highest risk rating was flooding given the past flooding history of the Thames River spanning 45 kilometres through London and the associated 82 kilometre tributaries within the city that influences a large percentage of London's urban and adjacent landscape. This is

due to London being located approximately at the midway point along the 273 kilometre length of river which in London, is subject to wide variations in flow (minimum = 3 cubic metres per second to maximum = 1,550 cubic metres per second). Flooding events which create flows that exceed 285 cubic metres per second trigger a ‘boating ban’ within the city limits intended to deter recreational boating and limit the need for emergency response.

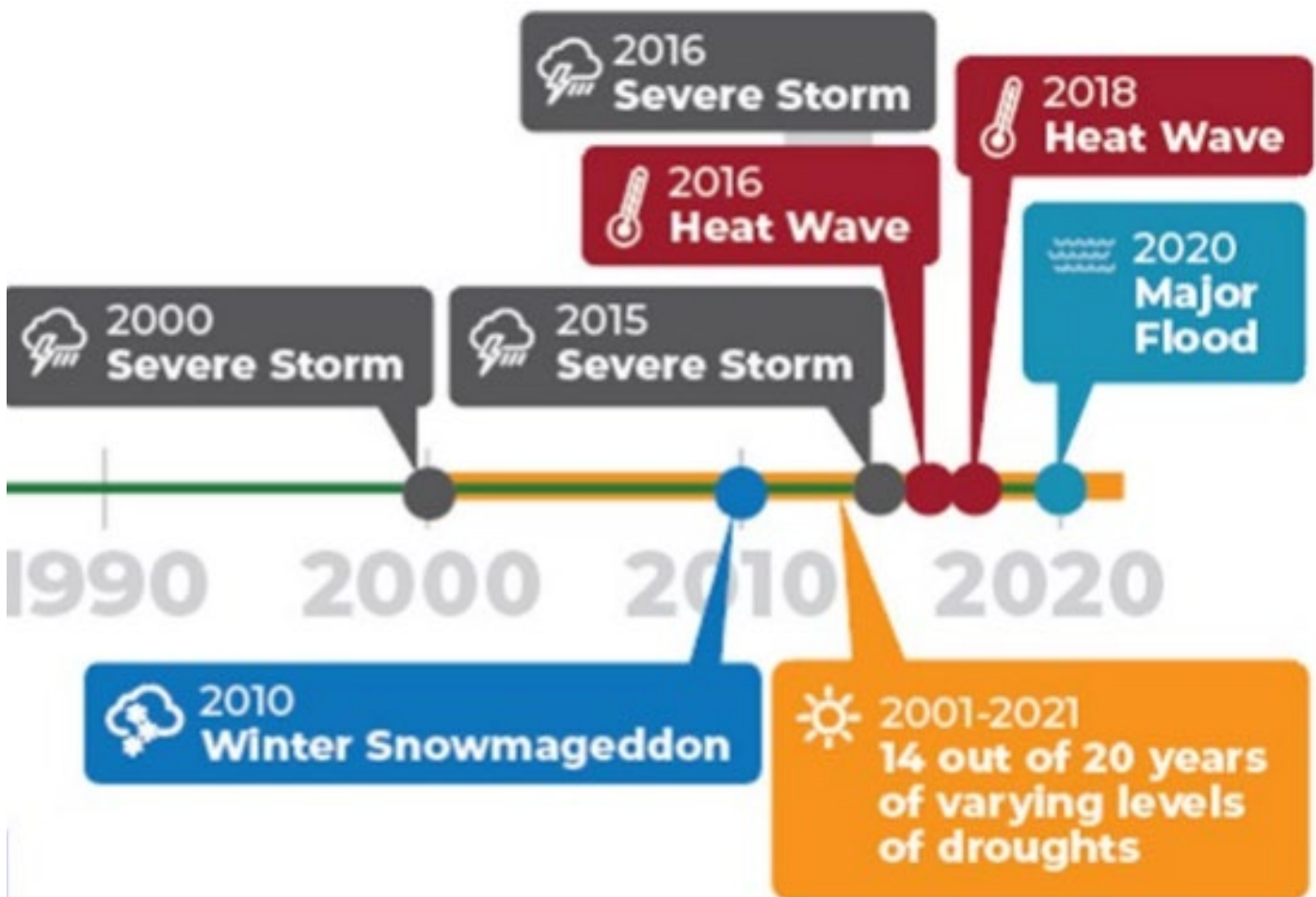
Figure A: Risk Exposure by Weather Events



July 2023 presented several new weather phenomena in and around London. For the first time, wildfire smoke from fires hundreds and thousands of kilometres from London significantly decreased air quality in the area to the extent that Health Canada and the Middlesex London Health Unit issued advisories on the topic. July was also an early start to heat warning days locally and July 2nd, 3rd and 4th were the hottest days for global average surface temperature on record.

London has a long history of river flooding and now these flood events are becoming more frequent in all seasons including winter, rather than occurring during the traditional spring melt. Flooding has been a common occurrence since 1937 when the ‘benchmark flood’ occurred killing one Londoner and causing millions of dollars in damage. Each subsequent severe storm event in London, including a major flood in 2020, has also been associated with subsequent droughts, illustrating the extreme range in observed conditions. Severe weather events since the year 2000 are noted on Figure B.

Figure B: Sample of Severe Weather Events in London (2000 to 2021)



Source: Public Safety Canada

3.3 The Differences Between Adaptation and Mitigation

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

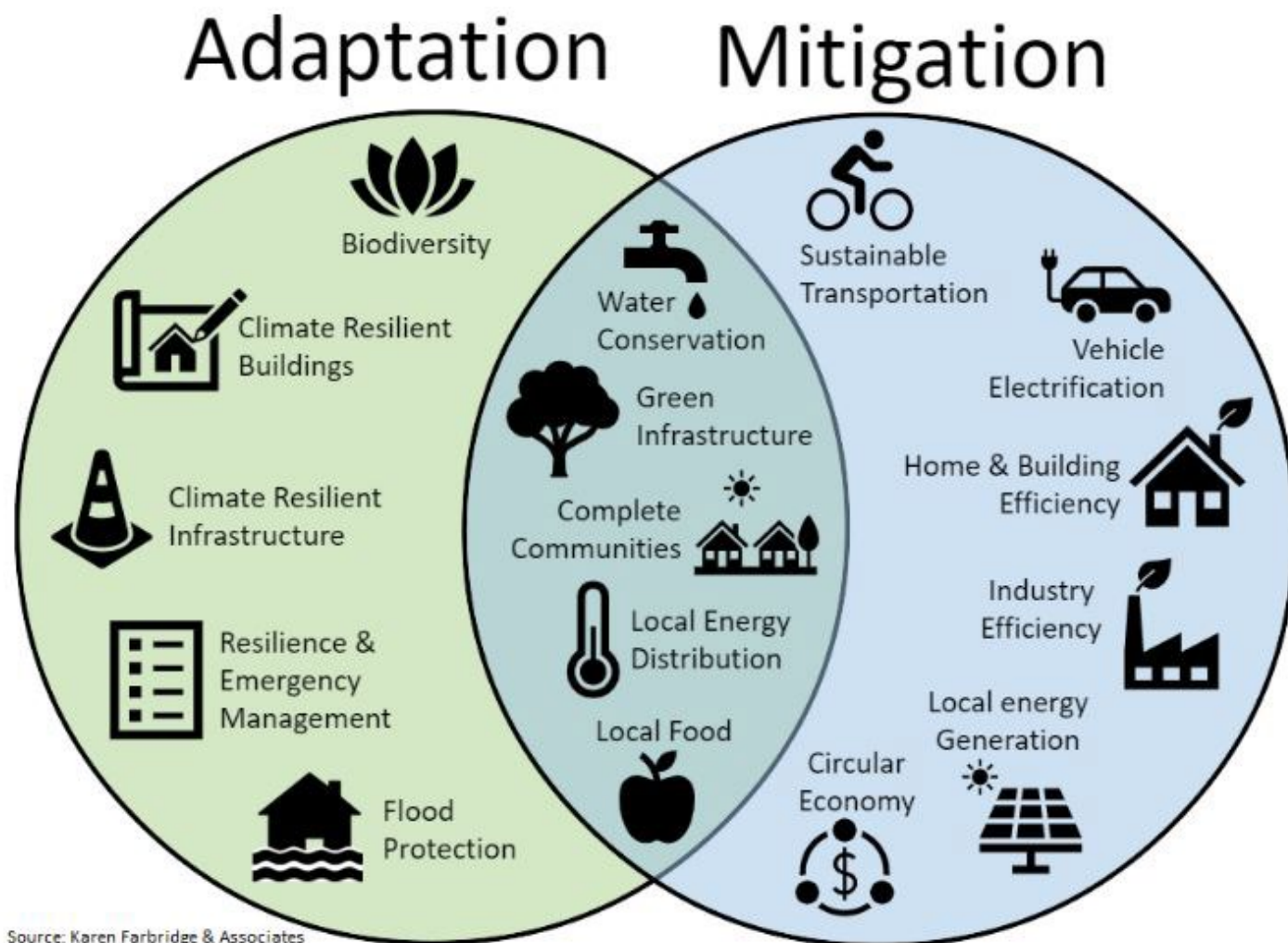
A community-based adaptation approach can further support local governments in building resilience while reducing vulnerability via engagement of communities and residents throughout the process of adaptation planning. A wide range of community participants should be involved allowing for collaborative co-development of an Adaptation Framework that addresses climate risks across multiple sectors and systems. Traditional and local indigenous knowledge and assets of community members should be incorporated to inform local adaptation planning and implementation.

Climate change mitigation refers to the implementation of policy, regulatory and project-based measures that contribute to the stabilization and subsequent reduction of greenhouse gas

concentrations in the atmosphere. These include programs to reduce the use of single occupancy vehicles, building retrofits to conserve energy, and transitioning to low-carbon energy sources.

Some actions needed to address the challenges of climate change share in addressing both mitigation and adaptation (see Figure C). These actions often become higher priorities.

Figure C: Comparing Adaptation and Mitigation Actions



Source: Karen Farbridge & Associates

3.4 Why Do We Need Adaptation?

As noted, London is already starting to see wetter, wilder, and warmer weather. In 2022, boulevard trees along Huron Street east of Highbury Avenue (among many others) were toppled by high winds assessed as a tornado. Several cars were damaged due to the falling debris. In 2021, residents in Kensington Village with properties along Cavendish Crescent, Wyatt and Walnut Streets were inundated with flood waters due to heavy rains and high river water levels. Basement flooding damage was considerable. Each year for the past decade, climate terms have been introduced into

everyday use to reflect major weather changes happening in Canada and Ontario. ‘El Nino’, ‘La Nina’, ‘Polar Vortex’, ‘Heat Domes’, ‘Atmospheric Rivers’, ‘Derechos’ and wildfire smoke are the latest events and terms to appear in the news media to help explain what is happening. Some of these terms may be new for many while others like El Nino and La Nina have been referred to for centuries. These events point to the need for adaptation to climate change to safeguard communities from extreme events and changing climate norms, both those happening now and expected in the future.

3.4.1 IPCC Direction

The United Nations Intergovernmental Panel on Climate Change (IPCC) is the UN institution tasked with assessing the scientific basis of climate change, its impacts and potential future risks, and potential response options. In its Sixth Assessment Report (AR6 Synthesis Report), released in May 2023, the IPCC declared with certainty the widespread impact of human-caused climatic changes. The report stated:

“Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability. The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt”.

The most urgent report to date, the AR6 reports states that even with major reductions of GHG emissions in the short term (known as an aggressive response to GHG reduction) there is greater than a 50 per cent likelihood that global warming will reach or exceed 1.5°C in the near term. This aggressive response is also known as the RCP2.5 scenario, or Representative Concentration Pathway 2.5 scenario and illustrates a low greenhouse gas concentration which will limit the effects of climate change. RCP4.5 is a moderate response and RCP8.5 is known as business-as-usual response which will do little to avoid the negative impacts. These pathways describe different climate scenarios all of which are considered possible depending on the amount greenhouse gases emitted in the years to come.

According to the report, “Global warming, reaching 1.5°C in the near-term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans. The level of risk will depend on concurrent near-term trends in vulnerability, exposure, level of socioeconomic development, and adaptation”. Now more than ever, it is crucial that cities implement comprehensive, effective, and innovative responses between adaptation and mitigation efforts to advance sustainable development and to capitalize on the co-benefits these strategies can provide. Actions taken now will also contribute to “cost avoidance” in the future.

3.4.2 Federal Policy Direction on Climate Adaptation

Canada was one of 195 countries to sign the Paris Agreement in December 2015. The Agreement aims to keep the global temperature to well below two degrees Celsius, and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels. In terms of adaptation, the Agreement has a goal to enhance adaptive capacity, strengthen resilience and reduce vulnerability to global climate change, in line with the temperature goal.

In addition to signing onto the Paris Climate Agreement, the Government of Canada has also produced several policy documents that inform and guide decision-makers on climate change adaptation. In 2016, the Government of Canada released its Pan Canadian Framework on Clean Growth and Climate Change, which includes adaptation considerations and actions to improve climate resiliency. In 2022, the Government of Canada developed Canada's first National Adaptation Strategy with provincial, territorial, and municipal governments, Indigenous Peoples, and other key partners. A major focus has been put on the development of Expert Advisory Tables to focus on:

- Health and Wellbeing;
- Resilient Natural and Built Infrastructure;
- Thriving Natural Environment;
- Strong and Resilient Economy; and
- Disaster Resilience and Security.

The National Adaptation Strategy, first announced in November 2020, was a two-year program with a companion Adaptation Action Plan that provides financial investments in flood hazard identification for updated mapping, and other adaptation-related activities. Disaster relief was also identified in the funding investment.

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 the unique set of climate change impacts they already experience or expect to face.

Other resources developed by the Government of Canada include the National Issues Report *Health of Canadians in a Changing Climate* (2022) to provide a national perspective on how climate is impacting Canadian communities, the environment, and its economies. The *Map of Adaptation Actions* is a repository of case studies from across Canada that explore how communities and sectors are adapting to a changing climate.

3.4.3 Provincial Policy Direction on Climate Adaptation

The Ontario Provincial Climate Change Impact Assessment (Climate Risk Institute, 2023) has highlighted the impacts to Ontario at a regional scale that include the impacts previously identified in 2014 for London. The provincial analysis completed by members of the Climate Risk Institute (CRI) focused on the five themes of infrastructure, food and agriculture, people and communities, natural resources, ecosystems, and the environment, and business and the economy.

The Government of Ontario's 'Made-in-Ontario Environment Plan' (2020) addresses climate change through both mitigation and adaptation strategies. These strategies include:

- emissions performance standards and regulations to reduce emissions from the transportation sector;

- programs to enhance and expand public transit networks;
- funding for extreme-weather resistant infrastructure;
- a province-wide multi-sector provincial climate change impact assessment; and
- the *Protecting People and Property: Ontario's Flooding Strategy* to reduce flood risk.

Additionally, the Provincial Policy Statement has been updated to include direction for planning authorities to prepare for the impacts of a changing climate, include climate change decision making in land-use and development policy, and enhanced stormwater management policies to increase climate resilience (e.g., allowing low impact development techniques to reduce water flowing into storm sewers). However, depending on how some recent amendments made to key legislation intended to address the housing shortage across the province (e.g., *More Homes Built Faster Act, 2022*) are implemented, will determine how they influence local community resilience.

3.4.4 The Cost of Doing Nothing

In support of the development of London's Climate Emergency Action Plan, several background documents were prepared by City staff to set the stage for action. The background document, titled "Overview of Current and Potential Climate Action Costs and Funding Opportunities" (available at [Getinvolved.London.ca/climate](https://getinvolved.london.ca/climate)) summarizes, among other things, reviews conducted by the Financial Accountability Office of Ontario of municipal asset vulnerabilities to climate change impacts. This review includes municipal and community costs associated with recovery from recent climate change-amplified severe weather events in Windsor, Toronto and Ottawa, and work done in other Canadian municipalities to estimate the potential costs of doing nothing to address climate change over the coming decades.

The review made clear that:

- municipalities will face major expenses to deal with climate change impacts in the absence of adaptation measures;
- the costs to recover from extreme weather events are rising for municipalities and residents with increasingly less losses being insured; and
- the cost of doing nothing to adapt to climate change is expected to far outweigh the cost of taking action to adapt key infrastructure and social systems.

More information on these aspects and others related to the costs of climate change are available in the previously noted CEAP supporting document.

The National Adaptation Strategy estimated a \$15 to \$1 ratio of 'return on investment' for adaptation work. This includes implementing flood and wildfire reduction actions, climate-related building code improvements and urban forest enhancements. Additional research by ICLEI Canada (ICLEI Canada 2022) has helped to re-define the costs of climate change by moving beyond the financial costs and defining both direct and indirect costs. Non-market direct and indirect costs include those to human health and well-being, as well as costs to the natural environment in the form of reduced ecosystem services. Equity issues are also identified along with the need to weave together Indigenous, local and western knowledge to achieve a holistic, evidence-based approach for policy and decision-making.

Estimating the potential adaptation costs for London requires an in-depth understanding of the community-wide vulnerabilities and potential actions required to address those vulnerabilities. As such, using work completed for other jurisdictions to estimate costs in London is not likely to result in realistic or defensible results. Evaluating and understanding the processes used and results achieved in other jurisdictions is valuable, however, and London continues to pursue this information as part of actions identified in the CEAP.

3.5 London's Commitment to Climate Change

London City Council declared a climate emergency in 2019 and subsequently, London's Climate Emergency Action Plan (CEAP) was approved in 2022. The CEAP has three main goals:

1. Net zero community greenhouse gas emissions by 2050;
2. Improved resilience to climate change impacts; and
3. Bring everyone along (e.g., individuals, households, businesses, neighbourhoods).

The Climate Change Adaptation Framework (Plan) that this Discussion Primer supports will directly address the CEAP's Area of Focus #8 - "Adapting and Making London More Resilient". The actions listed in the CEAP Area of Focus 8 workplan are:

1. Finalize an Adaptation Strategy based on the updated Risk Assessment for Climate Change Adaptation
 - a. Finalize London Working Group / Review Team
 - b. Use program and expertise of ICLEI
 - c. Develop list of focused actions under specific areas such as:
 - i. Integrate Climate Change Thinking and Response
 - ii. Protect Public Health and Safety
 - iii. Reduce Risk to Buildings and Property
 - iv. Strengthen Infrastructure Resilience
 - v. Protect Biodiversity and Enhance Ecosystem Functions
 - vi. Reduce Community Service Disruptions
 - vii. Build Community Resilience
2. Update the Climate Lens Process to incorporate the latest information included in the Adaptation Strategy to ensure corporate decision-making takes full advantage of the latest information
3. Identify and assess extreme weather events, impacts and data gaps
4. Implement recommendations guided by the timelines established in the completed Adaptation Strategy
5. Monitor best management practises of other municipalities to take full advantage of new developments in adaptation methods
6. Work with the Middlesex-London Health Unit and other community partners to review the effectiveness of existing extreme heat event response programs, including affordable access to indoor air cooling
7. Work with community partners to review the effectiveness of existing flooding event response programs, including access to current flood hazard mapping

In 2023 Council embedded the commitment to climate change action in the 2023-2027 Strategic Plan by including the Area of Focus of “Climate Action and Sustainable Growth”. The desired outcomes related to this Area of Focus are:

1. London has a strong and healthy environment;
2. London is one of the greenest and most resilient cities in Canada in alignment with the Council-declared climate emergency and the Climate Emergency Action Plan; and
3. London’s infrastructure and systems are built, maintained, and operated to meet the long-term needs of the community.

London is joined by many other municipalities in its efforts to prioritize climate change action. As part of development of the CEAP, City staff evaluated the approaches and actions taken by several other ‘peer’ municipalities in Ontario to inform London’s planning process. In similar fashion, a review of the work pursued on climate change adaptation in 11 peer Ontario municipalities was conducted to establish context for this work. A summary of this review is included in Appendix 1.

3.6 London’s Current Adaptation Actions

Taking action to build resilience and adapt to changes in London is not a new idea. Many actions have been taken in the recent and distant past that benefit London’s climate change resilience and it is nearly impossible to acknowledge them all. Many actions taken by the City of London derive from clear policy direction from Council (both current and past Councils) to strengthen infrastructure to safeguard future service delivery as London grows. This priority is and has been reflected in many planning and policy documents, including Asset Management Plans, Flooding Plans, Strategic Plans, and Environmental Assessments for infrastructure work including bridges, roads, waste management sites, pollution control plants, and water distribution systems, just to name a few.

The London Plan (Official Plan), approved in 2016, established the current vision and policy framework for London to grow inwards and upwards, and is supported with several climate change policies and directions. Municipal Council continues to recognize the importance of climate change mitigation and adaptation, sustainable energy use, related environmental issues, and the need for a more sustainable and resilient city in the development of its 2023-2027 Strategic Plan. Specifically, London’s efforts to both mitigate and adapt to climate change are addressed in the “Climate Action and Sustainable Growth” area of focus of the Strategic Plan. The other seven Strategic Plan areas of focus are connected, in one way or another, to climate change action as well, considering the complex and systems-wide nature of the effects of climate change on society.

Flooding is directly impacted by the changing climate and is one of the most significant resilience issues that is a focus of many City projects. Flood hazard protection and mitigation has been a longstanding program designed to protect historic London neighbourhoods. This program includes the 2.5 kilometre long West London Dyke that safeguards 1,200 buildings and 2,500 London residents. This dyke is undergoing a major, multi-year reconstruction project designed to increase flood protection along both the North Thames and main Thames River channels. Seven of 10 phases have been completed since 2016 with the financial assistance of the federal Disaster Mitigation and Adaptation Fund (DMAF). The anticipated timeline for completion of all phases of the project is 2028, encompassing the downstream section of the dyke. A second dyke along the Thames River

protecting 910 residential buildings in the Broughdale neighbourhood in London is also receiving DMAF funding to improve flood protection and resilience of the structure. This second dyke stretches 710 metres along the North Thames River immediately upstream of Western University.

Addressing flooding is one of many categories of adaptation action that have been pursued to date in London. Appendix 2 provides information on other projects and initiatives related to adaptation actions in London and the CEAP Supporting Document 6, “Overview of City Plans and Strategies that Support Climate Action” (available at london.ca/climate) highlights existing plans and strategies already in place that address climate change mitigation and adaptation.

Moving forward, London’s Climate Change Adaptation Framework will assist in aligning efforts and resources to most effectively address the risks and vulnerabilities from the changing climate. Having such a plan in place will also open the door to funding opportunities from other levels of government targeting climate change adaptation and potentially assist in regional efforts to address climate change issues that span municipal jurisdictions.

4. Climate Change Projections for London

Climate change is an increasingly critical issue at the national and local level. Recent events in Canada including flooding, ice storms, wildfires, heat domes, and other occurrences of extreme weather over the past several decades have highlighted the need to be prepared for ongoing challenges.

Impacts of climate change experienced in Ontario include increasing annual and seasonal temperatures as well as more extreme heat days, changes to precipitation patterns, and increased frequency of extreme weather events. These changes are broadly described as “warmer, wetter and wilder” weather.

Data highlighting the projected impacts of climate change on London derived from The Climate Atlas of Canada was used to access downscaled regional climate data for London. The parameters included in this report are related to temperature and precipitation. Key findings include increased temperature, increased precipitation in fall, winter, and spring, and increased intensity of rainfall. Also, regionally, the reduced ice cover on the Great Lakes, specifically Lake Huron will increase the number and severity of lake effect snow, known as “snow streamers” impacting London given the warmer air temperatures and more ice free lake conditions.

Elements of London’s future climate in 2050 are described and visually represented in an infographic (see Figure D) showing what ‘warmer, wetter and wilder’ might look like.

Figure D: London’s Projected Weather for 2050

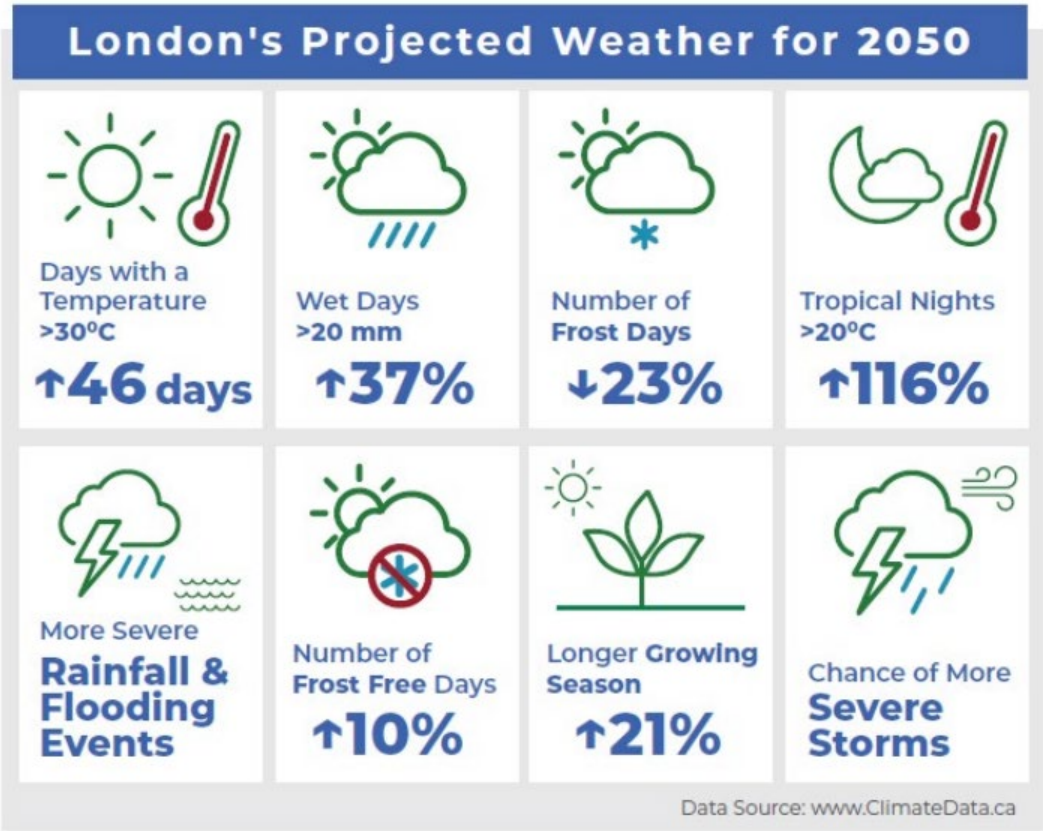


Figure D represents the future situation based on inaction and uses the “business as usual” scenario (RCP 8.5 emissions) based on increase in GHG emissions beyond control locally, nationally and globally. Background data analysis completed by City staff for this Discussion Primer was able to verify that the RCP 8.5 emissions projections for London were accurate. The 20-year overlap of data allowed for this verification. This was accomplished by taking the actual climate data for London for the timeframe 2000 to 2020 and comparing it to the projected climate data using the same timeframe and the projection modelling used by ClimateData.ca.

4.1 Temperature

Temperatures in London are expected to rise consistent with the provincial changes observed in the data above. The Climate Atlas of Canada tool was used to collect downscaled climate projections, using a baseline of 1976-2005. Within the tool, the London Airport was selected to collect this information, as it was the best available area with long-range observed historical data and future climate projections for the region.

In London there is a projected annual temperature increase to 10.1°C in the immediate future (by 2050) and 12.1°C by 2080 from the baseline mean under scenario RCP 8.5.

4.2 Hot Days

Days where the daily maximum temperatures exceed 30°C present the greatest threats to community health due to heat-related illnesses. Examples of these include heat cramps, heat edema, heat exhaustion, and heat stroke. Specific groups, such as those who work outside, infants and young children, older adults (over the age of 65), those with chronic medical conditions, people experiencing homelessness, people planning outdoor sports or activities, and those with limited mobility may be more adversely affected (Berry, P., & Schnitter, R., 2022). Moreover, while higher summer temperatures increase electricity demand for cooling, at the same time, it also can lower the ability of transmission lines to carry power, possibly leading to electricity reliability issues during heat waves.

The baseline average number of days when the maximum temperature was greater than or equal to 30°C was 15 days for London. This is expected to increase to an average of 59 days in the 2051-2080 period under the RCP8.5 scenario. This means there will be close to four times more days above 30°C by 2080 in the city.

With regards to the average length of heat waves (in days), London experienced an average of 5 days of heatwave conditions in the baseline period. In the 2051-2080 period, according to RCP8.5, London can expect to see an average heatwave event occurring for eight days – which is approximately a 60 per cent increase to the current length. Evenings where the temperature does not drop below 20°C. (termed ‘Tropical Nights’) are expected to increase by almost double from 15 to 26 days by 2050.

Overall, heatwave events are projected to occur more frequently and for longer periods of time. These changes become more pronounced as time goes on, and with regards to the higher emissions scenarios. Sustained over several days at a time, these extreme temperatures will have significant impacts on the health of individuals, specifically those individuals in London and other cities where an urban heat island effect is present. Urban areas with less vegetation and more buildings, asphalt and concrete get even warmer than surrounding rural or natural areas due primarily to heat retention,

which creates worse conditions, especially for those without the resources for air conditioning, or the ability to relocate to cooler areas. Refer to Appendix 3 for additional information on London's urban heat island effect.

Extreme heat can also influence wildfire occurrences as analyzed by the provincial government and applied to urban areas using a provincial ranking system that included London to show susceptible areas next to forested locations. Appendix 4 includes additional information pertaining to London's urban forest wildfire threats.

4.3 Freeze Thaw

A freeze-thaw cycle is any day where the minimum temperature is below 0°C and the maximum temperature is above 0°C. The RCP 8.5 ensembles project that freeze-thaw cycles will increase due to overall warmer temperatures. This is likely because overall, the days are getting warmer, and London is likely to experience an increase in the number of days that reach a minimum temperature below 0°C and a maximum temperature above zero. There will likely be an increase in the number of winter days where the minimum temperature does not go below 0°C, adding additional days where the ground would historically not experience thawing.

Under these conditions, it is likely that some water on the surface was both liquid and ice at some point during the 24-hour period. Freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting, and refreezing of water can over time cause significant damage to roadways, sidewalks, and other outdoor structures. Potholes on roads, that form during the spring, or during mid-winter melts, are good examples of the damage caused by this process.

4.4 Precipitation

On a seasonal basis, in London, spring, winter and fall precipitation accumulations are projected to increase by the end of the century with spring and winter experiencing the greatest increases. These seasonal trends, including relatively stable summer rainfall amounts paired with the projected increases in summer temperatures and heatwave lengths may lead to increased instances of drought.

For London, the baseline average annual precipitation is 917 millimetres (mm). In a high emission scenario, London can expect to experience an average annual precipitation increase of eight per cent or 990 mm during 2021-2050 and an increase of 10 per cent, or 1,000 mm during 2051-2080.

4.5 Heavy or Extreme Precipitation

Heavy precipitation days (both 10 mm and 20 mm) are days on which at least a total of 10 mm (or 20 mm) of rain or frozen precipitation falls. Frozen precipitation is measured according to its liquid equivalent: 10 centimetres (cm) of snow is usually about 10 mm of rain. Maximum 1-day precipitation and maximum 5-day precipitation indicate the amount of precipitation that falls on the wettest day of the year, and the five wettest days of the year respectively. The maximum 1-day precipitation amount could be the result of a short but intense precipitation event such as a storm or because a moderate amount of snow/rain falls continuously all day, rather than all at once.

Across Southwestern Ontario, heavy precipitation days are expected to increase from historical values (seven days) by approximately 31 days for 10 mm days and 9.5 days for 20 mm days according to RCP8.5 by 2051-2080. Maximum 1-day and 5-day events are also expected to increase for London, with the greatest increase in 5-day events. For example, maximum 5-day events are projected to increase from a baseline of 72 mm to 77 mm by 2051-2080 for RCP8.5.

The “Impacts of Climate Change in London” supporting document of the CEAP contains additional information on projected climate impacts and extreme weather events that have historically impacted London. It is available online at getinvolved.london.ca/climate.

5. Adaptation Framework Development

Climate change adaptation planning work to date has occurred in two specific timeframes and stages, with the implementation of actions and projects occurring continuously in between and on an ongoing manner. The two specific timeframes are:

- 2013 / 2014 - Climate Change Adaptation Risk Assessment Research, Analysis and Report
- 2020 to 2022 – Climate Change Adaptation work following the Building Adaptive and Resilient Communities (BARC) approach administered by ICLEI Canada, Global Covenant of Mayors, and Federation of Canadian Municipalities. This coincides with the development of London's CEAP.

The 2013 / 2014 - City of London Climate Change Adaptation Risk Assessment Report was prepared by a committee comprised primarily of City staff from a cross-section of departments (e.g., Risk Management, Asset Management, Stormwater Engineering, Parks Planning, and Environmental Programs) in addition to staff from the MLHU and with input from staff at the Upper Thames River Conservation Authority (UTRCA).

A Climate Change Adaptation working group was formed to identify and evaluate climate change risks to service delivery by the Corporation including its Boards and Commissions, determine options for managing those risks and implement improvements, where possible, intended to minimize the risks effectively and efficiently.

The working group compiled information from operations staff across the Corporation and from senior management to solicit climate change impacts, opinions, and data. With this information, the working group provided a total of six corporate wide considerations and 14 recommendations directed to service areas. (refer to Appendix 5 for the complete list).

All assessment and planning activities in 2020 through 2022 were informed by the work previously done and guided by the ICLEI Canada Advancing Adaptation Initiative.

Funded through a grant from the Ministry of the Environment, Conservation and Parks (MECP) under the Canada-Ontario Agreement (COA), London participated in ICLEI Canada's Advancing Adaptation initiative, which was a two-year initiative that engaged Ontario municipalities to build local capacity for climate change resilience and to advance efforts on adaptation. Centered around the process to create and draft an implementation-ready local climate change adaptation framework, the train-the-trainer planning stream brought together a cohort of four municipalities (London, Sudbury, Burlington and Timmins) between June 2021 and March 2022 to participate in multiple training workshops to network, learn, and share experiences about adaptation planning. ICLEI Canada provided expert advice, one-on-one training and consultation throughout the entire planning process, planning resources, training on stakeholder engagement, and support in the drafting and review of draft adaptation documentation.

5.1 BARC Program

ICLEI's Advancing Adaptation initiative focused on the implementation of their Building Adaptive and Resilient Communities (BARC) program. The BARC program is a five-milestone planning framework for local governments aimed at preparing communities for the impacts of climate change. The BARC program is a comprehensive planning methodology that guides municipalities through areas of research and climate impact assessment methods, plan development, action-setting processes, implementation planning, and monitoring and review. As part of the Advancing Adaptation project, London customized the BARC approach to meet local needs and initiated the work of Milestone 3 of the framework, as well as a review and reassessment of Milestones 1 and 2, which culminated in the creation of this Discussion Primer.

A brief description of the general BARC program milestones is provided below, and further details can be reviewed at ICLEI Canada's website (<https://icleicanada.org/barc-program/>).

MILESTONE 1 - 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 2 - 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 3 - 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, an adaptation plan is drafted. Baseline data are 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 4 - IMPLEMENT

In the fourth milestone, the Plan is presented and approved with 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 Plan.

MILESTONE 5 – MONITOR & REVIEW

The fifth and final milestone serves to assess whether there is a process to evaluate if the goals and objectives of the Plan have been achieved, and helps the community identify any problems that have been encountered and develop solutions. Additionally, the fifth milestone addresses the communication of progress to council and the general public.

5.2 Vulnerability and Risk Assessment

A key outcome of the BARC Program Milestones 1 and 2 was the completion of a vulnerability and risk assessment. Earlier City of London work from 2014 to evaluate climate change risks used a 5-point scale (where a rating of 1 was lowest and 5 was the highest) to characterize the severity and likelihood of an impact which would provide a risk factor with a maximum of 25 points (risk factor = severity rating x likelihood rating). These scores were calculated for both time periods of climate exposure in 2025 and in 2050. The 2014 risk assessment report included the risk factor scores for impacts to the Corporation of the City of London and provided direction and informed decision-making in Asset Management Planning in the years following its draft completion.

These previously identified climate change impacts and their risk ratings were re-assessed and analyzed with the assistance of ICLEI Canada staff based on historic weather occurrences (post 2014), updated climate projection data from Environment Canada and recent information from several climate change resources. This reassessment generally confirmed the original Risk Assessment Report's findings regarding the likelihood of impacts.

To support London's climate change risk assessment process, ICLEI Canada also conducted a gap analysis on the climate change impacts and results of risk and vulnerability assessments provided by the City to apply a diversity, equity and inclusion (DEI) lens. This step was taken to ensure alignment of London's process with the BARC Program and account for vulnerable groups that may be at greater risk to the effects of climate impacts. The vulnerable groups considered included seniors, Indigenous Peoples, low-income residents, persons with low literacy levels, homeless individuals, persons with a disability, medically dependent persons, children and youth, new immigrants, and cultural minorities, among other populations. Refer to Appendix 6 for the details of ICLEI Canada's gap analysis.

5.3 Priority Impacts and Issues for London

The following represents the priority impacts and issues identified through reassessment of the 2014 risk assessment, two workshops in 2022 with selected community groups, ICLEI Canada review and input, and discussions with key City staff in 2021 / 2022 during the establishment of the CEAP and associated tools (e.g., Climate Lens Framework).

The benchmark Risk Assessment in 2014 identified 45 consequences of climate change that were analyzed, assessed, and regrouped in 2022 into 25 impact statements provided in Table 1. The Median Risk Rating for each impact statement represents the median of all risk factor scores from the 2014 assessment that were calculated for Service Area impacts from the specific climate change consequence at the root of the impact statement. For example:

Impact Statement 2: "More extreme weather events causing more heavy snowfall / ice / sleet events creating challenges for transportation and snow clearing resulting in increased medical emergencies."

The climate change consequence is "more extreme weather causing more heavy snowfall / ice / sleet events", and the impacts are "challenges for transportation and snow clearing resulting in increased medical emergencies".

From the 2014 risk assessment, increased medical emergencies due to accidents on roadways or at facilities and reduced access for emergency vehicles due to 'intensive snow' or 'sleet, hail and ice storms' were analyzed for the London Fire Department (risk factor scores of 10, 20), London Police Service (risk factor scores of 10, 20), Transportation (risk factor scores of 15, 20), Facilities Maintenance/Buildings (risk factor scores of 20, 20), and the Middlesex London Health Unit (risk factor scores of 15, 20). The median of the risk factor scores from the 2014 risk assessment for this impact statement is therefore equal to 20.

In some instances, the median risk rating was adjusted slightly up or down to reflect input and experience of ICLEI Canada staff who had conducted similar risk and vulnerability work in other Canadian municipalities.

Table 1: Impact Statements	Median Risk Rating
1. More extreme weather events causing damaging winds and winter sleet storms damaging the urban forest and killing vegetation.	20
2. More extreme weather events causing more heavy snowfall / ice / sleet events creating challenges for transportation and snow clearing resulting in increased medical emergencies.	20
3. More extreme weather events resulting in more response calls for EMS for rescue and evacuation due to flooding, severe winds and snow squalls, straining emergency services capacity and ability to respond (staff, and equipment resources).	20
4. More extreme weather events will increase the demand for health services due to increased trauma, testing needs and mental stress.	20
5. More extreme rainfall events leading to increased flooding in low-lying areas & basements causing property damage/loss.	20
6. Extreme rainfall events increasing inflow and infiltration of rainwater into sanitary sewer systems causing sanitary sewer backup into residential/commercial properties.	20
7. More extreme rainfall events resulting in more frequent and intense localized flooding of environmentally sensitive areas and public park infrastructure, causing the need for repair / replacement of park pathways, structures and vegetation.	20
8. More extreme rainfall events resulting in flooding that expands the size of floodplains and requiring property redesignations, acquisitions of the most impacted properties, and re-examination of overland water flow routes.	20

Table 1: Impact Statements	Median Risk Rating
9. More frequent extreme heat events leading to health impacts on vulnerable populations, causing increased morbidity and mortality.	20
10. More frequent extreme heat events leading to an increase in chronic health conditions related to poor air quality, causing increased local public health concerns.	20
11. Warmer summer temperatures resulting in an increased energy demand for cooling centres as well as individual residences.	18
12. More frequent extreme rainfall events resulting in localized flooding causing increased injury to people, property, damage to parks, and infrastructure.	18
13. More frequent extreme weather events resulting in wind, freezing rain, ice storms that damage trees and hydro lines.	18
14. More frequent extreme rainfall events resulting in localized flooding causing increased operational and maintenance costs of infrastructure, both private and public	18
15. More extreme weather events (rain, wind, snow, sleet) resulting in more need for emergency accommodations especially involving vulnerable populations (e.g., those experiencing homelessness and residents in damaged affordable housing).	18
16. Increasing precipitation and more extreme rainfall events causing increased urban flooding and reduced sewer capacity creating challenges at wastewater treatment plants due to flood damages and the inability to treat additional quantities (e.g., due to water infiltration and interception).	15
17. More extreme weather events creating damages from severe wind and snow squalls interrupting City administration and services, impacting staff ability to get to work requiring alternative work arrangements.	15
18. More extreme weather events creating damages from severe wind and snow squalls causing damage to infrastructure (e.g., frozen water lines)	15
19. Increased winter precipitation and rain on snow events leading to increased risk of ice conditions on roads and sidewalks (e.g., traffic accidents, slips/falls).	15
20. More extreme weather events negatively impacting community health and well-being (e.g., health of vulnerable populations, access to recreation, access to social gathering spaces).	15

Table 1: Impact Statements	Median Risk Rating
21. More frequent extreme weather events resulting in more private property damages leading to increased financial strain for home repairs.	15
22. Warmer year-round temperatures and increased precipitation leading to increased impacts related to vector-borne diseases (e.g., Lyme Disease, West Nile)	12
23. Variability in precipitation and temperature leading to increased spring flooding events and longer periods of summer drought, causing increased crop failures and livestock challenges in agricultural production, affecting local food security and economic resilience.	10
24. More extreme rainfall events leading to increased flooding resulting in increased expenses for home repairs and quantity of debris and household garbage to retrieve curbside material destined for the landfill impacting landfill lifespan.	10
25. Warmer temperatures increasing the occurrence / likelihood of current and novel invasive species impacting local ecosystems, biodiversity and potentially human health (e.g., ticks and Lyme disease).	10

Three additional risks were identified as topics to monitor:

- Digital communications infrastructure – cell towers, mainframe computers, back-up power supplies are all critical infrastructure we rely on to communicate during extreme weather emergencies.
- Cascading effects – study the interdependence between infrastructure systems to minimize cascading effects of climate change (e.g., damage to one system impacts another system causing a domino effect).
- Climate induced migration – monitoring the geopolitical instability and creation of climate refugees around the world that may impact London and other Great Lakes cities.

The list of 25 impacts statements were further considered and a list of seven priority impacts were identified through workshops, surveys, and feedback from partners which were used to guide further discussion and potential action development:

- Strengthen infrastructure resilience;
- Use climate lens in decision-making at the municipal level and encourage London's agencies; board and commissions to apply it, as well;
- Protect public health and safety;
- Minimize risk to buildings and properties;

- Enhance biodiversity and ecosystem functions;
- Reduce community service disruptions; and
- Build community resilience.

5.4 Adaptation Planning

To advance work through the BARC Program's Milestone 3 (Plan), City staff convened two virtual workshops to solicit input and discussion regarding the original work completed in 2014 as well as to update the information with new insights and more recent climate developments. A summary of the initial workshops and the attendees is provided below:

Workshops

- Workshop #1 on February 9, 2022 using Zoom with the purpose to create a list of actions that will be taken in London to address climate change adaptation.
- Workshop #2 on March 8, 2022 using Zoom with the intended purpose to preliminarily discuss and identify the who, what, where, when, why, and how to complete and implement actions of a Climate Change Adaptation Plan.

Attendees

- Attendees to the workshop were City of London senior staff from all Service Areas (represented by 12 Director-level staff) as well as seven attendees from the community.
- The community members included three staff from the UTRCA and four staff from member organizations of the London Environmental Network (LEN, Reforest London, Carolinian Canada, and the Thames Talbot Land Trust).

Potential adaptation action development and implementation specifics identification were focused around the revisited and ICLEI Canada-reviewed impact statements. To streamline discussions, impact statements were grouped broadly into three categories: built environment, natural environment, and people/community. Attendees also provided feedback on the vision statement and provided early input on implementation responsibilities and leadership needs for some potential actions. The results of discussions and input from these early workshops are reflected in this Discussion Primer.

Additional sources of information were also reviewed and contributed to the base of knowledge informing this Discussion Primer and proposed actions for the Plan. Many of these sources of information provide valuable insight and perspectives on climate change adaptation unique to the expertise and knowledge of the authors and are intended to be further considered as part of Climate Change Adaptation Framework development. Refer to Section 9 – Adaptation Planning Resources for further information.

6. Themes, Objectives and Actions

The workshops completed in 2022 provided suggestions for a vision for the Adaptation Framework and included objectives and themes around which to organize potential actions. A suggested Vision Statement was:

“London will adapt to changing climatic conditions and embrace new opportunities to remain a livable, healthy and sustainable community”.

The vision statement discussion recognized that significant adaptation actions have occurred in the past in London in response to weather events and changing conditions. However, those actions may not have been necessarily described nor captured within a multi-year initiative linked to responding to changes in climate. Even though significant actions have occurred, they are still included as part of potential actions to carry forward into the Climate Change Adaptation Framework to either continue or expand on efforts.

The following four themes, along with related objectives and proposed actions, are the main areas that need to be addressed to move London closer to achieving the vision:

- Built Environment (4 objectives and 15 actions)
- Natural Environment (1 objective and 5 actions)
- People (4 objectives and 24 actions), and
- Engagement and Partnership (1 objective and 4 actions)

Further details are provided below. To assist, an initial identification of “leads” and “co-leads” has been provided. This should be viewed as a starting point for discussion. It should not be viewed as precluding involvement, identification of leads and co-leads, and other leadership roles from others.

6.1 Theme 1: Built Environment

This theme covers the buildings and infrastructure in London. The built environment provides its citizens with housing, facilities, and supports the delivery of services which keep citizens safe and keep the city operating smoothly.

Objective #1 – The resilience of buildings and property is strengthened against the effects of climate change.

Action 1.1 – Use available planning tools that will assist in preventing lot-level flooding for new and existing development.

- i. Review lot density and lot coverage calculations considering current and expected future flood risk areas to ensure sufficient pervious surfaces exist for water infiltration. (City lead)
- ii. Improve flood-proofing remediation incentives for specific target areas by reviewing and updating watercourse flood lines, surface flooding data / mapping, and basement flooding records. (City lead)

- iii. Expand flood educational information and awareness communication to widen the public understanding of the threat of flooding from natural watercourses and water infrastructure systems (stormwater and wastewater). (Conservation Authority Lead)

Action 1.2 – Ensure existing and new residential rental buildings provide cooling options to mitigate the effects of extreme heat events.

- i. Encourage multi-unit residential building owners to prepare for the need to ‘shelter in place’ with backup power generation and storage, water, and elevator services (Toronto’s Minimum Backup Power Guidelines for Multi-unit Residential Buildings (MURBs) is an example of voluntary performance standards for existing and new buildings. Refer to Section 9 – Adaptation Planning Resources for further information). (City lead)
- ii. Assess the potential need for increased use of public cooling centres (and warming centres) during power outages. (City lead)

Action 1.3 – Encourage all construction to align with Climate-Resilient Standards

- i. Test and deploy the use of “Electric-Vehicle-to-home” devices to enable EVs to provide emergency short-term power for single-family homes. (City lead)
- ii. Consider requiring cisterns for new public buildings on properties where irrigation systems are needed. (City lead)
- iii. Analyze a buy-out program for existing damaged buildings that are already severely impacted or at the highest risk of damage due to climate change impacts. (City lead)
- iv. Determine the benefit of the provincial government reinstating the 2018 requirement for rough-ins for EV charging stations in new residential and commercial buildings or how it can be introduced locally. (City lead)

Objective #2 – The impacts of flooding on infrastructure are reduced.

Action 2.1 – Consider alternatives for park rehabilitation projects where vulnerable park infrastructure exists and flooding and erosion concerns are predicted. (City lead)

Action 2.2 – Upgrade wastewater treatment and collection infrastructure to improve its resiliency to extreme weather / flooding.

- i. Construct the flood protection dykes through DMAF for Greenway and Adelaide wastewater treatment plants (City lead)
- ii. Continue to address ‘unwanted water’ making it into sanitary sewer systems by all sources (e.g., inflow and infiltration, illegal residential and business sewer connections) (City lead)

Action 2.3 – Ensure critical municipal digital infrastructure resources are secure and not vulnerable to extreme weather events (e.g., computer servers in basements with high flood risk). (City lead)

Action 2.4 – Ensure critical private digital infrastructure resources (e.g., communications, banking) are secure and not vulnerable to extreme weather events. (Business lead)

Action 2.5 – Address flood impacts on landfill operations and lifespan to prepare for additional waste due to significant infrastructure damage events (e.g., basement flooding). (City lead)

Action 2.6 – Enhance residential educational information on methods to improve private lot surface drainage, promote un-obstructed drainage routes and promote pervious surfaces to increase water infiltration. (City and Conservation Authority Co-lead)

Objective #3 – Strengthen the resilience of community transportation systems to the effects of climate change.

Action 3.1 – Review and update where needed plans for emergency response options when roads are flooded or damaged. Initial considerations are underway assessing flood risk levels and opportunities within the transportation network. (City lead)

Action 3.2 – Work with public and private sector equipment owners to review Emergency Management resources and evaluate opportunities to increase winter preparedness. (City lead)

Action 3.3 – Review snow clearing and ice maintenance procedures and by-laws for residential sidewalks to reduce slip / fall incidents and claims. (City lead)

Action 3.4 – Investigate environmental impacts and applicability of alternative road and sidewalk de-icing products that continue to support safe travel (e.g., advancements in the use of beet juice). (City lead)

Objective #4 – Disruptions to energy infrastructure due to climate change are reduced.

Action 4.1 – Ensure maintenance schedules and protocols for overhead electrical lines and hazard trees are up-to-date to reduce the potential for power interruptions and property damage. (London Hydro lead)

Action 4.2 – Review emergency protocols and resources related to power outages that may impact City services. (City lead)

Action 4.3 – Review the facilities used for emergency centres and the need for new power systems (e.g., stand-by power systems). (City lead)

6.2 Theme 2: Natural Environment

Objective #5 – Create “complete corridors” as a sustainable means to adapt to climate change by moving water, wildlife, and people through engineered stream corridors that protect and enhance Biodiversity and Ecosystem functions and provide multipurpose pathways through creating nature in urbanizing areas.

Action 5.1 – Improve stormwater management using Green Infrastructure (GI) and other natural features.

- i. Deliver enhanced economic incentives to expand natural features (e.g., woodland acquisition fund, purchase land with critical ecosystems where available). (City lead)
- ii. Pursue partnerships to enhance GI (e.g., Living Cities, Green Infrastructure Canada, London Environmental Network, Ducks Unlimited). (City lead)
- iii. Strengthen wetland protection and pursue integrated water resource management, including low impact development (LID) inclusion in parking lots, and GI on surplus lands. (City lead)
- iv. Consider water infiltration to improve soil health and groundwater resources as critical GI outcomes. (City lead)
- v. In Partnership with the CAs, review and redesignate floodplains as per Provincial Technical Guidelines. (City and Conservation Authority co-lead)
- vi. Continue preparation of post-emergency plans for neighbourhoods in floodplains, including the consideration of “willing seller / willing buyer” of homes in existing flood plains. (City lead)
- vii. In Partnership with the CAs, clearly identify floodplains in development information so flood susceptible development can be prevented. (City and Conservation Authority co-lead)

Action 5.2- Improve the protection of surface water and groundwater resources from polluted urban runoff.

- i. Continue to upgrade wastewater treatment and collection infrastructure to reduce the incidents of untreated sewage discharge. (City lead)
- ii. Continue to separate the remaining combined sewers by taking advantage of associated infrastructure projects in target neighbourhoods and other government funding. (City lead)
- iii. Continue to use and expand natural vegetation buffers along waterways to reduce surface water temperature and contamination. (City co-lead)

Action 5.3 – Manage, monitor, and mitigate the spread of invasive plant species in the natural environment through coordinated planning.

- i. Review and update Conservation Master Plans for Environmentally Sensitive Areas (ESA) to ensure the negative impact of existing and new invasive species are considered. (City co-lead)
- ii. Control invasive plants along roadsides which are major routes of transmission. (City lead)
- iii. Support efforts to prevent the sale of (regulated) invasive plants at local nurseries. (City and Conservation Authority co-lead)

- iv. Encourage the planting of diverse native species mixes to enhance resilience to invasive species. (City lead)
- v. Educate citizens about the value of using native plants in gardens and appropriate disposal methods of green waste that may include invasive species. (City co-lead)
- vi. Prioritize management of invasive species that directly affect human health (e.g., Giant Hogweed, black-legged ticks). (City and Health Unit co-lead)

Action 5.4 – Manage London’s urban forest to maximize its environmental, social, economic, and aesthetic benefits through improved resilience and diversity.

- i. Ensure all new plantings are non-invasive and future-climate locally adapted and are locally sourced when possible. (Community lead)
- ii. Group plantings in patches, where possible for improved resilience to extreme wind and enhancement of ecosystem functions. (City lead)
- iii. Research and incorporate methods to improve tree health / structure to extreme weather impacts. (Community lead)
- iv. Research current approaches to enhance London’s Tree Canopy Cover targets currently established at 34% given their importance as a key component to London’s healthy natural environment. (City lead)
- v. Support the implementation of the Urban Forest Management Strategy. (City lead)

Action 5.5 – Ensure that natural features and their functions are sustainable in a changing climate.

- i. Conduct vulnerability assessments to identify main climate threats to ESAs and other natural areas, including potential impacts on species at risk, critical functions, and species important to Indigenous communities. (City lead)
- ii. Consult Indigenous Communities about important features of the land and adaptation to climate change. (City co-lead)
- iii. Regularly monitor for emerging negative impacts to the features and functions that make London unique and/or are important (e.g., forested city, bird corridor, Thames River) to institute measures to adapt and protect. (City lead)
- iv. Select plant species that will thrive under anticipated changing climate conditions. (City lead)
- v. Increase the information available to Londoners on the value of protected natural areas that exclude development (supporting biodiversity, improving mental health, air and water purification, etc.) and the balance needed to enable residential intensification to reduce the need for green field development (e.g., inward, and upward versus urban sprawl and expansion). (City co-lead)

- vi. Consider the emerging importance of local agricultural, local food production, and food security in addition to the carbon sequestration capabilities of soil as part of current and future land use planning. (City co-lead)
- vii. Create new severance process for landowners to help support those that wish to donate/sell natural lands to conservation charities, such as along waterways. (City co-lead)

6.3 Theme 3: People

Objective #6 – Community members are prepared for extreme weather events.

- Action 6.1 – Inform residents susceptible to basement flooding of the need for adequate supply of backup batteries for existing sump pumps during power failures. (City lead)
- Action 6.2 – Establish financial supports and free or low-cost products for low-income Londoners to access emergency kit materials. (City lead)
- Action 6.3 – Leverage existing events and engagement opportunities to raise awareness about emergency preparedness for severe weather events. (City lead)
- Action 6.4 – Explore enhancing existing programming developed with the school boards to imbed local climate change education into the curriculum, including personal and community actions / protection. (City co-lead)
- Action 6.5 – Review and update emergency accommodation plans (short and longer term) for both vulnerable populations and neighbourhoods impacted by weather events.
 - i. Undertake and/or enhance/update social vulnerability index mapping to identify areas of high vulnerability to inform adaptation planning. (City lead)
- Action 6.6 – Involve agencies that support homeless populations in connecting information and resources to individuals about extreme weather impacts preparedness and recovery. (City lead)
- Action 6.7 – Ensure that education/information on extreme weather impacts is provided in multiple languages.
 - i. Partner with the London Cross-Cultural Learners Centre and similar organizations to develop educational programming. (City co-lead)
- Action 6.8 – Increase engagement with local media before, during and after extreme weather events to stress the message that these events are expected to be more common and personal preparedness is needed. (City lead)

Objective #7 – Vulnerable populations are protected from extreme weather and temperatures

- Action 7.1 – Investigate and assess the need for an early warning system for vulnerable people sleeping 'rough' in the river corridor being at an increased risk when flooding occurs. (City lead)

- Action 7.2 – Partner with local faith-based groups, hotels, schools, libraries, and community centres to consider options for expanding temporary accommodations and cooling/warming centres. (City lead)
- Action 7.3 – Consider increasing the number of splash pads, water fountains or swimmable urban fountains in public areas that rank high for urban heat island impacts affecting human heat stresses and comfort. (City lead)
- Action 7.4 – Consider approaches to address both short term heat waves / heat domes on vulnerable populations in addition to considering longer term, overall increased heat. (City lead)
- Action 7.5 – Develop a communication strategy for low-income renters to educate on and motivate individual action to improve extreme weather and temperature resilience within their home. (City lead)
- Action 7.6 – Continue to identify ways to assist vulnerable populations and staff involved in assisting such populations during extreme weather or temperature events. (City lead)
- Action 7.7 – Incorporate incentives for the participation of vulnerable populations in engagement opportunities relating to adaptation and resilience planning. (City lead)
- Action 7.8 – Establish consistent messaging from all organizations regarding personal actions and risk. Messaging needs to be locally significant and uses all of the City's and partners' communication conduits (e.g., websites, community centres, libraries) to spread key messages related to extreme weather and temperature impacts and preparedness. (City lead)

Objective #8 – Reduce the human health impacts from climate change.

- Action 8.1 – Minimize the impact of vector-borne diseases through public information and education. (MLHU lead)
- Action 8.2 – Track changes to population health using best management practices and innovative approaches (e.g., wastewater treatment plant testing or COVID traces in wastewater). (MLHU and City co-lead)
- Action 8.3 – Consider adding wildfire smoke to air quality monitoring impacts that may trigger increased morbidity and mortality. (MLHU lead)
- Action 8.4 – Track the migration of specific insects' species and the conditions where they thrive, to plan for potential impacts (e.g., on human health such as deer ticks and Lyme Disease). (MLHU lead)

Objective #9 – Improve local food security to reduce food scarcity following extreme weather events.

- Action 9.1 – Investigate approaches to further support Food Banks in the anticipation of rising food costs due to climate change. (City lead)

- Action 9.2 – Increase the number of neighbourhood-managed community gardens to provide local food supply. (Community and City co-lead)
- Action 9.3 – Promote local food production, urban farming, and delivery options. (Community and City co-lead)
- Action 9.4 – Incorporate information on how to evaluate food spoilage into messaging related to extreme weather power outage resilience and recovery. (City co-lead)

6.4 Theme 4: Engagement and Partnerships

Objective #10 – Climate change adaptation is integrated into all local work.

- Action 10.1 – Pursue climate change adaptation research and project partnerships with multiple organizations (e.g., UTRCA, Ontario Native Plant Council, Carolinian Canada, academia). (City co-lead)
- Action 10.2 – Incorporate resilience considerations and measures, as well as natural assets into all Asset Management Plans (e.g., City, Agencies, Boards, Commissions). (City co-lead)
- Action 10.3 – Encourage the incorporation of resilience considerations and measures into asset management plans and processes (e.g., businesses, community institutions). (Community and businesses lead)
- Action 10.4 – Involve and engage Indigenous community organizations (e.g., N'Amerind (London) Friendship Centre, Atlohsa Family Healing Centre) in London to assist with adaptation education and actions. (City co-lead)
- Action 10.5 – Review and update Severe Weather Protocols with emergency response partners (London Emergency Services, London Fire, London Police, London Ambulance, London Transit) to ensure they reflect current conditions and have been improved upon after recent incidents. (City co-lead)
- Action 10.6 – Collaborate with local Indigenous Peoples and First Nations, surrounding municipalities, conservation authorities and interested parties on adaptation actions with regional implications. (City co-lead)

Throughout discussions on enabling actions, a few categories of opportunities arose related to the impacts of climate change which may be worth further consideration as this planning process advances. At this time, these areas include:

- Agriculture
 - Some challenges within the existing agriculture system such as supply chain restrictions, irregularities in the growing season, and local food security has led to a re-focusing on urban agriculture in London.
 - London has a growing interest in local food production as evidenced by long waiting lists for individual plots in London's 21 Community Gardens and several local commercial and non-profit enterprises (e.g., [Urban Roots](#), [Growing Chefs London](#), The London Food Bank).

- [“The Patch”](#) – a Hutton House collaboration with the Cavendish Park Food Hub is a recent 2022 initiative providing both training, education and fresh affordable produce to London’s vulnerable populations.
- Business Cares (affiliated with the London Food Bank) is supplying materials for businesses and community groups interested in constructing greenhouses.

- Tourism

- The impact of climate change on tourism is less well known. Warmer temperatures will encourage more use of outdoor spaces and possibly more use of the river especially during the fall shoulder season related to tourism.
- Several initiatives related to fishing and paddling occurred over the period of the COVID pandemic (2019 – 2020) that would suggest an expanded interest in recreational use of the river (e.g., 2020 Kayak Fishing Derby)
- The [Fish & Paddle Guide](#), London’s first map-based guide for accessibility to the river was produced in 2017 and has been distributed by both fishing and paddling commercial businesses in London. This river interest has spawned the creation of the “City of London Paddling Plan” in 2023 for the City’s 43 km of river waterway adjacent to the Thames Valley Parkway multi-use trail. This plan will explore the interest by local First Nations in future collaborative enterprises.

- Green Economy

- Green Economy London is an expanding initiative helping businesses reduce GHG emissions and improve their resilience to climate change, especially attractive to smaller commercial and non-profit organizations who are challenged to resource environmental efforts with limited staff.

7. Plan Implementation, Monitoring and Governance

7.1 Implementation and Governance

For City of London staff, the implementation and governance of the Climate Change Adaptation Framework will follow the same process that was established for the CEAP. This process includes the assignment of actions to appropriate leaders and regular check-ins, reporting, and continuous improvement. It is expected that advisory committees will be engaged to provide input and advice from the community on the implementation of actions, learning and sharing with associations and groups with similar mandates (e.g., RPWCO, AMO, CAP, etc.) will contribute to implementation strategies and continuous improvement, and progress on the plan's actions will be reported to a committee of Council.

To help implement the final CCA Framework, there will be a need to establish a multi-agency leadership structure (or something similar), to ensure wide-ranging benefits, increase collaboration, share learnings, reduce conflicts with respect to London's local natural resources, economies, and communities and relationships and understandings with municipalities and First Nations nearby. The current emergency management approach in London represents one model that includes most if not all emergency partners and has the ability to reach many organizations in London and nearby.

7.2 Monitoring and Evaluation

A review and update cycle for the forthcoming Climate Change Adaptation Framework will coincide with a similar review and update cycle for the CEAP to align the works and adapt to the fast pace of change and knowledge growth relating to London's severe weather patterns and climate. Updates will be led and facilitated by City staff and others in a leadership role, be informed by input from Londoners and other interested parties, and be initiated by approval from City Council, where required. Monitoring and evaluation will follow the guidance provided in the CEAP Area of Focus #10 titled, "Measuring, Monitoring and Providing Feedback".

7.3 Funding

It is anticipated that some actions arising from community discussions, additional analyses, and reflection on best practices in other municipalities will not necessarily require additional funding to implement. Actions not requiring new funding may be relatively simple process changes or integrating climate change adaptation priorities into existing processes. Other actions, however, may require additional funding, particularly infrastructure projects identified for the primary purpose of improving resilience to one or more climate change impacts.

Upper levels of government currently provide funding through various means (e.g., the Federal Disaster Mitigation and Adaptation Fund) for certain adaptation projects and it is expected that new funding opportunities may arise as the need for climate change adaptation action continues to increase.

The process for funding initiatives of the City of London is well established and includes a Multi-Year Budget process (4-year) to align spending and investment with Council strategic priorities and annual updates to respond to changes in between. The most recent MYB for 2024-2027 includes numerous items addressing climate change adaptation through service area budgets, capital expenses, and newly approved business cases. Assessment of any additional financial requirements to deliver on the Climate Change Adaptation Framework can be evaluated as part of the annual budgeting process.

7.4 Communication, Education and Outreach

The Adaptation Framework, as a component of the CEAP, will benefit from the collaborative efforts of many City staff at environmental outreach events and initiatives. The City of London has an active environmental stewardship program (e.g., CityGreen) that includes regular engagement events in public spaces and forums where information on environmental, sustainability and climate change initiatives are shared.

The collaborations and leadership for communication, education and outreach will come from many as part of regular business and community practices and benefit from new opportunities to reach Londoners, businesses, institutions, individuals, and the community.

The Framework will be available directly to partners and collaborators in addition to being available on the City website. Details of CEAP communication, education and outreach objectives are included in CEAP Area of Focus # 1: “Engaging, Inspiring and Learning from People”.

8. Adaptation Planning Resources

Many publicly available resources relating to climate change adaptation have informed and will continue to inform the development of London's Climate Change Adaptation Framework. Considering the variety of impacts and issues that climate change presents globally, it is important to identify and focus on sources that pertain specifically to Ontario and London, where possible. Several pieces of work have been produced that address the climate change issues facing Ontario, and specifically London. Links and/or digital copies of the following documents will be included at [GetInvolved.London.ca/climate](https://getinvolved.london.ca/climate) for those interested in further information:

- Middlesex-London Health Unit (2024): *Middlesex-London Health Unit Approach to Climate Change Action, Middlesex-London Board of Health Report No.12-24*
- Climate Risk Institute (2024) – *A Climate Impact Assessment Comparative Analysis for the City of London*
- Green Communities Canada and London Environmental Network (2023): *A Pathway for London to Become a Living City – How London can accelerate equitable, abundant, and thriving green infrastructure*
- Dr. David Sills, Dr. James Voogt and Dr. Gregory Kopp Western University, London, Ontario, Canada (2023): *Weather Impacts and Trends in 2023: Report for the City of London*
- City of London (2022) – *Extreme Weather Resiliency and Response Plan for Homeless and Unsheltered Communities in London* (which has since been incorporated into the Encampment Strategy Table within The Health and Homelessness Whole of Community System Response).
- With The Health and Homelessness Whole of Community System Response, the Encampment Strategy Table is incorporating much of this summary in their work on inclement weather practices for unsheltered homelessness within their encampment strategies.
- City of London (2020) – CEAP Discussion Primer, including actions addressing adaptation
- Sajecki Planning, et. al. (2022) – *ReThink Zoning Discussion Papers: 5 – Zoning in on the Climate Emergency*
- City of Toronto (2016) - *Minimum Backup Power Guidelines for MURBs - Voluntary Performance Standards for Existing and New Buildings*

Additional resources compiled to inform this Discussion Primer also include those in the appendices.

9. Next Steps

London is already experiencing warmer, wetter and wilder weather. The impacts are here and being felt by individuals, neighbourhoods, businesses, and institutions. The future has more changes and extreme weather in-store, and we need to act now to prepare and adapt to these conditions.

The development of the Climate Change Adaptation Framework will continue on the following timeline:

July 2024	Release of Discussion Primer and accompanying resources to support engagement
August to November 2024	Engagement events and efforts to reach Londoners, businesses, institutions, individuals, and the community to solicit and collect input and feedback
December 2024	Engagement data and feedback analysis, draft framework writing; Additional engagement where needed
January/February 2025	Submit Update or Draft Final Climate Change Adaptation Framework to Committee and Council

Now and over the next few months following the release of this Discussion Primer there will be opportunities for Londoners to provide input and feedback on the direction and proposed actions to be included in the Climate Change Adaptation Framework. Feedback and input from a diverse set of Londoners will strengthen the Plan and help ensure that it meets the needs of others for the future. Particular attention and efforts will be made by City staff to ensure that opportunities to contribute are available to all Londoners, especially those groups that have historically encountered barriers to participation in civic engagement initiatives.

London's getInvolved.london.ca/climate engagement website will be the central platform for online engagement, announcing in-person engagement opportunities, and reporting out to Londoners on the progress of the Plan as it develops. For those interested in staying up to date on this project, please visit the getInvolved.london.ca/climate to subscribe for email updates about the Climate Change Adaptation Framework.

References

- Adaptation to Climate Change Team. (2021). A Low Carbon Resilience Decision Tool for Local Government. Retrieved August 2021, from https://act-adapt.org/wp-content/uploads/2021/05/ICABCCI_LCRDecisionToolLocalGovernment_WEB-2.pdf
- Berry, P., & Schnitter, R. (Eds.). (2022). Health of Canadians in a Changing Climate: Advancing our Knowledge for Action. Ottawa, ON: Government of Canada. <https://changingclimate.ca/site/assets/uploads/sites/5/2022/02/CCHA-REPORT-EN.pdf>
- Bush, E., & Lemmen, D. S. (Eds.). (2019). Canada's Changing Climate Report. Government of Canada. http://publications.gc.ca/collections/collection_2019/eccc/En4-368-2019-eng.pdf
- Canada, H. (2022, September 12). Climate Change and Health Vulnerability and Adaptation Assessments: Resource Guide. www.canada.ca. <https://www.canada.ca/en/health-canada/services/publications/healthy-living/climate-health-adapt-vulnerability-adaptation-assessments-resource-guide.html>
- Centre for Climate and Energy Solutions. (n.d.). Heat Waves and Climate Change. C2ES. Retrieved from <https://www.c2es.org/content/heat-waves-and-climate-change/>
- Climate Atlas of Canada, version 2 (2019). using BCCAQv2 climate model data. <https://climateatlas.ca/>
- ICLEI Canada. (2022). Report: Cost of Doing Nothing – A Toolbox for Building a Local Business Case for Adaptation. Retrieved from <https://icleicanada.org/project/codn/>
- Health Canada. (2011). Adapting to Extreme Heat Events: Guidelines for Assessing Health Vulnerability. Ottawa, ON. Retrieved from <http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/adapt/index-eng.php>
- Intergovernmental Panel on Climate Change. (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability Summary for Policy Makers. <https://www.ipcc.ch/report/ar6/wg2/resources/spm-headline-statements/>
- National Oceanic and Atmospheric Administration. (2022). 2021 was World's 6th-warmest Year on Record. NOAA. <https://www.noaa.gov/news/2021-was-worlds-6th-warmest-year-on-record>
- The London Plan (Official Plan) | City of London. (n.d.). Retrieved from london.ca website: <https://london.ca/government/council-civic-administration/master-plans-strategies/london-plan-official-plan>
- Urban Forest Strategy | Plans and strategies | City of London. (n.d.). Retrieved from london.ca website: <https://london.ca/government/council-civic-administration/master-plans-strategies/plans-strategies>
- World Meteorological Association. (2022). 2021 One of the seven warmest years on record, WMO consolidated data shows. <https://public.wmo.int/en/media/press-release/2021-one-of-seven-warmest-years-record-wmo-consolidated-data-shows>

Appendix 1 – Adaptation Summary for Peer Ontario Municipalities

This appendix summarizes key elements of climate change adaptation planning and progress that are publicly available from the City of Burlington, Durham Region, City of Guelph, City of Hamilton, City of Kingston, City of Mississauga, City of Ottawa, Waterloo Region, City of Windsor, City of Greater Sudbury, and Town of Oakville.

City of Burlington:

- [Climate Resilient Burlington Plan \(CRB\)](#): Approved by City Council (July 13, 2022), in progress
 - Climate Resilient Burlington: A Plan for adapting to our warmer, wetter and wilder weather [progress report](#) (July 11, 2023)
- Major risks: Flooding, forest and wildfires, extreme heat, tornadoes, extreme wind and hurricanes.
- 5 themes with 10 Objectives/Goals and 32 actions:
 - Resilient Built and Natural Infrastructure
 - Objective # 1: Manage infrastructure to prepare for future climate conditions and carbon neutral goals
 - Objective # 2: Enhance resilience of infrastructure exposed to high flood risk
 - Objective # 3: Invest in proactive measures to prepare for increased extreme events to avoid post-storm reactive costs
 - Thriving Natural Environment
 - Objective # 4: Reduce damage to trees while increasing the value of the services they provide
 - Objective # 5: Value, conserve and enhance the multiple services that natural areas provide
 - Health and Well-Being
 - Objective # 6: Provide City services to support the community during extreme heat events
 - Disaster Resilience
 - Objective # 7: Build capacity in the community to prepare for and respond to more extreme events and long-term climate stresses
 - Objective # 8: Encourage climate adaptation actions from citizens and businesses
 - Strong and Resilient Economy
 - Objective # 9: Support agricultural community in preparing for climate change
 - Objective # 10: Support and develop resilient local supply chains to help withstand impacts associated with extreme climate events outside of Burlington
- Each of the 32 actions includes:
 - Action type (assessment, partnership, plan, policy, procedure, program, or project)
 - Timeline (ongoing, 1-2 years, 3-5 years, or 5-10 years)

- Estimated additional cost to implement (low, medium, or high)
- Lead and supporting City department(s)
- Community connections
- Related initiatives
- Engagement matters:
 - Stakeholders from City departments, community groups and community members
 - Blog posts, presentations and lunch and learns

Durham Region:

- [Durham's Community Climate Adaptation Plan](#) 2016
- Major risks: Warmer air temperatures, more extreme heat days with temperatures above 30°C, less extreme cold days below -20°C, increasing precipitation particularly during the winter and spring seasons, more extreme weather events especially intense storms, longer growing season with the increased risk of pests.
- 7 Themes and 17 Objectives:
 - Cross-Sectoral
 - Objective # 1: Protect outside workers
 - Objective # 2: Social infrastructure for emergency resilience
 - Building Sector
 - Objective # 3: Improve the resilience of new buildings
 - Objective # 4: Promote the resilience of existing buildings
 - Electrical Sector
 - Objective # 5: Prevent loss of electrical supply caused by flooding
 - Objective # 6: Prevent electrical outages due to trees falling on electrical lines and equipment
 - Objective # 7: Improve electrical reliability
 - Flooding Sector
 - Objective # 8: Address urban flooding
 - Objective # 9: Redefine flood hazards to consider climate change
 - Objective # 10: Reduce the impacts of flooding
 - Objective # 11: Address riverine flooding
 - Human Health Sector
 - Objective # 12: Provide advanced warning of impending extreme weather
 - Objective # 13: Protect tenants in multi-residential buildings from excessive heat in their units
 - Objective # 14: Reduce ambient summer temperatures in urban areas in order to reduce heat stress
 - Roads Sector
 - Objective # 15: Improve the performance of roads under extreme heat conditions
 - Objective # 16: Improve the resilience of road systems to extreme rainstorms
 - Natural Environment Sector
 - Objective # 17: Achieving climate change resilience in the natural environment
- Total Actions: 67

City of Guelph:

- [Climate Adaptation Plan July 2023](#)
- Major risks: Guelph's future climate is expected to be warmer, wetter, and wilder compared to current and historical conditions.
- 5 Strategic Goals/Objectives:
 - Environment and Health: Sustain environmental health, biodiversity, and individual well-being
 - Infrastructure: Prepare for the future with resilient built and natural infrastructure, while protecting existing resources
 - Economy: Strengthen economic prosperity by reducing the risk of economic loss; focus on adaptation actions that are fiscally responsible and achieve measurable long-term benefits
 - Safety: Reduce risk, strengthen our community's emergency preparedness and disaster response
 - Equity: Ensure climate adaptation solutions cover all protected grounds under the Ontario Human Rights Code

City of Hamilton:

- [Climate Change Impact Adaptation Plan 2022](#)
- Major risks: Ice storms, power outages, recent waterfront flooding and the accompanying costly infrastructure repairs, increasing escarpment erosion and damage to escarpment access roads, basement flooding, increasing extreme heat events, windstorms, and vector-borne diseases such as Lyme.
- 4 Themes and 8 Objectives:
 - Built Environment
 - Objective # 1: Incorporate climate change into future land use, development, and construction
 - Objective # 2: Reduce transportation disruptions due to extreme weather events and improve the safety of travel on roads, sidewalks, and trails
 - People and Health
 - Objective # 3: Help vulnerable populations avoid or reduce health-related impacts of extreme weather and temperatures
 - Objective # 4: Improve community preparedness and resilience
 - Natural Environment, Agriculture and Water
 - Objective # 5: Proactively conserve and protect surface water and groundwater resources
 - Objective # 6: Monitor, maintain, and improve the diversity and resiliency of urban trees and forests
 - Energy and Economy
 - Objective # 7: Enable local businesses and organizations to plan for climate-related risk

- Objective # 8: Improve the resilience of energy infrastructure to weather-related disruptions
- Total Actions: 18

City of Kingston:

- [Climate Leadership Plan](#): Report to council 2021
- Major risks: severe and changing weather patterns like hotter and drier summers, higher intensity rainfall events, warmer winters, icing conditions, and new types of pests and diseases.
- 4 Themes and 9 Objectives:
 - Buildings and Energy Production
 - Objective #1: Accelerate local production of renewable and low carbon energy and energy storage
 - Objective #2: Support Kingston residents to invest in low carbon retrofits for their homes
 - Objective #3: Partner with Kingston businesses to retrofit and fuel-switch existing commercial buildings
 - Objective #4: Demonstrate leadership by making all municipal facilities Net Zero Energy by 2040
 - Objective #5: Advance the adoption of net zero ready new construction ahead of the release of requirements expected in national building and energy codes in 2030
 - Waste
 - Objective #6: Produce renewable natural gas locally from waste sources and encourage adoption of other low carbon fuels
 - Transportation
 - Objective #7: Develop active transportation connections and foster transit-oriented development to encourage a shift to sustainable modes and a reduced reliance on personal vehicle use
 - Objective #8: Transition to electric and renewably-powered personal, municipal and commercial motorized vehicles
 - Food And Forestry
 - Objective #9: Improve the vibrancy of the local food system to help reduce dependence on high carbon imported food
- Total Actions: 32

City of Mississauga:

- [Climate Change Action Plan 2019](#): covers both Mitigation and Adaptation
- Major Risks: By 2050, Mississauga is expected to be hotter at all times of the year, with changes to seasonal precipitation patterns, more rainstorms and more heat waves. Winter, spring, and fall will likely be wetter, while summer will be hotter.

- 4 Themes and 14 Objectives/Focus Areas:
 - Buildings & Clean Energy
 - Objective # 1: Reduction of GHG emissions from existing and newly developed buildings
 - Objective # 2: Increasing the use and supply of renewable energy
 - Objective # 3: Advancement of low carbon community energy systems
 - Objective # 4: Encouraging building occupants and owners to implement energy conservation measures
 - Resilient & Green Infrastructure
 - Objective # 5: Enhance community level resilience and preparedness for known climate risks, including flooding, extreme heat, wind, and ice storms
 - Objective # 6: Monitor and implement improvements to local air quality
 - Objective # 7: Support the development of green infrastructure and naturalized areas to improve resilience
 - Accelerating Discovery & Innovation
 - Objective # 8: Increase access to funding and resources for climate action and related projects
 - Objective # 9: Support growth of the green economy and the cleantech sector in Mississauga through partnerships with local businesses and industry leaders
 - Objective # 10: Create policies and procedures that will result in climate considerations being routinely taken into account in decision-making processes within the City
 - Objective # 11: Monitor innovation and change in low carbon and resilient technologies
 - Engagement & Partnerships
 - Objective # 12: Increase education and awareness of climate change
 - Objective # 13: Support attitude and behavioural change by providing meaningful engagement opportunities
 - Objective # 14: Encourage action by providing financial and non-financial incentives
- Total Actions: 62

City of Ottawa:

- [Climate Change Master Plan 2019](#): Climate Mitigation and Adaptation in one plan
- Major Risks:
 - Increased heat-related illnesses
 - Increased building cooling demands and inadequate air conditioning (especially in community buildings like schools, low-income housing, private long-term care facilities etc.)
 - More invasive species, pests and diseases harming trees, greenspaces, and agricultural production

- New or intensified disease vectors (for example ticks that carry Lyme disease, or mosquitoes that carry West Nile virus)
- Increased winter freeze-thaw damage to infrastructure
- Flood damage to infrastructure and property
- Reduced ability to respond to simultaneous or repeated extreme weather events
- Reduced access to essential services during extreme weather
- Increased pressures on people experiencing poverty or in precarious economic situations (mental, physical and financial health)
- 5 Main Objectives:
 - Public Health and Emergency Preparedness
 - Flood Risk Management
 - Combined Sewage Storage Tunnel (CSST)
 - Urban Forest Management Plan
 - Building Resilience of Residents

Waterloo Region:

- [Community Climate Adaptation Plan](#) 2019
- Major Risks: more extreme heat, intense rainfall, freezing rain events, storms and strong winds
- 4 Themes and 15 Objectives:
 - Health And Community
 - Objective # 1: Help vulnerable populations avoid or reduce the health-related risks of extreme weather and temperatures
 - Objective # 2: Improve the personal preparedness of community members to respond to emergencies
 - Objective # 3: Encourage community-based initiatives to improve community members' resilience to extreme weather events
 - Objective # 4: Monitor and plan for the potential introduction of new vectors and vector-borne illnesses to the community
 - Built Environment
 - Objective # 5: Incorporate climate change into future land use, development and construction, and improve the resilience of existing buildings to climate-related risks
 - Objective # 6: Improve the longevity and resilience of infrastructure to extreme weather and temperatures
 - Objective # 7: Reduce transportation disruptions due to extreme weather events and improve safety of travel on roads, sidewalks and trails
 - Natural Environment and Water
 - Objective # 8: Expand the use of natural features and green infrastructure to better manage storm water runoff and decrease flood risk
 - Objective # 9: Conserve and protect surface water and groundwater resources from urban runoff pollution

- Objective # 10: Monitor, coordinate, plan for and mitigate the spread of invasive species in the natural environment
- Objective # 11: Monitor, maintain and improve the diversity and resiliency of urban trees and forests
- Objective # 12: Maximize effective nutrient management and retention to reduce runoff from agricultural practices
- Energy And Economy
 - Objective # 13: Improve the resilience of energy infrastructure to weather-related disruptions
 - Objective # 14: Enable local organizations, businesses and community members to be more resilient to power interruptions
 - Objective # 15: Encourage local businesses and other organizations to identify and plan for climate-related risks and opportunities that may affect their business activities and/or quality of service
- Total Actions: 36

City of Windsor:

- [Climate Change Adaptation Plan \(2012\)](#)
- Major Risks:
 - Increase in operating/maintenance demands to deal with climate extremes
 - Increased chance of flooding to basements, roads and other infrastructure
 - Increase in demand to all areas of operations when responding to an increase in severe storms (during and after)
 - Increase in public health risks due to extreme heat
 - Implementation of development policies which were created in the absence of climate change considerations, which may increase our vulnerability
- The Climate Change Adaptation Plan has the following areas of focus/themes associated with 22 actions:
 - Reducing Risks Associated with Increased Precipitation
 - Reducing Risks Associated with Increased Precipitation and Temperatures
 - Reducing Risks Associated with Increased Temperature
 - General

City of Greater Sudbury:

- [Community Climate Change Adaptation Plan](#): Report to Council (June 13, 2023)
- Major Risks: Rising annual temperatures, increases/decreases in precipitation, and extreme weather events.
- 6 Themes and 17 Objectives:
 - Built Environment: homes, roads, water and sewer pipes, power lines, bridges and buildings.
 - Objective #1: Infrastructure and buildings are more resilient to future climate conditions and extreme events

- Objective #2: Urban flooding and wastewater system bypass events are less severe and less frequent
- Objective #3: Power and communication systems are more resilient to future climate conditions and extreme events
- Objective #4: Homes are more resilient to future climate conditions and extreme events
- Natural Environment: land, water, wetlands, trails, ecosystems, and wildlife.
 - Objective #5: Natural landscapes have enhanced adaptive capacity
 - Objective #6: Watersheds and shorelines are healthy and have increased canopy cover, root systems, water retention, and recharge capacity
 - Objective #7: Risk of invasive species spread is reduced
- Local Economy: local businesses, tourism, and farming
 - Objective #8: Local industry and businesses are resilient, diversified, attractive and sustainable
- Cultural and Social Cohesion: the connections we have through schools, community centres, faith and cultural centres, neighbourhoods, and volunteerism build our community resilience.
 - Objective #9: Cultural and social centres are resilient to future climate conditions and extreme events
- Community Health and Well-Being: our wellness, health care, food access, and emergency responses.
 - Objective #10: Service interruptions during extreme weather events are reduced
 - Objective #11: Health risks are reduced and safety is increased for populations impacted by extreme weather events
 - Objective #12: Risks of water-borne, vector-borne and food-borne illnesses are reduced
 - Objective #13: Risks of wildfire occurrence and impacts are reduced
 - Objective #14: Local food systems and drinking water supply are resilient to future climate conditions and extreme events
- Enabling Actions: inform and empower community members to act
 - Objective #15: Climate change adaptation is integrated into operational procedures and community decision-making
 - Objective #16: The community is informed and empowered
 - Objective #17: New technology and best practices in design and construction are incorporated
- Total Actions: 58

Town of Oakville

- [Climate Change Primer V1.1](#): covers both Mitigation and Adaptation. Report to Council in 2016
- Major Risks:
 - Increase in annual average temperatures
 - Increase in annual average precipitation
 - Increase in the severity and frequency of extreme weather events including:
 - High wind

- Heavy and longer duration precipitation events with increased lightning
- Extreme temperatures
- Winter precipitation
- 4 Themes:
 - Natural Environment and Biodiversity
 - Recreation and Tourism
 - Health and Wellness
 - Built Environment
 - Transportation Infrastructure and Operations
 - Buildings, Planning and Land Use
 - Storm Water Infrastructure
- 3 Objectives:
 - Objective # 1: To increase the town's capacity to protect against and respond to projected climate change impacts.
 - Objective # 2: To educate through effective and efficient means of communication.
 - Objective # 3: To monitor the implementation of adaptation actions and goals in order to make continuous operational improvements.
- Total Actions: 11

Appendix 2 – Examples of London's Adaptation Actions

Progress relating to improving London's resilience to the impacts of climate change includes the following actions (categorized into the proposed themes for the Climate Change Adaptation Framework, recognizing that many actions may relate to more than 1 theme), many of which were recently reported in the CEAP 2022 Progress Report:

Theme 1: Built Infrastructure

- Federal funding from the Disaster Mitigation and Adaptation Fund (DMAF) was secured for the improvement of the Broughdale Dyke, which protects 190 properties north of downtown London from Thames River flooding (construction work to commence in 2023).



Above: A photo of the Broughdale Dyke in 2023 ahead of construction work beginning to improve the dyke's flood resiliency.

- As part of the West London Dyke Master Repair Plan, structure dyke repairs are ongoing under a phased approach and will be completed by 2028. The West London Dyke is primarily an engineered structure which will continue to protect life and property during periods of extreme river flows due to heavy rainfall. DMAF-funded wastewater treatment plant adaptation infrastructure construction was completed at two of five plants. These infrastructure projects included the construction of earthen berms to protect the plants from floodwaters and the installation of lift

pumps to ensure that treated effluent from the plant can still be discharged to the Thames River during high water events.



Above: The West London Dyke at the Forks of the Thames. Additional improvements are ongoing as part of the West London Dyke Master Repair Plan

- A new 100 million litre drinking water reservoir at Reservoir Hill is nearing completion. This additional water storage will increase the amount of water available during an emergency mass power outage or a drop in raw water quality in the Great Lakes, London's source for water, caused by a major climate change event. Additional storage will provide extended timeframes that Londoners can receive water for both municipal use (e.g., drinking water, cleaning) and fire protection, while the cause of the disruption is being addressed.
- The Victoria Bridge replacement project on Ridout Street over the South Thames River included a design change to remove the centre support pillar. Since this concrete pillar is in the middle of the river and regularly traps floating debris, the elimination of this obstruction to allow free flow of the river is expected to reduce potentially dangerous blockages during flood events. Directly upstream, London Hydro has their equipment storage compound located within the floodplain thereby being flood susceptible in extreme events.

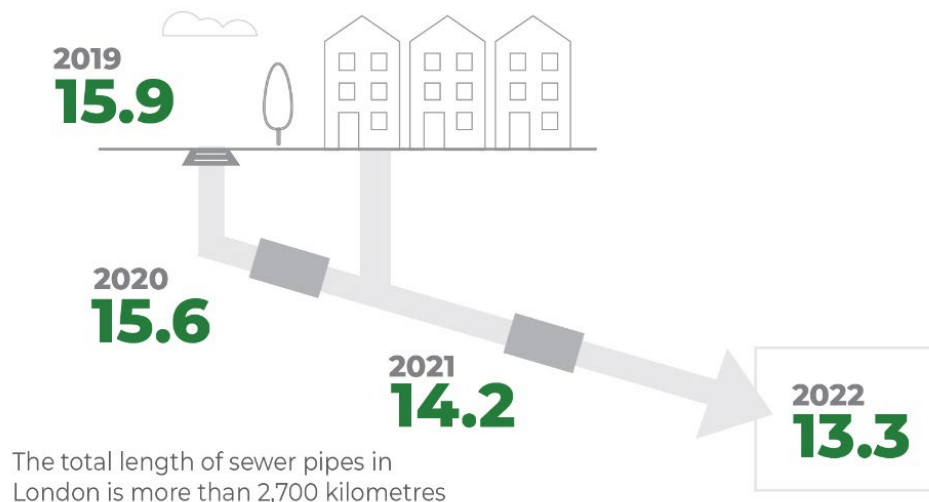


Above: The first of the two steel arches is lifted into place as part of the Victoria Bridge reconstruction project.

- Stormwater Management continues to adapt using more 'at source' techniques to reduce the amount of water runoff reaching the storm drainage system (e.g., low impact development approaches). Upgraded intensity-duration-frequency (IDF) curves are being used to design new stormwater infrastructure and new flood line mapping is in preparation along critical watercourses. Sensitivity analyses are conducted during the design of all stormwater infrastructure projects to evaluate resiliency beyond the 1:100-year and 1:250-year regional storm events.
- To build resilience through climate change adaptation practices, the Stormwater Engineering Division is currently reviewing long term rainfall data in comparison with the Environment Canada weather station to understand spatial variability in rainfall patterns. New IDF curves may be generated to better represent rainfall patterns across the City and update the current standards. Using representative IDF curves will build climate resiliency in the City's stormwater infrastructure for future developments.

- The Stormwater Engineering Division is reviewing the change in the level of imperviousness overtime and across subdivisions to better inform future developments with an appropriate runoff coefficient (C-value). The City's Design and Specifications Requirements Manual (DSRM) will be updated accordingly to incorporate a representative runoff coefficient value to build climate resiliency for new future developments.
- Significant rainfall events have added importance to the Basement Flooding Prevention Programs which continue to provide incentives for homeowners to improve their building resilience (e.g., sump pump back-up power, sewer backflow prevention).
- Aging combined sewers in London's downtown core continue to be separated as part of an overall plan to eliminate them altogether. This action will improve river water quality and reduce impacts on the Thames River, especially during significant rainfall events. During those events, the wastewater treatment system can be overwhelmed due to the added stormwater. Discharge of untreated water then occurs.

Number of kilometres of **combined sewer remaining**



- The Mud Creek rehabilitation project will reduce the frequency of flooding over Oxford Street at Proudfoot Lane, while benefitting from the co-benefits of increasing pedestrian use of the corridor and creating a more sustainable stream system. Phase 1 of the project was completed in 2022 including twin CN Rail culverts and a natural channel between Wonderland Road and CN Rail. Phase 2 is upcoming in 2024 and will continue to completion until 2026 to construct a natural channel between CN Rail and Oxford Street. This project will also facilitate infill housing within the Built Area.



Above: The completed first phase of the Mud Creek rehabilitation project included a natural channel between CN Rail and Oxford Street.

Theme 2: Natural Environment

- The Urban Forest Strategy was completed in 2016 to care for existing tree cover, plan for continued health and improve tree cover for the future. A Tree Planting Strategy is being updated which will also include an update to the Wildland Fire Risk rating (identified in 2017 as 'low to moderate' for London by Ontario Ministry of Natural Resources and Forestry) and will consider Urban Heat Island impacts.



Above: National Tree Day is celebrated in London with the City's annual tree giveaway. In 2023, the event distributed 2,000 trees to Londoners including 12 different types of native trees.

- Guidance documents for land use planning such as the Urban Design Guidelines, Complete Streets Manual and Parks and Recreation Master Plan are all promoting the increased use of street trees and vegetation to offset the impacts of the urban heat island effect. These heat impacts are made worse during heat waves making urban spaces less desirable and potentially harmful to human health. The downtown core and large parking areas associated with suburban malls (e.g., White Oaks, Masonville, Westmount) are key areas to focus on urban heat island remediation plans. This is based on projected and current conditions and previous technical research completed by the Middlesex London Health Unit (MLHU) in 2015. MLHU provided seven recommendations that included:
 1. Focus mitigation strategies where most needed due to the highest impacts to humans
 2. Mapping human discomfort areas and neighbourhoods could assist emergency response to heat waves
 3. Employ 'cool roof' strategies for indoor thermal comfort as well as energy demand reductions
 4. Reduce 'canyon' surface temperatures where tall buildings exist
 5. Incorporate vulnerable population status parameters into future analysis

6. Incorporate land use / land cover information to exclude those areas not high priority (e.g. airport runways) in future research
7. Incorporate urban models to examine the influence of heat reduction strategies in future research

- The Dingman Creek subwatershed Municipal Class Environmental Assessment is underway, which is evaluating a “complete corridor” approach as part of the EA process to promote the movement of stormwater, wildlife, and people. The recommended strategy is intended to be a showcase project for South London as well as a fiscally responsible approach to stormwater management in the subwatershed and consideration for future impacts from climate change. Floodplain mapping updates are being undertaken by the City to inform future new developments and completion is anticipated for 2024-2025.

Theme 3: People

- Assembly of eighty 72-hour emergency preparedness kits for homeowners to have in the case of power outages and/or other weather-related emergencies was funded through ‘Strong Neighbours Campaign’ administered by ICLEI Sustainable Cities Canada. These kits will improve the resilience of homeowners, are supported by London’s Emergency Management team and were distributed by City staff during community engagement events.



Above: City staff speak to Londoners at a Green in the City event about emergency preparedness and how to create a 72-hour kit for their homes.

- The Middlesex London Health Unit completed an Assessment of Vulnerability to the Health Impacts of Climate Change (2014) with recommendations for adaptation. These recommendations have been considered and where appropriate, incorporated which include:
 - Develop an Action Plan on Climate Change and Health
 - Education and outreach
 - Evaluating adaptations
 - Surveillance and Monitoring

Theme 4: Engagement and Partnerships

- 'Green in the City' is an environmental education and awareness program co-sponsored by the London Environmental Network, London Public Library, and the City. On April 4, 2023, the 'Grand Finale' was an evening presentation and panel discussion at Wolf Performance Hall. The title: "How climate change is impacting London's weather and how we can adapt" had the keynote speaker, Chris St. Clair, former Weather Network host and author, in conversation with panel experts regarding Urban Heat Island, Risk of Tornadoes and Building Sustainability.



Above: Chris St. Clair presents at the Green in the City finale event at Wolf Performance Hall.

- Regarding fires, correspondence with UTRCA staff who help manage London's Environmentally Significant Areas has identified they have some capacity to assist with fire suppression in urban

woodlots where London Fire Service equipment is not able to respond in remote access locations. Provincial guidelines on Wildland Fire Risk Assessment which support the Provincial Policy Statement, require the identification of High-Risk areas that have structures within 500 metres. Draft mapping has been created that show London has 6 such locations in High Risk with structures nearby. In these areas, educational materials created by the FireSmart Canada education program can be used for residential ignition suppression.

- The Emergency Management Team hosted a climate-focused emergency preparedness ‘mock emergency’ exercise at the Emergency Operations Centre. The full day session simulated a significant river flooding event and involved more than 100 personnel from 25 agencies and emergency organizations. An additional component was a live marine rescue operation held at Fanshawe Reservoir.



Above: The City’s annual emergency exercise at the Emergency Operations Centre simulating a significant river flooding event.

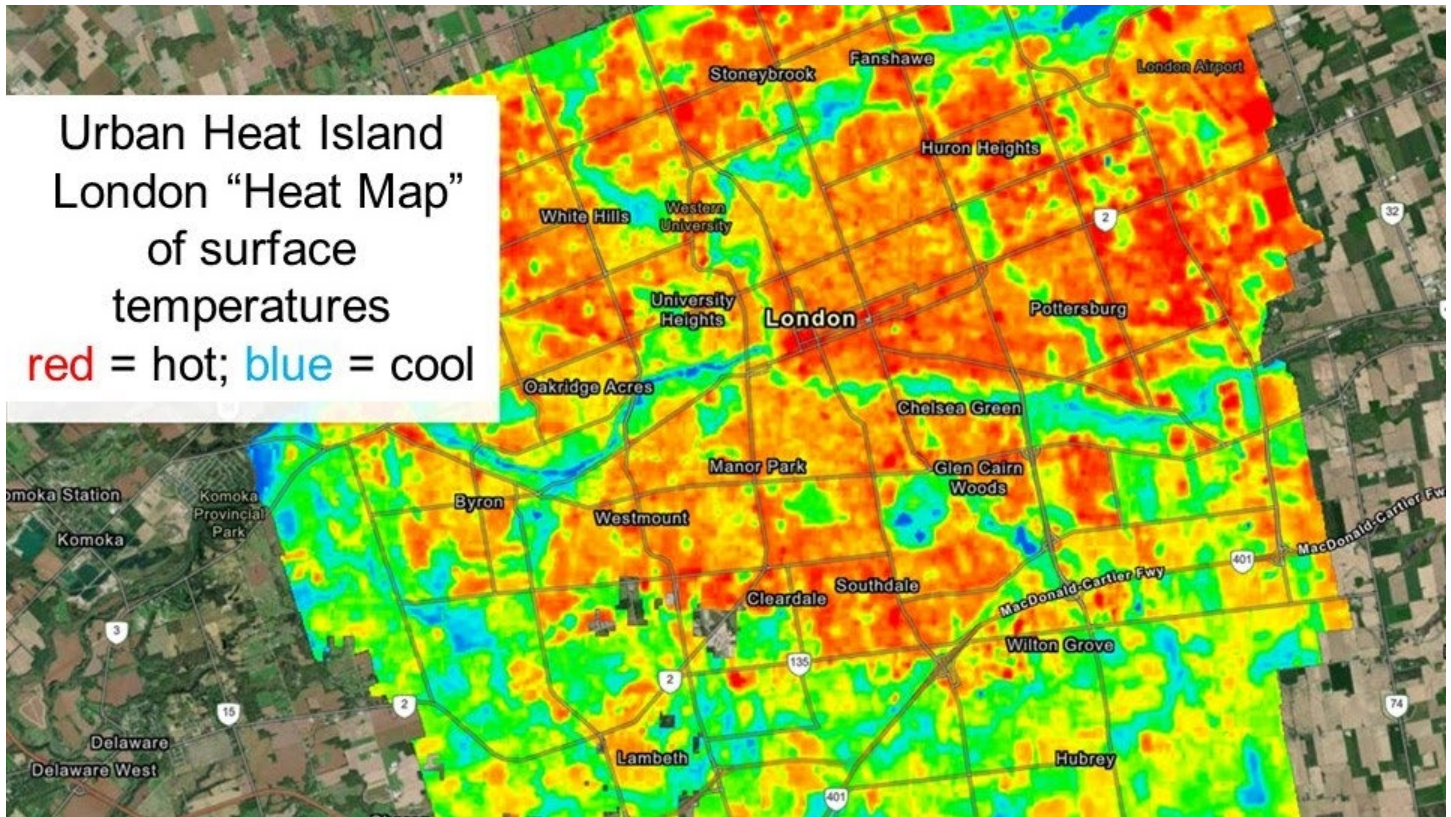
- The City’s emergency preparedness and response during extreme flood events have been coordinated and managed at the Emergency Operations Centre. The City’s Flood Coordinator works with staff at the UTRCA to monitor and respond to riverine flood risks during large storm events. Actions taken during recent events have included road closures and evacuation of identified vulnerable populations. Warning messages have been added to Flood Advisories issued by the UTRCA recommending against sheltering along riverbanks. These warnings are then relayed through the work of various programs including street level contact for those living rough in our parks along the river.
- Western University expertise in severe weather research and monitoring continues to grow with the announcement in 2022 of the Northern Hail Project which joins the Northern Tornadoes

Project, founded in 2017. This expansion adds a team of researchers studying ‘hail climatology’ to their growing research facility that focuses on tornadoes and severe winds. Their research extends across Canada but directly benefits London by providing access to state-of-the-art information and expertise for community awareness and engagement. These Western researchers continue the wind engineering research work that began in 1965 with the construction of the Boundary Layer Wind Tunnel Laboratory and, more recently in 2014 with the launch of the Wind Engineering, Energy and Environment Dome (WindEEE Dome).

Measures addressing climate change adaptation in London that predate the 2022 CEAP approval and 2022 Progress Report also exist and often do not explicitly state their connection to climate change adaptation. Examples of measures are included in:

- London Corporate Asset Management Plan (numerous updates including 2023);
- City of London Flood Plan;
- City of London Strategic Plan; and
- Various Municipal Class Environmental Assessments completed for new or repairs to infrastructure including bridges, roads, landfill, pollution control plants, and water distribution systems.

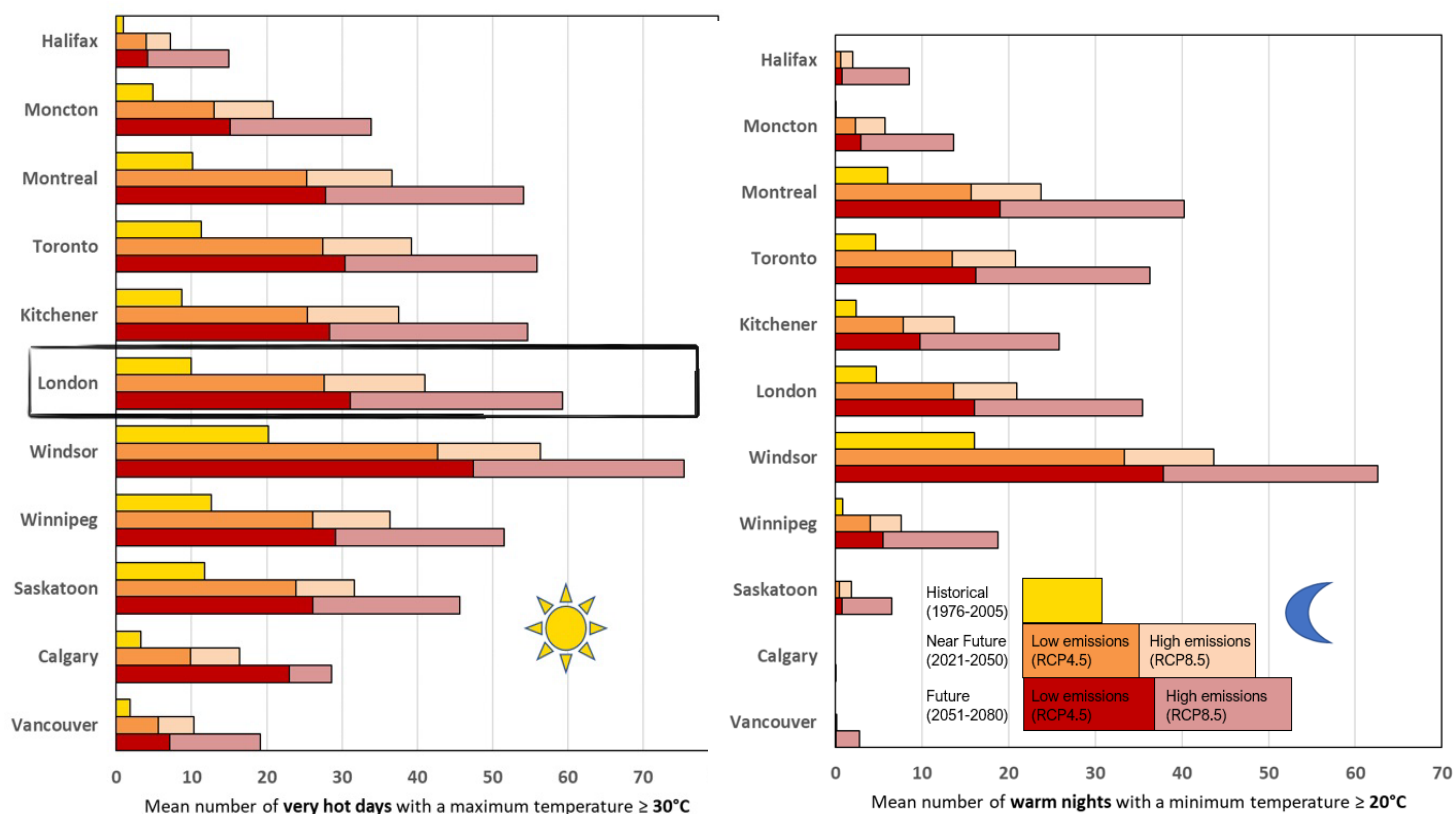
Appendix 3 – London’s Urban Heat Island



Source: Dr. Jamie Voogt, Western University, London depicting the noon temperatures on June 12, 2022

The heat map for London (above) illustrates a range of temperatures (up to 5° C. difference) from the Central Business District / Downtown Core area to the river corridors and agricultural region at the city’s south end. When this information is considered with future temperature projections (see below), the need to consider cooling resources becomes more critical.

The two diagrams below illustrate different cities and their projected temperatures for very hot days and the temperatures at night regarding very warm nights. The projections include the historical record to 2005, the near future to 2050 and the future to 2080. Both diagrams illustrate the city compared to other cities and illustrate we will experience much more days with hotter temperatures than what we currently experience.

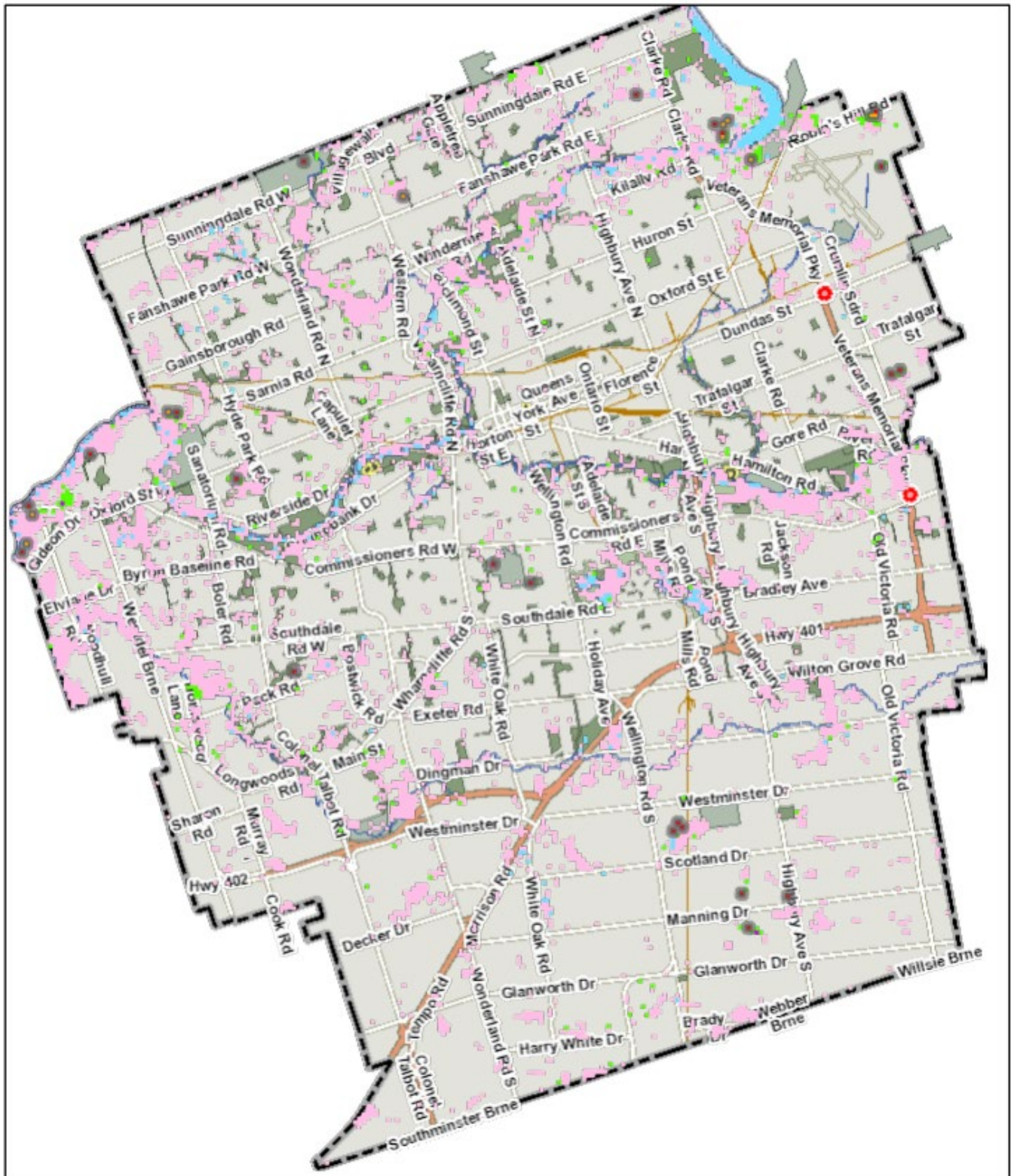


The Climate data in these plots come from <https://climate-scenarios.canada.ca/index.php?page=downscaled-indices-data>

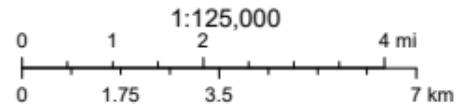
The plots use the median of the combined data from all 24 CMIP5 climate models. Cities are referenced to population centre shape files from Statistics Canada 2016 Boundary Files.

The plots were created by City staff by processing the median data for the two parameters (very hot days and warm nights) for the future emissions scenarios RCP 4.5 and 8.5 using geographical information software (QGIS). The data were read and the grid-based (raster) data calculator was used to determine the 30 year mean for the three time periods (1976-2005, 2021-2050, 2051-2080) for each data point from the downscaled climate model. The mean values were then intersected with the vector file representing the actual geographic boundaries of each city centre and a mean value representing each larger area was output. Bar charts were then created from the data as presented above.

Appendix 4 – Review of London's Urban Forest from a Wildfire Perspective



3/28/2024, 2:44:58 PM



The Corporation of the City of London
Corporation of the City of London | Produced For: Environmental & Engineering Services – Transportation Planning & Design | Produced by: Environmental & Engineering Services - Geomatics |

The data presented in this map were sourced from the FireSmart Priority Zones (available publicly from: <https://firesmartcanada.ca/about-firesmart/>)

The map shows the FireSmart priority zones (1-3) around wooded areas within the City. Priority Zones 1 and 2 (up to 10 m from a wooded area and up to 30 m from a wooded area, respectively) make up the Home Ignition Zone. Buildings within these areas are at the highest risk for wildland-urban interface fires. All three Priority Zones are referenced in the provincial guidelines on managing wildland fires, with their exact locations based on the Ministry of Natural Resources and Forests' (MNRF) **Fire - Potential Hazardous Forest Types for Wildland Fire** map available from GeoHub (available publicly from: <https://geohub.lio.gov.on.ca/documents/f52f092ee6744e0687ead57f78b5d88a/about>).

The higher priority areas shown are generally described as having a higher number of coniferous trees that are more susceptible to drought and more flammable, under the right conditions.

The areas are being further assessed and monitored for inclusion in Fire Department records.

Appendix 5 – 2014 Risk Assessment Considerations and Recommendations

A review by City staff in 2024 has confirmed that the considerations and recommendations identified in 2014 have been or are actively being addressed or incorporated into the relevant work or services.

	Corporate-wide Considerations	Responsibility for Action in 2014
1.	Incorporate climate change adaptation considerations into all relevant business cases proposed for budget deliberations.	All Staff
2.	Continue to encourage a risk-based approach but ensure that they include impacts from climate change to identify risks and consequences when formulating service and budget plans.	All Staff
3.	Consider post event activities and contingencies over the longer term necessary to return service delivery to pre-event conditions based on lessons learned from the Calgary or Toronto recovery experiences.	All staff
4.	Continue to undertake and, where possible, increase actions that address both adaptation and mitigation measures.	Senior Leadership Team (SLT) and Council and all staff
5.	Protect lands that help minimize impacts of climate change by preserving agricultural land, parks and natural areas.	SLT and Council and Planning staff
6.	Encourage greater collaboration with City boards, private sector energy and transportation service providers to adapt to climate change.	SLT and Council
	Service Area Recommendations and Strategy	Responsibility for Action in 2014
7.	Confirm supply-chain management back-up plans in the event that extreme weather interrupts regular supply of critical materials.	Purchasing, Environmental and Engineering Services and Community Services
8.	Consider methods to improve response to weather-related conditions for the safety of pedestrians in snow and ice conditions.	Environmental and Engineering Services
9.	Enhance information-sharing relationship with Conservation Authorities to expedite review and revision of floodplain maps.	Environmental and Engineering Services and Planning

	Service Area Recommendations and Strategy	Responsibility for Action in 2014
10.	Consider modifying buildings or property to reduce vulnerability to damage by extreme weather events as part of lifecycle improvements.	Finance
11.	Consider events where municipal services delivery is compromised as a result of extreme weather that affects the City's ability to meet legislative requirements and take appropriate action.	Environmental and Engineering Services, Middlesex London Health Unit (MLHU), Planning
12.	Consider options for expanding winter accessibility for citizens with mobility challenges.	Environmental and Engineering Services
13.	Consider opportunities to encourage new private sector buildings to include CCA adaptation measures such as water and energy conservation measures.	Environmental and Engineering Services, Planning, Building
14.	Encourage greater collaboration with government agencies and the public regarding ecosystem health.	Environmental and Engineering Services and Planning
15.	Encourage MLHU to take leadership role identifying public health and climate change variables and correlations for planning purposes.	Community Services, MLHU
16.	Assist in conducting, surveillance, monitoring and assessment of morbidity and mortality related health impacts from extreme weather events to its vulnerable population and assist in preparation, mitigation and adaptation related strategies for its citizens	Community Services, MLHU
17.	MLHU to collaborate with all relevant partners for climate change related health awareness, education, and knowledge exchange strategies to better adapt them.	Community Services – Long Term Care LMHU
18.	Consider the need to extend out-of-doors warm weather recreation programs and facilities maintenance to reflect the potential extended season	Community Services – Parks and Community Sports
19.	Ensure procedures are in place to protect City workers from extreme heat and wind chill conditions, and hazards caused by sleet, blizzard and similar events.	Human Resources – Health and Safety, Legal
20.	Consider options and strategies for protecting London's urban forest that will be more resilient and sustainable under changing conditions.	Planning – Parks Planning, Urban Forestry

Appendix 6 – Risk/Vulnerability Assessment Outcomes

RISK / VULNERABILITY ASSESSMENT OUTCOMES



City of London: Final List of Prioritized Risks and Effects on Vulnerable Populations

Final Impact Statement	Median Risk Rating	Effects on Vulnerable Populations
1. More extreme weather events causing damaging winds and winter sleet storms damaging the urban forest and killing vegetation.	20	Not Applicable (n/a)
2. More extreme weather events causing more heavy snowfall / ice / sleet events creating challenges for transportation and snow clearing resulting in increased medical emergencies.	20	Homeless and those living rough will be forced to take shelter and seek assistance.
3. More extreme weather events resulting in more response calls for EMS for rescue and evacuation due to flooding, severe winds and snow squalls, straining emergency services capacity and ability to respond (staff, and equipment resources).	20	Vulnerable populations are often those requiring emergency assistance (e.g., medical) during storm events who will be impacted by a slower response time.
4. More extreme weather events will increase the demand for health services due to increased trauma, testing needs and mental stress.	20	Vulnerable populations with medical needs will be placed in an increasing competitive environment for medical attention.
5. More extreme rainfall events leading to increased flooding in low-lying areas & basements causing property damage/loss.	20	Vulnerable populations, especially lower income earners renting basement apartments, would be forced to either repair or relocate.
6. Extreme rainfall events increasing inflow and infiltration of rainwater into sanitary sewer	20	n/a

Final Impact Statement	Median Risk Rating	Effects on Vulnerable Populations
systems causing sanitary sewer backup into residential/commercial properties.		
7. More extreme rainfall events resulting in more frequent and intense localized flooding of environmentally sensitive areas and impacting City park infrastructure, causing the need for repair / replacement of park pathways, structures and vegetation.	20	Homeless who use riverbanks and underpass locations will be forced to relocate.
8. More extreme rainfall events resulting in flooding that expands the size of floodplains and requiring property redesignations, acquisitions of the most impacted properties, and re-examination of overland water flow routes.	20	Low-income renters in basement apartments subject to flooding will need to repair or relocate.
9. Warmer summer temperatures resulting in an increased energy demand for cooling centres as well as individual residences.	18	Vulnerable populations especially lower income earners unable to afford air cooling equipment, would be forced to either relocate housing or rely on cooling centres.
10. More frequent extreme rainfall events resulting in localized flooding causing increased injury to people, property, damage to parks, and infrastructure.	18	Homeless who use riverbanks and underpass locations will be forced to relocate; low-income renters in basement apartments subject to flooding will need to repair or relocate.
11. More frequent extreme weather events resulting in wind, freezing rain, ice storms that damage trees and hydro lines	18	Vulnerable populations will be more challenged to perform routine daily activities outside their home creating more isolation.
12. More frequent extreme rainfall events resulting in localized flooding causing increased operational and maintenance costs of infrastructure, both private and public	18	n/a
13. More extreme weather events (rain, wind, snow, sleet) resulting in more need for emergency accommodations especially involving vulnerable populations (e.g., those experiencing homelessness and damaged affordable housing residents).	18	Vulnerable populations (e.g., those experiencing homeless) and residents of affordable housing deemed uninhabitable due to storm damage will need alternative accommodation.

Final Impact Statement	Median Risk Rating	Effects on Vulnerable Populations
14. More frequent extreme heat events leading to an increase in chronic health conditions related to poor air quality, causing increased local public health concerns.	15	Vulnerable populations with medical needs will be placed in an increasing competitive environment for medical attention.
15. Increasing precipitation and more extreme rainfall events causing increased urban flooding and reduced sewer capacity creating challenges at pollution control plants due to flood damages and the inability to treat additional quantities (e.g., I&I contributions).	15	n/a
16. More extreme weather events creating damages from severe wind and snow squalls interrupting City administration and services, impacting staff ability to get to work requiring alternative work arrangements	15	n/a
17. More extreme weather events creating damages from severe wind and snow squalls causing damage to infrastructure (e.g., frozen water lines)	15	n/a
18. Increased winter precipitation and rain on snow events leading to increased risk of ice conditions on roads and sidewalks (e.g., traffic accidents, slips/falls).	15	Vulnerable populations will be more challenged to perform routine daily activities outside their home creating more isolation.
19. More extreme weather events negatively impacting community health and well-being (e.g., health of vulnerable populations, access to recreation, access to social gathering spaces).	15	Vulnerable populations who would be inclined to use recreational facilities as refuge would need to find other venues / locations.
20. More frequent extreme weather events resulting in more private property damages leading to increased financial strain for home repairs	15	Increased insurance costs impacting fixed income and lower income families.
21. Warmer year-round temperatures and increased precipitation leading to increased impacts related to vector-borne diseases (e.g., Lyme Disease, West Nile).	12	Medically dependent populations will be more susceptible to additional diseases if they are already immune compromised.
22. Variability in precipitation and temperature leading to increased spring flooding events and longer periods of summer drought,	10	Vulnerable populations may find extra financial pressures due to higher cost of food.

Final Impact Statement	Median Risk Rating	Effects on Vulnerable Populations
causing increased crop failures and livestock challenges in agricultural production, affecting local food security and economic resilience.		
23. More extreme rainfall events leading to increased flooding resulting in increased expenses for home repairs and quantity of debris and household garbage to retrieve curbside material destined for the landfill impacting landfill lifespan.	10	n/a
24. Warmer temperatures increasing the occurrence / likelihood of current and novel invasive species impacting local ecosystems, biodiversity, and potentially human health (e.g., ticks and Lyme disease).	10	
25. More frequent extreme heat events leading to health impacts on vulnerable populations, causing increased morbidity and mortality.	10	Increased morbidity and mortality of vulnerable populations

Suggested 'Risks to Monitor'

Heat and Human Health - Increasing temperatures and extreme heat events leading to local air quality concerns (e.g., increased PM2.5, ground level ozone), causing increased morbidity and mortality related to respiratory illnesses, coronary vascular disease, asthma, and increasing risk of pregnancy complications, especially among vulnerable populations.

Digital Communications – With power outages due to increased storm activity, digital communications are often impacted. Adaptation measures include securing back-up emergency power, flood proofing measures, and enhanced cyber security measures.

Cascading Effects – study the interdependence between infrastructure systems to minimize cascading effects of climate change.

Climate Sanctuary City – monitor the long-term impacts of global and regional populations shifts to anticipate the growing pressure for increased services for an increasing population.

Resources:

https://climatechoices.ca/wp-content/uploads/2021/06/ClimateChoices_Health-report_Final_June2021.pdf

Note: Impact statements and risk scores are taken from benchmark assessments and data (forming 45 consequences) compiled in the 2014 Climate Change Adaptation Risk Assessment report