



STAFF REPORT ACTION REQUIRED

Resilient City – Preparing for a Changing Climate Status Update and Next Steps

Date:	November 2, 2016
To:	Parks and Environment Committee
From:	Chief Corporate Officer
Wards:	All Wards
Reference Number:	P:\2016\Internal Services\E&E\Pe16012e&e (AFS 22279)

SUMMARY

Toronto has and is forecast to experience altered patterns of extreme weather as a result of climate change. Enhancing the resilience of Toronto's infrastructure and services to these changing weather patterns to reduce the risk of damage and associated costs, injury and emergency situations is a priority of City Council.

In 2014, City Council adopted the Climate Change Risk Management Policy outlining responsibilities and a governance structure for implementing the policy. Council also directed that staff report back on the status of implementation of the policy in 2016.

Implementation of the policy has been guided by use of a Thematic Area High Level Risk Assessment (HLRA) approach, designed by the cross-corporate Resilient City Work Group to:

- identify and assess potential risks of climate change and associated extreme weather events;
- define the interdependencies between key infrastructure and service providers, both private and public sector; and
- outline the actions that could be taken to mitigate priority risks.

Over the past year, High Level Risk Assessments (HLRA) have been undertaken in three Thematic Areas: Utilities, Transportation and Water, in close collaboration with City divisions, as well as external private and broader public sector organizations. To date, work has involved City Planning, Environment & Energy, Engineering & Construction Services, Toronto Water, Toronto Public Health, Transportation Services, Toronto

Transit Commission (TTC), Toronto and Region Conservation Authority (TRCA), Toronto Hydro, Metrolinx, Hydro One, Independent Electricity System Operator (IESO), Enwave, Enbridge, and representatives of the telecom sector. This report presents the key findings of the HLRA process, including a discussion of risks and interdependencies.

The HLRA process has brought together City operations with private and broader public sector service providers to identify, assess and develop solutions to improve Toronto's resilience to climate change. The HLRA needs to continue to ensure the process is completed for the other seven thematic areas. For this work to continue, the Environment & Energy Division will require additional resources to restore staffing to 2016 levels to deliver on full implementation of the Resilient City Initiative.

This report also provides an update on:

- adoption of a Climate Change Risk Management Policy by key City Agencies and Corporations, as directed by Council in 2014;
- an update on the adaptation actions outlined in the 2014 *Resilient City - Preparing for a Changing Climate* Staff Report, plus new actions;
- the development of the Extreme Weather Portal; and
- the preparation of guidelines for back-up power in multi-residential buildings.

It is important to note that this report focuses on improving Toronto's resilience to extreme weather for the purposes of reducing or mitigating the risk of damage, injury and emergency situations. Extreme weather, while changing in frequency and severity due to climate change, is only one of many risks that the City must consider in building up its resilience to extreme shocks. The outcomes of the HLRA will be provided to the City's Toronto Emergency Management & Preparedness Committee (TEMPC) for discussion within the context of other risk management scenarios and evaluations.

RECOMMENDATIONS

The Chief Corporate Officer recommends that:

1. City Council receives this report for information.

Financial Impact

Approval of future budget requests is critical to expanding the staffing and resource capacity of the Environment and Energy Division to maintain and continue the Resilient City work programs. As part of the Resilient City initiative, funding requirements for additional resources to restore staffing levels from 2016 will be included in future Operating Budget submissions of the Facilities Management, Real Estate, Environment & Energy (FREEE) Division for Council consideration to deliver on activities associated with the implementation of the Resilient City initiative, as outlined in this report.

In subsequent fiscal years, business cases will be initiated to request the necessary operating and capital funds to support the implementation of the cross-corporate actions identified in this staff report, in concert with the City's budget process.

Provincial and federal programs may also create new direct funding and co-delivery opportunities for municipalities and/or their residents to support adaptation and resilience. Toronto should proactively position itself to take best advantage of these new funding resources. Private and philanthropic funding will also have a role to play.

The Deputy City Manager & Chief Financial Officer have reviewed this report and agree with the financial impact information.

DECISION HISTORY

In July 2007, City Council unanimously adopted the 64 consolidated actions proposed in the *Climate Change and Clean Air Action Plan* (item 2007.EX10.3). Included in that plan was a direction to develop a plan to reduce the negative impacts of unavoidable changes to climate. In July 2008, City Council approved the first set of actions for working to adapt to a changing climate (item 2008.EX22.4).

In February 2013 City Council received a report entitled, "**Toronto's Future Climate: Study Outcomes**", which reported on research conducted to forecast likely climate conditions Toronto can expect to experience in 2040-2049. City Council directed that a report be prepared on what changes may be necessary to address the forecasted change in climate (item 2013.PE18.2).

In response to that direction, in December 2013 City Council received a report entitled, "**Resilient City: Preparing for Extreme Weather**" that outlined existing policies, programs and initiatives, which are making Toronto a more resilient city (item 2013.PE24.3). The report identified that interdependencies between many different City and external operations should be studied further.

In June 2014, City Council received the report, "**Resilient City: Preparing for Climate Change**" (item 2014.PE28.6). This report outlined an approach for integrating climate change resilience into decision-making and co-ordination of City operations and services. That approach was endorsed with the adoption of the Climate Change Risk Management Policy, which defines responsibilities within the Toronto Public Service executive management for identifying and mitigating climate risks. Council also directed at this time that there be regular implementation status reports, starting in 2016. This report responds to this directive.

EQUITY LENS

Experience in Toronto and around the world indicates that people already considered to be vulnerable will be more likely to experience disproportionate negative impacts of climate change. A key principle of climate change adaptation work in Toronto is the consideration of vulnerable people and the impact climate change may have on the infrastructure and services upon which they depend. Climate change adaptation and resilience actions should provide multiple community benefits and recognize:

1. the need for a fair distribution of benefits and burdens across all segments of society, to help reduce poverty and create a diversity of job opportunities; and
2. the need to consider generational impacts and propose actions that do not result in unfair burdens for future generations.

ISSUE BACKGROUND

Climate change and changing patterns of extreme weather are no longer a distant possibility, but a current reality. The Intergovernmental Panel on Climate Change (IPCC) has concluded that the warming of the climate system is 'unequivocal' and that human influence on the climate system is clear. Timely action is required to reduce greenhouse gas emissions, as well as resilience and adaptation actions to mitigate the risks and impacts associated with a changing climate.

Climate change is already impacting built and natural systems across the planet. It is anticipated to impact key economic sectors and services, water resources, food security and food production systems, human health, human security, and livelihoods. The broad ranging and often unpredictable impacts of climate change will have global, regional and ultimately, local consequences.

The Future Weather and Climate Drivers Study, commissioned by the City in 2011, predicts that Toronto will experience an increase in extreme weather events ranging from more heat waves, more intense rain events and higher average annual and maximum temperatures.

Toronto has, and is seeing these impacts. For example, the estimated direct cost to the City from the July 8, 2013 rainstorm was just over \$70 million, while the Insurance Bureau of Canada reported about \$1 billion in insurance claims.

It is imperative that the City, its Agencies and Corporations, private and broader public sector service providers, businesses and residents continue to work together to address climate change risk and to minimize the costs and impacts associated with extreme weather events. Cities are at the forefront of climate challenge, because of their concentrations of people, resources and infrastructure. Toronto's leadership is

“Urban resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.”

Rockefeller Foundation

key to ensuring the livability, health and long-term sustainability of the City in the face of the chronic stresses and acute shocks it will experience.

COMMENTS

This update is organized according to the following topic areas:

1. Implementation of the Climate Change Risk Management Policy through use of a High Level Risk Assessment Process;
2. Adoption of the Climate Change Risk Management Policy by Agencies and Corporations;
3. Updates on existing and new cross corporate climate adaptation actions; and
4. Other Activities in support of resilience.

1. Implementation of the Climate Change Risk Management Policy – Thematic High Level Risk Assessment (HLRA)

For a city to enhance its resilience to climate change, it requires an understanding of current and future anticipated climate related shocks and stresses and how city infrastructure and services will be affected in the future. Taking a risk management approach provides a structured process for identifying risks, evaluating the acceptability of risks and determining the steps required to mitigate or reduce those risks.

The City of Toronto's thinking around climate risk assessment is shaped by work that was conducted with the assistance of Deloitte in 2009-11 based on concepts of Enterprise Risk Management and the International Standard for Risk Management known as ISO 31000. The work resulted in a tailored approach to climate change risk assessment for Toronto and a customized Microsoft Access software tool known as the Toronto Climate Change Risk Assessment Tool (TCCRAT).

In order to “assess the adequacy of the City’s infrastructure to accommodate future extreme weather and to consider interdependencies”, dozens of internal and external infrastructure and service organizations have been and will continue to be involved in the climate change risk assessment process.

The HLRA process was developed by the City’s inter-divisional Resilient City Work Group (RCWG) and was informed, in part, by a jurisdictional review of other cities and the approach they adopted to address similar issues. Best practices Toronto is modeling include Barcelona and New York City. In Barcelona, the city has established a Resilience Board that includes 37 public and private infrastructure groups mandated to develop and implement resilience building efforts. Following Superstorm Sandy and the impacts it had on New York City's population, environment and economy, the City undertook a significant review of the events that transpired, their impacts and means to mitigate these risks in the future. “A Stronger, More Resilient New York”, which outlines a comprehensive plan for increasing the resilience of infrastructure and buildings citywide, was prepared with extensive engagement of public and private service providers.

To facilitate the implementation and ensure interdependencies would be identified, ten Thematic Areas were defined and relevant organizations in the pertinent Thematic Areas were invited to participate in the HLRA process. The list below identifies the 10 Thematic Areas and the services and activities included in each thematic area:

1. Utilities (electricity, telecommunications, natural gas, district heating and cooling);
2. Transportation (public transit, highways, roads, railways, airports);
3. Water (water treatment and supply, wastewater collection and treatment, stormwater management);
4. Buildings (private and publicly owned);
5. Public safety (fire/police/emergency medical services);
6. Liquid fuels (accessibility, pumping capability, supply chain breakdowns);
7. Additional networks (waste management, social services, food supply);
8. Local economy/insurance/finance (economic impact on government, residents & businesses including insurance costs);
9. Health (healthcare facilities, clinics, outpatient care centres, and health oriented programs and services); and,
10. Natural environment (ecosystem services which includes a holistic acknowledgement of the critical role played by the environment, in providing direct and indirect contributions to the health and well-being of Toronto residents).

The first three Thematic Areas to be evaluated were Utilities; Transportation; and Water. The decision to focus initial efforts on these three areas was informed by the following factors:

1. Priority for organizations under City ownership and control. An initial understanding of the City's dependencies on these critical infrastructure systems, and our ability to influence work in these Thematic Areas.
2. Polling of the Resilient City Work Group about what they felt should be a priority.
3. Readiness of staff from different organizations to participate in this new work.

Early in 2016, the first three thematic area work groups were formed with participation from the following City operations and private and broader public sector organizations:

Table 1. High Level Risk Assessment (HLRA) Participants	
Transportation	Transportation Services Division, Toronto Transit Commission, Metrolinx
Utilities/Telecom	Toronto Hydro, Hydro One, Independent Electrical System Operator (IESO), Enbridge Gas, Enwave Energy Corporation, Telecommunication companies
Water	Toronto Water

In addition, staff from City Planning, Toronto Public Health, Engineering & Construction Services and the Toronto Region Conservation Authority were engaged in supporting the work groups in carrying out the risk assessments.

The HLRA process considered two sample geographic areas of the City: downtown and an area around the Scarborough Civic Centre. For these two areas, the HLRA examined the impact that heavy rainfall could have on the areas above as well as the impact of an extended city-wide heat wave. The discussion with workshop participants explored the potential for current impacts as well as future impacts, recognizing for example, projected increases in the frequency and severity of extreme weather, greater stress on infrastructure systems due to increases in population.

The first step to the process was to conduct HLRA workshops with the participants identified in Table 1. The organizations participating in each thematic area were then brought together, along with staff from other related City operations to share key areas of concern and dependencies with other organizations within their Thematic Areas and those outside. The final step involved a facilitated HLRA session for all three Thematic Areas. Each organization shared their risks and most critical dependencies as documented during the HLRA with the rest of the groups. Potential actions to mitigate those dependencies and future opportunities for collaborative planning and work arose from those discussions.

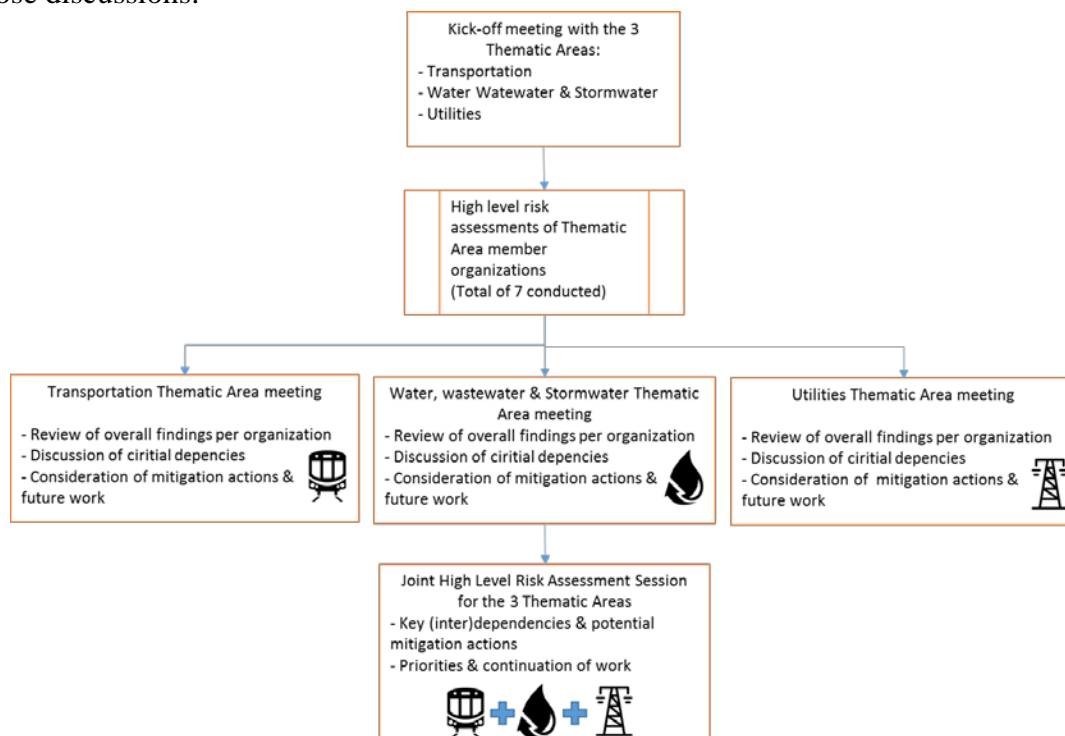


Figure 1: Overview of the High Level Risk Assessment (HLRA) process.

Figure 1. Above provides an overview of the HLRA implementation process and methodology described. Detailed information on key findings and dependencies from each Thematic Area are presented in Appendix A.

Key Cross-organizational Issues and Potential Actions

Over the course of the HLRA process, a number of cross-organizational issues emerged that may require coordinated action by a number of internal and external organizations. This is in addition to the issues and actions identified specific to individual organizations, specified in Appendix A.

Table 2 below, outlines potential actions and their rationale for inclusion. All require further research and analysis, and the development of a detailed business case, including an implementation plan and resourcing strategy.

Table 2: Resilience Actions for Future Evaluation & Assessment		
Possible Actions	Rationale	Lead(s) / Support
Cross-cutting Issues		
Coordinate with relevant City Divisions and external partners involved in the implementation of the High Level Risk Assessment process to convene an initial meeting to: a. better understand flood data availability; b. identify flood information needs for critical services and infrastructure providers; and c. coordinate data sharing to inform corporate decision making for planning and development purposes.	Stakeholders have requested greater collaboration to better understand flood information/data and how it can be better used to support decision making.	Lead: City Planning, Toronto Water, TRCA, Transportation Services Support: All relevant critical service and infrastructure providers as applicable
Explore the potential to better utilize GIS in asset management, risk identification, assessment and evaluation of control options. Conduct a municipal best practices scan and scoping exercise, to evaluate examples of GIS vulnerability assessment for applicability to Toronto.	This will assist in the planning and prioritization of resilience activities.	Lead: All relevant Divisions Support: SDFA, EED, All relevant Divisions Lead: City Planning Toronto Public Health
Further investigate options to mitigate risk associated with flooding in underpasses, to the benefit of a broad range of users and infrastructure providers.	More frequent extreme rain events are projected, which could potentially lead to more frequent flooding of underpasses.	Lead: Toronto Water, Transportation Services Division Support: Utilities, TTC, Metrolinx, Possibly other railway companies

Table 2: Resilience Actions for Future Evaluation & Assessment		
Possible Actions	Rationale	Lead(s) / Support
Investigate the financial mechanisms available for the funding of high-priority resilience projects of broad benefit to the corporation/community that require a cross-divisional approach. This will also enable the corporation to access potential external funding opportunities that may become available, but may require a matching catch contribution (e.g Public Safety Canada's National Disaster Mitigation Program)	Where individual divisional budgets do not exist or allow for a shared financing model a process is required.	Lead: Financial Planning Corporate Finance Support: EED All relevant Divisions
Assess the need for redundancy of clean, cold water supply for Deep Water Lake Cooling.	Better understand the need and business case for a redundant system that takes into account the various risks that could impact the system.	Enwave Toronto Water
Business Processes & Protocols		
Work to better understand and standardize the City's definition of 'critical buildings/operations' to inform resilience enhancement and emergency management protocols. (e.g. Only certain operations in the building may be critical, as opposed to an entire building. Similarly, critical operations could have redundancy or be movable).	Having a common definition of critical buildings/operations will assist the Corporation in prioritizing and coordinating risk reduction.	All relevant Divisions
Investigate and assess options for including threshold values for various weather parameters in construction project contracts, whereby construction activities need to change (such as too windy, too wet, too hot), based on impacts to quality and life cycle of the product. This could include assignment of responsibility for damages in the event of extreme weather during construction as infrastructure is more vulnerable to damage when it is under construction.	More volatile weather places constraints on construction, affecting the final quality of built infrastructure.	Lead: Engineering Construction Services Support: Client Divisions such as Toronto Water and Transportation Services

Table 2: Resilience Actions for Future Evaluation & Assessment		
Possible Actions	Rationale	Lead(s) / Support
Engage Ports Toronto, Billy Bishop Airport and Federal Agencies around special provisions to utilize airport and ferry infrastructure to access the Toronto Island Filtration Plant in emergency situations.	Opportunities exist to utilize the infrastructure of the organizations above to mitigate risk.	Toronto Water
Investigate options for utility accreditation to access/use emergency routes designated for first responders, as required.	This would support the restoration of critical services/infrastructure affected by severe weather.	Lead: Transportation Services Support: Utilities
Undertake an assessment to better understand the potential flood vulnerability of key downtown transformer stations.	This will provide information to better manage potential flood risk.	Lead: Toronto Hydro Hydro One Support: EED
Collaboration with other levels of government		
Request the Province of Ontario to prescribe standardized climate assumptions to inform updates and or development of standards, guidelines, and best practices in design, construction, and management of infrastructure and buildings as well as relevant processes (e.g. Environmental Assessment) and policies.	Agreed-upon climate assumptions will assist in the development and revision of standards and guidelines for the design and maintenance of infrastructure and delivery of service. It is not cost-effective for individual municipalities to develop their own local future climate assumptions. The Province is best positioned to coordinate/lead this work.	Lead: EED Support: All relevant Divisions, Agencies and Corporations
Communications - Public/ External		
Develop and implement an integrated resilience-focused communications strategy to inform residents and businesses about the available resources and actions they can take to increase their overall resilience to a changing climate and extreme weather.	Participating organizations identified that there is a need for a more coordinated approach to communicating key resilience messages by various City Divisions, Agencies and Corporations for the public and business sector to build their own resilience and community cohesion. Furthermore, there is a need to manage expectations of the City's role, resources and capabilities associated with	Lead: Strategic Communications Support: EED, All relevant City Divisions, Agencies and Corporations Utilities

Table 2: Resilience Actions for Future Evaluation & Assessment		
Possible Actions	Rationale	Lead(s) / Support
	managing extreme weather impacts on infrastructure and services.	
Identify or develop materials/resources to communicate the complex considerations the City takes into account in its decision making processes to incorporate climate change resilience considerations.	Internal and external stakeholders have identified the need for an enhanced understanding of where City processes incorporate considerations of climate change and extreme weather. This also supports the Climate Change Risk Management Policy .	Lead: EED Support: Strategic Communications
Communications - Critical Infrastructure, Service Groups		
Create a centralized alert portal to notify relevant critical infrastructure/service providers of watermain breaks and associated impacts.	Infrastructure stakeholders indicated more timely notification of watermain breaks would help reduce impacts and expedite response to service disruptions. Safety will also be enhanced.	Lead: Toronto Water Support: IT, Utility companies (e.g. Enbridge, Toronto Hydro), Transportation Services
Explore opportunities to enhance and integrate management (servicing/maintenance) of shared assets. For example, it is Transportation Services Division's responsibility to clean catch basins before and after storms; however, Toronto Water is responsible for cleaning the interior to guarantee catch basins will be able to handle increased volume of water.	For organizations that share responsibility for the management/use of assets, we identified opportunities for closer coordination to better manage potential risks associated with extreme weather events.	All relevant Divisions
Work with telecommunications service providers to assess critical service provisions, standards and understand service limitations.	Organizations that are critically dependent on telecom need to have a clear understanding of potential levels of disruption and implications to their own operations.	Lead: I & T Support: EED, PMMD, All relevant Divisions

Geographic Information Systems (GIS) Enabled Decision Making for Resilience

A number of North American jurisdictions have undertaken geo-spatial assessments of vulnerability and adaptive capacity as a way to visualize, communicate and prioritize actions to build community resiliency. New York City and San Francisco provide examples of best practices in the use of geographic information systems (GIS) to identify hazards, risks, impacts and community based solutions.

Toronto's Social Development Finance and Administration (SDFA) and Toronto City Planning have undertaken preliminary vulnerability assessments using GIS, conducted with the assistance of students. These assessments have led to an increased understanding of data needs, and challenges associated with identifying and weighting indicators that measure vulnerability and adaptive capacity.

A GIS vulnerability assessment will require a multi-layered approach that phases in goals and objectives of different Divisions over time, starting with an assessment of vulnerable populations' exposure to hazards, including climate change, followed by an assessment of vulnerable critical infrastructure and assets and an assessment of natural systems.

Overlaying these components will offer a powerful decision making tool for the implementation of the Climate Change Risk Management Policy and prioritization of work in the context of the City's overall resilience strategy.

Better Understanding of Flood Information

Numerous organizations throughout the risk assessment process expressed a need for 'flood or flood mapping' information. Various organizations have deployed significant resources and expertise to understand the potential for and impacts of various types of flooding.

For example, the Toronto Region Conservation Authority (TRCA) are custodians of *riverine* flood information. The TRCA is leading efforts to better understand riverine flooding and its risk implications. With funding from Public Safety Canada through the Natural Disaster Risk Reduction Program, TRCA is undertaking a comprehensive update to TRCA's Flood Vulnerable Areas database, creating a new geospatial tool to support mitigation analysis, emergency planning, public communication, and the prioritization of future risk reduction projects. This work will utilize detailed hazard information (hydraulic model outputs which include probabilistic factors), exposure information (e.g. structures/populations at risk), with vulnerability information (depth damage and risk to life curves), to define an overall riverine flood risk that can be overlaid and queried in a GIS environment. Two-dimensional hydraulic modelling for high-risk areas, including for the Rockcliffe Special Policy Area (SPA) in the Black Creek watershed is also being completed.

Through its Basement Flooding Protection Program, Toronto Water is undertaking detailed Environmental Assessment (EA) studies to examine the ability of the sewer system and overland flow paths to safely carry stormwater runoff during severe storms and recommend infrastructure improvements to increase the capacity of the sewer system that will reduce the risk of future flooding. These studies are well underway, but the completion of the EA studies across the entire City will take many more years.

The data and outputs arising from TRCA's and Toronto Water's efforts among others, will provide valuable information to a range of stakeholders interested in better understanding the relationship between water, Toronto's growth and development, key planning considerations, as well as more detailed information on vulnerabilities and risks associated with critical infrastructure.

In this regard, an opportunity exists to bring together key stakeholders with an expressed interest in:

- a. Better understanding flood data availability and its limitations (e.g. flood limit mapping versus flood risk mapping, overland versus riverine flood information);
- b. Identifying the flood information needs for critical services and infrastructure providers, recognizing flood information/data is currently needed to inform decisions; and
- c. Coordinating data sharing to inform corporate decision making for planning and development purposes.

Notwithstanding the above, property owners and critical infrastructure providers who suspect they may be at risk from flooding, need to take reasonable action to mitigate their risks.

Communications and Outreach

In July 2014, Council directed the Director of the Environment and Energy Division to "collaborate with the Director of Strategic Communications and all relevant City Division, Agencies and Corporations, to establish a corporate-wide integrated approach to communicating, educating, and engaging residents and businesses about the resources and supports available to them and the actions they can take to increase their resilience to a changing climate and extreme weather".

In response to that directive, in June 2016, the Environment and Energy Division in collaboration with Strategic Communications launched the Extreme Weather Portal. The purpose of the website is to educate residents about the risks of extreme weather and the actions they can take to help reduce those risks, weather-proof their homes and improve their resilience. With a focus on four weather scenarios – extreme heat, extreme rain/flooding, extreme cold, and extreme wind – the website provides resident a central portal to access information on programs, services and resources from a variety of City divisions, agencies, corporations and external organizations. The website has been and

will continue to be broadly promoted online and in-print. For more information of outreach activities, see Appendix D.

A need still exists to reach out to representatives of Toronto's business community. At the time of writing this staff report, a new private sector initiative known as ARISE was being planned by private sector groups such as PwC. The objective of ARISE Canada is to scale Canadian private sector action and engagement with government, cities and citizens in order to build a risk-resilient Canada through hazard risk-sensitive investments, disaster preparedness, response and recovery.

In addition to organizations from the private sector, community based organizations are interested to support City resilience building efforts. For example, with funding provided through a Live Green grant, Faith and the Common Good led the development of an Extreme Weather Toolkit for Faith Communities in the GTA, as well as a study on the cost of establishing 'resilience hubs'. This work has been built upon by additional community partners (e.g. Clarion, Community Resilience to Extreme Weather (CREW) in consultation with the Office of Emergency Management (OEM).

Opportunities exist to build on these initiatives with a focus on the development of an integrated resilience-focused communications strategy to inform and further engage residents and business about the available resources and actions they can take to increase their overall resilience to a changing climate and extreme weather.

Lessons Learned from HRLA Process

The HLRA process has helped to identify dependencies and interdependencies, enhance awareness of climate change and extreme weather related risks, and catalyze dialogue between key infrastructure groups. Our findings and feedback from participants led us to conclude the process has provided a broad range of benefits to the participating organizations and has provided a valuable contribution toward resilience building efforts by identifying complex issues and interdependencies (please see Appendix E: Dependency Diagrams), of which they may not have been fully aware.

This work has assisted participating organizations. In some instances, an organization may have understood that the loss of the service they provide has an impact, but did not fully understand the consequences. As an example, telecom services, specifically, cellular systems, are used to transmit stream flow data from TRCA's monitors. This information is critical to Transportation Services Division, Toronto Water, Metrolinx and various utilities in understanding watershed conditions, especially during periods of heavy rain. A communications outage therefore, has the potential to impact the ability for various organizations to manage their operations.

The process to undertake the HLRA was carefully developed, but during execution it sometimes required modification to accommodate the needs and requests of participating organizations. These requests were accommodated with an effort to maintain as much consistency of process and approach as possible. For instance, the HLRA workshops conducted with the Transportation and Water Thematic Areas were different from those conducted with the Utilities. For privately owned organizations, such as utilities, a different engagement approach and a different type of discussion around risks and vulnerabilities was required. Nonetheless, the discussions were considered valuable by all parties, resulting in subsequent follow up beyond the scope of the HLRA process.

Conducting a risk assessment exercise on another organizations' infrastructure and services, requires the development of trust and substantial buy-in. This process relies on active participation of subject matter experts and a considerable time commitment. To realize the full benefit of the HLRA process, the involvement of diverse stakeholders, with sufficient technical or operational expertise to best inform the exercise is required. Where those resources were made available and senior leadership directly participated in the process, the outcomes of the workshops have yielded more thorough results. Recognizing the sensitivity associated with some of the risks discussed, factors of liability, confidentiality, disclosure and privacy issues needed to be addressed to varying degrees.

Continuation of Work & Next Steps

The HLRA process highlighted a need for continuous and direct communication between critical service and infrastructure providers where dependencies exist. The vulnerabilities associated with their dependencies and interdependencies are exacerbated by the need for further collaborative planning and proactive sharing of information.

Follow up work is necessary to achieve the level of risk reduction that is truly possible. Going forward, the three Thematic Areas (Transportation, Utilities and Water) identified that maintaining the open channels of communication and continuing with sectoral efforts would be of great value to them. For example, the Transportation Thematic Area expressed an interest in engaging other transportation sector stakeholders, including, the Ministry of Transportation, railway companies and airport authorities. While work as a Thematic Area does not necessarily need to continue formally, an opportunity to collaborate on key issues and or specific actions does exist.

Based on the ongoing work, feedback and discussion, future activities under the Resilient City Initiative are needed in the following areas:

1. Additional work in remaining Thematic Areas (please see page 8);
2. Support for actions arising from work in the Transportation, Utilities and Water Thematic Areas;
3. Strategic and programmatic support for the 100 Resilient City initiative and the Chief Resilience Officer (CRO);
4. Support adoption/implementation of the Climate Change Risk Management policy;
5. Coordination of the cross-corporate RCWG and reporting on adaptation/resilience actions;
6. Support for detailed risk assessment using Toronto's CCRAT; and
7. Maintenance of Extreme Weather Portal and related communications focused activities.

The activities listed above, represent a significant body of work. EED staff, assigned to the Resilient City initiative have prioritized these activities for implementation. To support full implementation of these 7 activities, EED staff will develop the appropriate business cases for inclusion in the 2018 budget.

Recognizing a broad range of actions have been identified in Table 2, staff propose to work with the Resilient City Working Group and the Executive Environment Team to evaluate and prioritize which identified actions can be undertaken beginning in 2017, and to develop a more detailed business case and budget request to undertake these initiatives.

2. Adoption of a Climate Change Risk Management Policy by City Agencies and Corporations

In July 2014, City Council directed that all "City Agencies and requested that all City Corporations adopt the City's *Climate Change Risk Management Policy* or a similar policy that is consistent with the one adopted by City Council and advise the Chief Corporate Officer when such a policy has been adopted." The CCRMP establishes an ongoing approach for identifying risks as well as the clarification of responsibilities and accountability associated with managing identified risks.

Staff from the Environment and Energy Division worked with the City Manager's office to identify a total of twelve Agencies and Corporations that have the ability to implement such a policy based on their operations and services provided to the public, staffing availability and overall climate change risks. Table 3 below provides a summary.

Table 3. Adoption of a Climate Change Risk Management Policy by City Agencies and Corporations	
Organization	Status
Exhibition Place	Policy Adopted.
Toronto Parking Authority (TPA)	Policy Adopted.
Toronto Police Services (TPS)	In Progress.
Toronto Port Lands Company	Policy Adopted.
Toronto Public Library (TPL)	Policy Adopted.
Toronto Zoo	Policy Adopted.
Toronto Public Health (TPH)	Letter provided. Initiatives, plans and strategies currently underway that relate to climate change resilience. Annual reports are provided to the Board of Health.
Toronto Community Housing Corporation (TCHC)	Letter provided. Initiatives, plans and strategies currently underway that relate to climate change resilience
Toronto Transit Commission (TTC)	Adopted a formal Enterprise Risk Management policy and program which integrates the risk climate change along with the other corporate strategic objectives to provide a balanced risk score.
Toronto and Region Conservation Authority	Letter provided. Initiatives, plans and strategies currently underway that relate to climate change resilience.
Toronto Hydro	Letter provided. Initiatives, plans and strategies currently underway that relate to climate change resilience.
Build Toronto	Letter provided. Initiatives, plans and strategies currently underway that relate to climate change resilience.

While many of these agencies and corporations are actively engaged in the City's Resilient City Work Group (TTC, TCHC, TPH, TRCA, Toronto Hydro) and already provide regular updates on implementation activities, all twelve agencies and corporations will be asked in the future to provide regular updates to the Chief Corporate Officer for inclusion in status update reports to City Council.

3. Update to the Adaptation Actions from 2014

As part of the report to Council in July 2014, a list of short term adaptation actions from members of the Resilient City Working Group (RCWG) were attached as "Appendix B." An updated version of the document, which includes a list of new adaption actions – those implemented beyond 2014 – along with overall strategies, plans and initiatives that reflect the ongoing resilience work are included in the revised document and attached to this report as "Appendix B." The number of actions presented in Appendix B has increased significantly since 2014. This is a reflection of the importance placed by the

reporting operations on the need to increase the climate resilience of key infrastructure and services.

4. Other activities in support of resilience

Synergies with 100 Resilient Cities Opportunity

As part of its efforts to advance the practice of resilience building efforts in Toronto, the Environment and Energy Division led a successful application to join the 100 Resilient Cities Network, pioneered by the Rockefeller Foundation. The City of Toronto was one of 33 cities selected this year, from more than 325 applicants to join the existing network, alongside cities across the globe. In part, Toronto was selected for its existing and demonstrated commitment to resilience practice, as well as potential to further leadership and innovation in this area. Toronto's application was supported by the Mayor and City Manager, as well as numerous external partners interested in furthering Toronto's resilience building efforts, not only related to climate change, but also broader socioeconomic challenges facing Toronto.

Over the next two years, Toronto will be working to broaden the scope of its existing resilience building efforts, integrating existing plans and strategies and utilizing established resources and tools, such as the existing Resilient City Working Group. 100 Resilient Cities support for Toronto is provided in four key areas:

- a. Funding to hire a Chief Resilience Officer for a period of two years;
- b. Support to develop a broad City Resilience Strategy;
- c. A platform of services provided by platform partners to support strategy implementation; and
- d. Membership in the 100 Resilient City Network.

These supports are intended to help Toronto organize and integrate existing efforts in support of resilience and identify and scale solutions efficiently to tackle challenging urban issues. In collaboration with the City Manager's Office, the Office of the Chief Corporate Officer, the Environment and Energy Division will continue to coordinate and support resilience building efforts. In this capacity, the Division will support the Chief Resilience Officer in the development of the broader Resilience Strategy, while continuing to support work on climate resilience, including continued implementation of the HRLA process.

Collaboration with other levels of Government

At the municipal level, through its support for the Clean Air Council (CAC), Toronto is actively contributing to and benefiting from collaboration with other GTA municipalities also working on sustainability, climate change and resilience initiatives. Moreover, as authorized by City Council in the June 2014 Staff Report "Resilient City – Preparing for a Changing Climate", to date, the City has licenced the use of the Toronto Climate Change Risk Assessment Tool to York Region, the City of Mississauga and the City of

Calgary. The Transportation Association of Canada has raised \$140,000 that will be applied to updating the Tool and configuring it for use in the roads departments across Canada.

The City of Toronto continues its efforts to influence the climate change mitigation and adaptation work taking place at the Provincial level. Since the beginning of 2015, the Province of Ontario has taken significant steps towards advancing climate change action, including greenhouse gas emissions pricing. The City has provided feedback through the mechanisms available for connecting with the provincial government e.g. TOCCA – Toronto Ontario Cooperation and Consultation Agreement, in order to advocate for alignment of climate change action priorities and associated municipal needs to be taken into account. Particularly, the City has encouraged the Province to directly address the climate change adaptation challenges faced by Toronto and other municipalities, which are exacerbated by rapid population growth, social inequality and aging infrastructure.

At the international level, Toronto is also benefiting from, and participating in a network of leading global cities to advance climate change and resilience best practice. Through C40, a globally recognized coalition of 80 cities working on issues associated with climate change, Toronto participated most recently in the Conference of the Parties (COP21) in Paris, in December 2015. EED staff are co-leading a C40 Climate Change Risk Assessment Network project to document best practices in climate risk assessments that consider interdependencies and ways to prioritize risk reduction actions.

Furthermore, through the Urban Sustainability Directors Network (USDN), a network of American and Canadian cities working on broad issues in sustainability, including climate change, the City has participated in funded projects associated with climate equity issues and green infrastructure.

Complementary Corporate Initiatives

Numerous City-wide initiatives aimed at service enhancement or risk reductions are currently underway, many of which may have the potential to include consideration of climate change. Recognizing the existing Climate Change Risk Management Policy, an opportunity may exist to integrate these considerations into corporate initiatives currently underway, for example, the City's Enterprise Risk Management initiative, Excellence Toronto and the implementation of Environmental Management Systems and Quality Management Systems.

Resilience Indicators

No standard measurement of resilience is currently in use. However the City of Toronto is monitoring the work of the World Council on City Data, a leading organization developing a new international guidance document, *"Sustainable Development in Communities – Inventory of existing guidelines and approaches on sustainable development and resilience in cities and communities"*. This guidance document is sponsored by the International Organization for Standardization (ISO). It will

complement and build upon the existing ISO 37120 standard. Toronto subscribes to that standard and has been awarded "Platinum" level for the quality of its indicator data. City staff will continue to monitor developments with the ISO 37121 standard with an intent to assess the measures of resilience that may be appropriate for Toronto.

CONCLUSION

Since the adoption of the Climate Change Risk Management Policy in 2014, a broad cross-corporate effort has advanced climate adaptation and resilience building efforts in Toronto. Support for the HLRA process, implementation of the Climate Change Risk Management (CCRMP) policy, implementation of divisional resilience actions, and the development of a broad resiliency strategy through the 100 Resilient City initiative, among other initiatives, are key components of Toronto's resilience building efforts

As demonstrated by the findings, as well as the process underlying the HLRA, key interdependencies and potential risks do exist. However, taking deliberate steps to better understand and consequently address the challenges presented by climate change, including the interdependencies between physical, social and natural infrastructure, provide an opportunity for Toronto, to thrive despite the chronic stresses and acute shocks the city is currently facing and will continue to face.

CONTACT

Jim Baxter, Director, Environment & Energy Division
Telephone: 416-338-1295, E-mail: jbaxter2@toronto.ca

Mark Bekkering, Manager, Implementation and Support
Environment and Energy Division
(416) 392-8556 / mbekker@toronto.ca

SIGNATURE

Josie Scioli, Chief Corporate Officer

ATTACHMENTS

Appendix A: Key Findings from the High Level Risk Assessment Process
Appendix B: Adaption Actions
Appendix C: Back-up Power Considerations for Resiliency
Appendix D: Extreme Weather Portal – Promotion and Outreach
Appendix E: Dependency Diagrams

Appendix A: Key Findings from the High Level Risk Assessment Process

Transportation Thematic Area

The transportation thematic area focused on public transit as well as the road network and involved the following organizations: the Toronto Transit Commission (TTC); Metrolinx/GO Transit; and the Transportation Services Division (TSD). Provincial highways in Toronto, airports and CN/CP rail and water transportation were considered out of scope for this first phase of work.

Toronto Transit Commission (TTC)

The Toronto Transit Commission (TTC) has the third largest ridership in North America, after New York City and Mexico City. It operates 4 subway lines linked with 11 streetcar routes and more than 140 bus routes. Furthermore, the TTC also operates Wheel-Trans, a paratransit service for people with disabilities. With more than 1.7 million customers on an average weekday, in 2015, the TTC set an all-time record of 538 million rides, surpassing its previous all-time total of 535 million set in 2014¹.

The HLRA exercise was attended by the Chief Safety Officer as well as staff from the Engineering Department, Risk Management Office and Construction Department. Given the risk events within the purview of the assessment, the TTC team focused on subway infrastructure, service bus routes and yards – including the Hillcrest complex.

Key Findings

- a. The TTC is in the process of implementing an enterprise risk management framework which includes climate change-related risks.
- b. All transit modes have a high dependency on a reliable electrical power supply for traction power, control systems, information technology and building management systems. A thorough integrated review is needed to ensure the legacy systems remain fit for purpose, particularly in light of the many modernizing technology initiatives underway.
- c. TTC would be in a better position to manage flood risks if overland urban flood mapping was available for the City.
- d. Pumps located in subway stations are in the process of being updated to ensure they are in a good state of repair.

¹ https://www.ttc.ca/About_the_TTC/Operating_Statistics/2015/index.jsp

- e. The TTC has examined six culverts in detail and through a hydraulic analysis identified risks associated with flooding. In one instance it has been determined that embankments and consequently tracks, could be flooded by both a 10-year and a 25-year storm. This analysis has determined that the culvert does not provide adequate protection for TTC tracks.
- f. In a second instance, the culvert embankment would be overtopped under regional storm conditions. The culvert in question provides less than 25-year capacity and replacement is required. Flooding could result in damage to CN tracks. Currently, the ownership of these culverts is unclear and consequently, so are the risk management implications of this analysis.
- g. Flooding of roads and underpasses can cause localized, yet significant disruption of surface routes (buses and streetcars), as well as damage to TTC vehicles if the water were deep enough.

Dependencies on Toronto Hydro

- a. Critical dependencies exist, but risks are well understood.
- b. Blackouts, brownouts or significant instability in the Toronto grid will lead to suspension of service in the subway, Scarborough Rapid Transit, light rail and streetcar network which all rely on a stable supply of electricity for traction power. There are many ancillary impacts as well.
- c. Concerns include the impacts of loss of electrical power on the operation of subway drainage pumps leading to a potential flood that could ultimately affect wayside electrical, signalling and communications equipment.
- d. Similarly, loss of electrical power could also affect the ability to communicate with buses and streetcars and track their locations by impacting the operation of TTC's Communications and Information System (CIS). The CIS is a system that provides data and voice communications between buses, streetcars, and divisional control offices, including TTC's Transit Control. It is a real-time, mission-critical automatic vehicle locating tracking system, that provides route management and dispatch functions for surface revenue vehicles and is utilized for emergency response, dynamic scheduling, management reporting, and a passenger information system tool.
- e. In the event that Toronto Hydro's electrical feed is disrupted, maintenance and service activities at TTC bus garages could be disrupted. For example, fueling and coolant dispensing equipment will not function, rendering vehicles inoperable. TTC is installing permanent back-up power generator at each garage which will provide a temporary source of electrical power but in the event that a sustained power outage occurs, a larger portable generator will need to be brought to the impacted garage.

Dependencies on Toronto Water

- a. Risks associated with stormwater management are a concern for TTC. In some areas of the subway system, an extreme rain event may overwhelm the local combined sewer system (which conveys both wastewater and stormwater), thus contaminating the subway infrastructure and slowing recovery efforts due to the need to drain and decontaminate.
- b. Flooding of roadway and underpasses pose a risk to the operation of surface routes, both, buses and streetcars, leading to diversions and an overall degradation of transit service. Subway service could also be affected.
- c. Overland flooding of TTC-owned substations could result in interruption of subway and streetcar service. Furthermore, flooding of Toronto Hydro or Hydro One equipment can also result in the loss of supply of electricity to the TTC system.
- d. Understanding overland flood risks better will assist TTC in better integrating climate change resilience into its operation and infrastructure management.

Dependencies on Transportation Services

- a. TTC is dependent on the resilience of the transportation infrastructure, such as culverts under subway tracks. Inspection and maintenance of culverts, specifically removal of debris, so as to maintain the capacity of the culverts is a significant dependency.

Transportation Services Division (TSD)

The Transportation Services Division (TSD) is responsible for improvements to the City's public realm, road right-of-way regulation and road repair and maintenance, which can result in road restrictions. The Division also handles traffic operations, enforcement, street cleaning, snow clearing and road salting, pedestrian and cycling programs.

Assets managed by Transportation services include:

- 5,600 km of roads
- 7,945 km of sidewalks
- 600 bridges and culverts
- 481 pedestrian crosswalks
- 2,325 traffic signals
- 365 flashing beacons
- 4,100 bus shelters
- 1,000,000 signs
- 100,000 permits issued annually
- 112 km of bike lanes
- 168 km of bike trails
- 138 km of bike routes
- 9,000 pieces of street

Through the HLRA process, the TSD team worked through the pre-defined risk events to broadly explore the impacts of extreme weather and climate change on key infrastructure and services. This HLRA work is seen by the Division as the start of an update of the system-wide detailed climate change risk assessment work conducted by the Division six years ago.

The HLRA workshop was attended by 13 representatives from the following TSD Sections/Units: Traffic Management Centre Section; Surface Maintenance, Toronto and East York District; Transportation Infrastructure Management Section; Public Realm Section; and, Road Operations, Scarborough and North York District.

Key Findings

- a. The most critical climate change risk events for TSD were found to be extreme rain in the downtown core and extreme heat, city-wide.
- b. Existing infrastructure, especially for the downtown core, was constructed many years ago and were not designed to accommodate today's extreme weather events.
- c. Existing underpasses are a common point of flooding during extreme rain events, particularly when rainfall is greater than 40 mm. There are a number of underpasses in low-lying areas that pose a significant risk as a result of extreme rain events in the downtown core.
 - i. Examples include: Simcoe Street underpass just south of Front Street and King Street West just west of Sudbury Street – a location that has flooded on many occasions causing disruption to TTC streetcar service and significant traffic congestion in the area.
 - ii. These underpasses may not be redesigned or rebuilt in the near future. However, opportunities to mitigate the associated risks either do exist or could be developed/implemented.
 - iii. Some existing measures include: manually operated gates to restrict access to areas under risk of flooding, closed circuit television (CCTV) cameras, portable variable message signage, and communications to advise the general public of road closures.
 - iv. TSD has implemented a number of the above controls already in the Bayview Avenue flood area to allow for monitoring of status of traffic, level of water and provide advance notice of road closures. The development of business case to implement and fund automated flood gates is underway. Consideration should also be given to explore the use of water pump systems for those underpass locations prone to flooding and/or designing flood detour routes. Traffic re-routing would be of special importance for emergency services which rely on timely travel to and from emergencies.

- d. Established protocols to perform enhanced non-structural inspections of bridges and culverts in low-lying areas pre and post storm events are in place. Also, TSD cleans the top of catch basins in low lying areas prior to storm events.
- e. TSD is in the process of reviewing funds available for post-flooding exploratory excavation and repair of washed-out/softened roads that have been compromised, in order to adequately assess deep structural failures in the roadway base.
- f. On the occasion of an extreme rain event, culverts could be overwhelmed because of capacity issues or due to blockages caused by debris. This could trigger erosion of adjacent embankments, and potentially compromising the structure. Also, there is some chance that water could accumulate upstream of a collapsed culvert. A low probability but high impact event could be the sudden release of water causing a flash flood downstream, which could be a safety issue affecting people and built infrastructure downstream. TSD has taken action to better manage this known risk by inventorying culverts (less than 3 metres) city-wide, which will eventually lead to a comprehensive Culvert Management System. Also, TSD has been working with Engineering and Construction Services (ECS) to enhance the Bridge Management System (BMS) for culverts greater than 3 metres.
- g. Pavement softens and loses strength with heat, resulting in pavement 'rutting' and 'shoving' by heavy vehicles (e.g. buses), and settlement of the road surface where there are voids underground (possibly caused by previous minor undermining of the roadbed, or poorly compacted roadbeds or bike paths). In the event of an extended heat wave, there could be widespread pavement damage. Linear rutting could result in ponding of water and hydro-planing accidents. Pavement irregularities may also result in more vehicle and bicycle accidents. The cost to repair widespread deformed pavement could be very high.
- h. TSD has undertaken a comprehensive review to improve road repairs, resurfacing and reconstructions practices. The technical review has identified improved procedures and techniques and improved pavement specifications that are more sustainable and heat tolerant. In addition, TSD will now be incorporating quality assurance and quality control provisions into contracts, with third party verification used in some cases to ensure adequate practices and contract fulfillment.

Dependencies on Toronto Hydro

- a. Concerns include the loss of TSD's traffic signal system due to power failure, making diversion of vehicular traffic more challenging. This will impact the ability of emergency services to move around the core and the ability of the public to leave the downtown area in the event of an extreme rain event. TSD has put in place control measures aimed at mitigating the risks associated with this dependency. Examples include:
 - i. Priority intersections have been identified, which also includes railroad crossing, major arterial intersections and expressway ramps; and

- ii. Power redundancy (uninterrupted power supply) will be installed at 77 priority intersections by the end of 2016 in order to facilitate mobility and emergency response in the event of power outages.
- b. Interruption of electrical supply can cause disruption of the TSD's communications system, which can in turn cause untimely notification (to staff, media, and other transportation service providers) of problem areas affected by an extreme weather event. Deployment of City and contractor response personnel will be delayed, resulting in further congestion and increasing public safety issues and potential liability.
- c. The Congestion Management Plan supports resilience through the use of cameras and variable message signs on arterial and expressway roads that assist with incident and event response and congestion management, by monitoring traffic, and improving traveller information. The existing 174 CCTV cameras on expressways and arterials and planned additional 160 arterial CCTV cameras, being installed between 2016 and 2020 are dependent on electrical supply.

Dependencies on Telecom

- a. Transportation Services' traffic signal communications is reliant on wireless and land-line communications in order to allow for signal changes to be made remotely. This is especially important during an emergency when there is a need to make signal timing changes at many intersections to cope with blocked roads or diverted traffic.
- b. Transportation Services staff use their smart phones extensively, although many staff also have radios. In the event of cell phone disruption due to overuse by the public or due to cell system failure, it is understood that Transportation Services have a priority frequency. However, the protocol around activating the priority frequency or its definition are not clear.

Dependencies on Toronto Water

- a. Flooding of roads, especially low lying areas (e.g. underpasses), will cause loss of access to properties and interruption of other non-TSD services, such as transit and, of special concern, first responders and emergency services.
- b. Better understanding of overland flood risks will assist TSD in prioritizing resources and in better integrating climate change resilience into its operation and management of infrastructure.

Dependencies on TRCA

- a. TSD maintains a close working relationship with the TRCA, given its dependency on the automated notifications from their comprehensive flood monitoring, CCTV cameras and real time stream gauging network. These notifications are a key tool for the division's flood risk management activities, which may include, a need to implement lane and road closures.

Dependencies on TTC and Metrolinx

- a. Transit is reliant on TSD to ensure that the roads are safe and passable in order for their operations to function efficiently and effectively. Similarly, TSD is negatively impacted when the TTC and Metrolinx experience vulnerabilities and/or failures in their systems. A failure in the transit system has a significant impact on the mobility and safety of pedestrian, cyclists and motorist. Vulnerabilities in their system results in increased congestion, travel delays, and increased emissions.

Metrolinx

Metrolinx, an agency of the Government of Ontario established in 2006, was created to improve the coordination and integration of all modes of transportation in the Greater Toronto and Hamilton Area. The organization's mission is to champion, develop and implement an integrated transportation system for the region, which enhances prosperity, sustainability and quality of life. Metrolinx's Regional Transportation Plan, The Big Move, was launched in September 2008.

In 2009 Metrolinx merged with GO Transit, the regional public transit service. Moreover, two more operating divisions were added to the organization in 2010 and 2011 respectively. The Union Pearson Express, a express rail shuttle service between Union Station in downtown Toronto and Pearson Airport and PRESTO, a new electronic fare card that allows riders to transfer seamlessly across multiple transit systems.²

² http://www.metrolinx.com/en/aboutus/metrolinxoverview/metrolinx_overview.aspx

As of April 2015, Metrolinx managed over \$10 billion in assets across the GTHA:

Asset Group	Asset	Quantity
GO Train Service	Lines	7
	Stations	63
	Route kilometres	452
	Weekday Train Trips	252
	Weekday trainsets in use	52
	Locomotives	75
	Bi-level passenger railcars	615
GO Bus Service	Terminals (Plus numerous stops and ticket agents)	15
	Route kilometres	2,796
	Weekday bus trips, total systems	2,529
	Weekday bus trips, to/from Union	634
	Single-level buses	383
	Double-decker buses	117
Across GO Transit	Parking spaces	69,123
	Park and Ride lot spaces	3,911
	Parking structures	10
	Stations/terminals with bike shelters	59
	Stations with bike lockers	5
	Solar Panel (photovoltaic) installations	3

Source: Metrolinx (2015) *Moving the Region Forward: Metrolinx 2014-2015 Annual Report* (Toronto: Metrolinx), page 75. (http://www.metrolinx.com/en/aboutus/publications/Annual_Report_2014-2015_EN.pdf)

The Government of Ontario has committed approximately \$30 billion towards new infrastructure assets over the next 10-20 years that will increase two-way frequent service through the Regional Express Rail, electrify a significant part of the network, and provide additional Bus Rapid Transit and Light Rail Transit service such as the Eglinton Crosstown.

From 2012 to 2015, TSD and EED provided initial support and encouragement to Metrolinx on climate change risk management activities. In 2015 Metrolinx created an internal Resiliency Working Group as part of the development and implementation of a broader resilience program. Their first major task was to contribute to and oversee a Climate Change Engineering Vulnerability Assessment of six representative assets with the aim to identify actions to mitigate the vulnerability of its infrastructure to the impacts of climate change and extreme weather events. The assets selected were two maintenance facilities (bus and rail), two GO Stations, and segments of two rail corridors. This work utilized the PIEVC protocol.³

Furthermore, Metrolinx recently released a Sustainability Strategy, 2015-2020, that includes five key sustainability goals, including Goal 1: Become climate resilient, and a new track standards manual that includes a higher Preferred Rail Laying Temperature for all new track that should reduce the risk of track warping and 'sun kinks' due to hot

³ PIEVC is the Public Infrastructure Engineering Vulnerability Committee.

temperatures. The organization recognizes that it has been dealing with climate change risk across many divisions, but to date much of this work has been under-documented. Metrolinx is committed to establishing a Corporate Climate Adaptation Plan covering facilities, practices and protocols by the end of 2017. This includes developing climate resiliency requirements for inclusion within technical standards, manuals, guidelines, and procurement project agreements (e.g. Alternative Financing and Procurement (AFP) and Project Specific Output Specifications (PSOS)).

The HLRA exercise was attended by the Senior Advisor, Sustainability, Regional Planning, Planning & Policy. Considered during the session were flood risks to Union Station, including the Union Station Rail Corridor, the Union Station Bus Depot, and the GO Transit Control Centre (GTCC), as well as extreme heat risk to the UP Express corridor.

Findings from the PIEVC assessment could not be shared with the City, as the report had not yet been fully reviewed internally. Nevertheless, an attempt was made by Metrolinx to utilize the results to inform the HLRA process. However, given the underlying methodology guiding the separate assessments, the transferability of the results was of limited effectiveness. Metrolinx hopes to revisit applying a HLRA type exercise to more of their key infrastructure assets in the near future, including Union Station and the UP Express rail corridor that considers the full spectrum of relevant climatic parameters.

The City looks forward to learning the details of the PIEVC assessment report, the work of the internal Resiliency Working Group and the details of the Corporate Climate Adaptation Plan. This will assist the City in better understanding Metrolinx's vulnerabilities to climate change and its associated extreme weather events, its plan to address them, and the impact they could have on the overall resilience of the city.

Dependencies of Metrolinx on other organizations

Understanding and addressing vulnerability and risk, and developing effective response actions require a broader collaborative effort. In particular, the relationship between overland/urban/stormwater flooding and riverine flooding is a significant knowledge gap.

Upgrading stormwater management systems also has its own challenges due to uncertainty and financial considerations. For example, there is the challenge of determining new stormwater capacity design standards that takes climate change into account, given the uncertainty around the application of climate models to Intensity-Duration-Frequency (IDF) Statistics. Further, while enhanced standards are important, the added costs need to be considered relative to the costs of inaction.

The same applies to dependencies on reliable and resilient electricity supply, which will be even more important when a significant portion of the Regional Express Railway is electrified, and Light Rail Transit lines are operating. Back-up generators can be added to support stations or segments of lines, but the overall functioning of the network will be heavily reliant upon the supporting electrical system.

Given the interconnectedness of the regional transportation network with supporting systems, such as electricity and drainage, this poses a challenge for Metrolinx's infrastructure planning and delivery of services that are resilient to extreme weather and climate change.

Utilities

Toronto is reliant on energy inputs of electricity and natural gas, and telecommunications services, which in turn have significant interdependencies. For the purpose of the HLRA process the utilities thematic area focused on:

- Electricity - Toronto Hydro, Hydro One and the Independent Electricity System Operator (IESO)
- Downtown district heating and cooling - Enwave Energy Corporation
- Natural gas distribution - Enbridge Gas

Observers:

- Telecommunication - The Canadian Telecommunications Planning Association (CTEPA), Rogers, Telus and Allied Properties REIT (a major co-location server hotel operator in downtown Toronto).

The electrical power generation sector (e.g. Ontario Power Generation) was not included in scope.

Electrical Utilities

The HLRA of the electrical utility sector builds on previous climate change Engineering Vulnerability Assessments initiated in 2011 and funded by Natural Resources Canada. That work, using the PIEVC protocol, focused on better understanding the impact of climate change and extreme weather on electrical transmission and distribution infrastructure. Representatives from Toronto Hydro (Engineering and Investment Planning Division), Hydro One Networks (Planning) and the Independent Electricity System Operator's (IESO) System Planning Group were key participants in this process.

The electricity system is made up of three major elements: generation (the production of electricity), the transmission system (the high voltage transport of electricity to large substations), and the distribution system, which carries electricity from large substation to smaller stations and eventually homes, businesses and other customers.⁴

⁴ Electricity is supplied to Metro Toronto via stations, specifically, a network of seventeen 230kV and seventeen 115kV high voltage transmission stations. The Central area of Toronto, including the downtown core, is supplied by the 115kV network while the surrounding areas of Toronto are supplied by the 230kV network. Two key 230kV transformer stations – Manby station in the west and Leaside station in the east. They provide the supply to the Central 115kV stations via twelve 230kV to 115kV transformers. Several high voltage transmission lines terminate and emanate from these stations to supply the 115kV stations. The Portlands Energy Centre, a 550-MegaWatt natural gas electrical

Hydro One provides transmission of electricity from large centralized generating stations at high voltage to local distribution utilities across Ontario, such as Toronto Hydro. Toronto Hydro is a local distribution company that distributes electricity to Toronto's 2.8 million residents through approximately 756,000 customer connections. The City of Toronto is the sole shareholder of Toronto Hydro Corporation (the Corporation). The Corporation is a holding company which wholly owns two subsidiaries: Toronto Hydro-Electric System Limited (Toronto Hydro) which distributes electricity and engages in conservation and demand management (CDM) activities; and Toronto Hydro Energy Services Inc. which provides street lighting services.

The Independent Electricity System Operator (IESO) is responsible to ensure there is enough power to meet the province's energy needs in real time while also planning and securing energy for the future. It does this by balancing the supply of and demand for electricity in Ontario and directing its flow across the province's transmission lines; planning for the province's medium- and long-term energy needs and securing clean sources of supply to meet those needs; and overseeing the electricity wholesale market where the market price of electricity is set.

Regulatory control of electricity and natural gas sectors is a Provincial responsibility through the Ministry of Energy. The Ontario Energy Board (OEB) closely regulates energy utilities rates and the way that electrical utilities are operated and maintained. The OEB makes decisions for the approval of funding of projects required to upgrade and/or maintain the electrical system and its reliability based on the rate cases presented by the utilities.

Key Findings

- a. Recognizing the work previously completed through the PIEVC risk assessments, the focus for the HLRA process centered on high voltage transformer stations downtown. Given the relationship between distribution and transmission infrastructure, these stations are made up of infrastructure owned and operated jointly by two separate utilities (i.e., Hydro One and Toronto Hydro).
- b. Extreme rainfall in the downtown core and the associated potential for flooding were identified as potential risks for equipment at high voltage transformer stations in lower lying areas.
 - i. As a result of the HLRA, an assessment to better understand the potential flood vulnerability of key downtown transformer stations will be undertaken.

generating station on the Toronto waterfront is used to support system reliability and to meet peak electricity demand. In addition, approximately 1,500 new small-scale electricity generation facilities have been contracted for throughout the City of Toronto since 2008. These distributed generation facilities total about 95-Megawatts of new supply. The vast majority of these facilities are rooftop mounted solar photovoltaic facilities.

- c. Stations in the downtown are a concern because Toronto Hydro may not have transfer capability to restore all of the electrical load during peak periods from other supply stations.
- d. There is a concern that extreme overland flooding could cause damage to distribution and transmission station equipment such as protection systems, cables etc. and may result in extended outages. Battery systems and controls for critical protection systems must be kept dry to avoid any malfunctions and the activation of the protection system (breakers).
- e. Stations with electrical equipment in basements of buildings one or two floors below ground level are potentially more vulnerable to flooding, either from rainfall or watermain breakages. Sump pumps are in place in many locations to drain water from underground electrical equipment. However, sump pumps can also be impacted by corrosion and the gradual accumulation of debris that impacts effectiveness.
- f. During periods in which sewers may be surcharged, sump pumps servicing underground transformer vaults may be challenged to remove water from the vault due to back pressure from a surcharged sewer. Ongoing preventive maintenance operations are underway and key sump pumps are being replaced with grinder pumps to better deal with debris that can clog these systems.
- g. The prevalence of water main breaks was highlighted as a growing concern. For example, the freeze/thaw effect on surrounding soil and work associated with new development disturbs the ground, resulting in greater risks of water main breakage, especially during construction. Underground infrastructure includes drainage provisions (e.g. drainage or sump pumps). However, large volumes of water in a short time frame can exceed the capacity of the drainage system.
 - i. Repeated or sustained submersion of subsurface electrical equipment can result in reduced life expectancy and/or premature failure; and
 - ii. While watermain breaks typically flood cable chambers rather than transformer stations, the issue of watermain breaks is nevertheless a concern for stations as a larger number of customers could be impacted if a station were to sustain damage.
- h. Peak electricity demand typically occurs during a heat wave. Higher temperatures also reduce the available capacity of transformers and other electrical equipment. During 'contingency' transformer stations can operate at, or near rated capacity. Work is currently underway to add transformer capacity (e.g. new Copeland transformer station). This will help alleviate load from other stations.
- i. While extreme heat was identified as a potential operating challenge, it was considered unlikely to result in an emergency situation in which supply would need to be curtailed.

- i. In the event of a heat event, utilities usually have more forewarning, as opposed to a rainfall event, which allows for greater preparation. (E.g. communications to the public and large users to scale back usage, and as a last resort load shedding).
 - ii. Were an extreme heat event to occur and if load shedding was necessitated, it is important to understand the implications for Toronto residents, e.g. a lack of power to major residential towers.
- j. Key accounts or large users of electricity can decide to contact Toronto Hydro for operational information, but also for historical reliability data with relevance to their operations. Consequently, organizations can explore options for improving redundancy and reliability, for example, an organization may choose to pay for the installation of a secondary electrical feed.
- k. It is important for users of electricity, large and small, to understand that utilities cannot guarantee that power will be on 100% of the time. Documentation outlining conditions of service further clarify this point. Consequently, it is vital for critical customers in particular, to understand the impact a loss of electricity could have on their operations, and what measures they need to put in place to mitigate that potential impact.

Dependencies on Transportation Services Division

- a. Flooding of roadways and underpasses pose a risk to the operation of surface routes that electrical utilities rely on to access, assess and ultimately restore affected assets and equipment.

Dependencies on Drainage

- a. There is reliance on Toronto Water, Transportation Services and Engineering & Construction Services to ensure that during extreme rainfall events water drains away from transformer stations.
- b. An understanding of the potential for overland flooding would help electrical utilities in better assessing the risks to key facilities and infrastructure and assist in prioritizing where adaptation efforts should take place.

Dependencies on Telecom

- a. There is a reliance on Telecom systems to maintain remote operational capability of some switching equipment. Telecom systems are also used for internal communications. Backup and contingency plans are in place and initiatives are in progress to reduce the reliance on telecom systems.

Enwave Energy Corporation

Enwave, a private company, operates Toronto's largest district energy systems. Enwave provides District Heating services to 153 buildings through three modernized steam plants, and District Cooling services to 71 buildings through a world renowned geothermal cooling system (Deep Lake Water Cooling). The centralized steam heating system started in the 1970s, while cooling service was added in 2004. The company's innovative Deep Lake Water Cooling system uses cold water from Lake Ontario as its clean, renewable cooling source. The cold water used by Enwave is delivered to Enwave heat exchangers by Toronto Water through a single pipe from the Toronto Island Treatment plant. Steam is generated by burning natural gas and Enwave can burn diesel fuel in the event of natural gas curtailment arrangements.

Enwave's three steam plants, cooling plant and pumping station connect to a major network of distribution infrastructure including over 40 km of distribution piping, numerous tunnels, steam and cold water manholes. Customers supplied by Enwave include, Queen's Park, major hospitals, colocation hotels and major commercial office towers, data centres, the Air Canada Centre, and city buildings. Many of Enwave's customers can be considered critical; consequently, the services provided by Enwave and its response to routine and emergency situations, is of vital importance.

For the purposes of the HLRA, both heating and cooling services were considered in scope. The HLRA workshops were attended by senior Enwave representatives from the Systems Operations and Asset Management Group.

Key Findings

- a. Enwave has numerous controls in place to address issues that impact the routine delivery of its services, as well as during emergency situations. Through the HLRA, City and Enwave staff examined the impact that heavy rainfall downtown, an extended heat wave, and an extended cold period could have on Enwave's infrastructure and services, City infrastructure and services, as well as the potential impacts on the city at large.
- b. Enwave expressed an interest in establishing a utility committee with Toronto Hydro, Enbridge, telecommunication providers and their subcontractors who work on the streets (such as Entera, Beanfield etc.) to provide education on risk management in the event of steam leaks from Enwave's infrastructure and development of a steam leak notification protocol.

Impact on Cooling Operations due to Heavy Rainfall

- a. A key concern identified during the assessment was the impact of heavy rainfall and at times flooding, on Enwave infrastructure located at the Lower Simcoe underpass.
- b. During periods of heavy rainfall, the sewer infrastructure that provides heat sink to Enwave condensers in the Lower Simcoe underpass, is isolated to prevent damage to Enwave equipment. Consequently, heavy rainfall and potential flash flooding can result in reduced cooling capacity. When the Enwave infrastructure is reactivated after a flash flooding in Lower Simcoe, the combined storm and sanitary sewers contaminate Enwave condensers resulting in reduced cooling and power generation output. This happened on July 8, 2013 and more recently on July 27, 2016.

Impact on Heating Operations due to Heavy Rainfall

- a. Heavy rainfall can also result in water entering the steam tunnels. The greatest concern is associated with colder water interacting with steam pipes. This causes excessive localized steam condensation, resulting in water accumulation in pipes, that can lead to damaging "water hammer" situations leading to steam pipe or valve ruptures. Public safety may be compromised where live steam escapes into pedestrian and vehicular traffic areas.
- b. Enwave puts distribution crew and contractors on standby when the weather forecast suggests heavy rainfall, in order to proactively address any potential flooding issues in the steam chambers. Certain flood-prone manholes are equipped with sump level and temperature monitoring systems, which will send alarms to the control rooms, staffed 24/7. The safe repair and restoration of services would be prioritized. However, during this intervening time, some customers may be forced to go without supply.

Impact on Heating Distribution due to City Water Main Breaks

- a. Water main breaks can result in maintenance holes getting flooded, which can result in water hammer and steam leaks. Consequently, the repairs and restoration of service can require significant coordination with various City Divisions and agencies such as Toronto Police, Toronto Water, Toronto Fire, Toronto Hydro, Transportation Services Division and the Toronto Transit Commission (TTC), where for instance, streetcar track removal is required to affect repairs.

Impact on Cooling Operations due to Toronto Water Supply Interruption from Island Filtration Plant

- a. Another concern raised by Enwave was the potential impact that an interruption of clean water supply from the Island Filtration Plant to the mainland could have on cooling operations. An extended interruption of water supply could consequently impact the approximately 70 buildings that rely on Enwave for cooling. Toronto Water and Enwave have, and continue to work closely to address potential impacts to their respective systems where infrastructure overlaps.

Dependencies on Toronto Hydro

A constant supply of electrical power is vital in supporting heating and cooling services provided by Toronto Hydro to Enwave. To mitigate this dependency, Enwave has installed significant backup generator capacity to meet its needs, should electrical supply be interrupted. Through the HLRA process Enwave has been able to engage key contacts at Toronto Hydro that have resulted in a better understanding of the criticality of Enwave's operations on their part.

A request for a minimum of a 48-hour notification for regular planned outages has been communicated to Toronto Hydro, to ensure that both Toronto Water and Enwave are able to prepare their own equipment and customers for any temporary slow-downs or shut-downs in their services.

Dependencies on Toronto Water

Enwave is critically reliant on the supply of clean water provided through the Island Filtration Plant, via the John St. Pumping Station in order to support Deep Lake Water Cooling. The importance of this relationship is well understood by Toronto Water and Enwave and governed by the Energy Transfer Agreement. Consequently, detailed emergency planning procedures are in the works to ensure a steady supply of cold water is available, as are ongoing discussions of measures to improve overall system reliability.

In the event of City water main breaks, Enwave is heavily reliant on timely notification from Toronto Water to minimize the potential for steam leaks. Enwave also relies on Toronto Water to ensure any abandoned water mains coexisting with Enwave steam infrastructure are decommissioned expeditiously.

Enbridge Gas

Enbridge Gas, receives natural gas from a network of mostly, below ground transmission pipelines which move natural gas from various locations across North America. Valves and pressure sensors are located throughout the distribution system so that systems can be safely isolated for maintenance and emergency repairs. Distribution mains deliver gas to neighbourhoods and smaller service lines bring gas to customers.

City staff facilitated a half-day high level climate change risk assessment workshop hosted by Enbridge gas staff responsible for gas supply reliability. Enbridge participants included representatives of the following groups, Distribution System Integrity, Asset Management, Operations, and Emergency Response.

Key Findings

- a. The majority of gas distribution infrastructure is located underground and as a result is considered to be largely resilient to many types of extreme weather. Like other forms of linear infrastructure, gas pipelines cross numerous watercourses. In the event of extreme rainfall, the potential for erosion exists. In these instances, gas distribution infrastructure could be undermined by erosion, exposed or potentially damaged.
- b. Enbridge expressed considerable concern over watermain breaks that can sometimes result in damage to Enbridge pipelines, which often run parallel to other utility infrastructure, in particular water utilities. The damage can occur either from water undermining the pipe, or through "sandblasting" - a process by which a ruptured water line entrains abrasive soil particles that could compromise the gas line. When this occurs, the water utility needs to isolate the water leak before Enbridge can repair its pipe.
- c. The most significant climate induced risk for any gas utility would be a long duration cold period during which time there is a high demand on gas reserves that could result in shortages. Enbridge indicated that it has business practices in place to source gas from multiple locations in order to provide ongoing supply to customers. Climate projections generally indicate warmer as opposed to colder winters. However the winter of 2013/14 was significantly colder due to the "polar vortex" effect, which is in part brought on by climate change phenomena.

Dependencies on Toronto and Region Conservation Authority

- a. Enbridge relies on streamflow data and flooding information provided by Toronto and Region Conservation Authority to monitor and understand the potential impact of water levels on natural gas pipelines crossing waterways.

Dependencies on Telecom

- a. Enbridge staff rely on telecom technologies for dispatch staff. Although radio backup systems do exist, telecom disruption would result in slower response times of staff. Interruption of telecommunication signals (known as telemetry), which are required for monitoring pressures and flows and opening and closing valves remotely, may also be affected.

Telecommunications

Telecommunication (telecom) services are increasingly an essential part of daily life in Toronto for people and businesses. Greater Toronto's fully digital telecommunications infrastructure supports North America's largest flat rate local telephone calling area, the continent's highest percentage of wire-line telecommunications converted to fiber optic cable, and the highest per capita use of wireless devices of any city in North America. Toronto is served by fibre optic, coaxial cable, copper pair and wireless media. Toronto is home to 30% of the nation's 40,000 Information, Communication and Technology firms. The trend to higher dependency on telecom services will continue into the foreseeable future. (Source: Greater Toronto Marketing Alliance).

The telecom sector was added to the "Utilities Thematic Area" at the request of the electrical sector members, because of their significant dependency on the telecom sector for their operations. Representatives of the telecom sector included Rogers, Telus, Allied REIT (Co-location server hotel) and the Canadian Telecom Emergency Planning Association (CTEPA). Engagement with the telecom sector was limited to preliminary discussions and participation in the joint utility session and the joint thematic area session.

Initial research has revealed best practices in telecom resilience may be found in New York City and Los Angeles. In Los Angeles, the city has developed Memoranda of Understanding with telecom companies on what the city will do to help the telecom companies keep running during adverse situations and the telecom companies have committed to new actions that will help the City enhance its resilience. In New York City, staff have developed written submissions to the US federal telecom regulator asking them to impose higher levels of resilience requirements upon telecom service providers serving city.

EED staff have reached out to Canadian Federal agencies responsible for regulating the telecom industry. There is a national project underway that will consider climate hazards to the telecom sector in general. EED staff are assisting with this work.

Water

The scope of the assessment included water treatment and supply, waste water collection and treatment and stormwater management. The HLRA were attended by Toronto Water staff from Stormwater Management, Capital Programs and Facilities Asset Planning, Policy & Program Development, Sewer Asset Planning, Watermain Asset Planning, Operations Coordination, and Complex Systems.

Additional follow-up was conducted with key staff responsible for facilities including the John St. Pumping Station, the Ashbridge's Bay Wastewater Treatment Plant and the Island Filtration Plant. Other organizations invited to participate in the Water focused HLRA included the Toronto Region Conservation Authority, City Planning, Toronto Public Health, Engineering and Construction Services, and Enwave.

Key Findings

- a. Toronto Water discussed the risks from extreme rain affecting key infrastructure and services downtown. Issues raised included the impact of flooding on sanitary pumping stations, the John St. pumping station, overall drainage and collection systems.
- b. Extreme heat and its potential was not anticipated to be a major concern to the infrastructure and services discussed through the high level risk assessment process. Extreme heat however, could be an indirect concern if a heat event were to cause power disruptions.
- c. Although numerous controls are in place, in the event of a heavy rainstorm downtown, the potential for flooding of various roadways, underground parking garages, the downtown underground 'Path' and other types of sub-grade infrastructure does exist due to rain exceeding the designed capacity of the system.
- d. Sanitary pumping capacity is critical in order to discharge storm water, especially from low-lying areas. Concerns were raised recognizing that many sanitary pumping stations are below grade, as are the electrical control systems that support these stations. Sanitary pumping stations are constantly monitored and in many instances back-up generators are in place, should electrical power be lost. Installing back-up power systems for all pumping stations, (while not determined to be necessary) would be constrained by the availability of space to physically install these systems. Nevertheless concerns were raised with respect to ensuring the rapid movement of staff and equipment required to restore pumping facilities in the event of surface flooding.
- e. The probability of site flooding of the John Street Pumping Station is expected to be low. A concern was raised with respect to the potential that pipes carrying water could burst and result in flooding.
 - i. Recognizing the potential impact this could have on a key piece of infrastructure, numerous controls, including alarm systems and submersible pumps, are in place to de-water the station. If the John St. Pumping Station was to lose its connection to the Island Water Treatment Plant, redundant treated water supply would be available from the R.C. Harris Water Treatment Plant, the Parkdale Pumping Station, or numerous reservoirs.
 - ii. Given the importance of the John Street Pumping Station, two Toronto Hydro electrical feeds provide power to the station and detailed plans are in place to manage emergency situations working closely with Toronto Hydro. However, the Deep Lake Water Cooling operations where Enwave relies on the cold source of water from the Island Filtration Plant and the operations at John St. Pumping Station could be affected.

- f. Toronto Water has a wide range of redundant control systems and protocols in place to manage the impacts of flooding on infrastructure and services, in the event of a loss of electrical power.
- g. In the event of heavy rain downtown, the potential for the flooding of underpasses is present. A concern raised by Toronto Water participants as well as those from other Thematic Areas, focused on the Lower Simcoe underpass. While flooding of this and other underpasses is disruptive to a range of organizations and services, significant costs would be incurred to completely eliminate the risk of flooding (completely eliminating this risk may be impossible). Recognizing safety as a key concern, a more cost effective approach may be to use warning signs and barriers and active re-routing of traffic to reduce safety risks and minimize traffic disruption.
- h. Watermain breaks were identified by risk assessment participants as a particular area of concern. While methods to deal with watermain breaks are well-established, the timeliness of reporting and response play a key role in the overall impact. Different organizations expressed a desire for more timely information on the status and location of watermain breaks. There was some discussion around the concept of a real-time or near real-time alerting protocol.
- i. In understanding the risk associated with the potential for flooding, there is a need for property owners, buildings managers and operators to better understand what key electrical or mechanical equipment may be vulnerable, who it belongs to and who is responsible for it.
- j. Communications are provided by a dedicated trunk line, two-way radio back-up systems, as well as cellular services provided by more than one provider. Staff have advocated to maintain regular phone lines recognizing corporate telephony is increasingly provided by voice over internet (VOIP) systems (which relies upon an external electricity).
- k. An extensive rain gauge, flow monitoring and flooding monitoring network is also in place to maintain situational awareness and prepare for the potential impacts of extreme weather and other potential emergency situations, there is a strong dependency on electricity and telecom services to maintain the flow of communications.

Dependencies on Hydro One and Toronto Hydro

- a. Sanitary pumping stations rely on electricity provided by Toronto Hydro. In the event of power loss, approximately half of those pumping stations are able to run on diesel generators.

Dependencies on Enwave

- a. At the John Street Pumping station, Enwave is able to use its steam powered turbines to generate backup power should electricity supply be interrupted. This power is used by Toronto Water for its systems at the John Street Pumping Station, in addition to the redundancy provided by supply from the R.C. Harris Treatment plant and numerous other reservoirs.

Dependencies on Transportation Services Division

- a. In the event of heavy rainfall and flooding, the ability to effectively move Toronto Water staff to problem locations to make repairs is essential. Traffic conditions and flooding of roads can significantly slow Toronto Water staff response times. Cross-coordination with the Transportation Services Division is essential.

Dependencies on Telecom

- a. Toronto Water and the Toronto and Region Conservation Authority operate an extensive rain gauge, flow monitoring and flood monitoring network. This equipment all relies on telecommunications systems that are electrically powered. A loss of power could impact the flow of information at critical times, such as during extreme rain situations.

Appendix B: Adaption Actions

Existing Adaptation Actions, Policies and Procedures – those included in the 2014 report to Council with an update on the current status.				
New Adaptation Actions, Policies and Procedures – proposed or implemented following the 2014 "Resilience City – Preparing for a Changing Climate" report with an update on the current status				
Overall Strategies, Initiatives and Plans relating to resilience – provided following the 2014 "Resilience City – Preparing for a Changing Climate" report with an update on the current status				
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
1	City Planning	a) In 2015, City Planning will evaluate the impact of future weather (<i>Toronto's Future Weather & Climate Drivers Study</i>) on future built form including: buildings, infrastructure and landscapes, considering the areas we regulate and apply conditions of approval. A consulting study will be undertaken using a policy assessment methodology to complete the evaluation of some of City Planning's key policies, implementation tools and documents under a climate change/resiliency lens. The study will produce a set of priority actions that could be taken, that are most effectively implemented and addressed by City Planning.	a) City Planning prepares and stewards the City of Toronto Official Plan, a City Council adopted policy that manages growth and change. In order to better manage development in ways that contribute to a well-functioning City, City Planning in concert with other divisions coordinates the consistent application of design standards and requirements from partner divisions through the development review and approvals process. The content of City Planning policy documents needs a more detailed assessment to determine their adequacy in the face of climate change and more severe weather.	a) Request for Proposal currently under development.

		<p>b) Toronto Green Standard (TGS) and Green Roof Bylaw include performance metrics for new construction that address enhanced on-site storm water retention, increase the urban forest, reduce urban heat island effect, provisions for green and cool roofs and energy performance above the OBC. The Green Roof Bylaw has resulted in over 250 constructed green roofs resulting in a reduction of 25,000m³ of storm water (estimated). Cash-in lieu is directed to the Eco-roof incentive fund which has resulted in additional green roof retrofits on ICI structures.</p>	<p>b) Environmental performance metrics that mitigate climate change both in terms of mitigation and adaptation e.g. high energy performance for new buildings versus required water balance and quality requirements.</p>	<p>b) In effect since 2010. Work is ongoing.</p>
	City Planning	<p>New Adaptation Actions, Policies and Procedures</p>	<p>Rationale</p>	<p>Status</p>
		<p>a) Provincial Policy Statement (PPS) update included new policies to address climate change adaptation and green infrastructure.</p> <p>Official Plan Updated Environmental Policies (adopted by City Council in 2015 include harmonization with PPS climate change</p>	<p>a) Develop the policy framework required to support policy and implementation of resiliency strategies.</p>	<p>a) Adopted by Council in 2015, adopted by the Province of Ontario 2016 with commendation and no appeals.</p>

		adaptation and green infrastructure policies and greater emphasis on addressing the impacts of extreme weather and greenhouse gas reductions towards a carbon neutral built environment.		
	City Planning	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>a) City wide geo-spatial analysis of extreme weather vulnerabilities with cross divisional team.</p> <p>b) Vertical Community Resilience – research partnership with the Centre for Resilience of Critical Infrastructure.</p> <p>c) Resiliency Policy Framework – land use planning policy framework to</p>	<p>a) Develop a clearer picture and understanding of geographies of the City and factors influencing community vulnerability through cross divisional collaboration.</p> <ul style="list-style-type: none"> i. conduct a best practices cities scan and evaluate best examples of GIS vulnerability assessment for applicability to Toronto. ii. develop project scope, data layers required. iii. explore potential funding sources and multi-year budget requirements. <p>b) Dense, tall buildings provide a higher level of pressure on existing infrastructure and may expose populations to higher levels of vulnerability during disruptions.</p> <p>c) The City Planning Division needs a framework to understand, communicate and direct resiliency strategic actions over the coming decade.</p>	<p>a) Staff consultations in fall 2016. Project start anticipated for 2017.</p> <p>b) Ongoing.</p> <p>c) Ongoing.</p>

		<p>address extreme weather among partner divisions.</p> <p>d) Toronto Green Standard Update to version 3 includes energy, carbon and resiliency metrics for buildings.</p> <p>e) TOcore – looks at how the downtown area of the City of Toronto which is experiencing the highest levels of growth can positively contribute to Toronto's downtown as a great place to live, work, learn, play and invest.</p>	<p>d) TGS continues to ratchet up performance metrics for new construction using a two-tier approach: mandatory Tier 1 and voluntary Tier 2 with significant financial incentives.</p> <p>e) Helps determine how and where future growth will be accommodated, shaped and managed and what physical and social infrastructure will be needed, where it should be located and how it will be secured.</p>	<p>d) Ongoing.</p> <p>e) Ongoing since 2014.</p>
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
2	Engineering and Construction Services	Support the development and delivery of assets that are resilient.	As a delivery agent for the City's water, road, and solid waste infrastructure, proposed adaption actions are included in these division's comments.	Ongoing.

	Engineering and Construction Services	New Adaptation Actions, Policies and Procedures	Rationale	Status
		Initiated by Transportation Services; Review of Road Construction Standards and Specifications	A consultant has been hired to undertake an overall review of road construction standards and specifications, within which climate change impacts on infrastructure are being reviewed.	Consultant has received input in connection with extreme heat events on requiring new approaches to address infrastructure quality, specifically treatment of concrete during construction process to ensure integrity of delivered product. Consultant report to be completed in 2016.
	Engineering and Construction Services	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>a) Initiated by Toronto Water; Basement Flooding program, wherein once the projects have been prioritized and approved by Council through the Toronto Water Capital Budget submission, the projects are transferred to ECS for delivery, and undergo further investigation, preliminary and detailed design, and then construction.</p> <p>b) Initiated by Toronto Water; Projects to address</p>	<p>a) Work aimed at the reduction of flooding risk in areas prone to basement flooding. This will mitigate the impacts of extreme rain events. Work may include upgrades to the existing storm sewer system, such as the installation of new pipes, or the replacement of existing pipes with larger pipes, the installation of dry ponds or underground storage tanks, and other improvements to the sewer system.</p> <p>b) Restoration of a portion of East Highland Creek which was needed to protect the City's</p>	<p>a) Approved in June 2015, a 10 year plan for the provision of Professional Engineering Services for delivery of the Basement Flooding Protection Program by CH2M Hill Canada Ltd., to ensure that there is no interruption in the delivery of capital infrastructure to support the Basement Flooding Protection Program, the planned expenditures for which are expected to be about \$150 million annually. http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2015.PW6.3</p> <p>b) Investing \$10M, work started December 2011 and was</p>

		<p>weather related infrastructure protection, such as East Highland Creek Restoration.</p> <p>c) Bridge Condition Management System. Bridges (including culverts greater than 3m diameter) receive regular on-site inspections to monitor structural conditions which will include seeing impacts of ongoing weather related impacts.</p> <p>d) Initiated by Toronto Water; Design and Construction Administration of the Wet Weather Flow System to Control CSO Discharges to the Don River and Central Waterfront.</p>	<p>infrastructure (Sanitary Trunk Sewer) while minimizing valley and creek bed erosion. (1.6 km).</p> <p>c) Bridges are critical transportation infrastructure that must be well maintained. Having regular inspections allows tracking of conditions that may result from climate change driven weather conditions. Each bridge undergoes an inspection every two years.</p> <p>d) Wet Weather Flow (WWF) System addresses wet weather flows and sanitary servicing needs in one complete system that will mitigate the impacts of extreme weather events.</p>	<p>completed in June 2015. Riffle pool structures were built and the channel was realigned away from valley wall in order to prevent bed and valley wall erosion. New wetlands were created to provide flood relief.</p> <p>c) To provide information on the results of the Bridge Condition Management System, in October 2013, City staff were directed by the Public Works and Infrastructure Committee to create a tool that would inform residents about the City's bridges and their most recent inspection. The Bridge Condition website was launched in 2015. Expansion to include bridges in parks was completed in 2016. www.toronto.ca/bridges http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PW26.9</p> <p>d) Contract awarded in February 2014. Over the proposed 25-year implementation timeframe for the Project, additional elements would be constructed to achieve the significant water quality improvements and environmental benefits. The estimated cost for construction of the preferred solution as presented in the</p>
--	--	--	---	---

				Environmental Study Report was estimated at \$1.5 billion. http://www.toronto.ca/legdocs/mmis/2014/pw/bgrd/backgroundfile-67056.pdf
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
3	Facilities Management	<p>a) Include evaluation of risk of basement flooding in Building condition Assessments (BCAs).</p> <p>b) Upgrade sewer backflow prevention valves to prevent contamination in case of overwhelming rain. A capital program to upgrade water supply backflow prevention valves.</p>	<p>a) There is a policy to conduct BCAs on 20% of buildings annually. This does not include consideration of future extreme weather.</p> <p>b) Prevents backflow, the undesired reversal of water flow against normal direction, which can cause contaminants to enter into the drinking water supply system.</p>	<p>a) The entire BCA process is currently under revitalization in order to align with current market needs, aging infrastructure and SOGR standards.</p> <p>b) Ongoing.</p>
	Facilities Management	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>Short Term:</p> <p>a) Contract to reserve mobile generators on stand-by, which would be deployed to the four reception centres in case of an emergency.</p>	a – b) Investment in Critical Infrastructure.	<p>a) Contracts are currently in place for reservation of a 750KW and 250KW generators at supplier site ready to be deployed to the following sites:</p> <ul style="list-style-type: none"> - Edithvale CC - Wellesley CC - Etobicoke Olympium - Agincourt RC

		<p>b) Develop the timelines for emergency basis solutions and permanent solutions.</p> <p>c) Contract to assess City of Toronto Emergency Back-up Power for Critical Facilities Business Continuity.</p> <p><u>Long Term:</u></p> <p>d) Develop a permanent solution, including long-term costs and timelines.</p> <p>e) Identify sources of funding and procurement requirements.</p> <p>f) Develop site-by-site proposals based on needs and gap assessment at Critical facilities.</p> <p>g) Identify the long-term financial requirements to implement permanent solutions.</p>	<p>c) Risk Assessment.</p> <p>d – g) Investment in Critical Infrastructure.</p>	<p>b) Ongoing.</p> <p>c) Seven (7) critical sites have been assessed in 2015 and 18 essential sites are currently in the process of assessment.</p> <p>d) Ongoing.</p> <p>e) FM capital and REOI 9118-15-7233 for procurement of professional services and normal PMMD tender calls for construction.</p> <p>f) Ongoing as part of the assessments under item c) under short term section.</p> <p>g) Ongoing.</p>
--	--	--	---	---

	Facilities Management	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>The current FM resiliency strategy is being formalized and piloted in multiple buildings. The strategy outlines four objectives for all FM facilities as follows:</p> <p>1. Rapid Mitigation—the capacity to get systems back to normal as quickly as possible after a disaster. Carefully drafted contingency plans, competent emergency operations to get the appropriate manpower and resources to the right places are crucial. This may mean getting only critical systems up and running quickly while less critical systems can be slower to recover.</p> <p>2. Adaptability—the ability to absorb new lessons that can be drawn from a catastrophe. It involves revising plans, modifying procedures, and introducing new tools and technologies to improve robustness, resourcefulness and recovery capabilities before the next crisis.</p>	To combat climate change while addressing State of Good Repair (SOGR).	Ongoing.

		<p>3. Robustness—the ability to keep operating in the face of disaster. It translates into designing structures or systems to be strong enough or devising substitute or redundant systems to maintain operations. Robustness also entails investing in and maintaining elements of critical infrastructure to withstand low-probability but high-consequence events.</p> <p>4. Resourcefulness—the ability to skillfully manage a disaster as it unfolds. It includes identifying options, prioritizing what should be done both to control damage and to mitigate it, and communicating decisions for implementation. Resourcefulness depends primarily on people, not technology. Resourcefulness also includes the ability to cope if a key resource such as backup power becomes inoperable.</p>		
--	--	---	--	--

#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
4	Office of Emergency Management (OEM)	<p>a) Continuous improvement to response structures, associated plans and linkages to Toronto Hydro in response to extreme weather events.</p> <p>b) Continue to influence the public to be proactive (i.e. 72 hr kit and supplies) rather than reactive.</p> <p>c) Develop key preparedness messages for target populations (e.g., high-rise dwellers, small business, etc.).</p> <p>d) Conduct a risk assessment using established methodology with Toronto specific enhancement as required of the OEM under the Emergency Management and Civil Protection Act.</p>	<p>a) As identified in The Emergency Operations Centre After Action Report (July 8th Flood). And Council direction following the 2013 Ice Storm.</p> <p>b) Legislatively mandated to undertake public education related to emergency preparedness. Also included in the Emergency Risk Communicators Network – ERCoN mandate.</p> <p>c) Emergency Support Function – Emergency Social Services which includes the Vulnerable Populations Protocol. (Vulnerable Populations Working Group). Again, legislatively mandated requirement of OEM.</p> <p>d) Legislatively mandated for OEM to conduct comprehensive all-hazard Risk Assessment for the City of Toronto. The OEM must identify, document and rank the risks associated with potential threats/emergencies including extreme weather events in a detailed set of consequence and critical infrastructure categories for the entire City of Toronto.</p>	<p>a) Initiated in July 2013 - OEM and Toronto Hydro have coordinated links on OEM's Home Page and TH's updates are more accurate and updated more frequently than in the past.</p> <p>b) OEM has updated its Web Page and continues to undertake emergency preparedness presentations Meetings and solicitation of Support and Participation from Salvation Army, Canadian Red Cross MOU, Church of Latter Day Saints (Mormons), Aga Khan Foundation.</p> <p>c) OEM has developed the High Rise Living Guide and updates our website monthly (more frequent if needed). Low-income, high-rise population is the targeted demographic going into 2017.</p> <p>d) Weather related risks continue to be an important consideration in the development of the City of Toronto's Hazard Identification and Risk Assessment (HIRA).</p>

		<p>e) Continue data-driven approach to determine probability and magnitude of extreme weather events for use in the HIRA.</p>	<p>e) Hazard Identification and Risk Assessment (HIRA), utilizes a detailed, data-driven methodology to examine the natural, technological and human-caused events which can potentially impact the people, economy, environment, and infrastructure within the City of Toronto.</p> <p>The HIRA is a provincially mandated tool for municipalities to identify and understand potential hazards, under the Emergency Management and Civil Protection Act. HIRA provides a vital framework, within which the Office of Emergency Management fulfils its responsibility under the City of Toronto Municipal Code Chapter 59, Emergency Management, for overall co-ordination of the emergency management function for the City.</p> <p>Hazards are ranked based on their likelihood and impact, in order to determine their severity. This provides a way for the City of Toronto to measure the potential impact of an event upon the municipality. It is a key mechanism for the City to understand existing and future capacity to prevent, mitigate, respond to and recover from emergencies.</p> <p>Broadly speaking the following hazards represent top planning priorities for the Office of Emergency Management and partner Divisions:</p> <ul style="list-style-type: none"> • Extreme weather (including winter storms, extreme heat/cold and high speed winds) • Flooding 	<p>e) Office of the Fire Marshal and Emergency Management Ontario (OFMEM) and Office of Emergency Management (OEM) share the same weather related messaging annually.</p>
--	--	---	--	---

		<p>f) Continue to work with Emergency Management Ontario and Environment and Climate Change Canada to include extreme weather and cascading effects in their Provincial Methodology.</p>	<ul style="list-style-type: none"> • Human Health Emergency • Intentional Attack (Terrorism, Cyber Threats) • Critical Infrastructure Failure (including power outages and Nuclear incidents) • Hazardous Materials Incident/Spills • Fires/Explosion <p>The OEM utilizes industry best practice and provincial Emergency Management standards as guidance.</p> <p>f) Existing partnerships contribute to a standardized and integrated approach to response to, and management of risks associated to extreme weather events as a consequence of climate change.</p>	<p>f) Again, integral in the development of the City's HIRA.</p>
	Office of Emergency Management (OEM)	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>a) City Asset Mapping. The OEM as a part of its Emergency Social Services program, evaluated all City Recreation Facilities to gauge how they can be best leveraged for use during local and widespread emergencies.</p> <p>b) Community Outreach Process. Initiatives include:</p> <ol style="list-style-type: none"> Educating of Faith based community organizations of the issues to be 	<p>a) In 2017 OEM will attempt to engage students in Emergency Management or related programs to assist with further development of our asset mapping of the Wards across the City.</p> <p>b) OEM/City resources cannot serve all needs during an emergency. Promoting the notion of an 'empowered community' with neighbours helping neighbours is central to the development of neighbourhood resiliency in</p>	<p>a) Planning Stage for 2017.</p> <p>b) These efforts has involved:</p> <ul style="list-style-type: none"> • A Study to identify eight pilot faith buildings across Toronto to be potential resilience hubs

		<p>considered should they wish to establish Resiliency Hubs / emergency response hubs.</p> <p>ii. Assistance to Faith and the Common Good to develop a Business Model for assisting the public via a community based model.</p> <p>iii. Promoting the necessity of Personal and Family Preparedness to the General Public.</p> <p>iv. Presentations in the community on Personal Preparedness. OEM also assists with helping organizations develop response plans that are designed to support local communities.</p> <p>v. Community Capacity Survey – broadly distributed to assess community willingness to support emergency response at the local level. In 2015, the OEM issued a Community Capacity Survey asking</p>	<p>times of emergency. The OEM also directly approached many interested faith-based groups who are committed to assisting local communities during an emergency.</p> <p>Promote community resiliency through established community networks and better serve vulnerable populations at the local level</p>	<p>in the event of extreme weather or a power outage.</p> <ul style="list-style-type: none"> • Full day educational symposium at Scarborough Civic Centre on Resilience Hubs. • Evening summit on resilience hubs held at Metro Hall. • Study to identify community partners which could assist faith groups being resilience hubs. • Assisted in the completion of Completion of Tool Kit reference manual for establishing resilience hubs in faith buildings. • OEM assisted with estimates for a detailed costing analysis for establishing and running a resilience hub as compared to a regular City operated Shelter. • IPAC Conference/Resilientville, conducted in June 2016. An external subgroup name Clarion was formed out of this initiative to carry on this mission. Partnering with the City of San Francisco (a former Rockefeller Grant Recipient) to engage active community members in forming resilient networks at a local level across Toronto.
--	--	--	--	---

		community based organizations to evaluate their potential capacity for assisting the City during an emergency in a capacity they felt appropriate.		<ul style="list-style-type: none"> OEM conducts Community Education Sessions at various locations across the City on a Per Request Basis to inform the Public on Preparedness Techniques. <p>Sessions held in 2016:</p> <ul style="list-style-type: none"> Stonegate Community Health Centre, West End Neighbourhood Centre, 3079 Danforth Ave- Landlord Connect, Marina Delray Coop, 1051 Birchmount TCHC Building, Rockcliffe-Smythe Residents Association, 3047 Lawrence Ave, Tower Renewal Event, Markham Ave Property Mgt Group, FCG Training Sessions, Several Presentations to Toronto Area Interfaith Council.
	Office of Emergency Management (OEM)	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		a) Author and custodian of the City's Emergency Plan and its associated Emergency Support Functions as required under the Emergency Management and Civil Protection Act. (EMCP Act).	a) As part of the Municipal Code Ch.59 the OEM has the responsibility of the Emergency Response Plan and associated Support Functions. The ESS is a key component to response and resiliency of communities.	a) Work is ongoing.

		<p>b) Author and custodian of the City's Hazard Identification and Risk Assessment (HIRA) which is renewed and modified as required on a bi-annual basis as required under the EMCP Act.</p> <p>c) Champion, lead and general resource of the City's Corporate Business Continuity Program (BCP) assisting City Divisions with defining and planning to maintain critical operations during emergencies and with post event recovery as directed by City Council.</p> <p>d) Public Education and Awareness Activities. The OEM continually messages to the public the importance of personal and family emergency preparedness and actions to take prior to, during and after an emergency through a variety of communication</p>	<p>b) The OEM reviews the HIRA annually and has a global view of risks to the City. The OEM examines 53 hazards including but not limited to weather related impacts through a robust, evidence based, process as opposed to qualitative or speculative analysis. In the recent review process, weather related events have moved up on the HIRA chart and response plans have evolved through OEM's ESS process as well as continued partnerships with external subject-matter experts, climate specialists and levels of government, respectively.</p> <p>c) In endeavouring to improve citywide resiliency, OEM has conducted and continues to maintain a BCP to ensure rapid recovery to key City operations to major disaster events regardless of the source.</p> <p>d) In order to achieve a resilient community the OEM has been and continues to produce information in various mediums to reach the public. OEM's overall public education budget is very small at @\$0.006 per capita and would need to be enhanced to be more effective.</p> <p>e) Enhancement of the OEM web page to include and engage with community partners. OEM has expanded and</p>	<p>b) Active.</p> <p>c) Ongoing.</p> <p>d) Ongoing.</p>
--	--	---	--	---

		methods as required under the EMCP Act.	developed the Community Capacity/Engagement Portal.	
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
5	Parks, Forestry and Recreation (PF&R)	<p>a) More communication with the public to care for city and privately owned trees.</p> <p>b) Conduct Analysis of Assets prone to flooding and vulnerable to damage, keeping in mind emergency shelter status of centre.</p> <p>c) Develop a sump pump list and maintenance program that includes backup power.</p>	<p>a) "Sustaining & Expanding the Urban Forest: Toronto's Strategic Forest Management Plan" approved by Council in 2013, includes the objective of increasing tree canopy cover within the city from the current estimate of 26.6 - 28 % to 40 %. This can only be achieved by protecting the city's existing forest resource and successful establishment of numerous trees on an annual basis.</p> <p>b - d) In case of power failure, sump pumps do not operate leading to flooding of buildings. Some, but not all sump pumps have a second redundant backup pump running on regular electrical power in case the first pump breaks down.</p> <p>The consequences range from property damage (e.g., mold, mildew, electrical damage) and</p>	<p>a) Social media posts (Facebook, Twitter) to promote tree care and tree watering, particularly during summer drought conditions.</p> <p>New "Every Tree Counts" brochure to promote City's street tree planting program.</p> <p>Tree planting and tree care web site updates to accompany the new brochure are under development.</p> <p>New door hanger and planting notices under development.</p> <p>Media and public awareness campaigns include general advertising such as bus shelter ads promoting tree watering.</p> <p>b - d) Addressed project specifically when new projects are introduced and or State of Good Repair is implemented to manage current park assets.</p>

		<p>d) In areas of known flooding vulnerability, new construction should be designed to be flood resistant and redundancy in building systems incorporated to prevent flooding.</p> <p>e) Investigate whether PV panels feeding to the grid could be diverted during power outages for use by the facility.</p> <p>f) Increase the current tree maintenance program.</p>	<p>unavailability of buildings as emergency shelters to loss of use by public and revenue.</p> <p>e) PV panels feeding into the grid could be diverted during power outages, for use by the facility, if the system was designed accordingly with the correct measures in place. However, systems that are currently feeding the grid through the IESO Feed-in Tariff Contract, cannot be diverted during power outages.</p> <p>f) Proactive maintenance reduces the risk associated with tree/limb failure and improves tree health.</p>	<p>e) Parkway Forest CC was assessed for PV, and was deemed to be feasible. The community centre will be hosting a 80kW system, which has a Feed-in Tariff Contract, to supply energy to the grid for the next 20 years. Installation anticipated in 2017.</p> <p>f) Since 2009, Urban Forestry has implemented a proactive, systematic area tree maintenance program with a seven year average pruning cycle.</p> <p>The Newly Planted Tree Maintenance Program specifically targets recently planted trees to encourage good form and structure, thereby improving survivability; program includes watering, mulching and pruning.</p> <p>The Area Street Tree and Park Tree Maintenance programs focus on</p>
--	--	---	---	--

		<p>g) Refine tree watering programs</p> <p>h) Develop a preventative maintenance program for roofs.</p>	<p>g) To respond to prolonged periods of drought that are anticipated in future. Because of climate change, we are experiencing longer periods of little to no rainfall. The use of "watering bags" on newly planted trees allows for the slow release of water directly to the root zone of the tree. This means more efficient use of water and increased survival of new trees.</p> <p>h) Capital Projects conduct condition audits of faculties on a 5-yr cycle and develop a remedial plan for roofing systems, within the State of Good Repair (SoGR) program.</p>	<p>proactively inspecting and maintaining larger trees.</p> <p>g) The use of watering bags to be included in all planting contracts for 2017.</p> <p>h) There currently is a SoGR backlog. Buildings envelop is considered a high priority for emergency repairs.</p>
	Parks, Forestry and Recreation (PF&R)	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>a) Ravine Strategy.</p> <p>b) Biodiversity Training.</p> <p>c) Organic Horticulture Guidelines.</p>	<p>a) To guide the management, enhancement and protection of ravines. Short-term goals include the identification of up to 8 focal areas for investment and improvement.</p> <p>b) To provide operations Supervisors with an understanding of related policies/legislation, as well as how their work impacts biodiversity. Supervisors are scheduled for training late August, with frontline Parks staff tentatively scheduled for 2017.</p> <p>c) Based on best practices established at Corktown Common, the new guidelines will support staff in piloting this organic</p>	<p>a) Fall 2016/Spring 2017.</p> <p>b) Spring 2017.</p> <p>c) Scheduled for 2017.</p>

		<p>d) Installing bike racks over a 2 year period in select City parks (\$200K in racks) – 2017/18.</p> <p>e) Parks Maintenance Inspection Program.</p> <p>f) Growing Toronto's Tree Canopy (consultant report).</p> <p>g) Tree Species Diversity Policy and Guidelines.</p> <p>h) Forest Health Care Plan.</p> <p>i) Biodiversity Strategy (in partnership with City Planning and TRCA).</p>	<p>maintenance regime in up to 4 additional parks in 2017.</p> <p>d) Will promote increased use of bike paths/trails into parks.</p> <p>e) Through an electronic solution staff will be able to better asses and maintain parks assets.</p> <p>f) The 2013 Council approved Strategic Forest Management Plan had as one of its objectives; increasing the tree canopy from 26.6 – 28% to 40%. The SFMP also recognized that 60% of the land in the City is privately owned and that in order to increase the canopy, more planting would have to occur on private lands. In October 2016, a Staff Report, Growing Toronto's Tree Canopy will be presented to Parks and Environment Committee. The Report describes 16 actions that focus on programs and services to help increase tree planting and stewardship on private property.</p> <p>g) To improve the resiliency of the urban forest species diversity in response to forest health threats, urban stressors and climate change.</p> <p>h) Effective management of forest health threats, specifically insect and disease, is necessary to protect and mitigate effects to urban forest.</p> <p>i) To provide long term protection and enhancement of the City's flora and fauna; to enhance, connect and design.</p>	<p>d) Scheduled for 2017/2018.</p> <p>e) Ongoing on a monthly basis.</p> <p>f) October 2016.</p> <p>g) January 2017.</p> <p>h) November 2016.</p> <p>i) 2017-2018.</p>
--	--	--	--	--

#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
6	Purchasing and Materials Management	<p>a) Expiry of warehouse lease where pandemic supplies were controlled has occurred in 2015 and PMMD has relocated pandemic supplies to suitable City owned warehouse(s) as of 2016. The measures to protect pandemic supplies and warehouse(s), where pandemic supplies are stored, are in place, including without limitations:</p> <p>i) 48 hour per fill backup diesel power generator(s) for humidity and heat control and general facility and security operations,</p> <p>ii) new roof(s) with new photovoltaic installation(s) for local independent power generation,</p> <p>iii) serial locked access paths,</p> <p>iv) multiple distribution vehicles and</p> <p>v) Agreement with and that Toronto Public Health (TPH) is the primary authority responsible for distribution of</p>	<p>a) A current pandemic supplies storage solution is in place.</p> <p>Key stakeholders are aware and support the current pandemic supplies storage solution.</p>	a) Initiated in 2016 – currently in effect.

		pandemic supplies once received from PMMD warehouse(s) to locations determined as per TPH instructions.		
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
7	Shelter Support and Housing Administration (SSHA)	a) Engage in discussions with the Medical Officer Of Health to review the current temperature threshold and procedures for calling extreme cold weather alerts. Identify any required changes that would enhance responsiveness to vulnerable populations and improve services	a) Potential changes would improve responsiveness of the Division to the unique needs of marginalized and homeless individuals during extreme weather situations.	<p>a) Toronto Public Health is now overseeing and is responsible for the calling of Extreme Cold Weather Alerts. Comprehensive review of cold weather protocols complete. July 2014 City Council approved the transfer of responsibility for coordinating extreme cold weather alerts from SSHA to the Medical Officer of Health, TPH. The response plan is available on TPH website, November 2015.</p> <p>TPH is engaged in ongoing research w/ St. Michael's hospital and Public Health Ontario to investigate the need to make changes to threshold used to issue ECWA's. At this time insufficient evidence to support a change.</p> <p>Mass communication is sent out by SSHA to many community partners and stakeholders advising them when an ECWA is issued. SMIS notification of ECWA is also triggered.</p>

		<p>b) Assessment on backup power/building condition and cost associated with equipping/maintaining shelters.</p> <p>c) Development of a 10 year shelter asset management plan, in keeping with the Division's Planning framework, to address a number of issues with</p>	<p>b) This assessment would allow for potential improvement in service responses during extreme weather emergencies, including increasing the capacity of locations to shelter in place, reducing the need for evacuations.</p> <p>c) Housing Stability Service Plan action 4.2 Development of capital management and infrastructure strategy to support maintenance and redevelopment of shelter sites.</p>	<p>b) Partially Complete: Building site assessment tool has been developed and is used for new shelter developments, - This document is currently being reviewed and discussed for future use. Document not currently in use, last used in 2015. BCA's will be competed for two Directly Operated Shelters annually beginning Q4-2016/2017- Timeline to be confirmed. Facility features survey will be completed with shelter providers to obtain information concerning program/ building layout Q4-2016. New Toronto Shelter Standards, (October 1, 2015) (TSS): has defined expectation of shelter providers to identify an alternate local space in the event of an evacuation that can support the shelters continuity of service. Housing Stability Service Plan action 4.2 Development of capital management and infrastructure strategy which will support maintenance and redevelopment of shelter sites.</p> <p>c) Ongoing. As part of the divisions work towards meeting city councils 90% occupancy.</p>
--	--	--	--	--

		<p>current shelter facilities including availability of backup power and resilience against extreme rain conditions.</p> <p>d) Reinstating a system of flex beds within the shelter system which allows for shelters experiencing complications from extreme weather to relocate residents to other locations. The shelter system has had this flexibility in the past and it is vital to re-establish it for potential future events.</p> <p>e) Review staffing and operational costs under extreme weather conditions.</p>	<p>d) The ability to access and staff additional flex space within the shelter system would greatly improve service responses and reduce demand on other services such as reception/warming centres - Requirements for flex beds laid out in the Infrastructure and Service Improvement Plan for the Emergency Shelter System adopted by Council in 2015.</p> <p>e) Engaged in analysis to assess cost of 10-13 shelter programs moving to 24 hour operation. Improves client access to shelter services.</p>	<p>BCA's will be completed annually for up to 2 Directly Operated Shelter sites 2016/2017.</p> <p>Through realignment there is the opportunity to extend asset management to include shelter programs in 2017.</p> <p>d) Ongoing—plans to return flex beds to the shelter system at a future date. Flex beds are still permanent in the system. Investments have been made to provide 2 low barrier 24 hour drop-in programs, and Youth specific 24 hr drop-in to provide relief in the winter season 2015/16. 2 coed cold weather drop ins will operate in winter 2016/17. 2 24-hr Women's only drop-ins operate year round. A 3rd drop in site has not been located.</p> <p>e) Ongoing-- individual shelter sites are expected to plan for varying staff cost during unforeseen events as part of the expectations in the Toronto Shelter Standards; policies are due December 31, 2016. Cost analysis ongoing October 2016 and beyond.</p>
--	--	--	---	--

	Shelter Support and Housing Administration (SSHA)	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>a) Hostel Services Business Process for Business Continuity.</p> <p>b) Policy and Planning Business Process for Business Continuity.</p> <p>c) Partnership between SSHA and OEM.</p> <p>d) TSS - Development of emergency preparedness policies across the shelter system.</p>	<p>a) To lessen the impact of an emergency related event that could compromise the regular and essential operations of Hostel Services and its funded and supported programs.</p> <p>b) To ensure head office as the system administrator is meeting business continuity expectations to avoid potential impacts regarding service disruptions for shelter providers TSS implementation or QA.</p> <p>c) Agreement to prioritize vulnerable persons and facilities such as shelter system programs during emergency events. To be considered through the business continuity development and review process with OEM.</p> <p>d) Providers are encouraged to conduct risk assessments with tools such as Hazard Identification and Risk Assessment (HIRA). Reduces the providers need to acquire additional supports during emergency events.</p>	<p>a) Complete June 29, 2015 Business continuity plans for all directly operated shelters have been developed in partnership with OEM in June 2015. All BCP's will be reviewed and updated (as needed) on an annual basis to help facilitate the timely resumption of critical services in the event of a disruption.</p> <p>b) Complete – April 28, 2015.</p> <p>c) In progress – assigned to the Risk Management team.</p> <p>d) Complete. This is a requirement in the new TSS. In effect date February 2016. Partnership with OEM update pending is in the early stages.</p>

	Shelter Support and Housing Administration (SSHA)	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>a) Ensure identified evacuation safe sites meet the expectations outlined in the AODA.</p> <p>b) Implementation of Toronto Shelter Standards 2015.</p> <p>c) 10-year capital management and Infrastructure Strategy.</p>	<p>a) The homeless population is aging and there is an increased need of accessible spaces and facilities for persons with disabilities. Incorporate AODA expectation into evacuation and emergency plans.</p> <p>b) Improve service standards especially as it relates to emergency preparedness and business continuity within the shelter and homeless services sector. Emergency Preparedness Training for shelter staff as a defined expectation of the Toronto Shelter Standards</p> <p>c) Supports the maintenance and redevelopment of shelter sites/buildings/facilities.</p>	<p>a) Will be implemented in 2016. Toronto Shelter Standards 2015-11.4 Emergency Preparedness and Business Continuity (e) This section of the TSS took effect Feb 1.2016. Related policies from shelter providers are due December 31, 2016. HS has developed tools to review emergency preparedness policies to ensure this standard is met.</p> <p>b) TSS – Emergency Plan \Evacuation Plan training is now mandatory for all shelter staff within the first 3 months of hire. TSS training expectations deadline is June 30, 2017</p> <p>c) HS working with Facilities Management & PMMD on an RFQ to carry out accessibility audits for Purchase of Service and some DOS shelters. Through realignment an asset management team will be developed. SOGR funding assigned to POS and DOS annually for capital repairs and upgrades.</p> <p>Infrastructure and Service Improvement Plan for the Emergency Shelter System Report</p>

		d) Comprehensive Pandemic Flu Plan.	d) Sets out a clear outline of expectations for shelter staff as it relates to pandemic preparedness and health and safety practices. The Plan aims to reduce service disruptions due to staffing shortages and to support staff and the client group.	adopted by Council in April 2015; implementation currently underway. d) TSS 11.4 requires all shelter providers to have emergency/business continuity plans that include considerations for pandemic flu occurrences. Divisional Pandemic Plan created January 2010; requires updating. Divisional Realignment created Risk Management Section that may more appropriately oversee creation/maintenance of the plan.
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
8	Social Development, Finance & Administration (SDFA)	<p>a) Create a GIS tool that would consolidate data from City divisions such as the Office of Emergency Management, Transportation, Planning, Shelters (and others), Toronto Hydro, Hydro One, telecoms providers, TCHC, TDSB/TCDSB and community agencies to provide a more coherent map of which parts of the city contain critical infrastructure, vulnerable residents and available services.</p> <p>b) Determine the feasibility of pooling lists or developing</p>	<p>a) The data combined by the tool would increase response times during an emergency, cover more vulnerable persons and give responders a better picture of what is happening in various parts of the city.</p> <p>b) This will allow the City to identify those residents that will be at greater risk during</p>	<p>a) In the process of compiling data, recently received Hydro, Office of Emergency Management and Places of Worship datasets.</p> <p>No tool or app is currently available.</p> <p>Work underway since early 2015. Looking for lead division to take ownership of this as it is not tied to any current SDFA policy initiatives.</p> <p>b) This idea was rejected in the Ice Storm post-mortem report in 2013</p>

		<p>a new voluntary list of vulnerable persons (electrically-dependent, unable to move, cognitively disabled, etc.) in Toronto.</p> <p>c) Investigate the implementation of policies or program supports to improve the safety for residents of multi-residential buildings who remain in the building after the occurrence of a power outage related to an extreme weather event.</p>	<p>emergencies and incorporate this information into building Toronto's resilience.</p> <p>c) The Social Development Finance and Administration –Tower and Neighbourhood Revitalization Unit – prepares and implements policies and programs to support the improvement of apartment buildings and communities in terms of social, economic and environmental performance. Developing responses to the impacts of climate change and extreme weather aligns with the unit's objectives.</p>	<p>and is not being pursued at this time.</p> <p>c) Awareness building supports initiated in 2016 through STEP Program; broader investigation planned for 2017.</p>
	Social Development, Finance & Administration (SDFA)	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>a) Work with Faith & The Common Good to create a series of maps & profiles for 11 resiliency hubs in 2015.</p> <p>b) SDFA worked with City Planning to develop a preliminary neighbourhood-based vulnerability assessment based on a dozen indicators.</p>	<p>a) FCM is working with OEM and community faith organizations to develop community agency resiliency in neighbourhoods. This would increase response and resiliency for residents, who often turn to community agencies and religious locations for help during a mass emergency.</p> <p>b) Develop a clearer picture and understanding of geographies of the City and factors influencing community vulnerability through collaboration.</p>	<p>a) Completed in Dec 2015. Completed in Dec 2015. Funding for place of worship retrofits not currently available. No further action from the City at this time.</p> <p>b) Completed December 2015. Requires more data for further study.</p>

	Social Development, Finance & Administration	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		Development of preliminary resilience and emergency preparedness assessment questions and a toolkit resource as part of the STEP program assessment for older apartment buildings.	The STEP program supports the improvement of older apartment buildings and communities in terms of social, economic and environmental performance. Including resilience and emergency preparedness questions as part of the STEP assessment helps to build awareness of ways that older multi-residential buildings can address these issues.	Initiated in March 2016. Toolkit resource in development with assistance from OEM with targeted completion in 2016.
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
9	Toronto and Region Conservation Authority (TRCA)	<p>a) Continue to work with the Toronto Office of Emergency Management in support to its emergency planning relating to flooding.</p> <p>b) Maintenance and repairs of City's flood control infrastructure.</p> <p>c) Maintenance and repair of erosion control structures to preserve structural integrity and public safety.</p> <p>d) Develop integrated riverine/urban drainage models incorporating future</p>	<p>a) TRCA provides critical and timely hydrometric information to support municipal response plans for flood events to achieve the goal of reducing the risks to loss of life and property damage caused by flooding.</p> <p>b) Key to help manage the impact on flood control infrastructure.</p> <p>c) Severe damage from July 2013 Storm is being addressed through enhanced funding from the City. Sites include erosion hazard sites where the original protection has completely failed, placing municipal infrastructure at risk, valley system, shoreline and private property.</p> <p>d) This will provide decision makers, system planners, and field responders with more granular, timely information on impacts and</p>	<p>a) Ongoing Partnership. Further enhanced after 2013 Storm.</p> <p>b) This is an ongoing program of TRCA. Infrastructure is continuously monitored to evaluate priorities.</p> <p>c) The program was enhanced after the 2013 Storm.</p> <p>d) This work has not been initiated in Toronto yet. TRCA is working with other GTA municipalities such</p>

		<p>extreme weather. First priority will be to identify study areas for development of these models.</p> <p>e) Update Floodplain maps for Flood Vulnerable Areas incorporating new technologies (2-D modelling) with updates hydrology, hydraulics and future extreme weather projections. Location of critical infrastructure and vulnerable populations will be taken into account.</p> <p>f) Undertake a Natural Heritage risk assessment of Toronto's natural system to develop priority adaptation strategies</p> <p>g) Current gauging network is suitable for flood forecasting. However, additional flow gauging instrumentation could help comprehensively track the impacts of extreme weather on flows in valleys and ravines.</p> <p>h) Working in partnership with the WeatherWise Partnership Electrical Sector Core Project Team (facilitated</p>	<p>extent, and help address urban flooding issues. This work is contingent upon discussions with City staff (e.g., Toronto Water, OEM) and available funding.</p> <p>e) This will help determine high risk assets susceptible to riverine flooding. There is a fixed level of funding for routine floodplain map revisions and updates, and larger exercises require special budget asks.</p> <p>f) It is important to increase the resiliency of natural systems to climate change regardless of the types of change that are experienced in the future.</p> <p>g) The data collected by hydrometric networks is crucial to coordinate contingency plans, issue flood warnings, operate flood control structures and provide technical assistance to the City with respect to flood control.</p> <p>h) Electricity supply can impact critical infrastructure and services, supporting public health and safety and economic activity. This dependency makes a strong case for improving</p>	<p>as Mississauga and Brampton on urban flooding models. This work can inform any future work in Toronto related to urban flooding.</p> <p>e) Initiated in 2016 with Public Safety Canada Funding.</p> <p>f) To be initiated in 2017 Pending discussions with The City and funding availability.</p> <p>g) Ongoing.</p> <p>h) Project Completed in 2015. Report available on Ontario Climate Consortium Website.</p>
--	--	---	--	--

		by the Environment & Energy Division) TRCA initiated a risk and opportunity assessment project for the electrical transmission systems. This project is aligned well with Toronto Hydro's distribution system risk assessment.	our understanding of vulnerability of the electrical system to severe weather events and the potential influence of climate change.	http://climateconnections.ca/our-work/ .
	Toronto and Region Conservation Authority (TRCA)	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>a) Approval of “The Living City Policies for Planning and Development in the Watersheds of Toronto and Region Conservation Authority” (The LCP). The LCP will guide the implementation of TRCA’s legislated and delegated roles and responsibilities in the planning and development approvals process over the next ten years.</p> <p>b) Complex flood models for the flowing flood clusters have been completed.</p> <p>I. Lower Humber II. Lower Don including the transportation corridor</p>	<p>a) The requirement to conform with provincial legislation and policies such as the Oak Ridges Moraine Conservation Plan, the Greenbelt Plan, the Places to Grow Growth Plan and the 2005 Provincial Policy Statement, and Incorporation of systems-based approaches and best management practices to address climate change risks, environmental decline, and promote healthy, sustainable communities.</p> <p>b) TRCA has flood models for almost all the watercourse in Toronto, this information is used to delineate floodplains as per TRCA Regulation.</p>	<p>a) Approved by TRCA Board in November 2014.</p> <p>b) Completion scheduled for 2016.</p>

		<p>III. Jane/Wilson</p> <p>IV. Black Creek</p> <p>Flood risk mapping (riverine) and update of flood vulnerable database will be completed in 2016.</p> <p>c) Ontario Climate Consortium conducted a comprehensive review of climate change science in the Great Lakes Basin.</p>	<p>c) The 2015 State of Climate Change Science in the Great Lakes Basin report synthesizes available science on the observed and projected impacts of climate change in the Great Lakes Basin and documents the climate change assessment methods applied in the region.</p>	<p>c) Completed in 2016.</p>
	Toronto and Region Conservation Authority (TRCA)	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>a) Lead by Ontario Climate Consortium, TRCA is supporting a study on Comparison of Techniques for Updating Intensity Duration Frequency (IDF) Statistics – to understand the best methods for updating IDF statistics to account for projected climate change.</p> <p>b) “State of the Urban Forest in the Greater Toronto Area” report was released by Green Infrastructure Ontario Coalition completed in partnership with TRCA.</p>	<p>a) This research will help municipal water infrastructure managers to manage extreme precipitation that is expected as a result of climate change.</p> <p>b) Reports baseline data on the health of the urban forest across the Greater Toronto Area (GTA). It is a collaborative effort of 17 municipal and regional partners, bound together by a shared goal to preserve and enhance our urban forest - The Report is a Call to Action identifies four strategic priorities urgently needed to help protect and sustain Ontario's urban forests.</p>	<p>a) Completion scheduled for 2016.</p> <p>b) Report Released in 2016.</p>

		c) TRCA has flood models for almost all the watercourse in Toronto.	c) This information is used to delineate floodplains as per TRCA Regulation.	c) Models are updated on an ongoing basis using new science and land use information.
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
10	Toronto Hydro	<p>a) Conduct further studies to assess and identify assets/equipment that may be at risk due to extreme weather - results will be used to develop a plan that would enhance system resiliency.</p> <p>b) A Climate Change Risk Assessment following Engineers Canada's PIEVC protocol will be conducted in 2014, thanks to NRCan funding. The protocol will be used to evaluate key pieces of equipment under future climate scenarios. The duration and geographic extent of worst case plausible outages will be assessed.</p>	a, b) There have been some examples of extreme weather events in the province and City which resulted in prolonged outages. Aging underground distribution electricity infrastructure can be more susceptible to failure in the event of continued flooding.	<p>a) Additional assessments have been conducted to identify issues, corrective measures and lessons learned. As a result studies are included as part of our road map initiatives to alter design for future installations. The additional studies as part of the road map began in 2016 and are also discussed and coordinated with Hydro One.</p> <p>b) The final report was published in June 2015 and is available at pievc.ca.</p>

	Toronto Hydro	New Adaptation Actions, Policies and Procedures	Rationale	Status
		Adoption of the City of Toronto's <i>Climate Change Risk Management Policy</i> or a similar policy.	Requested in a memo from the City of Toronto.	Letter has been provided to the city stating that existing policies overlap with the City's policy. The city has accepted this letter and has confirmed compliance with the request.
	Toronto Hydro	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		a) Major Distribution Equipment Technical Specifications Review. b) Asset Impact Study. c) Risk Maps.	a) Toronto Hydro has developed Technical Specifications for major distribution equipment that is purchased. This initiative is to review all major equipment specifications and investigate the environmental testing requirements, compare them to the climate projections for Toronto and revise the specifications if necessary b) Each of the major distribution equipment or asset can be affected by climate change in different ways and with different magnitudes. This initiative is to conduct a study on how each type of asset is affected by the different aspects of climate change. This will drive actions in technical specifications, maintenance procedures, and replacement strategies. c) A mapping of the risk ratings was completed as part of the Climate Change Vulnerability Assessment report. This initiative is to validate these risk maps, provide access to	a-l) Work is underway. To be completed throughout 2016 and 2017.

		<p>d) Lightning Mapping.</p> <p>e) Overhead Distribution Lines Exiting Stations.</p> <p>f) Update Distribution System Planning Guidelines to include Climate Change.</p>	<p>them to planning engineers within Toronto Hydro and communicate how to utilize them within their job functions. Developing additional maps or combining risk factors into one map will also be investigated. Maps can also be used to show important locations such as critical loads (i.e. emergency services, vulnerable persons, etc.)</p> <p>d) This initiative is to create a detailed lightning activity map for the City of Toronto. This data will show where lightning tends to occur more frequently and may provide insight to where adaptation measures for this risk should be focused. This will also put in place the mechanisms to allow for continuous monitoring of lightning activity.</p> <p>e) This initiative is to produce a list of overhead feeder locations exiting stations with the highest risk. As a result of this analysis, new projects may be scoped under existing or new investment portfolios.</p> <p>f) The purpose of these guidelines is to ensure a uniform, strategic, and consistent approach to planning infrastructure renewal and modernization investments. This initiative is to review the guidelines and ensure that direction on incorporating climate change considerations are adequately given. The anticipated outcome is that planning engineers will be able to give better direction as to what design</p>	
--	--	--	---	--

		<p>g) Maintenance Program Review.</p> <p>h) Validate Climate Data.</p> <p>i) Review Asset Renewal.</p>	<p>considerations should be taken into account given the location of the asset.</p> <p>g) Toronto Hydro has developed and implemented a systematic approach in the area of electrical plant maintenance in order to ensure the continued performance and reliability of our distribution system. This initiative is to review the frequency and inspection criteria of assets that are affected by climate change based on the asset impact study. The expected results may include recommendations such as increased inspections or maintenance of certain equipment in high risk areas for those assets.</p> <p>h) This initiative is to review and validate Climate Data that was selected for the risk mapping and confirm that it is valid and widely accepted.</p> <p>i) Many of Toronto Hydro's assets will still be in the system for many years to come. This initiative is to review how many legacy assets are still planned to be in the system around 2030 and 2050 (study periods for the completed Climate Change Vulnerability Assessment). If the projections are that there will still be significant legacy assets in the system, then those should be included in the Asset Impact Study. Projections will also be used to update the risk maps as necessary.</p>	
--	--	--	---	--

		<p>j) Load Forecast Impact/Sensitivity.</p> <p>k) Capital Program Review</p> <p>l) Industry Review</p> <p>m) Analytical Tools Review</p>	<p>j) Every year Stations Planning prepares a Station Load Forecast report to provide a ten year peak load forecast for each transformer station (TS). This forecast is used for the purpose of evaluating station bus capacity adequacy. This initiative is to review and utilize the newly proposed and other more advanced load forecasting methodologies to create a forecasting template that can be used to evaluate the impact and/or sensitivity of the projected climate parameters in the future</p> <p>k) Toronto Hydro has a number of capital programs that are currently in progress or are scheduled to begin in the near future. This initiative is to review the capital programs and evaluate if any are affected by the projected climate parameters. The impact will be assessed and potential adaptation options will be proposed.</p> <p>l) This initiative is to conduct a review of climate adaptation plans of other utilities and benchmark against Toronto Hydro's plans. This would include other utilities in Ontario, Canada and the United States.</p> <p>m) This initiative is to review the currently used analytical tools and explore how the climate parameters can be integrated into the tools. Additional work would be required to understand how to best incorporate any viable options and evaluate the effectiveness of the changes</p>	
--	--	--	--	--

		n) Monitoring Reliability	n) This initiative is to improve our measures of reliability against various types of extreme weather to monitor the effectiveness that initiatives and resiliency efforts are having on improving system performance.	
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
11	Toronto Public Health (TPH)	<p>a) Toronto Public Health identified a need to conduct a more detailed assessment of the health and social impacts of climate change in Toronto (as recommended at the November 4, 2013 Board of Health meeting, HL25.4). This assessment would provide further details about the adequacy of existing procedures, policies and standards, recommend additional adaptation actions as needed and identify where additional resources are needed beyond existing budget.</p> <p>b) Explore new funding to support climate change activities, including:</p> <ul style="list-style-type: none"> - Research and policy development to support proactive health risk prevention measures. - Co-ordination and dissemination of climate- 	<p>a) As the climate changes, new health impacts are emerging and some existing health impacts are intensifying. TPH identified a need to better understand, prevent and respond to these impacts.</p> <p>b) Currently, climate change is one priority among many for staff at Toronto Public Health. Having a dedicated staff role to support climate change adaptation at Toronto Public Health helps ensure that TPH effectively supports resilience in communities and is prepared to respond to extreme weather events as they occur.</p>	<p>a) Initiated in November 2013. Work is underway.</p> <p>b) Initiated in July 2014. Work is underway.</p>

		<p>related information and needs within TPH.</p> <ul style="list-style-type: none"> - Public communications/health promotion to support resilient communities. - Partnership development and co-ordination with external partners including other City divisions, other levels of government, NGOs, professional associations, and the private sector. <p>c) Co-ordinated development of a Cold Weather Plan that considers the range of health impacts associated with cold weather.</p>	<p>c) Emerging research suggests that health impacts of cold weather affect not only homeless populations but also the general population and in particular those with pre-existing health conditions. A warming climate may mean that Toronto becomes less acclimatized to cold weather, while more variable and extreme weather events means that extreme cold remains a health risk</p>	<p>c) Initiated in January 2014. Development of the City's initial Cold Weather Plan is completed. The plan will be continuously updated.</p>
	Toronto Public Health (TPH)	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>In June 2015, TPH's Climate Change and Health Strategy was adopted by the Board of Health. Implementation of the Strategy to date includes:</p> <p>a) A comprehensive review of the City's cold weather protocol was completed and adopted by the Board of</p>	<p>a) Emerging research suggests that cold weather has a range of potential health impacts on both the homeless and general population. In addition, the high burden of illness associated</p>	<p>a) Initiated in January 2014. The City's Cold Weather Plan is reviewed and updated annually.</p>

		<p>Health in 2014, and responsibility for calling Extreme Cold Weather Alerts was transferred to the Medical Officer of Health from Shelter, Support & Housing Administration. A City of Toronto <i>Cold Weather Response Plan</i> was developed. Preparation of updated evidence-based messaging is complete and will be used starting winter 2016/2017. A report to the Board of Health for September 2016 will report on recent cold weather research, global best practises, and implications for cold weather Planning in the City of Toronto. Recommended future work includes ongoing research on the health impacts of cold weather, particularly on vulnerable populations.</p> <p>b) As part of Hot Weather Response, the City now follows the new Provincial Harmonized Heat Warning and Information System. This includes updated criteria used to call heat warnings. TPH proposes investigating the use of the Ontario Public</p>	<p>with moderately cold weather (as well as extreme cold weather) is increasingly recognized. To protect health there is a need to incorporate the latest health research into cold weather protocols.</p> <p>b) The Provincial Harmonized Heat Warning and Information System ensures that there is harmonized alerting and messaging across the province. The new criteria set by Environment Canada reflect the latest research on heat related illness and mortality. Use of the MOHLTC portal could increase the efficiency and efficacy of alert messaging to the public.</p>	<p>b) Initiated in 2013. Work is underway.</p>
--	--	---	---	--

		<p>Health Alerts Portal of the MOHLTC.</p> <p>c) Board of Health reports were adopted on options to reduce the health impact of extreme heat on vulnerable populations in apartment buildings, and a health-benchmark temperature. Recommended future work includes:</p> <ul style="list-style-type: none"> - Assessing the feasibility of, and consulting with stakeholders on, a maximum indoor temperature standard, indoor and outdoor shared cooling spaces, and a registry of vulnerable persons, - Providing guidance to landlords and tenants on strategies to cool apartments while maximizing passive cooling and minimizing the need for air conditioning; <p>In 2015, a corporate Advisory Group was established to guide and collaborate on future work on extreme heat in apartments. A dedicated climate change position has been established. Resources are being sought from</p>	<p>c) Many apartments in Toronto reach extremely high temperatures in summer, and many buildings house vulnerable populations. As heat waves become more frequent and intense, temperatures in apartments will increase, along with the use of window air conditioners. To protect health, improve equity and quality of life, and minimize energy consumption and carbon emissions, there is a need to identify energy efficient options to increase access to cooling for apartment residents.</p>	<p>c) The reports were adopted by the Board of Health in June and November 2015. Work is underway.</p>
--	--	---	--	--

		<p>external sources to fund heat-health related activities.</p> <p>d) A study of the health impacts of severe weather and potential interventions was undertaken;</p> <p>e) An investigation of the impact of climate change on the projected burden of illness of asthma and allergies associated with pollen is underway.</p>	<p>d) The rain and ice storms of 2013 indicated a need to better understand the health implications of severe weather and suitable interventions.</p> <p>e) Climate change is expected to alter the timing and intensity of pollen production from several tree species found in Toronto. While exposure to pollen and fungi is a risk factor for developing asthma and allergies, little is known about how climate change will impact Toronto residents' exposure to pollen or the associated asthma and allergy health risks</p>	<p>d) Initiated in January 2015. Completed.</p> <p>e) Initiated in September 2014. Work is underway.</p>
	Toronto Public Health (TPH)	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>TPH's Climate Change and Health Strategy for Toronto was adopted by the Board of Health in June 2015. This strategy describes potential health impacts from climate change and identifies actions to better understand and respond to these impacts. The Strategy complements other City strategies, including the Resilient City and TransformTO. Implementation and status</p>	<p>Climate change is already having an impact on our health. Serious health impacts can stem from both gradual shifts in climate and from sudden, extreme weather. TPH identified a need to better understand the health implications of climate change in Toronto, and identify health-specific mitigation and adaptation measures.</p>	<p>Adopted in June 2015. Work is underway.</p>

		reporting will continue to 2019.		
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
12	Toronto Transit Commission (TTC)	<p>a) Study the installation of emergency generators for bus garages.</p> <p>b) Study overland flooding at three subway stations (York Mills, Kipling and Union).</p> <p>c) Assessment and installation of emergency</p>	<p>a) Diesel fuelling of the TTC fleet is considered a critical and essential operation. Emergency generators are required with sufficient capacity to provide service continuity for extended periods/more widespread power outages.</p> <p>b) A study of each existing TTC facility would be required to quantify the risks of overland flooding.</p> <p>c) Experience has indicated that the over 500 pumps in the subway system can adequately remove rain and ground water collected in the</p>	<p>a) Small permanent back-up power generators will be installed at each garage <i>where feasible based on space restrictions and where approved funding exists</i>. Each generator will be manually activated when required and each load deemed "essential" will also be manually switched. In the event that a sustained power outage occurs, a larger portable generators will be brought to the impacted garage.</p> <p>b) A study is underway to examine the resiliency of TTC subway infrastructure to climate change and flooding. This first phase study will focus on a limited number of sections of the subway and will allow TTC to better understand the level of effort required to undertake similar studies based on varying levels of available flood modelling information.</p> <p>c) A preliminary study of the feasibility of installing standby power at subway stations has been</p>

		<p>back-up power for the drainage pumps.</p> <p>d) Conduct inspections of Fir Valley Culvert, Massey Creek Box Culvert, Massey Creek Pipe Culvert, Dorset Twin Pipe Culvert and East Don River Bridge.</p> <p>e) Review the reliability of traction power substations serving the subway and streetcar network.</p> <p>f) Enterprise Risk Management - TTC has adopted a structured and transparent approach to risk management with consistent processes for assessing risks of all types and at all levels across the organization. Risk controls will be implemented where it is reasonably practical to do so and where the cost or impact is proportionate to the expected benefits. Natural disaster and climate change</p>	<p>pump sumps at the current levels of precipitation; however, in the event that electrical power to these pumps is lost, flooding can occur at the invert level of the subway system resulting both in service disruptions and damage to track level electrical, train control and communications equipment.</p> <p>d) To assess current hydraulic capacity, deterioration and deficiencies. The work will help establish a plan for future corrective action.</p> <p>e) An outage in June 2015 called into question the redundancy of traction power supplies.</p> <p>f) Enterprise Risk Management is a core strategy of TTC's Five Year Corporate Plan.</p>	<p>carried out. Additional work will be conducted to prioritize, based on risk, the stations where back-up power should be installed.</p> <p>d) Engineering studies have been completed.</p> <p>e) Complete.</p> <p>f) TTC Risk Management Framework was endorsed by the Audit and Risk Management Committee of the TTC Board on November 12, 2015. Work is underway.</p>
--	--	---	---	---

		is one of TTC's eight risk classifications.		
	Toronto Transit Commission (TTC)	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>a) Integrated Corporate level review of the adequacy of electrical and communication systems to control the subway.</p> <p>b) Study to evaluate the effect of high temperature on the failure rate of subway signal relays and related equipment and on rolling stock vehicle system components.</p> <p>c) Development of a high heat operational plan for customer safety and comfort. It is anticipated such a plan would require maintenance and operational actions/costs not now in place.</p>	<p>a) Due to the condition of some of the infrastructure, it may no longer be adequate to ensure reliable control of key systems. A thorough integrated review is needed at the Commission level to identify critical vulnerabilities and next steps.</p> <p>b) Preliminary data indicates a correlation between the failure rate of vital signal equipment and what were hitherto considered extremely high temperatures. Most of this equipment is not protected by air conditioning and generates its own heat which amplifies the effect of high ambient temperatures. At this time we have insufficient data to develop an action plan and additional study of the heat vulnerability across a variety of equipment is a necessary next step.</p> <p>c) TTC has a highly effective winter storm plan to maintain service under extreme cold and snow conditions but lacks a parallel plan for high heat. The summer of 2016 highlighted the negative health impacts on our customers especially on Line 2, and consequent customer complaints. Introduction of rooftop air conditioning in the TR fleet on Line 1 exacerbates the problem by releasing large amounts of heated air into subway stations which were not designed for</p>	<p>a) Not scoped nor funded.</p> <p>b) Not scoped nor funded.</p> <p>c) Not scoped nor funded.</p>

			lengthy periods of these high ambient temperatures.	
	Toronto Water	New Adaptation Actions, Policies and Procedures	Rationale	Status
13		<p>a) In December 2015, City Council authorized Toronto Water and Corporate Finance to develop a detailed implementation plan for a stormwater charge, the revenue from which would be used to pay for capital works associated with stormwater management.</p> <p>b) The Wet Weather Flow Management Guidelines are a practical aid for the preparation, review and approval of stormwater management plans on development properties in Toronto. The requirements outlined in the Guidelines are being updated for clarification and in some cases are being made stricter, which will improve stormwater management across the City. Future editions of the Guidelines will</p>	<p>a) City Council has identified stormwater management as a growing concern and priority, the capital program for which is currently funded entirely from the water rate. A stormwater charge imposed upon property owners which is predicated on the amount of stormwater runoff from a property is a fair funding approach supported by the majority of stakeholders consulted to date. It also has the benefits of being more transparent, decreasing the volumetric water rate (i.e., the cost of water), and incentivizing certain property owners to manage more of their stormwater runoff.</p> <p>b) The current version of the Guidelines was published in 2006 and had the main benefit of harmonizing requirements from the former Greater Toronto municipalities that were amalgamated in 1998. The Guidelines were due for an update, and will be updated more regularly in the future.</p>	<p>a) Report back to City Council planned for the spring of 2017.</p> <p>b) Updated Guidelines to be published in 2016; date of enforcement TBD.</p>

		<p>further ratchet the requirements as Toronto Water continues to build its understanding of what will best improve the City's resilience.</p> <p>c) Toronto Water participated in the City of Toronto Emergency Back-Up Power Resilience for Critical Facilities Business Continuity Assessment. Representatives from Toronto Water Critical Facilities met with the team on site and provided requested information.</p> <p>d) In Q3 and Q4 2015, Toronto Water participated in a Toronto Hydro-led workshop with five key municipal services to pilot an approach and methodology for engaging key stakeholders on which services should be deemed priority for restoration in the event of a system-wide outage. Priority loads are those that have an impact on public security, health, safety, environment and economy.</p>	<p>c) As per recommendation #8 from the "Resilient City – Preparing for a Changing Climate" agenda item at City Council on July 8, 9, 10 and 11, 2014.</p> <p>d) To better understand electricity restoration priorities for key municipal services.</p>	<p>c) Ongoing. Assessment conducted in 2015, results published in 2016 and recommended works expected to go forward in 2017.</p> <p>d) Initiated in 2015. Ongoing.</p>
--	--	--	--	--

	Toronto Water	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		<p>a) The Basement Flooding Protection Program was expanded to become City-wide following the storm event of July 8, 2013. This expansion resulted in the creation of new environmental assessment (EA) study areas, bringing the total to 67.</p> <p>This program introduced service level improvement for drainage systems, when the targeted level of service for storm drainage systems was increased from that of a 2 year storm event to that of a 100 year storm event.</p> <p>b) The City's Basement Flooding Protection Subsidy Program offers property owners of single-family, duplex and triplex residential homes financial assistance of up to \$3,400 per property to install flood protection devices, including a backwater valve, sump pump, and pipe severance and capping of the home's</p>	<p>a) In 2006, Council approved a work plan to address basement flooding in 31 priority areas. The work plan was subsequently increased to 34 areas.</p> <p>City Council, at its meeting on October 8-11, 2013, requested the General Manager, Toronto Water, to report back during the 2014 budget process on the capital and operating budget impacts of expanding the Basement Flooding Protection Program on a city-wide basis beyond the existing 34 priority study areas, including methodologies for setting priorities and resource implications, so that the program continues to address urban flooding risks in a fair, well-organized, and efficient manner.</p> <p>b) The Basement Flooding Protection Subsidy Program was initially created for homeowners in response to the May 12, 2000 storm event, and was initially known as the "Voluntary Private Home Isolation from Public Sewer System Program". As a result of properties being impacted by subsequent storm events, City Council at its meeting in July 2006 adopted a report to expand the program City-wide and requested the General Manager of Toronto Water to incorporate funding to support the Program in its 2007 Capital Budget submission.</p>	<p>a) Initiated in 2006. Ongoing program.</p> <p>EA studies have been completed for 30 study areas as of September 2016. Eleven are underway, with three planned for completion in 2016, six planned for completion in late 2017, and two to be completed in 2018. The completed EAs have recommended an estimated \$1.683 billion of infrastructure improvements.</p> <p>b) Initiated in 2006. Ongoing program.</p> <p>More than 21,000 applications have been approved with over \$34,000,000 in total subsidy payments issued to property owners by Toronto Water as of the end of September 2016. On average, the City currently issues approximately \$1,600 in subsidy payments to participating properties.</p>

		<p>storm sewer or external weeping tile.</p> <p>c) Toronto Water coordinates with the Toronto and Region Conservation Authority to ensure that watercourse restoration projects are prioritized in order to protect public safety and Toronto Water assets and to respect availability of funding.</p> <p>d) Emergency stand-by power projects continue at Toronto Water's plants and pumping stations.</p>	<p>c) City Council at its meeting on June 10-13, 2014 confirmed the City's "Coordinated Watercourse Management Plan", whereby each division with infrastructure or facilities potentially affected by erosion in ravines, and stream and river valleys will be responsible for the inspection, assessment, design, construction, maintenance and monitoring of erosion control works necessary to protect their infrastructure. City Council, amongst a number of recommendations, further recommended that the TRCA will be responsible for assessing erosion hazard sites affecting private property and designating, constructing and maintaining erosion control works affecting one or more property owners, on a priority basis.</p> <p>d) Outlined in Toronto Water's 10-year Capital Plan.</p>	<p>c) Ongoing program.</p> <p>d) Ongoing.</p>
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
14	Transportation Services	<p>a) Mitigate the Risk of Flooding through a number of mitigation and adaptive actions that reduce the risk associated with riverine and urban flooding due to extreme weather events, such as:</p>	<p>a) The increasing severity and frequency of extreme weather requires the modification and expansion of existing programs and development of new projects and programs that can mitigate infrastructure damage and increase the operational effectiveness and safety of critical transportation infrastructure when flooding occurs. The following are number of measures that should be considered:</p>	<p>a) Updates below.</p>

		<p>i. Undertake municipal Environmental Assessments (EAs) that evaluate flooding in high priority transportation areas.</p>	<p>i. A holistic approach to flood mitigation is required, one which incorporates the concerns of both stakeholders and the economic, social and environmental impacts of possible solutions. Explore opportunities to undertake municipal EAs that identify various mitigating measures. In addition to the EAs a cost/benefit analysis is recommended that would evaluate flooding in high priority transportation areas adjacent to the Lower Don River (i.e., Don Valley Parkway and lower Bayview Avenue), Lake Shore Boulevard, and other various locations.</p>	<p>i. One of the recommendations included in the Lower Don Transportation Corridor (LDTC) Flood Risk Summary Report, dated April 2016 calls for a comprehensive EA to be undertaken that addresses the risk for all users. Currently no funding from any of the agencies and divisions has been committed or indication when such funding may be made available. The two key issues are:</p> <ul style="list-style-type: none"> • if one user provides localized flood proofing measures, it will increase flood risk to the others; • cost to mitigate flood risk to various infrastructure is typically more expensive in terms of disruptions during construction and the capital costs of construction, than simply dealing with the localized flooding and clean up currently underway. <p>The comprehensive EA will build on the recommendations resulting from the Port Lands Flood Protection and Enabling Infrastructure Project proposed</p>
--	--	---	--	--

		<p>ii. Establish a comprehensive cross-ABC&D response plan due to flooding.</p>	<p>ii. A comprehensive cross-ABCD response plan due to flooding will address the interdependencies between the various stakeholders and will allow for the formulation of adaptation actions to ensure short and long term resiliency. Transportation Services meets regularly with TRCA staff to review flood-response protocols and response to real time events.</p>	<p>flood mitigation measures south of the Don River Narrows.</p>
		<p>iii. Implement permeable and porous surfaces, bio-retention and Low Impact Development within the right-of-way.</p>	<p>iii. The impacts of urban flooding can be mitigated by reducing non-porous surfaces in the urban environment. Porous and permeable surfaces, LID and bio-retention reduces urban runoff, increases storm water capacity and improves storm water quality.</p>	<p>ii. Transportation Services Division (TSD), as a member of the LDTC Working Group, is working with TRCA to develop contingency plans and communication protocols. To-date data feeds and customized dashboards have been created by TRCA for TSD. Next steps is to provide an update to the Resilient City Working Group (RCWG) of the recommendation identified in the Lower Don Transportation Corridor Flood Risk Summary Report, April 2016. TSD will continue to support the efforts of the LDTC Working Group and moving forward one of the mandates of the group should be to have a cross ABC&D response to flooding.</p> <p>iii. As part of the neighbourhood improvement program: 136 neighbourhood project have either been constructed or are under design; installed eight community planting sites, maintained 200 horticultural location within the road right-of-way, under the "Orphan Space" program, constructed streetscape enhancements on</p>

		<p>iv. Develop a communication and management plan for dredging and/or debris removal from waterways.</p>	<p>iv. To obtain clarification on what approvals are required prior to proceeding with debris removal from waterways and cleaning out water channels and provide an information session to all affected stakeholders and document the process. Quite often the required clean out of channels is not undertaken due in large part to the time consuming approvals and consultation required with many of the approval agencies such as: E&CS, P&E, TRCA, Ministry of Natural Resources and Department of Fisheries and Ocean.</p>	<p>Front Street E and participated in the development of the detailed plan to revitalize Yonge Street streetscape from Sheppard Avenue to Finch Avenue.</p> <p>iv. Repairs to the Cherry Street Lift Bridge occurred in 2014 to allow the bridge to be lifted and allow barges to remove dredged material from the lower Don River channel.</p> <p>Dredging of Keating Chanel occurred in 2015. Funding for the design and replacement of the Cherry Street Bridge with a higher permanent fixed bridge to be explored.</p> <p>TRCA to undertake a sediment rate study to determine if the annual frequency of dredging of the Keating Channel is adequate. Dredging beyond the Keating Chanel, through the Don Narrows was assessed using the hydraulic models which demonstrated that ~3 metres of dredging is required to eliminate flooding of the DVP from a 2 year storm event. In addition, due to the low clearance under Lake Shore Blvd, specialized equipment is required to dredge</p>
--	--	---	---	--

		<p>v. Evaluate the hydraulic flows of waterways before and after implementation of new design/modification of culverts</p>	<p>v. Further studies are required to evaluate the hydraulic flows of waterways before and after implementation of new design and/or modifications to existing culverts and the impacts of upstream development. For example, an improvement of one culvert can potentially create problems downstream.</p>	<p>the Don Narrows, which poses risks to the existing sanitary trunk sewer. It has been determined that if dredging of the Don Narrows were undertaken, only a marginal benefit would be realized. In addition, any backwater effect caused by the 90 degree bend is unlikely to have impact on flooding in the Lower Don Transportation Corridor.</p> <p>v. TRCA has updated its hydraulic model to include flood characterization and risk mapping (from a depth x velocity perspective) of the area surrounding the river, for a 2 year storm event through to the regional storm events. TRCA is currently evaluating how the updated hydraulic model can be used in the Lower Don area to evaluate the various scenarios and assist with the development of flood mitigation measures on the adjacent transportation corridors - expected completion in September 2016.</p> <p>In addition future EA's will undertake an analysis of the hydraulic impact of the modification to the bridge or culvert, with the criteria being</p>
--	--	--	---	--

		<p>b) Assess the flood prone areas of the transportation network and implement flood-related road closure notification including but not limited to the following: installation of traffic control warning signs, road closure devices, cameras, emergency detour routes (EDRs) and water pump systems.</p>	<p>b) TSD Strategic agenda for 2014-2018 includes installing gates, signs and traffic control devices at flood-prone locations for faster road closure during flooding emergencies. A preliminary design for gates and warning devices for Bayview Avenue has been completed by Transportation Services. Funding for implementation in 2015-2017 to be explored. Locations for four (4) CCTV cameras were identified for flood prone areas and were installed in the spring of 2014. The cameras have already been used on a number of occasions during some recent severe weather warnings and a couple of short-duration flooding situations. The total cost of this implementation is ~\$80,000.</p>	<p>that the design modifications can't increase risk upstream or downstream.</p> <p>b) Transportation Services has begun flood management plans to close and reroute services during a flood emergency, including installing next-generation automatic flood gates to close road during floods. Preliminary design for automated traffic control gates at two priority location (River St / Bayview Ave, and Lawren Harris Square / Bayview Avenue) have been completed. The location of automated gates have been reviewed and mapped with implementation pending management approval. Currently, interim gates operated manually have been implemented. Two additional planned automatic flood gates planned in the next three years.</p> <p>Emergency detours have been established. Preliminary design for a new CCTV camera at one location underway. There have been 3 CCTV cameras installed at existing signalized intersections along Bayview Avenue flood area. Purchased 5 portable Variable Message Signs</p>
--	--	---	---	---

		<p>c) Implement an Environmental and Climate Change Risk Management System that focuses on building an integrated environmental and climate risk management program. An integral part of the program is to understand the interdependencies between the public and private sectors, such as energy, communication, insurance and financial sectors.</p>	<p>c) Assess the impacts of climate change and extreme weathers on Transportation Services critical infrastructure and services. Undertake a prioritization of adaptation actions for the division to mitigate the impacts of climate change for each of the business units and develop a short and long term action plan. Understanding interdependencies between the public and private sectors, such as energy, communication, insurance and financial sectors, will be critical when assessing climate change risk and identifying adaptation actions. Engagement and collaboration with these sectors will reduce the risk of economic disruption to the community and enable opportunities for well adaptive infrastructure systems to be realized.</p> <p>Understanding interdependencies between the public and private sectors is critical when assessing climate change risk and identifying corrective actions. Engagement and collaboration with these sectors will reduce the risk of economic disruption to the community and enable opportunities for well adaptive infrastructure systems to be in place.</p>	<p>to be placed at strategic locations to provide advanced notice of road closures. Development of business case to implement and fund automated flood gates underway.</p> <p>c) TSD Strategic Agenda 2014-2018 includes the implementation of the EMS to address the division's environmental impacts and update climate change risk assessment and implement changes to reduce risks. Future budget implications identified in 2017. In 2014, City Council adopted the Climate Change Risk Management Policy, which recommended the formation of an interdivisional/agency Resilient City Working Group. Transportation Services (TS) is a member of the working group, and as a pilot division, worked closely with Environment and Energy Division (EED) in developing the Climate Change Risk Assessment process and tool back in 2010. TS completed a system risk assessment of over 90 high priority assets and critical services.</p>
--	--	---	---	---

		<p>d) Develop a Culvert Management System that includes an inventory, staff training, develop an inspection program, maintenance, communication and documentation programs that consider extreme weather events.</p>	<p>d) Develop a Culvert Management System that includes an inventory, training, an inspection and assessment program, a maintenance program, a communication protocol and documentation system. The assessment evaluates whether culverts are cleared of debris, their condition (i.e., collapsed, damaged, etc.), and condition of surrounding earth.</p> <p>Mapping of all culverts (3 metres or smaller using GIS enabled hand-held devices during field inspections.</p>	<p>The Resilient City Working Group members have recently initiated a high level risk assessment in the following Thematic Areas: Water, Transportation, and Utilities (including telecom). The intention through this work is to identify any information gaps that may exist and address key interdependencies. The findings of this assessment will culminate in a report to City Council by EED before the end of 2016.</p> <p>d) A Ditch Rehabilitation & Culvert Reconstruction Program was approved in 2015 in the amount of \$1.6 M, with \$364,000 allocated to culvert inventory and mapping. This also includes the cost of data collection devices and hiring of students. In spring 2016 data collection was initiated; approximately 2 to 3 years to identify and assess approximately 10,000 culverts.</p> <p>Eventually the Culvert Management System program will be rolled up to the corporate work management system.</p>
--	--	--	--	--

		<p>e) Ensure 'Uninterrupted Power Supply' (UPS) at signals that are in close proximity to fire halls so that these signals continue to work in an emergency; at Railroad traffic control signals. Install UPS at priority signalized intersections located on emergency routes.</p> <p>f) Develop a harmonized process for implementing warranted concrete bus bays at TTC stops.</p>	<p>e) To ensure resiliency for priority signalized intersection during unplanned power outages or as a result of extreme weather events. One hundred (100) UPS locations have been identified and prioritized which include signals at railroad crossings, major intersections and expressway ramp terminals. A pilot program was initiated whereby twelve (12) high priority locations were outfitted with emergency back-up power. The total cost for the first 12 installations was approximately ~\$200,000. Two contracts have been tendered to install UPS at the remaining locations over the next two years. The estimated cost for the remaining installations is ~\$1,350,000. A second phase review is underway to identify the need for UPS along emergency routes.</p> <p>f) The surface of asphalt pavement, at bus stops, generally exhibit severe asphalt distortion (e.g., rutting) due to bus and truck loads, which becomes more severe under extreme heat conditions. Replacement of asphalt at bus stopping areas with concrete pads will reduce and/or eliminate these problems.</p> <p>Installation of concrete bus pads on the roadway will be done as part of resurfacing projects. This improvement is typically being applied only in situations where the existing asphalt surface is shoving or rutting moderately (>25mm) or more. Concrete pads last longer than standard asphalt.</p>	<p>e) To date 47 UPS locations have been completed and 30 locations will be completed in 2016. In addition, 85 priority signalized intersections have been identified that are based on highest traffic volume in each of 17 police divisions. These 85 signalized intersections (5 per police division) do not have power backup at this time. Under the Critical signalized intersection Police Control Protocol, between City and Toronto Police, police will provide traffic control at these intersections in power outage situations. The next review of the priority signalized intersections is ongoing.</p> <p>f) Concrete bus pads are implemented on arterial roads where bus and truck traffic is particularly heavy. There is an incremental cost in retrofitting these locations, but the benefits are in avoided maintenance costs.</p> <p>Approximately 20 to 25 concrete pads are constructed annually city-wide at a cost of \$25,000 each. As part of ongoing preventative maintenance program, 100 to 150 bus bays are rehabilitated each year. A final construction specification on concrete bus bay</p>
--	--	---	--	--

		g) Scheduled routine system-wide checks of the traffic control signals by Communication System Operator (CSO) should be expanded.	g) Currently, a scheduled routine system-wide check of the traffic control signals by CSO has been implemented, every (2 hours during Monday to Friday, 8am to 4pm). This regular system check ensures that extreme weather has not impacted the performance and operations of traffic control signals.	will be completed by November 2016. The next step is to develop a harmonized process for implementing warranted concrete bus bays and bus stops. g) Currently, system wide checks are conducted with existing operating funding. Extending the routine system-wide checks of signals beyond the typical work week to a 24/7 operations would require additional dedicated staff to monitor our traffic signals at an approximate cost of \$400,000 (based on four new required CSO staff). Currently, TSD does not actively monitor its two traffic control system 24/7. The current process is to monitor the system as the need arises. There is a new ATMS (Advanced Traffic Management System) that will be able to display the status of all our traffic signals (TransSuite and SCOOT control), to assist staff in identifying malfunctioning signals.
	Transportation Services	New Adaptation Actions, Policies and Procedures	Rationale	Status
		a) Improve weather monitoring system by expanding the Road Weather Information System (RWIS).	a) Evaluate and improve the current weather monitoring technology and forecasting systems, by undertaking the following: <ul style="list-style-type: none"> Evaluate the adequacy of the current number of RWIS stations and locations with objective to be more responsive to changing local weather conditions; 	a) Transportation Services currently has access to the TRCA and Ministry of Transportation weather stations. Transportation is evaluating what additional RWIS stations are required in

		<p>b) Mitigate the impacts of back-to-back extreme weather events by reviewing the current winter maintenance service levels.</p> <p>c) Ensure Minimum Maintenance Standard requirements are met.</p> <p>d) Evaluate Split Shifts for outside workers.</p>	<ul style="list-style-type: none"> • Work with Environment Canada to receive more timely weather forecasts; • Shared RWIS data: establish a system where all municipalities in the GTA have access to each other's RWIS information; • Ensure that all vehicles have ambient temperature sensors. • <p>b) Review the threshold levels of when to activate winter service in the context of back-to-back events. For example activating ploughing (prior to meeting the ploughing threshold values) in advance of a freezing rain storm may be warranted.</p> <p>c) Hire additional seasonal staff to assist in timely completion of investigations in order to meet the MMS requirements and a provide backup when there are staff shortages.</p> <p>d) Evaluate split shifts for inspection and investigation; morning and evening to mitigate effects of heat stress.</p>	<p>order to enhance its capability of tracking the weather patterns, in order to be more responsive to changing localized weather conditions.</p> <p>b) In the new winter maintenance contract, redundancy has been built into the contracts with 18 additional pieces of equipment to address the impact freezing rain on hills and bridges. A review of winter services needs to be undertaken and modification undertaken to address back-to-back events such as the combination of rain, freezing rain and snow.</p> <p>c) Additional seasonal staff (students) were hired to address the backlog of assessing the condition of sidewalks.</p> <p>d) Transportation Services is continually reviewing and evaluating the most appropriate health and safety practices and personal protective equipment requirements to ensure that staff are protected during various environmental</p>
--	--	--	---	--

		<p>e) Develop a coordinated ABC&D's response plan to flooding.</p> <p>f) Maintain an optimal level of street sweeping on roads to ensure that debris accumulation does not get washed down into the storm water system.</p>	<p>e) In addition to the adaptation actions identified, reducing the impact of flooding can be addressed through the development of ABCD's plan for flooding:</p> <ul style="list-style-type: none"> • Improve the timeliness of the TRCA Flood Warning System and enhance predictive capability; • As a corrective action to manage culvert risk, review existing practices and develop an intergraded plan and best practice that allows the coordination of work between Transportation, Toronto Water, TRCA and Parks, Forestry and Recreation in maintaining parkland and waterway areas; • Prioritization of high problem areas is required in order to perform pre and post event inspections; and • Complete emergency bridge/culvert/road/roadside inspections, immediately after extreme flooding events. <p>f) Determine the optimal level of street sweeping, year round, by:</p> <ul style="list-style-type: none"> • Implement alternative street parking so that streets can be swept and tops of catch basins kept clear; • Evaluate the consequences of decreasing the street sweeping frequency and resulting increase in the deposit of fugitive road dust into the catch basin. This in turn 	<p>conditions. During heat events staff are to take micro breaks and under certain conditions hard labour is suspended.</p> <p>e) TRCA has an enhanced event and flooding information through text and email alerts via its communication centre and modelling capability, providing more timely and predictive information about storm events. An effort has been initiated to map low lying areas throughout the City which will assist in prioritizing of pre and post event inspections.</p> <p>f) Review current on-street parking and identify a mechanism areas that sweeping is precluded due to parked vehicles; timing of review to be determined.</p> <p>Undertake a literature review of various studies that identify street sweeping as source</p>
--	--	---	--	--

		<p>g) Accelerate the implementation and monitoring of environmental controls in Traffic Control Signal controller cabinets and cameras.</p>	<p>increases the cost of water treatment, increasing the potential of a release of contaminated water into the natural water system, increasing debris accumulation in catch basins, and if not cleaned causing flooding/surface water downstream.</p> <p>g) To mitigate the impacts of extreme heat and cold, the following adaptation actions will provide resiliency to Traffic Control Signal controller cabinets:</p> <ul style="list-style-type: none"> • Undertake a study to determine the correlation between the temperature inside the TCS controller cabinet and ambient air temperature; and • Routine inspections should include the inspection of the heating and cooling system. 	<p>control for mitigating the impacts of debris accumulation and water quality in our natural water systems. The Clean Roads to Clean Air Program has identified a methodology and process to evaluate the impact of various street sweeping technologies in mitigating the impact to air and storm water quality. An evaluation of the optimal street sweeping frequency still needs to be undertaken.</p> <p>g) Currently, under the Tansuite project, approximately 2000 traffic control signals' new cabinets are installed with environmental controls (thermostat, heater and fan). Traffic Controllers are National Electrical Manufacturer Association rated for temperature (-34°C to 74°C). All cameras are IP57 rated at (-50°C to 60°C) and have internal environmental controls (heater and fan). The IP57 rating means it is resistant to dust and the device can withstand being immersed in 1m of freshwater for up to 30 minutes. LED modules are Institute of</p>
--	--	---	--	---

		h) Enhance Intelligent Transportation Systems	h) Cameras and variable message signs on arterial roads that assist with incident and event response and congestion management; expand traffic monitoring and management to mitigate congestion, improve traveller information, enhance and integrated corridor coordination. Evaluate resources required to develop and	<p>Transportation Engineer compliant (-40°C to 74°C).</p> <p>Routine maintenance and inspection is currently undertaken bi-annually, included is the inspection of environmental controls. There are contractual requirements for the contractor to meet emergency calls and Transportation Services staff work with contractors ahead of time to ensure sufficient resources are in place, especially under extreme weather events. Future actions include monitoring the use of heater and cooling fans and determine if the frequency is increasing over time. As well, a study to determine the correlation between the temperature inside the TCS controller cabinet and ambient air temperature; timing to be determined.</p> <p>h) The Congestion Management Plan 2014-2018 following goals support resiliency, they are as follows:</p> <p>i. Improve the City of Toronto's ability to detect and respond to incidents,</p>
--	--	---	--	---

			implement temporary/emergency traffic signal timing plans for extreme weather events.	<p>events and changing traffic conditions;</p> <p>ii. Improve the availability and reliability of information for the public; and</p> <p>iii. Reduce the impact of traffic on the environment (i.e., reduce GHG emissions).</p> <p>There are currently, 174 cameras on expressways and arterials. Planned are approximately 160 additional arterial CCTV cameras to be installed at existing signalized intersection between 2016 and 2020. A pilot for variable message signs, on arterial roads, will be implemented at one location by the end of 2016. There is also a long term plan to install CCTV cameras and automated gates to manage and mitigate the impacts of flood related road closures.</p>
		i) Assess the feasibility of overhead vehicle detection to replace detector loops.	i) Implementing and maintaining detector loops causes deterioration of asphalt which is further exacerbated by extreme weather events. Transportation Services should assess the feasibility of overhead vehicle detection system to replace detector loops.	i) Transportation Services are implementing non-intrusive video/radar detection methods where appropriate. There are 180 locations that have been implemented with non-intrusive vehicle detection

		<p>j) Undertake third party performance verification of cameras.</p> <p>k) Undertake a study to determine the correlation of Moisture, Heat and Wind, Freeze/Thaw Cycle</p>	<p>j) Undertake third party testing and verification of cameras and traffic control signal controller cabinet performance under extreme heat, rain, freezing rain, cold and snow. Engage manufacturers to develop controller components that are more heat and cold tolerant.</p> <p>k) A correlation between Moisture, Heat, Wind and Freeze/Thaw Cycle Study using the RWIS stations and other monitoring equipment to determine and track the number of above</p>	<p>technology. Transportation is currently gathering input from various jurisdictions on experience with non-intrusive detection. Transportation will be developing a new functional spec for non-intrusive detection technology.</p> <p>j) Electrical Safety Authority conducted field inspections of camera Power Over Ethernet cable and unit to make sure material supplied and installed is in compliance with regulations. Camera component specifications have been further updated to broaden the operating temperature ranges. New cabinet specification has been developed and matches applicable industry National Electrical Manufacturers Association (NEMA) standards. Transportation will continue to work with manufacturers and associations to build resiliency in all components of cameras and controller cabinets.</p> <p>k) An initial approach is to undertake a literature review of existing studies and tests in order to determine the scope</p>
--	--	---	--	---

		<p>on the Deterioration of Pavement.</p> <p>I) Future enhancement of Bridge Management System (BMS) includes incorporating other assets, such as culverts and developing spatial mapping that provides easy accessible information on location, condition and potential risk. Enhance the current level of communication and information sharing among stakeholders with respect to the condition of culverts and bridges.</p>	<p>weather events and associated pavement deterioration (i.e., type and severity).</p> <p>I) Enhancement of the BMS that reflects adaptive measures to various extreme events such as extreme cold, freeze/thaw and extreme rain, including:</p> <ul style="list-style-type: none"> ▪ As part of the next phase of the BMS ensure that the culverts (> than 3 metres), embankment and guiderails are included in the BMS; ▪ Develop a mapping application that provides information on the location and condition of the bridges, culverts, etc.; ▪ Utilize IDF and hydraulic model to generate mapping of bridges and culverts at highest risk locations; ▪ Identify how the road operations inspections are coordinated with regulatory inspections performed by Engineering Construction Services and how they will be incorporated into the BMS; ▪ Strike a working group that will identify the locations of high risk culverts and bridges with various stakeholders and develop a system for communication and information dissemination regarding these locations; and ▪ Engage the Canadian Standard Association to review the applicable codes and standards that are relevant to bridges and culverts with respect to extreme weather thresholds and 	<p>and scale of the study. The timing of the literature research to be determined.</p> <p>I) Transportation Services and ECS have collaborated and developed a web-enabled bridge application that provides information on bridges, with the next phase to include culverts that are greater >3 metres to be completed in 2016.</p> <p>As part of the Lower Don Transportation Corridor Working Group, working collaboratively with TRCA and others explore opportunities to identify the high risk bridges and culverts, identify mechanism to develop new design standards and review current protocol for communication and dissemination of information.</p>
--	--	--	--	---

		m) Develop maintenance protocols for green infrastructure	determine what new changes should be introduced. m) Review existing maintenance protocol for permeable, porous surfaces, Low Impact Development (LID) and culverts. Also, evaluate and develop best maintenance practices, most suitable technologies to clean and maintain the permeability of various green infrastructure and the associated operating and capital budget implications.	m) Collaborating with the Green Street Guidelines working group to review existing maintenance practices of the permeable, porous and LID surfaces. Currently, reviewing various sweeper technologies that exist in the marketplace.
	Transportation Services	Overall Strategies, Initiatives and Plans related to Resilience	Rationale	Status
		a) Undertake a prioritization of adaptation actions for the division and develop a short and long term action plan.	a) A prioritization of adaptation actions will ensure divisional efforts and resources on mitigating the impacts of extreme weather events and the impacts of changing climate, across each of the business units, are completed within a prescribed timeframe resulting in the greatest benefits.	a) An initial prioritization occurred back in 2010 and revisited in 2014 and 2016. The update of the Division's climate change risk assessment and implementing those necessary changes was identified as an objective in the Transportation Services' Strategic Agenda 2014-2018. A framework for a risk governance structure needs to be developed, including a central repository of adaptive and resilient policies, programs and initiatives. Transportation Services will work with the Resilient City Working Group in developing resiliency metrics that can assist in the prioritization, plan

		<p>b) Develop and/or augment current inventory systems to an Asset Management System for all Traffic Management Centre (TMC) assets.</p> <p>c) Review the existing Business Continuity Plan (BCP) for Pandemic Influenza and develop new BCPs for various extreme weather event scenarios, including periodic training and simulation to ensure competency.</p> <p>d) Public Awareness and Education Program that can inform the public about the benefits of reporting the condition of catch basins, culverts and waterways.</p>	<p>b) A comprehensive Asset Management System will provide the required information on assets with respect to location, quantity, conditions, material specification, etc. A comprehensive data system is critical in establishing what the adaptive capacity of an individual infrastructure as determined by its design, operation and maintenance and what the potential risks might be associated with extreme weather events and the change in the climate.</p> <p>c) Enhancements to the Business Continuity Plan (BCP) to cope with the impacts due to extreme weather events will ensure continued delivery of critical services.</p> <p>d) Evaluate the benefit of Public Awareness and Education Program, where a process is developed that encourages (safe) citizen reporting of blocked culverts due to debris in waterways. This would also be extended to include public reporting and/or cleaning of snow, leaves and debris around catch basins</p>	<p>development, monitoring and evaluation of various initiatives.</p> <p>b) TMC is exploring opportunities to develop a management system for its assets as part of the development of the new divisional Work Management System.</p> <p>c) Transportation Services has undertaken a business impact analysis of its business process due to disruptive events and identified critical business activities. The BCP will be reviewed periodically to by considering all risks thereby ensuring "time-critical" business processes have appropriate recovery time objectives.</p> <p>d) Road operation staff have identified this initiative as a priority to be initiated in the short term with timing to be determined. Currently, road operation's staff perform non-structural inspections of culverts and bridges annually.</p>
--	--	--	--	--

		<p>e) Consider incorporating climate change adaptation into the Division's procurement process (i.e., contracts, studies and other procurements).</p>	<p>in low lying areas. These actions would significantly assist during routine inspections, and especially during and post rain/snow/wind events.</p> <p>e) By incorporating provisions into contracts which require that climate change resiliency be considered with any future procurement of services, products and equipment, including contract management will ensure products and delivery of services are not impact by future extreme weather events. In addition, it is equally important to include contract clauses to address staffing issues during Heat Alerts and during periods when the Health Index is high; contractors should provide documentation that plans have been developed and implemented.</p> <p>Also, evaluate the knowledge gap and provide contract administration training to</p>	<p>Road operation staff will attempt to perform additional inspection of culverts and bridges, especially in low lying areas pre and post storm events, except in Etobicoke York. Etobicoke York will be evaluating their current inspection regime and develop a business case to expand their inspection program to include pre and post storm event inspections.</p> <p>Toronto Waters and Engineering and Construction Services perform structural inspections post storm events.</p> <p>e) The "Comprehensive Review to Improve Repairs, Resurfacing and Reconstruction Practices" final report dated July 2016 recommends expansion of the Transportation Infrastructure Management Section to oversee training and certification for both in-house and contracted staff through the establishment of a "Centre of Excellence for Training and Certification".</p>
--	--	---	---	--

		<p>f) Implement revised specifications for pavement asphalt to improve resiliency to heat - includes recommended performance grades for various Hot and Warm Mix asphalts. Implement standards for third party verification and associated training.</p>	<p>staff to reflect the shift from in-house staff management to contract administration. Enhancing contract management and training for in-house staff will help to address and avoid problems that may typically arise during extreme weather events.</p> <p>f) Pavement resiliency can only be achieved when more robust standards are implemented and construction specifications are adhered to. Deviation from those standards and best practices, and the added affects extreme weather events, only leads to accelerated pavement deterioration and a reduction in the life cycle of the asset.</p> <p>Ensure sufficient resources are dedicated to manage, monitor and enforce contracts, including QA/AC.</p>	<p>f) The Comprehensive Review to Improve Road Repairs, Resurfacing and Reconstruction Practices report, dated July 2016, provides recommendations on pavement asphalt types and construction specifications. As a result of the study the following have been implemented:</p> <ul style="list-style-type: none"> i. Performance grade of asphalt have been identified for various load and classifications that recommend for example for high traffic and load bearing arterial roads a performance grade of -28C to 70C that has a higher tolerance to heat stress; ii. Improvements have been made to hot mix asphalt specifications that improve tolerance and durability; iii. Training of key staff on the new hot mix asphalt specifications; and iv. Implemented modification to concrete specifications.
--	--	--	--	---

				<p>The report also recommends additional resources, training, rigorous quality control and quality assurance processes and third party verification be pursued to ensure best construction practices and material specifications.</p> <p>Currently, Transportation Services is also undertaking a Warm Mix Asphalt (WMA) Performance Review Study that is reviewing the performance of various roads throughout the City where WMA was utilized. WMA provides a dual benefit in terms of mitigation (i.e., reduction in GHG emissions) and resiliency (i.e., paving season extended due to WMA's tolerance to lower ambient temperatures).</p>
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
15	Toronto Building	<p>Toronto Building is the City of Toronto lead on building regulatory matters, including the Ontario Building Code (OBC).</p> <p>Toronto Building staff participate on technical advisory groups at the provincial and federal levels which consider changes to</p>	<p>Toronto Building is responsible for enforcing the administrative and technical requirements of the Ontario Building Code (OBC) in the City of Toronto.</p> <p>The OBC sets out the technical requirements for the construction and demolition of buildings. Resource conservation (including water conservation and energy conservation) and Environmental Integrity are Objectives of the OBC.</p>	Work is ongoing.

		<p>the model national codes and Ontario Building Code.</p> <p>Toronto Building is also responsible for developing and enforcing the Toronto Green Roof Construction Standard contained in the City of Toronto Green Roof By-law, under the authority of the City of Toronto Act.</p>		
	Toronto Building	New Adaptation Actions, Policies and Procedures	Rationale	Status
		<p>In November 2015, the Chief Building Official responded to the provincial request for proposed changes to the Ontario Building Code for consideration in the next edition.</p>	<p>The Chief Building Official's communication requested that the province review the Ontario Building Code for further opportunities and tools to address climate change, mitigation and adaptation. As part of this submission, the Chief Building Official reiterated Toronto City Council's request that the Ontario Building Code expand the existing provisions for continuous power supply for back-up generators in certain building types.</p>	<p>A new edition of the Ontario Building Code is expected to be released in 2017.</p> <p>A provincial code consultation containing specific code proposals is anticipated for in late-2016. As in the past, Toronto Building, in consultation with other City Divisions, will report to City Council on the proposed changes and recommend Council convey its position to the Minister of Municipal Affairs and Housing on key matters for City of Toronto.</p>
#	City Agency, Division or Corporation	Existing Adaptation Actions, Policies and Procedures	Rationale	Status

16	Solid Waste Management Services	<p>a) Debris management practices, the Debris Management Emergency Support Function (EFS) and the SWMS Debris Management Plan.</p> <p>b) Member of Toronto Emergency Management Program Committee (TEMPC).</p> <p>c) Member of the Emergency Working Group (EMWG).</p>	<p>a) The Solid Waste Management Services (SWMS) Division plays the lead role to facilitate and coordinate the management of debris following an extreme weather incident. Recognizing the likelihood that the frequency/severity of extreme weather events may increase, the ESF has been developed to mitigate against any potential threat to lives, health, safety and welfare of the impacted citizens, expedite search and rescue and/or recovery efforts of impacted area(s). The ESF defines the roles and responsibilities, of SWMS as the lead and other supporting Divisions and Agencies, for the management (removal, processing and disposal) of debris following an incident. The ESF sets the foundation of the SWMS Debris Management Plan, including the following requirements: pre-planning activities; needs/damage assessment; identification and deployment of equipment and personnel required; prioritized temporary debris storage/management sites; site preparation; debris removal phase; hazardous waste removal (if applicable); and public messaging.</p> <p>b-c) Working with other Divisions to better be prepared for potential emergency incidents including, but not limited to, extreme weather events stemming from climate change.</p>	<p>a) Ongoing.</p> <p>b-c) Ongoing.</p>
----	---------------------------------	--	--	---

#	External Organizations	Adaptation Actions, Policies and Procedures	Rationale	Status
17	Metrolinx ⁵ (Not a City ADC)	a) In the 2015-2020 Five Year Strategy, Metrolinx identified a commitment to establish a “Corporate Climate Adaptation Plan” covering facilities, practices and protocols by 2018. In response to this commitment, in early 2015 Metrolinx secured the services of a Senior Advisor with expertise in resiliency and adaptation, and set up an internal Resiliency and Adaptation Working Group as part of the development and implementation of a broader resiliency program. Metrolinx has been dealing with climate change risk across many divisions, but to date much of this work has been under documented and at times uncoordinated in its application.	<p>a) The July 8th, 2013 flood event and to a lesser extent the December 2013 ice storm demonstrated that some elements of Metrolinx’s infrastructure assets may be vulnerable and at risk to extreme weather and climate change. Not only does this concern apply to existing infrastructure and assets, but also to new projects that are expected to roll out over the next 10-20 years through the Regional Express Rail (RER, including electrification), and various projects through Regional Transit (e.g. LRTs, and BRTs).</p> <p>The investment in public transit represents a unique opportunity to upgrade and expand transportation infrastructure, and address issues around GHG emissions, as well as vulnerability and resiliency. Through the Regional Transportation Plan, the RER and RT will help the GTHA become more resilient by providing sustainable transportation options, and also by reducing its overall carbon footprint.</p> <p>While Metrolinx can internally address some of its own resiliency needs, the problem can sometimes require a broader collaborative and integrative effort. This applies both to understanding vulnerability and risk, and in developing effective response measures. In particular, the relationship between</p>	a) Initiated in 2015. Ongoing.

⁵ Metrolinx did not participate in the collection of adaptation actions in 2014. The measures outlined in the updated table includes actions that were in place prior to the report to Council in 2014, and those that have been implemented since the July 8th, 2013 flood.

		<p>The main focus during year 1 of the resiliency program has been to:</p> <ul style="list-style-type: none"> (i) benchmark Metrolinx vis-à-vis best practices on vulnerability assessment and resiliency measures; (ii) identify and support internal initiatives around resiliency and adaptation; and (iii) assess the vulnerability and risk of a selection of key critical assets to extreme weather and climate change using the PIEVC Protocol developed by Engineers Canada. <p>A PIEVC report is currently under review, involving a consultancy team from AECOM, RSI and TRCA. A complementary benchmarking report is also in development, while support for planning, practices and protocols are being strengthened and formalized.</p>	<p>overland/urban/stormwater flooding and riverine flooding is an important knowledge gap, the impact of the urban heat island on maximum surface temperatures, and in the future the relationship between electrified rail/LRTs and a resilient electricity grid.</p>	
--	--	---	--	--

		<p>b) A number of initiatives have been implemented to enhance resiliency to extreme weather across Metrolinx rail corridors:</p> <ul style="list-style-type: none"> i. Installation of a CCTV camera along the lower Don River; ii. Installation of high water detectors; iii. Direct communication protocols established with TRCA, re. flood warnings and access to real-time stream flow data; iv. Use of AccuWeather Advanced Skyguard to help predict incoming extreme weather and potential threats to infrastructure; v. GO Transit maintenance contractors monitor the weather and provide special track patrols during and after storm events; vi. Numerous studies on flood risk and adaptation options; 	b) Flood Mitigation/Prevention.	b) Completed. Work is ongoing.
--	--	---	---------------------------------	--------------------------------

		<p>vii. Working with the City of Toronto and the Toronto and Region Conservation Authority to identify mitigation strategies with improvements to infrastructure, operating procedures and communications/collaboration between stakeholders regarding the Lower Don transportation corridor.</p> <p>c) Development of emergency response measures that address customer and safety needs during an extreme weather event, and to assist in recovery following an incident.</p> <p>d) Improvement and implementation of a snow plan/winter readiness plan.</p> <p>e) Establishment of multiple data centres.</p>	<p>c) Extreme Weather and Emergency Response Planning.</p> <p>d) Responding to extreme winter weather conditions; improved delivery of on-time but reduced service.</p> <p>e) Enhancement of IT Disaster Recovery.</p>	<p>c) Completed.</p> <p>d) Completed. Work is ongoing.</p> <p>e) In progress.</p>
--	--	--	--	---

		<p>f) Incorporation of extreme weather and climate change into enterprise risk management.</p> <p>g) Emergency Electricity Back-up systems</p> <ul style="list-style-type: none"> i. installation of co- and tri-gen at bus maintenance facilities ii. use of diesel/locomotives for back up generation at rail maintenance facilities iii. new standard for back-up power added to the Design Requirements Manual for all GO Stations. <p>h) Higher preferred rail laying temperature in the first edition of Track Standards Manual.</p> <p>i) Inclusion of “Become Climate Resilient” in the Draft Sustainability Strategy 2015-2020:</p> <ul style="list-style-type: none"> i. establish a Corporate Climate Adaptation 	<p>f) Significant potential risk to infrastructure, safety and quality of service to extreme weather and climate change.</p> <p>g) Reduce interdependent electricity vulnerability to extreme weather events.</p> <p>h) Reduce risk of derailment due to track warping and sun kinks caused by extreme high temperatures.</p> <p>i) Achieve Goal 1 of the Draft sustainability Strategy 2015-2020.</p>	<p>f) In progress.</p> <p>g) Completed. Work is ongoing.</p> <p>h) Completed. Work is ongoing.</p> <p>i) Completed. Work is ongoing.</p>
--	--	---	--	--

		<p>Plan covering facilities, practices and protocols</p> <p>ii. developing climate resilience requirements for inclusion within technical standards, manuals, guidelines, and project procurement agreements.</p>		
#	External Organizations	Existing Adaptation Actions, Policies and Procedures	Rationale	Status
18	Hydro One (Not a City ADC)	a) Periodic planning studies are done jointly with THESL and the IESO to identify electrical system needs and actions plans developed to address them.	<p>a) Metro Toronto is served by Hydro One's transmission network of thirty-four 230 kV and 115 kV stations.</p> <p>The Central Toronto consists of "Eastern Sector" and "Western Sector" supplied through major 230 kV/115 kV Stations Leaside TS and Manby TS, respectively. In addition, Toronto also has the Portland Energy Centre, with 550MW generation capacity, and provides additional supply point.</p> <p>Leaside TS is supplied by six high voltage transmission lines, on three separate double-circuit towers, coming from Cherrywood TS. Manby TS is supplied by four high voltage transmission lines, on two separate double-</p>	a) Hydro one in collaboration with THESL and the IESO conducted a review electrical infrastructure needs of Metro Toronto in 2015. A regional infrastructure planning report for the Metro Toronto Region was published on January 12, 2016, and is available on Hydro One Website.

		<p>b) Periodic operations and maintenance meetings, that includes replacement of electrical infrastructure in the City, are undertaken on a regular basis with THESL. These meetings are to discuss and plan for different operating conditions.</p> <p>c) On as-required basis meetings and discussion are planned in advance of any extreme weather among the IESO, Hydro One and THESL.</p>	<p>circuit towers, coming from Richview TS. Each station also consists of six autotransformers and provides redundancy. Leaside TS and Manby TS have sixteen and eight high voltage transmission lines, respectively, that supply the stations in the Central Toronto area.</p> <p>b) Periodic evaluation of operating strategy and/or replacement of defective or aging equipment to ensure reliability and security of supply.</p> <p>c) Reviewing extreme and/or higher ambient temperature are adequately considered for equipment design, ratings and operations.</p>	<p>b) Hydro One has a process and procedure to identify, plan and replace equipment nearing their end of life.</p> <p>c) Working in consultation with the electricity industry and following trends, Hydro One undertakes consideration of extreme weather.</p>
	External Organizations	New Adaptation Actions, Policies and Procedures	Rationale	Status
	Hydro One	Review and consideration of critical station equipment that is susceptible to failure in the event of flooding.	Identifying high risk equipment to plan and make them resilient.	Hydro One conducted a station survey. This work is in progress.

Appendix C – Back-up Power Considerations for Resiliency

In advancing a discussion of resiliency around the provision of back-up power, the Environment and Energy Division (EED) has developed a Minimum Backup Power Guideline for multi-unit residential buildings (MURBs). Furthermore, EED will be developing a best practice/corporate policy for specifying back-up power generator systems based on life-cycle costing and other value-driven considerations not limited to first costs. Additional details on these two initiatives are provided below.

Backup Power for Multi-Unit Residential Buildings

Following the 2013 flood and ice storm, the Environment & Energy Division (EED) began exploring opportunities to help improve resilience to area-wide power outages in multi-unit residential buildings (MURBs), both existing and new, so that residents can remain in their buildings safely with a degree of comfort for extended periods of time.

EED has developed a "Minimum Backup Power Guideline for MURBs" which presents a number of opportunities to help improve resilience to area-wide power outages in multi-unit residential buildings (MURBs), both existing and new. It is based on a previous study (updated 2016) completed by the EED in collaboration with the Hidi Group, which included business cases for several representative MURBs. Based on the results of this study, key opportunities for strengthening resilience are:

- a. Powering essential loads beyond life safety requirements, such as additional elevators, domestic water pumps, and common areas;
- b. Ensuring backup power provision for at least 72 hours; and
- c. Using natural gas generators instead of diesel powered generators.

As more Torontonians are living in taller buildings and as extreme weather events are expected to increase in frequency and severity, improving backup power in MURBs will strengthen the city's overall resilience by allowing people to remain in their buildings during area-wide power outages. This will provide a degree of safety and comfort, especially to vulnerable populations, and may potentially reduce added demand on public services, infrastructure, and facilities during non-emergency situations.

Emergency power is provided in high rise buildings to meet minimum regulated life safety requirements, which specify a minimum 2 hours of power supply to facilitate occupant evacuation and firefighter access. Most backup power is diesel fuel powered. When that fuel runs out, it could be some time for the fuel to be refilled. During the time the tank is empty, the building and its occupants are left vulnerable. On the other hand natural gas generators get their fuel from the natural gas distribution system and do not require refueling.

On this premise, the Environment and Energy Division will work with relevant internal and external stakeholders to define an implementation plan for new minimum back-up power guidelines for Multi-Unit Residential Buildings (MURBS), including options for mandatory elements.

Back-up Power for City Buildings Best Practices

Traditionally, diesel-fired generator systems have been the default option for both back-up/stand-by and emergency systems in buildings. However, increasingly based on life-cycle costing, other options are becoming more attractive, including the use of natural gas generator system, as well as, renewable energy systems with storage.

As the City continues to implement its renewable energy program at city facilities, there are opportunities to evaluate the use of solar photovoltaic, which normally feed electricity into the grid, to be reconfigured and augmented with energy storage for back-up power capability during a power outage.

Natural-gas fired generator systems have several advantages to their diesel counterpart:

- a. Do not require a liquid-fuel (diesel) storage and handling system, since these generators get their fuel directly from the natural gas distribution system.
- b. Do not require refueling and liquid fuel conditioning/regeneration, and
- c. No potential liability associated with liquid fuel spillage and soil contamination
- d. d) Additionally ownership costs associated with diesel generator systems have increased to meet ongoing updates to the Technical Standards and Safety Authority (TSSA) fuel regulations

Moreover, recent extreme weather events including the 2013 Ice Storm have demonstrated the limitations of diesel fuel availability in an emergency.

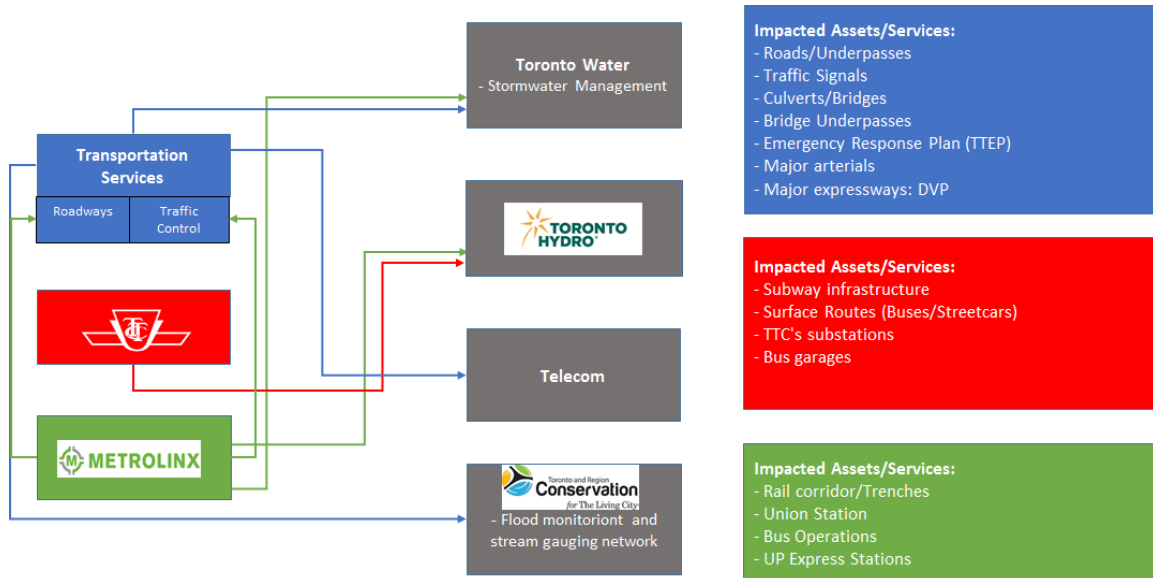
The Environment and Energy Division will work with Facilities Management and other appropriate capital project teams/divisions, to develop a best practice/corporate policy for specifying back-up power generator systems based of life-cycle costing and other value driven considerations not limited to first costs.

Appendix D Extreme Weather Portal – Promotion and Outreach

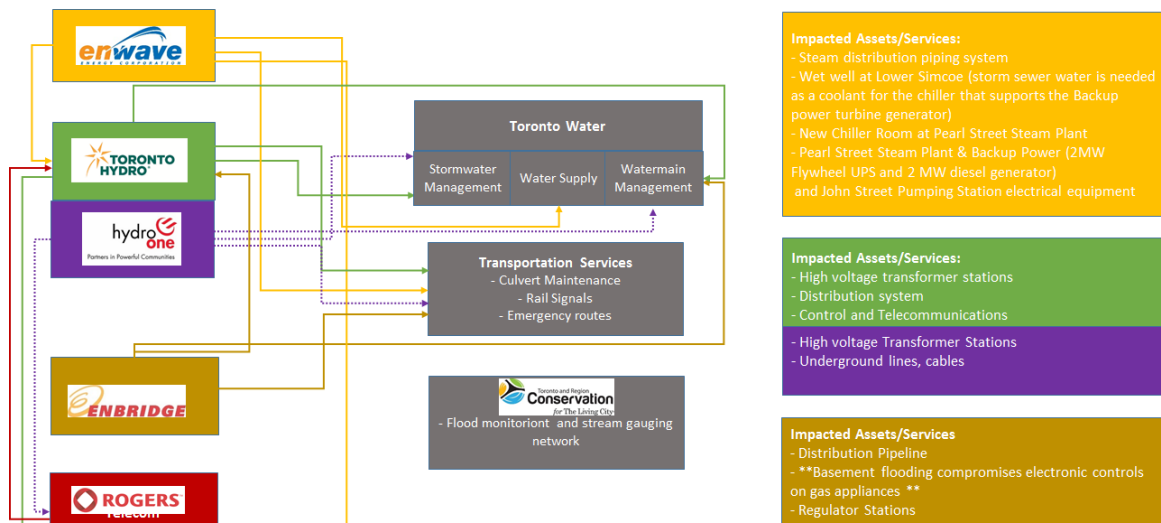
Method of Communication	Type of Promotion
Digital	<ul style="list-style-type: none"> • Official City news release • Monday morning news • City insider newsletter • Live Green newsletter • Social media outlets (Facebook and Twitter) by relevant City divisions, agencies, corporations and external organizations • Toronto.ca website • Heat warnings and Extreme Cold Weather Alerts issued by Public Health • Toolkit (web banner, icons, social media images, promotional blurbs) by relevant City divisions, agencies, corporations and external organizations • Professional and community networks: C40, Urban Sustainability Directors Network (USDN), and Community Resilience to Extreme Weather (CREW)
Print	<ul style="list-style-type: none"> • Public shelter transit ads (70 in total for four weeks) • Shelter ad outside City Hall • Bookmarks for distribution to the public
Community	<ul style="list-style-type: none"> • Live Green Toronto community events • Future Environment Days • Events hosted by other City divisions and external organizations

Appendix E: Dependency Diagrams

Transportation Thematic Area



Utilities Thematic Area



Water Thematic Area

