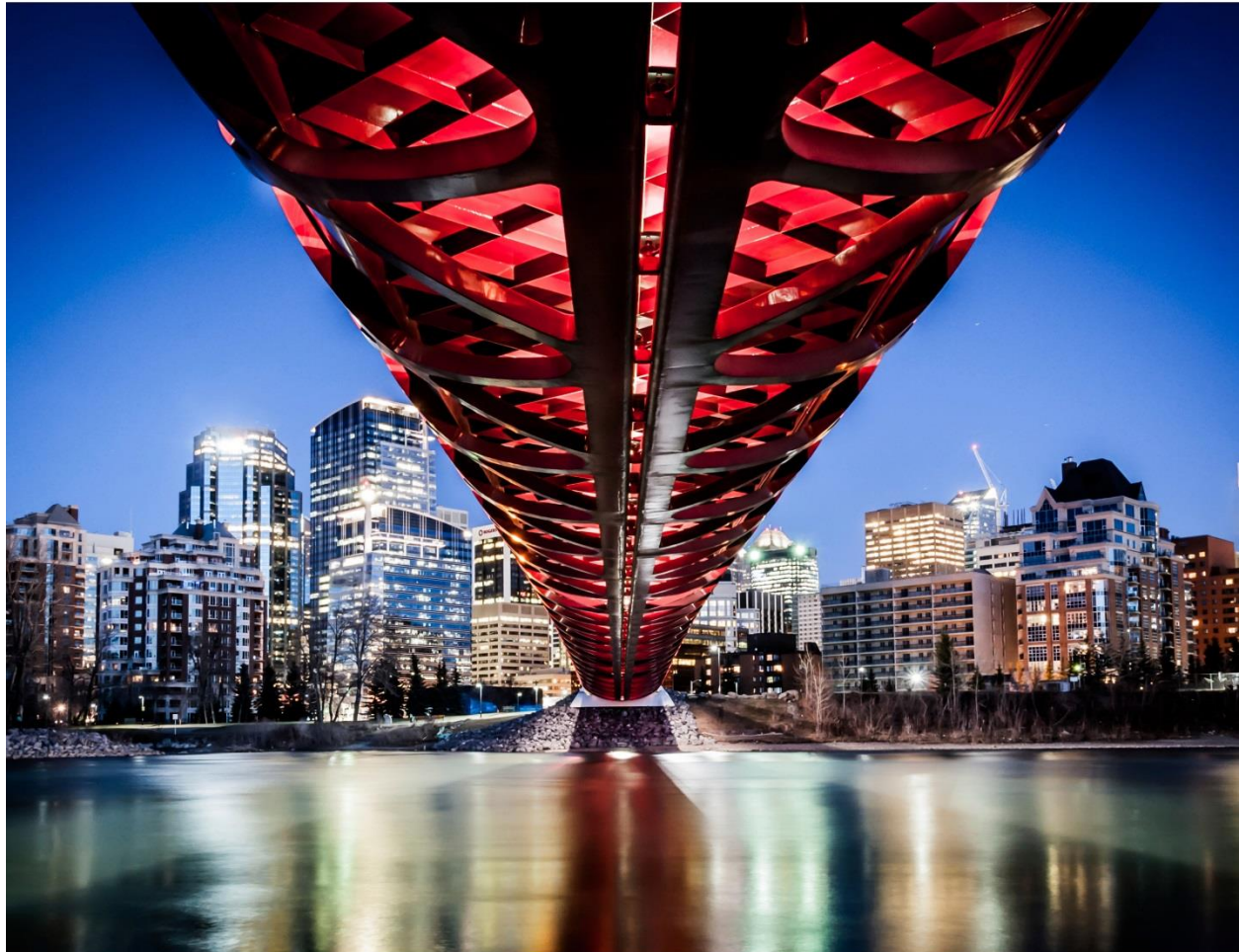




Climate Resilience Strategy

Mitigation & Adaptation Action Plans

Calgary **2018**

EXECUTIVE SUMMARY

The consequences of climate change are widespread and well known in Calgary, and include increasing frequency and magnitude of extreme weather events causing floods and outages. The inevitability of future climate change requires The City of Calgary (The City) to integrate climate resiliency across the organization to maintain the level of services and minimize costs.

The Climate Program evolved in several key areas over the past year including outreach and education, alignment with federal and provincial policy, risk integration into operations and services, and the development of strategies and actions. In-depth research and targeted stakeholder engagement was conducted in 2017 to establish baselines and analyze the risk and vulnerability of infrastructure, people and natural environment. Economic and greenhouse gas (GHG) modelling was also completed to identify GHG reductions and economic development opportunities. A vulnerability and risk assessment was conducted to provide the basis for City business units to identify the adaptive actions necessary to build climate resiliency for their infrastructure, operations and services.

The GHG modelling concluded that GHG emissions will increase in Calgary over time. When comparing low carbon development options with “business as usual” trends, research has found that the shift towards a lower carbon development path for Calgary is economically and technologically viable. Climate change also poses opportunities. Energy efficiency upgrades in buildings improve comfort and lower costs. These investments create jobs, especially for local businesses, while making the city more resilient to future shocks.

This report has three sections: The Climate Resilience Strategy (the Strategy), The Climate Mitigation Action Plan, and The Climate Adaptation Action Plan.

- The Strategy provides the main direction for Climate Resiliency in Calgary.
- The Climate Mitigation Action Plan identifies the role and actions of The City to ensure services, enabling activities, regulations and operations are provided to reduce emissions and enable the low carbon economy. The Plan identifies the actions in collaboration with stakeholders across the community and over the next one to two business cycles, and presents five themes (buildings and energy systems, land use and transportation, consumption and waste, natural infrastructure and leadership) that cover the largest areas of impact for emissions and energy in Calgary.
- The Climate Adaptation Action Plan identifies the risks and vulnerabilities from severe weather events and involves an iterative process of risk assessment. City business units identified a series of actions to manage the climate risks for Calgary grouped into a series of five themes (people, infrastructure, natural infrastructure, water management and governance).

The plans also contain the actions over the next ten years that will begin during the 2019 – 2022 business cycle. Alignment and integration with existing business planning processes was started in 2017 through the development of the two plans. In the spirit of One Calgary, each

business unit will deliver on their clearly defined roles in the Mitigation and Adaptation Action Plans.

Climate resilience in Calgary requires combined and collaborative initiative by The City alongside a diverse cross section of industry, academia, environmental organizations and citizens. By the same token, actions to reduce GHGs and climate risks, must be taken in all parts of The City's administration. It will include finance and funding, collaboration with partners and the measurement of results.

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LIST OF TERMS

Adaptation	The process and actions to manage the actual and projected climate impacts and risk to reduce the effects on built systems, the natural environment and people
ALT	Administrative Leadership Team
AQHI	Air Quality Health Index
BOMA	Building Owners and Managers Association
°C	Degrees Celsius
C40 Cities	The C40 Cities Climate Leadership Group connects more than 90 of the world's greatest cities, representing over 650 million people and one quarter of the global economy
CEMA	Calgary Emergency Management Agency
Climate	Weather conditions prevailing in an area in general or over a long period
Climate Risk	Risk resulting from climate change affecting natural and human systems
CO ₂	Carbon dioxide is the most common heat-trapping (greenhouse) gas, released through human activities such as deforestation and burning fossil fuels, as well as natural processes such as respiration and volcanic eruptions
CO ₂ e	Carbon dioxide equivalent is a standard unit for measuring the contribution of different greenhouse gases such as methane and nitrous oxide, which have different warming effects on the atmosphere. The impact of each different greenhouse gas is expressed in terms of the amount of CO ₂ that would create the same amount of warming.
COP21	United Nations 21 st Climate Change Conference of the Parties
CRAZ	Calgary Regional Airshed Zone
CTP	Calgary Transportation Plan
DALY	Disability Adjusted Life Year
ESM	Environmental & Safety Management
GHG	Greenhouse Gas is any gas in the atmosphere that absorbs infrared radiation, thereby trapping heat in the atmosphere

GHG Sink	An activity or process that tends to remove greenhouse gases from the atmosphere (e.g. planting trees)
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
IBC	Insurance Bureau of Canada
ICIP	Investing in Canada Infrastructure Plan
ICLEI	International Council for Local Environmental Initiatives
km/h	Kilometres per Hour
LRT	Light Rail Transit
MDP	Municipal Development Plan
Mitigation	The processes and actions that stabilize or reduce the greenhouse gas concentration in the atmosphere
mm	Millimetre
Mt	Megatonne
NRCan	Natural Resources Canada
NRTEE	National Round Table on the Environment and the Economy
OHS	Occupational Health and Safety
P&D	Planning and Development
PV	Photovoltaic
RCPs	Representative Concentration Pathways are scenarios that describe alternative trajectories for carbon dioxide emissions and the resulting atmospheric concentration from the year 2000 to 2100. The RCPs describe 4 different scenarios from low to high, namely RCP 2.6, RCP 4.5, RCP 6 and RCP 8.5.
UNFCCC	United Nations Framework Convention on Climate Change
Urban Resilience	The capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow despite chronic stresses (e.g. water shortages) and acute shocks they experience (e.g. floods)
Weather	The state of the atmosphere at a place and time regarding heat, dryness, sunshine, wind, rain, etc.

CLIMATE RESILIENCY IN CALGARY

1. THE CLIMATE PROGRAM

The Climate Program was developed in 2017 and is the broad administrative umbrella that provides strategic oversight to climate related activities at The City. It guides The City's compliance with current legislation, anticipated regulatory changes, and builds mitigation and adaptation considerations into existing and new plans, policies and projects. The Climate Program uses an approach that aligns with five key best practice areas in climate change planning for municipalities to ensure success (Figure 1).

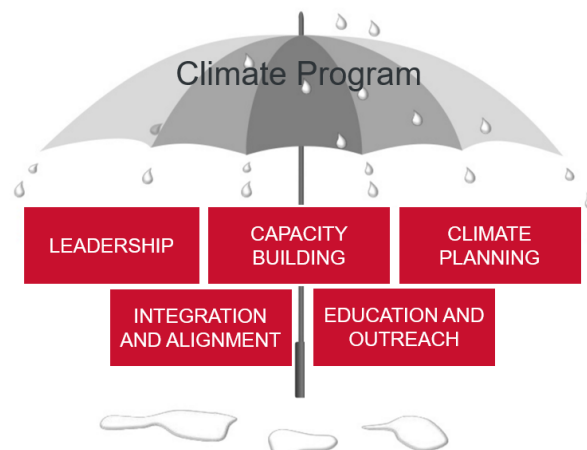


FIGURE 1 – THE CLIMATE PROGRAM

a) Leadership - At The City, both Council and Administrative Leadership Team (ALT) are informed of the risks and opportunities related to climate change that will enable them to lead and make informed decisions. The Climate Program will, through research, communication and with corporate collaboration, ensure that Council and ALT are updated on the most relevant information available.

b) Capacity Building - Municipalities have competing priorities that require constant reprioritization to maximize resources and provide the services expected by the community. Staff and financial capacity should be continuously developed to ensure analysis, evaluation and recommendations are made that consider the risks of climate change and GHG emissions reductions. Vulnerability and risk assessment is done via cross-corporate collaboration. Consistent with risk management, responsibility for action lies with each business unit.

c) Climate Planning - Integrated long-term planning (the focus of this Strategy) provides strategic oversight to climate actions within The City and in the community. The principles will enable Council to determine the most valuable investment of the resources available to deliver services to Calgarians that will achieve Council's vision for Calgary. Climate Planning will include:

- A Strategy to guide decision-making for climate resiliency.
- A Climate Adaptation Action Plan identifying actions to reduce the impacts from the changing climate.
- A Climate Mitigation Action Plan to give direction on City and community GHG and energy management.

d) Alignment with various projects and processes including Connect 4, 100 Resilient Cities, City Charter and Legislative Change Strategy, to name a few, provides the legislative framework and opportunity to integrate climate resiliency into business planning and budgeting. Supporting external strategies through partner agencies such as Calgary Economic Development and industry stakeholders ensures broad alignment with economic initiatives.

e) Public Awareness through Education and Public Outreach provides a strong foundation for collaborative action. Public engagement and robust communications will be required to provide input into the development of a strategy that effectively coordinates the actions of both external and internal stakeholders. Research and targeted engagement will continue to occur to better understand perceptions, identify opportunities for future engagement and develop appropriate communication tools.

2. CLIMATE PLANNING - THE CLIMATE RESILIENCE STRATEGY

The aim of the Strategy is to maximize the resilience of Calgary in the context of a changing climate guided by local and global policy settings and specific mitigation and adaptation actions to address climate change.

The Strategy will focus on supporting a low carbon future while reducing the impacts of a changing climate by:

- Defining The City's role in reducing GHG emissions, improving energy management, and adapting to the impacts of climate change
- Setting policy directions to guide implementation of the climate plans and actions
- Achieving long-term climate resilience objectives
- Setting out the next steps for implementation of climate resiliency by The City

The first phase (this Strategy and Plans) is to identify The City's role in ensuring continued efficient and effective services to Calgarians in a changing climate. In collaboration with the industrial, commercial and institutional sectors (Industry), it will also ensure that The City is able to foster a collaborative effort to transition to a low carbon economy.

The second phase of climate resilience is working directly with Calgarians to build capacity and provide choices to manage the impacts of severe weather events and to improve energy management and reduce emissions. It will also include the implementation of the actions identified in the first phase.

3. INTERNATIONAL TO LOCAL CONTEXT

In Canada, the temperature has already increased by 1.6°C over the last 70 years, a higher rate of warming than in most other regions of the world. The international community and all levels

of government in Canada have already started to take action to mitigate and adapt to climate change and to strengthen their local economies. The international, federal and provincial policy direction as well as the components of the recent City Charters for Calgary and Edmonton are discussed in detail in Attachment 1, Chapter 1 of this report.

4. THE CHALLENGE

The burning of fossil fuels and land use changes have released large amount of GHG's into the atmosphere that trap heat, and affect weather patterns and climate. The Earth's atmosphere today contains 40 per cent more carbon dioxide (CO₂) than 200 years ago.

Urban centres consume nearly 80 per cent of global energy and account for more than 70 per cent of global GHG emissions. The increase in GHGs is directly equated to the use of carbon-intensive energy for heating, cooling, building and transportation. Calgarians currently spend \$2.6 Billion on energy each year, equating to 3 per cent of all money earned in the city. By 2030 this could rise to \$6 Billion and 4 per cent of all money earned in the city through expected increases in energy prices and the growth of economic activity. Reducing emissions directly translates to reduced energy use and energy bills across the city.

As atmospheric GHG concentrations continue to rise at an increasing rate, some degree of climate change is inevitable, and extreme weather events such as droughts and rainstorms will become more frequent and intense worldwide. As a northern, cold-weather country, Canada will see its climate change more than the global average. From the Arctic sea ice cover melting, to rising sea levels on coastlines in Vancouver and Halifax, to extreme weather events experienced in Calgary – the higher rate of warming will bring unexpected changes.

The changing climate poses a serious risk to The City to deliver on its services to Calgarians. The consequences of climate change are widespread and well known in Calgary, including increasing frequency and magnitude of extreme weather events causing floods and service outages. The inevitability of future climate change means that preserving services and minimizing costs requires The City to consider and integrate climate resiliency across the organization.

5. THE OPPORTUNITY - CLIMATE RESILIENCE IN CALGARY

As a member of the 100 Resilient Cities network, The City and its partners are striving to increase capacity of individuals, communities, institutions, businesses, and systems within the city to survive, adapt, and grow, no matter what kinds of chronic stresses and acute shocks are experienced. Climate resilience plays a critical part of Calgary's overarching resilience framework given how climatic disruptions impact many aspects of Calgary's operations and services.

Economic opportunities – The City, and Calgary residents and businesses could significantly enhance their energy security through investments in energy efficiency and low carbon options.

Calgary's green economy is growing. There are already more than 15,000 Calgarians employed in this sector, from transportation to green buildings and energy efficiency in the commercial sector. In a recent study conducted by Calgary Economic Development, it was reported that this industry already brings in more than \$3 Billion of investment into Calgary. By investing in a low carbon, cost-effective economy, we not only generate jobs, but also keep investments in energy (fuel, energy efficiency and electricity) local.

Risk management – Climate change is a risk multiplier. Floods, hail storms, extensive heat days and more frequent and intense storms all have an impact on our services and operations.

There are many reasons for an organization, particularly a municipality, to enhance resiliency and adaptive capacity in the face of climate change. Canada's National Round Table on the Environment and the Economy (NRTEE) suggested that action is justified for three reasons (adapted):

- First — Doing nothing would expose an organization's assets, services, customers and employees to the full force of extreme weather events and climate change, as well as increasing GHG emissions and rising energy cost. It impedes the ability to meet organizational objectives and the expectations of investors, customers, employees and taxpayers.
- Second — Canadians who depend on municipal services have a growing expectation that decision-makers will take climate change into account when planning, building and operating infrastructure to maintain services into the future.
- Third — While significant risks will arise from climate change, adaptation measures could also create new opportunities for job growth and prosperity, such as drought resistant tree breeds, and innovative engineering solutions. Communities expect opportunities for growth and prospects to be realized.

For NRTEE, the key to success in managing risks and seizing opportunities in a changing climate is an agency's ability to raise awareness, assess and manage risks and opportunities, and build resiliency across the enterprise. While these action areas are largely internal, agencies are encouraged to also share best practices and work in partnership with external stakeholders.

The Global Commission on the Economy and Climate reported that well designed policies in resource efficiency, low carbon infrastructure investment and stimulating low carbon innovation will make growth and climate objectives mutually reinforcing both in the short and medium term. In the long term if climate change is not tackled, growth and prosperity itself will be at risk.

Being prepared is key in providing the services Calgarians need and rely on, to continue the quality of life they have here in Calgary. Strengthening the role of The City in climate resilience equips the corporation with tools and actions to address climate change risks, seize the opportunity and support the community.

6. FROM VISION TO ACTIONS

The City of Calgary has a long history of developing actions to reduce emissions and build resiliency to climate change. To manage the effects of climate change effectively, a coordinated approach is required that will result in effective management practices, business and budget prioritization and strategic oversight. From vision to actions, the strategy aligns with The City's direction toward resilience and sustainable future.

The City's **Vision** sets the primary direction for all systems, plans and actions. To build a city's resilience, systems will be designed and function in a way to withstand, respond to, and adapt more readily to shocks and stresses. The transition to a climate resilient city will require a clear view of the ideal future state.

VISION	A great place to make a living, a great place to make a life
PRINCIPLES	Five guiding principles for climate resilience
GOALS	- Reduce vulnerabilities and risks to severe weather and long-term climate effects - Improve energy use and reduce GHG emissions - Support the low carbon economy
TARGET	80 per cent GHG reduction by 2050

The **Principles**, approved by Council on March 21, 2018 (C2018-0340) will guide the mainstreaming of climate-specific decision-making into policies, programs and projects. The Climate **Goals** stipulate the key aspects to achieve over time to reach the 2050 **Target** of 80 per cent reduction in GHG emissions.

GUIDING PRINCIPLES FOR CLIMATE RESILIENCY

Innovation – The City will play an active role in the process of climate innovation.

Inclusiveness – The City will involve multiple stakeholders in planning and implementation at a city, regional and inter-governmental scale.

Integration – The City will integrate both mitigation and adaptation considerations in all investments to improve energy use, reduce GHG emissions, reduce disaster risks and strengthen resilience for future climate conditions.

Relevance – The City will develop locally-relevant solutions to address local climate-risks and vulnerabilities, and low carbon energy opportunities.

Commitment – The City will provide strong governance to assess and sustain progress, adequately fund and ensure ongoing meaningful partnerships.

The City's role in climate change involves enabling a culture of climate resiliency actions which are supported through regulation, service provision, enabling activities, and leadership. Integrating climate specific decision-making into policies, programs and projects ensures that The City services and operations are safe guarded against risks related to climate change and make use of opportunities. Guiding Principles enable the integration of climate resilience into decision-making. They create a line of sight for Council and Administration between climate risk reduction and effective service provision.

The main climate-resilient actions, described in Figure 2, are emission reduction and managing climate risks.

- Mitigation means reducing GHG emissions through better energy management (e.g. conservation and efficiency), implementing renewable energy projects, and supporting a low carbon economy.
- Adaptation means coping with an uncertain future and taking measures to reduce the negative effects of climatic changes.

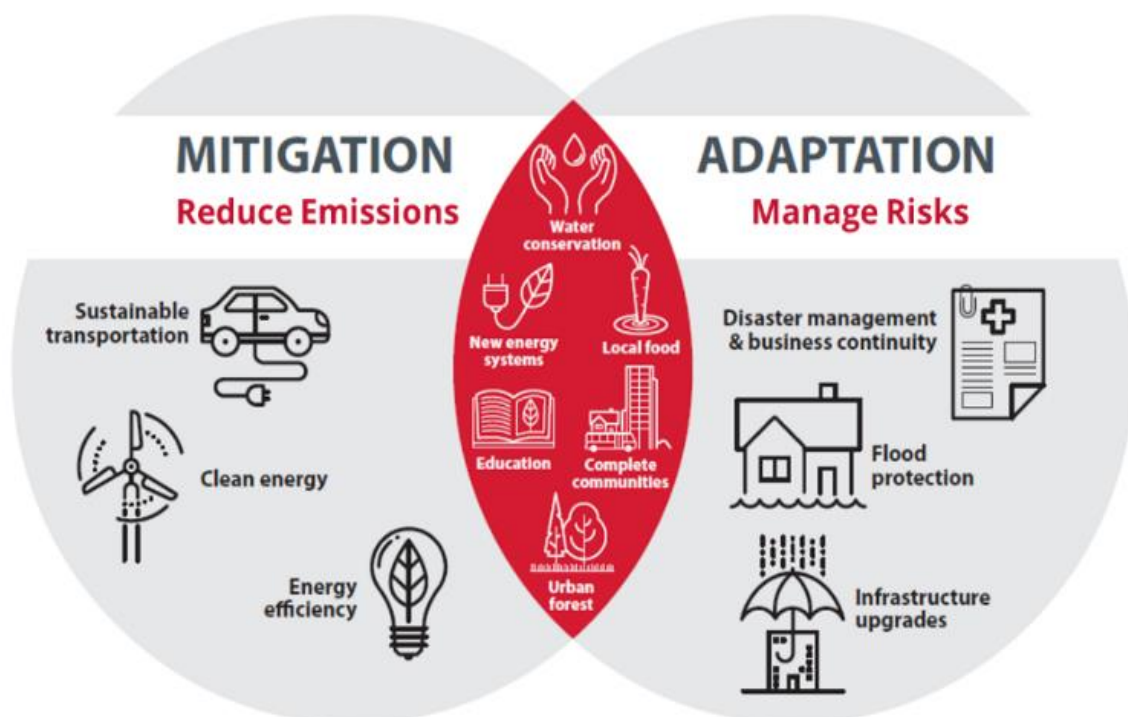
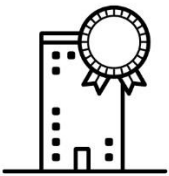


FIGURE 2 - MITIGATION AND ADAPTATION

Mitigation and adaptation actions need to be designed to mutually benefit each other, as effective mitigation can reduce climate impacts and therefore reduce the level of adaptation required by communities. Many mitigation actions also help to adapt to climate change, such as natural infrastructure, naturalization of green spaces, and neighbourhood scale renewable energy generation.

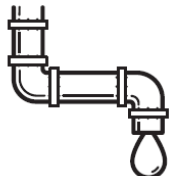
6.1 THE CLIMATE MITIGATION ACTION PLAN

The Climate Mitigation Action Plan for Calgary (Attachment 1) identifies the role and actions of The City to ensure services, enabling activities, regulations and operations are provided to reduce emissions and enable the low carbon economy. These are only the first steps. The Plan identifies the actions in collaboration with stakeholders across the community and over the next one to two business cycles, and presents five themes that cover the largest areas of impact for emissions and energy in Calgary. Ten programs focus on the specific outcomes to be pursued, and the actions are shown as the first steps in the process. The identified program areas and actions will focus on GHG emissions reductions that can be achieved in the following themes: Buildings and Energy Systems, Transportation and Land-use, Consumption and Waste, Natural Infrastructure and Leadership.

Theme	Program
	Buildings and Energy Systems • Energy Performance standards in new and existing buildings • Energy consumption information • On-site and neighbourhood scale renewable and low carbon energy systems
	Transportation and Land Use • Electric and low-emissions vehicles • Low or zero-emissions transportation modes • Land-use and transportation planning
	Consumption and Waste • Consumption and waste reduction • Waste management to minimize greenhouse gas emissions
	Natural Infrastructure • Green spaces and natural areas to support mitigation
	Leadership • The City of Calgary as a leader in climate change mitigation

6.2 THE CLIMATE ADAPTATION ACTION PLAN

The Climate Adaptation Action Plan for Calgary (Attachment 2) identifies the risks and vulnerabilities from severe weather events to City services and operations. It involves an iterative process of risk assessment. Based on the vulnerability and risk assessment done for the most severe climate impacts in Calgary, City business units identified a series of actions to manage the climate risks for Calgary. The actions are grouped into a series of five themes that reflect the interdisciplinary and comprehensive nature of climate change adaptation.

Theme	Program
 People: A city where people can thrive Reducing Calgarians' vulnerability to the impacts of climate change	• Air Quality Management • Extreme Heat Management • Staff and Citizen Outreach
 Infrastructure: The backbone of the city Strengthening the built environment to 'weather the storms'	• Backup Power for Critical Infrastructure • Design Standards and Practices
 Natural Infrastructure: The root of resilience Maximizing the services provided by natural systems	• Natural Assets Management • Natural Assets Adaptation
 Water Management: Every drop counts Preparing for increasing risks of flooding, drought and declining water quality	• River Flood Management • Stormwater Management • Long Term Water Supply
 Governance: Pro-active leadership Preparing for our climate-altered future through collaborative decision making	• Budgeting and Investment Priorities • Urban Planning and Processes • Severe Weather Response and Recovery Management

A wide variety of adaptation actions, ranging from low cost and easily implementable projects, to larger and more complex projects, is to be initiated over the next five years (2018 to 2022), with feasible and "no-regret" actions first.

7. THE WAY FORWARD

There is a growing awareness and acknowledgement that climate resilience is the responsibility of all levels of governments, industry, businesses, and citizens working collaboratively. Climate resilience in Calgary requires combined and collaborative initiative by The City alongside a diverse cross section of industry, academia, environmental organizations and citizens. By the same token, actions to reduce GHGs and climate risks, must be taken in all parts of The City's administration. It will include finance and funding, collaboration with partners and the measurement of results.

Alignment and integration with existing business planning processes already started in 2017 through the development of the mitigation and adaptation plans. Over 200 staff were involved in developing the actions with sign-off from directors.

On 2018 May 15 (ALT2018-0537) The City's Administrative Leadership Team provided direction to Administration to support the Climate Resilience Strategy and Action Plans, and to consider them in One Calgary service plans and budgets.

Each of the Plans contain their own sections for implementation. This section outlines the overarching aspects for Climate Resilience including governance, budget and investment, timing, measurement and reporting that will be coordinated and implemented by Environment & Safety Management (ESM).

7.1 GOVERNANCE

The processes utilized to develop the Climate Mitigation and Adaptation Action Plans created the foundation for implementation through a transparent and collaborative approach. The building blocks for such a collaborative approach include but are not limited to evidence-based decision making that include climate modelling and appropriate energy and GHG reduction measures, risk management and the inclusion of asset management. Meeting the climate resilience objectives will require:

- Prioritization of climate resilience as an ongoing, elevated strategic priority at The City including appropriate resources for implementation
- Alignment of City strategy, policy, regulation, and procedures
- Integrated decision making and responsibility embedded across departments
- Collaborative action from The City, industry and citizens

Building on existing models for climate governance, a group will be established to bring together key organizations and actors from across The City and from the public, private and third-party sectors. ESM will work with partners and City business units to establish the following objectives:

- Seek to be an independent voice in the city, providing authoritative advice on steps towards a low carbon, climate resilient future to inform policies and shape the actions of local stakeholders and decision makers.
- Monitor progress towards meeting The City's climate resilience goals to keep on track
- Advise on the assessment of the climate-related risks and adaptation opportunities in the city and on progress towards climate resilience.
- Foster collaboration on projects that result in measurable contributions towards meeting The City's GHG reduction targets and the delivery of enhanced climate resilience.
- Promote best practice in public engagement on climate change and its impacts to support robust decision-making.
- Act as a forum where organizations can exchange ideas, research findings, information and best practice on GHG reduction and climate resilience.
- Generate a report that will feed into the annual reporting of the Climate Resilience Strategy to Council.

ACTIONS:

Coordinating Business Unit – Environmental & Safety Management

- Work with industry to establish a Climate Resilience group that will aim to meet the above-mentioned objectives.
- Apply the Climate Resilience Principles as part of the implementation of actions.

7.2 PLANNING AND INVESTMENT

There are many opportunities to embed climate resiliency measures through business planning, investment and operating cycles. Managing risks when resources are constrained involves balancing the expense of higher design standards against the costs of an asset failing. Investment decisions require integration of risk trade-offs, and may be constrained by the status of a given project (i.e. between conception and construction). It is generally easier, less costly and less disruptive to build resiliency into a capital project in the planning stages, compared to incorporating resiliency into the construction phase.

Existing infrastructure can be problematic because it has been designed and constructed for a past or present climate, and may not be resilient to future climate conditions. New infrastructure provides an opportunity to embed lifelong resiliency into its design, operation and maintenance; doing so may require designing and building to higher standards, or embedding flexibility into the design so future adjustments can be made cost-effectively when climate conditions change.

The Federal Government's "Investing in Canada Infrastructure Plan" (ICIP) is a twelve year, over \$180 Billion national infrastructure funding plan that includes a proposed requirement to use a climate lens. The scope includes all the streams in ICIP, plus the Disaster Mitigation and Adaptation Fund. Under the Climate Lens, municipalities will be required to:

- Assess GHG emissions associated with the asset, including a Business-as-Usual or baseline assessment;
- Report on GHG emissions associated with the asset, including a quantification of any reductions achieved;
- Assess climate risks associated with the asset;
- Define their locally determined risk-tolerance; and
- Report on measures taken to address stated climate risks.

The City has already started to integrate the resilience decision-making into infrastructure investment. The City's capital investments should be managed in a way which provides maximum value to the community. An integrated and coordinated approach to capital planning, prioritization and funding, administered at the corporate level, refines investments, identifies efficiencies and achieves economies of scale. The City's Corporate Capital Infrastructure Investment Criteria incorporates climate resilience criteria and aligns with Federal guidelines. The work currently underway will ensure that specific criteria, including mitigation and adaptation, are applied when projects are proposed for capital investments.

ACTIONS:

Coordinating Business Unit – Environmental & Safety Management

- Evaluate and support opportunities for climate resilient budgeting, investment and efficiencies.
- Develop tools to support decision-making in mitigation and adaptation for business units.

7.3 FUNDING

Capital and operating funding will be required to implement the Climate Plans. Several funding programs from the Provincial and Federal Governments have been used in the past to secure infrastructure investment. A range of opportunities exist for cities to collaborate and invest in climate resilience. Coordinating and directing these funding opportunities for climate resilience enables The City to target actions and work collaboratively with industry.

Regional and national governments control a range of incentives and financing that both directly and indirectly affect cities. For example, energy efficiency standards for buildings and vehicles are often defined at the national level. Similarly, financing of major municipal infrastructure investments such as mass transit projects is also often controlled by regional or national governments. These types of large infrastructure investments lay the foundation for more efficient, productive, and accessible cities.

Procurement strategies. Cities and networks of cities can influence the supply of energy efficiency or GHG reduction products and services by communicating a near-term increase in demand to manufacturers and providers. They can also collaborate with private companies to foster innovative solutions for citizens, industry or The City of Calgary.

Innovative financing approaches. Cities have developed creative ways to finance infrastructure investments including debt financing, public–private partnerships, and land value capture. Other cities are increasingly exploring green bonds.

The private sector will play a critical role in the ability of cities to achieve emission reductions and improve energy management in buildings, industrial processes, and waste, but they also stand to benefit. Many of the actions building owners can take will pay back quickly in lower utility bills, but barriers include cash constraints for the up-front investments, and split incentive problems where building owners invest but their tenants benefit. Financing solutions (both from private as well as public providers) can help overcome the initial investment hurdle.

ACTIONS:

Coordinating Business Unit – Environmental & Safety Management

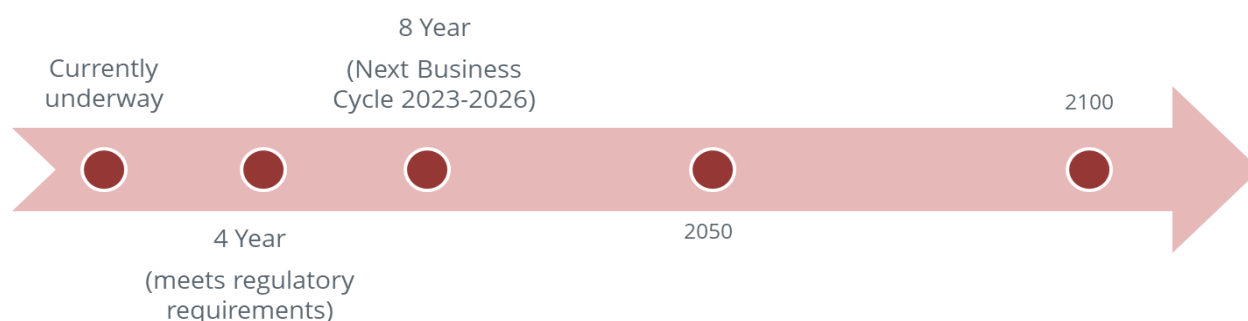
- Explore innovative funding and financing opportunities
- Evaluate and coordinate external funding for climate resilience initiatives as per the Climate Mitigation and Adaptation Action Plans
- Foster new ways to procure innovation that will increase climate resilience

7.4 TIMELINE

The Climate Resilience Strategy will consider a long-term view of climate change that overlaps with various business management cycles such as the four-year business planning and budget cycle, lifecycle management, maintaining the state of good repair, and capital investment planning.

Budgets and resources are applied where a combination of design and operations over the planning horizon would generate the most cost-effective outcome to reduce risk and increase resiliency and adaptive capacity. Good examples of this work would be flood resiliency and the proposed investment in corporate energy management.

Moving beyond the average lifespan of infrastructure (2100) will ensure that infrastructure investments are based on multiple bottom lines. 2050 is a key date that aligns with the



international community and major private companies to reduce emissions, structure investments, measure and report. Allocating budgets and directing resources into business management cycles could follow several approaches, ranging from: incremental decisions and improvements on a continuous basis; transformative, proactive and anticipatory measures that result in an immediate upgrade in design standards; or delaying transformative change until monitoring determines that such action is necessary.

The One Calgary process (business and budget planning 2019 – 2022) describes several modules for the creation of service-based budgets and business plans. Mitigation and adaption actions were created and integrated by business units to support the service lines. Some of the climate resilience actions are currently underway such flood mitigation and electric vehicle charging network, while other actions have been newly identified based on the vulnerability and risk assessment or by industry and The City to enhance the low carbon economy and reduce GHGs. These and other ongoing actions will be included and presented by business units as part of the One Calgary process. Many actions are also being implemented as a result of anticipated Federal and Provincial guidelines and regulations.

Necessary actions from previously approved plans were initiated or continued in 2018. Major new actions will be brought to Council as part of One Calgary in November 2018 for action in the next budget cycle. The remaining new actions will require either further analysis and development of new business cases before they can proceed, or require new sources of capital or operating funding.

City business units will review new information and actions in advance of the 2023 – 2026 business cycle for potential implementation. Many actions identified in the plans will involve further engagement with internal and external stakeholders, which will be conducted by the Coordinating business unit.

ACTIONS:

Coordinating Business Unit – Environmental & Safety Management

- Ensure the timely delivery of programs and projects
- Embed the Climate Resilience, Climate Mitigation and Climate Adaptation Actions in One Calgary submissions

7.5 MONITORING AND REPORTING

An important part of this Plan is to monitor, measure, report and publicly communicate Calgary's progress in implementing the actions of the Climate Resilience Strategy and Climate Mitigation and Climate Adaptation Action Plans. Efforts to build resiliency would benefit from a common reporting protocol and information repository. The City, in collaboration with its partners, will monitor progress. The City will report annually, and learn from experiences, insights, and from others. Unplanned or disruptive changes and unforeseen circumstances, such as shocks and

stresses, will shape our approach, including amongst other impacts, energy price changes, climatic changes, technological developments and funding availability, all of which will be considered in future recommendations and updates.

ACTIONS:

Coordinating Business Unit – Environmental & Safety Management

- Develop and update measures for climate actions where possible with relevant agencies and partners
- Report annually on the progress of the Climate Plans to Council
- Regularly review and update Climate Plans one year in advance of the four-year budgetary cycles
- Include climate resilience analysis (vulnerability and emissions) as part of risk reporting



Climate Mitigation Action Plan

for Calgary

Attachment 1

EXECUTIVE SUMMARY

Calgary's local climate is already changing. The trends demonstrate that our current trajectory for greenhouse gas (GHG) emissions poses risks to our economy, environment and collective health. The longer we wait to begin decreasing emissions, the more drastic and severe the climate change impacts will become, and the more expensive it will be to reduce emissions to safe levels and recover from extreme events.

Climate mitigation is the reduction of GHG emissions through better energy management (e.g. conservation and efficiency), implementing renewable energy projects, and supporting a low carbon economy. The key purpose of the Climate Mitigation Plan is to provide direction for The City on how to address GHG emissions.

The Council approved GHG reduction targets of 20 per cent below 2005 levels by 2020 and 80 per cent below 2005 by 2050 represent the emissions reductions necessary to limit global temperature increase to less than 2°C warming. Between 2005 and 2017, Calgary's overall GHG emissions have increased. This trend indicates the need to focus on emissions in Calgary and it is one of the primary drivers for the creation of the Mitigation Action Plan for Calgary.

Within Calgary, energy use in buildings, primarily electricity, accounts for approximately 65 per cent of the GHG emissions community-wide, and this sector represents major opportunities for emission reductions. Transportation generates about a third of Calgary's GHG emissions through the use of diesel and gasoline. To reduce vehicle emissions there are three broad approaches: switch vehicle fuels to a cleaner, lower carbon vehicle fuel; switch to transportation modes that use less energy; and build city infrastructure to minimize travel distances.

Modeling by the Leeds University and the University of Calgary for the Climate Mitigation Action Plan has shown that between 2018 and 2050 Calgary could reduce its baseline emissions by 70 per cent through cost neutral investments that could be adopted at no net cost to the city's economy if the benefits from cost effective measures were captured and re-invested in further low carbon measures. An economically and technologically viable transition to a low carbon Calgary is entirely possible. Calgarians can immediately benefit from their efforts to reduce emissions. Energy efficiency upgrades in buildings save money, improve comfort, and lower housing costs for families. These investments create jobs, especially for local businesses, while making the city more resilient to future shocks.

The Climate Mitigation Action Plan actions proposed to be undertaken over the next one to two business cycles were identified in collaboration with stakeholders across the community. Five themes (buildings and energy systems, transportation and land use, consumption and waste, natural infrastructure, and leadership) cover the largest areas of impact for emissions and energy in Calgary. Ten programs focus on the specific outcomes to be pursued, and the 69 actions are the first steps in the process.

Climate change mitigation is a continuous process, with this plan acting as a starting point for The City. Successful implementation will require participation and engagement across all business units/service lines, as well as collaboration with community stakeholders in order to successfully achieve Calgary's climate resilience objectives.

Progress on the Climate Mitigation Action Plan will be reported annually. This report will be presented to Council, and will be publicly reported through the Carbon Disclosure Project.

CLIMATE MITIGATION ACTION PLAN SUMMARY

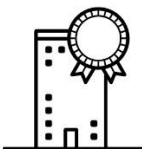
Theme	Program
	Buildings and Energy Systems 1. Energy performance standards in new and existing buildings 2. Energy consumption information 3. On-site and neighbourhood scale renewable and low carbon energy systems
	Transportation and Land Use 4. Electric and low-emissions vehicles 5. Low or zero-emissions transportation modes 6. Land-use and transportation planning
	Consumption and Waste 7. Consumption and waste reduction 8. Waste management to minimize greenhouse gas emissions
	Natural Infrastructure 9. Green spaces and natural areas to support mitigation
	Leadership 10. The City of Calgary as a leader in climate change mitigation

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CHAPTER 1: CLIMATE MITIGATION

Introduction

Scientists, business leaders and heads of government around the world are in agreement: climate change is one of the most serious challenges facing society today. Our climate is projected to become more unpredictable and extreme, posing significant risks to our communities, health and well-being, economy and the natural environment. Calgary's climate is already changing.

Climate Resilience means taking action to reduce Calgary's contribution to the problem of climate change, while also adapting our City to be better able to withstand the shocks that already know will occur. In the Climate Resilience Strategy, The City of Calgary uses new research results to better understand, reduce, and prepare for the impacts of a changing climate. This research takes a close look at the energy use forecast to 2050 and identifies cost-effective opportunities for shrinking Calgary's energy budget and GHG emissions. This new information supports better decisions about investment and the benefits we can expect through our actions.

Climate mitigation is the reduction of GHG emissions through better energy management (e.g. conservation and efficiency), implementing renewable energy projects, and supporting a low carbon economy.

Calgary and Climate Change

Over the past century, Alberta's average temperature has increased by 1.4°C, with most of that increase occurring since 1970. One or two degrees may not sound like much but prior to the industrial revolution this scale of temperature change occurred over thousands of years. A global rise of just a couple degrees has a big impact on our climate and weather.

Weather records show that the number of heat waves in the province has doubled since 1950, and this trend is forecast to increase over time. Calgary is projected to become drier during the summer, but wetter during autumn, winter and spring. During winter, precipitation could fall as heavy snow or rain, with the potential for ice storms in Calgary like those more common in eastern Canada. The potential for major river flooding, like the 2013 flood, or local flooding due to intense storms will also increase.

The trends demonstrate that our current trajectory poses risks to our economy, environment and collective health. The longer we wait to begin decreasing emissions, the more drastic and severe the climate change impacts will become, and the more expensive it will be to reduce emissions to safe levels and recover from extreme events. Over time, responding to these extreme events will undermine The City of Calgary's ability to maintain high quality services and infrastructure.

Past Work

The City has a long history of addressing climate change, from planning and preparation, to mitigation and adaptation, through to recovery. In 1994, Calgary was one of the first cities in Canada to participate in Partners for Climate Protection, a network of Canadian municipal governments committed to developing emission reduction plans.

In October 2009, Calgary was among nine members of the World Energy Cities Partnership to sign the Calgary Climate Change Accord. These cities committed to being environmental leaders and catalysts for change by utilizing official policies and plans to reduce municipal GHG emissions.

To meet the challenges of the Calgary Climate Change Accord, in November 2011, City Council adopted the Calgary Community GHG Reduction Plan. The Plan provides in-depth measurement of city-wide emissions sources and outlines actions with proven results in other jurisdictions for reducing those emissions. As part of the plan, Council also approved reduction targets of:

- 20 per cent below 2005 levels by 2020
- 80 per cent below 2005 levels by 2050

These targets apply for both corporate and community-wide GHG emissions. The plan also identified the potential for GHG reductions in Calgary, and the initial steps to make progress towards implementation.

A Changing Policy Context

The framework in which Calgary operates is in transition due to actions by governments, communities and business to limit the increase in global temperatures and adapt to a changing climate.

International Policy Direction

In December 2015 at the 21st Conference of the Parties (COP21), Canada was among 195 countries that agreed on the Paris Agreement within the United Nations Framework Convention on Climate Change. The key objectives of the Paris Agreement include:

- a goal to limit the increase in global temperatures to well below 2°C and pursue efforts to limit the rise to 1.5°C
- a commitment to achieve net-zero emissions, globally, by the second half of the century
- differentiated expectations for developed nations, including Canada, that they will reduce their emissions sooner than developing nations
- a five-year review and ratchet process which is likely to lead to more ambitious commitments from countries in the future.

Federal Policy Direction

In December 2016, Canada's federal government released the Pan-Canadian Framework on Climate Change. This framework aligns Canada's actions with that of the international community through COP21. The framework recommends several policy planks that support climate change mitigation, these include:

- Model Energy Requirements for existing buildings by 2022¹
- Model Net Zero Energy Ready Codes for Homes and Buildings by 2022²
- National Online Platform for Labelling and Sharing Energy Use Data³
- National Zero-Emissions Vehicle Strategy by 2018⁴

Additionally, the federal government also introduced a mandatory floor price on carbon of \$10 per tonne of carbon dioxide equivalent (CO₂e) in 2018, rising to \$50 per tonne CO₂e in 2022. A price on carbon will be imposed on those provinces that either do not adopt a carbon pricing system or fail to meet this federal minimum price of carbon.

Provincial Policy Direction

In November 2015, the Government of Alberta announced its Climate Leadership Plan. This plan focuses on reducing GHG emissions and energy use. Key elements of the plan are:

- Carbon Levy: \$20 per tonne CO₂e (2017), \$30 per tonne CO₂e (2018)
- Financial support for energy efficiency, infrastructure GHG reduction
- Phasing out emissions from coal-generated electricity by 2030 and developing more renewable energy

Further details of the levy were provided in June of 2016 with the approval of Bill 20 – the Climate Leadership Act. The purpose of the Act is to influence the choices of energy users by imposing a price on carbon across all sectors. In addition, financial support will be provided for energy-efficiency measures, green infrastructure development and GHG emission reductions.

City Charter for Calgary and Edmonton

The City of Calgary and the City of Edmonton have negotiated with the Government of Alberta to establish City Charters, which will be enacted as regulations under the *Municipal Government Act* in Spring 2018. A City Charter is a legislative tool that gives cities greater flexibility and authority intended to cover a range of issues from simple administrative efficiencies to complex regulatory changes.

The City Charters for Calgary and Edmonton will enable the cities to modify or replace provisions in the *Municipal Government Act* or any other provincial Act or regulation, where the

¹ Source: NRCan Build Smart Canada's Buildings Strategy https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/BuildSmart-infographic_EN_accessible.pdf

² Source: NRCan Build Smart Canada's Buildings Strategy https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/BuildSmart-infographic_EN_accessible.pdf

³ Source: NRCan Build Smart Canada's Buildings Strategy https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/BuildSmart-infographic_EN_accessible.pdf

⁴ Source: Transportation Canada https://www.canada.ca/en/transport-canada/news/2017/05/government_of_canadatodevelopanationalzero-emissionsvehiclestrat.html

province has specifically granted it authority to do so. City Charters also include a collaboration agreement to support ongoing, long-term coordination between the two cities and the Government of Alberta. Environment and climate change has been identified as one of three policy and planning tables for ongoing collaboration.

Within the charters, there are enabling provisions that allow The City of Calgary to enact regulations that were not previously allowed under the *Municipal Government Act* in helping to achieve climate change objectives. The Charter requires that The City undertake the creation of climate change adaptation and mitigation plans by 2020.

CHAPTER 2: EMISSIONS INVENTORY AND PROJECTIONS FOR CALGARY

The City measures and reports on city-wide greenhouse gas emissions every year and follows the Global Protocol for Cities to guide our emissions reporting. This means that we report on all energy used within Calgary's boundaries in buildings (heating, cooling, lighting and power), and in the transportation systems (diesel and gasoline). The inventory also reports methane emissions from The City's waste and wastewater treatment facilities.

Calgary community-wide GHG emissions by sector (2017)

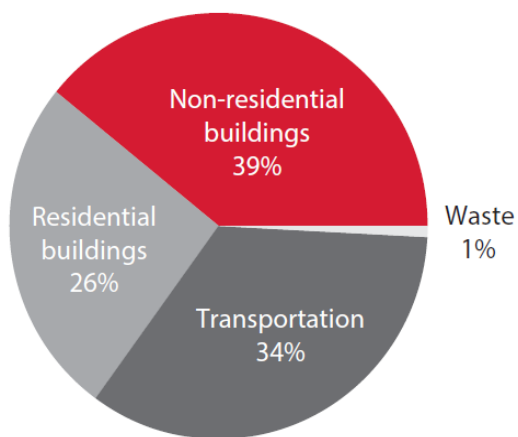


FIGURE 1 – COMMUNITY-WIDE GHG EMISSIONS BY SECTOR (2017)

Current Emissions

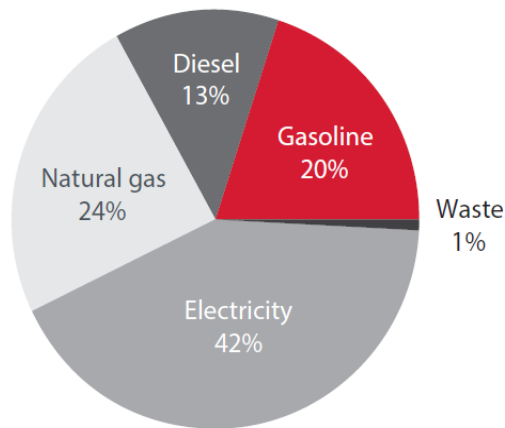
Energy is used in Calgary by households, businesses, and organizations to heat and power buildings, to provide services, and to move goods through and around the city (see Figure 1). Within Calgary, energy use in buildings accounts for approximately 65 per cent of the GHG emissions community-wide, and this sector represents major opportunities for emission reductions. Transportation generates about a third of Calgary's GHG emissions. Waste-related emissions are a combination of organic waste decomposing in municipal landfills and wastewater processing at Calgary's wastewater treatment plants, accounting for 1 per cent of Calgary's total.

Another way to report on Calgary's emissions is by fuel type (see Figure 2). In Calgary, electricity consumption accounts for 42 per cent of total GHG emissions. While electricity in Alberta is heavily reliant upon fossil fuels, Alberta's electricity grid is projected to improve, particularly as coal-powered generation is phased out. In 2016, 47 per cent of our power was supplied from coal, 40 per cent from natural gas, and the remaining 13 per cent from renewable sources.⁵

Natural gas is the main heating fuel for almost all buildings in Calgary. Natural gas use accounts for 24 per cent of total community-wide GHG emissions.

⁵ National Energy Board, Government of Canada
<https://www.neb-one.gc.ca/nrg/ntgrtd/mrkt/nrgsstmpfrfls/ab-eng.html>

Calgary community-wide GHG emissions by energy type (2017)



Buildings are the source of roughly two-thirds of emissions by sector, and electricity is currently the largest contributor within those buildings. Gasoline and diesel consumption account for 20 per cent and 13 per cent of community-wide GHG emissions respectively. Taken together, vehicles contribute about a third of Calgary's overall GHG emissions.

FIGURE 2 – COMMUNITY-WIDE GHG EMISSIONS BY ENERGY TYPE (2017)

Between 2005 and 2017, Calgary's overall GHG emissions have increased by 2.5 megatonnes (Mt) CO₂e (a 16 per cent increase). The upward trend over this period can be seen in each sector individually in Figure 3. In that time Calgary's population has grown from 955,998 to 1,246,231 and the city's overall geographic footprint has expanded. The GHG reduction targets of 20 per cent below 2005 levels by 2020 and 80 per cent below 2005 by 2050 represent the emission reductions necessary to limit global temperature increase to less than 2°C warming and have been adopted by cities around the world. In Calgary, these reductions correspond with absolute targets of 12.6 Mt CO₂e in 2020 and 3.2 Mt CO₂e in 2050. The most recent year-end data for 2017 indicates that Calgary's current GHG emissions of 18.3 Mt CO₂e are about 5.7 Mt CO₂e above the target for 2020, and 15.2 Mt CO₂e above the target set for 2050. This trend indicates the need to focus on emissions in Calgary and it is one of the primary drivers for the creation of the Mitigation Action Plan for Calgary.

Historical Calgary Community-Wide GHG Emissions (2005-2017)

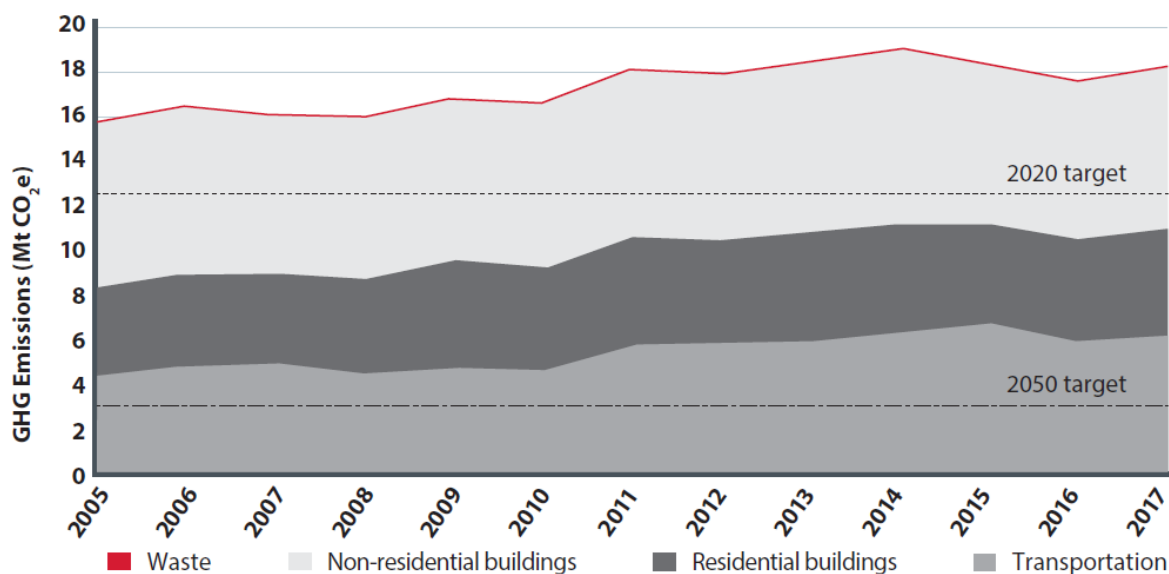


FIGURE 3 – COMMUNITY-WIDE GHG EMISSIONS FROM 2005 TO 2017

Consumption-Based Emissions

Some potentially significant sources of emissions are not reported in our current inventory. Consumption-based accounting of emissions (i.e., both the direct and indirect emissions due to consumption of goods and services in a specific jurisdiction) encompasses the full lifecycle emissions of goods and services: production, pre-purchase transportation, wholesale and retail sale, use, and post-consumer disposal. For example, the emissions that are embedded in the products we use (e.g., food or clothing) are not currently accounted for in our inventory.

Research in other leading municipalities shows that consumption-based emissions can as much as double the total community-wide GHG inventory. This is significant, and actions have been identified later in this plan to begin to quantify the impact of consumption-based emissions in Calgary.

The Challenge and Opportunity

Calgary is a city of more than one million people, with a gross domestic product of more than \$100 Billion a year and total annual expenditure on energy of \$2.6 Billion per year. On the path to GHG reductions, energy plays a dominant role. Our city's population is growing and is projected to increase by 1.3 per cent on average annually until 2050. Historically, as population grows, so too does demand for energy.

The University of Leeds and University of Calgary in 2018 published a report entitled "The Economics of Low Carbon Development: Calgary, Canada"⁶. It examines the economic case for

⁶ Source: <http://climatesmartcities.org/case-studies>

Calgary switching to a more energy efficient and lower carbon development path, and it provides both economic and broader evaluations on the desirability of different options and pathways. The evidence base generated is intended to provide policymakers, businesses and individuals in Calgary with reliable, locally relevant evidence so that they can take informed decisions on how best to switch to a lower carbon development path.

At a macro-level, the evidence shows that there is a strong economic case for switching to a lower carbon development path in the short to medium term, and that doing this would enable Calgary to be on track by 2030, but it also highlights some significant longer-term challenges in reaching Calgary's 2050 target. Preparing to meet these challenges in the short to medium term could significantly improve the chances and reduce the costs of meeting them in the longer term.

To inform the discussion on how Calgary could shape its future energy use and GHG emissions, the report assesses a long list of the measures that a range of actors in Calgary could take. Ranging from changing light bulbs to rebuilding offices, this analysis assesses the cost and GHG implications of single actions and of programs of action that could be implemented across the city. Individually, many of these actions have only a small impact on energy use and GHG emissions. Collectively, however, the findings show that thousands of small actions, and some broader programs, could generate massive savings in cost and GHG emissions, with significant additional impacts in areas such as job creation, cleaner air, reduced energy poverty, and improved mobility.

The report highlights both the opportunity presented to Calgary, and the challenges that need to be overcome if the opportunity is to be taken. Low carbon measures can require large investments, coordination between policymakers, businesses, and individuals, and changes to the ways in which we live and work. However, the analysis shows that the benefits of many actions can far outweigh the costs. A low carbon future for Calgary will not just improve the global climate, but bring economic and social benefits to the lives of Calgarians.

The report established the following projections for Calgary:

Baseline – The baseline scenario is what Calgary's emissions are projected to be with no action beyond business-as-usual. The baseline scenario is projected out to 2050 by combining (1) data on historical trends in Calgary's prosperity, energy use and GHG emissions, (2) population and economic growth projections, (3) provincial-level GHG emissions and energy price projections to 2050, and (4) a base assumption that Calgary's Municipal Development Plan (MDP) targets are achieved.

Cost-neutral – The cost-neutral scenario identifies the GHG reductions that can be achieved with no net negative effect on the economy. This scenario assumes deployment of all measures that could be afforded if the benefits from the cost-effective measures were captured and reinvested in further low carbon options. This scenario achieves the largest GHG reductions with the internal rate of return for the scenario remaining greater than zero.

Calgary's potential future emissions under the baseline and carbon reduction scenarios

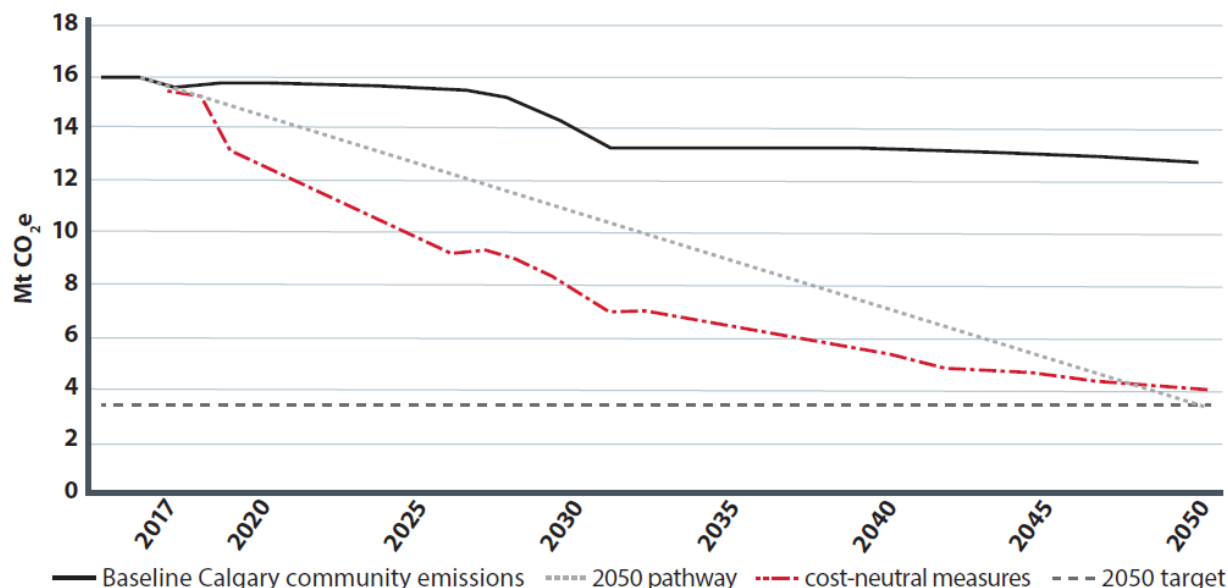


FIGURE 4 – CALGARY BASELINE AND CARBON REDUCTION SCENARIOS 2018 TO 2050

Figure 4 shows that between 2018 and 2050 Calgary could reduce its baseline emissions by:

70 per cent through cost neutral investments that could be adopted at no net cost to the city's economy if the benefits from cost effective measures were captured and re-invested in further low carbon measures. This would require cumulative investment of \$113 Billion, generating savings of up to \$5.6 Billion per year. Using net present values, the investment is paid back in 17 years with savings continuing over the lifetime of the measures still in place. Nearly 860,000 job-years could be generated by investing in cost neutral options.⁷ See Table 1 below for sectoral breakdown, potential reductions and economics of Cost Neutral projections.

⁷ Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report

Category	Total potential GHG reductions to 2050 (Mt)	Total Investment (Billion \$)	Annual Energy Savings (Billion \$)	Total Job Creation Potential (Thousand job years)	Payback period on original investment (Years)
Residential	129	32.8	1.4	427	23
Commercial	76	6.9	0.5	69	13
Industrial	10	5.8	0.176	4	24
Transportation	63	59.9	3.2	291	18
Distributed Energy	24	7.5	0.27	67	15
Total Potential	302	112.9	5.6	858	17

TABLE 1 – POTENTIAL REDUCTIONS AND ECONOMICS OF COST NEUTRAL PROJECTIONS

When comparing low carbon development options with “business as usual” trends, the report found that the shift towards a lower carbon development path for Calgary cannot be dismissed on technical or economic grounds. An economically and technologically viable transition to a low carbon Calgary is entirely possible.

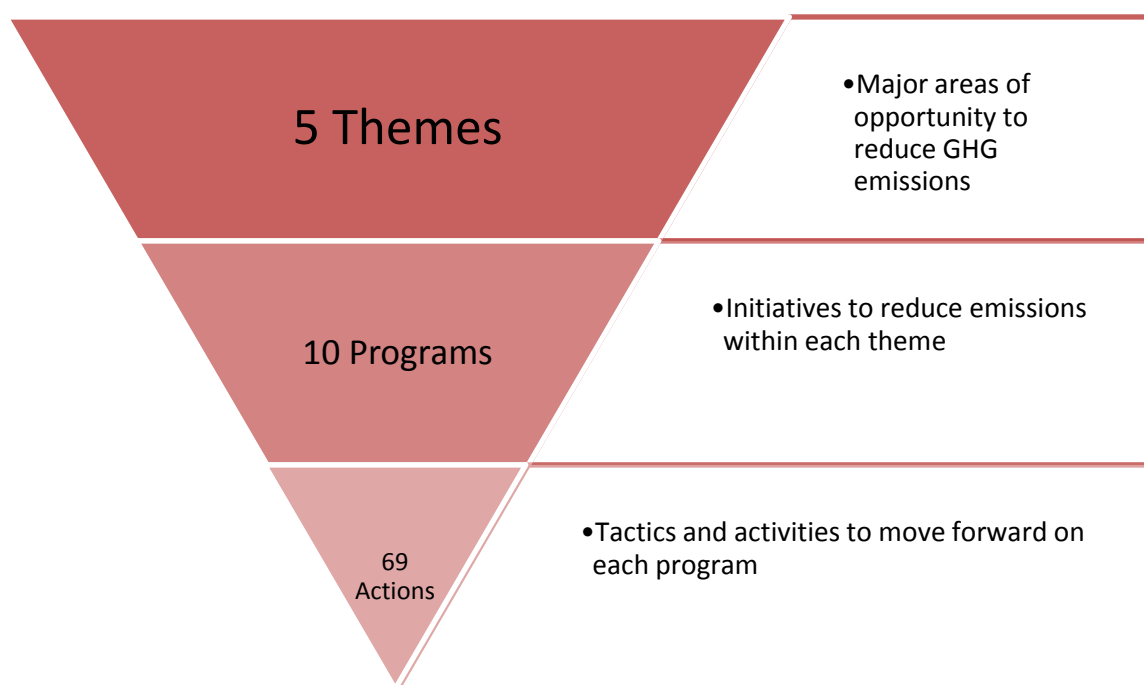
Despite the anticipated progress that will be made in reducing emissions due to the greening of Alberta’s electricity sector, the strength of the local economy and sustained population growth will continue to drive emissions in Calgary. The Climate Mitigation Action Plan for Calgary is moderate in its level of ambition but it puts in place actions that will start to decouple population and economic growth from overall emissions. However, further aggressive action will be required along the way to guide Calgary to a low carbon future. Though the task of GHG reductions seems daunting, the analysis in this report has shown that it is possible to get Calgary on the right trajectory to meet our targets.

CHAPTER 3: CLIMATE MITIGATION THEMES AND ACTIONS

Setting the Path to a Low Carbon Calgary

Plan Structure

The Climate Mitigation Action Plan for Calgary identifies the top actions to be undertaken over the next one to two business cycles to make progress to reduce emissions. Internal and external stakeholders reported to The City that these are the best opportunities to begin the transition of a low carbon future. The work is presented in five themes that cover the largest areas of impact for emissions and energy. Ten programs focus on the specific outcomes to be pursued, and the 69 actions become the first steps in the process.



These actions will result in both immediate and cumulative reductions in emissions from buildings, transportation, materials management, process emissions and industrial process sources. Although actions will need participation by all stakeholders across the community to achieve our GHG reduction targets, this plan focuses on actions that can be undertaken by The City directly through our roles: regulation, enabling activities, service provision, and operations. The relevant City business units identified a series of actions that will start to turn the curve on greenhouse gas emissions in Calgary.

Participating Business Units

For each program, there is a list of actions with one or more Participating Business Units identified as the implementer of each action. In general, the Participating Business Unit is responsible for most actions within the program, but are also responsible for coordinating actions occurring in other business units. Each action also has a funding status and a specific timeline for implementation.

Funding

Each of the programs include a wide variety of mitigation actions, ranging from low cost and easily implementable projects, to larger and more complex projects. For new actions, ESM will support other City Business Units as they develop new business cases and detailed funding requirements for these actions. Approved business cases will be submitted to One Calgary budgeting process in 2018 for a coordinated allocation of corporate funding through future business plan and budget updates.

City Role

While climate change is a global issue, cities play a crucial role in tackling climate change. Each level of government has a different level of jurisdiction and different tools to turn the curve in the right direction.

This plan is focused on The City's role to reduce city-wide greenhouse gas emissions. As a municipal government, The City can directly and indirectly influence city-wide emissions in four key ways:

- **Operational Control:** This is where The City has direct ownership over the initiatives, from capital and service delivery including the type of fuel we use in City vehicles to the how we build or the reduction of energy use in buildings to the design of roads to withstand severe flooding and heat exposure.
- **Educate, Inform, and Encourage:** These are creative and intelligent programs to support improved energy management behaviours and decision-making as well as actions that provide information and choice e.g. working with the Insurance industry and other cities on best practices for industry and home owners with regards to severe weather events. Helping citizens with information on buying storm resistant shingles for their roofs.
- **Influence:** These are actions where The City can promote and support the desired energy management opportunities and climate risk reduction (e.g. collaborating with other levels of government on policy design) or programs such as energy labelling.
- **Regulation:** The City uses its jurisdictional powers to ensure a clear path toward energy management, carbon reduction, risk reduction, and societal benefits. It is also the place where The City complies with provincial and federal mandated actions such as energy labelling or energy step codes.

Targeted Stakeholder Engagement

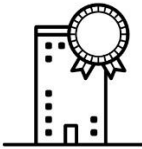
The City of Calgary established three external working groups with individuals representing industry, technical experts, academia, and the environmental sector to focus the top three areas to reduce greenhouse gas emissions in the community as listed in Table 2.

Buildings and Energy System	Land-use and Transportation	Consumption and Waste
• ATCO • Begin with Design • BILD Calgary • BOMA • Brookfield Residential • Canada Green Building Council • ENMAX Power • Flechas Architecture • KCP Energy • Mission Green Buildings • Morrison Hershfield • Pembina Institute • Southern Alberta Institute of Technology	• ATCO • BILD Calgary • Brookfield Residential • Calgary Airport Authority • Calgary Parking Authority • Canada Land Corporation • Car2Go • Electric Vehicle Association of Alberta • ENMAX Power • Federation of Calgary Communities • McElhanney Consulting Services • NAIOP • RKP Consulting • University of Calgary	• Alberta Food Processors Association • AWR Recycle • BILD Calgary • Blu Planet • Calgary Co-op • Green Calgary • Green Event Services • Leftovers YYC • Recycling Council of Alberta • University of Calgary

TABLE 2 – MEMBER COMPANIES OF THE CLIMATE CHANGE MITIGATION WORKING GROUPS

The working groups gathered for five workshops from June 2017 to May 2018 and contributed to all aspects of the Mitigation Action Plan, including shaping the technical analysis, offering stories and feedback about current challenges when working with The City to implement climate innovations, and developing the strategies, programs and actions contained within the Plan.

Themes and Programs

Theme	Program
 Buildings and Energy Systems	1. Energy performance standards in new and existing buildings 2. Energy consumption information 3. On-site and neighbourhood scale renewable and low carbon energy systems
 Transportation and Land Use	4. Electric and low-emissions vehicles 5. Low or zero-emissions transportation modes 6. Land-use and transportation planning
 Consumption and Waste	7. Consumption and waste reduction 8. Waste management to minimize greenhouse gas emissions
 Natural Infrastructure	9. Green spaces and natural areas to support mitigation
 Leadership	10. The City of Calgary as a leader in climate change mitigation

Buildings and Energy Systems

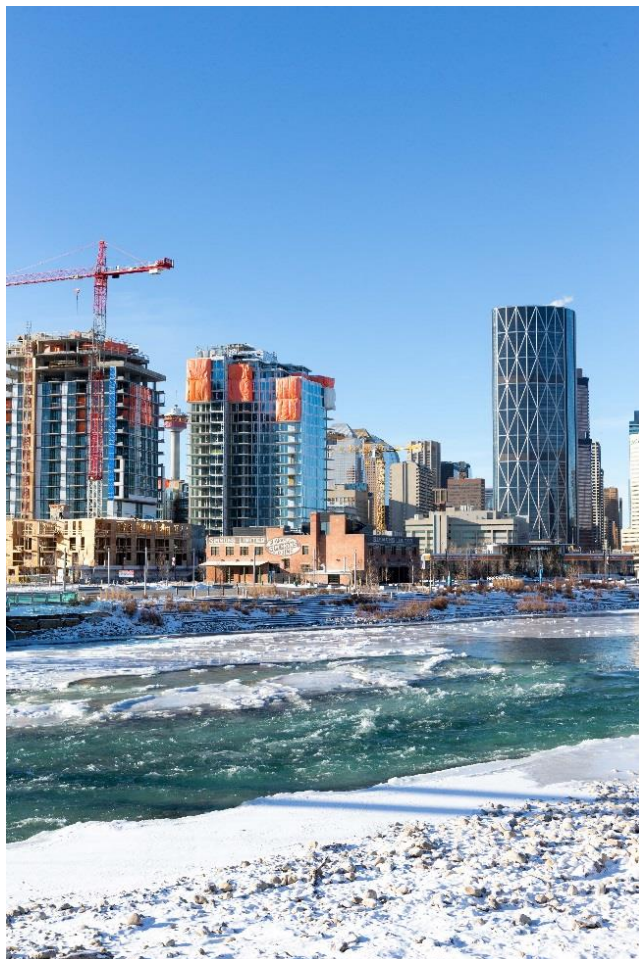
Energy use in buildings is the largest opportunity for GHG reductions in Calgary. From heating to cooling, from cooking to lighting, our buildings provide many energy intensive services. Natural gas and electricity used in Calgary's residential, commercial, institutional and industrial buildings make up almost 65 per cent of total emissions generated in the community. Improving the overall energy performance of buildings and making sure energy comes from clean, low-carbon sources are steps to reducing our emissions.

Investments in building energy efficiency and clean energy also present an unparalleled opportunity. By reinvesting in building stock and renewable energy systems, Calgarians will save money on utility bills, benefit from more comfortable and higher quality buildings, and support local job growth in the energy efficiency and clean energy sectors.

The actions within this theme are organized into three program areas:

- Energy performance standards
- Energy consumption information
- On-site and neighbourhood scale renewable and low carbon energy systems

Each program is explained in further detail below.



Program 1: Energy Performance Standards

Background

Energy performance standards refer to the minimum energy performance requirements that are regulated for new and existing buildings. Minimum energy performance standards for new buildings have been recently defined in the Energy Code, a subsection of the Alberta Building Code. This energy code has been in force since November 2016, and outlines both prescriptive and performance requirements for energy performance in new buildings. There are currently no energy performance requirements for existing buildings in any jurisdiction in Canada.

The federal government has indicated that there will be a strong push to continue to improve the energy performance standards of new buildings, and to begin to develop an energy code for existing buildings.

Natural Resources Canada⁸ has specified the following changes are expected to be brought forward in the building codes. In particular:

- Winter 2018 Launch ENERGY STAR certification for commercial and institutional buildings.
- 2018 to 2019 Launch a new program to ensure that energy codes are implemented properly when they are adopted.
- Winter 2019 Develop an online platform and framework for labelling and sharing home and building energy use data.
- Fall 2022 Publish additional tiers of Net Zero Energy Ready codes for buildings.
- Fall 2022 Publish model energy requirements for existing homes and buildings.

The provisions of the new Calgary City Charter enable The City to implement building code requirements beyond the current provincial building code. However, rather than utilizing this regulatory ability, this program focuses on supporting regulation at the provincial and federal level, and supporting energy performance beyond code through incentives and access to financing.

Why is this Priority?

Energy use in buildings makes up about 65 per cent of GHG emissions generated in the community.⁹ The new provincial energy code ensures that new buildings' energy performance will improve, however, to meet our GHG reduction targets standards in Calgary must improve more quickly than the energy code currently dictates. Importantly, a significant portion of the buildings that will exist in Calgary in 2050 have already been built today. Approximately 50 per cent of buildings will still be in use in 2050, depending on Calgary's growth.¹⁰ Energy performance of the existing building stock will need to improve through energy efficiency of equipment and conservation through improved building envelopes.

⁸ Source: NRCan Build Smart Canada's Buildings Strategy https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/BuildSmart-infographic_EN_accessible.pdf

⁹ Source: The City of Calgary 2017 GHG Inventory

¹⁰ Source: Calgary Growth Strategies

Even with a strong economic case for energy efficiency and improved energy performance, many residential and commercial building owners are not investing in better energy performance. Despite the economic benefits, there are other barriers to building or renovating buildings to improve energy performance. These actions attempt to reduce those challenges.

Potential emissions reductions and cost savings

This program examines opportunities to go beyond current energy standards for both existing and new buildings. The highlighted actions will assist to significantly reduce energy consumption by going beyond the existing energy codes, and by exploring innovative financing incentive and incentive programs.

Improve energy performance standards in new and existing buildings ¹¹					
Building type	Total potential GHG reductions to 2050 (Mt)	Total Investment (Billion \$)	Annual Energy Savings (Billion \$)	Total Job Creation Potential (Thousand job years)	Payback period on original investment (Years)
Residential	129	32.8	1.4	427	23.4
Commercial	76	6.9	0.5	69	13.8
Industrial	10	5.8	0.176	4	24
Total Potential	215	45.3	2.076	500	21.8

¹¹ Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report



What The City will do

The following actions have been identified as critical first steps to achieving improved energy performance standards in new and existing buildings. The actions are to:

Improve building performance requirements beyond current building code

ACTION	PARTICIPATING BUSINESS UNITS
1.1 Support the implementation of energy step codes for new buildings	Calgary Building Services
1.2 Prepare Calgary for the implementation of a retrofit building code	Calgary Building Services

Investigate incentives

ACTION	PARTICIPATING BUSINESS UNITS
1.3 Investigate policy approaches to provide monetary and non-monetary incentives to improve building performance.	Environmental & Safety Management Calgary Building Services Water Utility

Enable innovative financing mechanisms

ACTION	PARTICIPATING BUSINESS UNITS
1.4 Enable innovative financing mechanisms to fund improved energy performance.	Environmental & Safety Management

Program 2: Energy Consumption Information

Background

Energy use is often invisible to energy users. Many citizens and commercial building managers are unaware of how much energy their everyday activities require. By making energy consumption information more readily available and easily understood, we help provide the tools to make better decisions about how energy is used in specific buildings, and we also allow better comparisons between buildings.

Currently, most people in Calgary only get information on how much energy their home or building uses through monthly utility bills. However, this information is often difficult to decipher, and may not be readily available when buying, selling or renting a home or commercial space. The difference in energy costs between buildings that appear similar on the surface can actually be quite significant. This program is focused on making energy information more readily available and more easily understood for all building types in Calgary.

Building labelling (for residential buildings) and benchmarking (for commercial buildings) are ways to make energy information publicly available. A building energy label is a way to give a score to a home's energy performance, based on an assessment. This score can be made publicly available, and can be useful in understanding the opportunities to improve the energy performance of the home, and can also be useful in comparing the energy efficiency of similar homes.

Similarly, energy benchmarking is a system for comparing the energy performance between similar buildings, for instance offices or retail stores in the commercial sector.

Other options for providing improved access to energy consumption information can include publishing energy performance maps or building information, or redesigning utility bills to promote energy conservation.

Natural Resources Canada¹² has indicated that the following changes are expected to be brought forward in the building codes with regard to improving access to energy information:

- Winter 2018 Launch ENERGY STAR certification for commercial and institutional buildings.
- Winter 2019 Develop an online platform and framework for labelling and sharing home and building energy use data.
- Fall 2020 Complete national survey of commercial and institutional building energy use.

¹² Source: NRCan https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/BuildSmart-infographic_EN_accessible.pdf

Why is this Priority?

Understanding and managing the energy consumption in buildings is important for building owners and users to save energy and money in the long term, because buildings have a long service life.

Research has shown that simply increasing awareness of energy consumption can realize improved energy savings.

According to the Building Owners and Managers Association (BOMA) Best Certified Buildings (Commercial), a commercial building benchmarking program, registered buildings show on average a 15 per cent reduction in energy use.¹³

BOMA Best Certified Buildings (Commercial) also show other environmental benefits such as a 52 per cent reduction in water use, 18.7 per cent higher occupancy rate, 7 per cent higher tenant satisfaction score, and a 5.6 per cent higher lease renewal rate¹⁴

Perhaps most significantly, these programs can achieve these emission reductions at a relatively low cost.

What The City will do

The following actions have been identified as critical first steps to improving access to energy consumption information. The key actions are:

Implement building labelling and benchmarking for new and existing buildings

ACTION	PARTICIPATING BUSINESS UNITS
2.1 Develop a residential building labelling program for Calgary	Environmental & Safety Management
2.2 Develop a commercial building benchmarking program for Calgary	Environmental & Safety Management Corporate Analytics & Innovation

¹³ Source: 2017 BOMA BEST National Green Building Report <http://bomacanada.ca/wp-content/uploads/2017/05/2017-NGBR-Full-Report.pdf>

¹⁴ Source: 2017 BOMA BEST National Green Building Report <http://bomacanada.ca/wp-content/uploads/2017/05/2017-NGBR-Full-Report.pdf>

Improve energy literacy and capacity building

ACTION	PARTICIPATING BUSINESS UNITS
2.3 Develop and publish energy consumption information for all stakeholder groups to improve energy knowledge and stakeholder capacity to capitalize on energy efficiency opportunities, and to improve The City GHG reduction program design	Environmental & Safety Management Calgary Building Services
2.4 Partner with ENMAX and other energy retailers to expand the pilot of providing enhanced billing information to residential customers	Environmental & Safety Management

Program 3: Renewable and Low-carbon Energy Systems

Background

Reaching the city's emission reduction goals requires actions beyond increasing energy efficiency. On-site renewable energy systems and district energy systems are important strategies to transition away from fossil fuels. District energy systems, which supply heating and cooling to multiple buildings, can use waste heat and improve overall system performance. Renewables can provide a localized source of low carbon energy.

While energy efficiency measures and programs will be prioritized, replacing conventional energy sources with renewable and low carbon energy sources will eventually be required to meet The City's emissions reduction commitments. Each building owner will need to consider unique financial criteria, whether at the utility scale, neighbourhood scale, or within individual buildings. The City will encourage uptake of renewable and low carbon energy in Calgary by reducing barriers to implementation and supporting informed decision making for investment.

In 2015 to 2016, the Government of Alberta developed the Climate Leadership Plan.¹⁵ This plan focuses on reducing GHG emissions and energy use. Key elements of the plan are:

- Carbon Levy: \$20 per tonne CO₂e (2017), \$30 per tonne CO₂e (2018)
- Financial support for energy efficiency, infrastructure carbon reduction
- By 2030, phasing out emissions from coal-generated electricity, and providing 30 per cent of Alberta's electricity from renewable sources
- The creation of Energy Efficiency Alberta that is providing subsidies for solar installations.

Why is this Priority?

Local and distributed low carbon and renewable energy helps to decrease GHG emissions and energy usage in buildings and neighbourhoods, thereby reducing energy costs and improving local resilience.

Potential emissions reductions and cost savings

Increase the implementation of on-site and neighbourhood scale renewable and low-carbon energy systems ¹⁶				
Total potential GHG reductions to 2050 (Mt)	Total Investment (Billion \$)	Annual Energy Savings (Billion \$)	Total Job Creation Potential (Thousand job years)	Payback period on original investment (Years)
17	7.5	0.27	67	15.0

¹⁵ Source: Province of Alberta Climate Leadership Plan <https://www.alberta.ca/climate-leadership-plan.aspx>

¹⁶ Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report



What The City will do

The following actions have been identified as critical first steps to increase the implementation of renewable and low carbon energy systems. The key action areas are:

Enable the implementation of onsite renewable and low-carbon energy systems

ACTION	PARTICIPATING BUSINESS UNITS
3.1 Develop an approach to ensure large scale developments consider the feasibility of low-carbon energy systems as part of the approvals process including: solar photovoltaics, combined heat and power, and district energy (and other technologies where appropriate)	Community Planning Corporate Analytics & Innovation
3.2 Support the implementation of solar photovoltaics	Environmental & Safety Management Calgary Growth Strategies
3.3 Support the implementation of district energy systems	Community Planning Environmental & Safety Management
3.4 Support the implementation of combined heat and power	Environmental & Safety Management

Support alternative ownership models for renewable and low carbon energy systems

ACTION	PARTICIPATING BUSINESS UNITS
3.5 Support community ownership of renewable energy generation	Environmental & Safety Management

Transportation and Land-use

Where people live, work, and access amenities within Calgary impacts how they choose to get around Calgary. Currently, emissions associated with transporting people and goods account for one third of Calgary's emissions.¹⁷ How we design our neighbourhoods and city have a significant impact on the need for energy to be used in moving goods and people around.

Emissions from the transportation sector come from the use of two main transportation fuels: diesel and gasoline. To reduce these emissions there are three broad approaches: switch vehicle fuels to a cleaner, lower carbon vehicle fuel; switch to transportation modes that use less energy; and build city infrastructure to minimize travel distances.

This theme is organized into three program areas:

- Electric and low-emissions vehicles
- Low or zero-emissions transportation modes
- Land-use and transportation planning

While reducing emissions and energy costs are the primary purpose of this plan, these initiatives can also provide a number of other community benefits. Residents who can meet many of their daily needs by walking, bicycling, or riding transit also benefit from improved health, thriving local business districts, and increased opportunities for diverse housing and jobs.

The details of these programs are outlined below.



¹⁷ Source: The City of Calgary 2017 GHG Inventory

Program 4: Electric and Low-Emissions Vehicles

Background

While many of the Plan's actions support the need to reduce auto travel, cars and freight vehicles will remain part of our transportation system. In addition, the number of transit vehicles and trips will grow. Therefore, it is important that we reduce the impacts of the remaining cars, buses, and trucks through cleaner vehicles and fuels.

The Government of Canada is currently in the process of creating Transportation 2030: Green and Innovative Transportation. Part of this initiative is the creation of a National Zero-Emissions Vehicle Strategy by the end of 2018.¹⁸

Why is this Priority?

Fuel switching for vehicles for both privately-owned and commercial fleets is the most significant opportunity to reduce emissions and energy costs in the transportation sector. Electric and hybrid vehicles are the leading technology for emissions reductions and cost savings for privately-owned vehicles, whereas commercial fleets may shift to renewable diesel, renewable compressed natural gas or electric.

Potential emissions reductions and cost savings

The most cost effective of these actions is shifting private vehicles owners to hybrid and electric vehicles.

Accelerate the shift to low emissions vehicles projections ¹⁹				
Total potential GHG reductions to 2050 (Mt)	Total Investment (Billion \$)	Annual Energy Savings (Billion \$)	Total Job Creation Potential (Thousand job years)	Payback period on original investment (Years)
60.3	59	3.2	291	18.4

What The City will do

The following actions have been identified as critical first steps to increase the implementation of low emissions vehicles. The key action areas are:

¹⁸ Source: NRCan Transportation 2030 <https://www.tc.gc.ca/eng/future-transportation-canada-green-innovative-transportation.html>

¹⁹ Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report

Support and enable the uptake of electric vehicles

ACTION	PARTICIPATING BUSINESS UNITS
4.1 Partner with the private sector and other government agencies to implement local and regional electric vehicle charging infrastructure	Environmental & Safety Management
4.2 Work with the private sector and non-profit organizations to develop an electric vehicle education program for the general public and businesses	Environmental & Safety Management
4.3 Collaborate with the City of Edmonton, the Province, local development industry and utility companies to identify and analyze options to improve access to home charging for electric vehicles	Environmental & Safety Management
4.4 Monitor and provide input to new electric vehicle policies and regulations developed by other orders of government	Environmental & Safety Management
4.5 Streamline municipal and utility processes to support public and private electric vehicle projects and reduce barriers	Environmental & Safety Management
4.6 Partner with post-secondary institutions and the private sector to advance research and field testing of low emission technologies, supporting infrastructure and policy direction	Environmental & Safety Management

Support and enable the uptake of low emissions vehicles in commercial fleets

ACTION	PARTICIPATING BUSINESS UNITS
4.7 Monitor and provide input to new medium- and heavy-duty low emission vehicle policies and regulations developed by other orders of government	Transportation Planning
4.8 Develop a program to support the assessment of alternative fuel technologies for commercial vehicle fleets, and provide education information and emerging regulations from other orders of government	Environmental & Safety Management
4.9 Partner with post-secondary institutions to advance Calgary-specific research into goods movement GHG reduction and energy efficiency actions and supportive policies	Environmental & Safety Management

Program 5: Low or Zero-emissions Transportation Modes

Background

There are many choices for Calgarians to get around Calgary. It is The City's responsibility to provide transportation infrastructure for Calgarians that is convenient, affordable, attractive and safe. High quality transit, bike, pedestrian and car-pooling networks provide the underlying backbone of a low carbon transportation system. In recent years, The City has made much progress in this area. By continuing to prioritize safety, accessibility, and mobility for people to allow walking, cycling, and transit we can meet the needs of a growing population while significantly reducing emissions.

Why is this Priority?

Shifting Calgarians out of single-occupancy vehicles to lower or no emissions transportation modes is a key opportunity to reduce emissions. This strategy encompasses actions to directly shift Calgarians out of vehicles, or could more indirectly achieve this strategy through the development of higher-density complete communities.

Potential emissions reductions and cost savings

It is important to note that all Council approved actions in this sector such as the Calgary Transportation Plan, Route Ahead, the Cycling Strategy and the Pedestrian Strategy are included in the baseline calculations for this report. The potential GHG reductions for the aforementioned Council approved low or zero-emissions transportation modes are 15 Mt CO₂e by 2050.²⁰

Accelerate the shift to low or zero-emissions transportation modes ²¹	
Actions Beyond Council approved actions (Municipal Development Plan, Calgary Transportation Plan, Route Ahead, Cycling Strategy, Pedestrian Strategy included in the baseline projections)	Total potential GHG reductions to 2050 (Mt)
Expansion of Transit (25 per cent coverage)	2.1
Carpooling	0.7
Expanded non-motorized transport (biking and walking)	0.2
Total Potential	3.0

²⁰ Source: 2011 PlanIt Calgary & Calgary Metropolitan Plan Scenario Series report by Transportation Planning (Forecasting)

²¹ Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report



What The City will do

The following actions have been identified as critical steps to shifting Calgarians to low or zero-emissions transportation modes. It should be noted that these actions have been previously approved by Council through the following strategies: Step Forward, Cycling Strategy, Complete Streets and Route Ahead Strategy. The actions are reiterated here to demonstrate the alignment with the climate change objectives of the Mitigation Action Plan. The key actions are:

Enable increased walking and cycling

ACTION	PARTICIPATING BUSINESS UNITS
5.1 Continue to implement Step Forward, the Cycling Strategy and Complete Streets	Transportation Planning
5.2 Enhance the safety and accessibility of walking and cycling for all citizens	Transportation Planning Calgary Transit Parks Roads Urban Strategies
5.3 Support the utilization of new and innovative bicycle technologies and programs	Transportation Planning

Enable increased use of Calgary Transit

ACTION	PARTICIPATING BUSINESS UNITS
5.4 Continue to implement the RouteAhead 30-year strategic plan for Calgary Transit	Calgary Transit Green Line
5.5 Coordinate with regional transit partners to make transit service a more viable choice for regional travel	Calgary Transit
5.6 Enable transit oriented development along the Green, Red and Blue LRT lines	Planning & Development Real Estate & Development Services
5.7 Increase implementation of transit priorities and yield-to-bus measures	Calgary Transit

Enable increased use of ride-sharing, car-pooling, and working from home

ACTION	PARTICIPATING BUSINESS UNITS
5.8 Support businesses and the development industry to implement transportation demand management plans in new and existing communities or buildings	Transportation Planning
5.9 Monitor demand for loading or special parking zones for commercial vehicles as well as demand for special parking zones for rideshare services	Transportation Planning Calgary Parking Authority
5.10 Pilot partner ships with alternative mobility providers to provide mobility services	Calgary Transit
5.11 Develop a high occupancy vehicle strategy to support high-occupancy vehicles and buses, as well as consideration of electric vehicles	Transportation Planning

Program 6: Land-use and Transportation Planning

Background

How we design our neighbourhoods has a significant impact on the energy needed to move goods and people around Calgary. The City can tailor plans and policies for existing and future neighbourhoods to reduce the impact of emissions and energy consumption. Through the policies of the Municipal Development Plan (MDP) and the Calgary Transportation Plan (CTP), it is possible to build low carbon planning into land uses and transportation system.

Why is this Priority?

Planning and policy decisions on land use, transportation, city infrastructure and services can exacerbate emissions and energy consumption in Calgary. Integrating climate change considerations into land-use and transportation planning decisions, strategies, plans and processes plays a crucial role in understanding the impacts of development in relation to emissions and energy use.

Potential emissions reductions and cost savings

It is important to note that all Council approved actions in this sector such as the MDP are included in the baseline calculations for this report. By 2050, if The City were to adhere to maintaining the MDP targets, Calgary could avoid 12 Mt of emissions, save \$20 Billion dollars in avoided infrastructure costs and reduce energy bills by \$91 Million annually.²² The savings outlined in the table will be realized if we go beyond the current targets in the MDP.

Integrate climate change considerations into land-use and transportation planning and development decisions, strategies, plans and processes (beyond the current MDP) ²³		
Total potential GHG reductions to 2050 (Mt)	Net Savings in Infrastructure (Billion \$)	Annual Energy savings (Billion \$)
7	9	0.046

²² Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report

²³ Source: University of Leeds and University of Calgary, The Economics of Low Carbon Development: Calgary Report

What The City will do

The following actions have been identified as critical first steps to achieve GHG reductions in land-use and transportation planning. The key actions are:

ACTION	PARTICIPATING BUSINESS UNITS
6.1 Incorporate policies regarding climate risks and greenhouse gas reductions that may impact land use development and transportation infrastructure or services into the update of the Municipal Development Plan and Calgary Transportation Plan	Calgary Growth Strategies Transportation Planning
6.2 Develop methodologies to integrate GHG reduction potential into growth management decisions and transportation assessments	Calgary Growth Strategies Transportation Planning
6.3 Investigate the impact of disruptive transportation technologies on Calgary's transportation GHG emissions	Transportation Planning

Consumption and Waste

The waste we create and how we dispose of it can have a significant impact on GHG emissions. Currently, our GHG inventory only accounts for methane emissions from our waste and wastewater facilities, which accounts for about 1 per cent of the GHG emissions in Calgary.²⁴ However, there are GHG emissions that are embedded in the products that we use and dispose of in Calgary. We don't currently measure these emissions, but based on analysis from other cities, embedded emissions could double the emissions that we account for in our inventory.

Recognizing that “you can't manage what you don't measure”, this theme is focused on improving Calgary's measurement of consumption-based emissions, and reducing the creation of waste in the first place. Once waste creation has been minimized as much as possible, this theme area also aims to divert as much waste from our landfills as possible, particularly organic waste.

In recent years, The City has taken significant action in reducing GHG emissions from the waste sector by implementing a series of programs and actions surrounding waste reduction, recycling, GHG capture and composting. This plan aims to strengthen its commitment to reduce GHGs associated from waste emissions while starting to consider the embodied GHGs from the goods and services we consume.

Actions in this theme are organized into two key programs:

- Reduce overall consumption and waste generation
- Waste management to minimize greenhouse gas emissions

Each program is explained in further detail below.



²⁴ Source: The City of Calgary 2017 GHG Inventory

Program 7: Consumption and Waste Reduction

Background

Traditionally, climate change mitigation plans address waste emissions (i.e., methane) by capturing or managing the emissions once they are created. This program attempts to take a more proactive approach to reducing these emissions by reducing the amount of waste that is created in the first place.

While recycling and composting are helpful steps in reducing emissions associated with the things we buy, these actions only reduce disposal emissions. The majority of GHG emissions are generated before we even purchase the products. To achieve emissions reduction goals, The City's goal is to better understand the role of individuals, businesses, governments, and other organizations to make more sustainable purchasing, production and conservation decisions.

The City uses the international standard for GHG accounting called "The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories," or the GPC. This Protocol was developed in partnership by World Resources Institute, C40 Cities Climate Leadership Group and International Council for Local Environmental Initiatives (ICLEI), and provides a robust and clear framework for calculating and reporting community-wide GHG emissions.²⁵

Currently, The City reports scope 1 emissions (GHG emissions from sources located within the city boundary) and scope 2 emissions (GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and cooling within the city boundary), but does not track or report scope 3 consumption-based emissions (such as emissions from the production of goods used in Calgary, but manufactured elsewhere, or the emissions due to shipping goods to Calgary). A relatively small amount of GHG emissions come in the form of methane emissions from landfills.

Within the North American context, the City of Portland has been the first city to publish a consumption-based emissions inventory.²⁶

Why is this Priority?



²⁵ Source: GHG Protocol for Cities http://www.ghgprotocol.org/sites/default/files/ghgp/standards/GHGP_GPC_0.pdf

²⁶ Source: Portland 2015 Climate Action Plan <https://www.portlandoregon.gov/bps/article/531984>

Consumption-based emissions (scope 3) have not been quantified or included in previous climate mitigation plans. However, this is a growing area of focus in leading municipalities, and based on initial research has the potential to represent a significant portion of Calgary's overall emissions. In Portland, Oregon, a consumption-based inventory doubled the total overall emissions in the inventory.²⁷

Waste reduction and waste management is a core service that The City is responsible for providing to citizens. There are existing services that can further integrate GHG emissions considerations into how we minimize and manage waste in Calgary.

What The City will do

The following actions have been identified as critical first steps to reducing overall consumption and waste. The key actions are:

Reduce total waste generation in the residential and commercial sectors

ACTION	PARTICIPATING BUSINESS UNITS
7.1 Quantify the composition, scale and impact of consumption and waste on GHG emissions in Calgary	Environmental & Safety Management Waste & Recycling Services
7.2 Implement a “pay-as-you-throw” black cart program for residential waste	Waste & Recycling Services
7.3 Investigate options and develop a strategy for significantly reducing avoidable plastic waste and single-use items	Waste & Recycling Services
7.4 Work with the province to move forward extended producer responsibility regulations	Waste & Recycling Services
7.5 Focus on waste reduction in education programs for waste management	Waste & Recycling Services

²⁷ Source: Portland 2015 Climate Action Plan <https://www.portlandoregon.gov/bps/article/531984>

Improve access to local food

ACTION	PARTICIPATING BUSINESS UNITS
7.6 Review CalgaryEATS! Food Action Plan with enhanced climate resilience lens and develop a Food Resilience Plan	Calgary Growth Strategies
7.7 Conduct systems-level research on climate impacts across range of food systems activities and identify critical linkages among systems components and processes	Calgary Growth Strategies
7.8 Work with Provincial and Federal Governments and the private sector on a multi-level approach to climate programs and policies as it relates to food systems	Calgary Growth Strategies
7.9 Raise awareness of, and address, food loss and disposal to reduce wasted food	Calgary Growth Strategies
7.10 Promote urban and regional food production and support farmers through programs and policy	Calgary Growth Strategies
7.11 Review and update City and institutional food procurement policies	Calgary Growth Strategies
7.12 Support the regionalization and diversification of food supply chains	Calgary Growth Strategies

Program 8: Waste Management to Minimize Greenhouse Gas Emissions

Background

As part of achieving our GHG emission reduction targets, our aim is to remove as much as possible GHG emissions from the waste sector. The City's goal is to avoid landfilling all recyclables, discarded food and yard organic materials, where possible. Methane is an extremely potent greenhouse gas that is produced when organic waste decomposes in anaerobic conditions. In a municipal context, methane is generated from solid waste in landfills and in wastewater treatment.

Calgary's landfills and wastewater treatment facilities represent 1 per cent of city emissions.²⁸ While emissions from solid waste and wastewater are the result of citizens' activities in the wider community, The City has ownership and operational control over the waste handling facilities. There are opportunities to work with the citizens of Calgary to reduce waste before it gets into the collection and landfill stream, and to convert waste streams into value-added end products such as compost and biogas for use at our facilities. The actions that relate directly to the management of City-owned water and wastewater facilities have been detailed in the Leadership theme.

Why is this Priority?

Methane is an extremely potent greenhouse gas generated by Calgary's waste management and wastewater facilities that is reported annually in Calgary's GHG Inventory. In addition to existing mitigation efforts to reduce the environmental risk of these emissions, further reduction of organic waste disposed of in the landfills can minimize methane generation.

²⁸ Source: The City of Calgary 2017 GHG Inventory



What The City will do

The following actions have been identified as critical first steps to reducing methane emissions from landfills. The key action is:

ACTION	PARTICIPATING BUSINESS UNITS
8.1 Continue to educate and support Calgarians to divert organic waste away from landfills through the Residential Green Cart Program, the disposal surcharge rates at City landfills, and as required for all industrial, commercial, and industrial organizations under The City's bylaws.	Waste & Recycling Services

Natural Infrastructure



This theme focuses on gaining a greater understanding of the mitigation value of the natural environment in Calgary. It is important that this effort be conducted in unison with climate change adaptation work in order to gain a better understanding on the environmental stresses on our local environment, while building knowledge and expertise in areas that will deliver opportunities for better holistic management of our natural systems.

There is one program in this theme area:

- Conserve and manage green spaces and natural areas to support climate change mitigation

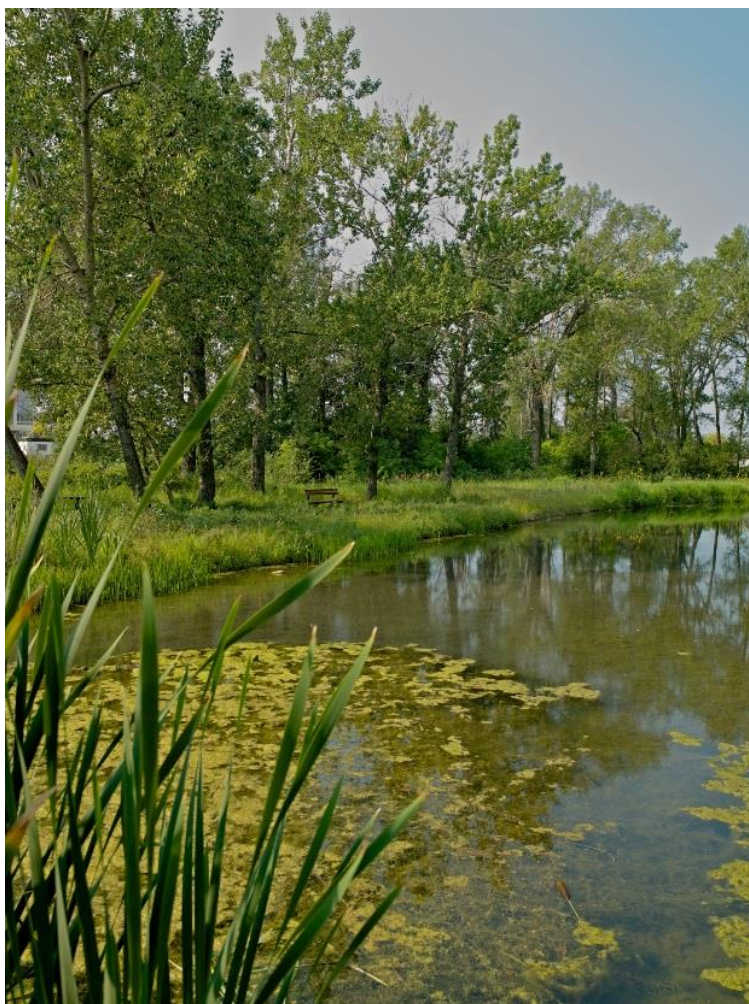
The details of this program are outlined below.

Program 9: Green Spaces and Natural Areas to Support Mitigation

Background

Natural assets include wetlands, river banks, trees and other 'green' infrastructure that provide similar services to hard infrastructure. In addition to providing a critical role in preparing for climate change, trees and other green infrastructure help by sequestering carbon dioxide and reducing building energy use through cooling and shading in summer and lessening heat loss in winter.

Protecting and maximizing the use of these natural assets can also offset costly investments in new hard infrastructure by absorbing emissions and providing additional benefits that reduce energy consumption within Calgary.



Why is this Priority?

The greenhouse gas impact of the disruption of our natural systems has not been previously included in Calgary's GHG mitigation plans. It is becoming an increasingly important area for consideration, as the conservation of natural areas, the restoration of disrupted systems, and the types of developments we permit in our city will directly impact the potential of these systems to act as a carbon sink, and to provide other environmental benefits.

The aim of these actions is to coordinate efforts across multiple City Business Units to develop processes to conserve and understand the mitigation properties of The City's natural assets in conjunction with the climate change adaptation work.

What The City will do

The following actions have been identified as critical first steps to valuing our natural systems. The key actions are:

ACTION	PARTICIPATING BUSINESS UNITS
9.1 Develop a methodology to quantify the value of natural systems (i.e., parks, riparian areas, natural areas, urban forest, etc.) as a greenhouse gas sink, and incorporate into our annual GHG inventory reporting	Environmental & Safety Management
9.2 Develop a formal working group to increase understanding of The City's natural assets for City staff and external stakeholders, including the integration of climate change mitigation considerations	Environmental & Safety Management
9.3 Incorporate the value of natural systems as a greenhouse gas sink into triple bottom line analysis and other business processes where necessary	Water Utility
9.4 Incorporate climate change mitigation considerations into existing strategies	Parks Water Utility
9.5 Remove regulatory policy barriers that prevent the effective conservation of wetlands in the city	Parks
9.6 Continue to promote the restoration of native habitat and naturalization of existing open space to augment the ability of Parks and Open Spaces to sequester carbon	Parks
9.7 Collaborate with the Province to develop a carbon offset program for natural systems	Environmental & Safety Management

Leadership



Demonstrating leadership is a critical role for The City. Leadership can take the form of setting an example through actions, providing information and education, or by enabling innovation and collaboration.

There is one program in this theme area:

- The City of Calgary as a leader in climate change mitigation

The details of this program are outlined below.

Program 10: The City of Calgary as a Leader in Climate Change Mitigation

Background

The City of Calgary has a responsibility to “walk the talk” on climate change mitigation. We cannot expect citizens, business or other stakeholders to take action without demonstrating our commitment to action. This leadership program is focused on demonstrating how The City of Calgary is leading by example in our own operations, improving The City of Calgary’s communication and engagement on climate change mitigation, as well as enabling innovation and collaboration with citizens and the private sector.

Why is this Priority?

We consistently heard from stakeholders that demonstrating leadership should be a top priority for The City of Calgary. The City is not able to achieve our climate change mitigation targets through our own activities. This Strategy is designed to better communicate climate change information and education, and to improve collaboration opportunities between The City and the private sector. This includes implementing and raising the profile of pilot projects, and creating structures to invite industry collaboration.

What The City will do

The following actions have been identified as critical first steps to demonstrating leadership on climate change mitigation. The key actions are:

Lead by example in our operations

ACTION	PARTICIPATING BUSINESS UNITS
10.1 Demonstrate leadership in the construction, operations, and maintenance of City-owned buildings, facilities, infrastructure and fleet to minimize GHG emissions by continuing the implementation of the Corporate Energy Plan 2016-2026	Corporate Analytics & Innovation Transportation Department Water Utility
10.2 Demonstrate leadership by installing low-carbon and renewable energy systems at City facilities and land	Corporate Analytics & Innovation Water Utility
10.3 Update the Corporate Energy Plan to fully integrate corporate GHG management, and establish a Corporate Energy and Emissions Plan	Corporate Analytics & Innovation Environmental & Safety Management
10.4 Evaluate and incorporate fully-electric, electric hybrid, and other low carbon vehicle technologies into City fleets and facilities	Environmental & Safety Management Corporate Analytics & Innovation Calgary Transit Fleet Services Waste & Recycling

Become a trusted source for Calgarians to access leading climate change mitigation information and education

ACTION	PARTICIPATING BUSINESS UNITS
10.5 Develop and implement a comprehensive climate change education program	Environmental & Safety Management
10.6 Integrate climate messages into existing City of Calgary public education programs	Environmental & Safety Management
10.7 Establish targeted and relevant communications material for key stakeholder groups	Environmental & Safety Management

Establish support and resources to enable innovation and collaboration by citizens, businesses, and other stakeholders

ACTION	PARTICIPATING BUSINESS UNITS
10.8 Develop and implement a public engagement plan to support the implementation of the Climate Resilience Strategy, the Mitigation Action Plan and the Adaptation Action Plan	Environmental & Safety Management
10.9 Establish resources to enable citizens to take action	Environmental & Safety Management
10.10 Develop a program to support large industrial energy users	Environmental & Safety Management Calgary Building Services Corporate Analytics & Innovation
10.11 Establish a structure and resources to enable innovation between The City and the private sector	Calgary Approvals Environmental & Safety Management
10.12 Establish a structure to ensure ongoing collaboration between The City, the private sector and academia	Environmental & Safety Management
10.13 Identify additional funding opportunities to support implementation of actions in the Mitigation Action Plan	Environmental & Safety Management

CHAPTER 4: PLAN IMPLEMENTATION AND NEXT STEPS

Implementation

Climate change mitigation is a continuous process, with this plan acting as a starting point for The City. Successful implementation will require participation and engagement across all business units/service lines, as well as collaboration with community stakeholders in order to successfully achieve Calgary's climate resilience objectives. The Climate Mitigation Action Plan is a 'living document' where future revisions of the plan are improved by accounting for new economic realities, new and improved technologies and overall ambition on reducing emissions.

The business units identified as accountable for actions in the Plan will be leading the action implementation. The Climate Program will provide coordination among business units and deliver on selected actions on behalf of Environmental & Safety Management that are identified in the Plan. Details and prioritization of the actions may change to reflect emerging challenges and opportunities, as well as funding made available through different levels of government or partnership with the private sector and institutions.

The effectiveness of the plan implementation is dependent on the extent to which the emissions reductions and plan actions are incorporated into existing plans, policies, standards and programs. Unplanned or disruptive changes and unforeseen circumstances will also shape our approach, including technological advancements, energy price changes, grant funding, which will all be considered in future recommendations and updates as well.

Updating the Climate Mitigation Action Plan

The City should review and evaluate the effectiveness of the Climate Mitigation Action Plan every four years to guide business planning and budget decisions, incorporating the advancements in reducing GHGs and an evaluation of the effectiveness of recommended actions. This revision cycle will also satisfy the Provincial Government's requirements for updates every five years. The review and evaluation should include:

- a summary of any observed or projected changes in emissions,
- a report on successfully implemented actions,
- a dashboard on implementation progress of the ten programs,
- proposed revisions to the mitigative actions or programs given updated trends and projections,
- identification of the economics of reducing emissions,
- potential new funding sources for mitigative projects, and
- updated tracking of progress on the GHG targets to 2050.

Monitoring and Reporting

Progress on the Climate Mitigation Action Plan will be reported annually. This report will be presented to Council, and will be publicly reported through the Carbon Disclosure Project.²⁹

The primary metrics used to evaluate The City's progress towards climate mitigation will be:

- impact on energy efficiency as an indicator of effective resource use,
- reduction in GHG emissions, and
- cost of energy in relation to the alternatives in Calgary.

These metrics may be used at a community or project level, and in combination or separately, depending on action being pursued. Some actions will be challenging to report on, primarily when the alternative outcome is unknowable, or the life cycle costs are estimated over a long period. Specific metrics will need to be developed for some actions to adequately report on results.

²⁹ The City of Calgary has been reporting annually to the Carbon Disclosure Project since 2014. This is a publicly-accessible portal to report on greenhouse gas emissions and climate risks, and the climate mitigation and actions The City of Calgary has taken. <https://www.cdp.net/en>



UCS2018-0688
Attachment 1



Climate Adaptation Action Plan for Calgary

Attachment 2

EXECUTIVE SUMMARY

Climate has a major influence on the way we live and Canadians and Calgarians have had plenty to “weather” as of late. In response, Calgary and cities around the world are focusing on developing policies, programs, infrastructure designs and leadership strategies to increase the climate resilience of their natural, built, socio-economic, political and administrative systems.

Climate adaptation is the process and actions to manage the actual and projected climate impacts and risk to reduce the effects on built systems, the natural environment and people. A key purpose of the Climate Adaptation Action Plan is to provide direction for The City of Calgary (The City) on how to address climate change impacts in the context of uncertainty. The Adaptation Action Plan is an essential document for communicating The City’s understanding of climate change and its commitment to improving climate resilience to protect local citizens, the environment, and the economy.

A vulnerability and risk assessment was conducted to provide the basis for City business units to identify the adaptive actions necessary to build climate resiliency for their infrastructure, operations and services. City business units identified a series of actions that should be implemented to manage the climate risks for Calgary. The wide range of actions are grouped into a series of five themes that reflect the interdisciplinary and comprehensive nature of climate change adaptation. Within each theme, two-to-three programs have been designed to ensure alignment and coordination of actions and outcomes.

Climate change adaptation is a continuous process, with this plan acting as a starting point for Calgary. The majority of the actions in the Climate Adaptation Action Plan should be initiated within the next business cycle 2019-2022, except ongoing actions that are already underway. Successful implementation will require participation and engagement across all business units/service lines, as well as collaboration with community stakeholders in order to successfully achieve Calgary’s climate resilience objectives.

The Climate Adaptation Action Plan will be updated every four years, in advance of each City business planning and budget cycle, with ongoing monitoring occurring between updates.

CLIMATE CHANGE ADAPTATION ACTION PLAN OUTCOMES SUMMARY

A total of 175 adaptation actions that should be initiated over next five years (2018-2022) have been identified by City business units. These actions are grouped into a series of five themes that reflect the interdisciplinary and comprehensive nature of climate change adaptation. Within each theme, two-to-three programs have been designed to ensure alignment and coordination of actions and outcomes.

The following table summarizes the outcomes for each program area:

Theme	Program Outcomes
 People: A city where people can thrive: Reducing Calgarians' vulnerability to the impacts of climate change	Air Quality Management - Reduced airborne emissions in Calgary from high-impact sources - Updated management plans to respond to high risk air quality events. Extreme Heat Management - Extreme heat management plans and actions are in place to support citizens and outdoor city workers. - Priority locations are identified for implementation of cooling and shading infrastructure or programs. Staff and Citizen Outreach - The City staff, Civic Partners, citizens and businesses have the resources they need to take action on climate change, enabling Calgary to adapt to more extreme weather events and long term climatic changes
 Infrastructure: The backbone of the city Strengthening the built environment to 'weather the storms'	Backup Power for Critical Infrastructure - The City staff has identified the infrastructure that is most essential for continuity of service delivery - Back-up power requirements of these mission critical City facilities have been prioritized based on a climate change vulnerability assessment - Specific upgrades, new backup power systems, or plans to provide mobile power in response to power outages, have been identified in collaboration with partners Design Standards and Practices - Expansion and maintenance of detailed climate data to inform infrastructure design decisions. - Updated design guidelines and practices across City business units, including infrastructure design specifications, building code and other City guidelines



Natural Infrastructure:

The root of resilience

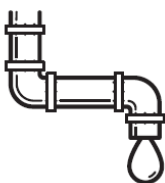
Maximizing the services provided by natural systems

Natural Assets Management

- A coordinated approach to conserve and enhance natural assets as part of The City's ongoing asset management processes
- Management and protection of natural assets and systems, such as soils and stormwater

Natural Assets Adaptation

- Increased number of healthy, well adapted natural assets in Calgary
- Updated planning and development practices for soil and vulnerable locations such as river banks and flood prone areas



Water Management:

Every drop counts

Preparing for increasing risks of flooding, drought and declining water quality

River Flood Management

- Enhanced long-term vision for flood resilience in Calgary to reflect changing climate conditions
- Aligned land use planning processes with flood risks and management practices

Stormwater Management

- Assessed design guidelines for stormwater management to deal with more intense summer storms.
- Flood warning systems and response plans in place to address more frequent localized flooding situations.

Long Term Water Supply

- Advanced drought management and response plans to manage the risk of declining water supply
- Strategic investments in water supply infrastructure and water demand management programs.



Governance:

Pro-active leadership

Preparing for our climate-altered future through collaborative decision making

Budgeting and Investment Priorities

- Leaders and project managers are aware of climate change risks and potential resilience solutions
- Corporate and departmental risk management and budgeting processes explicitly include climate change resilience criteria

City Planning and Processes

- City plans and policies ensure that communities, neighbourhoods, infrastructure and services are designed to respond to anticipated climate changes

Severe Weather Response and Recovery Management

- Systematically updated disaster risk reduction strategies that consider how climate change will increase the frequency and severity of extreme weather events
- Civic Partners are supported by The City in developing their own response and recovery plans

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Chapter 1 – Climate Adaptation

The Climate Resilience Strategy identifies a series of guiding principles that requires City policies and programs consider climate resilience (mitigation and adaptation) into all decision-making process. This will include service delivery, infrastructure, purchasing decisions and The City's regulations and policies.

The City has a long history of taking actions to reduce greenhouse gas (GHG) emissions, as well as adapting to climate change. The City's Climate Resilience Strategy continues this legacy of action by establishing a coordinated approach for City business units to act directly or to enable citizens and businesses to make Calgary a more climate resilient city. To become climate resilient, ambitious actions are required both to adapt to climate impacts, and to limit emission of greenhouse gases.

Mitigation and adaptation actions need to be designed to mutually benefit each other, as effective mitigation can reduce climate impacts and therefore reduce the level of adaptation required by communities. Many adaptation actions also help to mitigate climate change, such as natural infrastructure, naturalization of green spaces, neighborhood scale renewable energy generation, etc.

It is important to be aware that there is a significant time lag between mitigation activities and their effects on climate change. If not well planned, mitigation and adaptation measures can conflict with each other. An example would be air conditioning, which can help people to cope during a heat wave, but also increases energy use that in turn can increase energy use and GHG emissions.

Current Climate Adaptation Activities

In addition to the actions identified in this Climate Resilience Strategy, some adaptation initiatives are already underway at The City. They have not typically been called adaptation activities, but have been funded and actioned in large part to the recognition and pressures of a changing climate. Examples of such activities, broken down by the 100-Resilience Framework used by The City, include:

100-Resilience Framework Categories	Projects
Infrastructure & Environment	• Flood mitigation and resiliency initiatives • Assessments of local ecology and biodiversity • Asset management and assessment, including previous work using the Engineers Canada PIEVC protocol • The City's energy efficiency initiatives • Ongoing work to better monitor weather and climate for operational applications such as high winds
Leadership & Strategy	• The City's Resilience Program • Business continuity planning • Coordinated emergency response planning and resourcing by Calgary Emergency Management Agency (CEMA)

	Ongoing corporate and environmental risk management processes
Economy & Society	- Community networks of service providers and coordination of social services - Public and partner engagement on emissions reduction and adaptation - Expert stakeholder engagement on the Climate Mitigation Action Plan
Health & Wellbeing	Participation in regional air quality management programs (e.g. Calgary Region Airshed Zone (CRAZ) Board)

Direction from Other Orders of Government

The Cities of Calgary and Edmonton have negotiated City Charters with the Government of Alberta. The City Charter is a legislative framework that gives the two cities greater flexibility and authority on a range of issues from simple administrative efficiencies to complex regulatory changes. Climate Change has been a specific focus of the Charter negotiations for the environment and energy policy areas. The Charter made the development of climate change mitigation and adaptation plans mandatory for the cities of Calgary and Edmonton. The plans must be established by December 31, 2020 and a review of the plans is required at least once every five years.

The Federal Government released the Pan-Canadian Framework on Clean Growth and Climate Change in 2016. The Framework includes a high-level discussion on climate change adaptation for Canada as a whole. The City will monitor Federal projects and subsequent guidance or direction that should be implemented at a municipal level.

Targeted Stakeholder Engagement

Development of the Climate Adaptation Action Plan was conducted by The City's Climate Program, housed within Environmental & Safety Management (ESM) business unit, with other stakeholders within The City. The following business units participated directly in the development of The City's climate adaptation actions, including development of actions specific to their areas of responsibility that will help to address the climate impacts projected for Calgary.

Environmental & Safety
Management (ESM)
Calgary Approvals
Coordination
Calgary Building Services
Calgary Emergency
Management Agency
Calgary Growth Strategies
Calgary Fire Department
Calgary Housing

Calgary Parks
Calgary Neighborhoods
Calgary Recreation
Calgary Transit
Community Planning
Corporate Analytics &
Innovation
Facility Management
Fleet Services
Finance

Fleet Services
Infrastructure & Resilience
Information Technology
Law
Roads
Transportation Infrastructure
Transportation Planning
Water Resources Water
Services
Waste & Recycling Services

Chapter 2 – Climate Risks for Calgary

Why Climate Adaptation?

Climate change has become one of the defining issues of our time, given the effect communities across the country continue to experience, from more extreme heat waves to increased winter storms and flooding, to advancing invasive species and vector borne diseases. In response to these changes, cities and countries around the world are focusing on developing policies, programs, infrastructure designs, and leadership strategies to increase the climate resilience of natural, built, socio-economic, political and administrative systems.

The most recent international effort to agree on climate change actions and GHG reduction targets occurred at the 2015 Paris conference (COP21). The voluntary GHG reduction commitments made by nations, shown in Figure 1, would result in average global temperature increase of approximately 3.5°C by the year 2100. This is well above the Paris Agreement's aim to keep global temperature rises this century well below 2.0°C above pre-industrial levels. Right now, global GHG emissions are trending along the highest 'No Action' line, which is projected to result in an increase of 4.5°C by 2100.

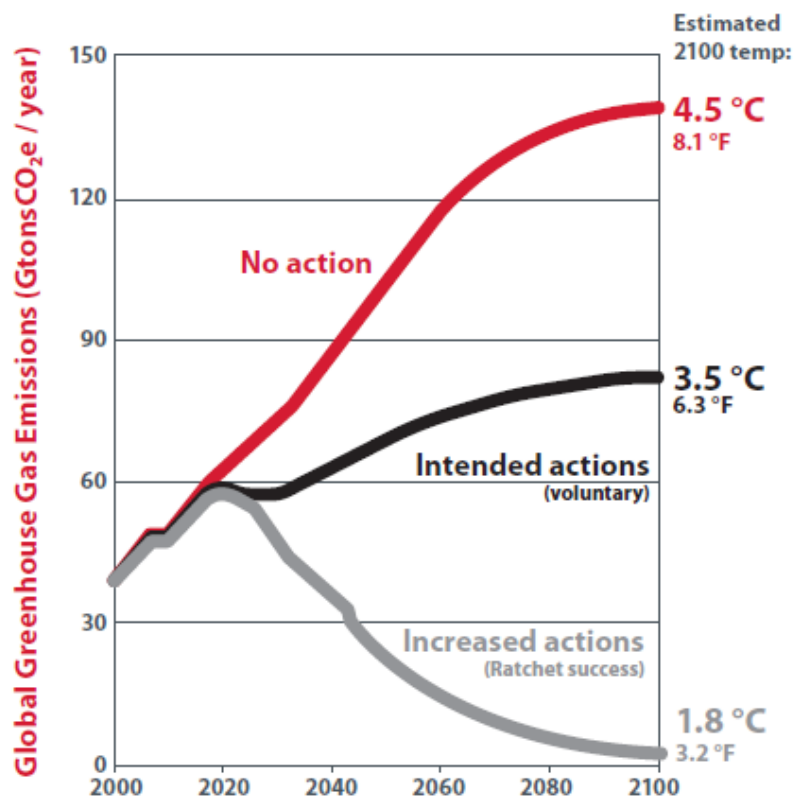


FIGURE 1 – GREENHOUSE GAS EMISSIONS (FRIEDLINGSTEIN ET AL. 2014)

Adaptation is not a new concept, Canadians have developed many approaches to deal with an extremely variable climate. For example, communities in the prairie provinces have already been designed to withstand extreme differences in seasonal temperatures. However, the

amount and rate of climate change is posing new challenges. Climate science now allows communities to anticipate a range of new and more extreme climate conditions, and therefore take action before the worst impacts are incurred.

Temperature increases for Calgary are projected to be higher than the global average, as northern regions are warming faster than the rest of the globe. Calgary is already facing more extreme and frequent severe weather events, and needs to pro-actively adapt to further changes.

In order to understand the specific impacts on Calgary, The City completed a vulnerability and risk assessment to analyze the major climate and weather changes expected over the next 30 to 60 years. The assessment used a combination of literature-based research, projections based on the latest climate projection models, input from City business units and analysis of local climate data.

Calgary's Key Climate Risks

Figure 2 illustrates the projected climate and extreme weather risks identified for Calgary through the vulnerability and risk assessment process with statistical data. Risks further to the right are projected to occur more frequently (higher likelihood), while the ones closer to the top will have more significant impacts on people, infrastructure, services and natural systems (higher consequence).

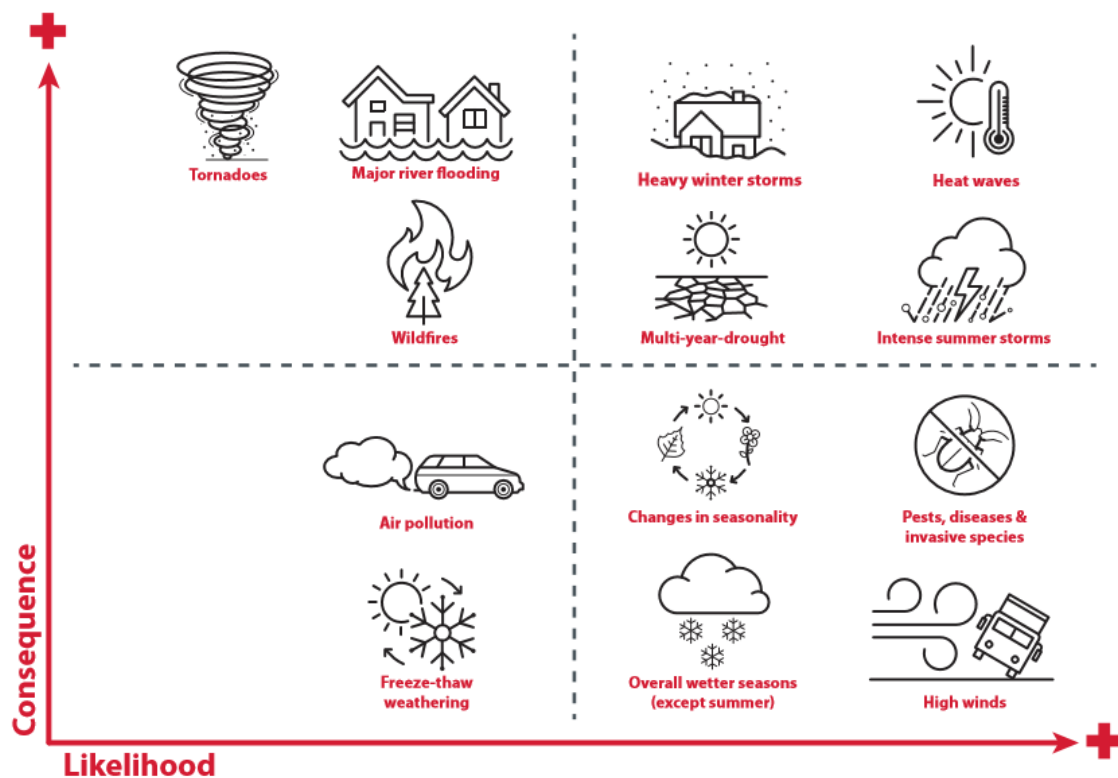


FIGURE 2 - CALGARY'S CLIMATE RISKS

For most of these climate risks, the likelihood or consequence will be worse in the decades to come than experienced in Calgary today.

The likelihood of each climate risk was determined through an evidence-based risk assessment process, which determined the annual frequency of an event occurring in two future time periods (centred on 2050 and 2080). The consequence of each climate risk was calculated based on The City data and staff input for the following five categories:

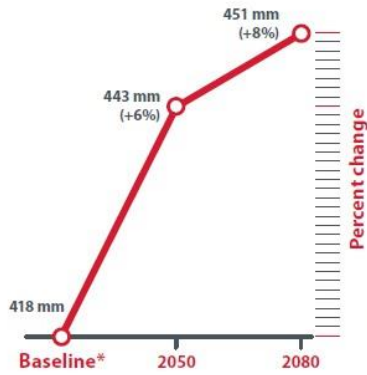
- **City asset damage** – based on an analysis of the infrastructure that would be affected by each climate risk, using historic data when available
- **City service disruption** – based on an analysis of The City services that would be affected by each climate risk, using historic data when available
- **Environmental effects** – based on the loss of rare or endangered species, transformation of landscapes and productive habitat, reduction in water supply, and decrease in water and air quality
- **Community effects** - considered access to services and community assets, along with community macroeconomic losses
- **Human health & safety (public and occupational)** - used a modified version of the disability adjusted life year (DALY) approach to determine the relative health impact of different risks

Each of the climate and extreme weather risks from Figure 2 are described in more detail below.

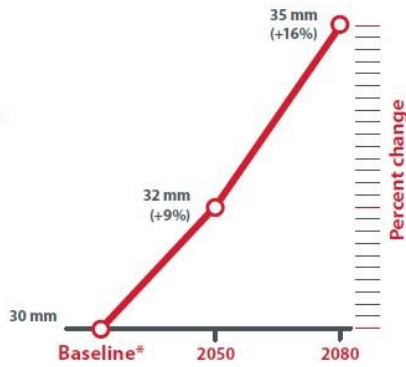
Projected Climate Changes for Calgary

To guide the development of the climate adaptation risks, and resulting actions, forty Global Climate Models were used to provide a highly robust characterization of the uncertainty in future projections of the high emission scenario (Representative Concentration Pathway 8.5) given the current path. Each of the Global Climate Models is a different representation of the physical processes that govern earth-atmosphere interactions (i.e., different models have different mathematical formulas and frameworks for representing physical processes). This approach was selected based on guidance from the Intergovernmental Panel on Climate Change, which suggests that, where possible, the maximum number of models should contribute to an ensemble. Projected changes for six climate variables for Calgary are shown below. These provide an indication of the impacts in the 2050s and 2080s.³⁰

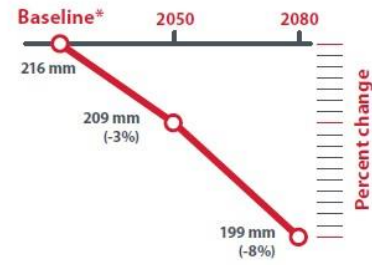
³⁰ Source: *Climate Change Adaptation Research: Vulnerabilities, Risks and Adaptation Action, Technical Report*. Prepared for the City of Calgary by WaterSMART Solutions Ltd., June 2017.



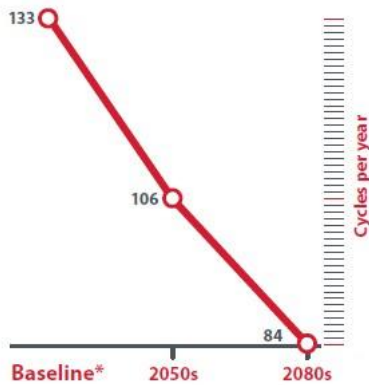
Annual precipitation



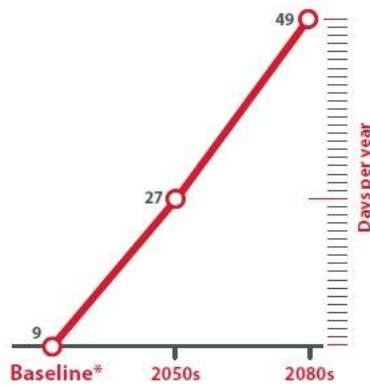
Winter precipitation



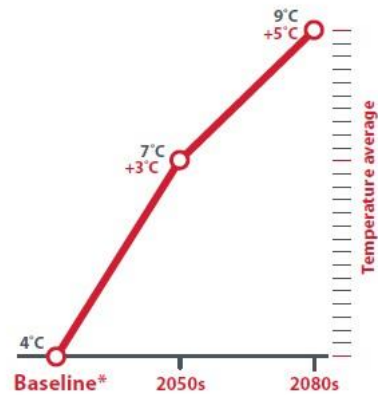
Summer precipitation



Freeze-thaw cycles



Hot days $29^{\circ}\geq$



Annual average

HIGH LIKELIHOOD, HIGH CONSEQUENCE RISKS

Heat Waves



Description: Days with temperature greater than or equal to 29°C.

Impact: Climate change will significantly impact the frequency, duration, and intensity of heat waves in Calgary. This may increase heat-related illnesses and fatalities, especially for outdoor workers, people with health conditions, children

and seniors. Heat waves can also result in increased electricity demand for cooling, which can lead to brownouts during periods of peak demand, further increasing health risks. Additional impacts include reduced ground-level air quality, reduced water quality, increased odours from waste and waste facilities, and heat-expansion damage to steel structures and infrastructure such as rail tracks and roadways.

Heat Days will increase from 9 per year to an average of 27 days by the 2050s.

Examples: In 2017 Environment Canada issued several heat warnings during the summer months. During the prolonged heat waves in British Columbia (July 2009) and in Quebec (July 2010), public-health officials stated that there were an estimated 156 and 280 deaths, respectively, from heat-related causes.

Intense Summer Storms



Description: Rainfall of 50 millimetres (mm) or more in an hour, often accompanied by localized flooding, damaging hail and lightning.

Impact: Summer precipitation presents a particular challenge. Even though evidence suggests that summers will become drier on average, when rainfall occurs it will more often happen as intense rainfall and thunderstorms. These storms can cause significant and costly damage when they strike homes and other buildings, can block drainage systems and cause localized flooding, or make key transportation corridors briefly impassable. Calgary and southern Alberta are also already impacted by severe hailstorms each year, as highlighted in Figure 3. Whether more intense summer storms will result in larger hail is unclear, but more frequent storms increase the risk of more frequent hail accompanying those storms.

Examples: In June 2016 Calgary experienced near record rainfall of 206.1 mm, causing an estimated \$50 Million in insured property damage. In addition to the torrential rains, the whole of Alberta experienced above average 576,721 lightning strikes, compared to an average 400,000 strikes over the summer.

Between 2005 and 2016, Alberta averaged approximately 78 hail storms, 28 wind storms and 7 rain storms per year, as seen in Figure 3.

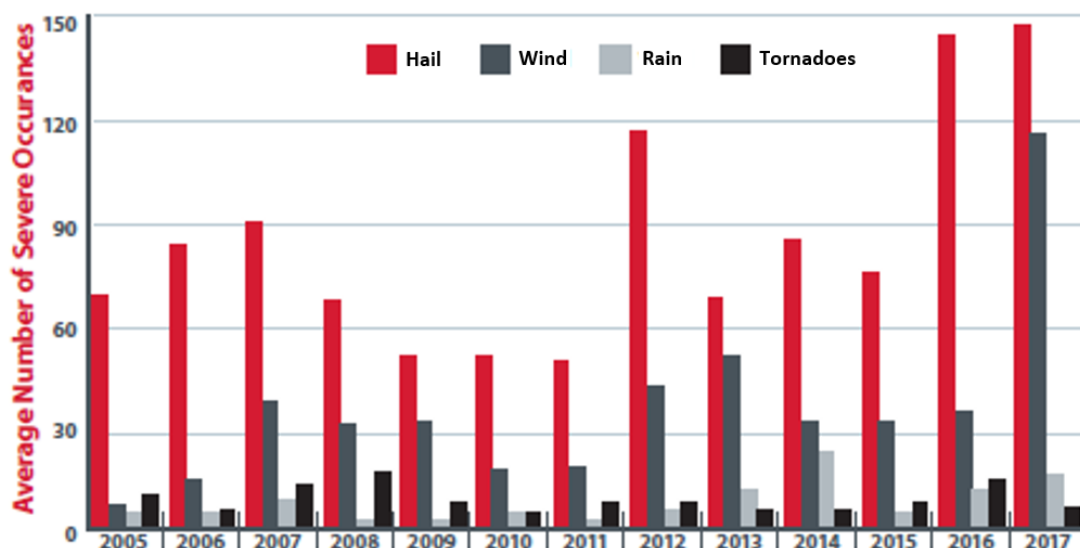


FIGURE 3 - NUMBER OF REPORTED SEVERE HAIL, WIND, RAIN AND TORNAOES EVENTS IN ALBERTA (ENVIRONMENT AND CLIMATE CHANGE CANADA, 2017)

Heavy Winter Storms



Description: Days with more than 10 centimetres (cm) of snow fall or freezing precipitation.

Impact: Winter is projected to have the most significant seasonal increase in precipitation for Calgary, falling as a mix of snow and rain. As the climate warms and more moisture can be held in the atmosphere, individual winter storms will become heavier with more snowfall per storm. Ice storms, like those experienced in eastern Canada today, will also begin to occur in Calgary. Ice storms in particular can damage infrastructure and cause power failures (e.g. downing of overhead power lines), increase the chance of multi-day service disruptions, and result in more injuries due to increased traffic accidents, or slipping and falling. The latter is a particular concern as Calgary's population ages and is more at risk of serious injury due to falls.

Examples: In 2014, the "Snowtember" event brought heavy snowfall in late summer and damaged half of the trees in the city. The 28 cm of snow that fell during Calgary's three-day September snowstorm cost the city \$17.4 Million in insured costs alone — nearly as much as the entire annual snow and ice control budget.

Winter and spring precipitation will increase up to 18 per cent by the 2050s, posing concerns for river flood risks, especially when in combination with mountain snowmelt.

Multi-Year Drought



Description: Below average annual precipitation and dry conditions lasting one to three years (or more).

Impact: Although annual precipitation is generally expected to roughly remain the same in Calgary, summers are projected to be drier due to potential decrease in summer rainfall and higher evaporation rate.

The potential for multi-year drought conditions will increase as well. As precipitation becomes more sporadic and variable, annual swings in total precipitation are more likely to occur, with prolonged drought conditions for up to several years at a time.

The consequences of a multi-year drought are far reaching. In addition to the impact on local agriculture, droughts affect the health of plants, wildlife, wetlands, forests, parks, open spaces, recreational facilities and private yards. Drying out of forests increases the risk of wildfires, which impact both local air quality and even water quality if they occur upstream of the source of Calgary's water supply. Trees and plants also become more susceptible to pest and disease outbreaks (e.g. pine beetles) since lack of water can stress trees, limiting their ability to react to these attacks.

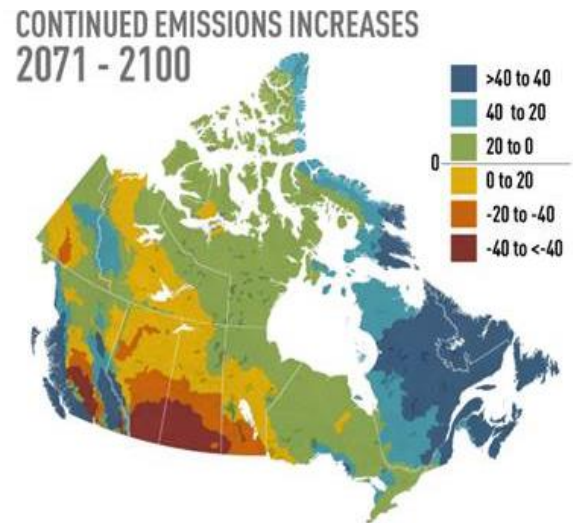


FIGURE 4 - CLIMATE MOISTURE INDEX, NRCAN – CFS, 2016

The climate moisture index by Natural Resources Canada (NRCAN), shown in Figure 4, measures the difference between annual precipitation and the potential water evaporation from landscape covered by vegetation. Below the zero line (yellow, orange and red areas), the conditions may be too dry to support a forest. This projection is for the years 2071-2100 assuming the world continues to increase GHG emissions.

Examples: In 2017, much of southern Saskatchewan experienced the driest July in over 130 years of record-keeping. In Regina, less than 2 mm of rain fell that month, far below the usual average of 60 mm. For farmers in the region, the heat and dryness conditions were especially damaging because they followed a rainy spring that had been so wet they'd been unable to properly seed their fields.

HIGH CONSEQUENCE, LOW LIKELIHOOD RISKS

Major River Flooding



Description: Major river flooding events that have a five per cent, or less, chance of happening in a given year.

Impacts: Major river flooding in Calgary can be triggered by a range of climate changes including intense summer storms, rain-on-snow, ice jamming, or combinations of all these events. These events all increase river and water table levels, leading to overland or groundwater flooding. Although these floods can last only a few days, the flood impacts on people and communities can remain for months to years. Some of the more significant impacts of floods include injuries and the risk of fatalities, power outages, dislocation of residents from their homes and communities, service disruptions, stormwater backups and basement flooding, costly damage to buildings and infrastructure, and long-term changes to rivers including erosion and reduced river bank stability.

Examples: The 2013 flood washed across one-quarter of the province and through the core of Calgary. The disruptive flood cut off dozens of communities throughout the province and prompted the largest evacuation across Canada in more than 60 years with nearly 120,000 people temporarily evacuated from their homes, power shut off to the downtown core for a week. Damage losses and recovery costs from the flood exceed \$6 Billion, including a record \$1.72 Billion in insured losses. This included 1,000 kilometres of destroyed roads, hundreds of washed-away bridges and culverts, and thousands of damaged or destroyed cars and homes.

Wildfires



Definition: A large-scale wildfire within or adjacent to Calgary city limits, lasting several days to weeks.

Impact: Calgary is less exposed to physical damage from local wildfires than communities like Fort McMurray or Waterton due to the limited amount of forest in close proximity to the city. Calgary has experienced multiple grass fires however, such as those on Nose Hill, and some communities in Calgary adjacent to urban forests and grassland areas have an elevated risk from wildfires.

Wildfires upstream along the Elbow and Bow Rivers could also impact drinking water supply and quality for years after a fire due to wildfire's tendency to destroy natural features that assist in protecting water sources from runoff contamination (chemicals, erosion and turbidity).

Examples: In 2016, the Fort McMurray wildfire resulted in approximately \$3.7 Billion in insured damage. This was more than twice the value of the previous costliest Canadian natural disaster on record. This was followed by the 2017 wildfire in and around Waterton National Park, which forced hundreds of people leave as fire burned over 38,000 hectares. In the aftermath of the

2016 Fort McMurray wildfire, the town has experienced a 50 per cent increase for water treatment expenses to avoid contamination of drinking water from post-fire pollutants washed into the river.

Tornadoes



Tornadoes

Description: Significant tornadoes are rated EF2 or stronger on the Enhanced Fujita Scale ranging from EF0 to an extreme EF5 (EF2 tornadoes have wind speeds up to 217 kilometres per hour (km/h), while EF5 tornadoes have wind speeds greater than 322 km/h).

Impact: While the probability of a tornado striking a particular site is relatively low, the consequences of a tornado depend on its location and the number of people present. Infrastructure impacts can include loss of power, severe damage to buildings and transportation corridors with possible loss of lives, as well as the potential for water service disruptions or sewage backup. Longer-term impacts could include the temporary displacement of people from their homes, injuries and deaths, loss of business revenue, and ongoing psychological trauma. Given the extreme difficulty in upgrading infrastructure to survive a tornado impact, improvements to weather monitoring and advance public warning systems are critical. Based on the available scientific data, it is not yet clear to what extent climate change could increase the frequency or severity of tornadoes in Alberta.

Examples: The most recent example of a larger scale tornado striking a large urban centre in Alberta is the 1987 Edmonton Tornado. The day came to be known as Black Friday after 27 people were killed and 300 people injured by the peak intensity EF-4 tornado that also caused more than \$330 Million in damage.

LOW CONSEQUENCE, HIGH LIKELIHOOD RISKS

High Wind Events



High winds

Description: High winds producing gusts greater than or equal to 90 km/h.

Impact: High winds can damage a wide variety of infrastructure including buildings, traffic signals, streetlights, and signs and can overturn heavy vehicles. Overhead power lines are also at risk during high wind events to power interruptions or outages. Areas of the city, such as the downtown core, could also be closed periodically during extreme high wind events. Injuries or fatalities as a result of such high wind events in Calgary have been rare, but have occurred on occasion.

Examples: Recent examples include multiple events in Calgary in October, 2017 that toppled trees, downed power lines, damaged roofs, and broke windows on a number of buildings in the downtown core.

Changes in Seasonality, Overall Wetter Seasons, and Pests, Diseases & Invasive Species



Description: A combination of above normal annual temperatures, increasing wet events with more than eight days of consecutive rainfall, and the spread of pests, diseases & invasive species that previously could not survive in the Alberta climate.

Impact: Projections indicate that average air temperatures in Calgary will increase across all of the seasons. With higher average temperatures, this can create ideal conditions for pest and disease outbreaks. This can directly impact people's health as new diseases migrate further north, as has already been seen with Lyme



Pests, diseases & invasive species

disease and the West Nile virus. Outdoor workers and those who enjoy outdoor activities will be most at risk. Growth of invasive species, such as the pine beetle, can wipe out entire forests, with potential impacts to the food chain and local wildlife, as well as negative impacts on forestry and tourism. Increased moisture would also lead to increased weathering of infrastructure, delays and disruptions to scheduled seasonal construction and maintenance, and increased costs for park and greenspace maintenance.



Overall wetter seasons (except summer)

Examples: Figure 5 shows the projected rapid change that is projected for Alberta from 2015 to 2071-2100. Today the majority of central and northern Alberta is covered by boreal forest. However, projections show that the majority of Alberta would become inhospitable for such forest by as early as 2071. Grasslands, as seen in the southeast corner of the province today, are projected to expand into central and northern Alberta instead.

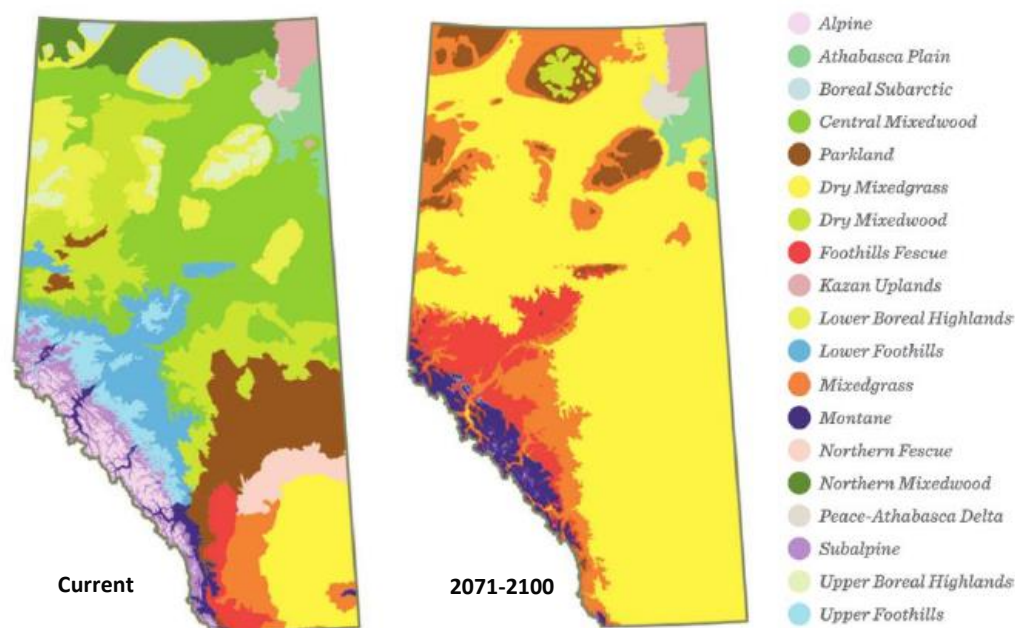


FIGURE 5 - PROJECTED CHANGE IN ALBERTA'S ECOSYSTEMS BY THE END OF THE CENTURY USING THE CURRENT EMISSION PATHWAY (NIXON ET AL., 2015), ABMI, EDMONTON

LOW CONSEQUENCE, LOW LIKELIHOOD RISKS

Air Pollution



Air pollution

Definition: Elevated air pollution events with an Air Quality Health Index (AQHI) value of 7 or greater.

Impact: Air quality is influenced by both human activities and natural events.

Large cities like Calgary may have poor air quality due to pollution from vehicle exhaust or emissions from industry and buildings. This can cause a variety of health impacts, including worsening of respiratory diseases. In Calgary, the worst air quality conditions often occur in winter when emissions from the city become trapped by an inversion (colder, stable air is trapped at the surface with warmer air above). Inversions can inhibit the normal mixing of emissions in the atmosphere, resulting in higher ambient air concentrations for pollutants. Forest fires are also a common cause of elevated air pollution, and can impact communities hundreds of kilometers away.

2017 was the smokiest year since 1953, with 321 hours of smoke due to wildfires.

Examples: In 2017, Calgary endured 321 hours of smoky conditions resulting from wildfires in the Rocky Mountains and the interior of British Columbia. This was by far the smokiest year since air-quality records began in 1953.

Freeze-Thaw Weathering



Description: Freeze-thaw refers to the stress on infrastructure caused by repeated temperature fluctuations just above or below the freezing point. This is further exacerbated by fluctuations in wind, precipitation, ice, snow and humidity.

Impact: An assessment of these conditions from climate models suggests that freeze-thaw conditions over the course of a year will decrease over the long-term, but remain significant in mild-winter months. It remains an important risk to consider in the short and moderate term, especially in late autumn and early spring as well as during the mild-winter months. Freeze-thaw can damage a wide range of infrastructure, including roadways, pathways, light rail transit (LRT) tracks and infrastructure buried in the roadway (e.g. water pipes). Weathering is causing frequent water supply main breaks, cracks and leaks from sewer systems, and compromises stormwater drainage systems performance from either line breaks or increased gravel deposition, and disrupts water supply or sewage services.

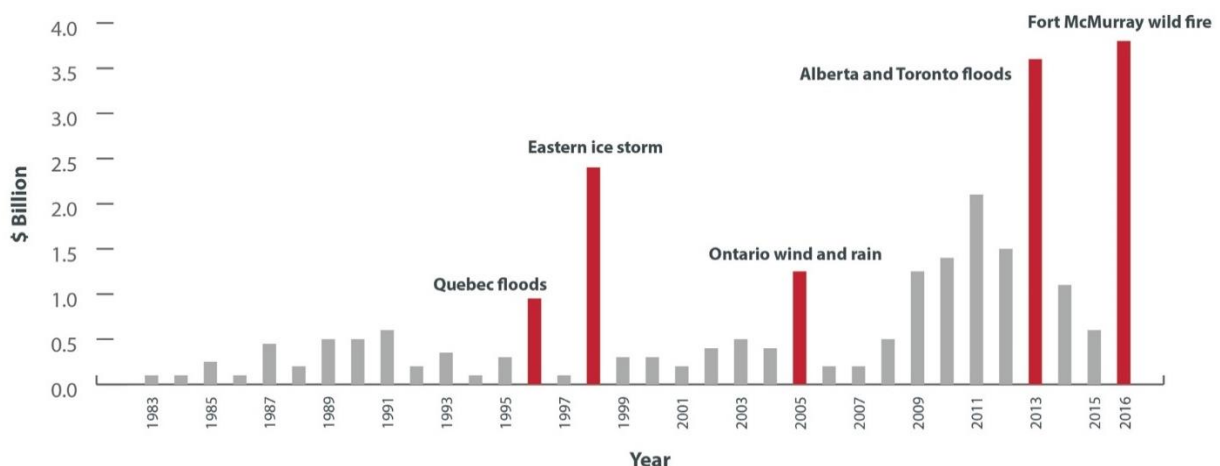
Examples: In January 2018 many homes, business and a number of schools experienced pipe bursts inside the buildings caused by freeze-thaw and fluctuating frost depth activity. The Calgary Fire department responded to more than 100 calls within 24 hours related to burst water pipes on January 1 and 2, 2018.

The Costs of Climate Change

Climate change impacts are being felt in Calgary, and across Canada and internationally. These impacts will grow over time, posing significant risks to our communities, health and well-being, economy and the natural environment.

Severe weather due to climate change is already costing Canadians billions of dollars annually according to the Insurance Bureau of Canada (IBC), with record insured damages of \$5 Billion reported in 2016. Figure 6 shows the growth in climate-related catastrophic insured losses in Canada between 1993 and 2016.

FIGURE 6 – CANADIAN CATASTROPHIC INSURED LOSSES (INSURANCE BUREAU OF CANADA)



Canada is not alone. IBC data shows that the annual economic cost of disasters around the world has increased five-fold since the 1980s. From an average of \$25 Billion a year in the 1980s, insured losses grew to an average of \$130 Billion a year in the 2000s. For most extreme weather events, uninsured losses exceed the value of insured losses, further adding to the burden on communities and the economy.

Figure 7 illustrates the ratio between insured and uninsured losses adjusted for inflation and exchange rate fluctuations worldwide. In the case of Canada, floods cause annual average economic losses of more than \$1.2 Billion with \$800 Million of those uninsured. As a result, Canada's insurance industry is calling on governments across the country to implement expansive climate actions that will better prepare Canadians and their communities for the impacts of climate change.

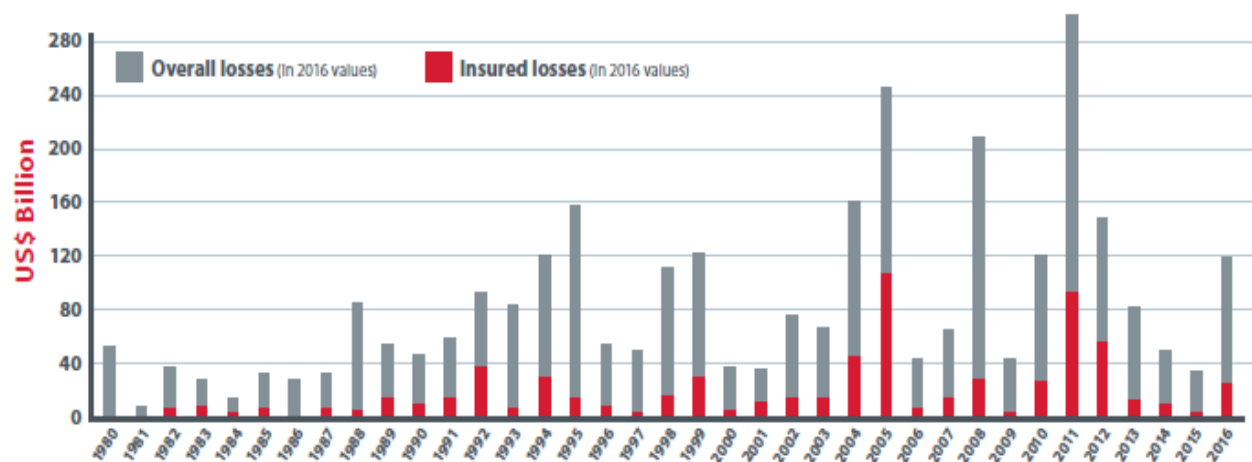


FIGURE 7 - INSURED AND UNINSURED NATURAL CATASTROPHIC LOSSES WORLDWIDE
(MUNICHRE NATCATSERVICE, 2017)

In order to avoid excessive recovery and repair costs to government, residents and businesses, Calgary must adapt to the projected impacts of climate change. Investing in adaptation actions today helps to minimize both short and long-term damage and disruptions. According to the United Nations Development Programme, from a global perspective it is estimated that every dollar spent today on adaptation results in \$7 saved in emergency response.

Climate impacts can cause a range of problems, including temporary loss of services, minor and major infrastructure repairs, loss of natural spaces, reduced economic growth, and a range of impacts on people and communities. More problematic for cities, is the fact that climate impacts in one area of services or operations can cascade through other interconnected city systems. Some specific examples of local and global climatic changes that could impact Calgary include:

Local	• Increasing number of heat days that affect the health and productivity of citizens, the natural environment and the lifespan of infrastructure • Infrastructure damage due to severe summer and winter storms causing financial losses, long-term physical and mental distress for individual and businesses • Crop losses for nearby farms due to pest and/ or severe weather events, • Potential tax increases to fund response & recovery costs due to increasing severe weather events • Increased insurance and maintenance costs in areas prone to stormwater and river flooding • More wildfires and air pollution during the fire season affecting the health of Calgarians and negatively impacting tourism • Melting glaciers that will reduce river flows, compromising our water supply and water quality • Increasingly disrupted and stretched municipal services, as a result of all of the above impacts
National	• Sea level rise in Canada leading to potential migration to cities such as Calgary, which would increase demands on local services and infrastructure • The spread of mountain pine beetles into Alberta increasing the threat to local forests and making them more prone to wildfires • Melting permafrost damaging infrastructure such as pipelines, buildings and roads owned by natural resources companies based in Calgary
International	• Increases in local food prices due to droughts in California or other food growing regions • Slowing of the global economy and demand for local resources and products due to damage and disruption from severe weather events • Shortages of imported products due to production and transportation interruptions caused by climatic changes • Increased migration of people due to climate change displacement, increasing demands on Canadian federal, provincial and municipal resources

Chapter 3 – Climate Adaptation Themes and Actions

Climate Change Adaptation Themes

Based on the vulnerability and risk assessment discussed in Chapter 2, City business units identified a series of actions that should be implemented to manage the climate risks for Calgary. The wide range of actions are grouped into a series of five themes that reflect the interdisciplinary and comprehensive nature of climate change adaptation. Within each theme, two-to-three programs have been designed to ensure alignment and coordination of actions and outcomes, as shown in Figure 8.

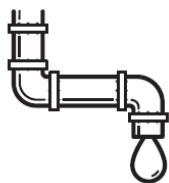
Theme	Programs
 People: A city where people can thrive Reducing Calgarians' vulnerability to the impacts of climate change	1. Air Quality Management 2. Extreme Heat Management 3. Staff and Citizen Outreach
 Infrastructure: The backbone of the city Strengthening the built environment to 'weather the storms'	4. Backup Power for Critical Infrastructure 5. Design Standards and Practices
 Natural Infrastructure: The root of resilience Maximizing the services provided by natural systems	6. Natural Assets Management 7. Natural Assets Adaptation
 Water Management: Every drop counts Preparing for increasing risks of flooding, drought and declining water quality	8. River Flood Management 9. Stormwater Management 10. Long Term Water Supply
 Governance: Pro-active leadership Preparing for our climate-altered future through collaborative decision making	11. Budgeting and Investment Priorities 12. Urban Planning and Processes 13. Severe Weather Response and Recovery Management

FIGURE 8 - CLIMATE ADAPTATION THEMES AND PROGRAMS

The full list of recommended adaptation actions was identified during the targeted stakeholder engagement process, with selected 'priority' actions highlighted in the remainder of Chapter 3. All of the actions should be initiated over the next five years (2018 – 2022) in order to increase Calgary's climate resilience in response to the projected climate risks. Additional actions that

were identified by City business units should be reviewed as the Climate Adaptation Action Plan is updated in advance of the 2023 – 2026 business cycle for potential implementation.

Climate Actions

Each of the 175 actions is attributed to one of the 13 programs which are described in the following pages. Each program includes a wide variety of adaptation actions, ranging from low cost and easily implementable projects, to larger and more complex projects. An important principle in developing the Climate Adaptation Action Plan was to focus first on feasible and “no-regret” actions.

The three to four priority actions listed in each of the programs are critical to managing climate impacts in Calgary, and lay the foundation for the rest of adaptation actions that have been identified.

Many adaptation actions identified in this plan will involve further engagement with internal and external stakeholders, which will be conducted by the Lead business unit.

Some of the adaptation actions are already underway (identified as ‘ongoing’). Other actions have been newly identified based on the vulnerability and risk assessment. The City is prepared to begin implementation of some new actions immediately, with at least partial funding having been secured. The remaining new actions will require further analysis and the development of new business cases before they can proceed, or require new sources of capital or operating funding.

Environment & Safety Management (ESM) will support other City business units as they develop new business cases and detailed funding requirements for many of the new actions. Approved business cases will be submitted to One Calgary for a coordinated allocation of corporate funding through future business plan and budget updates. ESM will also track the availability of new funding sources targeted for climate adaptation projects, and provide summary information to One Calgary and Infrastructure Calgary for consideration.

PEOPLE: A city where people can thrive

Reducing Calgary's vulnerability to the impacts of climate change

Although all people will be affected to some degree by climate impacts, some groups are more at risk. Vulnerable populations, including seniors, youth and some people with chronic illnesses are all more at risk of health complications from climate impacts such as heat waves, air pollution, pests and diseases. Calgary, like other North American cities, will also see a significant increase in the number of elderly citizens over time, increasing the health impacts of climate change and putting more strain on the health care system. Some healthy adults will also be more at risk from climate risks, including outdoor workers as well as athletes and outdoor enthusiasts. For workers this may require changes to job-site practices, or even the hours scheduled for outdoor work. And for outdoor athletes and enthusiasts this may require an adjustment of training and recreational hours.

The City will need to take direct action to address health risks to citizens, particularly around air quality and heat waves. In addition, it will be important to provide education and awareness programs for citizens and businesses. Such programs will enable people to prepare themselves and take their own actions in response to climate change.



Program 1: Air Quality Management



Background

Human activities, such as emissions from vehicles and buildings, and natural events like winter inversions and wildfires all affect Calgary's air quality. The impact on human health is considered 'high risk' when the Air Quality Health Index (AQHI) rises (a number used to communicate to the public how polluted the air currently is) to 7 or greater. Air quality in Calgary is generally good, with low risk to health. However, winter inversions can trap air over the city for days, allowing contaminants to accumulate and raise the AQHI. Smoke from recent wildfires have also resulted in poor air quality in Calgary.

Why is this a priority?

The number of premature death caused by air pollution is close to 7,700 people a year in Canada. There is a moderate likelihood that climate change is increasing the number of high risk air quality events in Calgary, as high temperatures increase the production of secondary airborne contaminants (e.g. ozone), and trap air over the city. Increased heat and drought conditions during the summer will also increase the chance of wildfire smoke from British Columbia and the United States moving into Calgary.

Anticipated outcomes

- Reduced airborne emissions in Calgary from high-impact sources.
- Updated management plans to respond to high risk air quality events.

The City is already undertaking air quality management through participation on the Calgary Region Airshed Zone (CRAZ) Board, and the Clean Air Strategic Alliance (CASA) Non-Point Source Project.

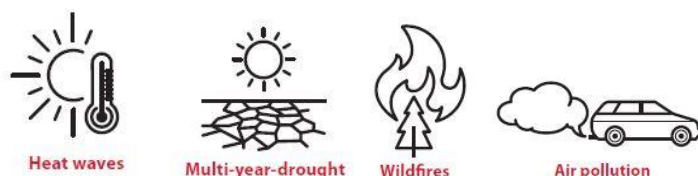
Actions in this program are closely linked to the Extreme Heat Management program, as heat waves degrade air quality. Some actions in the Low Carbon Plan will also help to improve air quality in Calgary.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
1.1 Continue to collaborate across the region and province on air quality management	Environmental & Safety Management
1.2 Develop messaging and response plans, in coordination with regional and provincial agencies, to provide information to Calgarians during poor air quality events	Environmental & Safety Management
1.3 Investigate the feasibility of implementing and enforcing bylaw restrictions or fire bans on backyard fire pits and wood burning during periods of poor air quality	Environmental & Safety Management
1.4 Support the adoption of electric vehicles and alternative fuels that minimize local air pollution	Transportation

Program 2: Extreme Heat Management



Background

Calgary typically has 8 to 9 extreme heat days per year, where the temperature is over 28°C. In the summer of 2017, Calgary experienced roughly double the number of heat warnings issued by Environment Canada. As a result of climate change, Calgary is projected to experience an average of:

- 27 annual extreme heat days by the 2050s (up to 43 days), and
- 49 annual extreme heat days by the 2080s (up to 76 days).

Why is this a priority?

Heat increases health risks for seniors, young children, and people with chronic illnesses as well as athletes and outdoor enthusiasts. Extreme heat can also cause a range of minor or serious heat-related illnesses, such as heat exhaustion, rashes and heat stroke. This is of particular concern for outdoor workers, whose ability to provide services may be negatively impacted.

During prolonged heat waves in British Columbia (July 2009) and in Quebec (July 2010), public-health officials stated that there were an estimated 156 and 280 deaths, respectively, from heat-related causes. Examples such as this, point to the need for improved private and public cooling opportunities, coordinated support for vulnerable people, and updated heat management plans.

Anticipated outcomes

- Extreme heat management plans and actions are in place to support citizens and outdoor city workers.
- Priority locations are identified for implementation of cooling and shading infrastructure or programs.

Several actions under the Infrastructure Theme also help to address the impact of extreme heat on built infrastructure.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
2.1 Ensure that heat alerts reach all Calgary Housing tenants, and provide advice on how to keep cool	Calgary Housing
2.2 Develop corporate standard and procedures for heat management to support business units in the development of their own plans	Environmental & Safety Management
2.3 Install and/or enhance shade structures and water stations in public parks as a part of capital lifecycle programs	Parks
2.4 Scope out and develop an urban heat island map to identify areas vulnerable to heat extremes, and develop measures to reduce impacts on citizens and staff	Environmental & Safety Management

Program 3: Staff and Citizen Outreach



Background

Feedback from The City-led climate change engagements and focus groups has identified a desire from Calgarians for The City to take a stronger role in fostering discussions about actions individuals, communities and businesses can take to tackle climate change.

Why is this a priority?

A key prerequisite for effective climate change adaptation and mitigation is that The City, businesses, communities and individuals work together. However, much of the climate data that is available for Calgary is not readily accessible or understandable, and many of the opportunities and benefits that can result from climate change actions have not been sufficiently communicated.

The aim of this program is to engage citizens and staff in The City-led climate change decisions and to share information on managing climate risks. The program will focus is on neighbourhood and city-wide planning processes relevant to citizens and community organisations, and on promoting learning opportunities. The program also includes public education aimed at increasing understanding of climate change so that individuals and businesses can take action on their own.

Anticipated outcomes

- The City staff, Civic Partners, citizens and businesses have the resources they need to take action on climate change, enabling Calgary to adapt to more extreme weather events and long term climatic changes.

This program will be fully integrated with outreach actions contained in the Climate Mitigation Action Plan.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
3.1 Develop and implement public and internal climate change education plans	Environmental & Safety Management
3.2 Develop a Climate Action Community Toolkit, and update communications plans to share climate change information with community groups, Civic Partners and private sector organizations	Environmental & Safety Management
3.3 Support Civic Partner's strategic and business continuity planning to address climate change risks, including sharing of The City research and plans	Calgary Neighbourhoods and Recreation
3.4 Coordinate with external agencies to increase safety and security checks of seniors and vulnerable tenants during extreme weather events	Calgary Housing

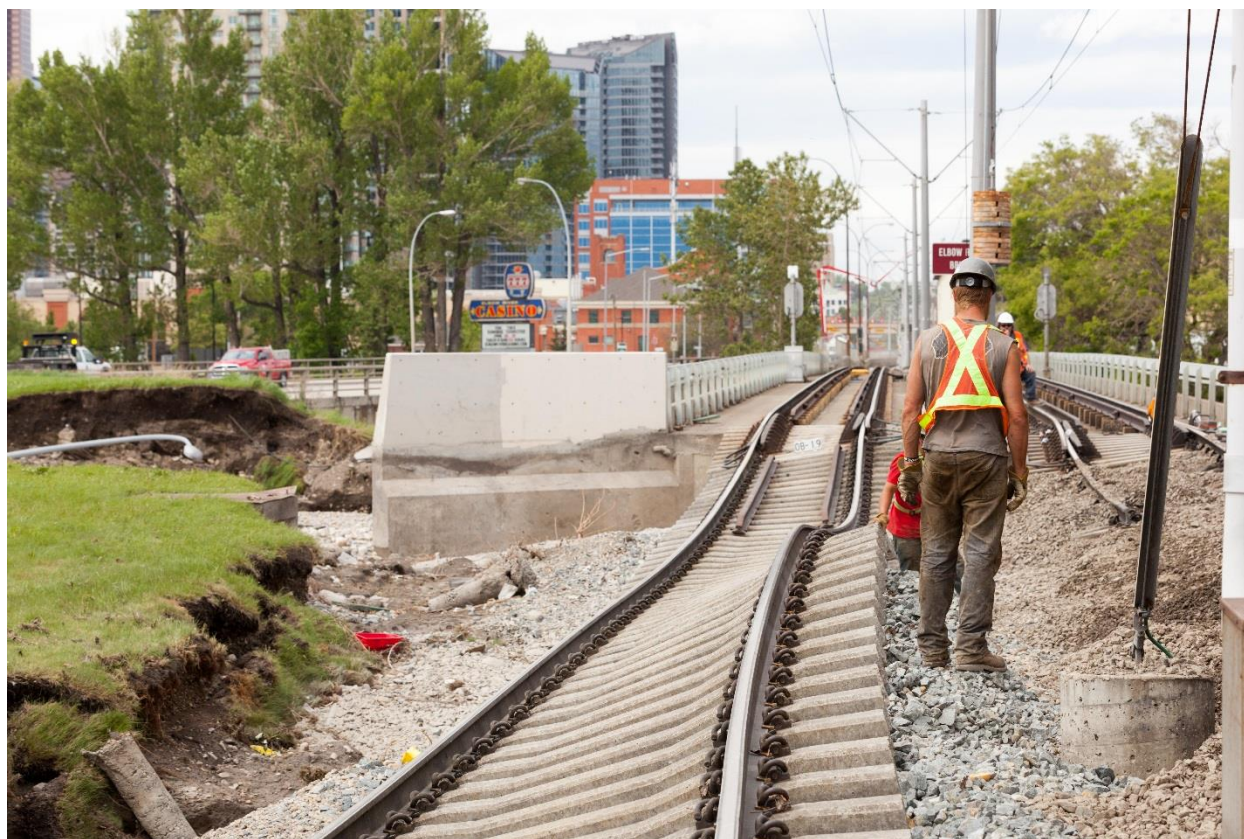
INFRASTRUCTURE: The backbone of the city

Strengthening our built environment to ‘weather the storms’

Municipal services make use of a wide range of infrastructure, ranging from roadways and light rail transit (LRT) tracks to recreation centres and power distribution systems. Disruption or damage to this infrastructure can have significant impacts on both municipal services and citizen’s daily routines.

The design parameters that go into planning and building Calgary’s infrastructure are often based on historic climate and weather patterns. As the climate change intensifies, historic data is no longer a useful guide to ensure future infrastructure can withstand the impact of chronic changes or extreme weather events. These parameters must be updated to account for the latest climate projections in order to provide reliable service, and to avoid costly and frequent repairs.

Water infrastructure, including stormwater systems and water treatment plants, are particularly vulnerable to climate and extreme weather changes. As this infrastructure is critical to the health and viability of people and businesses, programs and actions specific to water are summarized in a dedicated Water Management section.



Program 4: Backup Power for Critical Infrastructure



Background

Critical infrastructure refers to facilities and equipment that are essential to providing critical services. It supports the health, safety, security, economy and overall well-being of Calgarians. The 2013 flood demonstrated how the disruption of critical infrastructure affected the community. This could range from reduced quality and strength of wireless service due to increased rainfall, all the way to a complete power outage affecting an entire community.

Why is this a priority?

For The City of Calgary, access to power is essential for maintaining services to citizens. Some facilities and infrastructure play a key role in supporting the community, such as water treatment, transportation, protective services, and public housing. Behind the scenes, data centres and repair facilities are needed as well. During some events, The City facilities are used as muster points or shelters for displaced people.

Power loss can be triggered by various types of extreme weather events. It can be a wind or ice storm bringing tree branches down on power lines, extreme heat causing a blackout, or widespread flooding damaging electrical equipment. The City should prepare for various scenarios for maintaining services.

Anticipated outcomes

- The City staff has identified the infrastructure that is most essential for continuity of service delivery.
- Back-up power requirements of these mission critical City facilities have been prioritized based on a climate change vulnerability assessment.
- Specific upgrades, new backup power systems, or plans to provide mobile power in response to power outages, have been identified in collaboration with partners.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
4.1 Assess condition of power supplies in critical City facilities with priority given to facilities serving vulnerable populations	Facility Management
4.2 Determine backup power requirements for City systems and infrastructure in preparation for cascading power losses in the event of multiple extreme weather events	All business units
4.3 Evaluate mobile power plants for Calgary Housing Corporation properties with ENMAX to protect tenants and buildings against freezing	Calgary Housing

Program 5: Design Standards and Practices



Background

The City of Calgary has a wide range of standards and practices, aligned with national or international standards, which determine the design of infrastructure projects from bridges to stormwater pipes. Additional policies and bylaws influence the design of private developments like office towers and new communities.

The City's design standards and practices are based on extensive analysis, and in some cases national or provincial requirements. However, current standards and practices generally do not consider future climate, assuming instead that past climate conditions will continue into the future. Climate change fundamentally changes that assumption; therefore design standards and practices must be updated to ensure infrastructure and services can endure future climate and extreme weather events throughout their intended service life.

Why is this a priority?

Several of the climate risks for Calgary outlined in Chapter 2 impact how infrastructure or buildings need to be designed. Some examples include:

- more intense rainfall that exceeds current stormwater infrastructure capacity and can temporarily flood buildings and roadways;
- major river floods, like 2013, that can destroy riverbanks and bridges;
- increased temperatures and extreme heat that can deform infrastructure; and
- stronger winter storms that can increase roof snow loads or knock out power.

Design standards and practices must be updated to withstand these impacts to ensure reliable service, and minimize the risk of costly repairs after extreme weather events.

Anticipated outcomes

- Expansion and maintenance of detailed climate data to inform infrastructure design decisions.
- Updated design guidelines and practices across City business units, including infrastructure design specifications, building code and other City guidelines.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
5.1 Continue to drive improved energy code for buildings with additional focus on deployment of renewable energy. Work is in consultation with Provincial authorities and industry	Calgary Building Services
5.2 Collaborate with external partners to develop regionally-appropriate climate data to inform new design standards for City infrastructure	Environmental & Safety Management
5.3 Facilitate a cross-corporate working group to scope out and determine a corporate approach to collaboratively update City design standards for buildings	Corporate Analytics & Innovation
5.4 Update design guidelines and standards for City infrastructure (such as bridges, buildings and water systems) to ensure resilience to extreme weather events and chronic climate changes	All capital investing business units and Corporate Analytics & Innovation

NATURAL INFRASTRUCTURE: The root of resilience

Maximizing the services provided by our natural systems

Natural assets such as bio-swales, forests, fields, green roofs, rivers, rain gardens, streams, wetlands and river banks can provide municipalities with essential services equivalent to those from many engineered assets. Some examples include water supply, water purification, flood protection, climate regulation, soil quality and stability, as well as providing landscaping and natural amenities for communities. Natural infrastructure can serve two different purposes, and in some situations can achieve both:

- everyday service provision (e.g. park space, water conveyance), and
- adaptation to climate change (e.g. tree canopy shading, absorption of storm water).

Some natural assets are best protected in place as native habitat, while others are designed and engineered to mimic natural function and processes. Both types of natural assets have multiple benefits, and have some ability to self-adapt to climate change. The functionality of traditional engineered assets tends to decline as they age. In contrast, with appropriate maintenance and rehabilitation, the functionality of natural assets can improve as they age and mature.



Infrastructure Canada has identified natural infrastructure as a critical element of climate adaptation and is a component of the effort to support Canada's ongoing transition to a clean growth economy. The Federal 2017 budget lays out the Government's plan to invest \$12.9 Billion in natural infrastructure.

Program 6: Natural Assets Management



Background

Natural assets include prairie, wetlands, river banks, trees and other natural infrastructure that provide similar services to hard infrastructure such as water conveyance, runoff water quality treatment or shading structure. These may be naturally occurring assets, or engineered assets that mimic nature. Natural assets have additional benefits beyond traditional service delivery, including biodiversity and providing ecosystem habitat.

Current City processes do not fully account for the benefits of natural assets, putting their maintenance and protection at risk. The operation and maintenance of natural assets is also very different from the approach taken to maintaining hard infrastructure.

Why is this a priority?

Natural assets are better able to self-adapt to changes in Calgary's climate than hard infrastructure. Protecting and maximizing the use of these natural assets can also offset costly investments in new hard infrastructure, helping Calgary to efficiently manage the risk of increasingly intense storms and flooding.

In order to maximize their benefit in managing climate risks, natural assets need to be accounted for in City asset management programs, capital funding made available, and appropriate maintenance programs put in place.

Anticipated outcomes

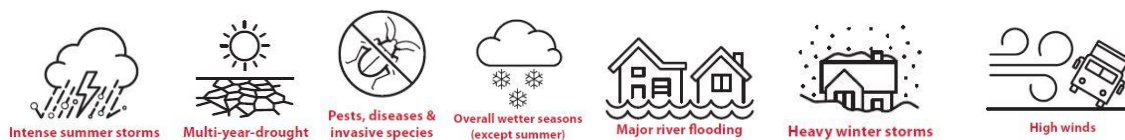
- A coordinated approach to conserve and enhance natural assets as part of The City's ongoing asset management processes.
- Management and protection of natural assets and systems, such as soils and stormwater.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
6.1 Continue to support and advocate for the priority protection of environmentally significant areas in accordance with the Municipal Development Plan (MDP)	Parks
6.2 Develop a formal working group to align environmental programs, develop objectives and associated instruments for integration of natural infrastructure in the urban form	Environmental & Safety Management
6.3 Develop a program to increase understanding of the value of natural infrastructure for City staff and external stakeholders	Resilience & Infrastructure Calgary Environmental & Safety Management
6.4 Integrate natural infrastructure into planning and corporate asset management	Resilience & Infrastructure Calgary Environmental & Safety Management

Program 7: Natural Assets Adaptation



Background

Based on current climate change trends, by mid-century the climate of southern Alberta is projected to become similar to Amarillo, Texas. For example, the number of extreme heat days over 28°C in Calgary is projected to increase from a current average of 9 days to 27 days per year in the 2050s and to 49 days by the 2080s on average. Although natural assets can self-adapt to climate changes better than hard infrastructure, this rate of change will still be too rapid for some local populations of species.

Why is this a priority?

If climate changes occur more quickly than some natural assets can handle, the benefits of these natural assets to Calgary may be reduced. Poorly maintained natural assets can also pose risks to Calgary. For example, unhealthy trees and shrubs pose a greater wildfire risk during extreme heat and drought conditions, or may break during extreme wind events and damage infrastructure such as power lines. In addition, natural assets under stress are more susceptible to invasive species which can be economically and ecologically damaging.

Natural asset management practices from other municipalities will not necessarily work in Calgary due to local differences in soil conditions, rainfall patterns, wind and other factors. As a result, Calgary must evaluate the best approach to help at-risk natural assets either adapt to climate changes, or even to accelerate the replacement of some species with new species better suited to our future climate.

Anticipated outcomes

- Increased number of healthy, well adapted natural assets in Calgary.
- Updated planning and development practices for soil and vulnerable locations such as river banks and flood prone areas.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
7.1 Continue and expand naturalization programs for City Parks and green space	Parks
7.2 Conduct a city-wide ecological analysis to develop a plan to build the resiliency of Calgary's natural systems	Parks
7.3 Develop new guideline for soil management to provide a functional support system for healthy green spaces and natural infrastructure	Parks
7.4 Implement Riparian Action Program to protect and enhance natural river areas and wetlands	Water Resources

WATER MANAGEMENT: Every drop counts

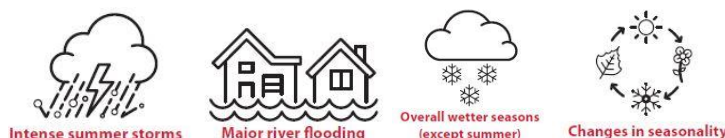
Preparing for increasing risks of flooding, drought and declining water quality

How and *when* we receive precipitation will change. Our future water supply will be further restricted being more prone to multi-year drought conditions. Integrated watershed management will be essential to ensure a reliable, secure and high-quality water supply for Calgary. Water supply and demand will both need to be managed effectively, and water storage capacity will be an increasing priority in response to drought and other climate impacts.

The spring season and mountain snowmelt are projected to occur earlier in the year. The growing season is also expected to become longer and hotter, putting higher demands on water supply. Warming temperatures will affect water quality, impacting the ability of water and wastewater treatment facilities to meet Calgary's needs. Precipitation will fall with more intensity, increasing the risk of river flooding as well as localized flooding overwhelming the drainage systems. Flood management will also be a priority with all citizens, businesses and governments having a role to build resilience.



Program 8: River Flood Management



Background

Calgary has suffered two major flood events in recent years. In June of 2005, Calgary received what was then a record rainfall of 248 mm, resulting in flood damage to 40,000 homes costing about \$75 Million. The impact of the June, 2013, flood was even more significant, with over 80,000 people temporarily evacuated from their homes, power shut off to the downtown core for a week, and over \$1.72 Billion in insured losses.

With the frequency and severity of storms and flood events projected to increase, Calgary must adapt to minimize the impact of future floods.

Why is this a priority?

More intense rainfall over longer durations will increase the potential for larger river flooding events than Calgary has experienced in the past. This includes both more severe surface flooding and elevated groundwater levels that can lead to basement flooding.

The City of Calgary is already taking action to protect the communities most vulnerable to major flooding, and is working with the Province to explore upstream water storage options. Overall, Calgary is making progress to be prepared for another 2013-scale flooding event, but additional planning and investment is required to adapt to even larger flood events.

Anticipated outcomes

- Enhanced long-term vision for flood resilience in Calgary to reflect changing climate conditions.
- Aligned land use planning processes with flood risks and management practices.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
8.1 Collaborate with other levels of government to advance river flood hazard mapping to include climate change	Water Resources
8.2 Continue to work with other levels of government on upstream storage to manage both river flood and drought risks exacerbated by climate change	Water Resources
8.3 Develop flood damage reduction policies including consideration of appropriate land uses and long term management of flood protection infrastructure	Calgary Growth Strategies Water Resources
8.4 Develop cross-corporate implementation and resourcing plans for river flood response actions taking future climate extremes into account	Water Services

Program 9: Stormwater Management



Background

The projected increase of intense summer storms increases the risk that local stormwater drainage systems will be overwhelmed. This will increase potential for localized surface flooding, elevated groundwater and backup of sewer systems leading to basement flooding in different communities. It will also lead to increased pollutants entering rivers and creeks. The precise location of these storms is currently impossible to forecast, so advance warning is limited but could be improved using new technologies.

Why is this a priority?

According to the Insurance Bureau of Canada, basement flooding is the number one cause of insurable damage in Canada. This tends to be worse in older, established communities where construction of stormwater ponds to manage overland flow were not common practice at that time. The risks of flooding are increasing in areas with active redevelopment due to decreased area of permeable space to absorb water, causing more surface runoff. Increased rainfall intensity due to climate change will further increase the risk for localized flooding.

Given that more frequent and severe summer storms are a high risk for Calgary, innovative solutions to manage stormwater volumes and to incorporate natural infrastructure will be required.

Anticipated outcomes

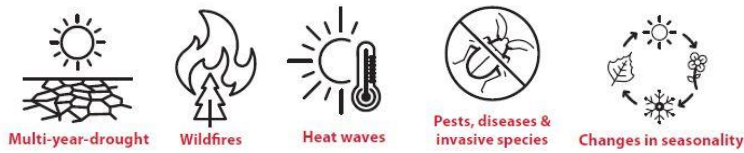
- Assessed design guidelines for stormwater management to deal with more intense summer storms.
- Flood warning systems and response plans in place to address more frequent localized flooding situations.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
9.1 Assess climate change impacts to rainfall intensity, duration and frequency to inform new development	Water Resources
9.2 Include climate change impacts in the development of the Stormwater Management Strategy and implementation planning to guide water management in development and redevelopment areas	Water Resources
9.3 Assess stormwater design guidelines to account for climate change in collaboration with stakeholders as part of the Stormwater Management Strategy	Water Resources
9.4 Develop localized flood warning system and response plan to proactively deploy resources to the community and to wastewater treatment facilities.	Water Services

Program 10: Long Term Water Supply



Background

A warmer global atmosphere can hold a larger amount of water vapour and can hold it for longer. This means that Calgary will be more prone to multi-year drought conditions, but when we get precipitation it will fall with great intensity and volume leading to flooding. It is both extremes of drought and flood that will be further exacerbated by climate change.

An earlier spring and warmer temperatures will result in longer growing seasons, providing opportunities for agriculture, recreation, and longer construction seasons. Warmer temperatures will also lead to rapid glacier melt decreasing the flow in mountain rivers, increases evaporation rates, and increases in river water temperatures. Collectively, these will result in decreased river water quality and volume. Therefore, the implications of long term changes to water supply and demand will need to be assessed for management of stormwater, and for operating water and wastewater treatments plants.

Why is this a priority?

Given the risk of reduced water supply during periods of peak demand, policies and programs to manage water demand across the entire Bow River watershed must be re-assessed for future climate conditions. This should include a review of water licenses, source water protection and integrated water supply management.

Citizens, business and government must work together to manage the Bow River watershed over the long-term. With climate change increasing the risk of drought, extreme temperatures and high winds, the risk of wildfires within our watershed increases and must be pro-actively managed.

Anticipated outcomes

- Advanced drought management and response plans to manage the risk of declining water supply.
- Strategic investments in water supply infrastructure and water demand management programs.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
10.1 Collaborate with other levels of government and regional stakeholders to analyze long term river flow and water quality in the Bow and Elbow Rivers	Water Resources
10.2 Advance the Drought Management Plan to enhance response tools and minimize impacts during multi-year droughts	Water Resources
10.3 Incorporate climate change in strategic plans and policies to manage long term water supply, wastewater treatment and stormwater management	Water Resources
10.4 Evaluate climate change impacts to water supply and demand to inform Water Efficiency Plan and water sustainability targets	Water Resources

GOVERNANCE: Pro-active leadership

Working together to prepare for climate change now and in the future

The City has a critical role to play in adapting to climate change and preparing the community to take appropriate actions. The City must consider the implications of Calgary's urban form and growth decisions, how services delivery needs to be modified, and the coordination of response and recovery to extreme weather events such as floods or winter storms.

A key prerequisite for effective adaptation to climate change is that The City, organizations, business associations, institutions and private individuals work together. However, many decision-makers are not yet sufficiently aware of the climate adaptation actions that are required, or the associated benefits. In addition, the available information is not easily accessible, or in some cases, understandable. This can lead to climate adaptation actions being initiated too late to ensure reliable services, or being uncoordinated and not taking into account important information. The programs and actions within this thematic area are designed to maximize the coordination and effectiveness of climate adaptation actions undertaken by The City.



Program 11: Budgeting and Investment Priorities



Background

At The City of Calgary, capital budgets are used to construct new infrastructure, or for major reconstruction of ageing infrastructure. Operating budgets are used to cover the costs for staff to operate and maintain City infrastructure and services.

Budget and investment decisions are guided by City Council goals and a variety of technical prioritization criteria. Most capital and operating prioritization processes at The City do not currently include climate change criteria to ensure that climate risks are being properly considered in budget decisions.

Why is this a priority?

In order to minimize the disruption of City services, managing the risks associated with climate change requires adequate capital and operating budgets. This Climate Adaptation Action Plan includes a number of projects (e.g. updating infrastructure design guidelines) that are specially designed to manage climate risks. Many other proposed City projects are not directly related to climate change, but would also help to manage climate risks.

Incorporating climate change criteria into budget and investment decisions will increase funding allocated to projects that manage climate risks. This should be combined with existing economic, social or environmental criteria to ensure balanced budget priorities.

Anticipated outcomes

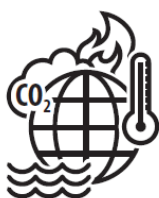
- Leaders and project managers are aware of climate change risks and potential resilience solutions.
- Corporate and departmental risk management and budgeting processes explicitly include climate change resilience criteria.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
11.1 Advocate for amendments to current disaster funding models with different levels of government to reflect the increased climate risks	Calgary Emergency Management Agency (CEMA)
11.2 Integrate climate resilience criteria within capital budget processes and funding allocation decisions	Resilience and Infrastructure Calgary all asset owning business units Environmental & Safety Management
11.3 Incorporate monitoring and tracking of corporate climate adaptation actions into existing environmental risk management monitoring processes	Environmental & Safety Management
11.4 Enhance awareness of leadership, project managers and business planners on climate change resilience actions and investments to manage climate risks	Environmental & Safety Management Finance

Program 12: City Planning and Processes



Background

Planning and policy decisions on land use, transportation, city infrastructure and services can help to build overall resilience to climate changes. The City can tailor plans and policies for existing and future neighbourhoods to reduce the impact of extreme weather events and long-term climatic changes that are expected to affect each area. Through the policies of the Municipal Development Plan (MDP) and the Calgary Transportation Plan (CTP), it is possible to build resiliency in planning land uses, water infrastructure and transportation connections. These plans' performance indicators will allow us to track progress toward increased resilience.

Why is this a priority?

Climate change poses a long-term risk to Calgary and its citizens. Since planning and policy decisions regarding land use, transportation, and city infrastructure shape the long-term growth of the city, these decisions can also help to manage the risks associated with climate change through proactive and responsive policies and climate-resilient design choices.

Anticipated outcomes

- City plans and policies ensure that communities, neighbourhoods, infrastructure and services are designed to respond to anticipated climate changes.

Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
12.1 Develop or join a community of researchers and practitioners to support information sharing on the management of climate change risks	Environmental & Safety Management
12.2 Update the Municipal Development Plan and Calgary Transportation Plan to address climate risks that may impact land development and transportation infrastructure or services	Calgary Growth Strategies Transportation
12.3 Align Local Area Plans policies with areas identified by Water Resources as disaster prone and undertake consultation and policy amendments to reduce potential damage to life and goods, and manage risks	Calgary Growth Strategies Community Planning
12.4 Conduct an ongoing evaluation of City policies against climate resiliency criteria to ensure alignment	Environmental & Safety Management

Program 13: Severe Weather Response and Recovery Management



Background

During an emergency, The City of Calgary's priorities are life safety, critical infrastructure, environment, and the economy. Calgary has effectively managed extreme weather events in the past, such as the 2013 flood, and is learning from those events to enhance its ability to manage extreme weather events in the future.

Climate change acts as a risk multiplier by increasing the frequency, variability, and intensity of hazards. An expected overall increase in the number of severe weather events will put further stress on operational budgets while challenging the city's ability to provide essential services, damaging critical infrastructure, and increasing the risk of injuries/fatalities. Response and recovery from extreme weather events can be very costly in terms of repair costs and staff time. The toll on citizens' physical and mental wellbeing can be severe and linger many years after the event.

Why is this a priority?

Preparing for a likely increase in the frequency, severity, and complexity of extreme weather events requires a coordinated cross-departmental and multidisciplinary approach. While the time horizons and scope are different, there is close alignment between disaster risk reduction and climate change adaptation. Climate change exacerbates weather-induced hazards, therefore, reducing disaster risk for those hazards is also a critical component of adaptation planning. Both fields are focused on assessing risk, reducing vulnerability, increasing capacity, mitigating potential damage, and enhancing resilience in order to achieve long-term sustainability goals. There is an opportunity to align disaster risk reduction and climate change adaptation in order to ensure both activities are working towards long-term societal resilience objectives.

Anticipated outcomes

- Systematically updated disaster risk reduction strategies that consider how climate change will increase the frequency and severity of extreme weather events.
- Civic Partners are supported by The City in developing their own response and recovery plans.



Highlighted Actions

ACTION	PARTICIPATING BUSINESS UNITS
13.1 Review capacity of Calgary Emergency Management Agency (CEMA) to provide local and regional support during response and recovery from identified climate impacts	Calgary Emergency Management Agency (CEMA)
13.2 Support Civic Partners as they build internal capacity, obtain resources and develop their own adaptive actions	Calgary Neighbourhoods
13.3 Review business continuity plan and integrate identified risks of more frequent and intense extreme weather events	All business units
13.4 Integrate climate adaptation programming into disaster risk reduction strategies in order to increase resilience	Calgary Emergency Management Agency (CEMA)

Chapter 4 – Plan Implementation and Next Steps

Implementation

Climate change adaptation is a continuous process, with this plan acting as a starting point for Calgary. The majority of the actions in the Climate Adaptation Action Plan should be initiated within the next business cycle 2019-2022, except ongoing actions that are already underway. Successful implementation will require participation and engagement across all business units/service lines, as well as collaboration with community stakeholders in order to successfully achieve Calgary's climate resilience objectives. The Climate Adaptation Action Plan is a 'living document', much like an Emergency Response Plan, where future revisions of the plan are improved by accounting for new data, analysis on successful risk reduction measures and understanding thresholds for triggering certain damaging climate impacts.

The City of Calgary's adaptation actions were developed by all impacted business units through a series of stakeholder workshops, and are tailored to address Calgary-specific climate risks.

The business units identified as accountable for actions in the Plan will be leading the action implementation.

The Climate Program will provide coordination among business units and deliver on selected actions on behalf of Environmental & Safety Management that are identified in the Plan. Details and prioritization of the actions may change to reflect emerging challenges and opportunities, as well as funding made available through different levels of government or partnership with the private sector and institutions.

The effectiveness of the plan implementation is dependent on the extent to which the climate risks, impacts and actions are incorporated into existing plans, policies, standards and programs (e.g. the Municipal Development Plan (MDP)). Continued research into best practices and collaboration with external stakeholders will also help to guide successful implementation of the actions that are presented in this plan.

Having identified the primary climate risks for Calgary, this Climate Adaptation Action Plan identifies actions that need to be undertaken by The City to increase the resilience of municipal infrastructure and services.

Updating the Climate Adaptation Action Plan

The City should review and evaluate the effectiveness of the Climate Adaptation Action Plan every four years to guide business planning and budget decisions, incorporating the latest climate data and an evaluation of the effectiveness of recommended actions. The review and evaluation should include:

- a summary of any observed or projected changes in climate risks,
- a report on successfully implemented actions,

- a dashboard on implementation progress of the 13 programs,
- proposed revisions to the adaptation actions or programs given the updated observations or projections,
- frequency of reaching specific impact thresholds
- identification of potential new funding sources for climate adaptation projects, and
- updated tracking of progress on the Core Climate Adaptation Indicators.

Monitoring and Reporting

The Climate Adaptation Action Plan will be updated every four years, in advance of each City business planning and budget cycle, with ongoing monitoring occurring between updates. The primary metric used to evaluate The City of Calgary's progress towards climate adaptation will be the percentage of climate adaptation actions identified that have been initiated within the recommended timeframes.

Successful adaptation means that some impacts are avoided or reduced, so it can be difficult to directly measure the effectiveness of pro-active adaptation actions against events that have been avoided or minimized. Climate adaptation indicators generally cannot be used independently, but must be combined to measure whether The City's actions are leading toward climate resilience on a city-wide scale. A set of potential climate adaptation indicators, linked to each of the program, are provided in Table 1, and these potential indicators can be used to evaluate whether The City's climate adaptation actions are achieving their desired goals. These should be reviewed further to establish a set of Core Climate Adaptation Indicators that can be reported to Council in advance of each business planning and budget cycle and evaluated to determine whether they will assist with implementation of the adaptation actions.

Due to the complexity of climate change adaptation, 13 indicators are not enough to fully establish whether The City is achieving comprehensive climate resilience. As a result, each business unit will monitor additional indicators specific to their actions to inform future business planning and budget recommendations.

TABLE 1 – POTENTIAL ADAPTATION INDICATORS

THEMES	PROGRAMS	CORE INDICATOR	METRIC
PEOPLE A city where people can thrive	1. Air Quality Management	Airborne emissions reduction	Per cent time Air Quality Health Index rated high risk (greater than 6)
	2. Extreme Heat Management	Heat waves	Per cent city area mapped as high risk of heat island effect
	3. Staff and Citizen Outreach	Climate literacy	Per cent increase in community awareness on climate adaptation Per cent of staff aware of climate projections Number of climate related partnership with partners
INFRASTRUCTURE The backbone of the city	4. Backup Power for Critical Infrastructure	Power supply for Critical Infrastructure	Per cent of City critical infrastructure with backup power
	5. Design Standards and Processes	Design Standards	Per cent of design standards updated to include climate change
NATURAL INFRASTRUCTURE The root of resilience	6. Natural Assets Management	Natural assets	Per cent of natural assets incorporated in the City's Asset Management Plans Dollars invested in natural assets
	7. Natural Assets Adaptation	Vulnerable areas	Per cent decrease of vulnerable areas Riparian health index

THEMES	PROGRAMS	CORE INDICATOR	METRIC
WATER MANAGEMENT Every drop counts	8. River Flood Management	Reduce risk, resilience	Number of properties at risk of river flooding for 1-in-2, 1-in-5, 1-in-20, 1-in-100 return period
	9. Stormwater Management	Reduce risk, resilience	Number of properties at risk of localized flooding for 1-in-2, 1-in-5, 1-in-20, 1-in-100 return period
	10. Long Term Water Supply	Reduce risk, resilience	Elbow River annual low flow (cubic metres per second (m ³ /s)) Nose Creek annual low flow (m ³ /s)
GOVERNANCE Pro-active leadership	11. Budgeting and Investment Priorities	Budget Integration	To be determined
	12. Urban Planning and Processes	Climate Resilience	Per cent of Local Area Plans that contain policies explicitly addressing climate risk management
	13. Severe Weather Response and Recovery Management	Business Continuity Planning	Per cent of business requirements that have an effective processes to allow business units to continue providing their services during severe weather events Total losses (in dollars) due to weather-related events incurred by The City