

RESILIENT FOOD SYSTEMS, RESILIENT CITIES:

A High-Level Vulnerability Assessment of Toronto's Food System

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The Initiative for a Competitive Inner City (ICIC)

ICIC is a national, nonprofit research and advisory organization focused on driving urban economic development since 1994. In 2014, ICIC developed a groundbreaking resilience framework to allow cities to conduct a rapid assessment of food system vulnerabilities to natural disasters and extreme weather events. ICIC has analyzed urban food system vulnerabilities in seven North American cities and national experts in the field have adopted our framework. For more information about ICIC, please visit www.icic.org.



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- Preventing the spread of disease, promoting healthy living and advocating for conditions that improve health for Toronto residents;
- Using surveillance to monitor the health status of the population in order to respond to on-going and emerging health needs; and
- Developing and implementing public policy and practices that enhance the health of individuals, communities and the entire city.

Toronto Environment & Energy Division

In addition to promoting environmental sustainability, energy efficiency and conservation within the City's internal operations, the Environment & Energy Division:

- Supports initiatives to enhance the resilience of the City of Toronto government, residents and businesses to the effects of climate change;
- Develops and implements environmental and energy policies, projects and programs that promote sustainable development and the growth of the green economy;
- Provides research and policy expertise;
- Establishes and leverages partnerships with internal and external stakeholders; and
- Delivers tools and resources to engage Toronto residents and businesses in adopting sustainable lifestyles and business practice.

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EXECUTIVE SUMMARY

The City of Toronto is part of a vanguard of global cities beginning to focus on the sustainability and resilience of their food systems. A food system includes all processes and infrastructure involved in feeding a population: growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food. The purpose of this study was to identify the most significant risks climate change would pose to food distribution and access within Toronto and make recommendations that would increase the resilience of the city's food system. The potential impact of climate change on food production in other parts of Canada and in other countries could have an impact on the overall cost and availability of food in Toronto, and thus on food access among more vulnerable populations and the general population; such impacts were however excluded as they are better addressed at a regional or national scale.

Toronto is at an advantage over most cities grappling with food system resilience because the City and Province have committed to addressing climate change resilience and already recognize food systems as a priority in resilience planning. At the time this report was published, only three other cities in North America, all in the U.S. (Baltimore, Boston, and New York City), have undertaken similar food system vulnerability assessments.

Goal: A resilient food system in Toronto that provides all residents with adequate and equitable access to food within walking distance immediately after an extreme weather event.

Is Toronto's food supply at significant risk right now? This report identifies risks to the food supply chain within Toronto and surrounding areas and examines potential public health impacts at the neighbourhood level, specifically considering the impact on vulnerable populations. The findings reveal that while extreme weather events could potentially disrupt Toronto's food supply, the current risk, especially on a massive scale, is relatively low. Instead, the report highlights that food access is the major risk because it could be significantly limited, especially in certain neighbourhoods, due to failures in electrical power, fuel distribution, telecommunication networks and transportation infrastructure. Therefore, involvement of organizations in these sectors is needed to minimize the risk and impact of these potential disruptions. Vulnerable populations face many barriers to accessing food; while this report does not address food security in general, it is expected that initiatives to increase resilience in the event of extreme weather events will contribute to more equitable food access in Toronto.

Approach









This study used Initiative for a Competitive Inner City (ICIC)'s Framework for Analyzing Urban Food System Resilience, Ontario's Climate Change and Health Vulnerability and Adaptation Assessment Guidelines and the City of Toronto's High-Level Risk Assessment (HLRA) Tool. Information was collected through a comprehensive literature review, the analysis of numerous public and proprietary data sets, a facilitated workshop with 23 stakeholders using the HLRA tool, and interviews with 49 individuals from public- and private-sector organizations.

The study examined food supply, food access and public health issues by analyzing the potential impact on various parts of the food system. The analysis included seven food system sectors and five critical, supporting parts of the city's infrastructure (Table 1). It also considered the prevalence of business continuity plans and adequate insurance (e.g., flood and business interruption) among private-sector food companies and nonprofit organizations. Further, it examined Toronto's existing emergency response plans related to food including preparedness planning, post-event communication with consumers and food companies, and post-event food safety inspections. Two attributes of Toronto that create unique food system vulnerabilities were also included in the analysis: a significant number of high-rise apartment buildings and the Ontario Food Terminal, the largest wholesale fruit and produce distribution centre in Canada and the third largest in North America.

The study considered the resilience of Toronto's food system to three extreme weather events: widespread flooding from significant rain, an extended heat wave, and a major winter ice storm. These events have caused extensive damage across the city in the past and are likely to become more severe with climate change.

In terms of public health, the study analyzed food insecurity and the capacity of food banks to explore the ability of Toronto residents (by neighbourhood) to secure sufficient food after an extreme weather event. The analysis of potential public health issues also included food sanitation vulnerabilities at commercial food businesses and food safety vulnerabilities associated with home meal preparation.

TABLE 1 Food System Sectors Analyzed for Toronto Vulnerability Assessment

Food System Sectors		
	Regional and local food production	All agricultural production including urban farms, vertical farms and community gardens within a 160 km radius of downtown Toronto.
	Food processing	All food cleaning, packaging, processing and manufacturing facilities.
	Food distribution	Primary warehouse suppliers (also known as wholesalers or distribution centres) and secondary suppliers that move food from processing facilities to food retail stores and other food access points (e.g., restaurants, food banks, etc.). This includes the Ontario Food Terminal.
	Food retail	Supermarkets, grocery stores, convenience stores and farmers markets.
	Restaurants	Chain and independent restaurants.
	Food assistance network	Food banks, food pantries, meal delivery programs, soup kitchens, and mobile soup kitchens that collect and distribute food to communities or individuals.
	Home meal preparation	Home food storage and meal preparation. This includes high-rise apartment units.
Food System Interdependent Infrastructure		
	Public transportation	Trains, subways, buses and streetcars that allow Toronto residents to access food or workers in the food sector to commute to work.
	Road network	Trans-Canada or National highways, major highways, secondary highways (major streets and arterial roads), collector roads, local roads, bridges and culverts in GTA used to distribute food to retail stores in Toronto and allow residents to access food.
	Electrical power system	The system of transmission terminal stations, municipal substations, switches, transformers and overhead and underground wires used to provide electrical power to residential, commercial, and industrial customers.
	Telecommunications	The network of land, mobile phones and internet service over which communications are transmitted.
	Fuel supply transportation, storage and distribution	All infrastructure required to process, transport, store, and distribute liquid fuels. Liquid fuels relevant to the food system include gasoline, diesel, propane and natural gas.

Findings: Key Vulnerabilities in Toronto's Food System

The analysis identified six key vulnerabilities to extreme weather events for Toronto's food system. In order to address these vulnerabilities and strengthen the resilience of the food system in Toronto and create *equitable* resilience, the City of Toronto will need to work with many different public and private organizations as it considers actions to increase Toronto's resilience to extreme weather that is expected to become more severe with climate change.

1. **Urban flooding:** The impact of an extreme rain event is the least well understood compared to extreme heat and an ice storm, because "urban flooding" has not yet been fully modeled for the city. Given the research to-date, however, river and urban flooding pose the greatest risk of the three extreme weather events studied for dairy processing, commercial bakeries, warehouse suppliers, the Ontario Food Terminal, food retail stores, and restaurants.
2. **Infrastructure:** The impact of extreme weather events on critical infrastructure poses the greatest risk to Toronto's food system, with electricity, the road network, and access to fuel posing the most significant potential vulnerabilities.
3. **The Ontario Food Terminal:** The Terminal represents a significant vulnerability for the supply of fresh produce in Toronto because of its market dominance, especially for smaller, independent food retail stores. The Terminal's location in a flood risk zone and its power supply configuration make it susceptible to power outages and it does not have sufficient backup power.
4. **Vulnerable neighbourhoods:** Food access in parts of Toronto's inner suburbs (York, Scarborough, Etobicoke) will be disproportionately impacted by extreme weather events because of a lack of large food retail stores, higher rates of food insecurity and numerous older residential high-rise communities. Seven neighbourhoods are the most vulnerable: Dorset Park, Downsview-Roding-CFB, Humbermede, Ionview, Rustic, Scarborough Village and Thistletown-Beaumont Heights.
5. **Food insecurity:** Food insecurity is a systemic vulnerability in Toronto that would be exacerbated by extreme weather events. Although food banks and other food assistance organizations were created to help people in need during times of severe financial constraint, they are supporting those in need for longer periods of time than intended. Therefore, while they are not part of Toronto's emergency food distribution plans, their limited capacity to meet a prolonged increase in demand for food assistance as more households become food insecure due to disaster-related expenses or loss of income is a critical component of equitable food resilience.
6. **Coordination:** Various municipal and provincial government agencies will need to be actively engaged in helping the food system recover quickly after an extreme weather event. In Toronto, the food system stakeholders that informed this report worried about inadequate and uncoordinated preparedness planning among government agencies, a lack of private sector participation in the planning process, a lack of clear communication about road closures and power outages in the aftermath of an extreme weather event, and food safety inspection delays. During an extreme weather event, businesses may be confused about who to contact in the government for relevant and timely information and, in turn, government agencies may not know the best way to effectively share information to all food businesses. The numerous reports and working groups focused on various aspects of resilience planning in Toronto could create additional confusion if left uncoordinated.

SECTION 1

OVERVIEW OF TORONTO'S FOOD SYSTEM VULNERABILITY ASSESSMENT



Food and health are interconnected across the food system, from production to processing, distribution to storage, and consumption to waste disposal. Climate change is expected to increase the frequency and severity of extreme weather events (Herring et al., 2018; National Academies of Sciences, Engineering, and Medicine, 2016) and this change poses a significant risk to the health of Toronto residents because of the potential impact on the city's food system. In its Climate Change and Health Strategy for Toronto, "[A Climate of Concern](#)," Toronto Public Health (TPH) identified the need to assess the impact of climate change on food safety, security and sustainability. As part of this effort, TPH, in collaboration with the Environment and Energy Division, undertook a high-level climate change vulnerability assessment of Toronto's food system with the assistance of the Initiative for a Competitive Inner City (ICIC), an experienced consultant selected through a competitive bid process.

Ensuring the resilience of Toronto to climate change will contribute to the health and well-being of its residents. A municipal government cannot prevent all disruptions due to a changing climate and extreme weather. However, a systematic approach to identifying risks and setting priorities can help to minimize the effects of shocks and stresses, especially among vulnerable populations, which are likely to be disproportionately affected by extreme weather events.

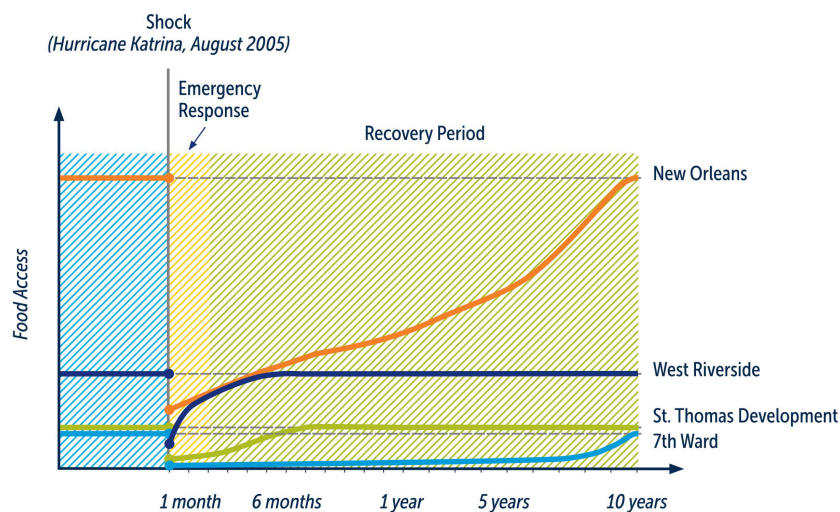
As cities prepare for climate change and extreme weather events, they often overlook food systems. The significant food supply disruptions caused by hurricane flooding in New Orleans in 2005, and more recently in the Caribbean and Florida, suggest this is a critical oversight (Arnold, 2017; Zeuli & Nijhuis, 2017b). "A Devastated Island's Cry: 'All the Food is Gone'" was the ominous *New York Times* headline describing food shortages in St. Martin in the aftermath of Hurricane Irma in 2017 (Ahmed & Semple, 2017). Although Canada has not experienced food supply disruptions of this same magnitude, ice storms in 1998 and 2013 created food access issues for some residents that lasted up to a week.

Over the last few decades, food industry consolidation and the drive to create a more efficient global food system, with "just-in-time" distribution, have created underlying vulnerabilities in urban food systems that lead to such food shortages. In Toronto, as in other cities, researchers estimate that most food retail stores may only have three days of fresh food and up to 17 days of all food products in stock (Bristow and Kennedy, 2013; Medical Officer of Health, 2008). Concentrated ownership also creates risk. For example, if the processing of a food product is owned by a single company and that company goes out of business, it would obviously create supply issues. Food processing and food retail ownership is increasingly concentrated in Canada and globally.

City leaders concerned about climate change need to consider vulnerabilities along the entire food supply chain, especially processing, distribution and retail, and not just focus on substituting imported food with local production. City leaders may also mistakenly assume that since food systems are predominantly comprised of private-sector businesses, food businesses have sufficient resources and motive to rapidly return to normal operations. However, this may not always be true. Extreme weather events create market uncertainties and smaller grocery stores and convenience stores typically do not have sufficient resources to deal with major catastrophes.

In addition, studies of natural disasters in other cities, including New Orleans, show that food system disruptions will vary by neighbourhood because of pre-existing differences in food insecurity and food retail markets, including stores that cater to unique, culturally diverse clients. As a result, food system disruptions can create significant food access issues for populations that are already food insecure or that seek culturally sensitive food (Figure 1). Therefore, cities need to prioritize creating *equitable resilience*.

FIGURE 1 Food Resilience Timeline, New Orleans



This report is part of the City of Toronto's efforts to make Toronto a more resilient city. It complements existing initiatives but also points to areas where more work needs to be done. Only three other cities in North America, all in the U.S. (Baltimore, Boston, and New York City), have undertaken similar food system vulnerability assessments (Biehl, Buzogany, Huang, Chodur, & Neff, 2017; New York City Economic Development Corporation and New York City Mayor's Office of Recovery & Resiliency, 2016; Zeuli & Nijhuis, 2017b). In 2014, Toronto's City Council adopted the report "[Resilient City](#)," and established the Climate Change Risk Management Policy, which mandated staff to build awareness and establish meaningful partnerships with the community, residents, the private sector and the broader public sector. In the 2016 update, "[Resilient City Update](#)," the food system was identified as one of the areas that needed to be assessed. Most businesses in the food system are in the private sector and regulated by Federal and Provincial governments, which compels the City to adopt a collaborative approach to resilience efforts and work with private- and public-sector organizations.

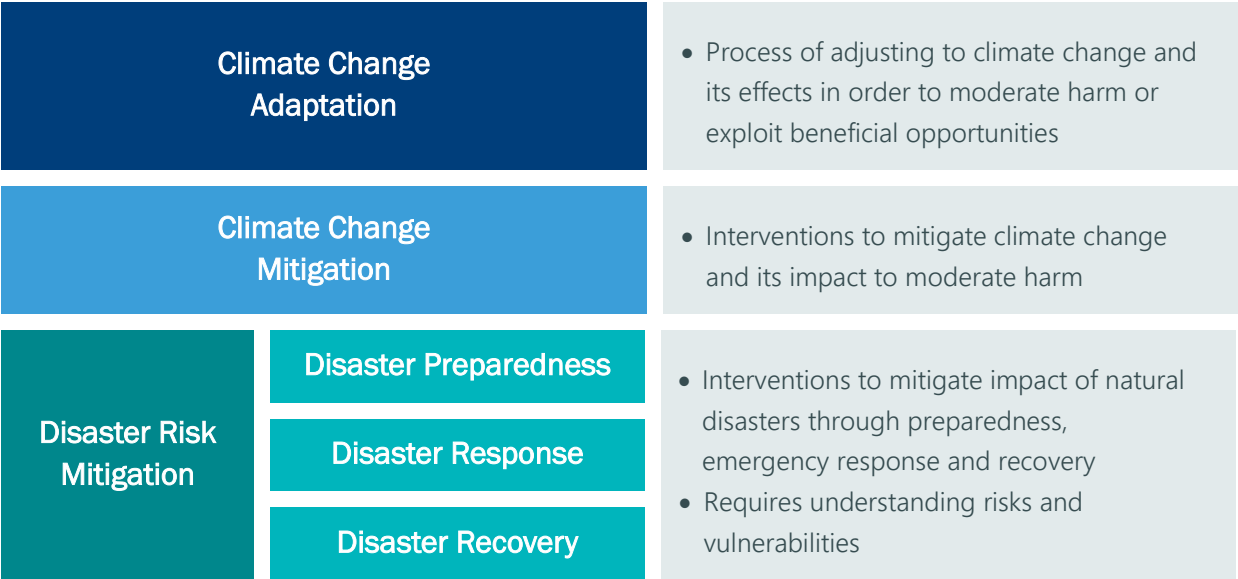
Goal: A resilient food system in Toronto that provides all residents with adequate and equitable access to food within walking distance immediately after an extreme weather event.

Approach

Developing a food system resilient to climate change involves adaptation as well as robust interventions across the entire food system to mitigate negative impacts (Figure 2).¹ The purpose of this report is to provide insights into the interventions needed to mitigate the impact of extreme weather events caused by climate change on the food system in Toronto. As such, it should inform the various, broad climate change initiatives already underway in the City of Toronto and at the Provincial and Federal levels to ensure that they consider the most significant, urgent risks in the food system in Toronto.

Three extreme weather events were analyzed—significant rain that leads to widespread flooding, an extended heat wave, and a significant winter ice storm—because these weather events have caused extensive damage across the city and are likely to become significantly worse in Toronto due to climate change. Events such as earthquakes that are not linked to climate change, and landslides, which are very localized, were excluded from consideration.

FIGURE 2 Approaches to Addressing Climate Change



While Toronto’s food supply comes from around the world, the report does not include any discussion of the adaptation or mitigation of global food systems to climate change. Therefore, it does not address the total risks associated with extreme weather events on Toronto’s food supply (e.g., drought on food imported from other areas), which are better examined at a regional or national scale. The more narrow analysis of this study allowed the authors to isolate a specific set of vulnerabilities over which the City can have more direct and immediate impact.

This study was guided by ICIC’s Framework for Analyzing Urban Food System Resilience, which allows cities to analyze the resilience of their food systems to different types of disasters and identify critical areas of weakness. The framework is focused on food processing, distribution, and access, and analyzes food vulnerabilities at the neighbourhood level to identify areas within the city where food access would be disproportionately impacted.

The Ontario Climate Change and Health Vulnerability and Adaptation Assessment Guidelines and the City of Toronto's High Level Risk Assessment (HLRA) Tool also guided and informed the research. This included a facilitated workshop that used the HLRA Tool to solicit input from 23 stakeholders on Toronto's food system vulnerabilities. These frameworks are described in Section 2.

Information was collected through a comprehensive literature review, analysis of public and proprietary data, and interviews with 49 individuals representing different parts of the food system. The analysis also included a review of eight other cities at the forefront of food resilience planning that are actively addressing the same extreme weather events as those facing Toronto: Barcelona, Calgary, London, Montreal, New York City, Oslo, Ottawa, and Vancouver.² Relevant strategies and actions from these cities are highlighted throughout the report as Global City Insights.

Highlights of Findings

The study finds that certain aspects of Toronto's food system are quite resilient to extreme weather events and, given estimates that less than 10 percent of all food consumed by Toronto residents is produced in the region, the impact of local extreme weather events on regional food production would be minimal. In addition, Toronto has planned for the recovery period and has an emergency food plan in place to cover the distribution of food and water in the immediate aftermath of any disaster (although food banks and other emergency food providers might be overwhelmed in a large-scale event). Toronto also has robust interventions (and resources) to address public food safety issues in the aftermath of any disaster.

The City of Toronto is part of a vanguard of global cities just beginning to focus on the resilience of their food systems to climate change (Dubbeling, Bucatariu, Santini, Vogt, & Eisenbeiß, 2016). The City and Province have committed to addressing climate change resilience and already recognize the crucial role food systems play in resilience strategies. Toronto is a signatory city of the Milan Urban Food Policy Pact and a member of C40's Food Systems Network. Toronto was also selected to join 100 Resilient Cities in 2016. This study, which identifies six critical vulnerabilities in Toronto's food system, can help guide these efforts.

Global Initiatives Catalyzing Food System Resilience Planning

The **Milan Urban Food Policy Pact** is perhaps the most prominent international initiative focused on food system resilience, although it does so through a sustainability framework (Milan Urban Food Policy Pact, 2015).³ It was established in 2015 to promote the development of sustainable food systems that are inclusive, resilient, safe and diverse, and able to adapt to and mitigate impacts of climate change. Leaders from 163 cities around the world, including three from Canada (counting Toronto), have signed the Pact, pledging to work across government departments and food industry sectors to build resilient and sustainable food systems (“Signatory cities,” n.d.).

C40, a network of 91 cities across the globe (including Toronto) committed to addressing climate change, is another high-profile initiative. Its **Food Systems Network** includes 34 cities (also including Toronto), that support efforts to reduce carbon emissions and increase resilience throughout their food systems (“Programmes,” n.d.).

The **100 Resilient Cities** organization has created a network of cities around the world to change how cities approach contemporary challenges (“Selected Cities,” n.d.). It defines urban resilience as “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” (“What is Urban Resilience?,” n.d.). The organization also provides funding for Chief Resilience Officers (CROs), a position in municipal governments that acts as the city’s point for resilience planning. Every city in the network commits to developing resilience plans for their cities, but only some specifically mention improving the resilience of food systems (e.g., New York City’s *One New York: The Plan for a Strong and Just City* [2015]). Toronto was selected to join 100 Resilient Cities in 2016 and the city’s resilience strategy is expected to be released in 2018.

The **United Nations Office for Disaster Risk Reduction (UNISDR)** has developed a Disaster Resilience Scorecard for Cities and a Making Cities Resilient Campaign in order to enhance private sector and community resilience. The Disaster Resilience Scorecard provides a set of assessment tools to help cities understand how resilient they are to natural disasters. The scorecard assesses a number of components of the food system including agricultural land at risk, a city’s ability to continue to feed its population, the existence of incentives to help nonprofits (including food safety net organizations) improve disaster resilience, and the continuity of administrative payment systems for social assistance, including food benefits (United Nations Office for Disaster Risk Reduction, 2017). The scorecard has not yet been used in Toronto. The Making Cities Resilient Campaign supports urban development through the promotion of resilience activities and increasing local understanding of disaster risk (“Frequently Asked Questions,” 2015). Food systems are not an explicit focus of the campaign, but participating cities are encouraged to utilize the Disaster Resilience Scorecard as part of their own resilience assessments and planning. Canada’s Prime Minister has called on the Minister of Public Safety Canada to develop a comprehensive emergency management strategy for Canada, which would align it with UNISDR’s disaster risk reduction framework.

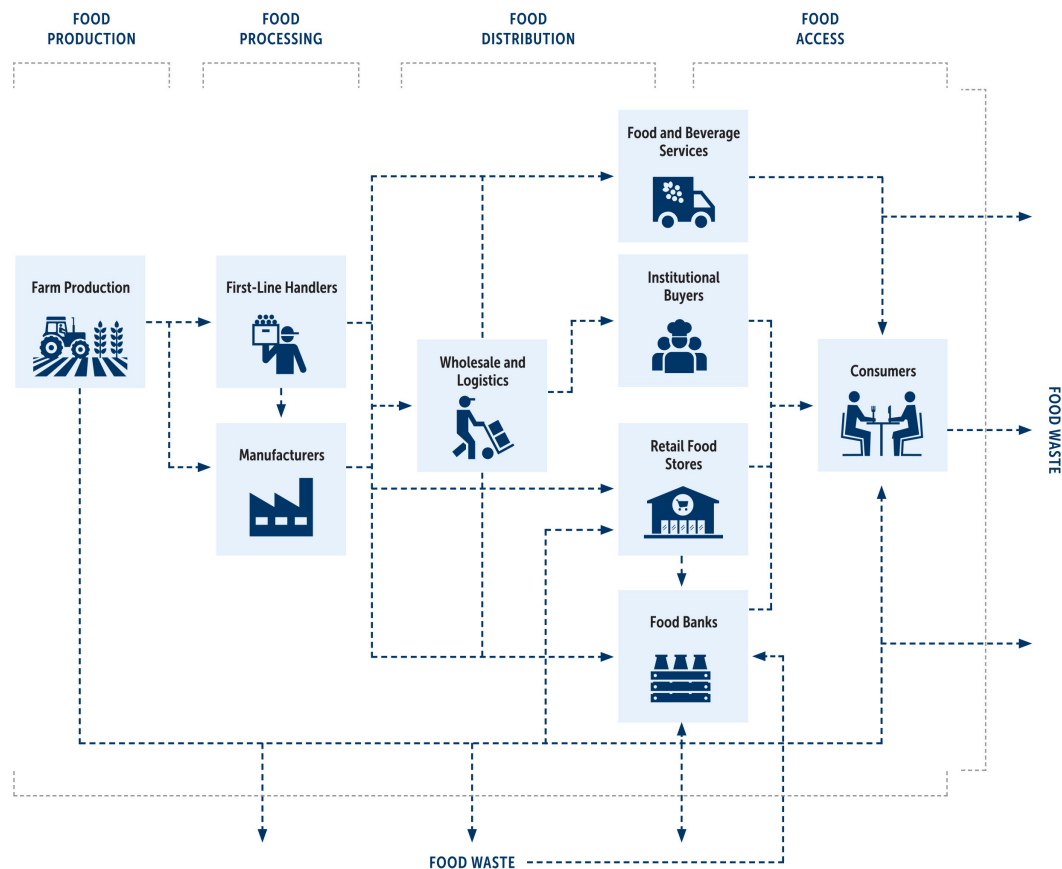
SECTION 2

ANALYZING THE VULNERABILITY OF TORONTO'S FOOD SYSTEM TO EXTREME WEATHER



A city's food system—growing, transforming, and moving food from farm to table—is incredibly complex (Figure 3). Food distribution in particular involves numerous businesses and different pathways to transport food products from processing facilities to food retail stores and restaurants.

FIGURE 3 An Illustration of the Food System



Source: Adapted from Nesheim, Malden C., Maria Oria, and Peggy Tsai Yih, eds A framework for assessing effects of the food system. *National Academies Press*, 2015.

The analysis of Toronto's food system utilized three frameworks to shape the methodology, identify food system risks, vulnerabilities, and public health impacts, and inform recommended actions: ICIC's Framework for Analyzing Urban Food System Resilience, the Ontario Climate Change and Health Vulnerability and Adaptation Assessment Guidelines, and the City of Toronto's High-Level Risk Assessment (HLRA) Tool. Each of these guiding frames is described below.

Information was collected through a comprehensive literature review, the analysis of numerous public and proprietary data sets, a facilitated workshop with 23 stakeholders using the HLRA tool (Appendix 1, p. 99), and interviews with 49 individuals from both public agencies and the private sector (Appendix 2, p. 101). The individuals chosen for interviews are experts on specific aspects of the food system (e.g., grocery stores), supporting systems (e.g., utilities), or are considered more general experts in their field (e.g., academics). A complete list of interviewees is included in Appendix 2.⁴

The analysis also included a review of actions in eight other cities considered leaders or peers in food resilience: Barcelona, Calgary, London, Montreal, New York City, Oslo, Ottawa, and Vancouver. These cities were selected because they are exposed to similar extreme weather threats as those facing Toronto and their city leaders are actively pursuing resilience and food system planning. All of the cities are either part of an international resilience initiative, such as 100 Resilient Cities or C40 Cities, or an international food system planning initiative, such as the C40 Food Systems Network or the Milan Urban Food Policy Pact.

ICIC's Framework for Analyzing Urban Food System Resilience

ICIC was chosen to complete the assessment of Toronto's food system in part because of the groundbreaking urban food system resilience framework (Figure 4) they developed that allows cities to analyze the resilience of their food system to different types of disasters and identify critical areas of weakness. In addition to offering a streamlined approach to tackling a complex system, the framework has two unique features:

1. It is designed to identify vulnerabilities associated with an extreme weather event or natural disaster striking an urban area. As a result, the analysis focuses on three food system components—food processing, food distribution and food access—since almost all food consumed in cities is produced outside of urban areas; and
2. It is focused on equitable resilience and, therefore, considers neighbourhood level vulnerabilities to identify variances in impact for specific areas (and populations) within a city. By analyzing neighborhood food retail markets (which reflect local demand), this methodology accounts for culturally sensitive food flows without having to analyze the myriad of food products consumed within a city. The methodology also specifically considers differences in food insecurity levels (poverty-based and emergency food) across a city.

Food Insecurity

The term food insecurity refers to a situation where households have limited or uncertain access to adequate food. Types of food insecurity that are relevant when analyzing urban resilience include:

Poverty-based food insecurity arises when households cannot afford to purchase adequate food. It is a systemic issue in Toronto and many low-income households in the city face this type of food insecurity. Extreme weather events could exacerbate this type of food insecurity because more residents could be pushed into poverty and some food products may become more expensive. Resilience strategies need to ensure that food assistance networks have sufficient capacity to handle increased demand. However, the underlying causes of poverty-based food insecurity requires broad public policy interventions to resolve and cannot be fixed by food resilience strategies alone.

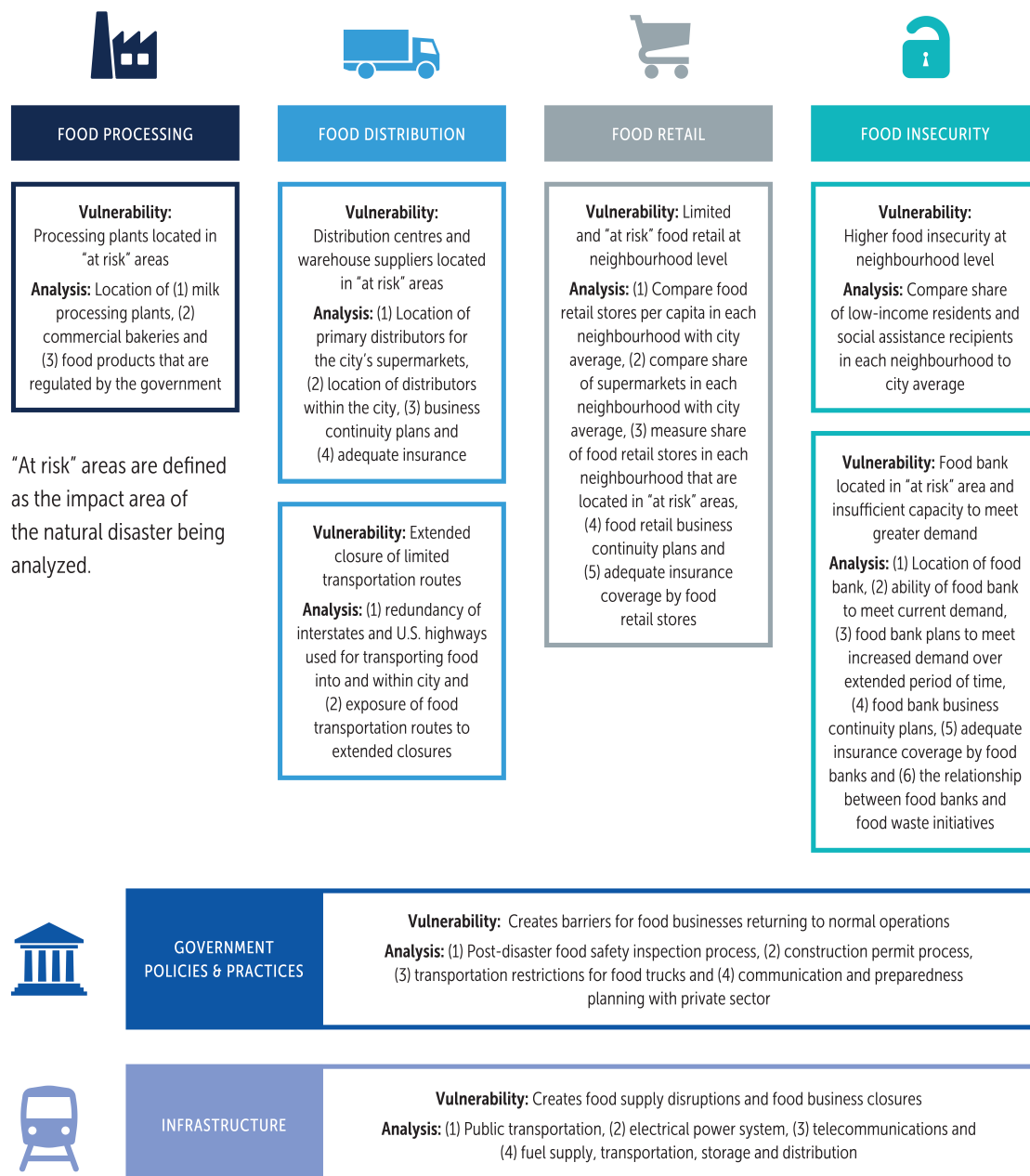
Emergency food insecurity arises when Toronto residents face limited or uncertain access to adequate food after an extreme weather event or natural disaster because of food supply disruptions and closures of food retail businesses and restaurants. Residents facing poverty-based food insecurity would be disproportionately impacted by emergency food insecurity.

The food system is an interconnected system—its functioning depends upon the performance of numerous other systems in a city. The most critical interdependencies include public transportation, the road network, the electrical power system, telecommunications, and the fuel supply transportation, storage and distribution infrastructure. Each of these are encompassed in ICIC’s analysis. Businesses can manage some of the risks of extreme weather events by having comprehensive business continuity plans in place and adequate insurance (e.g., flood and business interruption). Therefore, the analysis also explores the prevalence of these risk management tools for private-sector food companies and nonprofit organizations. Prior research on this topic has found that smaller businesses typically lack adequate business continuity plans and insurance. Even those with insurance typically lack sufficient capital to cover the costs associated with returning to business while waiting for insurance company reimbursements. Finally, the framework and analysis examines Toronto’s existing emergency response plans related to food including preparedness planning, post-event communication with consumers and food companies, and post-event food safety inspections.

To keep the analysis streamlined, institutions that provide food (e.g., schools, hospitals and prisons) are not typically included. Their exclusion is also justified because they are not a critical area of weakness in most urban food systems. Some institutions, such as schools, may be closed after a disaster and many institutions use large, private food service companies that would likely have business continuity plans in place and the capacity to quickly return to normal operations.

Food waste is a significant part of the food system and a critical consideration for sustainability and resilience. Helping food businesses divert edible food that cannot be sold to food banks can increase the availability of food for the food insecure, while diverting non-edible food from landfills can create environmental benefits, including the reduction of greenhouse gas emissions (Zeuli & Nijhuis, 2017b). Food waste was not considered in the Toronto assessment because the *Strategy for Waste-Free Ontario* and *Toronto’s Long Term Waste Strategy* both include initiatives focused on reducing food waste.

FIGURE 4 ICIC's Urban Food System Resilience Framework



ICIC developed the framework in 2014 when the organization was engaged by the City of Boston to analyze the city's food system vulnerabilities to extreme weather events (Zeuli & Nijhuis, 2017a). To analyze Toronto's food system, ICIC's framework was expanded to include local food production, restaurants and home meal preparation to reflect the interests of Toronto Public Health in understanding broader food system sustainability and public health issues (Table 2).













"Boston was lucky to avoid the worst of Sandy... We must better prepare our food system to be resilient after disruptions like hurricanes, floods, blizzards and other natural disasters."

~ Mayor Walsh, City of Boston, 2015

Boston was the first city in the U.S. to study the impact of natural disasters or extreme weather events on its food system. It was motivated by the near miss of Superstorm Sandy. As the newly elected Mayor Walsh wrote in support of the study, "Boston was lucky to avoid the worst of Sandy, but with climate change we can expect a rise in sea levels and more extreme weather events in the future. We must better prepare our food system to be resilient after disruptions like hurricanes, floods, blizzards and other natural disasters" (Initiative for a Competitive Inner City, 2015, p. 2). The Boston study, which was also a high-level vulnerability assessment, helped inform various climate resilience priorities for the city and state as well as catalyze new research and action plans for the critical weak points and vulnerable neighbourhoods identified in the study.

ICIC was also chosen to complete the assessment of Toronto's food system because their contributions to the growing field of food system resilience have been recognized nationally and internationally.⁵ With support from the Rockefeller Foundation, ICIC's framework was used to complete a [comparative analysis of food system vulnerabilities](#) in Los Angeles, Madison, Wisconsin, New Orleans, and New York City (Zeuli & Nijhuis 2017b).

TABLE 2 Food System Sectors Analyzed for Toronto Vulnerability Assessment

Food System Sectors		
	Regional and local food production	All agricultural production including urban farms, vertical farms and community gardens within a 160 km radius of downtown Toronto.
	Food processing	All food cleaning, packaging, processing and manufacturing facilities.
	Food distribution	Primary warehouse suppliers (also known as wholesalers or distribution centres) and secondary suppliers that move food from processing facilities to food retail stores and other food access points (e.g., restaurants, food banks, etc.). This includes the Ontario Food Terminal.
	Food retail	Supermarkets, grocery stores, convenience stores and farmers markets.
	Restaurants	Chain and independent restaurants.
	Food assistance network	Food banks, food pantries, meal delivery programs, soup kitchens, and mobile soup kitchens that collect and distribute food to communities or individuals.
	Home meal preparation	Home food storage and meal preparation. This includes high-rise apartment units.
Food System Interdependent Infrastructure		
	Public transportation	Trains, subways, buses and streetcars that allow Toronto residents to access food or workers in the food sector to commute to work.
	Road network	Trans-Canada or National highways, major highways, secondary highways (major streets and arterial roads), collector roads, local roads, bridges and culverts in GTA used to distribute food to retail stores in Toronto and allow residents to access food.
	Electrical power system	The system of transmission terminal stations, municipal substations, switches, transformers and overhead and underground wires used to provide electrical power to residential, commercial, and industrial customers.
	Telecommunications	The network of land, mobile phones and internet service over which communications are transmitted.
	Fuel supply transportation, storage and distribution	All infrastructure required to process, transport, store, and distribute liquid fuels. Liquid fuels relevant to the food system include gasoline, diesel, propane and natural gas.

Ontario Climate Change and Health Vulnerability and Adaptation Assessment Guidelines

The Ontario Ministry of Health and Long-Term Care developed the Ontario Climate Change and Health Vulnerability and Adaptation (V&A) Assessment Guidelines in 2016 to provide public health units across Ontario with a practical toolkit for conducting comprehensive vulnerability and adaptation assessments to climate change risks (Ebi, Anderson, Berry, Paterson, & Yusa, 2016). The primary objectives of the V&A assessment guidelines are to understand the current and projected future public health risks of climate change and to identify and develop policies and programs to increase resilience to these risks. The structure of the V&A guidelines are designed to be flexible and can be tailored to the circumstances of the assessment.⁶

The V&A Assessment Guidelines also identify possible public health effects for temperature extremes and extreme weather events. Potential public health effects of temperature extremes identified in the guidelines include cold-related illnesses and deaths, heat-related illnesses and deaths, and respiratory and cardiovascular disorders. Potential public health effects for extreme weather events include injuries, illnesses, and death from violent storms or floods; psychological health effects;

Potential public health effects of extreme weather events include injuries, illnesses, and death from violent storms or floods; psychological health effects; health impacts due to food or water shortages; illnesses related to drinking water contamination; effects of the displacement of populations and crowding in emergency shelters; and indirect health impacts from ecological changes, infrastructure damage, and interruptions in health services.

health impacts due to food or water shortages; illnesses related to drinking water contamination; effects of the displacement of populations and crowding in emergency shelters; and indirect health impacts from ecological changes, infrastructure damage, and interruptions in health services. For this study, the analysis focused on potential public health effects related to the food system, including food safety (e.g., food and water contamination and foodborne illnesses) and public health impacts due to food or water shortages. Public health effects not related to the food system were beyond the scope of the assessment.

The City of Toronto's High Level Risk Assessment Tool

The City of Toronto's High Level Risk Assessment (HLRA) tool was used to solicit additional input from a diverse group of key stakeholders through a structured workshop. This tool represents a distillation of Toronto's more complex and in depth Climate Risk Assessment Tool, which was originally developed to mirror the International Organization for Standardization (ISO) 37000 Risk Management standard.⁷

ICIC and Cadmus engaged 23 stakeholders representing different parts of Toronto's food system to participate in a facilitated workshop held on August 23, 2017 at Metro Hall in Toronto to assess the vulnerabilities of Toronto's food system to extreme weather events. The group included representatives from municipal and provincial government agencies, private food distributors and retailers, and nonprofit food service

organizations and associations. A simplified HLRA tool was used to guide input from stakeholders (See Appendix 1 for agenda, supporting materials and a list of participants.)

The City of Toronto developed the HLRA tool to help implement its Climate Change Risk Management Policy, which was designed to evaluate the ability of the city's infrastructure to accommodate extreme weather events.⁸ As of 2016, the HLRA tool has been used to assess the resilience of three different "Thematic Areas": utilities, transportation and water. During the workshop, the HLRA tool was used to surface perceived vulnerabilities in Toronto's food system in the context of three extreme weather event scenarios: an extreme summer storm, an extreme winter storm, and a heat wave. The scenarios were based on historical events to help the participants quickly engage in the scenarios and avoid the disbelief typically associated with hypothetical events. Since most of the participants had experienced these events, the structured workshop conversations asked them consider a broader set of food system vulnerabilities than their own unique experiences (e.g., the temporary closing—or not—of their local food store).

For the HLRA workshop, the key stakeholders were asked to consider vulnerabilities in a very systematic way by isolating impacts in the seven different parts of Toronto's food system included in the study's framework (Table 2). Stakeholders also considered the potential impact of extreme weather events on six supporting systems (public transportation, road networks, other transportation networks, the storm water management system, utilities and fuel) and the indirect effects on the food system sector they were exploring. For each part of the food system, the participants were then asked to rate the consequences of the extreme weather event (from insignificant to catastrophic) for six areas of impact:

- Premises/infrastructure/assets
- Cost/time/reputation
- Environment
- Logistics/supply chain/utilities and transport
- People/staff, clients of city services
- Corporate processes and functions/service delivery

The rating process and areas of impact were defined by the HLRA tool. To surface failure thresholds (i.e., whether the scenario was close to being more catastrophic), the participants were also asked to consider a scenario a bit worse than the ones they were provided (e.g., slightly more rain and hotter temperatures). While this was not a highly technical approach, it was easily understood by the workshop participants in the limited time available to conduct the workshop.

SECTION 3

EXTREME WEATHER EVENTS AND IMPACT AREAS IN TORONTO



The three extreme weather events used for the Toronto analysis are not hypothetical. They have already caused significant damage in the city. Given that climate change is expected to create more severe storms, the same type of weather events in the future could realistically cause widespread damage across the city, with impacts such as power outages and road closures lasting for an extended period. The following section provides historical context, future projections, a review of contributing factors, and a discussion of the methodology for analysis for each extreme weather event.

Analyzing the impact of an extreme weather event first requires defining the area most likely to be affected by the event. Therefore, the areas considered “at risk” will vary depending on the event. For example, heat waves and ice storms will affect a greater area than flooding from a severe storm.

For this analysis, the following events are assumed:

1. flooding from an extreme rainfall event of 100 mm in less than one day,
 2. a heat wave with three or more consecutive days when the maximum temperature is 35 degrees Celsius or higher, and
 3. an ice storm causing 30 mm of ice.
-

Clearly, the actual areas affected by each extreme weather event, and the extent of damage, will depend on the severity of the event. Our analysis provides a starting point for exploring current vulnerabilities in the food system by assuming the greatest possible impact area and that everything located in the defined “at risk” areas will be equally impacted by the event. A more detailed analysis might find that certain neighbourhoods are hit harder than others (e.g., icing may be more extreme in one part of the city than in others).

Defining Toronto’s Impact Areas

Toronto refers to the geographic area within the city limits of Toronto.

The term **Greater Toronto Area (GTA)** refers to the City of Toronto and its four surrounding regions: Durham, Halton, Peel, and York.

The **Greater Golden Horseshoe (GGH)** refers to the City of Toronto and its surrounding areas (a horseshoe shaped region around Lake Ontario), including: the City of Hamilton, the regions of Durham, Halton, Niagara, Peel, Waterloo and York, the counties of Brant, Dufferin, Haldimand, Northumberland, Peterborough, Simcoe, and Wellington, and the municipality of Kawartha Lakes.

Flooding

The average maximum rainfall in a one-day period in Toronto over the last five years is 53.6 mm.⁹ Extreme rain storms are predicted to become more severe in terms of daily maximum rainfall, but remain relatively unchanged in terms of frequency by 2040. Experts predict that maximum daily rainfall will increase to 166 mm by 2040 (SENES Consultants Limited, 2011). On October 15, 1954, Hurricane Hazel hit Toronto, with 121.4 mm of rain falling in one day and more than 200 mm of rain falling over 48 hours as well as heavy winds reaching 124 km per hour (Isai, 2016). Hurricane Hazel left over 4,000 people homeless in Ontario (1,868 people in Toronto) and 81 dead (Mortillaro, 2013). Significant damage occurred to roads and bridges, with major washouts on Highways 400 and 11 and on train tracks, causing major traffic disruptions. In addition, flooding destroyed or structurally damaged 40 bridges in the Toronto area. Some bridges were not passable for a few months ("Hurricane Hazel Impacts - Transportation," 2015).

More recently, on July 8, 2013, Toronto received 126 mm of rain in a one-day period during a severe thunderstorm, resulting in widespread flooding. This was the most rain Toronto had ever received in a day.¹⁰ More than 90 mm of rainfall occurred in just two hours—starting around 4:30 p.m. (Aulakh, 2013). Rainfall varied across the city, but was greatest in the western part of the city and towards downtown (General Manager, Toronto Water, 2013). Flooding caused overnight public transit and road closures, and power outages affected approximately 42 percent of Toronto Hydro's customers ("Toronto's July storm cost insurers \$850M," 2013).

Multiple factors contribute to the risk of flooding in Toronto. Toronto's southern edge is located on the shore of Lake Ontario. Three larger rivers, the Humber River, the Don River, and the Rouge River, as well as multiple other smaller rivers and streams, run through the city and into Lake Ontario, making a small number of areas in the city prone to river based (or riverine) flooding.¹¹ However, "urban flooding," also known as pluvial or overland flooding, is a greater risk across Toronto. This type of flooding occurs when extreme rainfall overwhelms the sewer system or when there is major overland water flow in a low-lying area ("Flood Plain Map," 2016). It can also cause sewer backups, which can lead to basement flooding. Significant urbanization in the Greater Toronto Area (GTA) has resulted in a larger percentage of hard impermeable surfaces across the area that cannot absorb precipitation, creating more runoff that can cause flooding.

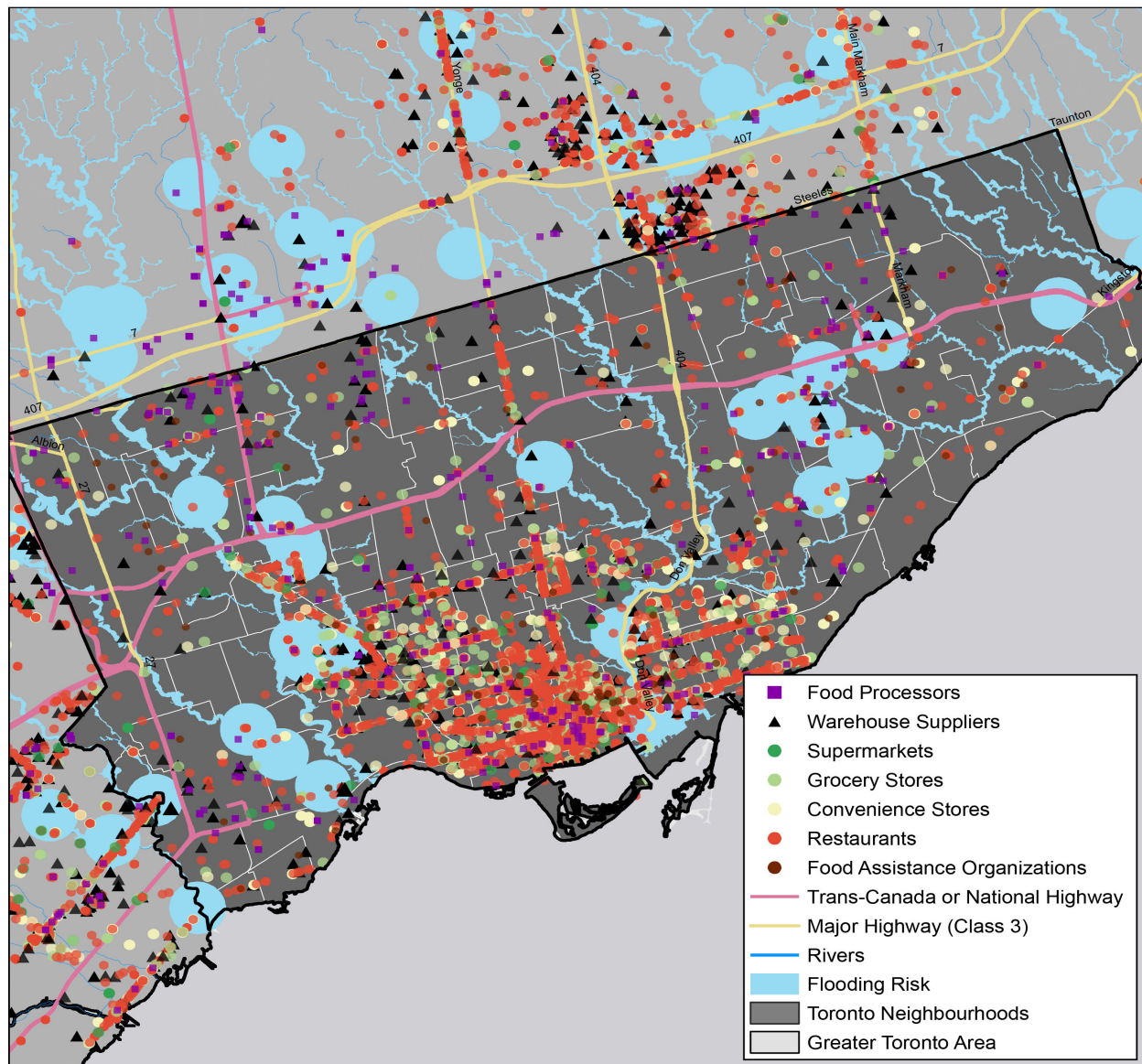
This analysis only considers river-based flooding. Urban flooding is more complex to model and understand compared to river-based flooding. For more than a decade, Toronto Water has worked on an extensive Basement Flood Protection Program and a Wet Weather Flow Master Plan, which combined will be providing a much better understanding of urban flooding and measures to reduce flooding associated with extreme rain. Toronto Water estimates this work could take at least another decade to achieve an understanding of urban flooding in all parts of the City. For this food system vulnerability assessment, only readily available riverine based flood maps were used. Using only these maps may underestimate the extent of possible "urban" or "overland" flooding. The City of Toronto already has identified the need to: "...better understand flood data availability; identify flood information needs for critical services and infrastructure providers; and coordinate data sharing to inform corporate decision making for planning and development purposes."¹²

Defining Areas Vulnerable to Flooding in Toronto

The areas vulnerable to river-based flooding from an extreme rain event are identified as areas that are either (1) in the Toronto and Region Conservation Authority (TRCA)'s regulatory (engineered) flood plain, (2) in TRCA's estimated flood plain, or (3) in TRCA's Flood Vulnerable Areas.¹³

The regulatory flood plain includes areas adjacent to waterways that would be inundated from "the most severe of the Hurricane Hazel Flood Event Standard (Regional Storm) or the 100-Year Flood Event Standard, whichever is greater," as formally approved by a qualified Professional Engineer and TRCA ("Flood Plain Map," 2016). The estimated flood plain includes areas adjacent to waterways that would be inundated from a Hurricane Hazel Flood Event Standard or the 100-Year Flood Event Standard. The TRCA defines Flood Vulnerable Areas as areas in or near river valleys that are at high risk for flooding, with high risk defined as areas with numerous structures within the flood plain and/or a high frequency of flooding (General Manager, Toronto Water, 2014). TRCA only maps flooding in the GTA, which is their jurisdiction (Map 1).

MAP 1 The City of Toronto's Food System



Sources: Canadian Food Inspection Agency, *Registered Shell Egg Stations* (2018); City of Toronto Social Development, Finance & Administration Division, *Neighborhoods* (2014); Dun and Bradstreet's Hoover's Database (2017); Ontario Food Terminal Board, *Directory | Ontario Food Terminal Board* (n.d.); Ontario Ministry of Agriculture, Food and Rural Affairs, *Provincially Licensed Meat and Dairy Plants* (2017); Toronto and Region Conservation Authority, *Regulator Flood Plain, Estimated Flood Plain, and Flood Vulnerable Areas* (n.d.).

Notes: Food processors include dairy processing facilities, poultry processing facilities, egg processing facilities, and commercial bakeries.



During 2014-2015, Vancouver conducted a two-part coastal flood risk assessment that considered ocean, river and urban flooding scenarios. Phase 1, which was completed in December 2014, provided a detailed flood hazard baseline associated with multiple sources of flooding (City of Vancouver, 2014). This phase also identified hot spots that included city infrastructure, services and populations at increased risk of disruption due to flooding. A high-level vulnerability assessment was conducted for these hot spots, as well as a consequence assessment to evaluate potential losses due to different flooding scenarios. Using the Hazus model, the assessment estimated a range of consequences, including: (1) number of displaced households and number of people who will seek shelter; (2) damage to essential facilities; and (3) building damage and loss.¹⁴

Phase 2 was completed in December 2015 and explored approaches to respond to the identified flood risks in eleven distinct zones within the city (City of Vancouver, 2015). The zones were determined based on similar geographic and flood-hazard characteristics. The baseline flooding assumption selected from Phase 1 was a 500-year event flood with a one metre rise in sea levels in 2100. The goal was to develop policies to mitigate the vulnerabilities to infrastructure, services and populations identified in Phase 1, inform the city's flood-proofing policies, and outline the trade-offs between different adaptation alternatives.

Heat Waves

Heat waves are defined by Environment and Climate Change Canada as three or more consecutive days when the maximum temperature is 32 degrees Celsius or more ("Weather Glossary," n.d.). On average between 2012 and 2016, the city experienced one heat wave per year. During that same time period, the highest daily temperature recorded was 36.8 degrees Celsius.¹⁵ Heat waves are predicted to increase in frequency by 2040, with an average of 2.5 heat waves per year and a maximum daily temperature of 44 degrees Celsius (SENES Consultants Limited, 2011).

On July 6, 2012, the temperature hit 36.3 degrees Celsius in Toronto, marking it the fourth time in eight days that temperatures exceeded 32 degrees Celsius.¹⁶ It was tied for the tenth hottest day on record in Toronto history, and tied for the second hottest day in 2012.¹⁷ During this heat wave, temporary power outages due to an overheated circuit breaker affected about 3,000 customers in Scarborough and 6,500 customers in eastern downtown (about one percent of Toronto Hydro's customers) ("Toronto breaks heat record," 2012).¹⁸

In 2017, Toronto experienced unseasonably warm temperatures in early fall (September 23-27). The maximum daily temperatures exceeded 30 degrees Celsius for five consecutive days, with temperatures exceeding 32 degrees Celsius on September 23rd and 24th.¹⁹ Toronto's Medical Officer of Health issued an Extreme Heat Alert during this period to warn people at risk of heat-related illness to take appropriate precautions ("Heat Alert Statistics," n.d.). A 12-hour power outage caused by an underground failure affected about 720 customers in the Forest Hill neighbourhood (less than one percent of Toronto Hydro's customers) (Wilson, 2017). While the exact cause of the failure was difficult to determine, a representative from Toronto Hydro speculated that the outage may have been related to the heat, stating in a media interview at the time that, "While we can't

say exactly what the cause of this is, we have been seeing some scattered outages in the last two nights throughout the city, and it wouldn't be far-fetched to guess that this is related to the heat" (Whalen, 2017).

Urbanization is also a contributing factor for heat waves. Urban heat islands, or pockets of warmer temperatures caused by the extra heat supplied to the air from the surface below it, can make temperatures warmer in urban areas than in surrounding rural areas (SENES Consultants Limited, 2011). In Toronto, the temperature differential from rural to urban areas can be as much as three degrees Celsius (Mohsin, 2009).

For this study, Toronto and the GTA are considered as areas at risk for a heat wave since heat waves are typically regional events.

Ice Storms

Ice storms are freezing rain events that form a coating of ice on the ground and on exposed objects ("Weather and Meteorology Glossary," 2009). While winter storms in Toronto are expected to decrease in frequency and magnitude by 2040, they pose a significant risk for the city over the next decade (SENES Consultants Limited, 2011). On average, between 2000 and 2009, Toronto was hit by 14 winter storms per year, which included ice storms (SENES Consultants Limited, 2011). The ice storms caused the greatest damage.

On December 23, 2013, freezing rain falling over a 24-hour period caused 10-30 mm of ice to build up in the city, leading to downed trees, icy roads and power outages, mostly from trees falling on power lines. Approximately 228,000 (31 percent) of Toronto Hydro's customers lost power overnight ("Toronto ice storm leaves 230,000 without power," 2013), and over 72,000 (10 percent) lost power for more than three days (Oved, 2013).²⁰ The worst hit areas included neighbourhoods near Ontario Highway 401, from Etobicoke to Scarborough (The Canadian Press, National Post Staff, & Edmiston, 2013).

Because ice storms tend to be regional events and the modeling of the impact of such storms is challenging, for the purposes of this study, Toronto and the GTA are considered as areas at risk to be hit by an ice storm.

SECTION 4

FOOD SYSTEM INFRASTRUCTURE VULNERABILITIES IN TORONTO



This section provides an overview of the potential impact of the three weather events on the most critical food system interdependencies—public transportation, the road network, the electrical power system, telecommunications, and fuel supply transportation, storage and distribution.

Public Transportation

The public transportation system in Toronto is an important mode of transportation for many of Toronto's residents and for some, their only method of transportation to access food. It includes a regional commuter rail and bus system operated by GO Transit and subways, streetcars and buses operated by the Toronto Transit Commission (TTC). GO Transit operates seven train lines and 15 bus terminals throughout Toronto, the GTA and the Greater Golden Horseshoe (GO Transit, 2017). Within the city, TTC operates three subway lines, the Scarborough RT line (light rail), 11 streetcar routes, and 146 bus routes (with some bus routes extending into the GTA), as well as Wheel-Trans, a paratransit service for people with disabilities ("System Quick Facts, n.d.). For the purposes of this study and the focus on food access within Toronto, only the public transportation system operated by TTC was analyzed.

On an average business day, 1.7 million passengers (roughly 13 percent of the GTA's population) use public transportation operated by TTC ("System Quick Facts, n.d.).²¹ A recent study (The Transportation Tomorrow Survey) found that 17 percent of Toronto residents are in possession of a valid transit pass (e.g., TTC Metropass) and Toronto residents used public transit for 24 percent of their trips (Data Management Group, University of Toronto Department of Civil Engineering, 2011).

Public transportation is critical for food access for a large number of people in Toronto, especially people with low incomes. It allows people to purchase groceries, eat out at restaurants or reach food banks. It is also essential for food supply, since many workers in the food sector rely on public transportation to get to work.

All of the TTC public transit services could be impacted by the three extreme weather events. The subway consists of underground and aboveground stations and tracks. Generally, the streetcar system operates aboveground, although there are several below grade stations. Overhead wires power the streetcar network. Flooding is the most significant risk and our analysis of TTC subway stations finds that ten of TTC's 75 subway stations (13 percent) are located in an "at risk" area vulnerable to flooding.²² Recognizing this flooding risk, TTC recently completed an in-depth study of flooding impacts on seven subway stations at risk for river-based flooding as well as urban flooding or sewer overload (AECOM, 2017). The TTC study found that the primary sources of flooding for the seven stations they studied were urban flooding and sewer overload, and each subway station would be uniquely impacted by flooding. Impacts included station flooding, track-level flooding, sewer backups, and drainage system failure. Track-level (under- or above ground) flooding could damage subway tracks and affect the traction power, signals, track switches, and electrical substations, causing service disruption. All of these disruptions would limit public transit services for Toronto residents.

A flooded station could disrupt service along the entire line until water is pumped out and electrical systems are restored. Most subway lines are equipped with fixed, electric-powered storm drainage pumps. They are relatively evenly spaced across subway lines, and located in subway stations or along tracks.²³ According to a representative from TTC, TTC should be able to pump storm water out of subway stations or subway tracks equipped with storm drainage pumps in a matter of hours, but service recovery could take much longer. Electrical equipment (such as signaling equipment) must be allowed to dry and then be tested before service can resume. For example, following the July 8, 2013 storm, service between Kipling and Islington was disrupted and not restored until July 10, 2013. Also, during an extreme weather event, it is conceivable that the capacity of the City's storm or combined sewer could be exceeded. In these instances, it is not possible to pump water into a City system already at capacity.

A previously completed High Level Risk Assessment for transportation systems found that localized flooding of roads and underpasses could also cause significant disruption to bus and streetcar surface routes and potentially damage TTC vehicles (City of Toronto, 2016b). According to a TTC representative, in the event of surface-street flooding, streetcars would be replaced by bus service in order to reroute service around flooded streetcar tracks, and buses could be rerouted around flooded streets. TTC does not believe that any flood event, regardless of the severity, would shut down the entire public transportation system. However, it is likely that some passengers would have limited access to public transportation. The bus system does not have the capacity to completely replace subway and streetcar service. Further, bus reroutes may leave certain neighbourhoods with limited bus service.

According to a representative from TTC, the chronology of events after the July 2013 floods shows how quickly a storm can impact public transportation. Within 38 minutes of Environment Canada issuing a special weather statement, all subway service was stopped, "holding in position" across the city due to signal problems or loss of electrical power.

17:55h	Environment Canada issues a Special Weather Statement
17:58h	Power outages in Etobicoke
18:04h	Downsview Station loss of signal power from Downsview to Lawrence West Station. Stop and Stay initiated. Approximately 130 customers evacuated.
18:08h	Union Station (to King) Track down due to excess water at track level. Five trains trapped at College to Queen and both ways at St Andrew Station. No service both ways between St Andrew to Bloor Stations for the remainder of service. Hydro One Networks Inc. experienced severe flooding at its Richview and Manby Transformer Stations causing interruptions of twenty-six 230,000 volt and eight 115,000-volt circuits. Hydro One declares a Level 2 Transmission Emergency after 3,400 MW of load was interrupted, causing widespread power outages to more than half a million households and businesses in the GTA.
18:11h	Kipling Station loss of power from Kipling to Royal York Stations due to severe weather conditions. Four trains trapped from Islington to Kipling Station and customers evacuated from trains.
18:11h	Sheppard Station (Yonge Sheppard) Service suspended due to loss of code and signal power caused by severe storm.
18:33h	All subway service holding. Signal and power issues throughout the city.

July 2013 Commuter Rail Shutdown due to Flooding

The July 2013 floods also made parts of GO Transit's Richmond Hill commuter rail line impassable. An afternoon rush hour train was stranded along the flooded portion of the line, resulting in flooding of the lower level of the train. Approximately 1,400 passengers were stranded on the train and it took more than six hours to rescue all of the passengers (Kuitenbrouwer, 2013).

To help address extreme winter storms, TTC has designed snow throwers, which can be installed on its fleet of diesel work cars to help remove snow from tracks. Special equipment has also been developed by TTC that dispenses anti-icing fluid to help prevent ice build-up on tracks. Track switches and wayside train stop equipment are also equipped with snow melters. Ice storms could disrupt streetcar service, however, because of ice buildup on overhead wires. For example, during the December 2013 ice storm, streetcar service was suspended for one day because of ice buildup on wires.

A significant heat wave could also cause some service disruptions due to the overheating of electrical systems, particularly those in poorly ventilated rooms in older portions of the subway. In extreme cases, rail buckling can occur in some sections of the subway. TTC is just beginning to study their system vulnerabilities to extreme heat.

A power outage from any of the extreme weather events would significantly exacerbate disruptions in public transit service. Electricity is needed to operate subway stations, subway tracks, track signals, switches for subways, overhead wires for streetcars, and pumps to fuel buses.

According to a representative from TTC, flooding has caused some instances of power loss at TTC bus garages. For example, during the 2013 floods, the Toronto Hydro feed to Arrow Road Garage was lost for a period of several days. A permanent diesel fueled back-up generator at every garage would provide a temporary source of electrical power during electrical power outages. However, the cost to install permanent back-up power at every garage sufficiently sized to power all garage activities for sustained periods is cost prohibitive. For this reason, TTC has taken the approach of installing smaller, permanent back-up power generators. Each generator will need to be manually activated for each power load deemed essential.

Electricity is also needed to power storm drainage pumps. According to a representative from TTC, in the event of a power outage, TTC has a handful of portable, diesel-powered backup generators that can be deployed to operate pumps in inundated subway stations. Due to the limited number of backup generators, however, only a few subway stations would be pumped out at a time in the event of a power outage. Road congestion (discussed below) could also delay emergency response crews from quickly reaching impacted stations, as a representative from TTC said happened after the 2013 floods.

The Road Network

Comprehensive data on the transportation of food in Toronto and the GTA, including transportation mode, volumes, routes, and origins and destinations, is not currently collected by any municipal, provincial or federal agency (Metrolinx, 2011). A recent study completed by the City of Toronto, however, found that trucks are used to transport the “majority of food” distributed in Toronto and throughout the GTA (no specific numbers are cited) (General Manager, Economic Development and Culture, 2016, p. 4). According to a representative from the Ontario Ministry of Agriculture, Food and Rural Affairs, most food moving *through* the GTA is transported by truck. He estimates, based on industry sources, that for GTA food imports and exports, about 70 to 75 percent is transported by truck, 20 percent by rail, less than five percent by ship and less than one percent by air.

The primary transportation routes for all trucks into Toronto include three east-west Trans-Canada or National Highways (Rank 1 or 2) (Highway 401, Highway 409, and F.G. Gardiner Expressway) and three Trans-Canada or National Highways (Highway 400, Highway 427, and Queen Elizabeth Way). In addition, there are five Major Highways (Rank 3) in Toronto: Albion Rd., Don Valley Parkway, Kingston Road, Markham Road, and Steeles Avenue.²⁴ The main transportation routes encompass numerous bridges and culverts, which cross Toronto’s rivers and streams. One food retail expert believes that the F.G. Gardiner Expressway and Don Valley Parkway are two major food transportation routes in Toronto.

Sections of Highway 400, Highway 401, and Highway 427 are located in areas at risk for riverine flooding. In addition, sections of the Don Valley Parkway, Kingston Road, and Steeles Avenue are located in areas at risk for riverine flooding. The F.G. Gardiner Expressway, which is an elevated highway, is not located in areas at risk for flooding. In Toronto, 49 of 309 bridges and culverts located on Trans-Canada or National Highways (16 percent) are located in areas vulnerable to flooding. (We did not analyze bridge and culvert vulnerabilities for the GTA because of insufficient data.) The July 2013 floods caused flooding on parts of Highway 401, 409 and 427, and caused an overnight closure of the Don Valley Parkway (Mortillaro & Armstrong, 2013).

In cities, nearly all food is distributed to retail stores and restaurants by truck, making roads, tunnels and bridges critical points of vulnerability for food distribution. To identify transportation vulnerabilities in Toronto, two factors were analyzed: the existence of redundant food truck transportation routes into the city, and the vulnerability of major transportation routes to extended closures. Secondary highways, collector roads and local roads are also critical because they are used for the “last mile” transportation of food within the city to food retail stores and restaurants. The impact of disruptions in the “last mile” is significant because it would limit the ability of consumers to purchase and consume food. Analysis of “last mile” transportation vulnerabilities was beyond the scope of this report.

The City of Toronto Transportation Services Division completed a Climate Change Risk Assessment of critical services and high priority assets (roads, bridges and culverts) in 2010 for seven extreme weather events. As a result, the representative interviewed for this report said they have a general understanding of the vulnerability of the assets they manage to extreme weather events and climate change. In the event of extreme rainfall that leads to flooding, the Toronto Transportation Services representative said they expect that highways and major roads would be closed for no more than a day or two, but smaller secondary roads (including driveways to warehouse facilities) could be closed for a longer period.

The previously completed HLRA for transportation systems in Toronto found that an extreme rain event could also “overwhelm” culverts or bridges because of capacity issues or blockages caused by debris, potentially damaging the structures (City of Toronto, 2016b, p.25). A washout of culvert or bridge serving a major highway could cause that road to be closed for an extended period, depending on the complexity of the repairs required. Toronto Transportation Services has implemented an enhanced culvert management system to help avoid culvert washouts. In addition, Toronto Transportation Services operates a bridge management system that meets the provincial regulated maintenance and inspection requirements and a road pavement management system.

The impact of any road closures in Toronto on the food system is mitigated by the existence of alternative food truck transportation routes. There are few heavy truck restrictions (e.g., load or height restrictions) on highways and expressways that would affect food trucks, and generally no restrictions on major arterials and minor arterials, with the exception of some seasonal or nighttime restrictions (Toronto Transportation Services, 2013). There are no truck height restrictions for bridges or culverts.

In the event of an ice storm, the Toronto Transportation Services representative said roads would remain open, but hazardous driving conditions would mean food truck deliveries would likely be delayed. Most roads remained open during the December 2013 ice storm, but the Ontario Provincial Police urged people to stay home or drive slowly due to poor driving conditions (Armstrong & Cain, 2013).

Under extreme heat conditions, roads may buckle or warp. For example, in July 2017, an off-ramp to Highway 7 in Manitoba, Canada buckled when temperatures reached 38 degrees Celsius. The ramp was closed for one day until damage could be fixed (Gerwing, 2017). Road buckling has occurred on Highway 401 in Toronto on extremely hot days. When buckling occurs, roads need to be closed until repairs are made. There is some concern that in the event of an extended heat wave softening of pavement will occur, but most expressways in Toronto have been upgraded with heat resistant asphalt. In addition, although not implemented to date, one tactic to reduce road damage during heat waves could be restricting heavier vehicles from using certain roads. Toronto Transportation Services will be undertaking a comprehensive study to develop a Freight and Goods Movement Strategy, which will include priority truck routes (General Manager, Transportation Services, 2017). Once these routes are identified, they plan on upgrading those routes with heat resilient asphalt.

Perhaps the greatest road transportation issue in Toronto is congestion. The region already experiences significant road congestion issues, with five of the top ten worst traffic bottlenecks in Canada located in the Toronto region, and commute times taking 60 percent longer during peak periods (CPCS, 2017). In any of the

extreme weather events, even if most roads are not closed, difficult driving conditions would increase congestion. According to one food retail expert interviewed for this study, current congestion is already causing issues with food truck deliveries and any additional congestion could cause more significant disruptions.

The City of Toronto's Congestion Management Plan

The City of Toronto's Congestion Management Plan (CMP) has been updated to cover the period of 2016-2020. The CMP's objective is to better manage congestion (e.g. reduce delays, reduce the number of stops, etc.) and improve safety through innovation and technology that will maximize the efficiency, reliability and sustainability of the road network for all users while reducing the impacts on the environment. The Congestion Management Plan and the various initiatives will assist with congestion and manage traffic incidents (Toronto Transportation Services, 2015).

Electrical Power

Toronto Hydro, the second largest municipally-owned electric distribution utility in Ontario, provides all electrical power in Toronto. Toronto Hydro serves 761,000 residential, commercial and industrial customers in the city and distributes approximately 19 percent of the electricity consumed in Ontario. Their electrical distribution system for Toronto includes one transmission system terminal station, 34 terminal stations, 157 in-service municipal substations, 16,500 primary switches, 60,420 distribution transformers, 15,560 km of overhead wires, and 13,040 km of underground wires (Toronto Hydro, 2016). The remainder of GTA municipalities are served by numerous other electric distribution utilities, with the majority of customers being served by Alectra Utilities (The Independent Electricity System Operator, 2017). Alectra Utilities serves nearly one million customers in the GTA (Blondeau & Friesen, 2017), and is the largest municipally-owned electric distribution utility in Canada and second only to Los Angeles in North America.²⁵

Electrical power is critical for all components of Toronto's food system, since it affects everything from food production to home meal preparation.

All three extreme weather events would cause some degree of power outages, although it is difficult to accurately predict the locations of the outages and which food businesses would be impacted. Flooding could damage low-lying substations, ice may damage overhead wires, and heat waves could overload or overheat various components of the electric distribution system.

According to representatives from Toronto Hydro and Alectra Utilities, in the case of all three events they would not expect outages to last more than a week, and power disruptions lasting more than one or two days would be localized to the areas most significantly impacted by the extreme weather. For example, in the July 2013 floods, power outages only lasted overnight for the majority of their customers (Kauri & Rogers, 2013). The same was true in the December 2013 ice storm, although over 72,000 customers (nearly 10 percent of Toronto Hydro's customers) lost power for more than three days (Oved, 2013). In the heat wave of 2012,

customers only lost power for a few hours. The Toronto Hydro representative also noted that it would be hard to imagine any of the three events causing power outages that impacted all (or most) of their customers in Toronto. In the July 2013 floods, approximately 42 percent of Toronto Hydro's customers lost power. In the December 2013 ice storm, approximately 31 percent of Toronto Hydro's customers lost power and in the heat wave of 2012, temporary power outages affected approximately one percent of Toronto Hydro's customers.²⁶

Toronto Hydro has taken a number of steps to enhance the resilience of the electric distribution system. It commissioned a Climate Change Engineering Vulnerability Assessment in 2015, conducted by AECOM, that used the Public Infrastructure Engineering Vulnerability Committee (PIEVC) protocol from Engineers Canada to identify areas of high risk to disruption from the most likely extreme weather events projected in the near term as well as more severe events that are likely to occur by 2050 (AECOM & RSI, 2015a). AECOM's assessment analyzed risks to Toronto Hydro's electrical power transmission stations (which convert high voltage electricity generated from power plants and transmitted through high voltage transmission lines to voltage levels used by customers) and feeder systems (the network of power lines, transformers, switches and equipment that distribute electricity to customers).²⁷

AECOM's assessment of the resilience of Toronto Hydro's electric distribution system included the following 20 extreme weather events:

- Daily maximum temperature of 25 degrees Celsius
- Daily maximum temperature of 30 degrees Celsius,
- Daily maximum temperature of 35 degrees Celsius,
- Daily maximum temperature of 40 degrees Celsius,
- High daily average temperature of 30 degrees Celsius,
- Three-day heat wave with maximum temperature over 30 degrees Celsius,
- Nighttime temperature low of 23 degrees Celsius,
- Extreme rainfall of 100 mm in less than one day,
- Ice storm with 15 mm of ice or freezing rain,
- Ice storm with 25 mm of ice or freezing rain,
- Ice storm with 60 mm of ice or freezing rain,
- High winds of 70 km per hour,
- High winds of 90 km per hour,
- High winds of 120 km per hour,
- Category EF1 or greater tornado,
- Category EF2 or greater tornado,
- Lightning storm,
- Snowfall greater than 10 cm per day,
- Snowfall greater than 5 cm per day, and
- Frost.

The extreme weather events assumed for our study are similar to those included AECOM's study, which looked at 20 different scenarios. For the extreme rainfall of 100 mm in less than one-day scenario, AECOM found that the primary risk was associated with localized flooding of non-submersible electrical equipment in low-lying areas. Electrical transmission station service areas located throughout Toronto, but concentrated in central and northeastern Toronto, were rated as "low" risk (i.e., not a significant issue) to extreme rainfall, with the remainder of transmission station service areas classified as "no" risk (see map in Appendix 4). Feeder systems

located throughout Toronto, but concentrated in central and northeastern Toronto, were rated as “low” to “medium” risk, with the remainder of Toronto feeder systems classified as “no” risk.

For the heat wave scenario (three-day heat wave with maximum temperature over 30 degrees Celsius), the study found that high temperatures would result in increased demand for electricity and decreased potential for transformers to cool overnight. These two factors would create risks ranging from “medium” to “high” depending on a transformer’s ability to meet additional demand. In this scenario, approximately half of electrical transmission station service areas throughout Toronto were classified as “high” risk with the other half classified as “medium” risk. The feeder system throughout Toronto was classified as “medium” risk (Toronto Hydro Vulnerability Assessment maps are available [here](#)).

For the 25 mm of ice or freezing rain scenario, AECOM found significant risks to overhead equipment due to fallen trees and tree branches. In this scenario, the majority of Toronto’s electrical transmission station service areas and feeder system were classified as “high” risk, with some transmission station service areas and feeder systems classified as “no” or “low” risk (AECOM & RSI, 2015b).

The Toronto Hydro study also noted that if no action is taken to upgrade the electrical system, the risk of power disruptions will be higher in the future due to more frequent extreme weather. Some of Toronto Hydro’s equipment is considered to be past its design lifespan and is in need of replacement. Toronto Hydro is increasing its efforts to upgrade its equipment to be more resilient to extreme weather and higher electrical demand.

According to a company representative, Alectra Utilities has also taken some steps to better understand the risks facing its electric distribution system. The representative reported that Alectra Utilities’ service area is at higher elevations and is less prone to flooding than Toronto Hydro, and only localized flooding is expected to impact its distribution system. Localized flooding could lead to some customers losing power for a day, but it is expected that power would be restored within minutes or hours for the majority of flooding events. Alectra Utilities has worked with some of the conservation authorities in its service area to understand flood risks, although this work has been on an ad hoc basis. The representative stated that ice storms pose the most significant threat to disrupting Alectra Utilities electric distribution system. In the event of a power outage from an ice storm, Alectra Utilities would prioritize mainline feeder systems, but more remote areas could experience loss of power for up to a week. A heat wave would cause localized disruption if equipment fails, with disruptions potentially impacting thousands of customers depending on the equipment failure.

Telecommunications

The primary telecommunication providers in Toronto and the GTA include Bell Canada, Rogers, and TELUS, but there are many other providers, making the telecom market more challenging to analyze than the electrical network. Furthermore, telecommunication networks vary by system. For land phones and internet service, voice and digital transmissions are transmitted via interconnected underground and overhead telephone and cable lines. For mobile phones, communications are transmitted wirelessly via a network of cellular towers dispersed throughout the region. GPS transmissions are transmitted via satellite, but rely on other telecommunications for some applications (e.g., transmitting GPS information to mobile phones).

Telecommunications (e.g., land lines, mobile phones, and internet service) are needed across the food system to support operations in food distribution centres (which are mostly automated), food transportation (which relies on GPS and remote sensors for temperature control), and payment systems at food retail stores and restaurants. For the purposes of this analysis, only business telecommunication issues are considered.

According to a telecommunication expert, all three extreme weather events could affect telecommunication networks, but the degree of impact would vary depending on the type of network and service provider. Ice storms, for example, could damage overhead wires. In Toronto, many telephone and cable lines are above ground, exposing them to potential ice damage. Although it could still be affected, the telecom network in the rest of the GTA is less exposed to this type of impact because many telephone and cable lines in these areas are underground.

All telecommunication networks are dependent on electricity in some capacity and all three extreme weather events would indirectly affect telecommunications in the event of a power outage. Electricity is required to power cell towers or cell sites (such as antennas on top of buildings). However, if one cell tower or site is offline, users in Toronto or the GTA will be served by other cell towers or sites in the near vicinity (as there is overlapping coverage). Only in the event of a widespread power outage that affects multiple cell towers, would cell coverage be limited. Furthermore, telecommunication providers can use on-site or portable generators to power cell towers. Most telecom equipment has some level of backup power generation, which typically uses diesel fuel. The backup generators are at risk only if diesel fuel supplies run out in the GTA during widespread, prolonged power outages.

Canadian Telecom Resiliency Working Group

The Canadian Telecom Resiliency Working Group (CTRWG), which includes telecommunication providers and stakeholders, was established to develop strategies to promote the resilience of the telecommunications sector. CTRWG, which replaced the Canadian Telecommunications Emergency Preparedness Association (CTEPA), reports to the Canadian Security Telecommunications Advisory Council (CSTAC), a Government of Canada initiative that allows the private and public sectors to exchange information and collaborate on issues that may affect telecommunication infrastructure (Amec Foster Wheeler & Credit Valley Conservation, 2017).

For transmitting voice and digital transmissions, power is needed to operate mobile phones, computers, GPS receivers, and payment systems. In the event of a power outage, generators, batteries, or other power sources would be needed to continue to power these devices.

Telecommunication representatives were included as observers (and not active participants) in the recent City of Toronto HLRA for utilities. A vulnerability assessment for telecommunications was not completed during the HLRA process, but other utility companies and City services identified significant dependencies on telecommunications for their operations. The assessment recommends that organizations dependent on telecommunications assess the potential levels of disruption and implications to their own operations from extreme weather events or natural disasters (City of Toronto, 2016b). At the time of writing this report, the Environment and Energy Division of the City of Toronto was working with the telecom sector to plan a climate change risk assessment for the telecom system in Toronto.

Telecommunications in Toronto and the GTA have not been significantly disrupted during previous extreme weather events. However, during the July 2013 floods, Toronto's largest telecommunications data centre hub, housing more than 150 tenants, including Rogers, TELUS, IBM, Verizon and the Toronto Internet Exchange, lost power. It was able to switch to generator power after Toronto Hydro went offline, but its cooling systems experienced an outage ("Toronto Flooding KOs Data Center Cooling Systems," 2013). Fortunately, the cooling system was restored before the facility experienced any significant disruption. During the December 2013 ice storm, telecommunications were indirectly impacted when customers could not power or recharge mobile phones and other devices due to power outages ("Canadians hang on to hard-wired phones in case of power outage," 2014).

Fuel Supply Transportation, Storage and Distribution

Fuel supply transportation, storage and distribution infrastructure includes all infrastructure required to process, transport, store, and distribute fuels. Fuels relevant to the food system include gasoline, diesel, propane and natural gas. Various fuel distribution companies operate in the GTA, including Esso, Petro-Canada, Shell and others. Enbridge Gas Distribution is the largest natural gas distribution company in Canada, serving two million customers in Ontario, including Toronto (Green, 2013). The City of Toronto considers the liquid fuel sector as one of the top ten critical systems that need to keep operating even during a natural disaster or extreme weather event. This sector has not been involved in any climate change risk assessments in Toronto to date.²⁸

Fuel (including gasoline, diesel, propane and natural gas) is critical for the food system. It is used for food transportation, personal transportation, public transportation, heating of buildings, commercial and home food preparation and emergency power generation.

In terms of direct impact from the extreme weather events, flooding is perhaps the greatest risk, which could disrupt the natural gas distribution system. Gas pipelines often run in parallel with other subsurface linear infrastructure such as water mains and sewers. Broken water or sewer pipes can potentially break gas pipelines or cause damage that creates gas leaks. Further, extreme rain may cause excessive erosion exposing gas pipelines, which could also damage the pipelines.

However, the greatest vulnerability for this sector is a fuel shortage driven by increased demand due to extended power outages, the inability to pump gas because of power outages, and fuel supply disruptions. In the event of a widespread power outage that lasts for an extended period of time (as was the case in a 2003 power outage), fuel supplies may become limited in the city as demand outstrips supply. In the event of a power outage, fuel depots typically have backup power generators to operate fuel pumps, while retail gas stations do not. This means personal cars and small delivery trucks and vans could have limited access to fuel during a power outage.

Flooded or icy roads could also delay fuel deliveries (and extreme cold might cause problems with diesel truck engines if the right fuel is not used). The largest users of fuel (those with contracts with suppliers) may have pipeline delivery systems and also often receive priority service in the event of fuel supply disruption. For example, the Toronto Transit Commission has contracts with its fuel suppliers to receive priority fuel deliveries in the event of a disruption. Smaller companies (e.g., small food retailers and food banks), may not receive priority service, and may experience fuel shortages. Limited fuel supplies would not only impact their backup power and ability to stay open, but gas shortages would also limit their truck and van food distribution.

Additional study is needed to fully assess the risks that would affect fuel supply transportation, storage and distribution for each extreme weather event scenario.



GLOBAL CITY INSIGHT

In 2008, the City of Barcelona initiated the security on services supply (3Ss) risk assessment process. The overall purpose was to collect information on city services, assess weak points and risk, and evaluate interdependencies between infrastructure networks. In 2009, the Urban Resilience Boards for Infrastructure and Services Supply (TISU) and the TISU coordination team were formed. The primary goal was to implement projects to reduce vulnerabilities across different infrastructure sectors, including electricity, energy and public transportation. Given the interdependencies between these sectors, the City of Barcelona also created an information platform called the Situation Room, which allows for intergovernmental sharing of information and also serves as a support for decision-making processes, either operational or strategic, improving the capacity of analysis on a wide range of city matters and on the state of performance of urban services (Ajuntament de Barcelona, 2013).



In 2013, New York State enacted a law (“Alternate generated power source at retail gasoline outlets”) requiring many fuel stations in downstate New York (New York City and Nassau, Rockland, Suffolk, and Westchester Counties) to install a transfer switch for either a portable or a permanently affixed emergency generator that could be deployed in emergencies. A transfer switch is an electrical switch that switches a building’s electrical power source from the municipal electrical distribution system to an emergency generator. Fuel stations required to install a transfer switch include (1) those located within one-half mile of an exit road on a controlled access highway or designated evacuation route, (2) additional chain stations located outside of the one-half mile limit, and (3) new or reconstructed gas stations built in downstate New York after April 1, 2014. Fuel stations selling less than 75,000 gallons per month are exempted from the law (State of New York, 2015).

Coinciding with the new law, the New York State Energy Research and Development Authority launched the Fuel NY initiative, which provides \$21 million in grant funding for fuel stations to install the transfer switches. In 2014, the Fuel NY initiative also implemented the Fuel NY Portable Emergency Generator Program, a voluntary program that deploys portable energy generators in the event of a declared energy or fuel supply emergency to participating fuel stations in downstate New York that only have a transfer switch, but no permanently affixed emergency generator (New York State Energy Research and Development Authority, 2015). As of January 2018, 753 fuel stations in downstate New York are prepared for emergency generation, with 605 participating in the Fuel NY Portable Emergency Generator Program, 107 installing a permanent emergency generator, and the remaining stations either using a private portable emergency generator contract or their own portable emergency generator.²⁹

After Superstorm Sandy, New York City also called on their state legislature to mandate larger food retailers (20,000 square feet or more of floor space or 60 or more full- or part-time employees) to install transfer switches for portable or permanently affixed emergency generators to ensure that food retailers have power to process transactions and operate emergency lighting and fire and security systems during an emergency (Zeuli & Nijhuis, 2017b). The legislation was introduced in 2013, but did not pass. According to New York City’s 2017 resilience strategy progress report, New York City Emergency Management also included emergency generators for food retailers on its legislative agenda in 2016, but no legislation has been passed to date. The City continues to explore the topic of emergency generators for food retailers as part of its overall resilience efforts (The City of New York, 2017).

SECTION 5

THE IMPACT OF EXTREME WEATHER EVENTS ON TORONTO'S FOOD SYSTEM



The following section summarizes the potential impact the three extreme weather events could have on Toronto's food production, food processing, food distribution, food retail, and restaurants. The direct impact, which is minimal in most cases, is discussed, as well as the more significant disruptions caused by failures in critical infrastructure.

Food Production Vulnerabilities

Food production refers to all crop and livestock farms and ranches, urban farms and community gardens.

This study analyzed the potential impact of extreme weather events on food production in the Greater Golden Horseshoe. This area lies within a 160 km radius of Toronto City Hall, which is the geographical boundary of the "100-mile diet."³⁰

No data are available to accurately determine the share of food consumed by Toronto residents that is produced in the Greater Golden Horseshoe. Therefore, it is difficult to assess the potential impact of any food production disruptions. However, the experts interviewed for this study estimate that less than 10 percent of all food consumed by Toronto residents is produced in the region, although the share varies depending on the food product.

Recent studies have found that the Greater Golden Horseshoe and the rest of Ontario are net importers of food and that it is also likely that a significant proportion of the food produced in the region is exported out of the region and Canada (Econometric Research Limited, Harry Cummings & Associates, & Rod MacRae, 2015; Miller, Blay-Palmer, & Dubbeling, 2017). For example, a recent analysis of the food flow of carrots in the Greater Golden Horseshoe estimates that 25 percent of carrots produced in region are exported and 20 percent of carrots consumed in the region are imported (Miller et al., 2017). The exceptions are for dairy, egg and poultry products (chicken and turkey), which are the only agricultural products in Canada regulated by national supply management systems ("Supply Management Systems," 2014). For these products, the federal government controls imports and sets provincial production levels based on provincial demand. Provincial marketing boards allocate production among farms and negotiate prices with buyers in order to maintain stable prices for both farmers and consumers for these products (Heminthavong, 2015). A larger share of dairy, egg and poultry products consumed by Toronto residents comes from Ontario, as compared to other agricultural products, because of the supply management regulations.

Regional food production

Regional food production in Toronto is concentrated in the Greater Golden Horseshoe outside of the GTA. Farms in both areas combined include over 973,000 acres, with an annual market value of \$4.1 billion in 2011, accounting for 36 percent of Southern Ontario's total farm output (Econometric Research Limited et al., 2015). The primary crops grown include soybeans, corn, alfalfa, wheat, and field vegetables. The primary fruits and vegetables grown include grapes, peaches, carrots, sweet corn, and apples. The primary livestock raised and produced include chicken (meat) and hens, sheep and lambs, turkey (meat), and eggs.

Dairy production in Ontario is managed by Dairy Farmers of Ontario (DFO), the marketing group for Ontario's dairy farmers. There are 970 dairy farms licensed with DFO in the Greater Golden Horseshoe.³¹

According to the dairy production experts interviewed for this study, the impact of any of the three extreme weather events on dairy production would be minimal (i.e., only affecting a few farms).³² Only one dairy farm in the Greater Golden Horseshoe is located in an area at risk for flooding. However, dairy cows are susceptible to significant changes in temperature, and heat stress can lead to loss of productivity (milk per cow) and increased risk of on-farm dairy cow mortality. For the average dairy farm in Southern Ontario, a three-day heat wave results in \$250 to \$2,500 of economic losses (Bishop-Williams, Berke, Pearl, Hand, & Kelton, 2015).

If a producer's facilities are significantly damaged by flooding or ice storms, the producer may be permitted to share facilities with one or more existing producers for a period of up to six months under DFO policies. If significant rebuilding is needed, a producer can share facilities for up to one year, with the possibility of an extension under certain conditions (Dairy Farmers of Ontario, 2010).

According to the dairy production experts interviewed for this study, the impact of any of the three extreme weather events on dairy production would be minimal.

Production, equipment and facilities would be affected by critical infrastructure failures. DFO is responsible for transporting all milk produced in Ontario through independent dairy transport companies. Road closures would disrupt DFO's ability to deliver milk to dairy processors. In the event of a road closure that disrupts normal milk pickup, dairy farmers are permitted to continue to fill their milk tanks to their storage capacity. If the farm does not have enough storage capacity, excess milk will need to be dumped. If milk is not picked up after three days, all milk stored in tanks must be dumped (Dairy Farmers of Ontario, 2010). As a result, if milk transportation is disrupted for longer than three days, milk supplies would be limited.

Power outages would also create supply disruptions because power is needed to milk the cows, to refrigerate the milk, and for the equipment to operate the barn. In 1998, Ontario and Quebec experienced approximately 70 mm of freezing rain and ice over a period of five days. Power outages led to approximately 5,500 farmers dumping 13.5 million litres of milk (Dupigny-Giroux, 2000). According to a dairy industry expert, in part due to this event, dairy farms now are required to have backup generators to maintain minimal operations during a power outage.

Poultry (chicken and turkey) and egg production in Ontario is managed by product-specific marketing groups, including Chicken Farmers of Ontario, Egg Farmers of Ontario, the Ontario Broiler Hatching Egg and Chick Commission, and Turkey Farmers of Ontario.

According to a poultry production expert, the impact of any of the three extreme weather events on poultry production also would be minimal. There are approximately 461 chicken egg or pullet (young hen) farms, 1,300 chicken farms and 176 turkey farms operating in Ontario.³³ According to ICIC analysis, there are five chicken egg farms in the Greater Golden Horseshoe and none are located in areas at risk for flooding.³⁴ There are 17 poultry farms (10 chicken farms and 7 turkey farms) in the Greater Golden Horseshoe and none are located in

areas at risk for flooding.³⁵ According to the same expert, chickens and turkeys are susceptible to heat stress, which can decrease egg productivity and lead to mortalities on farm and in transport.

According to a poultry production expert, the impact of any of the three extreme weather events on poultry production also would be minimal.

Poultry production, equipment and facilities would be impacted by critical infrastructure failures. Road closures would disrupt the transportation of poultry and eggs to processing facilities, which would create some food supply issues. Power outages would also create supply disruptions because power is needed for operations and cooling systems. According to the poultry industry expert, it is likely that all poultry farms have a backup generator.

Urban agriculture

The City of Toronto supports community gardens and allotment gardens ("Urban Agriculture," 2017). Community gardens provide residents with garden plots on City-owned, institutional, or private property. In addition, a number of schools also maintain gardens. A recent study found 257 school and community gardens within Toronto city limits (Toronto Food Policy Council, 2016). Allotment gardens operated by the City of Toronto provide residents with access to garden plots on City-owned land for an annual fee. The City of Toronto operates 11 outdoor allotment gardens and one indoor allotment garden within Toronto city limits ("Urban Agriculture," 2017). In addition, there are a handful of small-scale commercial farms, market gardens, and rooftop gardens. An unknown number of residents have private gardens within Toronto city limits, although no data exists on their numbers (Toronto Food Policy Council, 2012). Food production within the City of Toronto is very limited and would not provide a significant amount of food in an emergency. There is insufficient food production to serve the city in an emergency. However, there is an active community of gardening enthusiasts through the Toronto Urban Growers (torontourbangrowers.org), community organizations and private residents.

A study exploring the potential of commercial fruit and vegetable production within city limits on available land found that it would be difficult to grow even 10 percent of the fresh vegetable requirements for Toronto's population (MacRae, et. al., 2010).

There is significant interest in Toronto in expanding local food production and processing in the city and region, in part to create what some see as a more resilient food system. For example, in 2013, the Province of Ontario developed a Local Food Strategy to increase consumer awareness and consumption of local food in Ontario (Ontario Ministry of Agriculture, Food and Rural Affairs, 2017). This strategy is supported by Ontario's Local Food Act. The purpose of the Act is to "help foster successful and resilient local food economies and systems in Ontario, help increase awareness of local food in Ontario, including the diversity of local food, and develop new markets for local food" ("Ontario's Local Food Strategy," 2017). Toronto has been a leader in the global movement for creating sustainable food systems. Toronto Food Policy Council's GrowTO plan, released in 2012, outlines actions to promote urban agriculture in Toronto in order to provide healthy, sustainable, culturally diverse, accessible and affordable food for all (Toronto Food Policy Council, 2012). It builds on a number of previous initiatives to promote local food production and processing in the city.

While increasing local food production and processing may mitigate some climate change risks (e.g., by decreasing dependence on food produced in other areas that face their own risks and by shortening the supply chain), it may increase risks associated with local extreme weather events in Toronto. A greater number of food plots and food processing facilities would be exposed to these events, potentially creating greater food supply disruptions if they were destroyed. In that scenario, food retailers and households would need to find alternative sources of food and different supply chains, which cannot be done quickly. However, there are many benefits to an expanded local food production sector. A resilience perspective can be used to find the optimal balance between local and imported food and further research on this topic is warranted.

Food Processing Vulnerabilities

The term food processing refers to all aspects of the transformation of food from point of production to distribution, which includes cleaning, packaging and processing. Because of the global nature of the food system, a very small share of total food consumed in any city is processed and packaged locally. Furthermore, most food processors are exporters and serve global markets. Food processing overall, therefore, is not typically a critical area of vulnerability in most urban food systems although some sectors (such as dairy and bakeries) are more vulnerable because they tend to be located near their customers due to the perishability of their products. In addition, as noted above, a higher share of dairy, eggs and poultry consumed in Toronto may be produced in the region because of supply regulation. Dairy processing, for example, is concentrated in the GTA.

The food processing analysis for this study includes dairy, eggs, poultry and commercial bakeries within the Greater Golden Horseshoe.

There are 98 dairy processing facilities, 28 poultry processing facilities (16 chicken processing facilities and 12 turkey processing facilities), 26 egg processing facilities and 492 commercial bakeries (most of which are very small) located in the Greater Golden Horseshoe.³⁶ Six percent of dairy processing facilities and ten percent of commercial bakeries are located in areas at risk for flooding. No poultry processing facilities or egg processing facilities are located in areas at risk for flooding. The experts we interviewed expect minimal damage to the structures or equipment of dairy processing facilities, poultry processing facilities, egg processing facilities and commercial bakeries from an ice storm or heat wave. Although we were not able to contact all facilities, the experts we spoke to believe the facilities could adequately handle an ice storm or heat wave.

However, all of the facilities would be impacted by critical infrastructure failures. Road closures would disrupt their ability to source inputs and deliver product, thereby creating some food supply disruptions. They might also affect the ability of employees to drive to work, although public transportation disruptions might cause a greater impact on employee availability. Power outages and telecommunication disruptions would also create supply disruptions, as raw ingredients and food would perish (loss of inventory), processing and coolers would not function, and orders would need to be filled manually, taking significantly more time. According to industry experts, it is unknown how many dairy processing facilities and commercial bakeries have backup generators, but they feel that it is likely that most poultry and egg processing facilities have backup generators.

We were unable to identify whether dairy, egg, and poultry processing facilities or commercial bakeries had sufficient insurance or business continuity plans. However, most of the dairy processing facilities and commercial bakeries in the Greater Golden Horseshoe are small (i.e., annual revenues less than \$1 million), therefore, it is unlikely that they would have sufficient insurance or business continuity plans.³⁷ Most egg and poultry processing facilities are larger, meaning they are more likely to have sufficient insurance and plans in place.

Food Distribution Vulnerabilities

The distribution of food from packaging and processing facilities to consumers is a complex process that is very vulnerable to extreme weather events. The weaknesses in this sector are difficult to analyze because food products follow different paths from farm to retail, depending on the food item and the retailer. Food retailers generally receive all of their products from three different distribution channels: a primary distributor (a warehouse, wholesaler or distribution centre), secondary distributors (local warehouses, wholesalers or distribution centres), and direct store delivery (Arbulu, 2017; “Food Industry Glossary,” n.d.).³⁸ Distributors purchase products from processing facilities, store the products and ultimately deliver them to food retailers.³⁹ The primary distributor sources the majority of products sold by the retailer. Secondary distributors provide additional products that the primary supplier does not carry, including more specialty products and unique brands. They also typically provide fresh meat, fish and produce.

With direct store delivery, products are shipped directly from the grower or processing facility to the food retailer. Direct store delivery is limited to certain products—typically carbonated beverages, milk, bread, salty snacks, prepared frozen foods and some fresh produce (Grocery Manufacturers Association, AMR Research, Clarkston

Consulting, & The Nielsen Company, 2008). Supermarkets typically have a vertically integrated supply chain, meaning they own their primary distributor (Arbulu, 2017; Martinez, 2007). Smaller, independent grocery and convenience stores generally rely on independently owned distributors, and for fresh wholesale fruit and produce they rely on the Ontario Food Terminal (discussed below). In some cases, smaller independent grocery and convenience stores may also purchase from a supermarket’s vertically integrated distribution centre (Arbulu, 2017).

Large distribution facilities are generally located outside of Toronto city limits because they serve regional customers, while some smaller, secondary distributors are located within the city. The analysis included all primary distributors (vertically integrated and independently owned) for the majority of supermarket stores operating in Toronto and all secondary distributors located in Toronto and the GTA. This includes primary distributors for six supermarket companies that together account for 74 percent of supermarket stores located in Toronto: Loblaw Companies Limited, Lucky Supermarket, Max’s Market, Metro Inc., Sobeys and Whole

The distribution of food from packaging and processing facilities to consumers is a complex process that is very vulnerable to extreme weather events.

Foods.⁴⁰ Data limitations prevent us from identifying all distributors for Toronto's food retailers, because of proprietary information and the number of stores involved, but we know from previous studies and our expert interviews that the suppliers we captured account for the majority of food distributed to food retailers in Toronto. For example, the city's smaller, independently owned grocery stores and convenience stores typically rely on local distributors, meaning that many of their suppliers are those operating in the city.

In the GTA, one of five (20 percent) primary distributors for supermarkets is located in an area vulnerable to flooding (Map 1). Of the 1,489 local distributors located in Toronto and the GTA, 168 (11 percent) are located in areas at risk for flooding.⁴¹ We expect minimal damage to the structure or equipment of distribution facilities from an ice storm or heat wave. The experts we spoke to at distribution facilities believed that the facilities could adequately handle a heat wave or ice storm.

However, all distribution facilities would be impacted by critical infrastructure failures. Road closures or traffic congestion would disrupt their ability to deliver product on time, thereby creating some supply disruptions. Fuel shortages or limited access to fuel would also disrupt the ability to deliver product. Road or public transportation disruptions would affect the ability of employees to get to work.

Power outages and telecommunication disruptions would also create supply disruptions, as food in cold storage could perish. Automated and manual online ordering systems would not function and delivery routing systems, including computer applications, GPS receivers, and mobile phones (with drained batteries) would not function. For distribution centres with automated processes, orders would need to be filled and tracked manually taking significantly more time.

According to experts at distribution centres, most distribution centres for Toronto supermarkets have backup generators that would be able to fully power facilities and all equipment. Backup generators would, however, ultimately require fuel (natural gas or diesel) to operate over an extended period. For distribution centres with backup generators powered by natural gas, some may have direct pipeline connections. For these types of generators, running out of fuel is not a concern. For distribution centres with backup generators powered by diesel, diesel is delivered to the distribution centre by truck and stored onsite. For these types of generators, distribution centres would need to be able to receive fuel deliveries by truck to continue to operate their backup generators. Companies may operate multiple distribution centre facilities and the type of backup generator used varies by facility.

The food distribution industry has become more consolidated and very competitive, and in the event of a disruption, warehouse suppliers will do everything they can to recover as quickly as possible and deliver supplies to avoid losing customers.

Many large food retailers require their distributors to have business continuity plans in place in order to secure their purchasing contracts. Large food retailers also may work directly with suppliers to improve their business continuity planning.

Food distribution networks are generally fragmented, with different distributors spread across various locations, creating some resilience. National and vertically integrated distributors are also better prepared to handle disruptions because they have multiple locations and resources to invest in structural improvements to withstand disasters, including backup power. Smaller, local distributors are less likely to have business continuity plans in place, generally operate in only one location, and are less likely to invest in making their facilities more resilient to disaster. This creates a greater likelihood of supply disruptions to the food retailers they serve—mostly smaller grocery and convenience stores.



GLOBAL CITY INSIGHT

Following Superstorm Sandy in 2012, the City of New York published a comprehensive report, *A Stronger, More Resilient New York*, that incorporates lessons learned from the storm to inform recommendations to increase the overall resilience of New York City. The report strongly urges the City to focus on the risks to the city's food supply: "[C]omplacency in the wake of Sandy would be a mistake, as the food supply system may not escape significant impacts in the next extreme weather event" (The City of New York, 2013a, p. 222).

A targeted follow-up study, *Five Borough Food Flow*, was completed in 2016 and helped to identify particular vulnerabilities for food transportation (New York City Economic Development Corporation and New York City Mayor's Office of Recovery & Resiliency, 2016).⁴² The Five Borough Food Flow study included a partial (representative) analysis of the city's "last mile" food distribution system by aggregating secondary data sources of point-of-sale outlets and warehouse suppliers and conducting interviews and surveys with food retailers and distributors across the city. The study was able to identify the geographic distribution of some food distributors, major food transportation routes, and the preparedness of food retailers for future disruptions. The City has integrated this study into its overall resilience efforts and has formed interagency working groups in 2017 as a result of the study to continue to build on this effort (New York City Economic Development Corporation and New York City Mayor's Office of Recovery & Resiliency, 2016, p. 14). Working group topics include electrical and flooding resilience and small business preparedness (The City of New York, 2017, p. 228).

Ontario Food Terminal

Toronto also has a large, centralized fresh produce distribution centre, the Ontario Food Terminal—the largest wholesale fruit and produce distribution centre in Canada, and the third largest in North America. It houses 21 wholesalers and 400 farmer market tenants who supply produce to over 5,000 retailers across the country ("Welcome to the Ontario Food Terminal Board," n.d.). The retailers (who must be registered buyers with the Terminal) range from small to large food retailers and include fruit and vegetable stores, restaurants, florists/landscapers, food service companies, conveniences stores and others.⁴³ In addition, large supermarkets will sometimes use the Ontario Food Terminal as a secondary distributor to supplement produce distributed from their primary distribution centres. On average, the Ontario Food Terminal distributes 5.5 million pounds of fruit, produce and horticultural products per day (2 billion pounds annually) ("About Us," n.d.-a). It is estimated that 35 to 40 percent of produce that moves through the terminal is grown in Ontario (Coutu, Fusca,

Shyllit, Thorpe, & Vidoni, 2012; Robbins, 2017). According to a representative from the Ontario Food Terminal, it is very difficult to determine the share of produce sold in Toronto, but he estimates that between 35 to 40 percent of produce sold in Toronto is from the Ontario Food Terminal. Twenty-one of the local distributors (one percent) included in the analysis are located in the Ontario Food Terminal.

The Ontario Food Terminal opened in 1954 and is situated on a 40-acre site between the Humber River, Mimico Creek and Humber Bay, Lake Ontario, making it vulnerable to riverine flooding from extreme rainfalls. It is located in one of TCRA's Flood Vulnerable Areas. According to a representative from the Ontario Food Terminal, they would expect only minimal flooding to warehouse buildings, truck parking sites and property egresses from any extreme rain event. Their concern would be the impact of flooding on the Terminal's electricity. The Terminal has only one transformer station that supplies power to its facilities. The Terminal's transformer station is located near a culvert at the edge of the site, making it potentially vulnerable to flooding, and subsequent power outages. According to facility staff, no flooding event has occurred at the transformer station to date. However, there is no redundancy for this transformation station and it represents a potential "single point of failure" for this important facility. There is also a large cell tower that is located close to the transformer station. If that tower were to fall in an extreme wind or ice event, there is a risk that the transformer station could be disabled.

Any disruptions at the Ontario Food Terminal would not only affect produce availability within Toronto, but also across Canada.

According to a representative from the Ontario Food Terminal, the Terminal carries flood and business interruption insurance and all tenants also carry business interruption insurance. The Ontario Food Terminal has a business continuity plan in place in the event of a power outage but it does not have a permanent backup generator. Due to the building's age, it does not have the capability to hook up to mobile "Plug and Play" generators for backup power. The Ontario Food Terminal looked into purchasing on-site backup generators, but they were considered cost prohibitive. Another option for reducing power supply vulnerability at the Terminal could be obtaining a second electrical feed to the complex, although it would also be costly and not helpful in a widespread power outage.

Toronto Hydro maintains a priority loads list, which prioritizes the restoration of power for public health and safety (e.g., hospitals) after a power outage.⁴⁴ According to a representative from Toronto Hydro, the electrical feeder the Ontario Food Terminal is connected to is currently on their priority loads list.

Minimal damage is expected to Ontario Food Terminal's structure or equipment from an ice storm or heat wave. However, it would be impacted by critical infrastructure failures caused by these events. Ice storms and heat waves could lead to power outages at the Terminal. For example, according to the representative from the Ontario Food Terminal, the December 2013 ice storm led to a power outage lasting 72 hours. During this time, the Ontario Food Terminal was not able to sell produce to its buyers ("Ontario Food Terminal - Three Year Business Plan 2014 - 2017," n.d.). The Ontario Food Terminal was able to preserve cold storage for products

in storage due to the winter cold temperatures, but prolonged or more frequent power outages, especially in warmer weather, would pose a more significant risk, as discussed above.

Road closures or traffic congestion would disrupt the ability of warehouse suppliers located in the Ontario Food Terminal to receive or deliver product. Road closures and congestion would also make it difficult for buyers to access the Ontario Food Terminal. The Ontario Food Terminal has one entrance point for trucks (on The Queensway) and one restricted entrance for employee cars to access the parking deck (on Park Lawn Road). All entrances are located in areas at risk for flooding. Fuel shortages or limited access to fuel would also disrupt the ability to receive and deliver product since all product is transported by truck. Road and public transportation disruptions would also affect the ability of employees to get to work.

The Ontario Food Terminal poses the greatest single point of fresh fruit, vegetables and produce distribution vulnerability for the city because of the concentration of wholesalers in a single location and its relative importance to the city's smaller food retailers and restaurants. This market also plays a significant role in fresh produce distribution across Canada. If the Food Terminal was closed or had limited operations for an extended period, the small businesses would have difficulty finding alternative sources of fresh produce and the price of produce would increase for all food businesses.

Food Retail Vulnerabilities

Food retail stores include supermarkets, grocery stores, and convenience stores, and farmers markets. Supermarkets are defined as grocery stores with \$2 million or more in annual revenue ("Supermarket Facts," n.d.).⁴⁵ Convenience stores are small retail stores that sell a limited line of food products that generally include milk, bread, soda and snacks. There are at least 36 farmers markets operating in Toronto throughout the year (Ipsium, 2017). They are excluded from this analysis, however, because they represent a very small share of food consumed in Toronto.

A neighbourhood level analysis for food retail is important because city averages can mask significant disparities in food access.

In most cities, neighbourhoods are not equally served by the same number and type of food retail stores, creating local food availability vulnerabilities. In areas that are underserved by all types of food retailers, individual store closures will have a significant impact on food availability. In areas that have more convenience stores than grocery stores, prolonged store closures are more likely. Our analysis is concerned with the availability of food in general and does not specifically consider the availability of healthy food. This is a limitation of the assessment since Toronto is facing more food swamps (areas where unhealthy food is more readily available than healthy food) than food deserts.⁴⁶ However, since food swamps are often characterized

by a higher share of convenience stores, our methodology indirectly captures this aspect of Toronto's food retail market.

The majority of supermarkets are likely to have short- and long-term business continuity plans in place. Smaller grocery stores may have short-term business continuity plans, but may not be prepared for long-term supply chain disruptions. Smaller grocery stores and convenience stores that are independently owned, and not part of a national or regional chain, may not have adequate (or any) business continuity plans in place and may face longer periods of closure after an extreme weather event because they have limited access to supply chains, fewer resources and often insufficient (or no) insurance (Runyan, 2006). Even if they have insurance, owners of smaller food stores typically need to cover all costs associated with reopening their business while waiting for reimbursement from their insurance companies and assistance from public agencies. For some business owners, these costs can be prohibitive and they simply may not have the resources to reopen. They may also lack sufficient insurance (e.g., flood or business interruption) to cover extensive damages.⁴⁷ Increasing costs of flood insurance, especially for properties located in flood risk areas, may mean fewer food retailers will carry sufficient insurance. In addition, the approval process for public disaster recovery funds often requires a lot of time and the distribution of funds for business owners can be delayed.

The Disaster Financial Assistance Arrangements Program

In Canada, the federal government provides financial assistance through the Disaster Financial Assistance Arrangements (DFAA) program, which is administered by Public Safety Canada. When response and recovery costs exceed what individual provinces or territories could reasonably be expected to bear on their own, the DFAA provides the Government of Canada with a fair and equitable means of assisting provincial and territorial governments. The Disaster Recovery Assistance for Ontarians (DRAO), the DFAA program for Ontario, is designed to help homeowners, tenants, small owner-operated businesses and farms, and nonprofit organizations to restore essential structures, furnishings and property to pre-disaster condition ("Disaster Recovery Assistance for Ontarians," n.d.). DRAO replaced the Ontario Disaster Relief Assistance Program in 2015 to "[make] it easier and faster for municipalities and individuals to get financial assistance following natural disasters" (Ministry of Municipal Affairs, 2015, p. 1). Toronto did not receive assistance from the Ontario Disaster Relief Assistance Program following the July 2013 floods. However, Toronto and 48 other municipalities were approved for assistance from the Program following the December 2013 ice storm. Assistance was approved in February 2015, more than one year after the storm (Shum, 2015).

Since this study is concerned with the impact of weather disruptions on Toronto residents, the analysis of food retail stores is limited to those located in Toronto. Toronto is served by a mix of national and regional supermarkets, independent and chain grocery stores, and convenience stores.⁴⁸ There are 91 supermarkets, 749 grocery stores and 537 convenience stores in Toronto. The analysis excludes general retail stores that sell food (e.g., Walmart).

Three characteristics of food retail at the neighbourhood level matter for resilience to extreme weather events: the number of food retail stores of any kind; the mix of supermarkets, grocery stores and convenience stores; and the location of food retail stores in “at risk” areas.

For this analysis, vulnerable food retail neighbourhoods are those that either have no food retail stores, or those that meet the following criteria: (1) fewer food retail stores per capita than the city average (i.e., the neighbourhood is underserved); (2) the share of supermarkets is lower than the city average (i.e., neighbourhood residents rely more on smaller grocery and convenience stores for daily food needs); and (3) more than 50 percent of all food retail stores are located in areas at risk for flooding.⁴⁹ Eight percent of supermarkets, five percent of grocery stores and six percent of convenience stores in Toronto are located in areas at risk for flooding.

The analysis finds 22 out of 140 neighbourhoods (16 percent) with vulnerable food retail (Table 3).⁵⁰ Seventeen of the neighbourhoods (those highlighted in orange in the table) have no food retail stores. All 22 neighbourhoods are located in three of Toronto’s inner suburbs (and former municipalities): Etobicoke, North York and Scarborough.

Six of the 22 neighbourhoods are designated as Neighbourhood Improvement Areas (NIAs) (those with an asterisk in Table 3).⁵¹ NIAs were selected by Toronto’s City Council based on their Neighbourhood Equity Index, a score developed measuring the overall burden of inequities faced by a neighbourhood (e.g., economic, social, health, physical environment, etc.) (Executive Director, Social Development, Finance and Administration, 2014). Neighbourhoods with the lowest Neighbourhood Equity Index scores were selected as NIAs and receive targeted support to strengthen the social, economic and physical conditions of the neighbourhood, as part of the Toronto Strong Neighbourhoods Strategy 2020 (“Toronto Strong Neighbourhoods Strategy 2020,” 2017).

TABLE 3 Toronto Neighbourhoods with Vulnerable Food Retail

Agincourt South-Malvern West	Ionview*
Bridle Path-Sunnybrook-York Mills	Kingsway South
Cliffcrest	Maple Leaf
Dorset Park	Newtonbrook East
Downsview-Roding-CFB*	Newtonbrook West
Edenbridge-Humber Valley	Pleasant View
Etobicoke West Mall	Princess-Rosethorn
Highland Creek	Rexdale-Kipling
Hillcrest Village	Rustic*
Humber Heights-Westmount	Scarborough Village*
Humbermede*	Thistletown-Beaumont Heights*

Notes: Orange highlighted neighbourhoods denote neighbourhoods with no food retail stores; An asterisk denotes neighbourhoods designated as Neighbourhood Improvement Areas.

The experts interviewed for this study believe that food retail stores could adequately handle a heat wave or ice storm. However, all food retail stores would be impacted by critical infrastructure failure. Road closures would disrupt food deliveries from warehouse suppliers, customer access, and the commute time of employees. Public transportation disruptions might also impact customer access and the commute time of employees, especially for residents who do not own cars. Power outages would impact cold storage, potentially causing some food to perish, and cause safety concerns for consumers. Power outages combined with telecommunications disruptions would impact payment systems and ordering systems, because these systems require both power and either a phone or internet connection to process payments. As a result of these issues, most food retail stores close during power outages.

There is disagreement among the experts interviewed for this study about the prevalence of backup generators in Toronto's supermarkets, grocery stores and convenience stores. There is no regulatory requirement for backup power in retail stores. The Canadian Federation of Independent Grocers, which includes 53 independent food retail companies in Toronto (about 15 to 20 percent of the market share), has surveyed their members on the use of backup generators since the 2013 ice storm. According to a representative from this association, their data shows that almost all of their members in Toronto have backup generators at their stores. However, according to a representative from a major supermarket chain, most of their food retail stores do not have backup power generators and would have to close their businesses after a few hours without power. A representative from yet another major super market chain stated that some of their retail stores have backup power generators, but the generators cannot support refrigeration and therefore even these stores

close during a power outage. To address the situation, the company has started to install generators in their stores—six so far in Toronto.



GLOBAL CITY INSIGHT

The City of Calgary's, *Calgary Eats!: A Food System Assessment Plan for Calgary*, launched in 2012, called for a concerted effort to reduce the prevalence of food deserts, both by improving multimodal accessibility to existing food retail stores, and by attracting additional food retail stores to areas of need (The Calgary Food Committee, Serecon Management Consulting, Inc., & Altus Group, 2012). The City has remained committed to the Plan's primary goals of increasing local food production within Calgary and alleviating household food insecurity, and in 2016 hired a dedicated staff to lead this work. The City recently amended bylaws to allow for indoor food production in commercial districts, and has launched a pilot project to lease city-owned land for urban farms. The City has also completed extensive food desert mapping and developed Neighbourhood Food Plans for 20 priority neighbourhoods to assess the local social context and implement local initiatives focused on increasing food security, including school lunch and breakfast programs, community meals, collective kitchens, community gardens, coordination of good food boxes, advocating for satellite food depots, and cooking programs (CalgaryEATS! Progress Report, 2017).

A recent study in New York City found that food retailers are more likely to purchase insurance to prepare for a disaster instead of making capital investments, such as purchasing a backup generator, because insurance is often the lower cost option (New York City Economic Development Corporation and New York City Mayor's Office of Recovery & Resiliency, 2016). Further, many food retailers rent their space and therefore do not have the incentive (or may not be allowed) to improve their business space with a generator. However, if they do rent their space, some insurance (such as flood) may be carried by the landlord.

Restaurant Vulnerabilities

As is the case in many cities, restaurants are an important source of food for Toronto residents. Across Canada, 61 percent of people eat at a restaurant at least once a week (Holroyd & Elliott, 2010). In Ontario, 33 percent of the average household's food expenditures are spent on food purchased from restaurants.⁵² There are 6,096 restaurants in Toronto and 275 (five percent) are located in areas at risk to flooding.⁵³ In five of the 22 neighbourhoods with vulnerable food retail, 50 percent or more of the neighbourhood restaurants are located in areas at risk to flooding, making them even more vulnerable to food access issues after an extreme weather event: Dorset Park, Downsview-Roding-CFB, Edenbridge-Humber Valley, Ionview, and Kingsway South.

An ice storm or heat wave is expected to create minimal damage for restaurants. However, all food restaurants would be impacted by critical infrastructure failure. Fuel (natural gas) is needed for meal preparation on gas stoves. Road closures would disrupt deliveries from warehouse suppliers, impact employee commute time and could prevent some customers from patronizing the restaurants. Public transportation disruptions could also affect employee commute time and could prevent some customers from patronizing the restaurants, especially for residents who do not own cars. Power outages would affect refrigerators and freezers, potentially causing food to perish. Power outages combined with telecommunications disruptions would impact payment systems and ordering systems, because these systems require both power and either a phone or internet connection to process payments. Experts interviewed for this study believe that most restaurants do not have backup generators.

Restaurants may not have the financial resources or insurance to prepare for an extreme weather event. The average annual revenue for Toronto restaurants is approximately \$300,000.⁵⁴ According to a restaurant industry expert, profit margins for restaurants in Ontario are typically lower than the rest of Canada. Lower profit margins mean that restaurants do not prioritize purchasing backup generators, or flood or business interruption insurance. In addition, for restaurants that rent, it is often the building owner who would be responsible for purchasing and installing backup generators and purchasing flood insurance. In Toronto, 82 percent of restaurants rent their space.⁵⁵



GLOBAL CITY INSIGHT

New York City's Food Retail Expansion to Support Health (FRESH) program, an interagency program led by the New York City Economic Development Corporation, provides zoning and financial incentives to establish or expand grocery stores in underserved communities. As of February 2018, 31 FRESH projects have been approved for zoning or financial incentives. Sixteen stores have completed construction and are now open to the public.⁵⁶ The FRESH program is highlighted in New York City's resilience strategy as an initiative to support community and economic recovery in areas impacted by Superstorm Sandy (The City of New York, 2015).

High-Rises Increase the Distance to Food Retail Stores and Restaurants

Toronto is home to 493,270 high-rise apartment units (defined by the City of Toronto as an apartment in a building that has five or more stories), which accounts for 44 percent of all occupied private dwellings in the city.⁵⁷ Many high-rises in the city are over 30 stories high, and the tallest residential high-rise is 78 stories (Pigg, 2012). In the event of a power outage, inoperable elevators would make it difficult for residents living on higher floors to leave their apartments to access food. While in 2017 the City adopted guidelines for backup power in multi-unit residential buildings, most high-rise dwellings are only required to have backup generators to power elevators and life safety systems (e.g., fire alarm system, standpipe and hose system, or sprinkler system) for up to two hours during a power outage.⁵⁸ The backup generators are only meant to enable residents to evacuate their apartments and emergency services personnel to access the building. Older high-rise buildings can have particular vulnerabilities because many residents living in these buildings are lower-income,

newcomers, or senior populations who are more likely to shelter-in-place rather than seek alternative shelter in the event of a power outage. In addition, the Canadian government has been promoting sheltering-in-place for all residents, meaning all residents need to have access to food, fuel and cash (Hay and Willibald, 2017).

Lack of elevators would require residents to use the stairs to travel to restaurants or to get groceries, effectively increasing the distance they travel and making it more difficult to carry food to their apartments. This is especially true for senior populations. In Toronto, 39 percent of seniors 65 years and over live in high-rise apartments.⁵⁹ High-rise apartments are attractive for seniors in Canada because space is usually confined to a single floor, residents typically are not physically responsible for maintenance and upkeep, and elevators reduce the risk of falls on stairs (Canada Mortgage and Housing Corporation, 2015).



GLOBAL CITY INSIGHT

In Boston, four large supermarkets closed in the inner city in the early 1990s, creating food deserts. In response, the City of Boston, under the leadership of Mayor Menino, focused on expanding the number of grocery stores in the city, especially in underserved neighbourhoods. By the end of the decade, 13 new or renovated supermarkets were open across Boston (Lima, Melnik, Dowd, & Wong, 2013).

According to housing and resilience experts interviewed for this study, many high-rise neighbourhoods in Toronto's inner suburbs have limited food retail stores. A case study on resilience planning in Toronto identified the need for in-depth study on food deserts in high-rise neighbourhoods due to potentially higher vulnerabilities associated with lack of food retail access and reliance on electricity to power elevators (Bristow, 2015). A study on walkability in eight of Toronto's high-rise neighbourhoods (seven of which are located in Toronto's inner suburbs) found that walking was the most common way for residents to access food. The study, which included surveys and focus groups, found that 27 percent of survey respondents walked to food retail stores, while an additional 26 percent used mixed-mode transportation. Mixed-mode shopping trips usually included walking to a store in one direction and returning by public transportation or taxi (Hess & Farrow, 2011).

All 22 neighbourhoods with vulnerable food retail are located in the inner suburbs. Of those 22 neighbourhoods, six have a higher share of high-rise apartment dwellings compared to the city average: Etobicoke West Mall, Humber Heights-Westmount, Ionview, Newtonbrook West, Rustic, and Scarborough Village. All six of these neighbourhoods also have a higher share of population aged 65 years or over compared to the city average.

SECTION 6

FOOD-RELATED PUBLIC HEALTH IMPACTS FROM EXTREME WEATHER EVENTS



After any extreme weather event, food safety can become a critical public health issue. Improper food safety and sanitation practices across the food system, including at processing and distribution sites, food retail stores, restaurants and homes, can lead to food-related illnesses from the consumption of contaminated food. Extreme weather events also exacerbate food insecurity, which is a systemic vulnerability in Toronto. More households may become food insecure due to disaster-related expenses or loss of income. To assess this vulnerability, the analysis looks at both the levels of food insecurity at the neighbourhood level—to determine areas where food access is the most likely to be significantly limited after an extreme weather event—and the vulnerability of food banks because they are the backbone of the food assistance network in Toronto.

Food Safety Vulnerabilities Associated with Home Meal Preparation

Prolonged power outages can lead to bacteria build-up on perishable food stored in refrigerators and freezers, making them unsafe to eat. The most common food-related illnesses from contaminated food may include stomach cramps, nausea, vomiting, diarrhea and fever (“Power failure and food safety,” n.d.). Toronto Public Health publishes food safety guidelines in the event of power outages and floods (“Power failure and food safety,” n.d.; “Power Outages,” n.d.). The guidelines state that food will keep for 24 to 48 hours in a freezer and for 12 to 24 hours in the fridge, provided the doors remain closed. During an extreme heat event, food may spoil faster.

A loss of power also limits the ability of households to prepare hot meals and may lead to improper food handling. For example, some food needs to be heated to a certain temperature before consumption. Further, domestic water supply systems above the sixth or seventh floors in high-rises would probably not be operational during power outages because booster pumps are required for getting water above this level. As a result, food may not be safely cleaned.

After a disaster, Toronto Public Health will release public reminders (e.g., press releases) about food safety guidelines. In addition, inspectors will conduct regular visits to all City emergency reception centres to ensure food safety protocols are in place (Scheuer, 2013).

Food Sanitation Vulnerabilities at Commercial Food Businesses

In Canada, federal, provincial, and municipal governments are responsible for inspecting all food facilities (any facility that touches food) to verify that food sanitation practices are being followed (“Restaurant and Food Service Inspection in Canada,” 2017). The Canadian Food Inspection Agency (CFIA) is responsible for inspecting federally registered establishments, which includes dairy, egg, fish and seafood, fresh fruit and vegetables, honey, and meat and poultry processing farms and processing and distribution facilities that move food products across provincial or national boundaries (“Food,” 2015). The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) inspects dairy farms and processing facilities, animal processing facilities, fruit and vegetable processing facilities, egg processing facilities and livestock processing facilities. The Ontario Ministry of Natural Resources is responsible for inspecting fish and fish facilities (“Starting a Food Business,” n.d.). Toronto Public Health is responsible for inspecting eating and drinking establishments (establishments where food items are intended for human consumption are made for sale, offered for sale, stored, or sold) located in

Toronto ("Regulation and Licensing Requirements," 2015). All food facilities are regularly inspected, but the frequency depends on the type of facility and its food sanitation risk level, with visits ranging from one to three times per year (Thompson, 2009).

If an extreme weather event causes any food facility, including warehouse suppliers, food retail stores or restaurants to voluntarily close, they do not need to pass a food safety inspection to reopen. Toronto Public Health inspectors will conduct spot checks of food facilities to ensure food is safe for sale. However, with over 17,000 food facilities under its jurisdiction and only 80 inspectors on staff, it would be extremely difficult for Toronto Public Health inspectors to inspect a large number of facilities impacted by an extreme weather event. Toronto Public Health inspectors will prioritize inspections in areas hardest hit by an extreme weather event and facilities most vulnerable to food safety issues, such as hospitals, daycare facilities and full-service restaurants. In a widespread event, Toronto Public Health would seek assistance from inspectors in other departments, from surrounding health units, and from Ontario Ministry of Agriculture, Food and Rural Affairs.

Poverty-Based Food Insecurity

Poverty-based food insecurity arises when households cannot afford to purchase adequate food. It is a significant and systemic problem in Toronto and across Canada. In the Toronto region, one in eight households (13 percent) are food insecure, which is roughly the same as the national average (Tarasuk, Mitchell, & Dachner, 2017).⁶⁰

In Toronto, 22 percent of the population is classified as low income (earning less than 50 percent of the median adjusted after-tax income of households) and 10 percent of the population receives social assistance.⁶¹ Households on social assistance are typically the most likely to be food insecure. In Ontario, 65 percent of households that rely on social assistance are food insecure (Tarasuk et al., 2017).

A network of charitable food assistance organizations, which include food banks, soup kitchens and other hunger assistance programs, directly tackle food security in Toronto by helping individuals and households access more food than they can afford to purchase.⁶² Most of the charitable food agencies that provide groceries to individuals or households are part of the food bank network. However, only a small share of food insecure households seek help from food assistance agencies. One study finds that 75 percent of 371 low-income Toronto families had experienced some food insecurity, but only 23 percent had received food from community food programs (Loopstra & Tarasuk, 2012).⁶³

Food Banks Canada

Food Banks Canada is the national charitable organization providing support to Provincial Food Bank Associations and their affiliated members across Canada. Food Banks Canada acquires food from businesses and funds to share with its network of Provincial Food Bank Associations and affiliated food banks across Canada (Food Banks Canada, 2017). The Ontario Association of Food Banks (OAFB) supports its members (food banks and other food assistance agencies) in Ontario by helping them secure food donations and funds. Approximately 84 percent of Toronto's food banks are members or affiliates of OAFB.⁶⁴

Although food assistance organizations were created to help people in need during times of severe financial constraint, they are supporting those in need for longer periods than intended. Therefore, while they are not part of Toronto's emergency food distribution plans (see p. 68), they will play a critical role in the recovery process.

Canadian Public Food Assistance

In Canada, there are no separate food subsidy programs, but provincial social assistance programs provide financial assistance to low-income households.⁶⁵ In Ontario, there are two social assistance programs: Ontario Works and the Ontario Disability Support Program. Ontario Works provides temporary financial support and employment assistance for individuals with temporary financial need. The Ontario Disability Support Program provides people with disabilities with financial support and employment assistance. A recent study found that individuals and households on Ontario Works or the Ontario Disability Support Program do not receive sufficient assistance to purchase nutritious and healthy food (Toronto Public Health, 2016).

In the aftermath of an extreme weather event, replacing spoiled food could be prohibitive for low-income residents and residents on social assistance or with fixed incomes. These vulnerable populations may need additional public assistance to replace food. Within the Ontario Works Act there is a provision for emergency assistance for social assistance recipients that need essential household items replaced as a result of a fire or other catastrophic occurrences (Ontario Ministry of Community and Social Services, 2016).

The City of Toronto established a Shelter Fund reserve in 1999 to provide additional financial assistance to low-income families with children receiving social assistance (Toronto City Council, 2000). This fund is utilized to address eligible needs that cannot currently be met through other social assistance programs. For example, according to a representative from Toronto Employment and Social Services, the City of Toronto provided additional support to replace spoiled food to social assistance recipients who experienced a loss of food due to prolonged power outages in Toronto after the December 2013 ice storm. In addition, Ontario residents in a crisis or emergency who do not receive social assistance can be assessed for emergency assistance through Ontario Works to help cover the costs of basic needs including food, clothing and shelter.

Public assistance can also be provided on an ad hoc basis after some extreme weather events. For example, after the December 2013 ice storm, the Province of Ontario provided residents that demonstrated need gift cards of up to \$100 per family to cover food replacement costs. The gift card program relied on corporate donations, primarily from Loblaw, the Retail Council of Canada, Shoppers Drug Mart, Metro, Sobeys, and Coppa's Fresh Market, and \$100,000 in matching funds from the Province of Ontario ("Ontario Helps People Replace Food Lost During Ice Storm," 2013). Toronto Employment and Social Services was responsible for administering the gift cards in Toronto. In total, more than \$500,000 worth of gift cards were distributed to more than 5,000 families ("Toronto ice storm: Food replacement gift cards run out again," 2014). This gift card program was a one-time program.

Neighbourhood Vulnerability Analysis

Neighbourhoods with both food retail and food insecurity vulnerabilities are at greatest risk of limited food access in the aftermath of an extreme weather event. Therefore, this analysis examines food insecurity for the 22 vulnerable food retail neighbourhoods identified above (Table 3, p. 56). To analyze food insecurity in these neighbourhoods, household income and social assistance rates were used as proxies because food insecurity data at that geography is not available. While these are not perfect proxies for food insecurity (e.g., many households that are food insecure may not receive social assistance), this is the most reliable data available that can be used to gain some insight into neighbourhood level food insecurity.

Identifying neighbourhoods where the share of population classified as low income is greater than the city average (22 percent) was the first step in the vulnerability analysis. This analysis finds 11 of the 22 vulnerable food retail neighbourhoods as having a greater share of low income residents than the city average.⁶⁶ Within this set of 11 neighbourhoods, areas that have higher social assistance rates than the city average (10 percent) were then identified. This final set of seven neighbourhoods (Table 4) are considered to be at greatest risk for limited food access after an extreme weather event because they have higher rates of food vulnerability and food insecurity.⁶⁷ All seven neighbourhoods are in the inner suburbs, an area of Toronto that has experienced increased population growth, declining average income and increased demand on food banks over the past decade.⁶⁸ Of this final list of seven neighbourhoods, three have a higher share of high-rise apartment dwellings compared to the city average: Ionview, Rustic, and Scarborough Village. Three of the seven neighbourhoods also have a higher share of population aged 65 years or over compared to the city average: Downsview-Roding-CFB, Rustic, and Thistletown-Beaumont Heights. Six of the seven neighbourhoods (all except for Dorset Park) are designated Neighbourhood Improvement Areas (NIAs) (as denoted by asterisks in Table 4).

The final list of seven neighbourhoods represent 126,266 people (5 percent of Toronto’s population). Of these people, 26 percent are classified as low income, 16 percent receive social assistance, and 15 percent are aged 65 years or over. Within these neighbourhoods, 40 percent of dwellings are high-rise apartments.

In the aftermath of an extreme weather event, food will also play an important role in creating or maintaining social cohesion (Clay, Papas, Gill, & Abramson, 2017). Social interaction is especially important in times of crises. This is only beginning to be studied.

TABLE 4 Toronto Neighbourhoods Facing Greatest Risk for Limited Food Access after Extreme Weather Events

Dorset Park
Downsview-Roding-CFB*
Humbermede*
Ionview*
Rustic*
Scarborough Village*
Thistletown-Beaumont Heights*

Notes: Asterisk denotes neighbourhoods designated as Neighbourhood Improvement Areas.



In 2005, following a new provincial mandate emphasizing food security as a critical component of public health, Vancouver Coastal Health (VCH) (one of five regional health authorities created by the Ministry of Health in British Columbia), formed the Community Food Action Initiative to identify gaps in the regional food system and support interventions to address food insecurity. Recognizing geographic disparities in food security and the importance of addressing the unique needs of diverse communities within Vancouver, in 2006 VCH began supporting a number of community-based, grassroots organizations implementing interventions to address food system issues at a neighbourhood-level. In 2009, in an effort to facilitate the sharing of best practices and maximize the impact of individual, neighbourhood-based efforts, VCH convened community-based organizations working on food systems in Vancouver as part of a workshop to better understand and operationalize a network approach to food organizing. As a result of this convening, the Vancouver Neighbourhood Food Networks (NFNs) was formalized as a coalition of grassroots organizations and community groups working collaboratively to increase local food security.

In 2013, the City of Vancouver adopted its own food strategy and in 2017, an updated action plan, which emphasized food system gaps and vulnerabilities due to socio-economic and demographic conditions (City of Vancouver, 2013b). Vancouver's strategy includes an action to stabilize funding for NFNs across the city. Since 2010, the network has grown organically from five to 14 NFNs. While the primary focus is on healthy and inclusive local food systems, the NFNs also foster greater neighbourhood food system knowledge and skills, which should strengthen resilience to extreme weather events or natural disasters. According to a representative of the City, the NFNs allow stakeholders to develop interventions in response to the unique needs of a neighbourhood's population (e.g., refugees, homeless, seniors, etc.). In 2011, almost 20,000 people were engaged in or directly benefited from the work of six NFNs (City of Vancouver, 2013b). VCH also continues to fund the NFNs and provide additional support through training and capacity-building resources.

Food Bank Vulnerability Analysis

For this high-level risk assessment, the vulnerability of food banks in Toronto overall was analyzed rather than the vulnerability of food assistance agencies at the neighbourhood level. To assess their vulnerability, the location of food banks in flood risk areas, their ability to withstand ice storms and heat waves, and their business continuity plans were analyzed. The analysis also assessed their ability to meet current demand and their plans to meet increased demand over an extended period. Previous studies have shown that in the aftermath of an extreme weather event, demand for food from food assistance organizations remains elevated for a prolonged period (Zeuli & Nijhuis, 2017b). If these organizations do not have the capacity or resources to meet current demand, obviously they will be less likely to meet increased demand, especially over an extended period.

The analysis considered the two largest food banks in Toronto, Daily Bread and North York Harvest Food Bank, which both support agencies serving households in Toronto's inner suburbs. According to a representative

from the Ontario Association of Food Banks, approximately 60 to 70 percent of food assistance organizations in Ontario are part of its network, which includes Daily Bread and North York Harvest Food Bank. Daily Bread Food Bank,

the largest food bank in Canada, provides food and support to almost 200 food banks, meal programs and other food assistance agencies across Toronto. In addition, in 2015, Daily Bread Food Bank provided food for 716,000 hampers and prepared more than 3,000 meals per week in its kitchen that were sent out to shelters, hostels and neighbourhood meal programs (“About Us,” n.d.-b).

North York Harvest Food Bank, the primary food bank for the northern part of Toronto, provides food to a network of 47 community agencies (including food banks and other food assistance organizations) operating 77 meal programs (“Food collection and distribution,” n.d.). In 2015, it also provided food for 180,000 food hampers (“What We’re All About,” n.d.). Both food banks report an increase in demand at their member agencies located in Toronto’s inner suburbs. Client visits to both Daily Bread Food Bank and North York Harvest Food Bank member agencies increased 68 percent between 2008 and 2017 in the inner suburbs, while client visits decreased 14 percent in the city core (Daily Bread Food Bank, 2017).

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Nine percent of Toronto’s 96 food banks are operating in facilities located in flood risk areas.⁶⁹ According to a representative from Food Banks Canada, most food banks have flood insurance because they rent their facilities and their landlords would carry the policy, but very few would have business continuity plans.

Daily Bread Food Bank is not located in an area at risk for flooding and, according to a representative, the food bank could adequately handle a heat wave or ice storm. However, the food bank does not have a business continuity plan in place. North York Harvest Food Bank is not located in an area at risk for flooding either, and according to a representative, the food bank could adequately handle a heat wave or ice storm. In

addition, the food bank does have a business continuity plan in place. However, in spite of business continuity plans, food banks will only be able to distribute food if they continue to receive donated product.

All of Toronto’s food banks would be impacted by critical infrastructure failures. Road closures or traffic congestion would disrupt their ability to receive and deliver donated products, thereby creating some food supply disruptions to smaller food banks and other food assistance agencies. Fuel shortages or limited access to fuel would also disrupt the ability to deliver donated products. Road or public transportation disruptions would affect the ability of employees, volunteers and member agencies to get to the food banks.

Power outages and telecommunication disruptions would also create supply disruptions, as food in cold storage could perish. This would be a bigger issue during winter ice storms, when food banks receive a large supply of donated products during the holiday period. In the event of a power outage, Daily Bread Food Bank

All of Toronto’s food banks would be impacted by critical infrastructure failures.



Following the 2013 Southern Alberta flood, the Calgary Chamber of Voluntary Organizations (CCVO), which includes several food banks, commissioned a series of surveys and reports that examined the short- and long-term impacts of the flood on the nonprofit sector. A dearth of disaster preparedness and business continuity plans was identified as a critical gap for many nonprofits (Calgary Chamber of Voluntary Organizations, 2013). In 2015, CCVO, CEMA, the City of Calgary's Community and Neighbourhood Services and several other community partners established the Emergency Preparedness Initiative of Calgary (EPIC) Project to help the nonprofit sector identify gaps in emergency responses, support business continuity planning and seek opportunities for collaboration and coordination between the nonprofit and public sectors. EPIC has identified flooding, blackouts, and severe weather among the risks facing nonprofits in Calgary (Emergency Preparedness Initiative of Calgary, 2015).⁷⁰

would be able to call in a company with portable generators to power its facilities, including cold storage, and they estimate that power could be restored in two hours. North York Harvest Food Bank had an onsite backup generator in its previous location, but it now leases space that does not have a backup generator on site. The food bank would not be able to sustain refrigeration for more than 24 hours after a power loss.

Perhaps the greater risk of an extreme weather event is that Toronto's food banks might not be able to meet a prolonged increase in demand for food assistance. A recent study found that most food assistance agencies in Toronto are not fully meeting their clients' food needs. Specifically, 78 percent of agencies reported that their clients needed more food than the agency was able to provide, 62 percent of agencies sometimes altered the variety of food provided due to a lack of food, and 53 percent of agencies sometimes cut the size of food hampers provided because of insufficient food (Tarasuk, Dachner, et al., 2014). And again, as noted above, not all food insecure households are going to food assistance agencies, which means the real need is even greater. Multiple food bank representatives and food policy experts predict that in the event of an extreme weather event there would be an increase in demand for services from food banks and other food assistance agencies. The households who currently use food banks and other food assistance agencies would likely have an even greater need for assistance. As one expert noted, "The gap between what they get and what they need will only widen." Further, more households would become food insecure and people who typically do not access these services may be pushed into either needing support from a food assistance program or more people may simply access them because they will be easier to access during recovery periods (i.e., the agencies will provide more outreach into communities).

Food banks would lack resources and staff to meet the sustained increased demand. In the aftermath of an extreme weather event in Toronto, OAFB and local food banks would solicit donations to purchase and distribute food to food assistance agencies. In addition, the Salvation Army and Canadian Red Cross would solicit donations to provide emergency relief to individuals, including hot meals and food vouchers, through their emergency disaster assistance programs. These organizations are reliant on donations in the aftermath of extreme weather events and no federal or provincial funds or reserves are allocated for this purpose. Food Banks Canada would have a limited role, but could source additional food and help manage logistics. Most

food banks and other food assistance agencies are predominantly staffed by volunteers because they are relatively small (Tarasuk, Dachner, et al., 2014).

Daily Bread and North York Harvest are not able to meet current demand and would have to go to their donor base to solicit additional donations in the aftermath of an extreme weather event. Neither have formal plans in place to meet expected increases in demand, but both have an informal strategy in place to solicit cash and food donations from public donors and suppliers who donate or sell food to the food bank. The representatives we spoke to said “donor fatigue” would be a concern if increased demand was sustained for an extended period of time.

It is important to note that this analysis of food bank vulnerabilities underestimates the food insecurity risks because there are many food assistance organizations that operate independently, outside of the food bank system. These tend to be small, charity organizations that typically serve specific communities (e.g., a certain faith or immigrant population). They may be the most vulnerable food assistance organizations and they may be serving the most vulnerable populations.

Toronto’s Emergency Food Response Plans

Various public agencies in Toronto have established emergency response protocols to manage emergency food provisions in the immediate aftermath of an extreme weather event. The City of Toronto’s Office of Emergency Management (OEM) is responsible for coordinating the response to an emergency in Toronto. In the event that an emergency exceeds the City’s ability and resources to deal with the emergency, the Provincial Office of the Fire Marshall and Emergency Management would be engaged for support. Toronto’s Office of Emergency Management operates the City’s Emergency Operations Centre (EOC), a multi-agency incident facility. The EOC has an Emergency Social Services Branch, which draws staff from the Office of Emergency Management, City Divisions as well as nongovernmental organizations, including the Canadian Red Cross and the Salvation Army (City of Toronto Office of Emergency Management, 2016b). Local food assistance agencies would likely be drawn upon to help distribute emergency food provisions.

For large scale incidents (e.g. incidents impacting more than a small number of households or incidents expected to last for a longer period of time) such as extreme weather events, the Office of Emergency Management makes arrangements for the provision of Emergency Social Services such as food and accommodation to eligible residents. Eligible residents, such as evacuees, may receive emergency food provisions for up to 14 days after the emergency incident. Households that meet low-income eligibility criteria may be eligible for support beyond 14 days.

The Office of Emergency Management also provides personal preparedness guidelines to help residents prepare for an extreme weather event. The guidelines recommend that residents have enough non-perishable food and water to last for 72 hours in the event of an extreme weather event (City of Toronto Office of Emergency Management, n.d.).

Multiple non-governmental organizations (NGOs) would also provide emergency response and recovery support after an extreme weather event in Toronto. The Salvation Army and the Canadian Red Cross are the primary organizations that would provide emergency food assistance. According to an emergency response expert, typically the Salvation Army will provide food or prepared meals, while the Canadian Red Cross provides vouchers to purchase food. The Salvation Army's Emergency Disaster Services program can activate within a few hours to provide food and hydration services through mobile food kitchens ("Emergency Disaster Services," 2017). The Canadian Red Cross provides emergency food through various means, including vouchers, meals at a shelter or assisting in referrals to other agencies ("Red Cross Services - Canadian Red Cross," n.d.).

In 2016, the NGO Alliance of Ontario was established to provide coordinated emergency response by its members in Ontario. The NGO Alliance consists of eight member NGOs, including The Salvation Army, the Canadian Red Cross, Samaritan's Purse and others. The NGO Alliance asks each NGO to map out their preparedness, response, recovery and rebuilding efforts, in coordination with provincial and municipal governments. The NGO Alliance identifies the roles of each NGO in the emergency management continuum. The Salvation Army and Canadian Red Cross are identified by the NGO Alliance as the lead organizations for emergency food assistance. The Salvation Army is working with the City of Toronto to formalize this agreement.



GLOBAL CITY INSIGHT

In the days following Superstorm Sandy, the City of New York formed a multi-agency task force with state and federal governments and the nonprofit sector to develop and implement the largest emergency feeding operation in New York City's history. Through in-place and emergency contracts, the City of New York and its multi-agency partners were able to distribute over 2.1 million shelf-stable meals, 700,000 prepared meals and approximately 270,000 meals from food trucks from October 2012 through January 31, 2013 (The City of New York, 2013a). Following Superstorm Sandy, New York City Emergency Management developed a Food and Water Distribution Task Force and Action Plan to formalize the City's food and water distribution response to natural disasters in the future. The plan identifies lead agencies and coordinating partners, emergency food and water distribution points in high risk areas, transportation access plans that account for road and bridge closures, and a protocol for requesting public assistance benefits and waivers for use after future events that disrupt food and public assistance benefit access (The City of New York, 2013b).

SECTION 7

KEY VULNERABILITIES AND ACTIONS FOR CREATING A MORE RESILIENT FOOD SYSTEM IN TORONTO



This analysis provides insights into critical vulnerabilities in Toronto's food system to extreme weather events. As such, it makes an important contribution to the city's climate change planning and points to a set of strategies and actions that city leaders can take to strengthen the resilience of Toronto's food system to extreme weather events and ensure equitable food access across the city after such a disaster. Key findings are summarized below.

Toronto is at an advantage over many cities because the City and Province have committed to addressing climate change resilience (see Appendix 3 for an overview of current resilience and food planning efforts and organizations) and already have begun to recognize food systems as a priority in resilience planning (e.g., in Ontario's 2015 Climate Change Strategy, Toronto's 2008 Food Strategy and Toronto City Councils' *Resilient City* reports). Toronto is at the vanguard of food system resilience planning, as this study attests to, and is a signatory city of the Milan Urban Food Policy Pact and a member of C40's Food Systems Network. Toronto was also selected to join 100 Resilient Cities in 2016. Toronto has a long history of food policy action—the Toronto Food Policy council has been in existence for 27 years.

Toronto also has an emergency food plan in place to cover the distribution of food and water in the immediate aftermath of any disaster, although food banks and other emergency food providers might be overwhelmed in a large-scale event and coordination could be improved. Toronto also has robust interventions (and resources) to address public food safety issues in the aftermath of any disaster. Given estimates that less than 10 percent of all food consumed by Toronto residents is produced in the region, the impact of local extreme weather events on regional food production would be minimal.

However, the analysis of Toronto's food system identified the following six critical vulnerabilities that need to be addressed to strengthen its resilience to extreme weather events and create *equitable* resilience:

1. **Flooding Risk:** The impact of extreme weather events considered for this report—significant rain and flooding, an extended heat wave, and a significant winter ice storm—was assumed to be more widespread and last longer than any have in Toronto's recent history. The impact of an extreme rain event is the least well understood compared to extreme heat and an ice storm, because "urban flooding" has not yet been fully modeled for the city, and likely poses the greatest risk for the food system of the three weather events studied.

- Six percent of dairy processing facilities and ten percent of commercial bakeries in the Greater Golden Horseshoe are located in areas at risk for flooding. In addition, most dairy processing facilities and bakeries are small and are unlikely have sufficient insurance or a business continuity plan in place.
- One of the five (20 percent) primary distributors for supermarkets, 168 of the 1,489 local distributors (11 percent) located in Toronto and the GTA, and the Ontario Food Terminal are located in areas at risk for flooding. These suppliers distribute approximately 15 percent of all food and more than 35 to 40 percent of all produce in Toronto. The Ontario Food Terminal carries flood insurance and business interruption insurance and their tenants carry business interruption insurance. In general, local distributors are less likely to have business continuity plans in place, generally operate in only one location, and are less likely to invest in making their facilities more resilient to disaster. This

creates a greater likelihood of supply disruptions to the food retailers they serve—mostly smaller grocery and convenience stores, which are important access points for food in the aftermath of an extreme weather event.

- Eight percent of supermarkets, five percent of grocery stores and six percent of convenience stores in Toronto are located in areas at risk for flooding. The smaller stores are less likely to have insurance or business continuity plans in place, meaning they will stay closed for longer periods or even permanently.
- While relatively few of Toronto’s restaurants (five percent) are located in areas at risk for flooding, in five of the 22 neighbourhoods with vulnerable food retail, about half of restaurants are located in areas at risk for flooding, further exacerbating limited food supplies in these areas. Further, many restaurants may not have insurance or business continuity plans in place, meaning they will stay closed for longer periods or permanently.



GLOBAL CITY INSIGHT

The London Resilience Partnership, first established in 2002, is a public-private coalition of over 170 organizations focused on multiagency response to emergencies, which, among other responsibilities, maintains the London Risk Register. The Risk Register includes a risk description, a risk rating based on likelihood and impact, and a description of controls in place to manage the risk. The register helps define the partnership’s priorities and helps communities and businesses develop their own emergency and business continuity arrangements (London Resilience Partnership, 2017). London Resilience also offers extensive resources to private businesses for preparing continuity plans and reducing disruption. This includes citywide system alerts, a business continuity self-assessment tool, a planning template, and a guidance document on preparing a plan. A nonprofit partner, London First, has also developed a Community Resilience for Business Districts guide that provides resources for developing local community resilience (London First, n.d.).



GLOBAL CITY INSIGHT

The North Shore Emergency Management Office in Vancouver worked with public and academic partners to develop the Business and Employer Emergency Preparedness (BEEP) Guide. Related resources include both an overall resource guide and planning tools. The BEEP Guide, published in 2017, was adapted for Vancouver from content developed by the North Shore Emergency Management Office in conjunction with the University of British Columbia’s School of Community and Regional Planning. The guide promotes a proactive approach among businesses, and covers a range of topics, including utility disruption. The guide and tools were developed in response to a city review of local business preparedness, including one conducted following a 48-hour power failure in the summer of 2008 (“Prepare your business for disasters and emergencies,” 2017). The guide and tools, which are available online, align with the Province of British Columbia’s small business emergency preparedness resources, PreparedBC: Guide For Small Businesses (Province of British Columbia, n.d.).

2. **Electricity, Road Network and Fuel Infrastructure:** The functioning of the food system depends on critical infrastructure: public transportation, the road network, the electrical power system, telecommunications and fuel supply transportation, storage and distribution infrastructure. The impact of extreme weather events on critical infrastructure poses the greatest risk to Toronto's food system, with electricity, the road network, and fuel posing the greatest potential vulnerabilities.

- Electrical power is critical for all components of Toronto's food system, since it affects everything from food production to home meal preparation. All three extreme weather events would cause some degree of power outages, but more research is needed to accurately predict the locations of the outages and which food businesses would be impacted. A Toronto Hydro study shows heat waves and ice storms pose the greatest risk and could cause localized power outages that last for an extended period of time (up to a week).
- There are sufficient route redundancies for food trucks on Toronto's expressways if one main expressway is closed, and the major roadways have historically experienced limited closures after extreme weather events. However, flooding and icy conditions on secondary roads, and the traffic congestion these weather events create on expressways, create the greatest risks for localized food supply and food access problems. Securing sufficient truck drivers after an extreme weather event is another potential vulnerability given that drivers are in high demand during normal conditions.
- Fuel (including gasoline, diesel, propane and natural gas) is used for food transportation, public transportation, heating of buildings, commercial and home food preparation and emergency power generation. While the City of Toronto considers the liquid fuel sector as one of the top ten critical systems that need to keep operating even during a natural disaster or extreme weather event, this sector has not been involved in any climate change risk assessments in Toronto to date. Smaller companies (for example, food retailers), may not receive priority fuel service after an extreme weather event, and may experience fuel shortages. As a result, vulnerable food retail neighbourhoods may have even less access to food as stores with backup generators would still close without fuel to power the generators.



GLOBAL CITY INSIGHT

The City of Ottawa reviews and revises an annual fuel management guide as part of its Emergency Management Plan to ensure the sustainability of fuel supply. In addition, the City of Ottawa maintains a number of small, mobile generators, which can be deployed quickly during emergencies, such as extreme flooding events (Feltmate & Moudrak, 2015). Critical public infrastructure in City-owned facilities, including emergency services buildings and community centres used as emergency facilities, are also equipped with in-situ generators.



GLOBAL CITY INSIGHT

Vancouver's earthquake preparedness strategy includes a specific focus on risk reduction for its energy system. The strategy includes the development of Neighbourhood Energy Utilities (NEUs), which are neighbourhood-scaled renewable energy systems that supply heat, water, and sometimes cooling to multiple buildings ("Neighbourhood Energy Strategy," n.d.). Vancouver's three NEUs, the first of which was created in the 1960s, are operated by public utility companies. While the primary incentive for developing the NEUs was cost efficiency, they also strengthen resilience by distributing energy utilities. The earthquake preparedness strategy also includes an assessment of gasoline and fuel requirements across Vancouver (City of Vancouver, 2013a). In addition, the City has created 25 disaster support hubs by placing shipping containers equipped with basic supplies and technology for emergency social service response in communities across the city.

3. **The Ontario Food Terminal:** The Ontario Food Terminal represents a significant vulnerability for the supply of fresh produce in Toronto because of its market dominance, especially for smaller, independent food retail stores. The Terminal's location in a flood risk zone and its power supply configuration makes it susceptible to power outages and it does not have sufficient backup power generators.
 - Between 35 to 40 percent of produce sold in Toronto is estimated to come from the Ontario Food Terminal.
 - The Terminal does not have sufficient resources to invest in permanent backup power generators, which would be costly for their large structures. The Food Terminal Board, which is a provincial organization, would need to raise additional capital for this investment.



GLOBAL CITY INSIGHT

New York City has prioritized investments in bolstering the resilience of the Hunts Point Food Distribution Center, the city's fresh food distribution centre. Resilience investments in the Hunts Point Food Distribution Center are guided by Hunts Point Lifelines, a design proposal for the Distribution Center and surrounding neighbourhood that was selected as one of the winners of Rebuild by Design, a 2013 competition launched by the U.S. Department of Housing and Urban Development to improve coastal area resilience in regions impacted by Superstorm Sandy. The City allocated \$45 million to advance concepts in the Hunts Point Lifelines proposal and implement a resiliency pilot project. In 2015, the New York City Economic Development Corporation and the Office of Recovery and Resiliency convened the Hunts Point Advisory Working Group to develop resilience priorities for the Hunts Point area. As a result of this effort, the City has prioritized flood risk reduction and resilient energy. The first pilot project will be to build a resilient energy grid at the Distribution Center ("Hunts Point Resiliency," n.d.; New York City Economic Development Corporation, 2015). The City is in the process of developing a conceptual design of the preferred pilot project (New York City Mayor's Office of Recovery & Resiliency & New York City Economic Development Corporation, 2017).

4. **Food Access in Inner Suburban Neighbourhoods:** Food access in three of Toronto's inner suburbs will be disproportionately impacted by extreme weather events because of a lack of large food retail stores, higher rates of food insecurity and their older residential high-rise communities.
- Seven neighbourhoods are the most vulnerable: Dorset Park, Downsview-Roding-CFB, Humbermede, Ionview, Rustic, Scarborough Village and Thistletown-Beaumont Heights. All except for Dorset Park are designated as Neighbourhood Improvement Areas and three have a higher share of high-rise apartment dwellings compared to the city average: Ionview, Rustic, and Scarborough Village.
 - It is unlikely that the smaller food businesses (retail stores and restaurants) and food assistance organizations operating in these neighbourhoods have business continuity plans in place. They are more likely to purchase insurance to prepare for a disaster instead of making capital investments, such as purchasing a backup generator, because insurance is often the lower cost option and many rent their space and may not be allowed to install a generator. However, many small businesses may also lack adequate insurance to cover costs associated with an extreme weather event.
 - Toronto's older residential high-rises create a unique food system vulnerability in the city. Extended power outages could create critical food access and food preparation issues for people who live in these buildings, especially people with limited mobility such as older adults, who would have to walk down numerous flights of stairs in buildings that lack backup power systems. In Toronto, 39 percent of seniors 65 years and over live in high-rise apartments. Many high-rise communities tend to have poor access to food retail and particularly, healthy food retail, within walking distance.



GLOBAL CITY INSIGHT

New York City has developed multiple resources to help businesses better prepare for disasters. New York City Emergency Management and New York City Small Business Services developed Ready New York For Business, a public education campaign to better prepare businesses for emergencies caused by natural and man-made disasters (New York City Emergency Management, New York City Small Business Services, 2017). Additional resources for businesses are available through New York City Emergency Management's website and the City's Ready NYC app, a mobile application that allows users to make an emergency plan ("Ready New York - Guides & Resources," n.d.). In 2013, New York City Emergency Management published emergency preparedness guidelines specifically for food retailers to help them prepare and recover after a flood or power outage and ensure food safety (The City of New York, State of New York, 2013). In addition, New York City Emergency Management partners with the Food Industry Alliance of New York State, a food retail trade association for New York State representing 850 supermarket chains, independent grocery stores, convenience stores, wholesalers and manufacturers, through its Public/Private Initiatives Unit to better prepare food retailers for emergencies and improve emergency response (Zeuli & Nijhuis, 2017b).

5. **Food Insecurity and the Food Assistance Network:** Food insecurity is a systemic vulnerability in Toronto that would be exacerbated by extreme weather events. Although food banks and other food assistance organizations were created to help people in need during times of severe financial constraint, they are supporting those in need for longer periods than intended. Therefore, while they are not part of Toronto's emergency food distribution plans, their limited capacity to meet a prolonged increase in demand for food assistance as more households become food insecure due to disaster-related expenses or loss of income is a critical component of equitable food resilience.

- In the Toronto region, 13 percent of households are food insecure. Most food assistance agencies in Toronto are not able to provide enough food for their clients under normal conditions and they serve a small share of food insecure households.
- In addition, many small food assistance organizations (approximately 36 percent of the total) that serve specific populations operate independently, outside of the food bank system. They may be the most vulnerable food assistance organizations and they may be serving the most vulnerable populations.

Ontario and Toronto recognize and have started to address food insecurity, although more needs to be done:

- In 2017, the Ontario Poverty Reduction Strategy Office began to develop Ontario's First Food Security Strategy. The goal of the strategy is to ensure that all Ontarians have sufficient access to affordable and nutritious food.
- The City of Toronto has actively sought to address food insecurity over the last two decades. The Food and Hunger Action Committee was approved in 1999 by Toronto City Council and the Toronto Food Charter was adopted by Toronto City Council in 2001. The Food and Hunger Action Committee, which is now defunct, developed the Food and Hunger Action Plan, a series of three reports that recommended opportunities to promote food security for all residents (Toronto City Council, 2001b; Toronto City Council, 2001a). The Toronto Food Charter, which was driven by the Food and Hunger Action Plan, outlines strategies for Toronto City Council to promote food security (City of Toronto, 2011). The City of Toronto released *TO Prosperity: Toronto Poverty Reduction Strategy* in 2015. The strategy identifies food access as one of its six focus areas, and identifies short-term recommendations to eliminate hunger and increase access to affordable, nutritious and culturally appropriate food from 2015 to 2018 (City of Toronto, 2015).



GLOBAL CITY INSIGHT

If what gets measured matters ("Food Metrics Report," n.d.), Toronto should consider annually measuring progress on its food initiatives. Since 2012, New York City's Office of the Director of Food Policy publishes annual Food Metrics Reports to track the City's progress in addressing a wide variety of food system issues, including food insecurity, healthy food access, and supporting a more environmentally sustainable and just food system ("Food Metrics Report," n.d.).

6. **Coordination, Collaboration, Planning and Preparedness:** Various municipal and provincial government agencies will need to be actively engaged in helping the food system recover quickly after an extreme weather event. In Toronto, the food system stakeholders that informed this report worried about inadequate and uncoordinated preparedness planning among and within government agencies, a lack of participation by private sector representatives in the planning process, a lack of clear communication about road closures and power outages in the aftermath of an extreme weather event and food safety inspection delays. During an extreme weather event, businesses may be confused about who to contact for relevant and timely information and, in turn, government agencies may not know the best way to effectively share information to all food businesses. Further, the numerous reports and working groups focused on resilience planning in Toronto can create additional confusion if not coordinated.
- Toronto Public Health leads the Toronto Food Strategy, which promotes a healthy sustainable food system and which incubates a number of food policy and project initiatives to address food access. The Toronto Food Strategy team works alongside the Toronto Food Policy Council, and partners with City agencies and divisions, institutions, community agencies and the private sector to facilitate effective food policies and initiatives. This effort could be leveraged to address some of the additional research and planning recommended in the report's findings.
 - Established in 2013 by the City, the Resilient City Working Group is a collaborative working group consisting of City of Toronto divisions, agencies, corporations and external stakeholders to provide expert knowledge and technical support to facilitate the implementation of resilience actions.
 - Toronto joined 100 Resilient Cities in 2016 and has a dedicated Chief Resilience Officer that reports to the City Manager. The CRO is well-placed to encourage collaboration and act as a coordination point for the City. The City's resilience strategy is expected to be released in 2018.
 - Food processing and retail trade associations, including the Canadian Federation of Independent Grocers, Food and Beverage Ontario, and Retail Council of Canada, should be important partners in planning, communicating and coordinating responses to extreme weather events and currently they are not playing this role. Such partnerships also help marshal the business community to assist with disaster recovery (e.g., providing donated food and water supplies) and identify the resources businesses need to prepare for disasters and quickly return to normal operations (e.g., identifying transportation routes or other infrastructure requiring maintenance). Finally, the associations can help catalyze food retailers to establish business continuity plans.
 - Launched in 2017, ARISE Canada is the Canadian chapter of the United Nations Office for Disaster Risk Reduction (UNISDR)'s Private Sector Alliance for Disaster Resilient Societies. ARISE is a global network of private-sector businesses and stakeholders that aims to create disaster resilient societies through private- and public-sector engagement and collaboration. Sixteen businesses have joined ARISE Canada and this organization could also be encouraged to expand private-sector partnerships and coordination.



GLOBAL CITY INSIGHT

In 2014, the City of Barcelona established a Resilience Department to oversee all resilience planning and implementation. The Department works across the City Council's Organization and reports to the City's Adjunct Office for Infrastructures and Mobility, and was used as a model for the City of Toronto's Resilient City Working Group.



GLOBAL CITY INSIGHT

The Calgary Chamber of Commerce and Calgary Emergency Management Agency (CEMA) have developed a business continuity reference guide and template to help small- and medium-sized businesses develop a comprehensive plan for resumption of operations after an emergency. A food supplier and retailer are included as an example in the guide (Calgary Emergency Management Agency, n.d.). In 2013 (in response to major flooding that year), the Chamber launched the Emergency Business Contact Database, which is designed to strengthen communication between CEMA and the business community during a risk event (The City of Calgary, 2017). The Chamber employs three staff that have responsibilities related to business preparedness, maintaining the database, and coordinating with CEMA. In the event of an emergency, the Chamber sits at a dedicated desk within CEMA's Emergency Operations Centre.

In order to address these vulnerabilities and strengthen the resilience of the food system in Toronto, and create equitable resilience, the City of Toronto will need to work with many different public and private organizations as it considers actions to improve the sustainability of the food system to increase Toronto's resilience to extreme weather that is expected to become more severe with climate change.

Recommendations

Food System Transformation Actions

The City of Toronto has developed a food strategy and poverty reduction strategy that addresses food access issues. However, there is a need to further develop these strategies to incorporate a resiliency framework. A more in depth food flow analysis would identify vulnerabilities and opportunities to increase resiliency at both neighbourhood and city-wide levels. Understanding the "last mile" supply chain is key in determining access and promoting resiliency at the neighbourhood and community level.

Community & Neighbourhood Resilience Actions

Many existing vulnerable neighbourhoods may become isolated during an extreme weather event. Developing local community food resilience action plans and food emergency response plans particularly in neighbourhoods with critical food access issues can help address food insecurity and increase communities'

emergency food preparedness, response and recovery. It would build on existing community assets but would also identify gaps in the supply chain.

Infrastructure & Food Industry Sector Resilience Actions and Emergency Preparedness

The food sector is highly dependent on different forms of infrastructure such as electricity, roads, water supply, and telecommunication. For example, an extended power disruption at the Ontario Food Terminal would affect availability of fresh food to a very large number of Toronto and Ontario based independent food businesses and consumers in Toronto and beyond. The food industry sector has a critical role in building resilient and sustainable food systems, including being prepared in the event of an emergency. There is a value to understanding how key infrastructures on which the food sector relies could be at risk due to extreme weather and to identify ways to improve resiliency of the city as a whole, and the food system in particular.

ENDNOTES

¹ Climate change adaptation, climate change mitigation and disaster risk management terminology adapted from definitions in the Intergovernmental Plan on Climate Change (IPCC, 2012).

² All of the cities, except Oslo and Ottawa, are members of the 100 Resilient Cities network and have developed resilience plans for their cities or are in the process of doing so. Five of the cities, Barcelona, London, Montreal, New York City, and Vancouver, have signed the Milan Urban Food Policy Pact. All of the cities, except Calgary and Ottawa, are members of C40. Of the six C40 members, all, except Montreal, are members of the C40 Food Systems Network.

³ We do not consider sustainability to mean the same as resilience. Sustainability refers to engaging in practices that meet the resource needs of the present without compromising the needs of the future, whereas resilience refers to the ability of systems to survive, withstand and adapt to various shocks and stresses. For a discussion of the differences between sustain-ability and resilience, see (Redman, 2014).

⁴ The interviews were all conducted by phone between July and October 2017 using an interview guide developed and administered by ICIC.

⁵ ICIC's work has been highlighted at RES/CON: The Global Resilience Summit in 2017 and was recognized by the Climate Change Urban Food Initiative, which showcases successful mechanisms and approaches to help cities respond to the challenges of achieving sustainable urban food systems in a changing climate (Watson, Gaspard, & Lebreton, 2016). This is a joint initiative of the Fondation Nicolas Hulot (FNH), the International Urban Food Network (IUFN) and the United Nations Environment Programme (UNEP).

⁶ The six assessment steps outlined in the V&A assessment guidelines include the following: (1) frame and scope the assessment; (2) describe current risks, including vulnerabilities and capacities; (3) project future health risks; (4) identify and prioritize policies and programs to manage the additional health risks associated with a changing climate; (5) establish an iterative process for managing and monitoring health risks; and (6) examine the potential health benefits and co-harms of adaptation and mitigation options implemented in other sectors.

⁷ For additional information, see <https://www.iso.org/iso-31000-risk-management.html>

⁸ The HLRA tool used for the High Level Risk Assessment workshop was provided by the City of Toronto Environment and Energy Division. For further information about the HLRA tool, see City of Toronto Deputy City Manager and Chief Financial Officer (2014).

⁹ ICIC analysis using historical January 1, 2012 to December 31, 2016 daily total precipitation records for Toronto Pearson International Airport from Environment and Climate Change Canada.

¹⁰ ICIC analysis using historical daily total precipitation records from 1937 to 2016 for Toronto Pearson International Airport from Environment and Climate Change Canada.

¹¹ The Toronto and Region Conservation Authority has identified four "Special Policy Areas" in Toronto in the Don River and Humber River Watersheds that historically existed in the flood plain and are more prone to river based flooding. "Special Policy Areas" are areas within a municipality where TRCA, the member municipality, and the Province of Ontario agree to relax provincial flood proofing and technical standards (while accepting greater flood risk) in order to provide for the continued viability of existing land uses. The four "Special Policy Areas" in Toronto are Hoggs Hollow (Don River Watershed), Lower Don (Don River Watershed), Black Creek (Humber River Watershed) and Rockcliffe (Humber River Watershed) (Toronto and Region Conservation Authority, 2013)

¹² See City of Toronto Staff report: Resilient City – Preparing for a Changing Climate Status Update and Next Steps (City of Toronto, 2016b, p. 8).

¹³ Regulatory flood plain and Flood Vulnerable Areas data provided by the Toronto and Region Conservation Authority. For further information about TRCA's regulatory flood plain and Flood Vulnerable Areas, see: <https://trca.ca/conservation/flood-risk-management/flood-plain-map-viewer/>

¹⁴ Hazus is a geographic information system-based natural hazard analysis tool developed and distributed by the U.S. Federal Emergency Management Agency and adapted for use in Canada by Natural Resources Canada.

¹⁵ ICIC analysis using historical January 1, 2012 to December 31, 2016 daily maximum temperature records for Toronto Pearson International Airport from Environment and Climate Change Canada.

¹⁶ ICIC analysis using historical June 29, 2012 to July 6, 2012 daily maximum temperature records for Toronto Pearson International Airport from Environment and Climate Change Canada. The hottest day on record between 2012 and 2016 is July 17, 2012 when the maximum temperature reached 36.8 degrees Celsius. The hottest day on record in 2012 is July 17, 2012 when the maximum temperature reached 36.8 degrees Celsius. July 4, 2012 and July 6, 2012 are tied for the second hottest day on record in 2012, when the maximum temperature reached 36.3 degrees Celsius.

¹⁷ ICIC analysis using historical daily maximum temperature records from 1937 to 2016 for Toronto Pearson International Airport from Environment and Climate Change Canada. The hottest day on record is August 25, 1948, when the maximum daily maximum temperature reached 38.3 degrees Celsius.

¹⁸ Percentage of Toronto Hydro's customers calculated using the reported affected customers and the approximate number of Toronto Hydro customers listed in Toronto Hydro's 2012 Annual Report.

¹⁹ ICIC analysis using historical September 23, 2017 to September 27, 2017 daily maximum temperature records for Toronto Pearson International Airport from Environment and Climate Change Canada.

²⁰ Percentage of Toronto Hydro's customers calculated using the reported affected customers and the approximate number of Toronto Hydro customers listed in Toronto Hydro's 2013 Annual Report.

²¹ ICIC analysis of TTC ridership figures and 2016 Census population data for the GTA from Statistics Canada. We assume each passenger takes two trips per day (roundtrip). We do not account for riders from outside of the GTA that use TTC (e.g., visitors). Our calculations likely overestimate the share of the GTA's population that uses TTC due to these assumptions.

²² ICIC analysis of 2017 TTC subway station locations listed on <https://www.ttc.ca/Subway/index.jsp>. The 10 subway stations at risk for flooding include one on Line 1 Yonge-University Line, four on Line 2 Bloor-Danforth Line, and five on Line 3 Scarborough RT Line. There are no subway stations at risk for flooding on Line 4 Sheppard Line.

²³ ICIC analysis of TTC storm track and sewage pump locations provided by TTC.

²⁴ ICIC analysis of 2016 Statistics Canada Road Network File. Road rankings drawn from the National Geographic Database, a joint Statistics Canada-Elections Canada initiative. We use the National Geographic Database classification system due to data availability. The National Geographic Database classification system differs from the City of Toronto's Road Classification System, which classifies roads from expressways to local roads. Road network data that uses the City of Toronto's Road Classification System was not available. Parts of the F.G. Gardiner Expressway and Queen Elizabeth Way are classified as National Highway (Rank 2), Secondary Highway, Major Street (Rank 4) and All Other Streets (Rank 5) in Toronto.

²⁵ Alectra serves the municipalities of Alliston, Aurora, Barrie, Beeton, Brampton, Bradford, Hamilton, Markham, Mississauga, Penetanguishene, Richmond Hill, St. Catharines, Thornton, Tottenham and Vaughan.

²⁶ ICIC analysis of reported power outages and the approximate number of Toronto Hydro customers listed in Toronto Hydro's annual reports.

²⁷ The complete study can be found on the PIEVC website: <https://pievc.ca/enhancing-resilience-severe-weather-and-climate-change-distribution-sector>.

²⁸ Under the Technical Standards and Safety Act, if the natural gas supply to a fuel distributor is curtailed or interrupted, the Minister can order the distributor to halt or reduce the supply of natural gas to a consumer or class of consumer.

²⁹ Data provided by New York State Energy Research and Development Authority staff on February 20, 2018.

³⁰ The "100-mile diet" concept refers to a diet in which an individual consumes food that is grown 100 miles or less from where the individual lives (Ontario EcoSchools, 2016). It is used to raise awareness and action promoting local food production and processing.

³¹ Dairy farm data is from Dairy Farmers of Ontario and includes all businesses that have been issued a license and receive a milk quota allotment from Dairy Farmers of Ontario

³² We interviewed a dairy production and processing expert from OMAFRA and a representative from DFO participated in the HLRA workshop to inform our assessment. We were unable to interview representatives from individual dairy farms.

³³ Data is for licensed farms. Chicken egg farm data is found in Egg Farmers of Ontario 2016 Annual Report (Egg Farmers of Ontario, 2017). Chicken Farmers of Ontario provided the chicken farm data. Turkey farm data is found at the Turkey Farmers of Ontario website (<http://turkeyfarmers.on.ca/>). We interviewed a poultry production and processing expert from OMAFRA to inform our assessment.

³⁴ Chicken egg farm data is from 2017 Dun and Bradstreet's Hoover's Database and includes all businesses classified as NAICS code 112310 (Chicken Egg Production).

³⁵ Poultry farm data is from 2017 Dun and Bradstreet's Hoover's Database and includes all businesses classified as NAICS code 112340 (Poultry Hatcheries) and NAICS code 112330 (Turkey Production).

³⁶ ICIC analysis using 2017 Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) list of provincially licensed meat and dairy plants, 2018 Canadian Food Inspection Agency registered shell egg stations, and 2017 Dun and Bradstreet's Hoover's Database for NAICS code 311812 (Commercial Bakeries). Dairy plants include all locations of licensed dairy plants and is current as of August 8, 2017. OMAFRA does not classify dairy facilities by type of dairy product (e.g., fluid milk, creamery/butter, cheese, dry milk, etc.) processed at the facility. Poultry plants include the locations of licensed meat plants specializing in the slaughter "Chicken, Fowl" as of July 14, 2017 and "Turkey" as of January 31, 2018. Egg processing plants include all locations of licensed shell egg stations. Commercial bakeries includes all establishments primarily engaged in manufacturing fresh and frozen bread and bread-type rolls and other fresh bakery (except cookies and crackers) products. We interviewed a poultry production and processing expert from OMAFRA, representatives from the Baking Association of Canada, a national trade association for bakeries, and Ontario Food and Beverage, a trade association for Ontario food and beverage processors, and a food sector specialist from the City of Toronto to inform our assessment. We were unable to interview representatives from the Ontario Dairy Council, a trade association for Ontario dairy processors, or the Poultry Industry Council, a trade association for Ontario poultry processors, or the Canadian Hatching Egg Producers, a trade association for Canadian egg producers, or representatives from individual processors.

³⁷ Using Dun and Bradstreet data, 31 percent of dairy processing facilities, 63 percent of poultry processing facilities, 71 percent of egg processing facilities, and 13 percent of commercial bakeries in the Greater Golden Horseshoe have annual revenues greater than \$1 million.

³⁸ Food retailers may also use alternative food vendors for certain products (e.g., local produce), but the three categories of food suppliers covers nearly all food distributed to food retailers.

³⁹ Some warehouses may not handle distribution. Food distribution companies fill this gap.

⁴⁰ We count all distribution facilities as an unique location. For example, if a single company operates multiple warehouses, we count and analyze the location of each warehouse separately. Primary distributors for supermarkets were identified as those publicly listed on websites, annual reports and industry reports. To identify local distributors operating in Toronto the GTA, we used supplier data from 2017 Dun and Bradstreet's Hoover's Database and the Ontario Food Terminal's directory of warehouse tenants. We identified all businesses classified as NAICS code 4244 (Grocery and Related Product Merchant Wholesales) in 2017 Dun and Bradstreet's Hoover's Database and all businesses listed as warehouse tenants in the Ontario Food Terminal's directory of warehouse tenants ("Directory | Ontario Food Terminal Board," n.d.). Distributors listed in each data source were cross-referenced to remove any duplicate listings. A comprehensive list of food distributors was not publicly available from municipal, provincial or federal sources.

⁴¹ Local distributors include the 21 wholesalers located in the Ontario Food Terminal, all of which are located in an area at risk for flooding.

⁴² New York City's *Five Borough Food Flow* was commissioned by the New York City Economic Development Corporation and Mayor's Office of Recovery & Resiliency.

⁴³ ICIC analysis of Ontario Food Terminal's registered buyers provided by the Ontario Food Terminal Board.

⁴⁴ Toronto Hydro fully complies with provincial requirements for reviewing and approving emergency plans or activities. The company is mandated by the province to prioritize restoration efforts during emergencies as follows:

1. Critical services: including hospitals, fire, police and essential citywide systems.
2. Stations and feeder lines: stations or major feeder lines serving the largest number of customers.
3. Smaller neighbourhoods, streets and individual homes or businesses
(<http://www.torontohydro.com/sites/electricsystem/PowerOutages/Pages/howwerestorepower.aspx>).

⁴⁵ This is the definition used by the Food Marketing Institute (FMI), which is the national trade association for the food retail industry in the United States. For more information about FMI, see: <https://www.fmi.org/>.

⁴⁶ The U.S. Department of Agriculture defines food deserts as census tracts with a substantial share of residents who live in low-income areas that have limited access to a grocery store or other healthy, affordable food retail stores (Dutko, Ver Ploeg, & Farrigan, 2012).

⁴⁷ Flood insurance generally covers physical damage to properties and inventory, but not financial losses. Business interruption insurance covers operating expenses and lost revenue.

⁴⁸ Supermarkets include all businesses classified as NAICS code 445110, Supermarkets and Other Grocery (except Convenience) stores with \$2 million or more in annual revenue. Grocery stores include all businesses classified as NAICS code 445110, Supermarkets and Other Grocery (except Convenience) stores with less than \$2 million in annual revenue. Convenience stores include all businesses classified as 445120, Convenience Stores and NAICS code 447110, Gasoline Stations with Convenience Stores.

⁴⁹ Food retail data is from 2017 Dun and Bradstreet's Hoover's Database and includes all businesses classified as NAICS code 445110 (Supermarkets and Other Grocery Stores, except Convenience Stores), NAICS code 445120 (Convenience Stores) and NAICS code 447110 (Gasoline Stations with Convenience Stores).

⁵⁰ Neighbourhoods are defined by the City of Toronto Social Development, Finance & Administration Division and are available through the Toronto Open Data catalogue. Neighbourhoods are based on Statistics Canada census tracts. There are 140 total neighbourhoods in the city of Toronto.

⁵¹ ICIC analysis using 2014 Neighbourhood Improvement Area Profiles from the City of Toronto.

⁵² ICIC analysis using 2015 Survey of Household Spending (SHS) (Table 203-0028) data from Statistics Canada.

⁵³ Restaurant data is from 2017 Dun and Bradstreet's Hoover's Database and includes all businesses classified as NAICS code 7225 (Restaurants and Other Eating Places).

⁵⁴ Restaurant data is from 2017 Dun and Bradstreet's Hoover's Database and includes all businesses classified as NAICS code 7225 (Restaurants and Other Eating Places).

⁵⁵ Restaurant data is from 2017 Dun and Bradstreet's Hoover's Database and includes all businesses classified as NAICS code 7225 (Restaurants and Other Eating Places).

⁵⁶ Data provided by New York City Economic Development Corporation and New York City Department of City Planning staff on February 23, 2018.

⁵⁷ ICIC analysis using 2016 Census data from Statistics Canada. We use the definition for high-rise dwellings used by the City of Toronto (City of Toronto, 2017a).

⁵⁸ See the 2016 Minimum Backup Power Guidelines for multi-unit residential buildings (MURBs): <https://www.toronto.ca/wp-content/uploads/2017/11/91ca-Minimum-Backup-Power-Guideline-for-MURBs-October-2016.pdf>

⁵⁹ ICIC analysis using 2011 National Household Survey data from Statistics Canada.

⁶⁰ The Toronto region refers to the Toronto Census Metropolitan Area defined by Statistics Canada. Due to data restrictions, *Tarasuk et al.* (2017) were unable to estimate the number of households in the Toronto region that are food insecure. Food insecurity has remained relatively constant in the Toronto region since 2008: 12.5 percent of households were food insecure in 2008 and 11.96 percent were food insecure in 2011 (Tarasuk, Mitchell, & Dachner, 2014).

⁶¹ ICIC analysis of low income population and population data from Wellbeing Toronto. Low income population is from 2012, the most recent year available from Wellbeing Toronto. Total population is from 2011, the closest year to 2012 with

available data. Low income population is defined by Statistics Canada as the population earning less than 50 percent of the median adjusted after-tax income of households (the Low-Income Measure After Tax [LIM-AT] threshold). Social assistance rate is defined as the share of the total neighbourhood population receiving social assistance from Ontario Works (OW) or Ontario Disability Support Program (ODSP). Our analysis uses 2012 social assistance population and population data from Wellbeing Toronto, the most recent year available.

⁶² The term food bank in Canada covers many different types of organizations. Some food banks operate warehouses and distribute food to a range of other food assistance organizations (their member agencies), while also providing food directly for individuals. Other food banks only distribute food directly to individuals. Regional food hubs, defined by the U.S. Department of Agriculture as “a business or organization that actively manages the aggregation, distribution, and marketing of source-identified food products primarily from local and regional producers to strengthen their ability to satisfy wholesale, retail and institutional demand” (Barham et al., 2012, p. 4), may also operate food banks and other food assistance programs to distribute food directly to individuals in need. Examples of regional food hubs that offer food assistance programs in Toronto include FoodShare and The Stop (“The Popularity and Potential of Regional Food Hubs,” 2012). The term food assistance organization in Canada also covers many different types of organizations. For example, *Tarasuk, Dachner, et al.* (2014) includes agencies that “provide food free of charge or at nominal cost, in the form of groceries or prepared meals and snacks” (p. 2) as charitable food assistance programs. Charitable food assistance programs include member agencies for centralized food donation distributors or agencies identified through municipal sources that receive funding for initiatives that might include charitable food assistance.

⁶³ The study defines community food programs as “food banks, community gardens, community kitchens, and a subsidized fruit and vegetable box program based in Toronto.”

⁶⁴ ICIC analysis of OAFB food bank members provided by the Ontario Association of Food Banks, food bank members of Daily Bread Food Bank and North York Harvest Food Bank (“Member Agencies,” n.d.; “Types of Agencies,” n.d.), and food banks listed on 211 Toronto. OAFB affiliate food banks are defined by the Ontario Association of Food Banks as member agencies of Daily Bread Food Bank and North York Harvest Food Bank.

⁶⁵ The exception is Nutrition North Canada, a federal assistance program launched in 2011 that provides a subsidy to retailers and suppliers to bring healthy food to eligible communities in North Canada. The subsidy offsets the high cost of stocking and/or shipping perishable food in isolated Northern communities (“How Nutrition North Canada works,” 2017).

⁶⁶ The 11 neighbourhoods include: Agincourt South-Malvern West, Dorset Park, Downsview-Roding-CFB, Hillcrest Village, Humbermede, Ionview, Newtonbrook East, Newtonbrook West, Rustic, Scarborough Village and Thistletown-Beaumont Heights.

⁶⁷ Our analysis identifies 58 neighbourhoods (out of 140) with a higher share of low-income residents compared to the city average and 61 neighbourhoods with a higher share of residents receiving social assistance compared to the city average. ICIC analysis of 2012 Wellbeing Toronto data on low income and social assistance populations. Low income population is the population living in low-income census families and non-family persons based on the Low-Income Measure After Tax (LIM-AT). Social assistance population is the population receiving aid from Ontario Works (OW) or Ontario Disability Support Program (ODSP).

⁶⁸ ICIC analysis of Wellbeing Toronto data on population in 2006 and 2016 and Daily Bread Food Bank’s *Who’s Hungry 2017 Profile of Hunger in Toronto* report (Daily Bread Food Bank, 2017) and *The Three Cities Within Toronto: Income Polarization Among Toronto’s Neighbourhoods, 1970-2005* (Hulchanski, University of Toronto, & Cities Centre, 2011). The inner suburb population grew six percent between 2006 and 2016. The inner city (former municipality of Toronto) grew 17 percent between 2006 and 2016. Data limitations prohibit analysis of food insecurity at the neighbourhood level over the past decade. Food insecurity data at the neighbourhood level is not available. Due to methodological changes in the 2006 and 2016 Census, low-income household data available from Wellbeing Toronto is not comparable between years. Social assistance data is not yet available from Wellbeing Toronto for 2016 and is only available for 2008 and 2012.

⁶⁹ ICIC analysis using food banks listed on 211 Toronto. 211 Toronto is a website listing over 20,000 community, health, social and related government services and funded by the City of Toronto and United Way Toronto.

⁷⁰ The EPIC website is no longer active. For additional information and archived reports from the EPIC project, please visit: <http://www.calgarycvco.org/flood-resources/>

GLOSSARY

Backup generator (backup power generator): Backup power source for a building or facility used in the event of a power outage of a municipality's electric distribution system. Backup generators may power all of a building or facility's electrical systems or only essential systems. Backup generators may be portable or located on-site and are powered by a variety of fuel sources, including diesel or natural gas.

Business continuity plan: Strategies to reduce risk during an extreme weather event, which when implemented by businesses can ensure operational continuity, allowing businesses to meet ongoing obligations to customers (Center for Climate and Energy Solutions, 2013).

Climate change: Change in the state of climate, due to natural variability or impact of human activity, which can be statistically identified over an extended period of time (Intergovernmental Panel on Climate Change, 2007).

Climate change adaptation: Process of adjusting to climate change and its effects in order to moderate harm or exploit beneficial opportunities (Intergovernmental Panel on Climate Change, 2012b).

Climate change mitigation: Interventions to mitigate climate change by reducing greenhouse gas (GHG) sources or enhancing GHG sinks (Intergovernmental Panel on Climate Change, 2012b).

Climate change planning: The preparation and policy decisions made with the intention of improving the ability of natural and human systems to mitigate and manage the impact of climate change (United National Human Settlements Program, 2012).

Disaster risk management: Process for designing, implementing and evaluating strategies and measures to understand and reduce disaster risks. Includes disaster risk mitigation, preparedness, response and recovery (Intergovernmental Panel on Climate Change, 2012b).

Electric distribution utility: Electricity provider for a municipality or region responsible for distributing electricity to customers through the electricity distribution system.

Extreme Weather: A weather event, such as a flood, ice storm or heat wave, that is rare within its statistical reference distribution at a particular place. Definitions of rare vary and differ from place to place (Intergovernmental Panel on Climate Change, 2012a).

Feeder system: A network of underground and overhead power lines, transformers, switches and related equipment used to distribute electricity to customers.

Flood Vulnerable Area: Defined by the Toronto and Region Conservation Agency (TRCA) as areas in or near river valleys that are at high risk for flooding, with high risk defined as areas with numerous structures within the flood plain and/or a high frequency of flooding

Flooding (riverine): Flooding that occurs when water levels of rivers, streams or creeks overflow their banks and spill onto adjacent areas.

Flooding (urban): Flooding that occurs in localized areas when there is more water than the local storm water management system (e.g., sewers) can handle, or when there is major overland water flow in a low-lying area.

Food assistance network: Food banks, food pantries, meal delivery programs, soup kitchens, and mobile soup kitchens that collect and distribute food to communities or individuals.

Food insecurity: The inability to purchase adequate food due to financial constraints.

Food safety: Handling, preparation and storage procedures for food to prevent foodborne illnesses and other public health hazards.

Greater Golden Horseshoe (GGH): The five regions and two cities in the Golden Horseshoe (the City of Toronto and the City of Hamilton and the regions of Durham, Halton, Niagara, Peel, and York) and the one region and eight counties in the Outer Greater Golden Horseshoe (the Waterloo region and the counties of Brant, Dufferin, Haldimand, Northumberland, Peterborough, Simcoe, and Wellington, and the municipality of Kawartha Lakes).

Greater Toronto Area (GTA): The City of Toronto and the four surrounding regions of Durham, Halton, Peel, and York

High Level Risk Assessment (HLRA) Tool: Tool and process developed by the City of Toronto to evaluate the City's infrastructure to accommodate extreme weather events.

Regulatory flood plain: The approved standard used in a particular watershed to define the limit of the flood plain for regulatory purposes. Within the Toronto and Region Conservation Area's jurisdiction, the flood plain is based on the regional storm, Hurricane Hazel, or the 100 year flood; whichever is greater.

Resilience planning: The preparation and policy decisions that build the capacity of individuals, institutions and community to minimize and mitigate the short- and long-term impacts of system stresses and shocks, including extreme weather events.

Supermarket: Grocery stores with \$2 million or more in annual revenue.

Telecommunications: The network of land, mobile phones and internet service over which communications are transmitted.

Transmission station: Interdependent electrical equipment that converts high voltage electricity from electric power plants into voltage levels that can be distributed to customers.

Warehouse supplier (primary and secondary): **Primary** warehouse suppliers source the majority of products sold by retailers, and secondary suppliers provide more specialty items and brands the primary supplier does not carry.

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APPENDIX 1: SUMMARY OF HIGH LEVEL RISK ASSESSMENT (HLRA) STAKEHOLDER WORKSHOP

As a key component of the overall vulnerability assessment, ICIC and Cadmus designed and facilitated a half-day workshop that used the City of Toronto's High Level Risk Assessment (HLRA) tool to identify vulnerabilities in Toronto's food system. The workshop was held on August 23, 2017 at Metro Hall in Toronto, and was led by Julie Curti and Kathryn Wright from Cadmus, and Kim Zeuli and Zachary Nieder from ICIC.

ICIC and Cadmus engaged a diverse group of 23 key stakeholders representing different aspects of Toronto's food system. The group included municipal and provincial government agencies, private food distributors and retailers, and nonprofit food service organizations and associations.

Stakeholders were broken into three groups and each breakout group focused their discussion around one of three extreme weather-event scenarios: an extreme summer storm, an extreme winter storm, and a heat wave. Within the breakout groups, stakeholders were then broken into pairs to assess the impact of the scenario on two particular food system components (e.g., food process). Following the breakout group discussion, a closing plenary allowed for cross-group discussion and sharing of insights.

Workshop Agenda

Agenda Item	Time
Refreshments and Networking	8:30 a.m. to 8:45 a.m.
Introduction to the Workshop Process	8:45 a.m. to 8:55 a.m.
Context Setting <ul style="list-style-type: none">City of Toronto Resilience Planning EffortsOverview of Current Food System Resilience Research	8:55 a.m. to 9:30 a.m.
Transition to Small Groups	9:30 a.m. to 9:35 a.m.
Breakout Group Sessions	9:35 a.m. to 10:40 a.m.
Break	10:40 a.m. to 10:50 a.m.
Small Group Report-outs and Feedback Session	10:50 a.m. to 11:35 a.m.
Wrap-up and Next Steps	11:35 a.m. to 11:45 a.m.

TABLE 5 Key Stakeholder Participants in HLRA Workshop on August 23, 2017

Name	Title	Organization
Boris Rosolak	Coordinator	Toronto Office of Emergency Management
Paul Sawtell	Chief Executive Officer	100 KM Foods Inc.
Brian Cook	Health Research Specialist, Toronto Food Strategy	Toronto Public Health
Michael Wolfson	Senior Advisor, Food and Beverage Sector	Toronto Economic Development and Culture Division
Carolyn Stewart	Executive Director	Ontario Association of Food Banks
Raqueeb Anwar	Engineer	Toronto Hydro
Jennifer Smysnuik	Coordinator	Toronto Office of Emergency Management
Gary Rygus	Director of Government Relations	Retail Council of Canada
Jessica Munn	Public Health Dietitian, Chronic Disease and Injury Prevention	Toronto Public Health
Sue Evans	Policy Advisor, Agri-Food Climate Change Policy Unit	Ontario Ministry of Agriculture, Food and Rural Affairs
Vesna Stevanovic-Briatico	Transportation Coordinator	Toronto Transportation Services
Laura Nelson-Hamilton	Senior Policy Analyst, Poverty Reduction Strategy Office	Toronto Social Development, Finance & Administration
Kristin Benke	Economist	Dairy Farmers of Ontario
Stewart Dutfield	Project Lead Resilience	Toronto Environment & Energy Division
Jennifer Levy	Health Policy Specialist, Toronto Food Strategy	Toronto Public Health
Ryan Noble	Executive Director	North York Harvest Food Bank
Bruce Nicholas	General Manager	Ontario Food Terminal
Sylvanus Thompson	Associate Director, Healthy Environments	Toronto Public Health
Rhonda Teitel-Payne	Coordinator	Toronto Urban Growers
Taryn Ridsdale	Health Policy Specialist, Healthy Public Policy	Toronto Public Health
Ronald Macfarlane	Manager, Healthy Public Policy	Toronto Public Health
David MacLeod	Senior Environmental Specialist	Toronto Environment & Energy Division
Barbara Emanuel	Manager, Toronto Food Strategy	Toronto Public Health

APPENDIX 2: INTERVIEW SUBJECTS

The following list includes the 49 individuals we interviewed for this report.

Name	Title	Organization
Aderonke Akande	Project Manager, Tower and Neighbourhood Revitalization	Toronto Social Development, Finance & Administration, Tower & Neighbourhood Revitalization Unit
Norm Beal	Chief Executive Officer	Food and Beverage Ontario
Naz Capano	Manager, Operational Planning and Policy	Toronto Transportation Services
Safiah Chowdhury	Policy Development Officer, Poverty Reduction Strategy Office	Toronto Social Development, Finance & Administration
Gary Da Silva	Operations Manager	Ontario Food Terminal
Al Dam	Poultry Specialist, Guelph	Ontario Ministry of Agriculture, Food and Rural Affairs
Stewart Dutfield	Project Lead Resilience	Toronto Environment & Energy Division
Tony Elenis	President and Chief Executive Officer	Ontario Restaurant Hotel and Motel Association
Steve Elliott	Regional Disaster Response Coordinator	Samaritan's Purse Canada
Debbie Field	Executive Director (former)	Toronto FoodShare
Graham Fleming	Manager, Corporate Planning and Projects Unit	Ontario Ministry of Agriculture, Food and Rural Affairs
Rachel Gray	Executive Director	The Stop Community Food Centre
David Greenall	Senior Director, Sustainable Business Solutions	PricewaterhouseCoopers
Thom Hagerty	Associate Director, Economic Development Policy Branch	Ontario Ministry of Agriculture, Food and Rural Affairs
Alec Hay	Adjunct Professor, Department of Civil Engineering	University of Toronto
Paul Hetherington	President and Chief Executive Officer	Baking Association of Canada
Lisa King	Senior Planner	Toronto City Planning
Mustafa Koc	Professor, Department of Sociology	Ryerson University
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Gianfranco Leo	Administration Manager	Ontario Food Terminal
Jason Libralesso	Senior Director of Transportation	Sobeys
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Bruce Nicholas	General Manager	Ontario Food Terminal
Ryan Noble	Executive Director	North York Harvest Food Bank
Gail Nyberg	Executive Director	Daily Bread Food Bank
John O'Grady	Chief Safety Officer	Toronto Transit Commission
Shawn Pegg	Director, Policy and Research	Food Banks Canada
Jessica Reeve	Community Development Officer, Poverty Reduction Strategy Office	Toronto Social Development, Finance & Administration
Gary Rygus	Director of Government Relations	Retail Council of Canada
Gary Sands	Vice President, Government Relations	Canadian Federation of Independent Grocers
Rejean Sewlal	Senior Manager, Business Continuity Planning	Rogers
Mark Shembri	Vice President, Supermarket Systems and Store Maintenance	Loblaw
Jennifer Smysnuik	Coordinator	Toronto Office of Emergency Management
Laurie Snyder	Director, Operations	Daily Bread Food Bank
Lori Stahlbrand	Manager	Toronto Food Policy Council
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Cindy Tan	Manager, Strategic Policy	Ontario Poverty Reduction Strategy Office
Valerie Tarasuk	Professor, Department of Sociology	University of Toronto
Sarah Thompson	Coordinator	Toronto Office of Emergency Management
Sylvanus Thompson	Associate Director, Health Environments	Toronto Public Health
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APPENDIX 3: OVERVIEW OF CURRENT RESILIENCE AND FOOD PLANNING EFFORTS AND ORGANIZATIONS IN TORONTO AND ONTARIO

Organization or Agency	Description of Planning Efforts
ARISE Canada	Launched in 2017, ARISE Canada is the Canadian chapter of the United Nations Office for Disaster Risk Reduction (UNISDR)'s Private Sector Alliance for Disaster Resilient Societies. ARISE is a global network of private-sector businesses and stakeholders that aims to create disaster resilient societies through private- and public-sector engagement and collaboration. Currently, there are 13 businesses that have joined ARISE Canada. ARISE members agree to advance five areas: (1) raise awareness with respect to disaster risk management, (2) exercise influence in respective spheres of expertise, (3) share knowledge and bring in expertise of the private sector, (4) be a catalyst to generate innovation and collaboration, and (5) implement tangible projects and activities to achieve the targets of the Sendai Framework, UNISDR's disaster risk reduction framework for 2015-2030.
CREW Toronto	Launched in 2014, CREW (Community Resilience to Extreme Weather) Toronto is a volunteer network at the neighbourhood level that helps to inform, educate, and connect Toronto's residents to resilience information, models, and toolkits. CREW Toronto's overall objective is to create City Ward Resilience Profiles that map community resilience using a number of indicators.
Ontario Climate Change Strategy	Released in 2015, Ontario's Climate Change Strategy is the province's vision-setting climate change mitigation and adaptation plan to reduce greenhouse gas emissions by 80 percent by 2050 and enhance climate resilience by 2030. The strategy identified that climate change (especially through extreme weather events) can lead to disruptions in food production, access, and price stability and calls for the proactive agri-food policies and programs to make food systems and agricultural lands proactively protected and resilient.
Ontario Local Food Strategy	In 2013, the Province of Ontario developed a Local Food Strategy to increase consumer awareness and consumption of local food in Ontario. The strategy is supported by Ontario's Local Food Act (Bill 36, the Local Food Act, 2013), passed in November 2013.
Ontario Poverty Reduction Strategy Office	In 2017, the Ontario Poverty Reduction Strategy Office is beginning to develop Ontario's First Food Security Strategy. The goal of the strategy is to ensure that all Ontarians have sufficient access to affordable and nutritious food. Currently in the planning stages, a discussion paper lays out a multi-ministry and multi-partner approach to addressing food security in Ontario.

ResilientTO	Launched in 2016, as part of its commitment to 100 Resilient Cities, ResilientTO is the City of Toronto's effort to develop a comprehensive resilience strategy. This initiative builds on all of the City of Toronto's existing resilience-related efforts. The City of Toronto is currently working to complete a baseline assessment of Toronto's resilience and expects to release the City's resilience strategy in 2018 (City of Toronto, 2016c).
TO Prosperity	The City of Toronto released <i>TO Prosperity: Toronto Poverty Reduction Strategy</i> in 2015. The strategy identifies food access as one of its six focus areas, and identifies short-term recommendations to eliminate hunger and increase access to affordable, nutritious and culturally appropriate food from 2015 to 2018.
Toronto City Council	<p>Toronto City Council approved the Food and Hunger Action Committee in 1999. The Food and Hunger Action Committee developed the Food and Hunger Action Plan, a series of two reports that recommended opportunities to promote food security for all Torontonians .</p> <p>Toronto City Council adopted the Toronto Food Charter in 2001, which was driven by the Food and Hunger Action Plan. The Toronto Food Charter outlines strategies for Toronto City Council to promote food security.</p> <p>Toronto City Council adopted <i>Resilient City</i>, two reports released in 2013 and 2014, that outline an approach to integrate climate change resilience into decision-making and coordination of the City's operations and services to better prepare for the impacts of climate change and extreme weather. The reports recognize that climate change and the correlative increase in extreme weather events will impact food supplies, food safety and food security. They create an approach to mitigate the impacts of extreme weather events associated with climate change.</p>
Toronto City Planning Division	The Toronto City Planning Division is responsible for reviewing and updating the Toronto Official Plan, the City of Toronto's development plan for areas such as transit, land use development and the environment. The current plan, released in 2015, embraces sustainability as a central concept, which includes social equity and inclusion, environmental protection, and good governance and city-building. To support Toronto's food system, the Plan calls for adequate amounts of safe, nutritious, culturally acceptable food that are available to all and for preserving high-quality agricultural lands to protect Toronto's food security. The Plan is also linked to the City's Food and Hunger Action Plan.

Toronto Environment and Energy Division	<p>The Toronto Environment and Energy Division is responsible for a number of resilience planning initiatives. It plays a lead role in the ResilientTO initiative. In addition, the Division developed the High Level Risk Assessment Tool in 2011 to conduct vulnerability assessments of the City's infrastructure and services, and prepared <i>Ahead of the Storm: Preparing Toronto for Climate Change</i> (2008), a framework that is designed to help engage members of the public in designing and implementing a climate change adaptation strategy for Toronto (City of Toronto, 2008).</p> <p>Initiated in 2015, TransformTO is Toronto's short and long-term climate change mitigation strategies to reduce greenhouse gas emissions by 30 percent by 2020 and 80 percent by 2050 (City of Toronto, 2016d; City of Toronto, 2017b). TransformTO is a community-wide, cross-corporate initiative designed to engage residents, experts, stakeholders and all City Divisions, Agencies and Corporations on how Toronto can reduce greenhouse gas emissions and achieve a low-carbon future. In March 2015, Toronto City Council established the Parks and Environment Subcommittee on Climate Change Mitigation and Adaptation to guide and support the project. TransformTO is co-managed by the Toronto Environment and Energy Division and the Toronto Atmospheric Fund, a fund established by the City of Toronto in 1991 to finance local initiatives to combat climate change and improve air quality in Toronto. As part of TransformTO, Toronto is in the process of developing neighbourhood-scaled energy systems to lessen the strain on the electrical power system.</p>
Toronto Food Policy Council	<p>The Toronto Food Policy Council (TFPC) reports to the Toronto Board of Health. TFPC is responsible for advising the City of Toronto on food policy related matters. TFPC collaborates on many of the food-policy initiatives and plans in the city. Currently, TFPC's major initiatives include urban agriculture promotion, food waste reduction, and a partnership with the Greater Toronto Area Agricultural Action Committee (GTA AAC).</p>
Toronto Food Strategy	<p>Toronto Food Strategy was initiated in 2008 to build a "healthier, more sustainable food system for all Torontonians." The Toronto Food Strategy, which is led by Toronto Public Health, addresses a number of issues across the food system that align with those of the Milan Urban Food Policy Pact, including healthy food access; community building and inclusion; food literacy; community economic engagement; infrastructure and supply chain; and improving the food environment.</p>
Toronto Public Health	<p>Toronto's food system planning is currently spearheaded by Toronto Public Health. Toronto Public Health's Toronto Food Strategy, established in 2008, addresses a number of issues across the food system, including healthy food access, community building, food literacy, community economic engagement, infrastructure and supply chains, and improving the food environment (Acting Medical Officer of Health, 2016). Toronto Public Health has also developed a report on Healthy, Sustainable Diets. The report will support the objectives of TransformTO.</p> <p>Released in 2015, Toronto Public Health's <i>A Climate of Concern: Climate Change and Health Strategy for Toronto</i> was developed to better</p>

	understand and respond to the public health effects of climate change. The strategy identifies that climate change could impact the city's food system, including food insecurity and food-borne illness, and outlines a set of actions to address food system safety and security issues.
Toronto Resilient City Working Group	Established in 2013 by the City of Toronto, the Resilient City Working Group is a collaborative working group consisting of City of Toronto divisions, agencies, corporations and external stakeholders to provide expert knowledge and technical support to facilitate the implementation of climate change resilience actions. The Working Group builds on the now defunct WeatherWise group.