

### Section III – Items for Information of the Board

**TO:** Chair and Members of the Board of Directors  
Meeting #6/20, Friday, September 25, 2020

**FROM:** Sameer Dhalla, Director, Development and Engineering Services

**RE:** **FLOOD RISK MANAGEMENT ANNUAL UPDATE**  
Overview of Flood Forecasting and Warning Program and Flood Response Planning Activities with Municipal Emergency Management Partners

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#### KEY ISSUE

Summary of current and future non-structural flood risk management initiatives, highlights of flood events experienced in the past year, and overview of flood response planning activities occurring in conjunction with municipal partner staff.

#### RECOMMENDATION

**WHEREAS TRCA staff provided an overview of the Flood Risk Management Program at the Board of Directors meeting #6/19 held on June 21, 2019, and were directed to provide an annual summary of flood risk management work that has been completed;**

**IT IS RECOMMENDED THAT this report be received.**

#### BACKGROUND

Almost 5 million people live within the 9 watersheds and Lake Ontario waterfront that make up TRCA's jurisdiction. With drainage areas ranging from 38 square km for the Carruthers Creek to 900 square km for the Humber River, all of TRCA's watersheds are relatively small. These small drainage areas, with short stream lengths and highly urbanized (impervious) surfaces, leave little lead time between rainfall and flood impacts. Year-round flood threats include ice-jams in the winter, snowmelt in spring, unpredictable thunderstorms in the summer, and hurricane remnants in the fall. While land-use planning has effectively reduced risk in greenfield areas, many neighbourhoods were historically settled near rivers prior to flood plain management. Examples include old downtowns in Brampton, Bolton, Unionville, and Stouffville. In other places, spills from altered watercourses and floodplains extend into populated areas. Across TRCA's jurisdiction, there are 41 such Flood Vulnerable Clusters, or areas where there is a high concentration of buildings in the floodplain.

TRCA undertakes a wide variety of programs to fulfil our Strategic Plan objectives to reduce flood risks and protect communities. These programs span the full spectrum of the emergency management cycle: from land-use planning to prevent exposure to hazards, to capital projects to mitigate flooding, to the many non-structural initiatives in the preparedness, response, and recovery phases that work to reduce the threat to public safety in areas of existing flood risk. These non-structural initiatives include flood emergency planning with municipal partners, personal preparedness education and outreach, and the Flood Forecasting and Warning (FFW) program. TRCA's flood risk management activities are leading-edge, incorporating state of the art technologies in real-time gauging, hydrology and hydraulic modeling and multi-mode communications. Many of the recommendations of the 2020 Ontario Flooding Strategy refer to flood risk reduction activities that have long been in-place at TRCA. During flood events, the information provided by TRCA plays a critical role assisting municipal partners in making decisions for emergency response. The FFW program is staffed by a complement of Flood Duty

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Officers (FDOs) and Chief Flood Duty Officers (CFDOs) who are on-call 24 hours a day, 7 days a week, 365 days a year.

At TRCA Board of Directors Meeting #6/19, held on June 21, 2019, a summary of Flood Risk Management activities was presented to the Board, and the following resolutions were approved:

*THAT TRCA staff, in partnership with TRCA's municipal partners, continue to implement and advance flood risk management projects;*

*AND THAT TRCA staff be directed to continue to work with municipal staff and the insurance industry to share information from NDMP projects to advance and improve flood communications;*

*AND FURTHER THAT staff provide an annual summary of flood risk management work that has been completed.*

As outlined in the Ontario Flooding Strategy, the roles and responsibilities for ensuring public safety during flood events are shared between various levels of government, conservation authorities, and individuals. Municipalities have the primary role in undertaking emergency response actions, including road closures and evacuations, and are legislated, through the Provincial Emergency Management and Civil Protection Act, to develop emergency plans and conduct training exercises to support preparedness. In areas where a Conservation Authority exists, they hold the delegated responsibility from the Ministry of Natural Resources and Forestry (MNRF) to operate a Flood Forecasting and Warning Program in accordance with the *Provincial Flood Forecasting and Warning Guidelines*. The FFW program is designed to:

- Support municipal flood emergency planning,
- Monitor weather and watershed conditions daily and maintain a local data collection network,
- Issue flood messages to municipalities, applicable agencies, media and the public in order to advise of potential flooding when appropriate,
- Operate TRCA dams and flood control structures to reduce the effects of flooding when appropriate,
- Maintain communications with municipalities and the MNRF Surface Water Monitoring Centre during a flood event.

In fulfilling these objectives, TRCA works closely with partner municipalities, and with meteorological authorities such as the Ontario Storm Prediction Centre (OSPC) operated by Environment Canada and Climate Change (ECCC).

To support effective flood response during an event, and to support municipal partners in fulfilling their emergency management responsibilities, TRCA staff also participate in the development of flood emergency response plans, training, and emergency management exercises. The remaining sections of this report provide a summary of notable flood events over the past year, as well as highlight key advancements in flood forecasting and emergency response planning that have been supported by funding from the National Disaster Mitigation Program (NDMP).

### RATIONALE

#### Significant weather events of 2019 and 2020

Since the last program update, several weather events occurred within TRCA's jurisdiction, some of which resulted in flood impacts to specific areas. Fifty-six (56) flood messages were issued covering 35 different forecasted weather events, some of which had no impacts and others which featured more notable impacts (or a higher degree of unpredictability), as outlined below:

#### 1) Lake Ontario high water levels – Spring/Summer 2019

Lake Ontario water levels in 2019 exceeded the previous record level set in 2017 by 2cm, with a daily 24-hour average level at the Toronto gauge peaking at 75.95m. In addition to the higher peak water level, the duration of the peak level was significantly longer than in 2017. Regardless, the tools, mitigation tactics, operational protocols and relationships that were established in responding to the 2017 high lake levels allowed areas like the Toronto Islands to remain open in spite of the conditions.

Anticipating the potential for high levels again in 2020, the Lake Ontario High Water Level Incident Management System (IMS) response structure was pro-actively implemented in March of 2020, to support the pro-active resilience works requested by TRCA's municipal partners. Tools, such as the Lake Ontario High Water Levels Viewer, were improved and re-deployed to provide members of the public with enhanced situational awareness. A relatively dry spring and the favourable snowmelt of the Ottawa River allowed water levels on Lake Ontario to peak below major impact thresholds in 2020.

#### 2) Severe thunderstorm - July 17, 2019

An unexpected thunderstorm developed over parts of Toronto and Mississauga on the morning of July 17, 2019, impacting the Etobicoke and Humber River watersheds. Flood Warnings were issued, and staff were in communication with emergency management partners. Minor riverine flooding was observed in parklands alongside Little Etobicoke Creek. Riverine flooding was not observed along Black Creek, however, there were numerous reports of urban (pluvial) flooding in the area. Localized rainfall totals reached 95mm, with the highest value recorded on the City of Toronto gauge network.

#### 3) Winter rain event – January 11-12, 2020

A large low-pressure system brought significant precipitation to the TRCA jurisdiction in early January. Rainfall events in the winter can result in significant runoff as frozen ground conditions can absorb little rainfall. This rainfall event was widespread and affected the entire jurisdiction, bringing between 70-95mm over the course of two days. The runoff passed quickly through some watercourses with smaller drainage areas, such as Black Creek and Little Etobicoke Creek, without critical water levels being reached. By contrast, TRCA's larger watersheds with significant headwater systems, such as the Humber River, Rouge River, and Duffins Creek, responded to the significant volume of water, with flooding and erosion reported at many points along the valley system. Many of the impacts were to recreational amenities and land uses, and included road closures, trail washouts, and service road impacts. TRCA's virtual Emergency Operations Centre

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(EOC) for flood events was partially activated for this event, providing support to municipal partner EOCs.

### 4) Ninja Storm – July 8, 2020

On the seventh anniversary of major flooding, and much like the “Ninja Storm” that occurred two summers earlier, an unexpected convective storm developed in the mid-afternoon and delivered 65-75mm of rain concentrated in the Black Creek subwatershed. In addition to numerous reports of urban (pluvial) flooding, riverine flooding into parkland, lawns, and parking lots occurred where Black Creek exceeded its banks in several locations. The key challenge with these types of storms is their intensity and unpredictability. Flood Duty Officers were able to quickly respond to the conditions that differed significantly from the original forecast, and the rapid response was aided by the previous installation of additional real-time gauges, such as the Westmount Park rain gauge in Rockcliffe, and access to radar-based forecasting tools.

As illustrated by flooding events in recent years, many areas within TRCA's jurisdiction are prone to flooding from mechanisms that have little predictability. The lack of lead-time to initiate emergency response actions necessitates the streamlining of information sharing during flood emergencies in TRCA's most at-risk areas. To enable this, investments in two program areas were undertaken as part of the National Disaster Mitigation Program: the development of the Delft-FEWS flood forecasting decision support system (DSS), and the development of site-specific flood emergency planning documents.

#### Site-specific Flood Response Planning (SSFRP)

Municipalities have the primary responsibility for ensuring the welfare of residents. This includes the mandate for response actions such as evacuations, road closures, and procedures to safeguard infrastructure. TRCA's role is that of providing expertise and technical assistance regarding the riverine flood hazard to municipalities.

While the potential for a flood to develop can have little *predictability*, there is an enhanced understanding of *impacts* in the most vulnerable areas, particularly following the completion of TRCA's Flood Risk Assessment and Ranking project. Information derived from this project and the updated floodplain mapping undertaken in recent years had already been utilized by FDOs and CFDOs to assist during flood emergencies, however, the SSFRP project aimed to establish a common understanding of risks, responsibilities, and possible protective actions between TRCA and our municipal partners. The project involved joint development of a set of impact tables and possible response procedures, together with simplified mapping that could be utilized by first responders.

The development of SSFRPs in partnership with municipalities was targeted for the following Flood Vulnerable Clusters (FVCs)

- Rockcliffe (City of Toronto)
- Jane-Wilson (City of Toronto)
- Dixie-Dundas (City of Mississauga)
- Spring Creek/Bramalea (City of Brampton)
- Bolton Core (Town of Caledon)
- Stouffville Centre (Town of Whitchurch-Stouffville)
- Oak Ridges/Lake Wilcox (Town of Richmond Hill)
- Unionville (City of Markham)

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- Woodbridge (City of Vaughan)
- Lower Carruthers (Town of Ajax)

To support the development of these site-specific documents, TRCA staff develop draft flood impact tables and maps, which are shared with Emergency Management staff at each municipality, who in turn convene the appropriate divisions to confirm the impacts and identify possible protective actions to be undertaken. The key component of a SSFRP is an action table outlining the impacts as flood threats progress, the associated actions, and the party responsible for implementing those actions. Examples of actions include road closures, potential evacuations, infrastructure inspections, and facility closures. The purpose of developing the SSFRP is to provide a framework for communications, actions, and procedures associated with responding to a flooding event specific to known impacts in vulnerable communities. It has also provided TRCA staff with an understanding of the type of information municipalities require during flood events, which in turn ensures that TRCA's IMS structure for flood emergencies mirrors that of municipal partners.

Depending on the municipality, the SSFRPs do not necessarily represent formal response plans, but rather represent “site-specific risk information packages” meant to complement existing municipal emergency plans or risk-specific plans for flooding. The utility of developing these plans was illustrated as the communication channels established for the Rockcliffe and Jane-Wilson enabled TRCA and first responders to connect more quickly during the July 8, 2020 Ninja Storm.

The above locations were selected to represent high-risk clusters distributed across partner municipalities. The process of developing the SSFRP has also strengthened working relationships with each of these municipal emergency management partners. Typically, TRCA staff work together with municipalities to deliver flood related education and outreach information during Emergency Preparedness Week and other appropriate events. In 2020, however, the COVID-19 response resulted in the cancellation of outreach activities, as well as in delays in finalizing SSFRP documentation, as municipal emergency management staff have been focused on pandemic response measures.

### Flood Early Warning System (FEWS) Development

Priority 3 of the Ontario Flooding Strategy – Enhance Flood Preparedness – includes action areas to enhance flood forecasting and early warning systems. TRCA's Flood Forecasting and Warning program is constantly evolving to meet the unique challenges of our jurisdiction, adding new tools and data sources as they become available. Recognizing that the characteristics of TRCA watersheds and the nature of the weather systems that impact them make it difficult to predict flooding, TRCA has been working to develop a decision support system (DSS) for FDOs that consolidates the myriad of information and data sources used, and that incorporates the next generation of flood forecasting models. Following an internal gap-analysis exercise and a third-party review of available tools for flood forecasting, the Delft Flood Early Warning System (FEWS) was selected as the platform on which to build TRCA's next generation DSS.

FEWS is an industry-leading, open-source decision support system software that organizes the forecasting process. It brings together various sources of weather forecasts, radar information, measured rainfall and streamflow data, as well as real-time hydrologic models and data assimilation algorithms, to support and streamline flood forecasting and warning activities. It is not a model itself, but rather a model-agnostic decision support system that can run multiple models or ensemble predictions, as well as support and document decisions. As an open-source platform, it has a wide user-base internationally as well as in North America, including the entire US National Weather Service, Manitoba Hydro, BC Hydro, and Alberta Environment.

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It is highly customizable, but requires significant configuration effort, which is supported by an engaged user community.

Leveraging funding from the final intake of the NDMP, a pilot system has been developed which will form the basis of configuration for TRCA's jurisdiction. The completed pilot provides aggregation and spatial averaging of weather and radar forecasts for all of TRCA's jurisdiction, as well as a customized adaptor that allows for FEWS to run hydrologic models in SWMM, which is one of the programs that is used by TRCA for floodplain mapping purposes. The pilot allows real-time rain and streamflow data to be incorporated into forecasts, including simple data assimilation methods. While the completed pilot represents the beginning of the journey towards more targeted flood messaging, continued efforts in configuration to bring in other flow forecasting models will be required in the coming years. Staff are in the process of training on the functionality and configuration settings of the system, and the Flood Risk Management team will be testing and building upon the pilot project before making the system operational.

### Real-time Gauging Network and Website

TRCA's real-time gauging network, together with the updated real-time gauging website, are essential tools for TRCA's Flood Forecasting and Warning program. The Flood Infrastructure and Hydrometrics team continues to expand the real-time gauging network; recent additions include a stream gauge near the Elgin Mills and Newkirk Business Park flood vulnerable clusters in Richmond Hill, as well as two rain gauges in the Carruthers Creek watershed. The real-time network currently comprises 22 stream and dam gauges, and 26 rain gauges (some of which do not operate in the winter). With the increased network density, however, comes increased operations and maintenance requirements. In addition to providing Flood Duty Officers, municipal partners, and members of the public with critical information during flood events, the gauging website is often utilized by the scientific community and praised by weather forecasters for being able to concisely present information. An update to the gauging website back-end is currently underway to consolidate its data source with the primary hydrometric data management system.

TRCA is collaborating with the Region of Peel to support its Gauge-Adjusted-Radar-Rainfall (GARR) project, providing rain gauge data used in real-time calibration, and post-event validation, of radar-rainfall products. As it would be impossible to achieve rain gauge coverage everywhere, GARR products represent an important advancement in flood forecasting and warning and are utilized where available to assist Flood Duty Officers. TRCA is also working with municipal partners, such as the City of Toronto, to import their rain gauge network information, with the aim of providing FDOs with a consolidated real-time precipitation network.

### Flood Risk Outreach

As outlined in the report adopted by resolution #A88/20 at the June 24, 2020 Board of Directors meeting, TRCA has exhibited leadership in the delivery of flood risk information to residents through the Flood Risk Awareness and Education Program. While the focus since April has shifted to the creation of digital content in the absence of NDMP funding and in light of COVID-19 restrictions on gatherings, flood outreach activities remain an important component of the Flood Risk Management program. Ensuring Ontarians are aware of flood risks is one of five overarching objectives within the Ontario Flooding Strategy, and communications activities for this year include the development of new digital content, informational videos, and pursuing partnerships for pro-active communications together with the Peel Climate Change Partnership, Conservation Ontario, and various municipal partners. In the realm of knowledge transfer, TRCA continues to play a role in facilitating the Provincial Flood Forecasting and Warning Committee workshop, which will be held virtually in the fall. TRCA is also participating in the

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upcoming Technical Transfer Workshop, which will be hosted by the Canadian Water Resources Association.

### **Conclusion**

TRCA takes a multi-disciplinary approach to Flood Risk Management, including strong programs in Flood Forecasting and Warning and flood emergency management. TRCA's urbanized watersheds and the increasing threat from extreme events require advanced technology and robust response protocols to manage flood events efficiently. TRCA is consistently improving the flood management program, leveraging best-available technologies and processes to mitigate risk for priority areas. As the flood risk management program evolves to meet the challenges of our jurisdiction, the degree of technical support and expertise required to administer the various tools and technologies also increases. TRCA will continue to pursue both structural and non-structural measures to reduce the existing and substantial flood risk in our jurisdiction, leveraging updating flood mapping and modeling, incorporating new technologies in remote sensing, and enhancing emergency preparedness planning with municipal partners.

### **Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan**

This report supports the following strategy set forth in the TRCA 2013-2022 Strategic Plan:  
**Strategy 2 – Manage our regional water resources for current and future generations**

### **FINANCIAL DETAILS**

Funds for general FFW operations are available in operating account 115-60 (Flood Warning Program) and 115-62 (Flood Risk Management and Communications). Gauging is funded through capital account 107-01 (Flood Forecasting and Warning System). The Site-Specific Flood Response Planning and FEWS Decision Support System projects were funded through capital accounts 107-74 and 107-73 respectively, which were supported by the National Disaster Mitigation Program, and capital funding from the City of Toronto, York, Peel and Durham Region

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