



# PARTNERS FOR ACTION

Preparedness of Fifteen Canadian Cities to Limit Flood Damage

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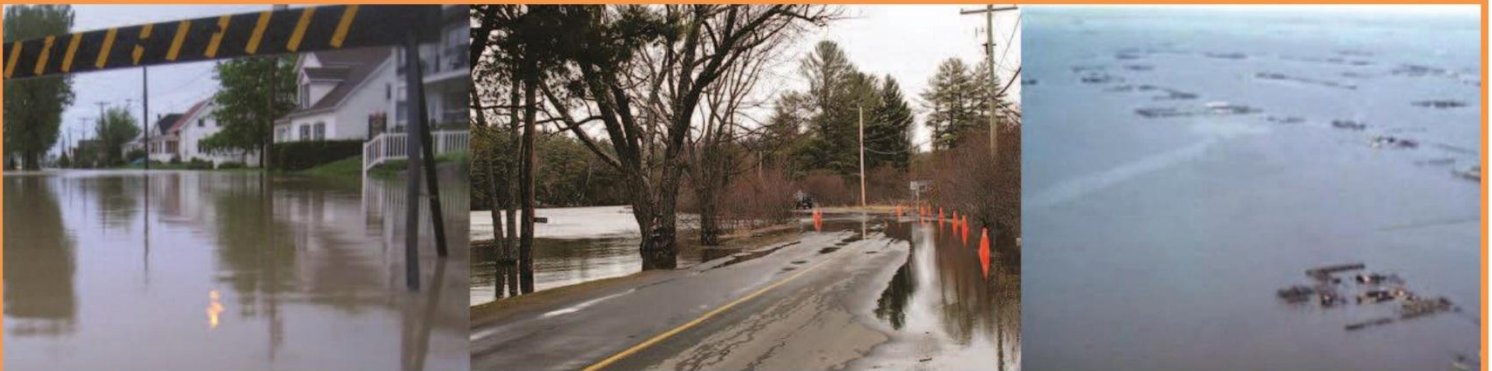
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## FOREWORD

In 2013, The Co-operators initiated a research project aimed at identifying ways to better protect Canadian homeowners from the increasing risk of overland flooding. In its first phase, researchers at the University of Waterloo engaged senior executives in the property and casualty insurance industry who identified 14 conditions that, if met, would create an environment conducive to offering overland flood insurance.

A key recommendation of the report was to initiate a broad-based discussion on the actions necessary to improve flood and disaster risk management with key stakeholders. Acting upon this recommendation, Phase II of the research engaged 60 experts from a wide range of stakeholders, who identified three priority areas where action could most effectively reduce the risk of overland flooding:

1. Flood Plain Mapping
2. Preparedness of Cities
3. Built Infrastructure

We determined that in Phase III, our emphasis for action would be on the Preparedness of Cities – the one area not being materially pursued by any level of government or organization. By assessing how well prepared major Canadian cities are for flooding, this report identifies effective adaptation initiatives that could significantly enhance flood resiliency, while providing a benchmark for these municipalities to use as they take steps to better protect their communities in the years ahead.

We are very appreciative of the time and effort of all those who participated in this study. In particular, we are thankful to the co-operation and assistance of those who provided information about each of the 15 cities assessed. Without them, this study would not have been possible.

We are also very pleased that Farm Mutual Reinsurance Plan joined The Co-operators this spring as a co-founding partner of the Partners for Action (P4A) Network at the University of Waterloo's Faculty of Environment. P4A will use a collaborative approach that brings together a diverse set of stakeholders from business, government and non-governmental organizations to advance flood resiliency in Canada. We look forward to continuing our work in this important area, and welcome other organizations to join us in this effort.



Rob Wesseling  
Executive Vice-President and Chief Operating Officer, P&C Operations  
The Co-operators



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# Executive Summary

This report documents the level of preparedness of fifteen major Canadian cities to limit potential flood damage relative to current (2015) and anticipated (2030) high intensity and duration precipitation events. The report aims to motivate cities to increase efforts to limit flood risk resulting from extreme precipitation, which the Insurance Bureau of Canada identifies as the most costly factor affecting catastrophic losses in the housing sector within Canada (Canadian Press 2013).

The preparedness of cities was assessed based on interviews (initiated by The Co-operators Group Ltd. and executed by the University of Waterloo) with subject matter experts, on a city-by-city basis, relative to sixteen areas of flood vulnerability:

- |  |                                |
|--|--------------------------------|
| 1. Flood Plain Mapping                                       | 8. Commercial Real Estate      |
| 2. Land Use Planning   | 9. Electricity Supply          |
| 3. Urban Drainage Maintenance                                | 10. Petroleum Supply           |
| 4. Backwater Valve Installation<br>(New House Construction)  | 11. Transportation Systems     |
| 5. Backwater Valve Installation<br>(Existing Home Retrofits) | 12. Telecommunication Systems  |
| 6. Water Supply & Raw Waste<br>Management                    | 13. Retail Food Supply         |
| 7. Home Adaptation Audit                                     | 14. Banking/Financial Services |
|  | 15. Human Health and Safety    |
|  | 16. Emergency Responders       |

Collectively, sixty city officials participated in the survey and shared their perspectives over the period January – April, 2015. The preparedness of each city, relative to each of the above parameters, was assessed on a scale of A (higher preparation) to E (lower preparation).

If none of the pre-defined answers were considered appropriate by a city relative to how flood potential had been addressed for a particular factor, the city could opt for a response of “N/A” (Not Applicable). The response was noted, however a response of N/A was not included in the overall score calculation for the particular factor, nor was it included in the calculation of the city’s individual score.

For a city, or a factor, for which a lower flood preparation score was received, this may not necessarily imply lack of flood preparedness – a city may have deemed a factor to not be vulnerable to flood impacts due to location, low density of infrastructure within a flood zone, etc. Thus, interpretation of the flood preparedness of cities within this report requires the combined review of both text and figures.

The results from flood vulnerability assessments are profiled in two ways:

1. The flood preparedness of each city, relative to all parameters, is presented on a single figure and juxtaposed to the average (national) preparedness score for all fifteen cities, and
2. The flood preparedness for each factor, across all cities, is presented on a single figure.

The flood preparedness scores of the cities are presented in Table 1.

**Table 1:** Flood preparedness (2015) of fifteen Canadian cities – A and E identify higher and lower scores for preparedness, respectively.

City	Grade Score
1. Ottawa	A-
2. Winnipeg	B+
3. Calgary	B
4. St. John's	B
5. Toronto	B-
6. Montreal	B-
7. Mississauga	C+
8. Edmonton	C
9. Fredericton	C
10. Whitehorse	C
11. Charlottetown	C-
12. Quebec City	C-
13. Regina	C-
14. Vancouver	C-
15. Halifax	D

## Areas of Strength Regarding Flood Preparedness

Canadian cities showed strength regarding flood preparedness in four areas – residential backwater valves, flood plain mapping, land use planning and urban drainage:

- **Residential Backwater Valves (New House Build):** A backwater valve is a device that inhibits water from entering a house through the basement drain, when the sewer system is over-whelmed following a large storm. Most Canadian cities are now mandating the installation of backwater valves for new home construction.
- **Flood Plain Mapping:** Flood plain mapping can be used to predict the extent of flood coverage that will occur following major storms. In recent years, most cities in the survey updated their flood plain maps to reflect current high intensity and duration precipitation events, and those predicted to occur 15 – 25 years beyond present, based on climate models (however, in most cases these maps would not be sufficient to calculate flood hazards translatable to Property & Casualty insurance underwriting).

- **Land Use Planning:** Land use planning can be used to help ensure that infrastructure is not built in areas prone to flooding. In most Canadian cities, land-use planners are using flood plain maps to inform regulations regarding the placement of infrastructure.
- **Urban Drainage:** Urban drainage maintenance refers to pro-active efforts to ensure that structures such as culverts, sewer grates and storm sewer systems remain clear. Eight cities in the survey have established formalized programs to maintain urban drainage – notably, Vancouver is near completion of an integrated storm water management plan, which will include recommendations for green infrastructure on public and private land.

## Areas of Outstanding Challenge Regarding Flood Preparedness

Areas where less progress is underway in terms of flood preparedness are as follows:

- **Retail Food Supply:** Cities indicated that the control over private enterprises is not within the mandate of the municipal government. Accordingly, this is not a common area of focus for flood preparedness.
- **Banking and Financial Services:** Cities indicated that the responsibility for banking and financial services is not within the municipal mandate, and also not a common area of focus for flood preparedness.
- **Petroleum Supply:** Coordination of agreements with fuel suppliers was identified as an area of challenge relative to ensuring the provision of petroleum/fuel during emergencies. Nevertheless, some cities were able to become highly engaged with their respective petroleum suppliers in addressing this challenge.
- **Electricity Supply:** While the majority of the cities surveyed have worked with electrical utilities to identify and limit flood-related electricity outages, less effort had been directed to ensuring the integrity of back-up electricity generation supply. Only the City of Ottawa indicated that sustainment of redundant power supply is included in the budget process.
- **Commercial Real Estate:** None of the cities surveyed indicated having a commercial real estate adaptation audit program in place.
- **Residential Backwater Valves (Retrofits):** Cities indicated that there was limited uptake of voluntary, often subsidized backwater valve installation for existing houses.

The flood preparedness scores for each of the fifteen Canadian cities surveyed are presented in Figure 1, with the average score of all cities presented as a national benchmark.

In 2018, the fifteen cities profiled above will be re-surveyed to determine if they have advanced their level of flood preparedness.



**Figure 1: Flood preparedness of 15 Canadian cities, relative to 16 factors.**  
 Orange depicts average score of all 15 cities in survey, and aquamarine depicts individual city score.

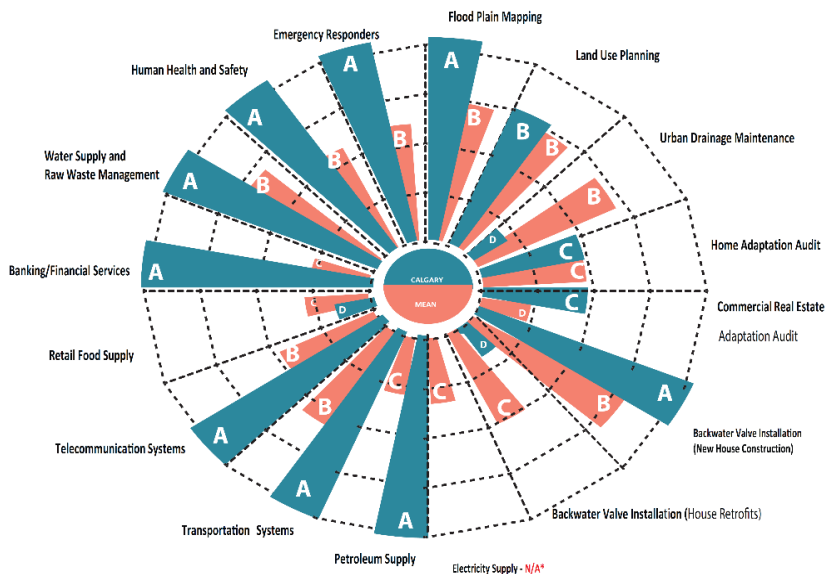
**City of Ottawa Individual Score: A-**



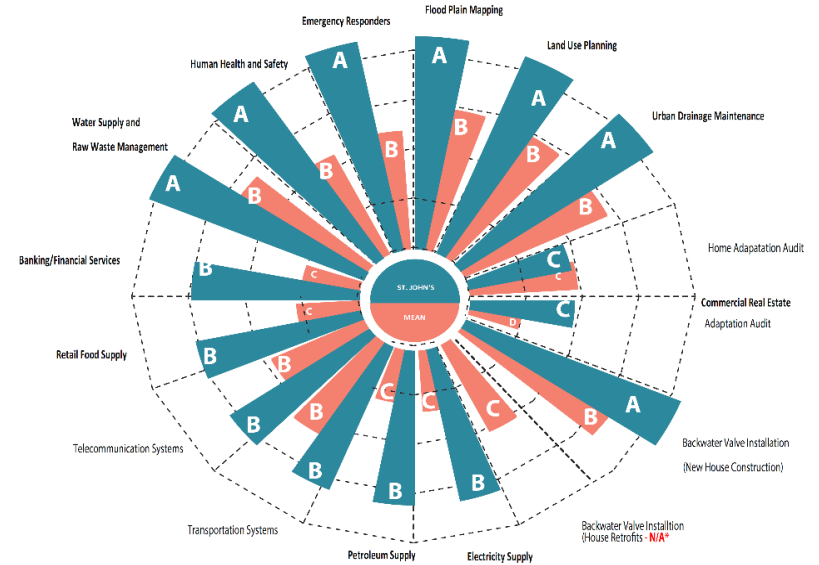
**City of Winnipeg Individual Score: B+**



**City of Calgary Individual Score: B**

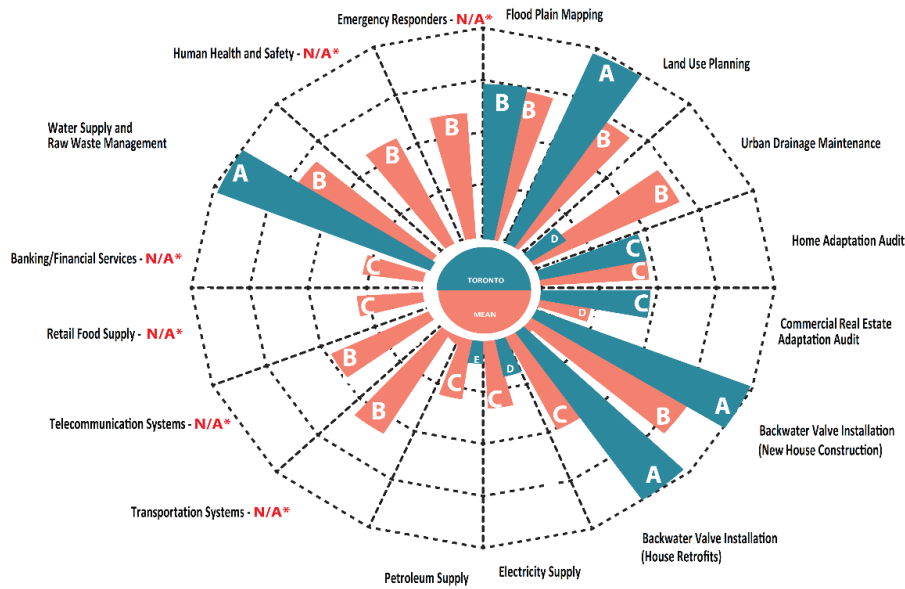


**City of St. John's Individual Score: B**

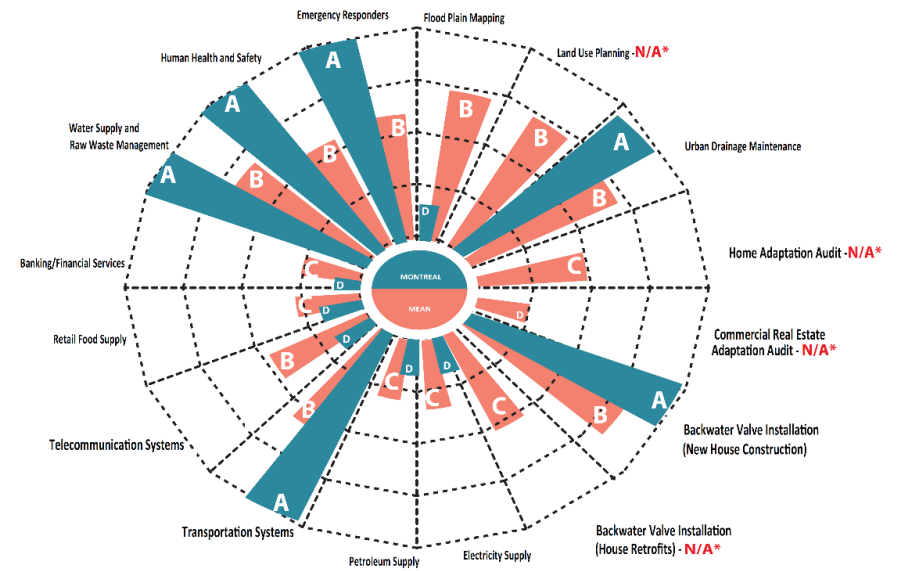


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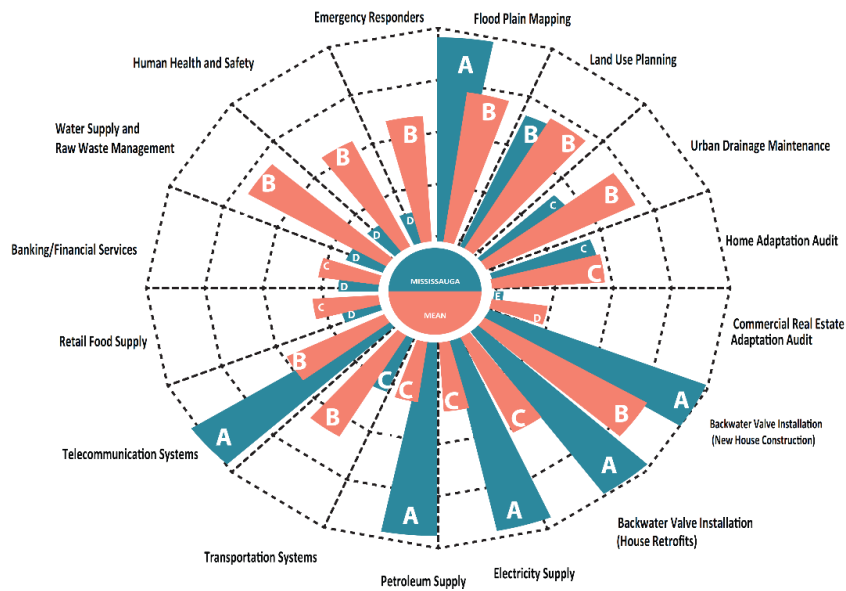
**City of Toronto Individual Score B-**



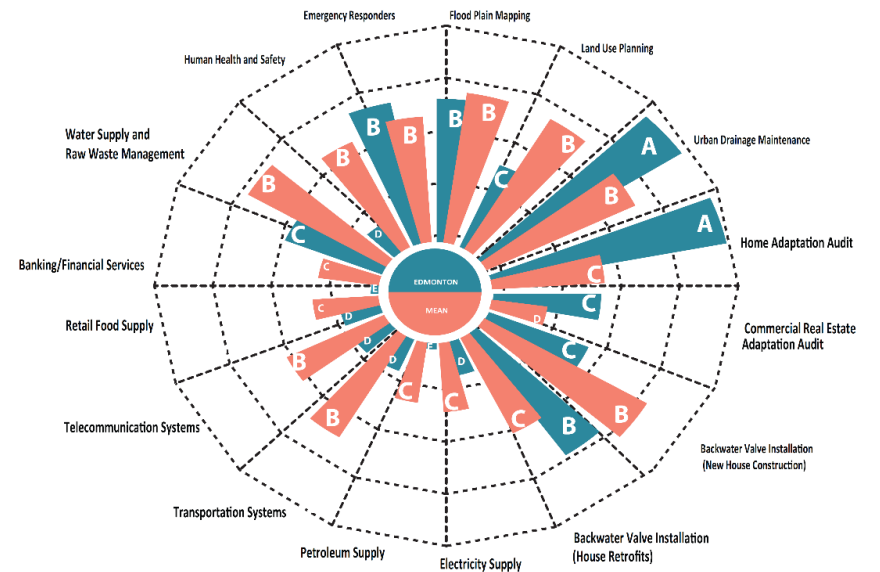
**City of Montreal Individual Score B-**



**City of Mississauga Individual Score C+**

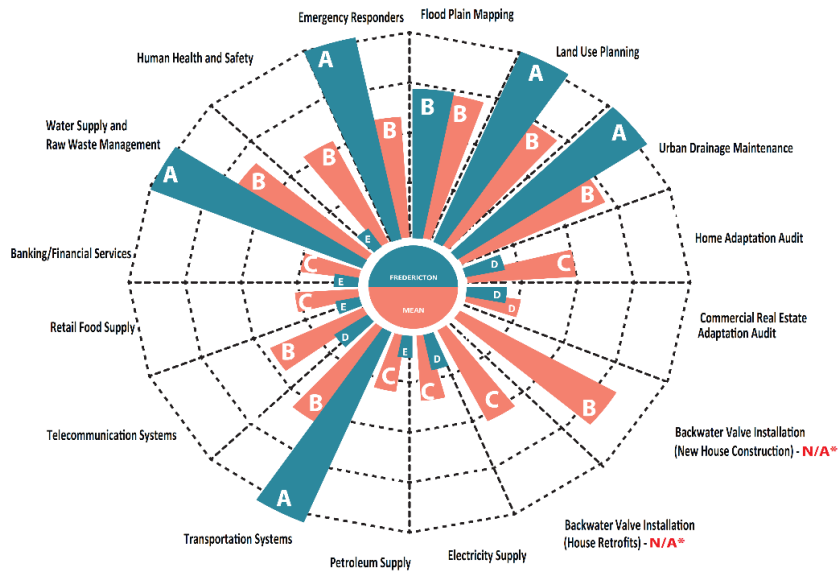


**City of Edmonton Individual Score C**

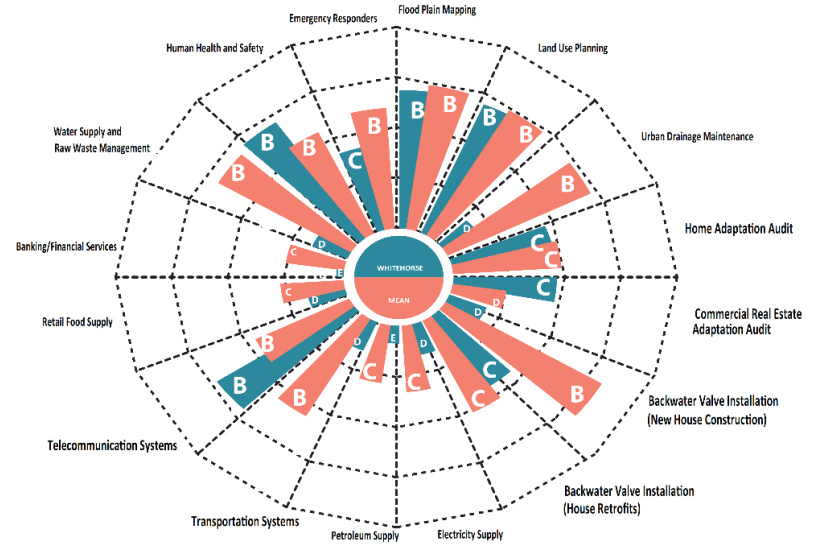


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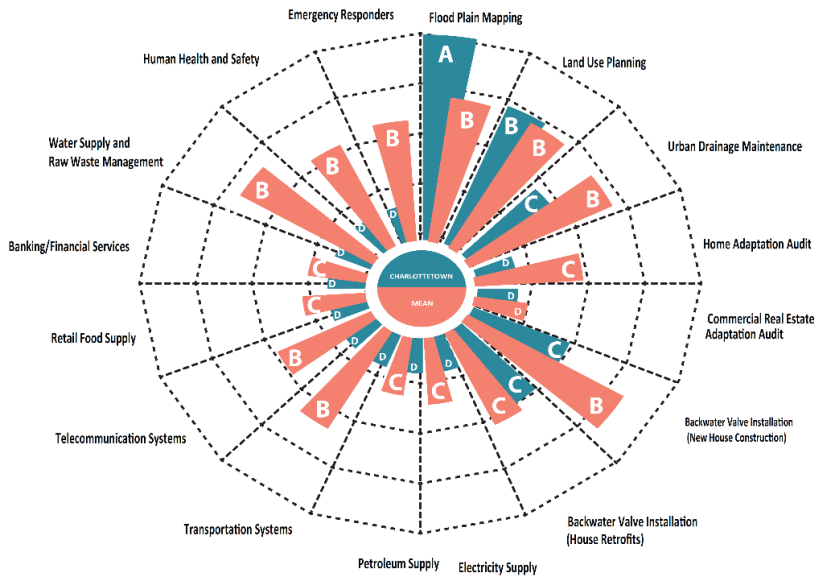
**City of Fredericton Individual Score C**



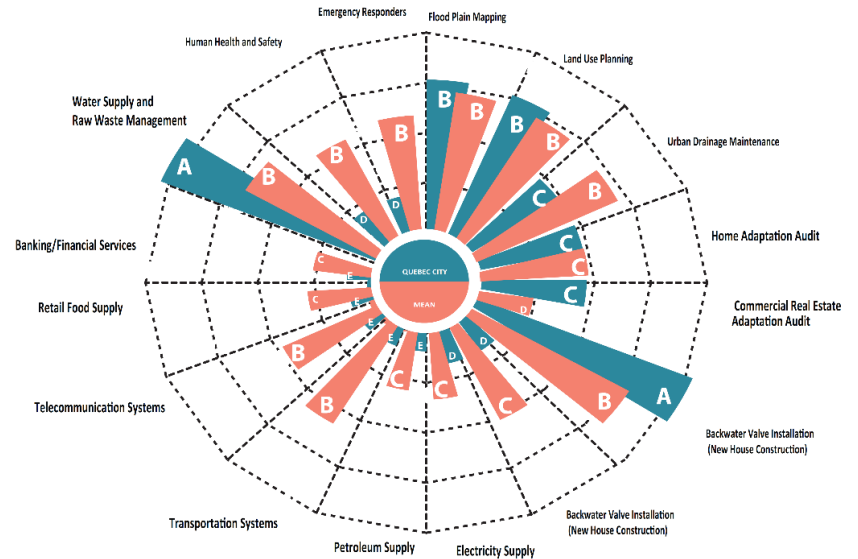
**City of Whitehorse Individual Score C**



**City of Charlottetown Individual Score C-**

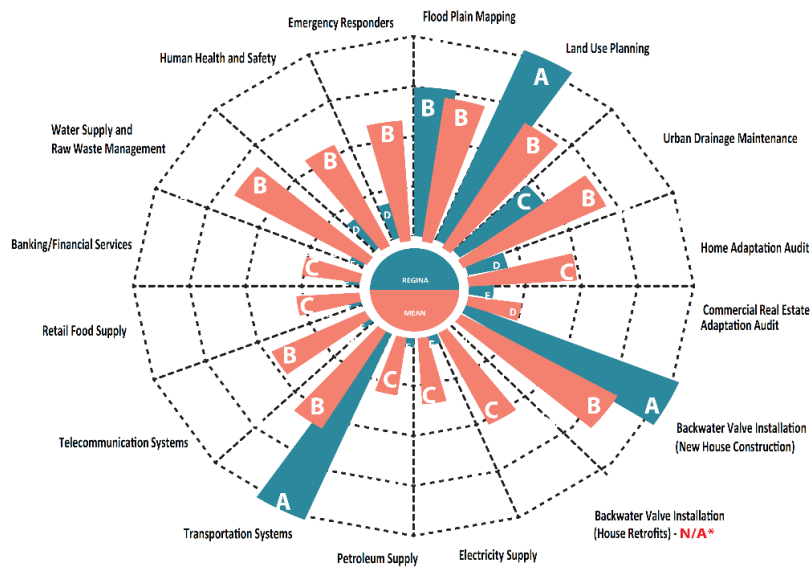


**Québec City Individual Score C-**

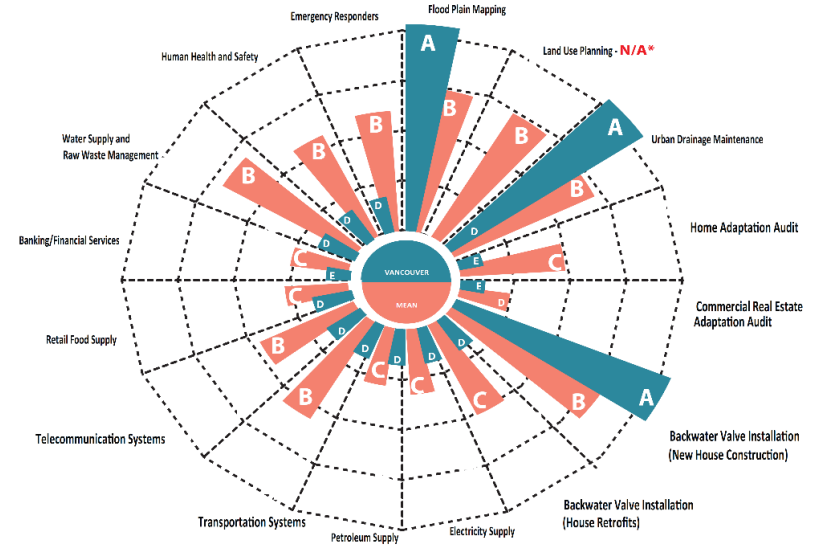


**Figure 1: Flood preparedness of 15 Canadian cities, relative to 16 factors.**  
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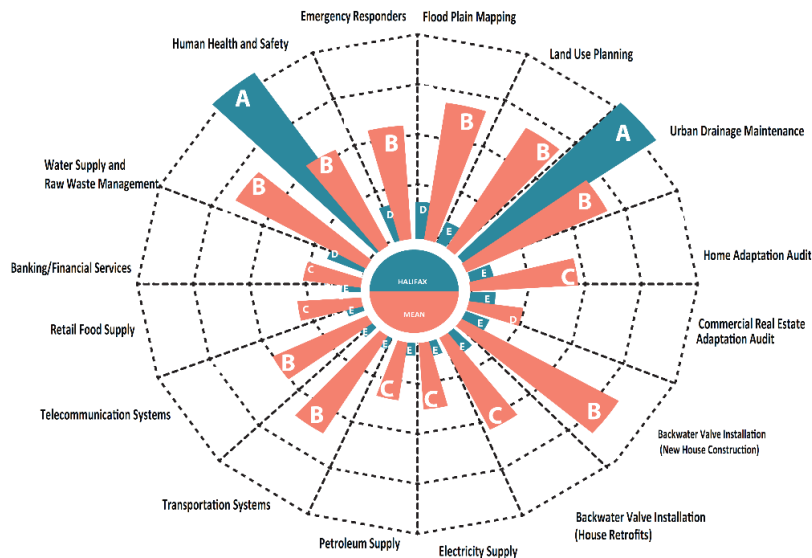
**City of Regina Individual Score C-**



**City of Vancouver Individual Score C-**



**City of Halifax Individual Score D**



**N/A:** This indicates that the city chose the non-applicable option in response to the question

## 1.0 Introduction

The purpose of this project is to assess the preparedness of fifteen major Canadian cities to limit potential flood damage relative to current (2015) and anticipated future (2030) high intensity and duration precipitation events. By way of outcome, the project should function to motivate cities to increase efforts to limit flood risk resulting from extreme precipitation.

### 1.1. Background

In 2013/14, a two-phase project<sup>1</sup> to determine means to de-risk the Canadian residential property market from the increasingly negative impacts of overland flooding was initiated by The Co-operators Group Ltd. and executed by the University of Waterloo.

A roundtable representing a diverse group of stakeholders (Partners for Action – “P4A”) was engaged to act as advisors to the project. This group included Property & Casualty (P&C) insurers, government policymakers, flood risk experts, professional associations, businesses and the legal community – the interdisciplinary expertise of P4A members helped to ensure that flood risk was not viewed from any single perspective.

In Phase I, senior P&C executives – representing fifty-seven per cent of Canada’s P&C 2011 underwriting market – identified fourteen conditions that, if met, would create an environment conducive to offering overland flood insurance.

In Phase II, stakeholders were surveyed in reference to the urgency and feasibility (i.e., cost-effectiveness and technical capacity to execute) to act upon the fourteen flood insurance conditions identified in Phase I. Their perspectives were validated at a P4A Roundtable, which identified three *winning conditions* that must be established within Canada to help de-risk flood potential:

- Canadians understand the risk that flooding presents to their homes, businesses and communities,
- Canadian decision-makers use their understanding of flood risk to make sound adaptation decisions, and
- Canadians have access to means to transfer the risks associated with flood damage that remains after they have engaged adaptation.

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<sup>1</sup> Assessing the Viability of Overland Flood Insurance: The Canadian Residential Property Market. Accessed on February 22, 2015 at:  
<https://www.cooperators.ca/~media/Cooperators%20Media/Section%20Media/AboutUs/Sustainability/Assessing%20the%20Viability%20of%20Flood%20Insurance%20in%20Canada%20-%20Eng.pdf>

Partners for Action: Priorities for Advancing Flood Resilience in Canada. Accessed on February 22, 2015 at:  
[http://www.cooperators.ca/~media/Cooperators%20Media/Section%20Media/AboutUs/Sustainability/Partners%20for%20Action%20Flood%20Report\\_EN\\_19September2014.pdf](http://www.cooperators.ca/~media/Cooperators%20Media/Section%20Media/AboutUs/Sustainability/Partners%20for%20Action%20Flood%20Report_EN_19September2014.pdf).

Using these *winning conditions* as guidance, *Partners for Action* reviewed each of the fourteen initiatives and subsequently voted to establish a short list of priority areas that could constitute focal points to de-risk flood potential within Canada. One of these points was the need to evaluate the level of flood preparedness of major Canadian cities, thus establishing the mandate for this report.

## 1.2. Method

### Criteria to Select Target Cities

Based on a literature review of cities and extreme weather impacts (Brugmann 2013, Ceres 2013, Jha *et al.* 2012, Tyler and Moench 2012, Government of Ireland 2009), four criteria emerged to direct the selection of fifteen Canadian cities to be assessed relative to flood preparedness:

1. Cities that collectively encompass Canada's geographic range,
2. Larger cities that, by definition, reflect densely populated areas,
3. Cities instrumental to supporting the economic continuity of Canada, and
4. Cities instrumental to supporting regional economic continuity (i.e., at the provincial or territory level)

Based upon the above four criteria, the following fifteen Canadian cities were selected for flood preparedness assessment:

- |                  |                |
|------------------|----------------|
| 1. St. John's    | 9. Ottawa      |
| 2. Halifax       | 10. Winnipeg   |
| 3. Charlottetown | 11. Regina     |
| 4. Fredericton   | 12. Calgary    |
| 5. Montreal      | 13. Edmonton   |
| 6. Quebec City   | 14. Vancouver  |
| 7. Toronto       | 15. Whitehorse |
| 8. Mississauga   |                |



## Categories to Assess Preparedness of Cities

Based on a literature review of “city flood preparedness” (City of Toronto and Toronto Hydro 2014, Ceres 2013, Brugmann 2013, Sandink 2013, Tyler and Moench 2012), two factors emerged as key to establishing the criteria against which city preparedness to address flooding should be measured:

1. Within the urban flood-related literature, categories of evaluation were identified as critical to flood preparedness in two or more refereed documents
2. Categories were pre-disposed to quantification relative to flood preparedness

Based on these two criteria, sixteen evaluative factors of city flood-preparedness were identified (see Appendix A for a description of the relevance of these factors in reference to flood preparedness), as follows:

1. Flood Plain Mapping
2. Land Use Planning
3. Urban Drainage Maintenance
4. Home Adaptation Audit
5. Commercial Real Estate Adaptation Audit
6. Backwater Valve Installation (new house construction)
7. Backwater Valve Installation (house retrofits)
8. Electricity Supply
9. Petroleum Supply
10. Transportation Systems
11. Telecommunication Systems
12. Retail Food Supply
13. Banking/Financial Services
14. Water Supply and Raw Waste Management
15. Human Health & Safety
16. Emergency Responders

## City Flood Preparedness Survey

In reference to each of the sixteen points of flood preparedness evaluation, city-specific subject matter experts were interviewed. Interview participants were initially identified based on website reviews that identified Chief Operating Officers, City Managers, Chief Planners and/or other senior city staff. By contacting these senior staff, they subsequently identified subject matter experts appropriate to respond to flood preparedness survey questions.

In general, survey questions were addressed by city planning, public works, sustainable development and/or emergency management departments. Periodically, city officials invited participation of local conservation authorities and utilities. Collectively, sixty subject-matter experts addressed survey questions (profiled under Key Findings) over a four month period (January – April, 2015).

## Data Analysis

Quantitative methods were used to assign scores to each of the survey questions. Each survey question was comprised of five pre-defined answer options modelled on a “Plan, Do, Check, Act” management framework.

To illustrate, if a city engaged no preparation in reference addressing flood potential relative to, for example, Electricity Supply, it would receive the lowest score of E. If the city was formulating a plan to address an area of flood preparedness, it would receive a higher score of D. If the city had a plan and if that plan was being implemented, the score would be C, and so on, to A.

If none of the pre-defined answers were considered appropriate by a city relative to how flood potential had been addressed for a particular factor, the city could opt for a response of “N/A” (Not Applicable). The response was noted, however a response of N/A was not included in the overall score calculation for the particular factor, nor was it included in the calculation of the city’s individual score.

To validate data collected during interviews, and to limit potential misinterpretation of survey responses, cities were provided with the option to review their responses. No further verification (e.g., in the form of an audit) pertaining to the validity of responses was undertaken.

The survey results are presented in two ways:

1. The flood preparedness of each city, relative to all parameters, is presented on a single figure and juxtaposed to the average (national) preparedness score for all fifteen cities (see Executive Summary), and
2. The flood preparedness for each factor, across all cities, is presented on a single figure (see Results).

Cities provided additional feedback about initiatives underway to mitigate impacts of flood events and challenges being faced. This qualitative feedback was assessed to identify common trends and implications, including select accomplishments and areas of challenge. Chapter 2 profiles the qualitative feedback received from the fifteen cities included in the survey.



## 2.0 Key Findings

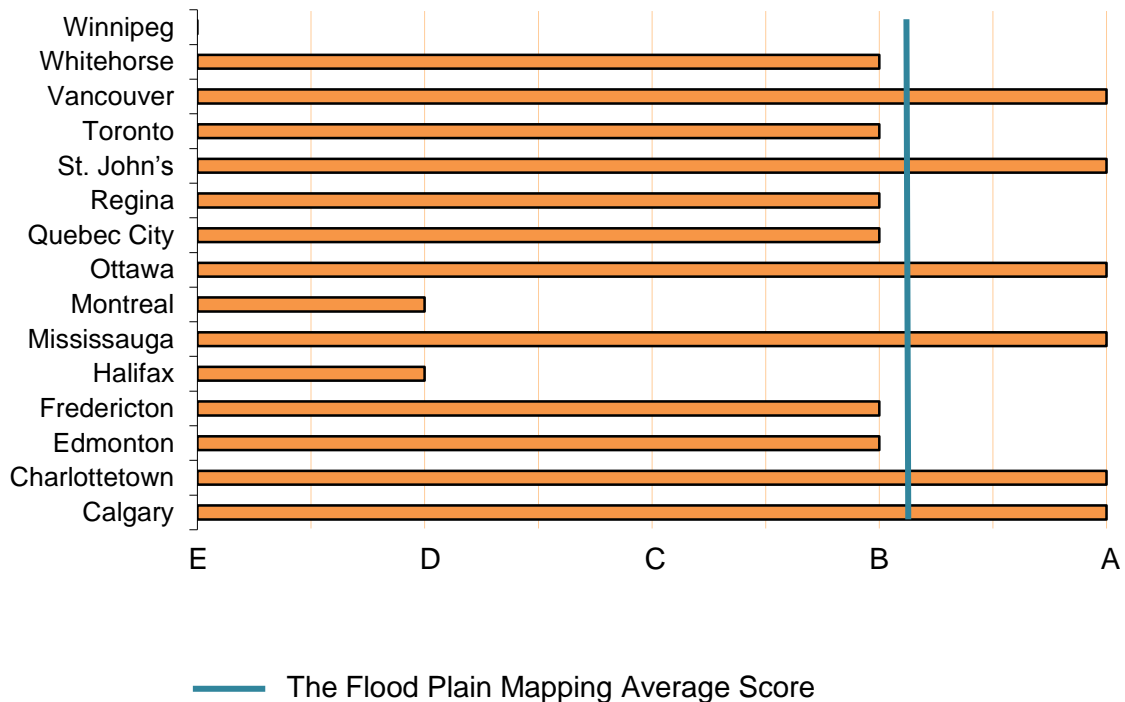
### 2.1. Flood Plain Mapping

Flood plain mapping is an important tool in the assessment and management of flood risks. Flood plain maps constitute a basis for land use and planning, infrastructure maintenance and development and emergency planning. Flood plain maps require regular updates to communicate accurate and reliable information to those who manage development within flood areas and to those who continue to live within the floodplains. For purposes of this study, no distinction was made between riverine (e.g., rain causing rivers to overflow banks) and urban (e.g., rain causing sewer back-ups) flooding.

**Survey Question 1:** Relative to flood-plain mapping, at which stage is your city in reference to addressing climate change/extreme weather and the establishment of flood plain maps?

- A. Flood plain maps for your city have been updated within the past 5 years, and they are forward projected (e.g., 15-25 years) to model future flood plains
- B. Flood plain maps for our city have been updated within the past 5 years
- C. Flood plain maps for our city were updated 5-15 years ago
- D. Flood plain maps were last updated for our city 15 years ago or longer
- E. Our city has no flood plain maps

**Figure 2.1: Flood Plain Mapping, Distribution of Scores for Fifteen Cities**



Note: Winnipeg selected the N/A answer option for the survey question above – accordingly, the city was not included in the scoring above. The city indicated that given the City’s flood protection system in place, there is no reason to update flood plain mapping.

### Select Accomplishments:

- Vancouver recently completed a coastal flood modeling project, which considered several sea level rise scenarios (0.6 meter, 1 meter and 2 meters). In addition to flood mapping, the project identified public infrastructure and assets that are located within the flood plain for the various sea level rise scenarios. This work led the city to amend its building bylaw with updated designated flood plains and flood construction levels in 2014, based on 1 meter of sea level rise (expected by 2100) and a 1-in-500-year storm surge. The city is now working on Phase 2 of the coastal flood risk project, which entails evaluating long-term flood management options for each of the flood plain areas. The objective is to create a roadmap for responding to rising sea level changes and will include structural and non-structural (i.e., planning, emergency response) approaches. This work is expected to be completed by the end of 2015.
- Winnipeg relies on its primary dike system and flood diversion projects (the Floodway) that divert floodwaters around the city. The city’s flood plain mapping c1980 deals with areas between the primary dike and the river and provides elevations that properties need to be protected. The mapping is up to the 1-in-100-year flood level and the Floodway was expanded 5 years ago to provide theoretical protection up to 1-in-700-year flood level.
- While Fredericton’s downtown is built in a historical flood plain and is over 200 years old, the city upgraded its sewer system to a separate sanitary and storm infrastructure. The city does not permit developments to connect drain tile to the storm system or sanitary system in the downtown. The city also implemented proactive building controls, which mandate that habitable space is only built in areas that were assessed above 1-in-500-year flood level.
- Calgary indicated that most of the flood plain mapping has been updated within the last 5 years and includes modeling of future flood plains (15-25 years out).
- In late 2012, Ottawa initiated a multi-year program to update and create new flood plain maps through funding support for local Conservation Authorities. The first sets of new and updated maps were approved in 2014.

## Areas of Challenge:

- Some survey respondents noted difficulties with assessing flood risks to critical infrastructure such as power, telecommunications, and transportation networks in flood plain areas. The difficulties are due to some of this infrastructure being privately held and managed, meaning that specific risks of flooding are hard to determine. It is usually only after a flood event that these risks are recognized. Proactive measures to address privately-owned and managed critical infrastructure are also hard to implement if there is insufficient cooperation between all parties involved.
- Although cities recognize the importance of flood plain mapping, some survey respondents indicated that climate change/extreme weather flood risk mapping is not considered part of a standard methodology.

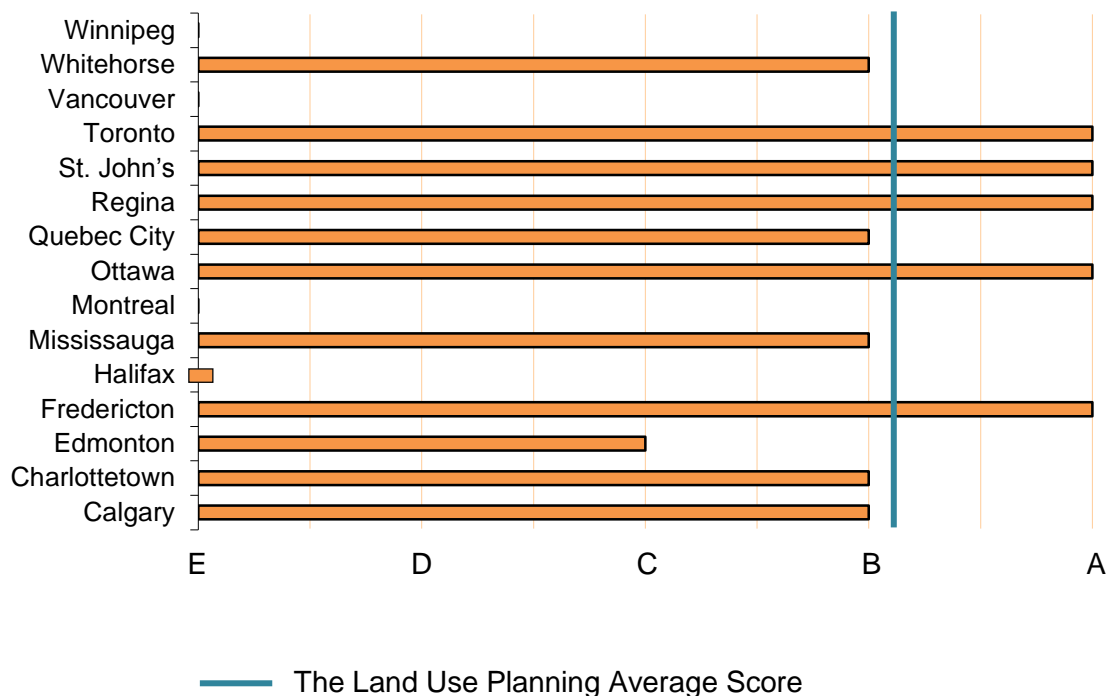
## 2.2. Land Use Planning

Regulations and policies pertaining to land use planning control new and existing development in flood areas and integrate flood risk management into municipal planning. Land use planning is considered one of the more critical components in managing flood risks, especially as a preventive measure. Detailed and regularly updated floodplain maps are the central instruments for flood risks assessments of municipal strategies and development plans.

**Survey Question 2:** Within your city, in reference to new residential and commercial development, to what degree does the potential for flooding factor into siting?

- A. Any history of flooding in an area would negate infrastructure development
- B. Flooding in an area over the period of the past 50 years would negate siting structures, or infrastructure would be established to limit the potential for 50 year floods
- C. Flooding in an area over the period of the past 20 - 50 years would negate siting structures, or infrastructure would be established to limit the potential for 20 – 50 year floods
- D. Flooding in an area over the period of the past 10 years would negate siting structures
- E. Past flooding in an area does not factor into siting structures

**Figure 2.2: Land Use Planning, Distribution of Scores for Fifteen Cities**



Note: Vancouver, Winnipeg and Montreal selected the N/A answer option for the survey question. Accordingly, these cities were not included in the scoring above. Cities provided the following comments:

- Vancouver does not have a history of flooding. High ocean water levels have generally affected only beaches and the seawall. Flooding from rainfall events has been fairly limited and generally resolved through upsizing pipes or installed additional catch basins.
- Winnipeg relies on a primary dike system: if a property is located on the “dry-side” of the primary dike there are no development restrictions. If a property is located on the “wet-side” of the primary dike, new developments need to be flood proofed to the flood protection level which is equivalent to the 1-in-100-year flood.

### Select Accomplishments:

- In light of the past few flood events (1-in-10 to 1-in-50-year floods) Regina undertook construction of some permanent flood control structures in the residential neighborhoods located in the flood plain areas. The city predicts that this measure will result in significant resource savings through reduction of costs associated with emergency response and recovery. The city estimates that only 1-in-100-year flood events pose an element of risk.
- St. John’s has placed flood mitigation as a priority with respect to infrastructure improvement, especially infrastructure that is susceptible to property damage. The city does not permit new development within flood plains and buffers and requires all new development to comply with zero net runoff.
- Toronto does not permit new development within the floodplain, except for within Special Policy Areas (SPAs), which must be protected from flooding to at least the 350-year level. SPA's are identified in the City's Official Plan.
- In light of the recent (2013) flood events, Calgary does not permit new development within floodways. Any new development within the flood fringe must mitigate the effects of floodwaters by building the main floor, mechanical and electrical systems above the anticipated 100 year flood level. City-owned infrastructure deemed necessary to be developed or maintained within the floodway is exempt from the above rules (this allows the city to develop such things as bridge abutments, cycling paths and walkways where they are needed).

## Areas of Challenge:

- Although cities recognize the importance of flood risk assessments, conflict can occur between City Administration and City Council. As one of the responders noted, “recently we had a case where a developer proposed a low income housing project on a known flood plain. City Administration recommended that this development application be denied based on previous flooding information of the area. Against our recommendation City Council approved the developer’s application and this development is currently underway.”
- Similarly, another responder noted that a registered owner of the land can apply for rezoning of land parcels located in flood plain area. If City Council approves rezoning, it is difficult to stop development.

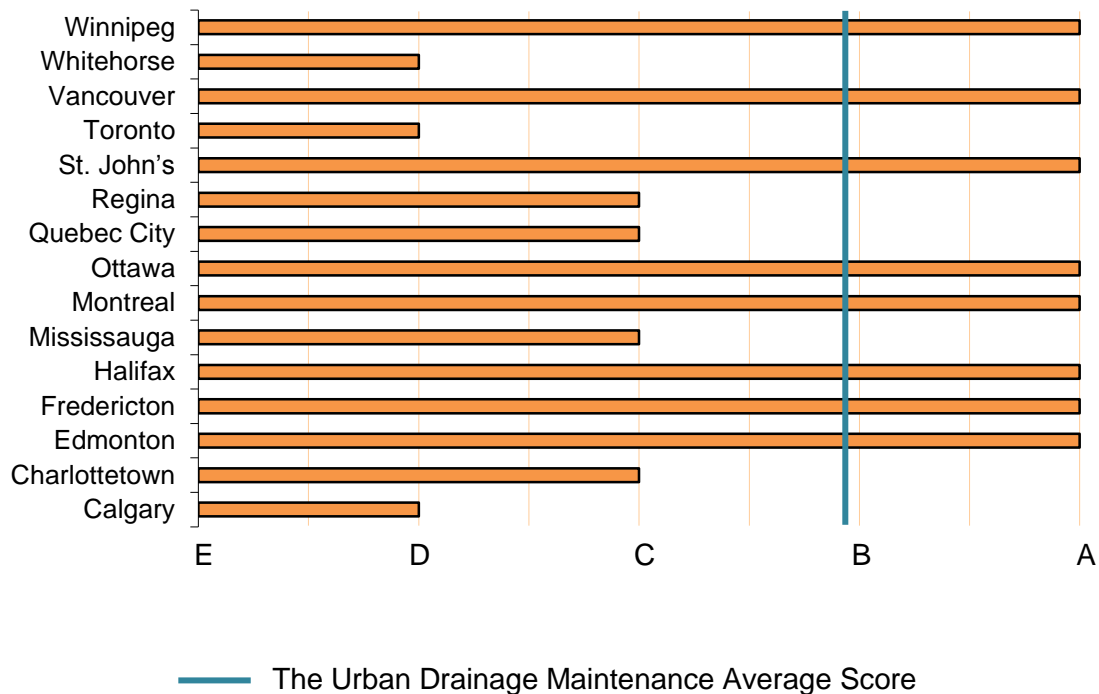
### 2.3. Urban Drainage Maintenance

Regular maintenance of urban drainage systems is essential for mitigating flooding and preventing pollutants from entering watercourses. Storm water drainage maintenance is required for preventing storm water flooding when the discharge capacity of a storm water drainage system is exceeded. With the growth of urban population, aging urban drainage infrastructure and increased intensity of precipitation, risk assessment of urban drainage systems is necessary for effective maintenance policies and programs.

**Survey Question 3:** In reference to water drainage capacity, what level of program does your city have in place?

- A. A city policy is in place to ensure water courses (e.g., culverts, sewer grates) remain free of debris, and the policy is in operation
- B. A city policy is in place to ensure water courses are free of obstruction(s)
- C. Water courses are cleared of debris during times of year when the potential for flooding is high
- D. A city practice is in place to clear water courses of blockages on an “as needed” basis
- E. No city practices are in place to ensure water courses remain free of debris

**Figure 2.3: Urban Drainage Maintenance, Distribution of Scores for Fifteen Cities**



## Select Accomplishments:

- In 2004 and 2012, Edmonton experienced unusually heavy rains, accompanied by hail stones and high wind. These storm events caused street flooding and sewer backups in more than 5,200 homes city-wide. Some of the city's infrastructure also experienced considerable damage including manhole blow-outs, pump station flooding, park trail wash-out, and bridge abutment erosion. A number of flood mitigation projects were developed to address future flooding in the most affected communities relative to similar major rainfall events. A number of these projects have either been constructed or scheduled for implementation. These flood mitigation works were designed to address flooding in only the impacted neighborhoods and hence are reactive in nature.

The severity of these extreme weather events and associated damages have also prompted Drainage Services to have a proactive and a long-term city-wide flood mitigation strategy in place to address flooding in other communities that are at risk, but have not experienced any major rainstorm events in the past.

Through a preliminary risk assessment study, based on Edmonton's current drainage system level of service, historically reported flooding and the extent of low-trapped locations, over 150 residential neighborhoods and 28 industrial areas have been identified for further investigation and potential flood mitigation enhancements. The drainage systems in these areas have limited capacities as they were designed to only carry runoff from small and frequent rainfall events, without major drainage systems or overland drainage for flood control i.e., these were the engineering design standards in effect at the time these areas were built. Many locations in these areas have low-trapped areas without well-defined outlet for surface water to drain away. During major storm events, surface flooding in these low-trapped areas can inundate the sanitary sewer systems and cause sanitary sewer lines to be filled beyond capacity.

Drainage Services is currently undertaking engineering assessment studies to help identify potential capital mitigation measures and include them in a proposed city-wide Flood Mitigation Program. These assessments are being conducted in phases.

For each area, the proposed flood mitigation strategy of Edmonton is expected to be holistic and comprehensive to ensure that:

1. Where feasible, all mature and at-risk neighborhoods have major drainage systems such as storm water management ponds and/or well-defined overland flow routes in place to reduce flood risk,
2. Any drainage improvement works take into consideration the increasing frequency and severity of extreme weather events in Edmonton,
3. Plans and management strategies are in place for flood prone neighbourhoods that exist within the River Valley such as Rosssdale, Riverdale and Cloverdale, and
4. Where practical, combined sewer separation is implemented to help reduce flood risk in areas where there is combined sewer service.



- In the early 2000's, the Fredericton adopted a policy to increase all major urban drainage system components capacity to 1.2 times the 1-in-100-year event. Since then, the majority of large culverts and other drainage structures owned by the city have been upgraded to this new standard. The city maintains a minor urban drainage system built for 1-in-10-year events. The city also invested into replacing a combined sewer system by installing separated sanitary and sewer lines, which eliminated the risk of combined sewer overflow.
- Ottawa monitors storm sewer inlet and outlet grates and clears them on regularly. Spring freshet flood mitigation measures for open water systems are undertaken to prevent ice jams and to absorb the release of upstream reserves at dams. City staff are engaged with common citizens to monitor vulnerable areas. When the potential for flooding is high, the watercourses are cleared. This is an annual and budgeted program.
- Vancouver has nearly completed (2015) an Integrated Storm Water Management Plan, which will include recommendations for green infrastructure on public and private land. The plan is meant to help support more permeable approaches to storm water management in the city and to provide better resilience to flooding and improved water quality of the storm water runoff. The city has an annual storm water maintenance program for catch basins and pipes. There are very few open watercourses in the city and these are primarily located in parks. Maintenance for these is done on an as-needed basis. The city is working toward the Province of British Columbia's environmental goal to eliminate sewage overflows by 2050.
- Winnipeg described urban drainage approaches that vary according to the season: during winter, major drainage systems are cleared of snow prior to the snowmelt, during spring inlet grates on these drains are inspected and kept clear, and during summer a cattail cutting program is carried out to keep the major drains open. The city maintains an on-going beaver trapping and dam removal program throughout the open-water season.
- Some cities indicated that having natural drainage infrastructure features, such as disconnected downspouts, rock pits, drainage swales and detention ponds, should be encouraged to reduce the volumes of water from entering sewer systems during floods.

### Areas of Challenge:

- Some respondents pointed out that watercourses are not sewers and having natural vegetation/logs within them can be a very good thing from a biological and water quality point of view. They noted that a blanket policy to keep watercourses free of obstructions may not be always preferred.
- Some respondents suggested that better coordination between urban planners, developers, and municipal officials is required to improve drainage systems (in particular, natural drainage systems) and to encourage public involvement in reducing basement flooding.

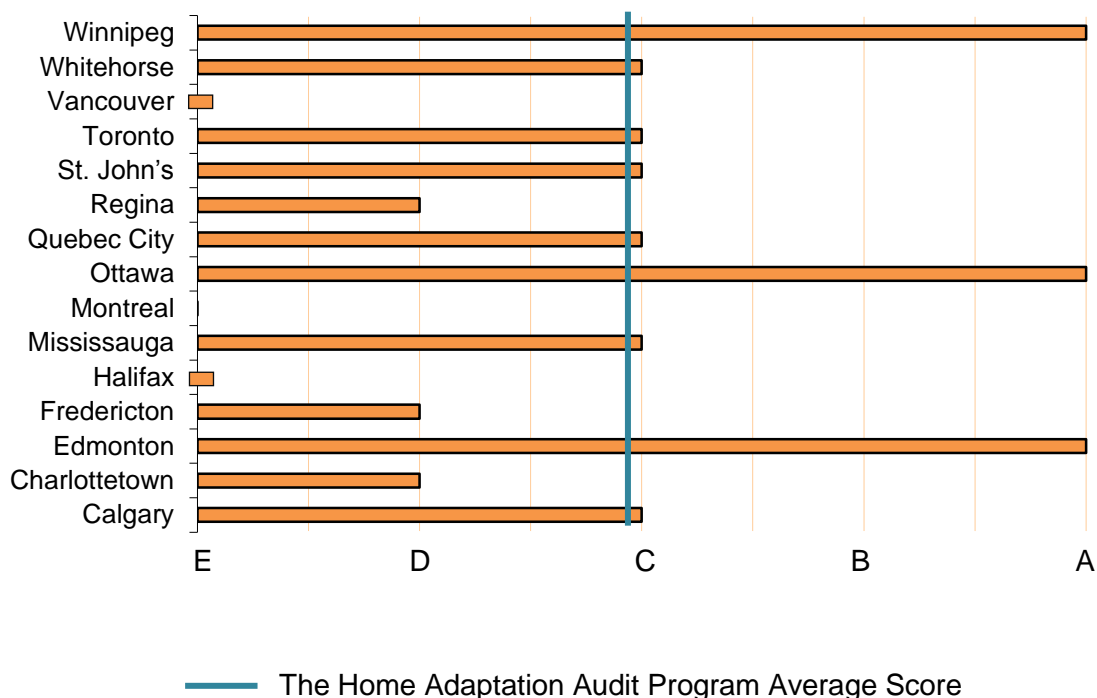
## 2.4. Home Adaptation Audit

Home adaptation audit programs help homeowners identify key areas where their homes may be vulnerable to basement flooding. Cities across Canada have begun offering education programs and subsidies to encourage the public to undertake home renovations to minimize property damages during flood events.

**Survey Question 4:** In reference to helping home owners limit the probability of household/basement flooding, what level of program does your city have in place?

- A. Our city has a city subsidized Home Adaptation Audit Program (or equivalent) to help homeowners identify key areas where homes may be vulnerable to basement flooding
- B. Our city has a non-subsidized Home Adaptation Audit Program (or equivalent) to identify key areas where homes are vulnerable to basement flooding
- C. Our city provides on-line information to help homeowners self-assess their property relative to basement flood potential
- D. Our city encourages homeowners to self-assess to limit the probability of basement flooding
- E. Our city has no program to encourage homeowners to limit basement flooding

**Figure 2.4: Home Adaptation Audit Program, Distribution of Scores for Fifteen Cities**



Note: Montreal selected the N/A answer option for the survey question above, and was therefore not included in the scoring.

## Select Accomplishments:

- Edmonton provides a Flood Prevention Home Check-Up service, which brings a drainage specialist into homes for a free one-on-one interior and exterior drainage assessment. The service is available to any residential homeowner in Edmonton. However, preference for booking an appointment is given to homeowners that have a history of flooding.
- Fredericton provides a free 24 hr/7 day a week cleaning service for sanitary sewer laterals. This practice allows its staff to check for cross connections. The city indicated that there are very few basement flooding incidents caused by the back-up of sanitary sewers and that this is not expected to change due to climate change.
- Winnipeg implemented a number of programs to mitigate urban flood risks. For example, the city has an on-going program to add storm relief pipes and improve level of service for combined sewer districts. The city sends a yearly mail-out to homeowners to inform them of options to prevent basement flooding and offers a subsidy program for installing approved backwater valves and sump pits. Winnipeg and Province of Manitoba have introduced a subsidy program to help homeowners protect their basement from flooding caused by overloaded sewers during severe weather.
- Toronto provides educational materials and information through their website on benefits of installing backwater valves. This is a complementary action that the city undertakes as part of its Basement Flooding Protection Program to inform, educate, and help the public take actions to reduce the risk of flooding on their property.

## Areas of Challenge:

- Some respondents identified issues with offering 100% reimbursement for the installation of backwater valves for new or redeveloped homes in light of other property owners having already paid for these installations without any subsidies.
- Other respondents expressed concerns with using public funds to improve privately-owned properties, as opposed to making investments into public drainage system development.
- During interviews, one respondent shared that a large townhouse development was recently approved in a flood-prone area. Neighboring residents were faced with waste and storm sewer backup in their basements for years, indicating that the trunk line in the area already could not handle the water that was flowing into it. These residents expressed concerns that the new townhouse development may make their situation worse. The city has engaged a study to investigate sewer backup issues in the area. As a follow on to the study, the city offered a subsidy program to the residents living in the area to buy high-end back-flow valves for their basements. However, the city did not communicate which houses were offered the program because of the potential negative impact to property value. City Council approved the zoning bylaw amendment to accommodate the development.

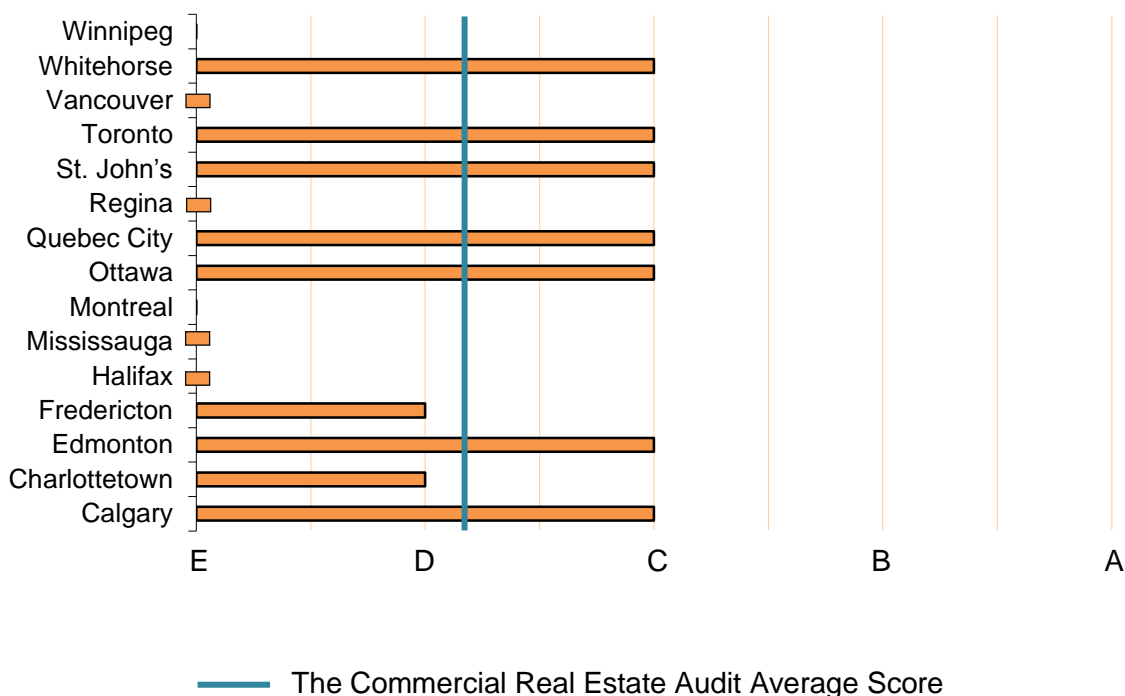
## 2.5. Commercial Real Estate Adaptation Audit

Commercial real estate adaptation audit programs help commercial property owners identify key areas where their properties may be vulnerable to flooding. Cities across Canada have begun to offer education programs and subsidies to encourage commercial property owners to undertake renovations/actions to minimize potential flood damage.

**Survey Question 5:** In reference to helping commercial real estate owners/managers limit the probability of flooding of commercial buildings, what level of program does your city have in place?

- A. Our city has a subsidized Commercial Real Estate Adaptation Audit Program (or equivalent) in place to identify key areas where commercial real estate may be vulnerable to flooding
- B. Our city has a non-subsidized Commercial Real Estate Adaptation Audit Program (or equivalent) in place to identify key areas where commercial real estate may be vulnerable to flooding
- C. Our city provides on-line information to help commercial real estate property owners/managers to self-assess their property relative to flood potential
- D. Our city encourages commercial real estate owners/managers to self-assess to limit the probability of flooding
- E. Our city has no program to encourage commercial real estate property owners/managers to limit flooding

**Figure 2.5: Commercial Real Estate Audit, Distribution of Scores for Fifteen Cities**



Note: Winnipeg and Montreal selected the N/A answer option for the survey question. Accordingly, these cities were not included in the scoring above.

### Select Accomplishments:

- Ottawa and surrounding Ontario Conservation Authorities have a memorandum of understanding to provide technical advice to residents and developers with regards to planning applications. Individuals interested in purchasing commercial real estate within the city can submit requests to obtain flood plain information through the Conservation Authority. They can also access flood plain information through the online application, GeoOttawa. If a property is in or adjacent to a regulated floodplain, owners need to obtain a permit from the local Conservation Authority for any development, in addition to meeting city zoning requirements.
- Toronto provides information on its website in reference to basement flooding issues, in an effort to raise awareness and educate the public on actions that they can take to reduce the risk of flooding on private property. In addition, Toronto and Region Conservation Authority (TRCA) provides information to real estate/property owners through a solicitor/realtor inquiry program. This information can be accessed online through a TRCA maps application.

### Areas of Challenge:

- None of the cities indicated that they offer a commercial real estate adaptation audit program, either subsidized or a non-subsidized. This led to a relatively low Commercial Real Estate Adaptation Audit score.

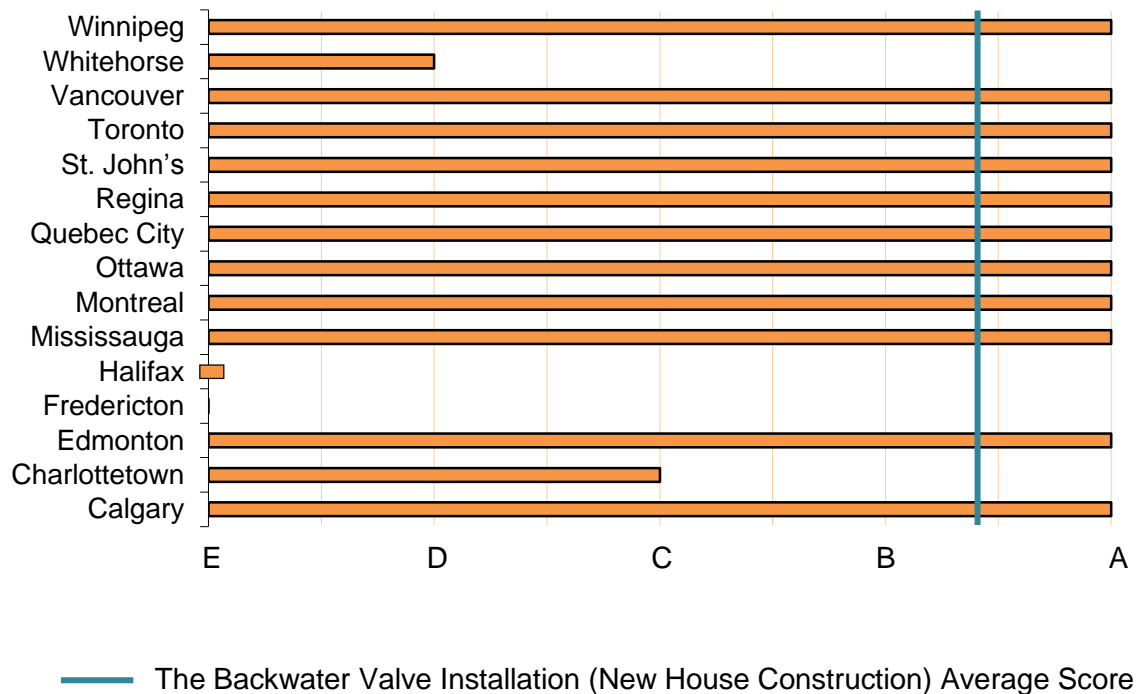
## 2.6. Backwater Valve Installation (New House Construction)

Backwater valve installations can reduce the risk of sewer back-up water inflows during extreme precipitation events for houses connected to municipal sewer systems. Overall, cities across Canada have done exceptionally well in mandating, and in many instances subsidizing, backwater valve installations for new house construction.

**Survey Question 6:** To what level does your city mandate the installation of backwater valves to limit potential residential basement flooding?

- A. Our city mandates the installation of backwater valves during new house construction
- B. Our city offers a subsidy to install backwater valves during new house construction
- C. Our city provides educational programs to encourage homeowners to install backwater valves during new house construction
- D. Our city encourages homeowners to install backwater valves during new house construction
- E. Our city has no program to encourage the installation of backwater valves for new house construction

**Figure 2.6: Backwater Valve Installation (New House Construction), Distribution of Scores for Fifteen Cities**



Note: Fredericton selected the N/A answer option for the survey question indicating that backwater valves are installed on all sanitary sewer connections. Accordingly, the city was not included in the scoring above.

## Select Accomplishments:

- Eleven cities indicated that they mandate backwater valve installation for new house construction. Notably, the 2012 Ontario Building Code stipulates that sewage back-water valves are required in residential buildings connected to a public sewage system, if deemed necessary at a local level<sup>2</sup>.
- Calgary extended its previous program, requiring only basement bathrooms to have a dedicated backwater valve, to require all main house service connections to be equipped with backwater valves.
- Winnipeg was an early enactor of by-laws to require backwater valves and sump pits installed for new construction, in 1979 and 1990 respectively.

## Areas of Challenge:

- Some responders described the risks of not having a backwater valve installation mandate for properties located in high risk areas. They shared instances where one home installed a backwater valve but the adjacent home did not – basement flooding was often compounded in the unprotected home.
- Some responders noted that installation of backwater valves provides only a secondary line of defense. Improvements to drainage infrastructure, long term investments into redevelopment of sanitary and storm sewer systems, and the introduction of green infrastructure techniques are also required to protect property from loss.

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<sup>2</sup> Ontario Ministry of Municipal Affairs and Housing. 2012 Building Code Overview. Accessed on March 23, 2015 at: <http://www.mah.gov.on.ca/Page10300.aspx>

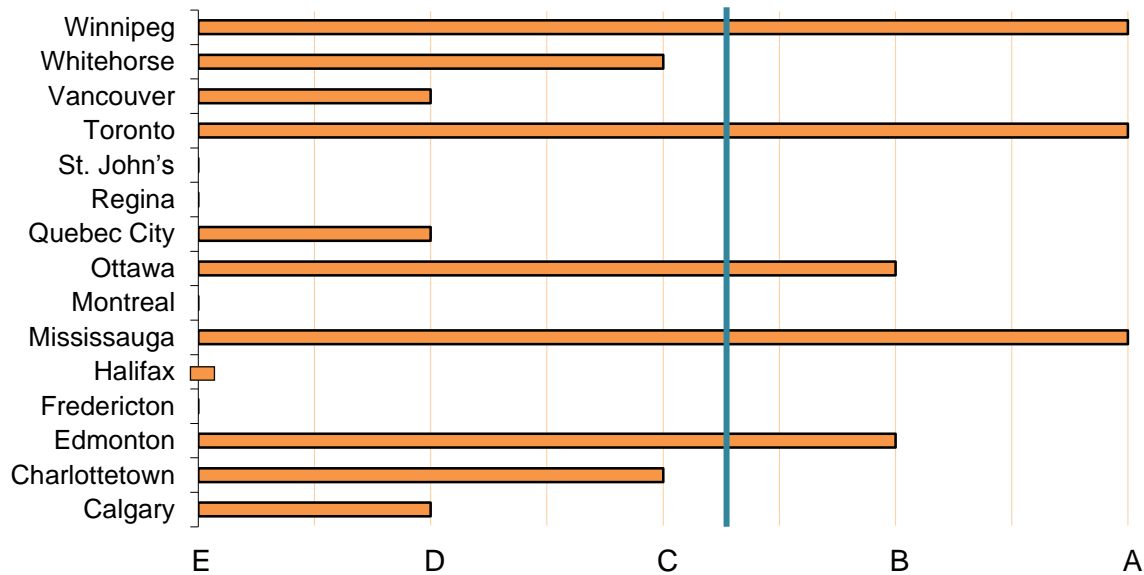
## 2.7. Backwater Valve Installation (House Retrofits)

To limit basement flood potential for existing homes, some cities provide subsidies for backwater valves to be installed. Eligibility requirements for subsidies varied substantially between cities.

**Survey Question 7:** To what level does your city support retrofits for backwater valve installation to existing housing?

- A. Our city offers a subsidy to all home owners to install a backwater valve
- B. For homeowners who have experienced basement flooding, our city offers a subsidy to home owners to install a backwater valve
- C. Our city offers educational programs to encourage homeowners to install backwater valves as retrofits
- D. Our city encourages homeowners to install backwater valves as retrofits
- E. Our city has no program to encourage the installation of backwater valves as retrofits

**Figure 2.7: Backwater Valve Installation (House Retrofits), Distribution of Scores for Fifteen Cities**



— The Backwater Valve Installation (House Retrofits) Average Score

Note: Fredericton, Montreal, Regina and St. John's selected the N/A answer option for the survey question. Accordingly, these cities were not included in the scoring above.



## Select Accomplishments:

- Mississauga has waived building permit fees for the installation of backwater valves for residents that experienced flooding resulting from a July 8, 2013 high intensity rain.
- Toronto offers owners of single-family, duplex and triplex residential homes a financial subsidy of up to \$3,400 per property to install flood protection devices, including a backwater valve, sump pump, and pipe severance and capping of the home's storm sewer or external weeping tile connection.
- Edmonton has reimbursed 5,044 homes for backwater valves installation from 1991 - 2015.

## Areas of Challenge:

- Some respondents surveyed indicated that there is generally a limited uptake of backwater valve installation for house retrofits. This may be due to low levels of household owner awareness of the potential flood risks and their property damage exposure. Cities indicated that even residents who experience sewer back-up issues are often reluctant to apply for a subsidy to install backwater valves.
- Some respondents noted that residents are hesitant to install backwater valves because of their concerns with potential problems with the device. One of the responders indicated that if a backwater valve is operated manually it is sometimes impossible for homeowners to close it during heavy rainfalls. Some automatic versions of backwater valves require frequent maintenance and regular inspection; some have very specific installation requirements.
- Other respondents also noted that backwater valves do not eliminate the risk of property loss or damage; they can be effective only if adequate municipal storm and wastewater systems are in place.

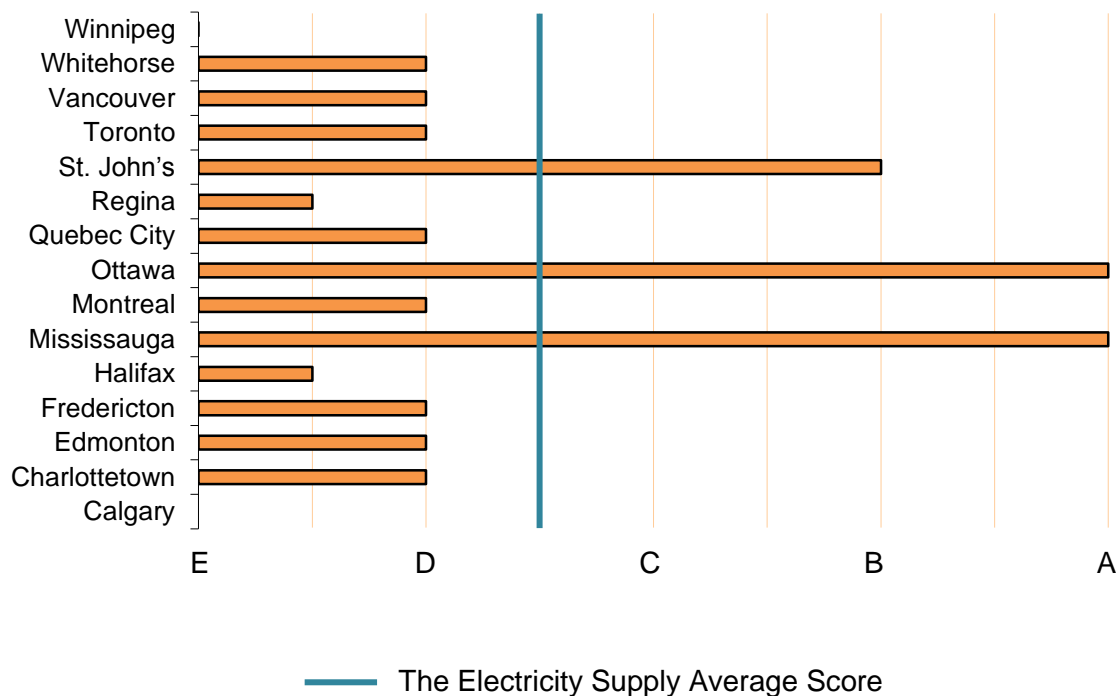
## 2.8. Electricity Supply

Electricity supply relies on the effective functioning of generation, transmission and distribution systems. Disruption of electricity supply can seriously impact the ability of cities to operate essential life support systems, including water treatment facilities and sewage pumping stations, hospitals and health care facilities, emergency centers, transportation and telecommunication systems.

**Survey Question 8:** To what level has your city factored flood mitigation into maintaining the continuity of electricity supply?

- A. Relative to electricity generation, transmission and distribution, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to electricity generation, transmission and distribution, our city has identified flood-related vulnerabilities and instituted adaptation practices
- C. Relative to electricity generation, transmission and distribution, our city has identified and budgeted for flood-related vulnerabilities
- D. Relative to electricity generation, or transmission, or distribution, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify the vulnerability of electricity supply to flooding

**Figure 2.8: Electricity Supply, Distribution of Scores for Fifteen Cities**



Note: Calgary and Winnipeg selected the N/A answer option for the survey question. Accordingly, both cities were not included in the scoring above. These cities provided the following comments:

- Winnipeg indicated that electrical transmission and distribution is located on the “dry side” of the primary dike system.
- Calgary indicated that while the city has identified flood-related vulnerabilities and works with ENMAX Corporation to address flood related issues, the city is not responsible for maintaining a continuity of electricity supply during a flood.

### Select Accomplishments:

- Ottawa has a mix of redundant power supply for various city facilities based on the type of building, their primary purpose, date of build and budget requirements. For example, the city utilizes a mix of full back-up power and uninterruptible power supply (UPS) systems in some facilities, while other facilities rely on generator power only. A variety of redundancies for the corporate radio system including redundant power sources, back-up generator power and universal power systems to ensure availability during flood or other emergency have been implemented. The city offers smaller generators for deployment as necessary.
- Calgary has indicated that ENMAX Corporation is a member of Calgary Emergency Management Agency (CEMA), and both organizations work closely to ensure continuity of power to citizens.
- Enersource Corporation, the City of Mississauga energy provider, indicated that there is no generation within Mississauga that would be affected by flooding.
- Working in close collaboration with the major organizations involved in the provision and delivery of electricity to the City of Toronto (i.e. Toronto Hydro, Hydro One, Ontario Power Generation, Ontario Power Authority, and the Ontario Ministry of Energy), the city is currently evaluating the vulnerability of electrical systems to severe weather events.

### Areas of Challenge:

- Responsibility for electricity supply to the community at large is not within the municipal mandate. Some respondents indicated that they are not responsible for maintaining continuity of electricity supply during a flood.
- Some respondents indicated that aging electricity infrastructure, including power plants, transmission and distribution lines, transformers, substations and building electrical equipment threaten their cities’ ability to respond to flooding and ensure public safety.
- Furthermore, power network vulnerability can cause a domino-effect on other critical infrastructure, sometimes leading to disruptions to the operation of water treatment plants, sewage pipelines, pumping stations, gas pipelines, as well as transportation and other life-critical systems. Continuity of electricity supply, or lack thereof, can impact the ability of emergency responders to act, and to ensure the safety of citizens.

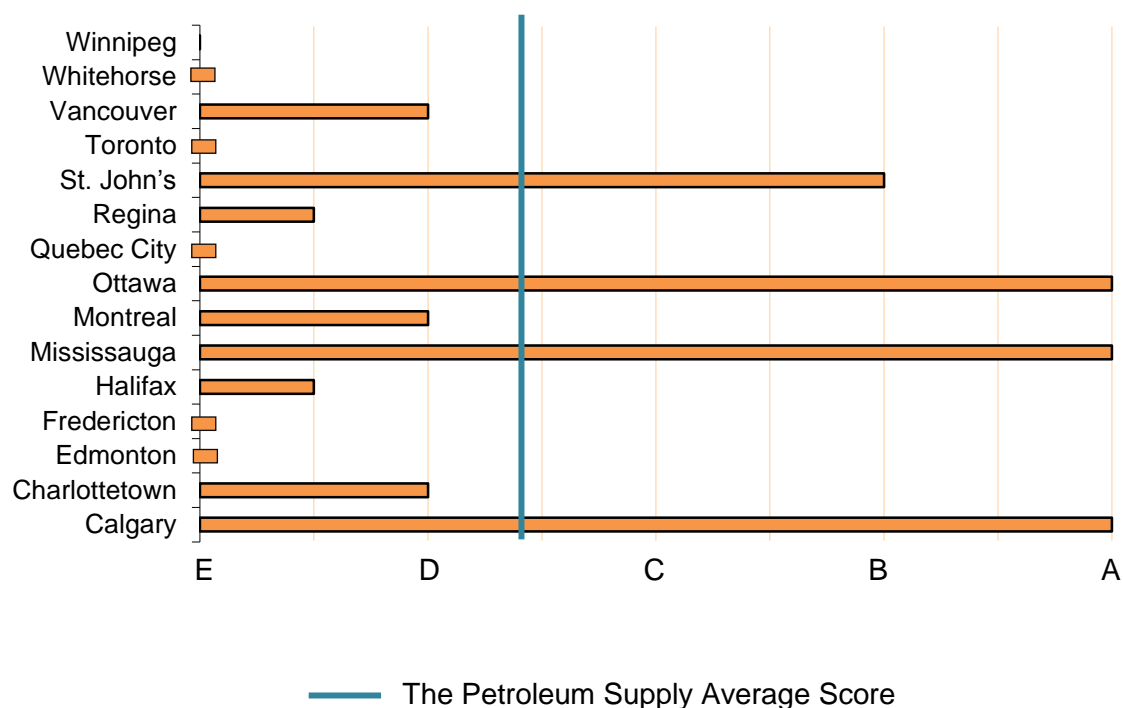
## 2.9. Petroleum Supply

The vulnerability and reliability of a city's petroleum supply affects the cities' ability to manage emergency response during flooding. The continuity of petroleum supply depends on a city's ability to coordinate agreements with suppliers during a flood. Assessment of the fuel demand during an emergency is typically required to ensure cities have fuel supply needed for emergency response, heavy equipment vehicles, generators, and for members of the community needing to fuel personal vehicles to abide evacuation orders.

**Survey Question 9:** To what level has your city factored flood mitigation into maintaining the continuity of petroleum supply (gas, oil and diesel)?

- A. Relative to petroleum supply, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to petroleum supply, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to petroleum supply, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to petroleum supply, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of petroleum supply

**Figure 2.9: Petroleum Supply, Distribution of Scores for Fifteen Cities**



Note: Winnipeg selected N/A answer option for the survey question indicating that none of the city's petroleum supplies are located in flood prone areas. Accordingly, the city was not included in the scoring above.

### Select Accomplishments:

- Calgary has agreements with suppliers for the provision of fuel during emergencies. The city has identified critical functions, which should there be a shortage of fuel, are guaranteed to receive fuel provisions.
- Mississauga emphasized the importance of underground fuel storage tanks and electronic fuel pumps to secure its gasoline and diesel supply. These storage facilities allow the city to continue to operate critical facilities run by back-up generators in the event of a flood. An electronic fuel dispensing system is set-up at the fuelling pumps for security and tracking purposes. A manual override is provided for dispensing, if required. All work yards have emergency back-up generators capable of providing electrical power supply for the fuel pumps. The underground fuel storage tanks are refueled once fuel levels decrease to less than one-quarter full. Fuel service delivery is provided the next day by the city's fuel supplier.
- Ottawa has completed a fuel management guide and has done work to ensure redundant supply of petroleum for key city activities and facilities. The city also has plans in place to prioritize city fuel needs. The plans are reviewed annually, or as required. While the city's fuel supply is a part of the annual budget, the costs of emergency fuel provisions are included in disaster recovery funds.

### Areas of Challenge:

- Similar to electricity supply, some respondents indicated that the responsibility for petroleum supply to the community at large is typically not within the municipal mandate. Four cities surveyed indicated that they are not responsible for maintaining the continuity of petroleum supply during a flood.

Notably, petroleum supply typically comes from bulk storage facilities that contain hazardous materials such as oil products and chemical substances, which pose significant risk if subject to floods. Although they are privately owned or operated, in case of structural damage during flooding, the city is responsible for ensuring public safety and health.

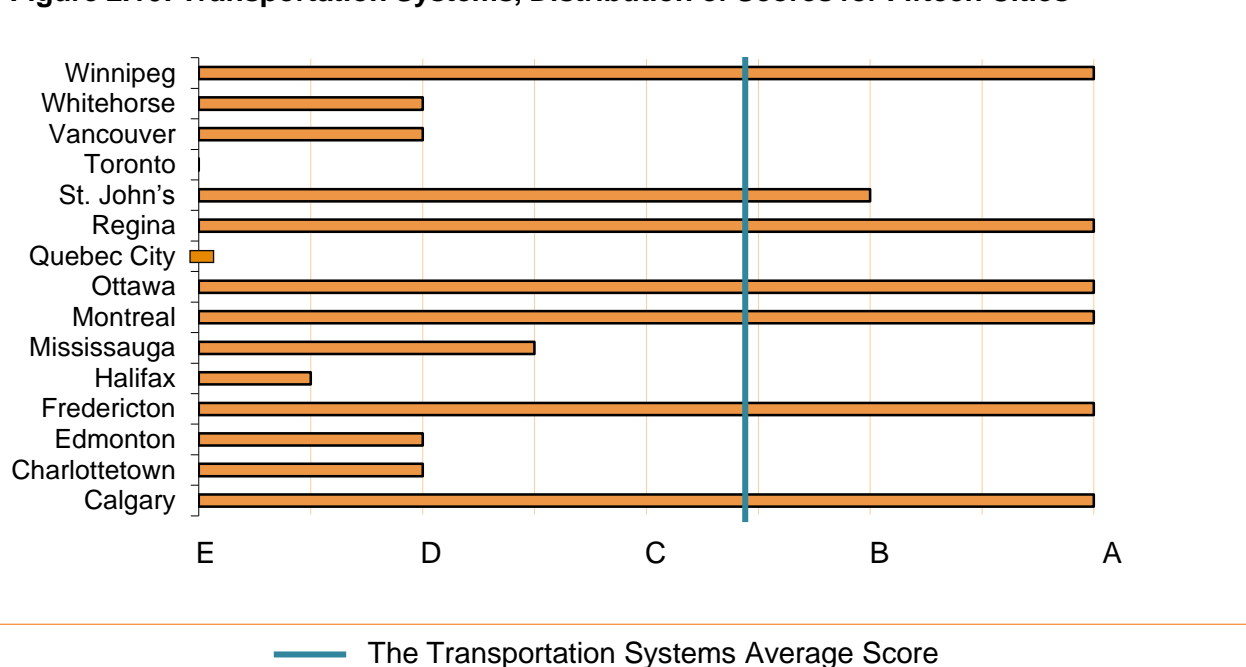
## 2.10. Transportation Systems

Flood related adaptation practices include identification of flood prone areas of transportation networks, vulnerability assessments, existence of mechanisms to mitigate impacts of flooding, such as flood related road closure notifications, traffic control warning signs and emergency detour routes.

**Survey Question 10:** To what level has your city factored flood mitigation into maintaining the continuity of transportation systems (road, rail, air, ship)?

- A. Relative to transportation, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to transportation, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to transportation, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to transportation, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of transportation systems

**Figure 2.10: Transportation Systems, Distribution of Scores for Fifteen Cities**



Note: Toronto selected the N/A answer option for the survey question indicating that transportation is a multi-jurisdictional issue and therefore cannot be answered solely by the City. Accordingly, the city was not included in the scoring above.

### Select Accomplishments:

- Calgary has prioritized the road network into three priority routes. Priority one routes, should they be affected by a flood event, are addressed first. Access and egress in communities is also maintained in the event of an evacuation order.
- Regina indicated that roads and bridges can be affected by flooding. Every year the city monitors for ice damming at several locations. In case of a potential flood year, the city uses permanent and temporary flood control measures to keep water off the roads and to maintain access to all services and properties.
- Toronto Transportation Services division has undertaken a detailed climate change risk assessment of its operations and services and is integrating the results into operations and planning. Transportation Services is primarily focused on the operation and maintenance of the city's road network. Similar work is underway by the TTC.
- Fredericton has designated sections of the city's major transportation network to first responders to be used during flood events. The City has also installed flood check valves at key locations to keep roadways open during floods.
- Ottawa is using flood plain mapping to identify where roads may be inundated during floods to improve route planning.

### Areas of Challenge:

- Some respondents indicated that transportation is a multi-jurisdictional issue and therefore cannot be answered solely by the cities. Although transportation networks are not always solely under municipal responsibility, cities remain responsible for well-being of its citizens, who may be directly affected by potential events resulting from damage of these networks.
- Some respondents indicated that they do not consider flood-related vulnerabilities of gas and oil pipelines – effectively transportation systems – located in flood-prone areas. Indeed, some cities have granted permanent easements for natural gas pipelines to be located partially within regional storm flood plain areas.

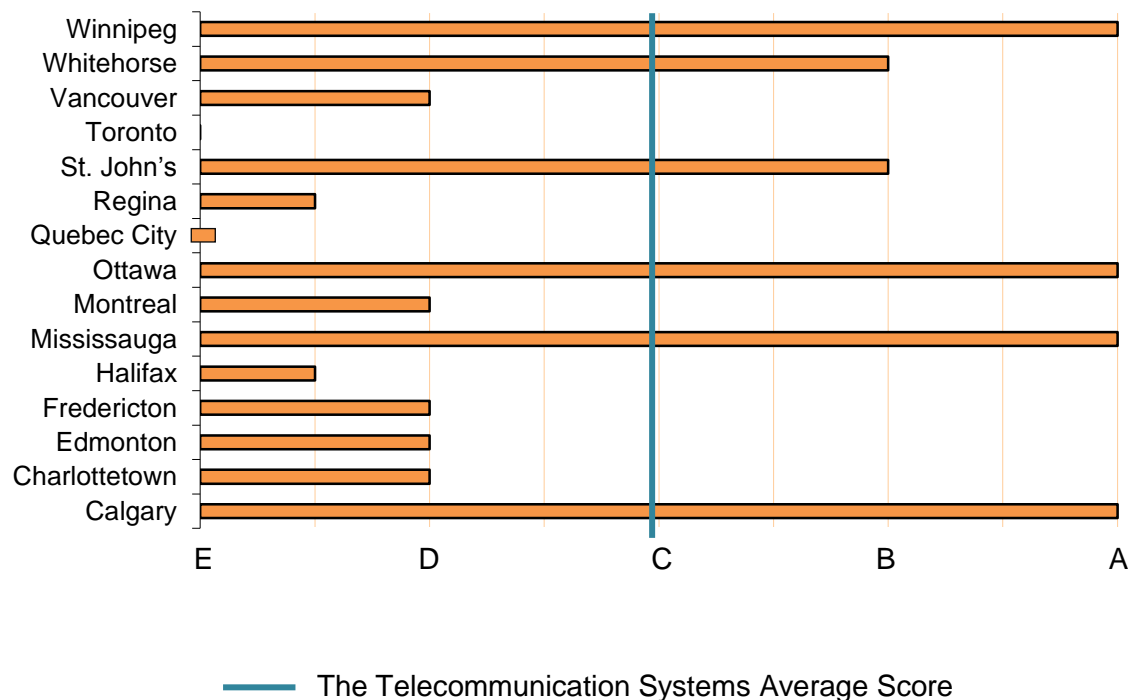
## 2.11. Telecommunication Systems

The vulnerability and reliability of telecommunication systems affects cities' ability to manage emergency response during flooding. Flood related adaptation practices include vulnerability assessments of telecommunication hubs that provide emergency information for the general population.

**Survey Question 11:** To what level has your city factored flood mitigation into maintaining the continuity of telecommunications networks (phone, internet, TV)?

- A. Relative to telecommunications, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to telecommunications, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to telecommunications, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to telecommunications, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of telecommunications systems

**Figure 2.11: Telecommunication Systems, Distribution of Scores for Fifteen Cities**



Note: Toronto selected the N/A answer option for the survey question indicating that telecommunication system is not a direct city responsibility. Accordingly, the city was not included in the scoring above.



## Select Accomplishments:

- Calgary indicated that telecommunications networks are mostly outside the city's control. Where telecommunications networks are owned by member agencies, CEMA (Calgary Emergency Management Agency) supports efforts to protect critical infrastructure through mapping of members' critical infrastructure onto its common operating database. Based on this information, CEMA determines which infrastructure is more at risk based on various parameters, such as flood inundation map layers.
- Mississauga has full redundancy for all of the city's telecommunications/systems for all disaster types, including floods or power outages. The city has a complete redundant site over 30 km's away from primary site, which has full telecommunications (voice/data/Internet) in an ACTIVE mode. The redundant site is always active and will continue to provide voice/data/internet services should the primary site be interrupted.
- Ottawa has undertaken a variety of hazard mitigation activities to support the continuity of telecommunication networks including internet, data networks and voice over IP systems. The city acknowledged that its data centers are not located within identified flood plains nor below grade. However, these data centers could be impacted by urban flooding, thus the city is currently undertaking a business continuity assessment to determine where and what technology is critical relative to recovery timelines.
- Regina is in the process (2015) of implementing an emergency notification system developed by Everbridge. This system keeps everyone who signs up for the program informed before, during and after events.

## Areas of Challenge:

- Telecommunication systems are generally perceived to not fall within the direct responsibility of a city's mandate. Accordingly, some cities have concentrated their efforts on encouraging the telecommunications industry to consider flood risks, supporting telecommunications providers with expert advice, where applicable.
- Respondents acknowledged that modern cities cannot function without constant access to data centers, as critical facilities such as hospitals rely on constant access to information housed within their data centers. As flooding may require immediate shutdown of power networks to prevent further damage, telecommunication systems may become unavailable, which implies that data centers may become temporarily inaccessible.

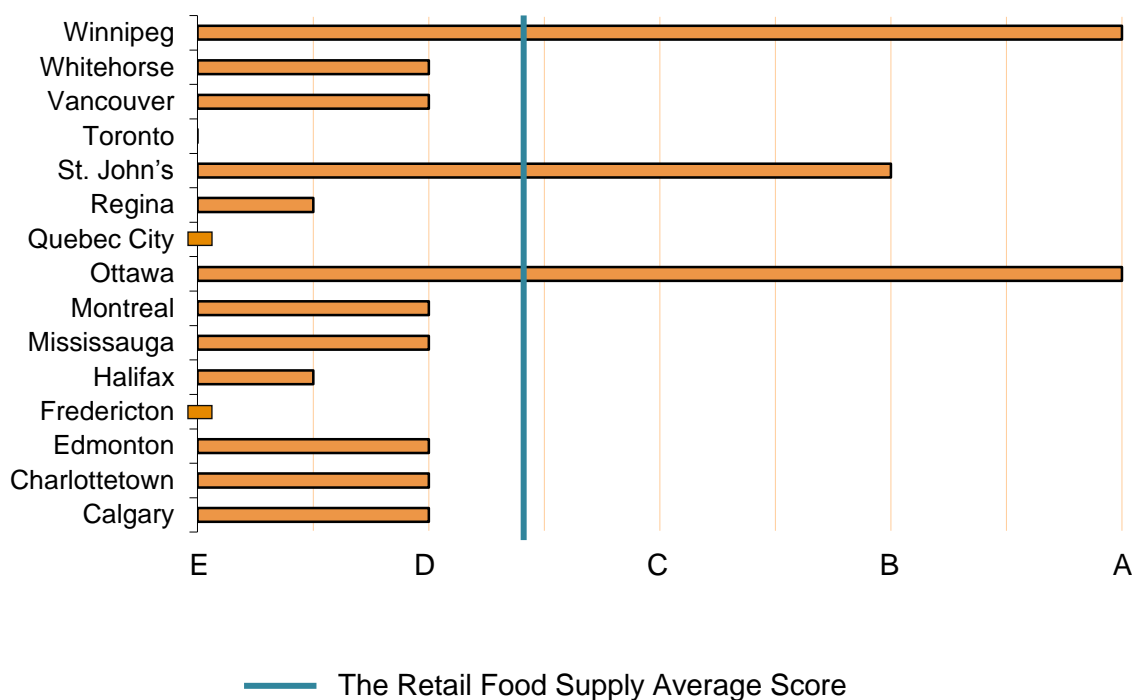
## 2.12. Retail Food Supply

The vulnerability of retail food supply relates to the extent to which cities coordinate agreements with suppliers for the provision of food during a flood.

**Survey Question 12:** To what level has your city factored flood mitigation into maintaining the integrity of retail food supply?

- A. Relative to retail food supply, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to retail food supply, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to retail food supply, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to retail food supply, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of retail food supply

**Figure 2.12: Retail Food Supply, Distribution of Scores for Fifteen Cities**



Note: Toronto selected the N/A answer option for the survey question, indicating that the city is not involved directly in this area. Accordingly, the city was not included in the scoring above. The city provided the following comments:

- Toronto does have a food security and supply strategy, and an urban agriculture strategy, which indirectly addresses this issue. Action is being taken from a perspective of social/health benefits as opposed to a climate change resilience lens.

### Select Accomplishments:

- Ottawa has a public feeding supply function, under the emergency social services plan contained within the overall city emergency plan. This feeding function establishes procedures, processes and protocols to ensure access to a safe and appropriate food supply for people affected by emergencies, as well as guidance for emergency responders. The delivery of emergency social services is supported by a memorandum of understanding between the city and relevant agencies and is not included in the city budget. The delivery of emergency social services is tested frequently on smaller scale events from a variety of causes including flooding and involves a continuous improvement process that focuses on performance evaluations and reporting and corrective actions, as required. Ottawa also has a commodity distribution guide that aims to facilitate rapid distribution of items (generally bottled water) to the public, and a process is in place to deploy food inspectors to emergency shelter centres.

### Areas of Challenge:

- Some respondents indicated that influence over private enterprises is not within a municipality's mandates. Accordingly, the provision of food supply during flooding was believed to be outside the direct responsibility of many municipal governments.
- It was noted that resilient food supply also depends on a reliable power network, functional transportation and sufficient fuel supply to provide food to the most vulnerable citizens as part of emergency response planning.

## 2.13. Banking/Financial Services

The vulnerability and reliability of financial services pertains to the involvement of cities to ensure cash liquidity and continuity of services during a flood.

**Survey Question 13:** To what level has your city factored flood mitigation into maintaining the continuity of banking/financial services and cash liquidity?

- A. Relative to financial services, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to financial services, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to financial services, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to financial services, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of financial services

**Figure 2.13: Banking/Financial Services, Distribution of Scores for Fifteen Cities**



Note: Toronto selected the N/A answer option for the survey question. Accordingly, the city was not included in the scoring above.

### Select Accomplishments:

- Ottawa has in place a variety of business continuity practices that ensure the availability of funds to conduct operations during an emergency. While not specific to flooding, the city has an Emergency Purchases clause in the Purchasing By-law that expands purchasing power during an emergency. If electronic purchases are unavailable for any duration, processes are in place to record such transactions and make system entries and payments at a later date. Payments from the city are also validated by banking institutions should the funds not be immediately available due to systems failures. These processes are reviewed annually and improved upon as required. Moreover, business continuity practices are a component of regular business and as such are included in the budget.

### Areas of Challenge:

- The cities surveyed indicated that generally the responsibility for banking/financial services is not within the municipal mandate and not a common area of focus for flood preparedness efforts.

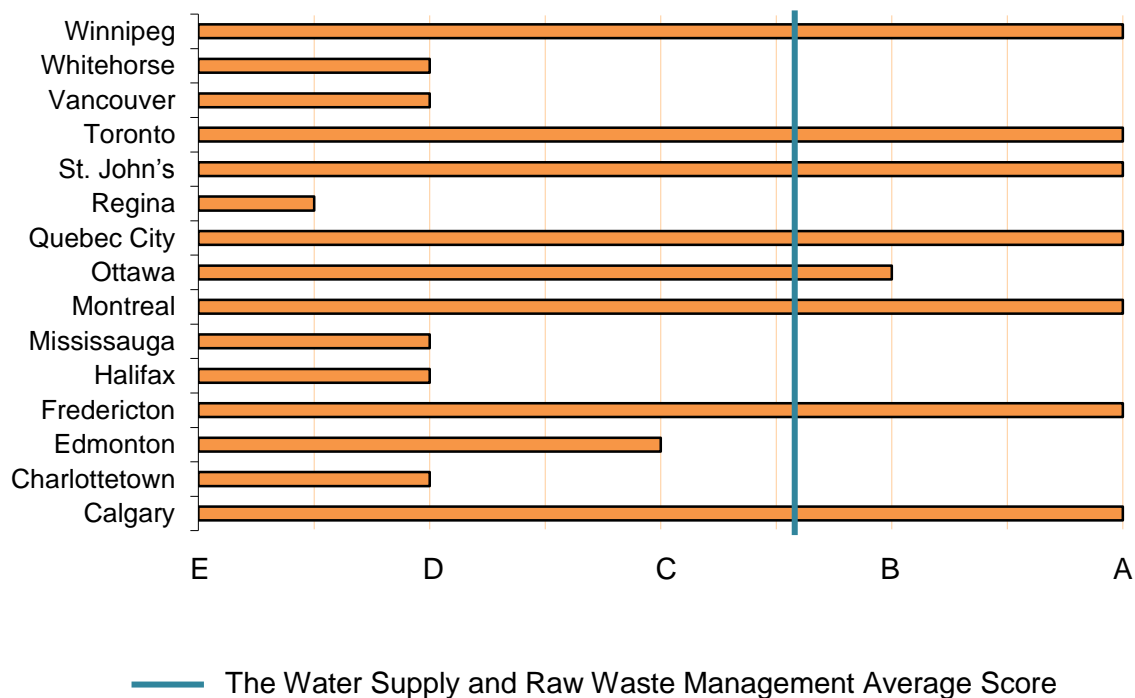
## 2.14. Water Supply and Raw Waste Management

Water supply and raw waste management are critical services that can substantially impact a city in the absence of strategies and policies to mitigate flood impacts.

**Survey Question 14:** To what level has your city factored flood mitigation into maintaining the integrity of water supply and raw waste management?

- A. Relative to water supply and raw waste management, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to water supply and raw waste management, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to water supply and raw waste management, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to water supply and raw waste management, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of water supply and raw waste management services

**Figure 2.14: Water Supply and Raw Waste Management, Distribution of Scores for Fifteen Cities**



### Select Accomplishments:

- Calgary indicated that all water and wastewater infrastructure has been evaluated for flood vulnerabilities, and where necessary upgrades have been implemented. All damaged lift stations have been improved. All pipeline crossings have been analyzed and plans have been developed for upgrading where necessary. The waste water infrastructure has been built/re-built to be protected from flooding conditions.
- While water supply reservoirs and pump stations for Winnipeg are not located in flood prone areas, the city has nevertheless undertaken flood vulnerability assessments for its wastewater systems. The city also developed procedures to guide actions during high-water events.

### Areas of Challenge:

- Some respondents noted that they face an infrastructure deficit and that increasing sewer capacity, redesigning and/or replacing older sewers, may be cost prohibitive.
- Failure of wastewater treatment systems, including pumping stations and treatment plants, due to a flood or storm runoff and consequent loss of electrical power was often noted as an area of concern due to the location of treatment facilities within high-risk flood zones.

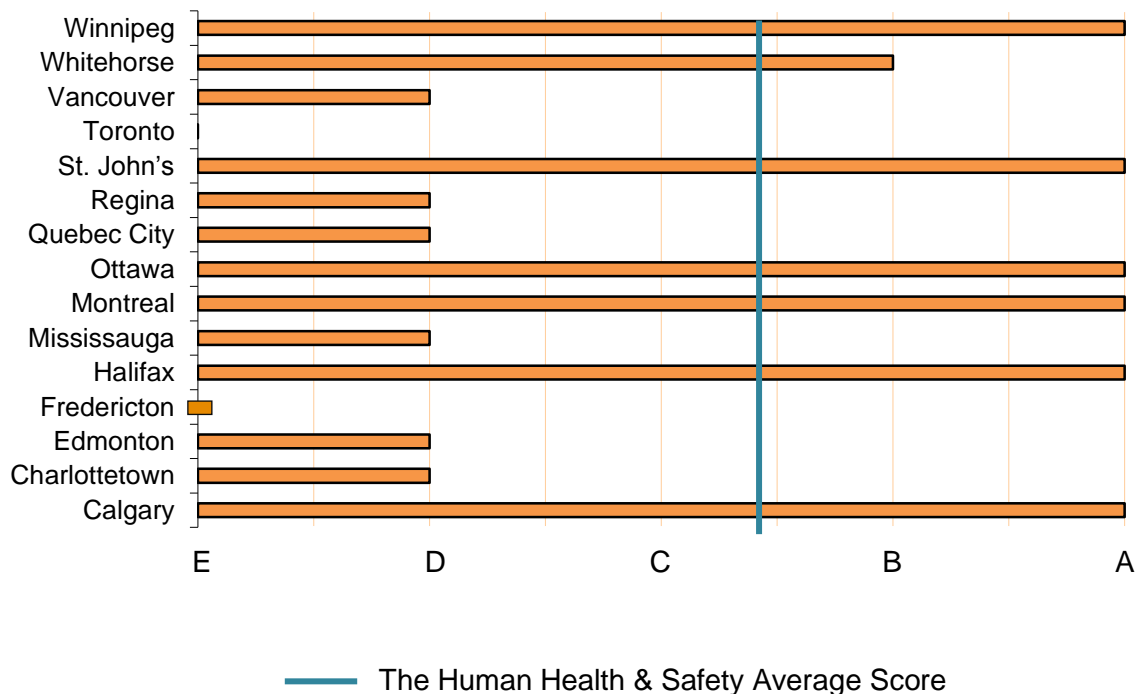
## 2.15. Human Health & Safety

Human health and safety measures pertaining to flood preparedness include health awareness campaigns to provide information on protecting individual and public health during a flood event.

**Survey Question 15:** To what level has your city factored flood mitigation into ensuring the health and safety of its most vulnerable citizens (elderly and young)?

- A. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to ensuring the health and safety of its most vulnerable citizens

**Figure 2.15: Human Health & Safety, Distribution of Scores for Fifteen Cities**



Note: Toronto selected the N/A answer option for the survey question indicating the city does not designate any citizens as especially vulnerable in relation to flood mitigation. Accordingly, the city was not included in the scoring above.



## Select Accomplishments:

- Calgary emergency social services staff and staff from Community and Neighbourhood Services are responsible for programs aimed to protect vulnerable populations. In addition, Calgary Emergency Management Agency's business continuity staff work closely with external agencies such as NGOs and service providers in the community to ensure their business continuity plans include care of their clients in the event of an emergency.
- Winnipeg has identified vulnerable citizens and developed mitigation steps including assistance in flood fighting and evacuation.
- Vancouver completed a coastal flood risk assessment, which identified potential shelter needs in the event of a major flood. The next phase will include prioritization of vulnerable people and an assessment of flood protection options.

## Areas of Challenge:

- Some responders noted that while they restrict development of hospitals and other life-critical facilities in flood risk areas, these facilities need a constant supply of electricity in order to eliminate risks to human life and health. The disruption of electricity supply may cause malfunction of life-critical facilities. For example, without accessible transportation networks for emergency responders and without access to critical data should outages to telecommunications networks occur, hospitals cannot support emergency response operations. The back-up electricity that is available can only be used for existing critical life-support systems and is typically not sufficient to support normal levels of operation for these facilities.
- Some responders noted that there were occurrences when an extreme weather event caused failure of telecommunications system, disrupting access to emergency resources both online and over the phone.

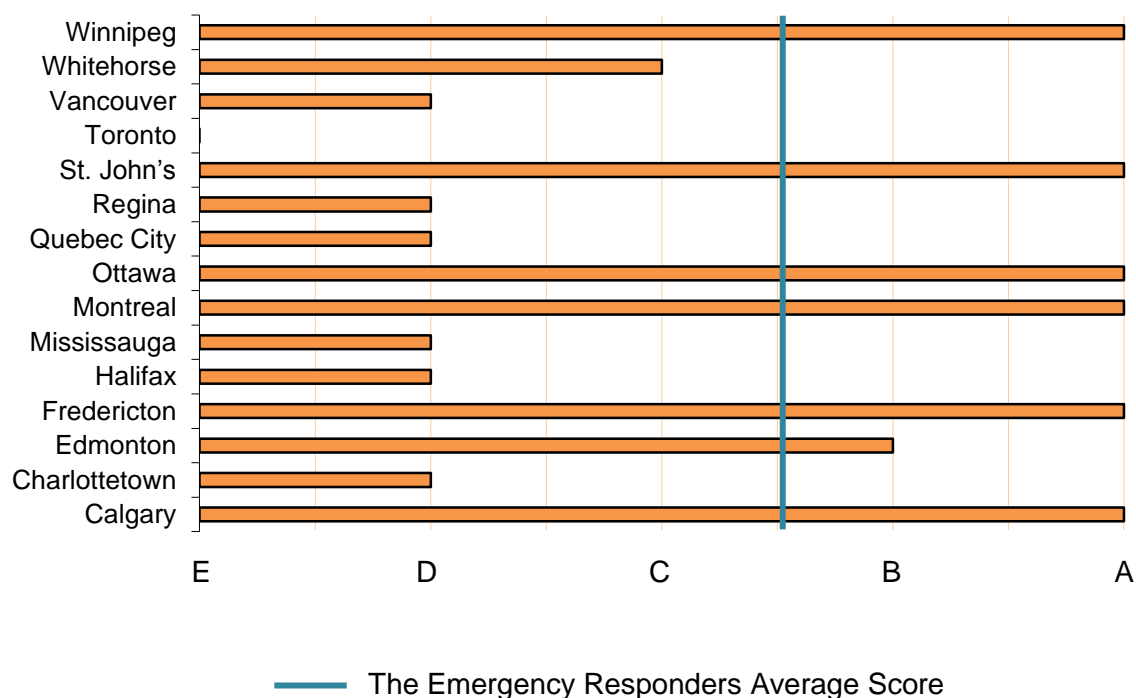
## 2.16. Emergency Responders

Flood related adaptation practices related to emergency responders include business and government continuity planning (BGCP) in the event of floods, ability to deliver critical services, or resume services with minimum delay and ensuring emergency public shelter, drinking water supply, toiletry and other critical service provisions.

**Survey Question 16:** To what level has your city factored flood mitigation into efforts to ensure the ability of emergency responders (e.g., fire, police, ambulance and hospitals) to respond?

- A. Relative to emergency responders, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement
- B. Relative to emergency responders, our city has identified, budgeted for, and instituted flood-related adaptation practices
- C. Relative to emergency responders, our city has identified, and budgeted for flood-related adaptation practices
- D. Relative to emergency responders, our city has identified flood-related vulnerabilities
- E. Our city has not engaged efforts to identify flood risk related to ensuring the ability of emergency responders to respond

**Figure 2.16: Emergency Responders, Distribution of Scores for Fifteen Cities**



Note: Toronto selected the N/A answer option for the survey question. Accordingly, the city was not included in the scoring above. The city provided the following comments:

- The city has a risk-specific plan for flooding which details the methods in which the city mobilizes its resources during a flood emergency. The plan includes all city organizations, emergency response services and key agencies. The office of emergency management (OEM), in consultation with Toronto and Region Conservation Authority (TRCA), undertakes an annual review of this plan including mapping updates, flood exercise support, and on-going hazard/risk training.

### Select Accomplishments:

- Six cities surveyed indicated that they have identified flood-related vulnerabilities, shared the flood mapping information with the emergency management department and will be working closely with them to adjust/adapt emergency response practices (evacuation routes, shelters, marshaling stations, etc.)
- Ottawa's Official Plan, and Comprehensive Zoning by-law, Section 58, restricts development in a flood plain area to minimize the threat of injury or loss of life and to prohibit land uses where flooding may compromise the ability to deliver essential services. In addition, any development adjacent to, or within, a flood plain area must ensure safe access under emergency conditions – this is a policy directly administered by the Conservation Authorities in Ontario, under the Conservation Authorities Act, 1990.

### Areas of Challenge:

- A key concern identified by some respondents was the ability of emergency responders to reach citizens in need, especially those who live or work in flood prone areas to which access may be limited or challenging. Accordingly, some of the cities surveyed indicated that transportation network vulnerability is a key challenge to ensure timely emergency response.

## 2.17. Chief Resilience Officer

The Chief Resilience Officer leads city actions during extreme weather/flood events. This position has responsibility for coordinating all of the City's resiliency efforts with the goal being to make the city as resilient as possible.

**Survey Question 17:** Does your city have a full-time “Chief Resiliency Officer” (or equivalent):

Yes

No

Equivalent

**Table 2.17: Chief Resilience Officer, Distribution of Responses for Fifteen Cities**

City	Chief Resilience Officer
1. Calgary	Equivalent
2. Charlottetown	No
3. Edmonton	No
4. Fredericton	Equivalent
5. Halifax	No
6. Mississauga	Equivalent
7. Montreal	Yes
8. Ottawa	Equivalent
9. Quebec City	Yes
10. Regina	Equivalent
11. St. John's	Yes
12. Toronto	No
13. Vancouver	Equivalent
14. Whitehorse	Equivalent
15. Winnipeg	No

Note: Only three cities indicated that they have a Chief Resiliency Officer – Ottawa provided the following commentary:

- The Chief Resiliency Officer is understood to be a very new role within municipalities driven by the 100 Resilient Cities initiative from the Rockefeller Foundation. It is further understood that most municipalities that have instituted the role have done so with funding from the 100 Resilient Cities initiative.

## Select Accomplishments:

- Ottawa has two departments tasked with ensuring the city's resiliency. To this end, the Planning and Infrastructure Deputy City Manager oversees long-term city development and the Chief Of Security and Emergency Management from the Office of Emergency Management ensures that appropriate planning is in place for identified hazards. The City of Ottawa Emergency Management Program indicated they will be the first municipality in Canada to receive accreditation from the Emergency Management Accreditation Program (EMAP).
- In July 2014, the City Council of Toronto adopted the "Climate Change Risk Management Policy" which identifies the City Manager and three Deputy City Managers as Toronto's Resilient City Leads responsible for corporate wide implementation of the policy. The policy further identifies that all Division Heads are accountable for climate change resilience in their areas of responsibility. To support their efforts and implementation of their responsibilities, a dedicated project team of five staff is being established in the Environment and Energy Division. This approach effectively makes climate change resilience the responsibility of all members of the City's Executive Management and the creation of a project team gives them access to the internal expertise to assist them in coordinating efforts, identifying interdependencies, connecting with private sector and broader public sector service providers and evaluating their direct operations. Toronto already has strategies and initiatives such as the Toronto Green Standard, Wet Weather Flow Master Plan, the Hot Weather Response Plan and the Strategic Forest Management Plan that are building up Toronto's resilience.
- The City of Fredericton EMO structure has a staff person who facilitates meetings and a Director of the EMO is appointed every two years. The Director is an existing Director in one of the City's departments, who takes this role on as an additional duty with the authority to secure resources as needed. The Director of EMO could be the Fire Chief, the City Engineer, the Police Chief, the Director of Public Safety or similar.

### 3.0 Recommendations and Next Steps

The flood preparedness of the fifteen Canadian cities reviewed in this report ranged from those that are highly prepared to address a wide range of potential flood vulnerabilities (e.g., Ottawa), to those that have only considered a short list of prospective concerns.

Three areas of flood preparedness common to many cities included: (1) the installation of backwater valves in the basements of newly built homes, (2) development of up-to-date flood plain maps within and around cities, and (3) ensuring that the potential for flooding is factored into land use planning. Cities perceived all three of these areas to be within their direct line of responsibility.

Areas of flood preparedness that were not broadly engaged by cities included those that were deemed to be “outside of a city’s responsibility” – for example:

- Toronto, in response to addressing the flood preparedness surrounding transportation systems, indicated that transportation is under a multi-jurisdictional mandate for which responsibility extends beyond the city (e.g., 400 series highways are a Province of Ontario responsibility, Pearson International Airport is federally regulated, etc.),
- Vancouver, in response to flood preparedness questions regarding electricity supply, indicated that electricity generation/transmission is under the authority of the Province of British Columbia (BC Hydro),
- Halifax, in response to ensuring that urban water courses function optimally during major storms, indicated that storm water sewer systems are under the management of Halifax Water, whereas water courses (streams, rivers, etc.) are under the direction of the Province of Nova Scotia’s Environment Department, and
- Various cities advised that they did not have the authority to direct the flood preparedness of private/public entities such as food suppliers, telecommunications companies, banking & financial services – based on this view, many cities are ill-prepared to limit the impacts that flooding may convey to these essential services.

The first recommendation of this report is directed primarily to city mayors – they should create forums to address flood preparedness relative to the sixteen perspectives profiled in this study (as per Figure 1, p. viii), regardless of jurisdictional authority. It is in the best interests of all levels of government, public/private corporations, NGOs and the public to endorse and participate in such forums. When systems break down during or following a flood, it will be Mayors, first and foremost, who will be held most accountable for non-preparedness – or conversely, who will receive accolades for preparedness.

Second, when identifying actions to be taken to address flood preparedness, effort should focus on producing a short-list of priority concerns, rather than on developing long lists of all possible scenarios. Interviewees engaged for this report often commented that within their city, when planning to address flood risk, efforts often devolved into the *relentless pursuit of meaningless perfection* – resulting in what is colloquially referred to as *analysis paralysis* – rather than focusing on a short list of actionable priorities.

Finally, greater effort must be made by cities to better inform citizens when subsidies exist to de-risk personal property relative to flood risk. For example, many interviewees made reference to backwater valve subsidies that were available to home owners as retrofits, but that were largely not utilized because home owners either did not understand the function of a backwater valve, and/or that a subsidy was available.

As next steps for P4A, research will focus on calculating the return on investment (ROI) associated with flood preparedness of major cities, or conversely, the costs of inaction. The need for quantitative guidance regarding the ROI associated with flood preparedness was identified by at least one interviewee associated with almost every city reviewed for this report. Finally, this report focused on Canada's largest fifteen cities – as flood plain maps for Canada continue to be updated, P4A may focus on a national review of the preparedness of smaller cities and towns deemed to be at risk.

## Appendix A: Population and Recent Flood Information for Cities Evaluated for Flood Preparedness

City Name	Province	Population	Type*	Recent Floods	Cause of Flood	Flood Event**
Calgary	Alberta	1,214,839	CMA	<ul style="list-style-type: none"> <li>• June 2013</li> <li>• May 2011</li> <li>• June 2005</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> <li>• Rainfall</li> <li>• Heavy Rain</li> </ul>	<ul style="list-style-type: none"> <li>• Severe</li> <li>• Major</li> <li>• 1-in-200-year</li> </ul>
Charlottetown	Prince Edward Island	64,490	CA	<ul style="list-style-type: none"> <li>• August 2010</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> </ul>	
Edmonton	Alberta	1,159,869	CMA	<ul style="list-style-type: none"> <li>• July 2012</li> <li>• July 2004</li> </ul>	<ul style="list-style-type: none"> <li>• Storm</li> <li>• Flash flood</li> </ul>	<ul style="list-style-type: none"> <li>• Major</li> <li>• 1-in-200 year</li> </ul>
Fredericton	New Brunswick	94,270	CA	<ul style="list-style-type: none"> <li>• April 2014</li> <li>• December 2010</li> <li>• April 2008</li> </ul>	<ul style="list-style-type: none"> <li>• Ice jam</li> <li>• Heavy Rain</li> <li>• Rain &amp; Snow</li> </ul>	<ul style="list-style-type: none"> <li>• Major</li> <li>• Severe</li> </ul>
Halifax	Nova Scotia	390,328	CMA	<ul style="list-style-type: none"> <li>• February 2015</li> <li>• August 2011</li> <li>• November 2010</li> </ul>	<ul style="list-style-type: none"> <li>• Heavy Snow</li> <li>• Rainfall</li> </ul>	
Mississauga	Ontario	713,443	CY	<ul style="list-style-type: none"> <li>• July 2013</li> <li>• August 2009</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> <li>• Rainstorm</li> </ul>	<ul style="list-style-type: none"> <li>• Severe</li> <li>• Severe</li> </ul>
Montreal	Quebec	3,824,221	CMA	<ul style="list-style-type: none"> <li>• May 2012</li> </ul>	<ul style="list-style-type: none"> <li>• Rainstorm</li> </ul>	<ul style="list-style-type: none"> <li>• 1-in-100 year</li> </ul>
Ottawa	Ontario	1,236,324	CMA	<ul style="list-style-type: none"> <li>• July 2009</li> <li>• September 2004</li> </ul>	<ul style="list-style-type: none"> <li>• Rainstorm</li> </ul>	<ul style="list-style-type: none"> <li>• Major</li> </ul>
Quebec City	Quebec	765,706	CMA	<ul style="list-style-type: none"> <li>• March 2012</li> <li>• August 2011</li> </ul>		
Regina	Saskatchewan	210,556	CMA	<ul style="list-style-type: none"> <li>• June 2014</li> <li>• April 2011</li> </ul>	<ul style="list-style-type: none"> <li>• Rainstorm</li> <li>• Spring Runoff</li> </ul>	
St. John's	Newfoundland and Labrador	196,966	CMA	<ul style="list-style-type: none"> <li>• August 2011</li> <li>• November 2004</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> </ul>	<ul style="list-style-type: none"> <li>• Major</li> </ul>
Toronto	Ontario	5,583,064	CMA	<ul style="list-style-type: none"> <li>• July 2013</li> <li>• August 2005</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> <li>• Flash Flood</li> </ul>	<ul style="list-style-type: none"> <li>• Severe</li> <li>• Severe</li> </ul>
Vancouver	British Columbia	2,313,328	CMA	September 2010	<ul style="list-style-type: none"> <li>• Rainfall</li> </ul>	
Winnipeg	Manitoba	730,018	CMA	<ul style="list-style-type: none"> <li>• April 2011</li> <li>• May 2010</li> <li>• July 2005</li> </ul>	<ul style="list-style-type: none"> <li>• Rainfall</li> <li>• Ice jam</li> <li>• Rainfall</li> </ul>	
Whitehorse	Yukon	26,028	CA			



\*The table above lists the census metropolitan areas and agglomerations in Canada by population, using data from the Canada 2011 Census.<sup>3</sup> Each entry type is identified as follows:

- CMA - Census Metropolitan Area;
- CA – Census Agglomeration;
- CY – City

\*\* Flood Event:

- Severe – used to describe intensity of flood, this being the event with more destructive power<sup>4</sup>
- Major – used to describe intensity of flood, this being the even with less destructive power<sup>5</sup>
- 1-in-200-year – two-hundred-year flood is a flood event that has a 0.5% probability of occurring in any given year<sup>6</sup>
- 1-in-100-year - one-hundred-year flood is a flood event that has a 1% probability of occurring in any given year<sup>7</sup>

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<sup>3</sup> Statistics Canada. Focus on Geography Series, 2011. Census Census metropolitan areas (CMAs), census agglomerations (CAs) grouped by provinces and territories. Accessed on February 28, 2015 at: <http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/select-Geo-Choix.cfm?Lang=Eng&GK=CMA&PR=10#PR12>

<sup>4</sup> Environment Canada. Canada's Top Ten Weather Stories for 2004. Accessed on February 28, 2015 at: <http://www.ec.gc.ca/meteo-weather/default.asp?lang=En&n=9CA2BD37-1>

<sup>5</sup> Ibid.

<sup>6</sup> Environment Canada. Causes of Flooding. Accessed on February 25, 2015 at: <https://www.ec.gc.ca/eau-water/default.asp?lang=En&n=E7EF8E56-1>

<sup>7</sup> Ibid.

## Appendix B: Survey Questionnaire

No.	Question	Answers
1.	<p>Flood Plain Mapping</p> <p>Relative to flood-plain mapping, at which stage is your city in reference to addressing climate change/extreme weather and the establishment of flood plain maps?</p>	<p>A. Flood plain maps for our city have been updated within the past 5 years, and they are forward projected (e.g., 15-25 years) to model future flood plains</p> <p>B. Flood plain maps for our city have been updated within the past 5 years</p> <p>C. Flood plain maps for our city were updated 5-15 years ago</p> <p>D. Flood plain maps were last updated for our city 15 years ago or longer</p> <p>E. Our city has no flood plain maps</p>
2.	<p>Land Use Planning</p> <p>Within your city, in reference to new residential and commercial development, to what degree does the potential for flooding factor into siting?</p>	<p>A. Any history of flooding in an area would negate infrastructure development</p> <p>B. Flooding in an area over the period of the past 50 years would negate siting structures, or infrastructure would be established to limit the potential for 50 year floods</p> <p>C. Flooding in an area over the period of the past 20 - 50 years would negate siting structures, or infrastructure would be established to limit the potential for 20 – 50 year floods</p> <p>D. Flooding in an area over the period of the past 10 years would negate siting structures</p> <p>E. Past flooding in an area does not factor into siting structures</p>
3.	<p>Urban Drainage Maintenance</p> <p>In reference to water drainage capacity, what level of program does your city have in place?</p>	<p>A. A city policy is in place to ensure water courses (e.g., culverts, sewer grates) remain free of debris, and the policy is in operation</p> <p>B. A city policy is in place to ensure water courses are free of obstruction(s)</p> <p>C. Water courses are cleared of debris during times of year when the potential for flooding is high</p> <p>D. A city practice is in place to clear water courses of blockages on an “as needed” basis</p> <p>E. No city practices are in place to ensure water courses remain free of debris</p>

4.	<p>Home Adaptation Audit</p> <p>In reference to helping home owners limit the probability of household/basement flooding, what level of program does your city have in place?</p>	<p>A. Our city has a city subsidized Home Adaptation Audit Program (or equivalent) to help homeowners identify key areas where homes may be vulnerable to basement flooding</p> <p>B. Our city has a non-subsidized Home Adaptation Audit Program (or equivalent) to identify key areas where homes are vulnerable to basement flooding</p> <p>C. Our city provides on-line information to help homeowners self-assess their property relative to basement flood potential</p> <p>D. Our city encourages homeowners to self-assess to limit the probability of basement flooding</p> <p>E. Our city has no program to encourage homeowners to limit basement flooding</p>
5.	<p>Commercial Real Estate Adaptation Audit</p> <p>In reference to helping commercial real estate owners/managers limit the probability of flooding of commercial buildings, what level of program does your city have in place?</p>	<p>A. Our city has a subsidized Commercial Real Estate Adaptation Audit Program (or equivalent) in place to identify key areas where commercial real estate may be vulnerable to flooding</p> <p>B. Our city has a non-subsidized Commercial Real Estate Adaptation Audit Program (or equivalent) in place to identify key areas where commercial real estate may be vulnerable to flooding</p> <p>C. Our city provides on-line information to help commercial real estate property owners/managers to self-assess their property relative to flood potential</p> <p>D. Our city encourages commercial real estate owners/managers to self-assess to limit the probability of flooding</p> <p>E. Our city has no program to encourage commercial real estate property owners/managers to limit flooding</p>
6.	<p>Backwater Valve Installation (new house construction)</p> <p>To what level does your city mandate the installation of backwater valves to limit potential residential basement flooding?</p>	<p>A. Our city mandates the installation of backwater valves during new house construction</p> <p>B. Our city offers a subsidy to install backwater valves during new house construction</p> <p>C. Our city provides educational programs to encourage homeowners to install backwater valves during new house construction</p> <p>D. Our city encourages homeowners to install backwater valves during new house construction</p> <p>E. Our city has no program to encourage the installation of backwater valves for new house construction</p>

7.	<p>Backwater Valve Installation (house retrofits)</p> <p>To what level does your city support retrofits for backwater valve installation to existing housing?</p>	<p>A. Our city offers a subsidy to all home owners to install a backwater valve</p> <p>B. For homeowners who have experienced basement flooding, Our city offers a subsidy to home owners to install a backwater valve</p> <p>C. Our city offers educational programs to encourage homeowners to install backwater valves as retrofits</p> <p>D. Our city encourages homeowners to install backwater valves as retrofits</p> <p>E. Our city has no program to encourage the installation of backwater valves as retrofits</p>
8.	<p>Electricity Supply</p> <p>To what level has your city factored flood mitigation into maintaining the continuity of electricity supply?</p>	<p>A. Relative to electricity generation, transmission and distribution, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to electricity generation, transmission and distribution, our city has identified flood-related vulnerabilities and instituted adaptation practices</p> <p>C. Relative to electricity generation, transmission and distribution, our city has identified and budgeted for flood-related vulnerabilities</p> <p>D. Relative to electricity generation, or transmission, or distribution, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify the vulnerability of electricity supply to flooding</p>
9.	<p>Petroleum Supply</p> <p>To what level has your city factored flood mitigation into maintaining the continuity of petroleum supply (gas, oil and diesel)?</p>	<p>A. Relative to petroleum supply, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to petroleum supply, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to petroleum supply, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to petroleum supply, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of petroleum supply</p>

10.	<p>Transportation Systems</p> <p>To what level has your city factored flood mitigation into maintaining the continuity of transportation systems (road, rail, air, ship)?</p>	<p>A. Relative to transportation, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to transportation, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to transportation, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to transportation, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of transportation systems</p>
11.	<p>Telecommunication Systems</p> <p>To what level has your city factored flood mitigation into maintaining the continuity of telecommunications networks (phone, internet, TV)?</p>	<p>A. Relative to telecommunications, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to telecommunications, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to telecommunications, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to telecommunications, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of telecommunications systems</p>
12.	<p>Retail Food Supply</p> <p>To what level has your city factored flood mitigation into maintaining the integrity of retail food supply?</p>	<p>A. Relative to retail food supply, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to retail food supply, our city has identified, budgeted for and instituted flood-related adaptation practices</p> <p>C. Relative to retail food supply, our city has identified, and budgeted for, flood-related adaptation practices</p> <p>D. Relative to retails food supply, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related</p>

13.	<p>Banking/Financial Services</p> <p>To what level has your city factored flood mitigation into maintaining the continuity of banking/financial services and cash liquidity?</p>	<p>A. Relative to financial services, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to financial services, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to financial services, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to financial services, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of financial services</p>
14.	<p>Water Supply and Raw Waste Management</p> <p>To what level has your city factored flood mitigation into maintaining the integrity of water supply and raw waste management?</p>	<p>A. Relative to water supply and raw waste management, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to water supply and raw waste management, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to water supply and raw waste management, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to water supply and raw waste management, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to maintaining the continuity of water supply and raw waste management services</p>

15.	<p>Human Health &amp; Safety</p> <p>To what level has your city factored flood mitigation into ensuring the health and safety of its most vulnerable citizens (elderly and young)?</p>	<p>A. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to ensuring the health and safety of its most vulnerable citizens, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to ensuring the health and safety of its most vulnerable citizens</p>
16.	<p>Emergency Responders</p> <p>To what level has your city factored flood mitigation into efforts to ensure the ability of emergency responders (e.g., fire, police, ambulance and hospitals) to respond?</p>	<p>A. Relative to emergency responders, our city has identified flood-related vulnerabilities, budgeted for and instituted adaptation practices, and maintains a system of continuous improvement</p> <p>B. Relative to emergency responders, our city has identified, budgeted for, and instituted flood-related adaptation practices</p> <p>C. Relative to emergency responders, our city has identified, and budgeted for flood-related adaptation practices</p> <p>D. Relative to emergency responders, our city has identified flood-related vulnerabilities</p> <p>E. Our city has not engaged efforts to identify flood risk related to ensuring the ability of emergency responders to respond</p>
	<p>Chief Resilience Officer</p> <p>Does your city have a full-time “Chief Resiliency Officer” (or equivalent):</p>	<p>Yes    ___                      No    ___                      Equivalent    ___</p>

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