For Action

Audit, Risk and Compliance: Flood Risk Management

Date: September 24, 2019
To: TTC Board

Summary

The subject report, reviewed at the TTC Audit and Risk Management Committee on September 19, 2019 is forwarded to the TTC Board for information.

Contact

Marg Verbeek, Director of Emergency Management, ARC Department
416-393-3961
marg.verbeek@ttc.ca

For Action

Audit, Risk and Compliance: Flood Risk Management

Date: September 19, 2019
To: TTC Audit and Risk Management Committee
From: Tara Bal, Head of Audit, Risk and Compliance

Summary

Toronto's flood risk has increased significantly with a changing climate, causing four major flooding events in a recent six-year period with TTC service disruptions and damage to infrastructure. The summer of 2017 and 2019 saw extreme amounts of rain, which led to Lake Ontario reaching record high water levels, flooding the Toronto Islands. Global climate change will result in more intense and severe storms, increasing the risk of flooding and its impact, while the city's growth has put more people and property at risk.

Emergency Management staff within the Audit, Risk and Compliance (ARC) Department will conduct a comprehensive Hazard Identification and Risk Assessment (HIRA) by year-end that broadly evaluates the impacts of top corporate risks and hazards, and provide strategic recommendations for enhancing preparedness initiatives. In the meantime, this preliminary review examined the TTC capital projects aimed at mitigating flood risks and the flood response preparedness measures to ensure service continuance.

This preliminary review also involved gaining an understanding of obligations and responsibilities established through the TTC's participation in various City-led flood initiatives. In this respect, the TTC continues to collaborate with the City and other external organizations in their flood risk management projects to advance the TTC's ability to identify at-risk facilities and infrastructure. In particular, the TTC is supporting Toronto's First Resilience Strategy in the development of site-specific flood response plans in top priority areas of the city, and using Toronto and Region Conservation Authority (TRCA) flood resources and tools to develop a TTC critical infrastructure flood risk map.

Recommendations

It is recommended that the TTC Audit and Risk Management Committee:

1. Receive this report for information.
2. Forward a copy of this report to the TTC Board for information.

Financial Summary

The funding implications related to the Report recommendations are included in the approved 2019 Operating Budget. Any additional funding requirements will be requested as part of a future budget submission.

The CFO has reviewed this report and agrees with the financial summary information.

Equity/Accessibility Matters

There are no accessibility or equity impacts associated with this report.

Decision History

In June 2019 the Audit and Risk Management Committee (ARMC) requested the ARC Department conduct an assessment of the current TTC risk management strategy pertaining to flooding and related initiatives and provide the ARMC with a status report in September.

TTC Emergency Management is currently assessing the TTC's flood risk and readiness posture. This involves collaborating with internal departments and external agencies that have undertaken structural mitigation and response planning initiatives to enhance the TTC's resiliency, as well as those involved with risk mapping.

To better understand the TTC's vulnerability to climate change and increase infrastructure resilience to future events, a study was completed by AECOM in 2017. The study focused on seven subway stations, and summarized past severe flood incidents that impacted subway service and streetcars.

Key TTC flood mitigation activities and relevant capital projects include:

- Pump Maintenance and Drainage Cleaning;
- Subway Pump Replacement Program;
- Five Culverts and East Don River Bridge Rehabilitation Project;
- Reduction of Flood Impact at Kipling Station (future project); and
- Flood Readiness and Response Plans.

Flood initiatives led by the City with the full participation of the TTC include:

- Toronto's First Resiliency Strategy;
- Flood Resilience Working Group;
- Flood Resilient Toronto Charter;
- City-wide Flood Planning and Prioritization Tool;
- Site-Specific Flood Response Plans; and
- Downtown Basement Flooding Protection Program Environmental Assessment.

Issue Background

A changing climate poses more severe storm events causing increased risk to TTC's aging infrastructure. Often with no or little lead time, the GTA is likely to experience more frequent, shorter duration, high intensity rainfalls much like August 7, 2018 and July 17, 2019 storms which had serious impacts to TTC networks. Major flooding has become a normal occurrence, and by all indications, it is becoming worse each year.

The July 8, 2013 flash flood across the GTA resulted in a hybrid bus that was caught in low lying areas in the Mt. Dennis and Weston Road area. Significant damage was done to the interior of the vehicle, however Duncan Shop rebuilt this bus within two to three weeks.

Between June 1, 2012 and August 7, 2018, four flood-related incidents triggered insurance claims of approximately $4-5 million that are still in progress. These claims each have a deductible bringing the portion covered by insurance to $3-4 million. The June 1 Union Station flood was caused by a large inflow of storm and sanitary sewer water, resulting in the closure of the station to permit extensive clean-up efforts. The August 7 flash flood resulted in two severely damaged streetcars located at the King/Atlantic underpass. Flood water quickly filled the vehicles approximately four feet above the floor level of the vehicle. Significant damage to the propulsion system, interior floors and wall panels, seating, cab and some electrical wiring occurred. Sewage water mixed with storm and flood waters also means the vehicles need to be thoroughly cleaned and decontaminated. The TTC is awaiting Bombardier's completed assessment on these two streetcars, as they are currently compiling pricing and logistical information from various suppliers that will be needed to rebuild or re-qualify equipment.

Between 2014 and 2019, Transit Control Centre (TCC) delay logs showed 20 subway floods caused by broken pipes, water main breaks, pumping system failures, or heavy rainfalls – 12 on Line 1 and eight on Line 2, with 16 of them actually occurring in either stations or bus bays, and four at track level.

Comments

1. Current Status of Flood Mitigation Activities

TTC Emergency Management, in collaboration with various internal departments and external stakeholders, is currently assessing the TTC's flood risk and readiness posture. This involves structural mitigation and response planning initiatives to enhance the TTC's resiliency, as well as those involved with risk mapping, and public outreach and consultation.

The following provides an overview of the TTC Flood Mitigation Activities:

1.1 Current Capital Projects

There are two existing capital projects and a proposed project to address the identified structural deficiencies and the vulnerability of Subway Infrastructure assets at watercourses, due to climate change trends.

1) Subway Pump Replacement Program

The Subway Pump Replacement Program is an ongoing 'state of good repair' initiative. The scope includes end of life replacement of existing sanitary and storm drainage system pumps. There are more than 500 pumps that discharge sewage, rain and ground water collection at low depths within the stations and tunnels into municipal drainage lines.

Many pumps have exceeded or are approaching the end of their life cycle. A detailed third-party condition assessment was completed in 2012, identifying pumps needing immediate replacement, and those to be replaced over the next several years. Where feasible, some pumps have been replaced under the station modernization project.

In addition to the third-party condition assessment performed under the Subway Pump Replacement Program, Plant Maintenance assesses the condition of pumps on an ongoing basis, develops an annual priority list yearly during the budget cycle, and regularly reviews the priority sequence with the Construction Department, EC&E so they can schedule pump replacement projects accordingly. Plant Maintenance also issue a weekly Subway Storm Pumping Station Impairment Map (Attachment 1) where out of service pumps exist to minimize risk of potential flooding.

Budget provisions were increased in 2015 enabling the replacement acceleration of high priority pumps (from one to two locations per year to approximately five). Since 2012 to the end of 2019, the Construction Department will have completed 26 locations. The 2019 Capital Budget is at $94.2 million, and the 2020 Capital Budget request is to increase it to $108.1 million. Over the next 10 years, our 2019 Budget would be sufficient for approximately 30 more locations. The 2020 Budget request would be sufficient for approximately 39 more locations.

Since 2015, the replacement of old and defective pumps has significantly reduced the risk of possible flooding and service disruption. However special/key constraints exist:

- While pumps are twinned for redundancy, they require portable generators for back up emergency power;
- The condition assessment of the discharge drainage line between each pumping station and each City of Toronto sanitary or storm connection is not in the scope of this program;
- Resources – both internal and external (contractor availability);
- Storm pumps at track level need track level access (contractors can only work for two to three hours per night and four to five hours on Saturday, resulting in additional costs);

- Track access to do cabling in the tunnel;
- Work car availability;
- Lead delivery times on pumps; and
- Additional capital funding and associated prioritization would be required to address any of the above constraints and related scope changes.

2) Five Culverts and East Don River Bridge Rehabilitation Project

The City performed a Climate Change Risk Assessment in 2010 that identified the need to replace five TTC culverts and rehabilitate the East Don River Bridge so they can handle larger volumes of rainfall and minimize subway infrastructure flooding. Subsequently, from 2014 to 2016, the TTC conducted a condition survey, and a structural and hydraulic evaluation of the culverts and the bridge. SNC Lavalin were retained to conduct the Engineering Pre-Design of each asset. In 2016, the total project order of magnitude cost was estimated as $28 million based on the Pre-Design and this cost will be updated as the detailed design progresses. Currently, the approved budget is $10 million but the request for the 2020-2029 Capital Budget is to increase the funding to $28 million.

In 2018, the Preliminary Design was undertaken, and two internal risk assessments reported that one of the culverts (Dorset Twin Pipe – below Line 3 Scarborough) does not provide adequate flood protection for TTC tracks, and that Massey Creek twin pipe culvert (located under Line 2 Bloor-Danforth between Warden and Kennedy stations) would be overtopped by a regional-level storm, with less than 25-year storm capacity. The detailed design is now being performed with construction scheduled to start in 2021 and completed in three to four years after for all locations. (See Attachment 1 for the Rehabilitation Project locations)

3) Subway Infrastructure Resiliency Study

AECOM was retained to conduct a resiliency study related to the impact of climate change on the subway infrastructure. This pilot study of seven subway stations (Wilson, Yorkdale, Lawrence West, Glencairn, Warden, Kipling, and Islington) was to help the TTC better understand its vulnerability to extreme rainfall, and increase infrastructure resilience to future events. The project team (internal departments and AECOM) selected the piloted stations based on the completed Toronto Basement Flooding Environmental Assessment study plus Kipling Station as it has experienced floods. The objectives of the study were:

- To identify climate change and resiliency measures other GTA agencies have implemented, and applied to TTC infrastructure;
- To determine the causes of flooding at the stations;
- To identify flood vulnerabilities due to the architectural elements and urban drainage systems at each station;
- To develop priority ranking of stations with the highest flood vulnerability; and

- To provide a list of opportunities and constraints to flood remediation and recommendations for future detailed studies.

In their July 2017 report, AECOM recommended a generalized summary of design, monitoring and operational recommendations, and a table of study findings presented in a prioritized matrix of infrastructure components for each of the piloted stations.

The Safety and Environment Department is currently proposing structural flood mitigation works be undertaken at Kipling Station, as recommended by AECOM. The Safety Resilience Initiatives 2020-2029 Capital Budget may allocate funds for this project, pending a review of resource requirements.

1.2 Pump Maintenance and Drainage Cleaning

The TTC's Plant Maintenance Department performs regular maintenance of all sanitary and storm drainage pumps in the subway system. In addition, they perform regular cleaning of trench and floor drains, and of the storm drainage catch basins and associated exterior drains at surface properties and at non-track level subway locations (such as subway station bus roadways). The Subway Infrastructure Department maintains all drains at track level, and is responsible to cleaning all catch basins and storm drainage pits at track level.

Storm drainage pumping stations are connected to the Supervisory Control and Data Acquisition (SCADA) system that gathers data in real time from remote locations in order to control equipment and conditions. The TTC Transit Control Centre monitors on a 24/7 basis warning alarms for high water levels, power loss and pump failures. An emergency equipment group consisting of 10 electricians and 10 millwrights in Plant Maintenance is responsible for maintaining all the subway pumps, as well as other emergency equipment. Additionally, Plant Maintenance replaces underperforming or malfunctioning pumps with temporary pumps. For better response times, pumps and hoses have been strategically stationed in key depot locations across the city, and generators placed on standby during impending storms to minimize the power restoration timeframe. This group is available on standby 24/7. They monitor weather forecasts, and are cognizant of the flood risk areas across the subway network.

1.3 TTC Flood Readiness and Response Plans

During flooding events the goal is to avoid vehicle damage or derailment, infrastructure damage, and mitigate the effect on revenue services due to surface route detours, station closures and subway turn backs. Flood readiness and response actions are contained within Subway Operations and Service Delivery Group Severe Weather Plan, August 2019, and in the Subway Infrastructure Emergency Flood Response Procedure, April 2019. The TTC's Transit Control Centre and Emergency Management receive TRCA's flood forecasting and warning messages by e-mail that enables us to initiate response action sooner.

City-led Flood Mitigation Activities:

2. Flood Resilient Toronto

On June 4, 2019, *Toronto's First Resilience Strategy*[1] was launched, setting out a vision, goals and actions to help Toronto survive, adapt and thrive in the face of any challenge, particularly climate change. The Strategy provides the City with a community vision for a "Resilient Toronto" and actions to improve resilience. The Strategy has 10 goals and 27 actions organized into three focus areas: (i) people and neighbourhoods; (ii) infrastructure; and (iii) leading a resilient city. One of the priorities for improving resilience in Toronto is mitigating flood risk, with the goal: "*Toronto is more resilient to climate change, including the hazards of flooding and heat."*

The City's Resilience Office leads the Flood Resilience Working Group that was assembled in 2017, comprised of key City divisions, agencies (TTC), industry and academia. The purpose of the Working Group is to explore urban flooding resilience strategy and address Toronto's urban flood risk. The TTC's Director of Emergency Management is a member of this Working Group.

The Working Group developed three flood actions for the Strategy. They are:

1) Institutionalize an integrated, resilience approach to flooding by adopting the Flood Resilient Toronto Charter (Attachment 2);
2) Centralize resources towards a city-wide flood planning and prioritization tool; and
3) Review and update existing flood mitigation programs to account for resilience.

2.1 Flood Resilient Toronto Charter

The TTC's Chief Safety Officer signed the Flood Resilient Toronto Charter on May 31, 2019, along with the other senior leaders in the Working Group. The Charter set goals for flood resilience and guides decision-making around a collective vision and set of principles to reduce flooding in Toronto. By signing this Charter, the City and its partners have committed to seven actions to address heavy rainfall flooding, from using a risk-based planning approach to promoting innovation in building flood resilience.

2.2 City-wide Flood Planning and Prioritization Tool

Urban flooding occurs when rainfall overwhelms sewer and drainage capacity, forcing the water to flow overland. The Working Group is centralizing resources to develop a city-wide flood planning and prioritization tool that will:

- Improve modelling and urban flooding risk mapping;
- Focus on communications and education; and
- Provide real-time modelling and forecasting.

[1] Toronto Resilience Strategy, June 2019.

Currently, extensive effort is being undertaken to create engineering models of drainage systems, and to map Toronto's floodplains. This is a critical gap that needs addressing as there is no city-wide map of the urban flood risk.

Using this tool, the Resilience Office will synthesize existing data sets as they identify and prioritize problematic urban flooding areas. With input from the Working Group, this tool will account for flood risk using topography and sewer capacity and overlay key concerns such as critical infrastructure and vulnerable populations.

2.3 City Existing Flood Mitigation Programs

The Downtown Basement Flooding Protection Program Environmental Assessment (EA) Study is now underway. This will involve the City examining the storm water and sewage systems, and determining if its systems are causing flooding issues in subway stations. The TTC's Chief Engineer of Civil Design, Engineering, Construction & Expansion (EC&E) is a member of the City's project team.

Beginning in late September 2019, the Flood Resilience Working Group will operationalize the Charter, starting with developing an implementation plan, and refining the scope of the tool. A proposed schedule of early 2020 is targeted for commencing development of the tool. Dedicated project funding has not been identified, and a collaborative funding structure with key agencies will be explored. The Resilience Office will provide a progress report to Council in December 2019.

3. Toronto and Region Conservation Authority

3.1 TRCA Mapping Layer

TRCA's Riverine Flood Risk Assessment and Ranking Project is a geospatial-mapping tool (based on Hurricane Hazel flood boundary) that the TTC is using to determine what critical infrastructure is within the flood plain and at risk. Fourteen cluster areas across the TRCA were identified as flood vulnerable areas.

Emergency Management has recently acquired the preliminary flood risk map (Attachment 3) that shows TTC infrastructure and service routes in the flood plain. This basic map requires further assessment, and the TTC requires a more comprehensive flood risk map with greater detail to determine vulnerable infrastructure.

3.2 Site-Specific Flood Response Plans

TRCA and the City's Office of Emergency Management are co-leading the development of site-specific flood emergency plans, with the TTC's participation. These plans will utilize the updated flood risk mapping to allow better communication and resource deployment for road closures and evacuations during flood emergencies for the pre-identified flood vulnerable clusters. This activity will also enhance the TTC's flood response plans. TRCA has already convened a Working Group for the Rockcliffe-Smythe neighbourhood site-specific flood response plan, which will form a template for

the remainder of the plans. Top priority area plans are to be completed by March 2020. The Rockcliffe cluster was number one in the Flood Risk Assessment and Ranking Project, being the most flood-vulnerable area in the city and across the TRCA region.

4. Next Steps

There are a number of initiatives to be undertaken to progress the assessment of the TTC's flood risk across the system, protect infrastructure, and enhance readiness measures. These upcoming initiatives contain both internal activities, as well as those externally led by City and other organizations.

4.1 TTC Activities – Led by Emergency Management

Emergency Management, with the support of numerous departments, will lead the following activities to assess the flood risk across the system, provide ongoing progress status reports on flood risk capital projects, and determine future resilience and response initiatives to mitigate and minimize flooding impacts. They are:

1) Review the current project status of the Subway Pump Replacement Program and the Five Culverts and East Don River Bridge Rehabilitation Project to assess the impact of the implementation schedule on flood risks.

2) Review the recommendations and table of study findings in the AECOM report to assess the status of implemented mitigation measures.

3) Review the After Action Reports and Improvement Plans for the four flood-related incidents triggering insurance claims that occurred between 2012 and 2018, as well as the 20 subway floods that occurred between 2014 and 2019, and advise of the status of implemented corrected measures.

4) Plant Maintenance, supported by Emergency Management and EC&E to prepare a business case detailing the rationale and costing of connecting the storm drainage pumps to auxiliary power.

5) Assist Transit Control Centre to determine the feasibility of utilizing the TRCA real-time flood forecasting warning tool to monitor flood warnings to support operational and strategic decision-making.

6) Review all departmental flood readiness and response plans and related procedures, and provide departments with constructive feedback and recommendations for improving their plans and procedures.

7) Prepare a corporate-level Flood Emergency Response Plan as an Annex to the Corporate Emergency Response Plan. Train staff on the Plan, and conduct an exercise drill to ensure it is effective during a major flood.

8) Review the TTC's critical infrastructure flood risk map based on riverine and urban flooding, and identify the impacts to the TTC.

9) Develop a Flood Resilient Project Plan and share this with the City for inclusion in their Resilience Strategy's Implementation Plan (as part of their progress report to Council in December 2019).

4.2 External Activities – Led by the City or Other Organizations

1) Emergency Management to participate in the Flood Resilient Toronto project as a member of the Flood Resilience Working Group. This will involve operationalizing the Charter, and refining the scope of the City-wide Flood Planning and Prioritization Tool.

2) Emergency Management to participate as a member of the Site-Specific Flood Emergency Response Plan Working Group to contribute to the preparation of site-specific flood response plans within the City.

3) EC&E to participate on the Downtown Basement Flooding Protection Program EA Study.

Contact

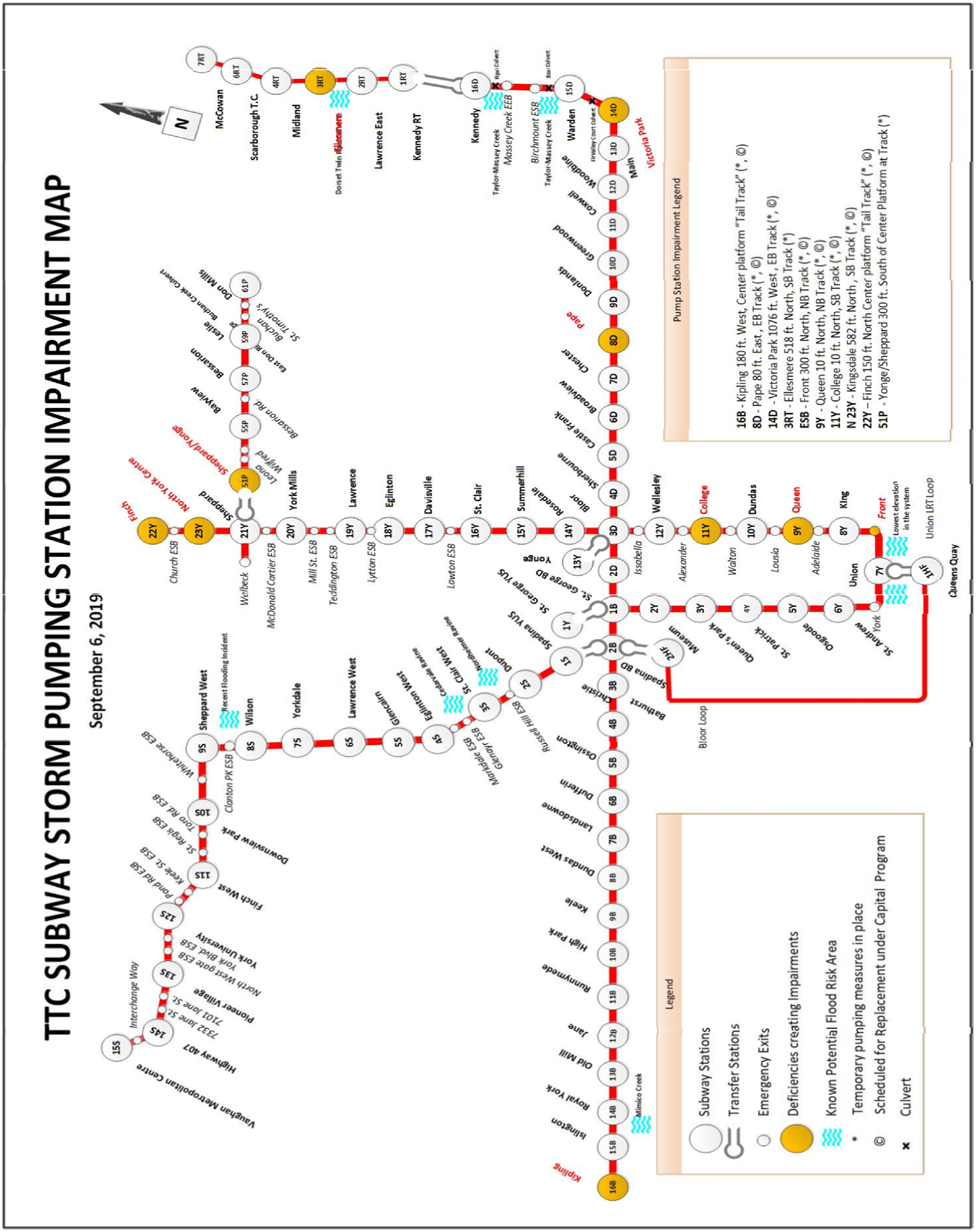
Marg Verbeek, Director of Emergency Management, ARC Department
416-393-3961
marg.verbeek@ttc.ca

Signature

Tara Bal
Head – Audit, Risk and Compliance

Attachments

Attachment 1 - Subway Storm Pumping Station Impairment Map
Attachment 2 - Flood Resilient Toronto Charter
Attachment 3 - Preliminary TTC Flood Risk Map with TRCA Flood Plain


TTC SUBWAY STORM PUMPING STATION IMPAIRMENT MAP
September 6, 2019
Legend
Subway Stations
Transfer Stations
Emergency Exits
Deficiencies creating Impairments
Known Potential Flood Risk Area
Temporary pumping measures in place
Scheduled for Replacement under Capital Program
Culvert
Pump Station Impairment Legend
16B - Kipling 180 ft. West, Center platform "Tail Track" (*, ©)
8D - Pape 80 ft. East , EB Track (*, ©)
14D - Victoria Park 1076 ft. West , EB Track (*, ©)
3RT - Ellesmere 518 ft. North, SB Track (*)
ESB - Front 300 ft. North, NB Track (*, ©)
9Y - Queen 10 ft. North, NB Track (*, ©)
11Y - College 10 ft. North, SB Track (*, ©)
N 23Y - Kingsdale 582 ft. North , SB Track (*, ©)
22Y – Finch 150 ft. North Center platform "Tail Track" (*, ©)
51P - Yonge/Sheppard 300 ft. South of Center Platform at Track (*)
Recent Flooding Incident
Lowest elevation in the system
Bloor Loop
Union LRT Loop

Charter for a Flood Resilient Toronto

May 8, 2019

Letter from the Chief Resilience Officer

In August of last year, a major rain storm resulted in widespread impacts to public and private property in Toronto. The storm impacted critical infrastructure and services as 16,000 homes experienced power outage, and transit services were heavily impacted with streetcars damaged and transit stations such as Union Station flooding. Hundreds of Torontonians' homes were flooded with over $80 million in property damage.

These flooding events are not unique; another Toronto storm in July 2013 was the costliest natural disaster in Ontario's history, with a staggering $1 billion in damages.

Global climate change will result in increased frequency and intensity of these storms, which will increase the risk of flooding and its impact, while the City's growth has put more people and property at risk.

The Opportunity

We cannot stop storms from happening, but the impact of rainfall flooding on Toronto is up to us. We are lucky to face fewer natural hazards than many cities our size; Toronto is not as risk from rising sea levels and is fortunate to be situated on a source of plentiful, clean fresh water. However, our risk of heavy rainfall flooding is evident, and growing. We can learn from the ambitious action plans implemented by cities faced with similar challenges, such as Copenhagen and New York City.

The majority of pieces are already in place within government and the private sector to achieve this ambition. The City has made substantial investments and progress to mitigate riverine and basement flooding and improve water quality.

The Vision

An achievable goal for Toronto is to become a world leader in urban flooding resilience. We can achieve great success in working together to address the risk of rainfall flooding, and adapt to a changing climate.

This charter outlines actions that will set Toronto on a course to be a leader in flood resilience. It is the result of a unique, year-long collaboration between City divisions, agencies; the private sector; academia; other orders of government; and internationally, 100 Resilient Cities and Deltares.

Demonstrating leadership on urban flooding through broad, meaningful cross-sector partnership is essential. Further collaboration is the only way to achieve our vision. Signing this charter commits us to a shared ambition and a set of actions for Toronto to become a world leader in flood resilience.

Elliott Cappell
Chief Resilience Officer, City of Toronto

RESILIENT TORONTO

Flood Resilient Toronto Charter

The City of Toronto and its partners commit to the following actions to address heavy rainfall flooding as a world leader, resulting in a Flood Resilient Toronto:

1. Use a risk based approach to drive city planning, projects and programming. Make decisions based on a collaborative approach, with a focus on continuous learning and improvement.

2. Conduct and maintain city-wide modelling to identify hazards, assess impacts and map vulnerabilities, critical infrastructure and interdependencies.

3. Develop best management practices for operations based on risk and level of service, and develop funding plans accordingly.

4. Develop plans to align capital funding with risk and level of service, and prioritize infrastructure renewal based on risk management best practice.

5. Support and promote innovation in building flood resilience; encourage partnerships, new technical and infrastructure approaches, innovative planning, foster education and a shift in thinking towards flood resilience.

6. Collaborate across the City, with other governments, academia, industry, and community, and participate in national and international exchanges. Demonstrate leadership in flood resilience locally and abroad.

7. Transparently communicate flood risk, and encourage and support residents and businesses to take action to mitigate risk.

To implement these actions, the Flood Resilient Toronto Working Group will collaborate to finalize a Work Plan and revised Terms of Reference for the working group.

Flood Resilient Toronto Working Group:

- Elliott Cappell, Resilience Office, Toronto
- Kevin Tudhope, Toronto Water, City of Toronto
- David Kellershohn, Toronto Water, City of Toronto
- Stewart Dutfield, Environment and Energy, City of Toronto
- Vesna Stevanovic-Briatico, Transportation Services, City of Toronto
- Jane Welsh, City Planning, City of Toronto
- Dylan Aster, Toronto Building, City of Toronto
- Hazel Breton, Engineering and Construction Services, City of Toronto
- John McCarthy, Facilities Management, City of Toronto
- Sameer Dhalla, Toronto Region Conservation Authority
- Rob McKeown, Toronto Hydro
- Geoffrey Turner, Toronto Transit Commission
- Quentin Chiotti, Metrolinx
- John Antoszek, Ministry of Environment, Conservation and Parks, Province of Ontario
- Jo-Anne Rzadki, Conservation Ontario
- Dan Sandink, Institute for Catastrophic Loss Reduction
- Cheryl Evans, Intact Centre on Climate Adaptation
- Fadi Masoud, University of Toronto John H. Daniels Faculty of Architecture, Landscape and Design

In agreement to make best efforts to adhere to the terms established in this Charter, the parties below have executed this Charter.

Original Signed by:

Date May 8, 2019

Elliott Cappell
Chief Resilience Officer, City of Toronto

Date May 27, 2019

Tracey Cook
Deputy City Manager,
Infrastructure and Development Services,
City of Toronto

Date May 27/19

Josie Scioli
Deputy City Manager,
Internal Corporate Services,
City of Toronto

Date May 14/19

Lou Di Gironimo
General Manager, Toronto Water, City of Toronto

RESILIENT TORONTO

Date May 29, 2019

Jim Baxter
Director, Environment and Energy, City of Toronto

Date 05/27/19

Barbara Gray
General Manager, Transportation Services, City of Toronto

Date May 22 2019

Gregg Lintern
Chief Planner, City Planning, City of Toronto

Date May 17, 2019.

Michael D'Andrea
Chief Engineer and Executive Director, Engineering & Construction Services, City of Toronto

Date May 23/19

Will Johnston
Chief Building Official/Executive Director, Toronto Building, City of Toronto

Date May 30, 2019

Pat Matozzo
General Manager (Interim)
Facilities Management, City of Toronto

Date May 31, 2019

Dino Priore
Executive Vice-President and Chief Engineering and Construction Officer
Toronto Hydro

Date May 27, 2019

John Mackenzie
Chief Executive Officer
Toronto and Region Conservation Authority

Date May 31, 2019

Mathieu Goetzke
Chief Planning Officer
Metrolinx

Date May 31/19

John O'Grady
Chief Safety Officer
Toronto Transit Commission

PRELIMINARY TTC FLOOD RISK MAP WITH TRCA FLOOD ZONES