

CLIMATE CHANGE ADAPTATION PLANNING IN TORONTO: PROGRESS AND CHALLENGES

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Summary:

The City of Toronto is one of the first Canadian cities to establish a citywide process to respond to its vulnerability to climate change. In 2008, Toronto developed *Ahead of the Storm*, a climate change adaptation strategy. This case study describes past, current and potential future impacts of climate change on Toronto, along with the steps taken to develop the adaptation strategy. These steps include the creation of an Adaptation Steering Group and the development of an initial framework document. The strategy was underpinned by existing programs that provide protection from current weather extremes and included short term actions as well as a longer-term process for developing a comprehensive strategy. The City is in the early stages of implementing the strategy. This paper also reflects on some of the barriers to implementation that may affect the integration/mainstreaming of adaptation into City plans and programs.

Key Words:

climate change
adaptation
impacts
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I. INTRODUCTION

In the last decade, public awareness of climate change has increased dramatically in Canada, and changing weather trends, extreme weather events, and associated impacts are being blamed – rightly or wrongly – on climate change. Municipalities are responsible for many affected services and infrastructure: electricity distribution; water supply; stormwater management; the state of local roads, bridges, and culverts; public health; social welfare; and more. As a consequence, a growing number of local governments are considering how to respond to climate change.

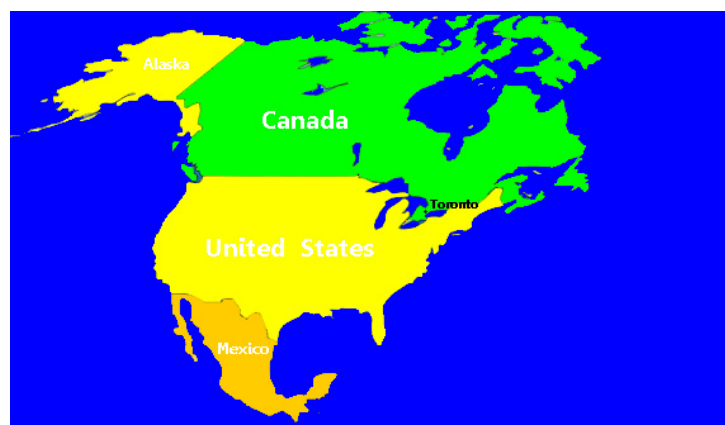
Toronto is Canada's largest city and has often been a leader in the development and implementation of many new environmental policies. In 2008, after almost a year of planning, the City adopted a new Climate Change Adaptation Strategy (City of Toronto, 2008a) and is now in the early stages of implementing it. Although Toronto is not the first municipality in Canada to undertake explicit adaptation planning – Halifax has that distinction – lessons learned from Toronto's experience are likely to influence the development and implementation of adaptation programs elsewhere in the country.

II. CONTEXT

1. The City of Toronto

Toronto is situated on the northwestern shore of Lake Ontario, the smallest of North America's Great Lakes.

Figure 1: Toronto in North America



Source: Thea Dickinson

It is Canada's largest city, with approximately 2.7 million inhabitants in an urban region of more than 5 million people. Toronto is the capital of the province of Ontario.

2. Emerging Climate Change Impacts and Concerns

Until recently, the City of Toronto paid greater attention to reducing greenhouse gas emissions than to local climate change impacts and the need for adaptation. This has begun to change as Toronto's weather has become noticeably more extreme. In the last four years, Toronto has suffered through the hottest and smoggiest summer in the City's history (2005), the most intense rainfall and costliest flood (also 2005), one of the driest summers on record (2007) followed by the wettest (2008) and the snowiest winter in 70 years (2007-2008).

These weather events drew the City's attention to the following expected climate change impacts:

2.1 Heat waves and declining air quality

Toronto's summer temperatures have climbed an average of 2.7°C in the last forty years (Rhodes, 2008), and the incidence and duration of heat waves has also increased. In response to this, Toronto Public Health (TPH) launched a heat alert and response system in 1999. TPH also commissioned a study which evaluated mortality due to heat waves (Pengelly *et al.*, 2005). The study estimated that heat waves currently contribute to an average of 120 deaths annually in Toronto. However, as a result of climate change, heat-related mortality is projected to double by 2020 and triple by 2080, in the absence of effective adaptation. Hotter weather and prolonged heat waves also negatively affect air quality. Pengelly *et al.* estimated that 1,700 people die prematurely in Toronto and about 6,000 are hospitalized each year from exposure to smog and other air pollutants. The study predicted that these figures would rise 20% by 2020 and 25% by 2080 as a result of climate change.

Rising summer temperatures also have a significant impact on Toronto's electricity demand, which soars on hot days and triggers the purchase of electricity from coal-fired generating stations in the Ohio Valley. This increases greenhouse gas emissions, and because these plants are upwind from Southern Ontario, also intensifies air pollution and smog in the region. The increase in demand also strains the electrical transmission systems, increasing the risk of brownouts and blackouts.

2.2 Intense rainfall and flooding

For some time Toronto Water has been concerned about the escalating intensity of rainstorms, which caused eight local floods between 1986 and 2006 (D'Andrea, 2007). A three-hour storm on August 19, 2005 dropped more than 150 mm of rain on some areas of the city and cost at least half a billion dollars in flood damages – the most expensive natural disaster ever in Ontario (Yakabuski, 2008). Impacts included: flash floods of creeks, rivers and ravines; the erosion and collapse of stream banks; more than 4,200 flooded basements in homes and commercial properties; and damage to parks, trees, roads, water mains, gas mains, underground electrical and telephone cables, sanitary sewers and bridge foundations, as well as vehicles (D'Andrea, 2007).

Figure 2: Toronto's Finch Avenue after the August 19, 2005 Storm



Source: City of Toronto

2.3 Record snowfalls and freezing rain

Although changes in snowfall trends in Southern Ontario are not considered statistically significant up to the year 2000 (Zhang *et al.*, 2001), a number of extreme snowfall events have occurred in Toronto since the late-1990's. For example, 118 cm of snow fell in a two-week period in January 1999, more than usually falls in an entire winter. Toronto's former Mayor requested help from the military to clear away one million tonnes of snow from the downtown area. Snow clearing that month cost \$70 million, more than twice the City's budget for the entire year (Environment Canada, 2006). Major snowstorms were also experienced in 2001, 2002 and 2005. In the winter of 2007-8 snowfall totalled 194 cm, the most snow the city had seen in 70 years. This resulted in multiple power outages, traffic pile-ups and airport closures, and snow-clearing costs again greatly exceeded the budget for the year. The City attributes record snowfalls to later freeze-up of the Great Lakes, resulting in more moisture in the air when winter storms arrive (City of Toronto Transportation Services, 2009). Also of concern are increased freeze-thaw cycles, which damage roads as well as trees and plants, and increases in freezing rain, which result in traffic accidents and deaths.

2.4 Impacts on the Urban Forest

Toronto's trees make the city more beautiful and more liveable. In 2007, the City of Toronto committed to doubling its tree canopy from 17 to 34% by 2050 to cool the city, reduce stormwater runoff, absorb some air pollutants and sequester carbon (City of Toronto, 2007a). Climate change will challenge the City's ability to meet this goal. Toronto's canopy has actually declined 4 – 5 % in the last 15 years. Increases in heat, erratic precipitation, storms, and exotic pests – all exacerbated by climate change – make life difficult for urban trees (Wieditz and Penney, 2007).

III. TAKING ACTION ON ADAPTATION

1. Including Adaptation in Toronto's Climate Change Plan

Despite growing awareness of climate change impacts, when a new City Council decided in late 2006 to create an ambitious new climate change plan, adaptation was not yet top of mind. Adaptation was included in the plan at the urging of the Clean Air Partnership (CAP), a local non-governmental organization. CAP had published *A Scan of Climate Change Impacts on Toronto* (Wieditz and Penney) in 2006, and met individually with the Mayor and many City Councillors to discuss the need to adapt to avoid the worst impacts. CAP also hosted two workshops for City of Toronto staff on the issue. Two key City Councillors – the Chair and Vice Chair of the City's Parks and Environment Committee – became convinced that adaptation was necessary. As a consequence, the City incorporated a commitment to investigate Toronto's vulnerability to climate change in *Change is in the Air*, the City's climate change plan, adopted in the summer of 2007 (City of Toronto, 2007b).

2. The Adaptation Team

To guide this work, the Toronto Environment Office (TEO) established an Adaptation Steering Group. The group consisted of policy and program staff from 14 City Divisions and Agencies expected to be impacted by climate change. TEO also set up and chaired a core group of seven staff to undertake the day-to-day work of mapping out an adaptation plan and managing the public consultation process. This group met almost weekly from September 2007 until April 2008.

Six departments – Toronto Public Health, City Planning, Toronto Water, Transportation Services, Urban Forestry and Financial Services – expressed great interest in a citywide adaptation project, as did the Toronto and Region Conservation Authority, which had been working hard for several years on the issue. However, there were some pockets of resistance in some areas. A few staff expressed scepticism about climate change. Others felt that that uncertainties in the science precluded taking action at this time. Some staff members were concerned about additional workload, and others felt that new adaptation measures would likely prove too costly in light the financial pressures on the City. The Deputy City Manager advised staff, however, that the adaptation project required their cooperation.

Over the next eight months, the Adaptation Steering Group completed a framework document that outlined the issues, developed a broad adaptation strategy, and ushered it through a public consultation process.

3. Building Capacity and Engagement

Many members of the Adaptation Steering Group had little previous experience in assessing climate change impacts or planning to adapt and they faced a steep learning curve. The Chair of the group undertook a number of activities to make available information on impacts and

adaptation to group members and in some cases to engage other key City staff. These activities included:

- Compiling information about what other municipalities were doing on the issue;
- Encouraging attendance at workshops and conferences to increase familiarity with concepts and issues in climate change impacts and adaptation;
- Participating in the regular webinars of the new Canadian Alliance for Resilient Cities as well as meetings of its U.S. counterpart, the Urban Leaders Adaptation Initiative; and
- Organizing meetings with the Climate Change Scenarios Network, the Public Infrastructure Engineering Vulnerability Committee, the Canadian Institute of Planners, and others to help the City with thinking about climate change scenario modelling, infrastructure risk assessment and other issues.

To increase internal engagement, the Chair of the Adaptation Steering Group also arranged individual meetings with key divisions, including: Insurance and Risk Management, Community Development, Water Infrastructure Management, the City's Emergency Management Working Group, the Economic Development Office, Toronto Public Health, Toronto Hydro and the Executive Environment Team. These meetings included presentations about climate change and its potential impacts in the region and engaged officials in discussions about what they might need to do to respond. TEO also met with the Mayor and with the Chair of the Parks and Environment Committee to brief them on the developing adaptation strategy and public consultation process.

The Adaptation Steering Group also invited a number of climate and adaptation scientists, analysts from the insurance industry and infrastructure engineers to join an Expert Panel to provide advice. Members of the Expert panel made presentations at two key meetings: an internal meeting with senior staff from the City's Divisions held in November 2007, and a large public meeting of the City's Parks and Environment Committee in January 2008, attended by more than 100 members of City staff, local environmental organizations, the public and the press. The Panel presentations gave City staff and political officials a sobering preview of potential climate impacts on the City, including the costs of not taking action to prepare for expected changes.

4. Developing a Framework Document

The Adaptation Steering Group developed a "framework document" to help inform internal and public discussion about climate change impacts and adaptation. This document proved harder to write than expected. The issues were new for many of the members, and the group was attempting to devise a comprehensive strategy for a large and complex city with no real precedent. Several international cities had begun adaptation planning, but few had made detailed information available about their processes, so there were few examples to follow (Penney and Wieditz, 2007). When the first draft was completed, fourteen City departments made detailed – and in some cases divergent – recommendations, which had to be considered in reworking the document.

The final framework document was called *Ahead of the Storm: Preparing Toronto for Climate Change* (City of Toronto, 2008b). It provided information on the impacts Toronto can expect from climate change, explained why adaptation is necessary and recommended a long-term process for developing a comprehensive adaptation strategy for Toronto. This longer-term process has nine steps:

- Create the internal mechanisms and processes for the development of a comprehensive, multi-year adaptation process;
- Engage the public, business and other stakeholder groups;
- Incorporate climate change adaptation into City policies and high level plans;
- Use best available science to analyze how climate is changing locally and what the future is likely to bring;
- Use this analysis to identify Toronto's vulnerabilities to climate change;
- Conduct a risk assessment to identify priority impacts requiring adaptation action;
- Identify and assess adaptation options to reduce the risk;
- Develop and implement climate change adaptation strategies; and
- Monitor climate change, evaluate the effectiveness of adaptation initiatives in protecting the City from continuing changes, and adjust strategies when necessary.

Ahead of the Storm identified a number of existing programs that serve to provide protection from current weather extremes, and which provide a basis for building a more comprehensive adaptation program aimed at protecting against future impacts of climate change. The framework document also proposed a number of short-term projects that could be undertaken right away, and could help address current and future impacts, some of which are included in Table 1.

The Toronto Environment Office produced a shorter "highlights" version of the framework document to help in the public consultation process. This report was distributed in print form and made available on the City of Toronto website.

Figure 3: *Ahead of the Storm: Highlights Version*



Source: City of Toronto (2008c)

Table 1: A Selection of Short-term Adaptation Projects Recommended in the Toronto Strategy

Recommended Short-term Adaptation Projects	Anticipated Benefits
Study of Recent Regional Climate Trends and Future Climate Projections	Improved information on expected climate extremes as well as likely gradual changes to permit better decision making on adaptation planning and for use in next generation watershed plans.
Climate Change Vulnerability and Risk Assessment of City Operations	Improved understanding of where vulnerabilities are and ranking of risks to help prioritize adaptation actions
Updating of regional extreme precipitation intensity, duration and frequency curves	Improved ability to design storm drainage infrastructure for extreme runoff events
Scan of methods used in other jurisdictions for assessing vulnerability to heat	Leading to development of heat-related vulnerability assessment tool to provide strategic direction for Toronto's Hot Weather Response Plan
Analysis of when and where green roofs could be required	Support for a new Green Roof by-law expected to reduce demand for air conditioning and storm water runoff
Urban Heat Island research to inform land use planning policy approaches to "cooling" the City	Identification of Toronto's "hotspots", what causes them, and strategies to reduce them
Climate change vulnerability risk assessment of major road culverts and bridges	Informing upgrades to infrastructure, and reducing the risk of infrastructure failure due to extreme weather, so that disruptions to the public and significant insurance claims can be minimized
Expand parkland naturalization and naturalization of lands surrounding water and wastewater facilities	Increased canopy cover in our parks and open spaces from 30% to over 50% and reduced stormwater runoff
Introduce a new standard for supporting healthy tree growth by continuous soil trench systems in commercial areas	Extended life of trees from 6 years to 35 years in commercial areas, increasing shade, and reducing energy demand for cooling
Elimination of new reverse slope driveways	Reduced flooding during extreme precipitation events

Source: Adapted from Ahead of the Storm (City of Toronto, 2008b)

5. Consulting the Public and Other Stakeholders

The Toronto Environment Office held six meetings to consult the public and stakeholders on *Ahead of the Storm*. Each of the meetings began with a presentation of the main issues and recommendations from the document. Attendees were then invited to discuss the impacts they felt were key, any gaps they saw in the City's analysis and action the City should take.

Many of the participants at the consultation meetings struggled with the concept of climate change adaptation. They were much more familiar with – and many were more committed to – mitigation measures to reduce greenhouse gas emissions than adaptation. Business representatives were quick to understand some of the potential impacts of climate change, since several had experienced the adverse economic effects of power outages, floods and other results of extreme weather (David MacLeod, personal communication, May 26, 2008). As a result, business groups had a strong focus on emergency response issues. All the meetings recommended that the City should increase and broaden education programs to make Torontonians aware of the threats of climate change, and about potential adaptation solutions.

6. Political Commitments and Early Implementation

Following the public consultations the Toronto Environment Office prepared a Staff Report on a *Climate Change Adaptation Strategy* with recommendations for Council (City of Toronto, 2008a). The report was adopted unanimously by Council on July 15, 2008. The main commitments of the report and the implementation to date are as follows:

6.1 Incorporate explicit goals for adaptation of infrastructure and buildings into Toronto's Official Plan

Toronto's Official Plan comes up for review in 2010. As instructed by Council, City Planning is currently developing specific commitments for climate change mitigation and adaptation to include in the Official Plan next year (Lisa King, personal communication, April 4, 2009). Because the Official Plan guides all land-use planning and development for the City, this will ensure that climate change impacts are taken into account in all new developments and major redevelopments.

6.2 Incorporate climate change concerns into planning of all City Agencies and Divisions for 2009 and identify in 2009 budget submissions the specific actions they plan to take

In the fall of 2008, Toronto's Deputy City Manager required all City Divisions to incorporate climate change mitigation and adaptation into their programs and to identify climate change activities in their budget submissions for 2009. This directive was announced just a few months before the new budgets were due, and so none of the Divisions included brand new adaptation initiatives. However, adaptation was highlighted in Division plans and budget submissions in a way that had not occurred previously, and several existing programs were strengthened or expanded in order to better address current climate extremes and future climate change.

For example, the Parks, Forestry and Recreation Division successfully appealed for extra funds to expand the maintenance of existing trees, increase tree planting and support research into effective ways of improving the health and growth of urban trees and increasing the tree canopy (City of Toronto Parks, Forestry and Recreation, 2009). These activities are aimed at achieving the City's goal of doubling the tree canopy in the next 40 years, and reducing the urban heat island effect and stormwater runoff among other benefits. Urban Forestry has also altered and diversified tree species being planted to better withstand the expanded range of pests and more extreme conditions expected under climate change.

For several years, Toronto Water has incorporated concerns about climate change into its planning and programs. Recently, the Division identified 31 areas within the City prone to flooding and sewage backup as a result of more extreme rainfall and is undertaking a detailed analysis for each area to identify ways to reduce the risk of future flooding. Toronto Water expects to allocate several hundred million in capital projects over the next ten years to address this issue (Toronto Water, 2008). The Division is also implementing a Water Efficiency Plan that is expected to reduce pressures on the water supply system in cases of drought. Toronto Water is also collaborating with the Toronto Region Conservation Authority and adjacent municipalities to update standards for stormwater infrastructure to better protect against intense rainfall.

Toronto Public Health is conducting research in order to identify and map Toronto populations vulnerable to heat, with a view to developing a more targeted heat response system that may be more effective in protecting citizens during hot days and heat waves. With the support of the Medical Officer of Health, the Environmental Protection Office at Toronto Public Health is also trying to insert climate change concerns into a broader strategic review of priorities (Stephanie Gower, personal communication, April 4, 2009).

In 2006, City Council adopted a Green Development Standard prepared by City Planning. It set demanding environmental standards for new City-owned buildings and encouraged developers to apply the standards to private developments as well (City of Toronto, 2007b). Several requirements of the Standard serve to reduce Toronto's vulnerability to climate change by: mitigating the urban heat island effect; enlarging the urban forest; increasing shade for pedestrians; using permeable surfaces to reduce flooding, promoting on-site water storage and reuse; and encouraging drought resistant plantings. Planning officials are also piloting community-scale renewable energy generation and local distribution systems designed to enhance neighbourhood energy security. This year the City revised the standard and as of September 2009, its minimum requirements (Tier 1) will apply to all new developments in the City. The City will offer incentives to developers to achieve a higher standard (Tier 2) as well. City Planning is also working with Toronto Building on a by-law that will require green roofs on new buildings and establish construction standards for them.

The new Eco-Roof Program, managed by the Toronto Environment Office, was launched March 2009 and provides a financial incentive for existing commercial, industrial and institutional buildings to install green roofs or cool roofs on their buildings. This expands on the previous Green Roof Pilot Program run by Toronto Water in 2006-7. Green roofs absorb rainfall and slow the flow of stormwater, potentially reducing urban flooding from intense storms. They also insulate the buildings below them, cooling them naturally, reducing the need for air conditioning

in hot summers, and reducing peak demand for electricity and pressure on the grid during hot days and heat waves. “Cool roofs” reflect solar radiation, reduce heat in buildings, and demand for electricity as well.

Although these initiatives are all encouraging indicators of the integration of adaptation into City programs, some of the short-term adaptation projects proposed for specific Divisions in *Ahead of the Storm* were not included in 2009 budget proposals and some Divisions did not include any adaptation initiatives in their proposals. None of the new or expanded programs have utilized future climate projections to establish specific adaptation targets, though this may change when the Toronto Environment Office has concluded its study of recent climate trends and future climate projections for the region. (See section 6.4 below.)

6.3 To investigate a funding strategy for climate change adaptation planning and actions, including the creation of an Extreme Weather Reserve Fund

In January 2009, the City created an Environmental Protection Reserve Fund for the purpose of funding the development of Toronto’s long-term adaptation strategy, the operating budget for the Toronto Environment Office and Energy Efficiency Office, and for projects such as Deep Lake Water cooling and expanding the tree canopy. For 2009, the City committed \$500,000 from this fund for the climate and risk assessment studies described in the next section.

At the recommendation of the City’s Financial Services Division, Council also created the Extreme Weather Reserve Group of accounts to offset budget deficits arising from unexpected and unbudgeted extreme weather costs to City programs and services (City of Toronto, 2009a). Such a fund could help pay the costs of extreme weather events like the 2005 flood or the unprecedented snowfalls of 2007-8 without diverting finances from other City priorities. Unfortunately, Council decided that the funds for the Extreme Weather Reserve Group are to be provided out of end-of-year surpluses. Given the current economic climate, such surpluses seem unlikely in the near future, which leaves City operating budgets vulnerable to extreme weather events.

6.4 To establish a process for the development of a longer-term, comprehensive adaptation strategy

The City has two current projects to support development of a longer-term adaptation strategy. The Toronto Environment Office is working with a consultant, as well as with Environment Canada, the Ontario Ministry of the Environment and the Toronto Region Conservation Authority, to analyse Toronto’s current and expected future weather patterns. Particular attention will be paid to the magnitude, frequency and probability of extreme events and the main drivers that contribute to them. The study will identify the tools and data that can be used to predict future weather and climate for the region, which should be useful in planning, especially for long-lived infrastructure (City of Toronto, 2009b). Expected to be released in 2010, the study should be of value to the whole of southern Ontario (Christopher Morgan, personal communication, April 4, 2009).

The Toronto Environment Office is also in the process of hiring a consultant to develop a risk assessment methodology for identifying and prioritizing environmental risks that the City faces. As originally conceived, this tool was to focus on assessing and prioritizing risks that climate change poses for Toronto. However, at the time of writing, climate change risk assessment was about to be folded into a more general assessment of environmental risks for the City. (David MacLeod, personal communication, April 13, 2009). It is not clear if an integrated risk assessment process will ultimately benefit or detract from the assessment and prioritization of Toronto's climate risks and vulnerabilities.

6.5 To help establish and develop an Urban Climate Change Network to support co-operation, among governments, universities, colleges and non-governmental organizations on climate change mitigation and adaptation actions and strategies relevant to the City of Toronto and other urban centres.

The idea for a Toronto Urban Climate Change Network was proposed at the first consultation meeting on *Ahead of the Storm*, which brought together academics from three local universities, representatives from the environmental departments of the provincial and federal governments, and non-governmental organizations with knowledge of adaptation issues. Participants in this consultation supported the idea of an ongoing forum where they could promote collaboration and practical research that could help in the implementation of adaptation policies and programs in the Toronto region. With City Council's approval, TEO set up this Network in the fall of 2008. One of the first activities of the Network was to organize the timely *Forum on Infrastructure and Climate Change Adaptation* in April 2009, designed to promote the integration of climate change considerations into urban infrastructure projects that are currently on the upswing because of new economic stimulus investments. A large number of City staff attended this forum and participated actively in its discussions and deliberations.

Forum participants discussed potential climate change impacts for five broad areas of infrastructure: transportation; drainage and water; buildings; natural spaces; and energy. For each area, they identified critical vulnerabilities, key data needs and priority areas for action. The Forum strongly recommended the creation of a Toronto Climate Change Adaptation Working Group of decision-makers to encourage the uptake of adaptation actions in the private and public sectors and in the community. The City has agreed to convene this group in the coming months.

IV. DISCUSSION

Toronto is one of a handful of North American cities that has made a commitment to comprehensive climate change adaptation. It is still too early in the process to provide a full assessment, but the overall outlook is quite positive.

The work of the last year and a half has led to a substantial increase in the awareness and engagement of City politicians and staff on this issue. Staff members – including senior staff – from most of the City's Divisions have attended a variety of presentations and workshops on climate impacts and adaptation and participated in discussions on ways to move the agenda forward.

There is an increased understanding that a number of existing programs that protect against the effects of existing climate variability can also provide a strong basis for future adaptation efforts.

In addition to these internal activities to increase awareness and engagement, the City has reached out to community members and to other organizations that have an interest in adapting to climate change by means of public and business consultations on *Ahead of the Storm* and by establishing the Toronto Urban Climate Change Network. The proposed Adaptation Working Group, expected to include both public and private decision-makers, should expand this outreach further. The City is also heavily involved with a new Ontario Regional Adaptation Collaborative, which should raise the profile of climate change adaptation throughout the province, and stimulate an even wider range of discussion and activity.

Adaptation is beginning to be explicitly incorporated into City-wide plans and high-level policies, starting with Toronto's Official Plan. The requirement for Divisions to specifically address mitigation and adaptation in their budget submissions is also a major step forward in mainstreaming adaptation thinking and action.

Several City Divisions have integrated climate change adaptation activities into their individual planning and programs, and embarked on short-term projects to assess potential climate impacts and the adequacy of current responses. Some are in the process of strengthening existing programs that provide protection from extreme weather.

This array of current projects and activities is not yet welded together into a detailed long-term strategy, however, and there are both internal and external barriers to the development and implementation of such a strategy.

First, it is very hard to get decision-makers to commit to what could be expensive and far-reaching adaptation projects and retrofits where they are not convinced about the extent and the timeline of expected changes. There is still considerable uncertainty in climate change projections and in the identification of impacts for the region. TEO has undertaken two research projects to tackle these issues, but the results are unlikely to be available for another two years.

Also, while the City has dozens of staff working on projects and programs related to climate change mitigation, it has only one staff person whose primary work is adaptation. The task is larger than a single person can manage. Toronto's Adaptation Steering Group – with representatives from most City Divisions – should and could contribute to the ongoing leadership and coordination of adaptation, but it remains an ad hoc group without a clear mandate, targets, or regular meeting schedule. Activity by the group as a whole diminished after City Council adopted the Climate Change Adaptation Strategy, at a time when the hard work of implementing an integrated strategy needed sustained attention.

Another issue is financial resources. The current global economic recession has hit the City hard. This resulted in Toronto's decision to base its new Extreme Weather Reserve Fund on end-of-year surpluses – which look quite unlikely in the near future. Like other cities, Toronto has a major infrastructure deficit stemming from cutbacks in spending by governments at all levels during the previous two decades, The Federation of Canadian Municipalities estimates Canada's

municipal infrastructure deficit at \$123 billion (Mirza, 2007). While the need to replace crumbling infrastructure may be regarded as an opportunity for incorporating adaptation into new transportation, water, stormwater and other systems, available financing to upgrade or replace existing systems is inadequate. Where new funding is available – such as that provided by the federal government’s economic stimulus package – there is pressure to get projects built quickly, which is likely to reduce the integration of climate change adaptation measures in the projects.

Despite these challenges, it is important to recognize the leadership that Toronto has shown as one of the first urban centres in Canada to acknowledge the need for climate change adaptation and to take substantive action to tackle the problem. Toronto has made significant headway in the development and implementation of climate change adaptation plans and activities. It will be important for the City to maintain focus and momentum in order to weld together a coordinated and comprehensive strategy out of the array of activities on which it has embarked, to protect its citizens from the impacts of climate change.

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