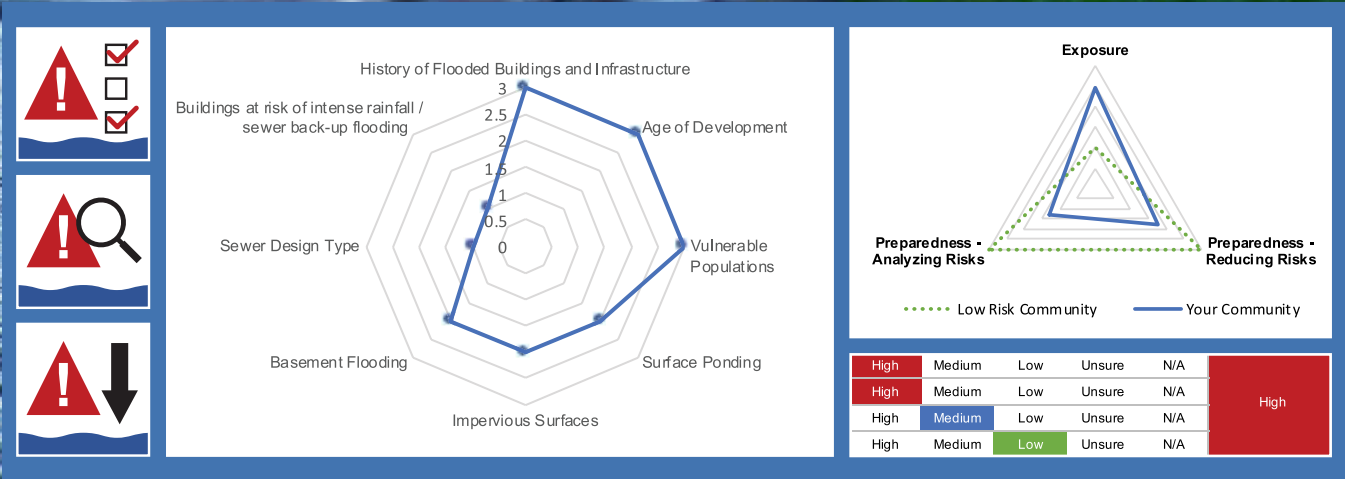


A FLOOD RISK CHECK-UP FOR CANADIAN MUNICIPALITIES: TACKLING FLOODING TOGETHER



Supported by:



Joanna Eyquem
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The Intact Centre on Climate Adaptation (Intact Centre) is an applied research institute with a national focus, located within the Faculty of Environment at the University of Waterloo. The Intact Centre works with residents, communities, governments, and businesses to identify and reduce risks associated with climate change, such as flooding, wildfire, and extreme heat. The Centre has developed numerous guidelines and is quoted almost daily in the media, focusing consistently on the need to act with urgency to limit the impacts of climate change and extreme weather.

To this end, the Intact Centre is an incubator of new adaptation ideas, conducting research, knowledge mobilization and promoting initiatives aimed at de-risking the negative impacts of a changing climate and extreme weather, including flooding. For additional information, visit: www.intactcentreclimateadaptation.ca.

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All findings and recommendations of this study are those of the Intact Centre.

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Executive Summary

Municipalities are on the frontlines of adapting to climate change impacts, including flooding. Action and investment are required, not only to understand and map flood risks, but also to **implement measures on the ground to reduce the risks.**

The key challenge is reducing flood risk, **RAPIDLY**. Flooding is already a drain on Canadians, both financially and socially, and costs are expected to keep rising under the influence of irreversible climate change. Municipalities, businesses, and residents that may not be at risk of flooding today, may be at risk of flooding tomorrow if flood risk reduction measures are not taken.

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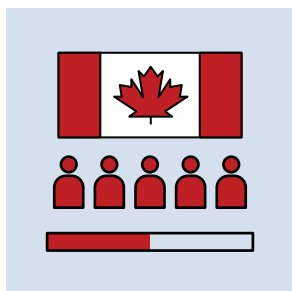
Increased attention is required to reduce municipal flood risk. Many Canadian municipalities are currently more advanced in climate mitigation (reducing greenhouse gas emissions) than they are in climate adaptation (reducing climate impacts). Some municipalities, particularly those serving small and medium-sized communities, also face challenges due to resource constraints and gaps in their understanding of flood risk. This limits their awareness of available guidance and ability to identify appropriate actions to reduce flood risk. While there is emphasis on, and benefit from, flood mapping activities to understand hazards, many “no-regrets” actions to prepare for flooding and reduce risk can be undertaken without detailed flood mapping.

The **Municipal Flood Risk Check-Up** has been developed to support Canadian municipalities in better preparing for heavy rainfall, river, and coastal flooding. It is a self-assessment questionnaire with 50 questions designed to assess potential flood hazards (flood exposure), and implementation of actions to reduce flood risks (flood preparedness). The Check-Up helps users navigate the variety of existing standards, guidance, and tools available, and focuses on the role of municipal action at multiple levels: from the localized protection of individual homes to the management of flooding processes at the watershed scale .

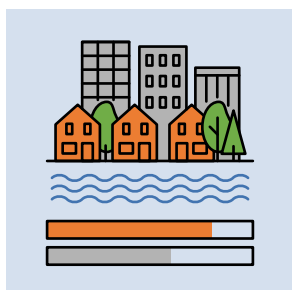
Municipalities are encouraged to use the Check-Up to:

1. **Gain** an understanding of flood exposure, even where flood mapping is not available.
2. **Benchmark** and document their current flood preparedness by drawing on Canadian guidance and standards.
3. **Document** progress towards reduction of municipal flood risk over time.
4. **Access** a library of key resources on flood risk and preparedness, including National Standards of Canada.
5. **Demonstrate** municipal flood preparedness to interested parties.
6. **Prioritise** actions for different flood types and at different scales.
7. **Inform** future investment planning and funding applications.
8. **Anticipate** and answer questions that may be asked by municipal insurers in developing insurance policies.
9. **Contribute** to objectives and targets identified in Canada’s National Adaptation Strategy.
10. **Support** municipal staff and service delivery.

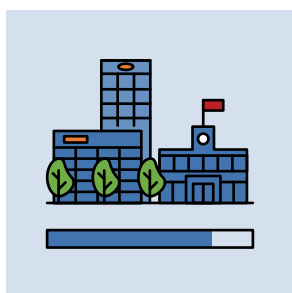
Positive municipal action aligns with several **National Adaptation Strategy targets**, including:



By 2025, 50% of Canadians have taken concrete actions to better prepare for and respond to climate change risks facing their household.



By 2027, 80% of coastal communities and 60% of businesses located in coastal regions are implementing adaptation actions to increase climate resilience and reduce the economic impacts of climate change.



By 2030, 80% of public and municipal organizations have factored climate change adaptation into their decision-making processes.

Reducing flood risk is in the interest of all parties that live and work in municipalities, including residents, businesses, governments, and financial institutions. While municipalities act on the front lines, other parties also have a key role to play in supporting them. Organizations including the Federation of Canadian Municipalities, provincial and territorial municipal associations, standards organizations, municipal insurers, financial institutions, and non-governmental organizations are called upon to help **raise awareness**

and encourage use of the Municipal Flood Risk Check-Up to accelerate widespread action.

Tackling flood risk requires a whole-of-society approach. Support from multiple actors will be critical to operationalize the Municipal Flood Risk Check-Up to really make a change on the ground. **By facing flooding together, we can make lives better and safer.**



1. The Urgent Need for Municipal Action to Reduce Flood Risk

The impacts of flooding are felt in municipalities across Canada, from coast to coast to coast. It is the most common and costly natural hazard in terms of property damage.¹ Flood events can also cause loss of life, physical injuries, and negative impacts on mental health.² Certain vulnerable populations, for example those in underserved communities, may be disproportionately at risk and require additional support to adapt.

Flood risks can be reduced by applying flood risk management best practices, for which there are several national standards and guidance publications. The key challenge is to reduce flood risk with the urgency required, as these risks are expected to increase over time due to the influence of irreversible climate change, particularly in urban and coastal areas.³ This means that municipalities, businesses, and homes that may not be at risk of flooding today, may be at risk of flooding “tomorrow” if flood risk reduction measures are not taken.

While flood risk management and land use planning regulation is largely the responsibility of Canada’s provinces and territories, the responsibility for managing flood risk on the ground is often delegated to municipal governments. Activities including flood mapping, flood risk assessment, planning and design of adaptation measures, emergency response and recovery, are therefore frequently executed at the local level, rather than at the provincial, territorial, or federal level.

Municipalities, however, need support in understanding and managing their flood risks. Small and medium-sized municipalities do not necessarily have the resources or dedicated staff to effectively tackle flood risk on their own. Additionally, organizations with an interest in assessing the flood risk profile of municipalities, such as municipal insurers, institutional investors, securities commissions, and credit rating agencies, also have limited access to information on flood preparedness.

This report describes the development of a **Municipal Flood Risk Check-Up tool** that will help municipalities of all sizes and other users assess flood risk in a way that combines flood hazard and exposure, and flood preparedness.

1.1 Costs of Flooding

Flooding is a significant cost to Canada, including Canadian municipalities and their residents. In terms of residential flooding, the cost of risk from intense rainfall flooding, river and coastal flooding, is estimated at \$2.9 billion per year. Most of the risk is concentrated in a small number of the highest risk homes—of the \$2.9 billion, 89% (\$2.6 billion) is associated with the top 10% highest risk homes.⁴ These figures are based on Average Annual Loss (AAL), which is the cost of flood damage that is expected to occur each year, averaged over the long term. The average masks the fact that losses may be very small most of the time but have the potential to be catastrophic for major events. Since flood insurance is currently not available to residents in high-risk flood zones, the costs of damages in these areas are mostly paid by governments and the residents themselves.

The rise in catastrophic insured losses in Canada between 1983 and 2023 indicates that the costs of extreme weather events, such as floods, are already on the rise (Figure 1). Between 1983 and 2008, insured losses averaged \$456 million a year. Since 2008, losses have surged and now regularly exceed \$2 billion per year, mostly due to water-related damage.⁵ The rising trend in claims is not solely due to changes in extreme weather; other factors, such as the loss of natural infrastructure and continued development in high-risk areas, contribute to these costs.⁶ It should also be noted that, for every dollar of losses borne by insurers in Canada, an estimated three to four dollars are incurred by governments, homeowners and business owners. For example, for the \$3.4 billion of insured losses in

2022,⁷ this would be an estimated \$10 to \$13 billion in uninsured losses.

Flooding is already having an impact on the housing market. A recent study indicated that over the past eight years, catastrophic flooding in communities studied resulted in an average 8.2% reduction in the final sale price of houses, 44.3% reduction in the number of houses listed for sale, and 19.8% more days on market to sell a house.⁸

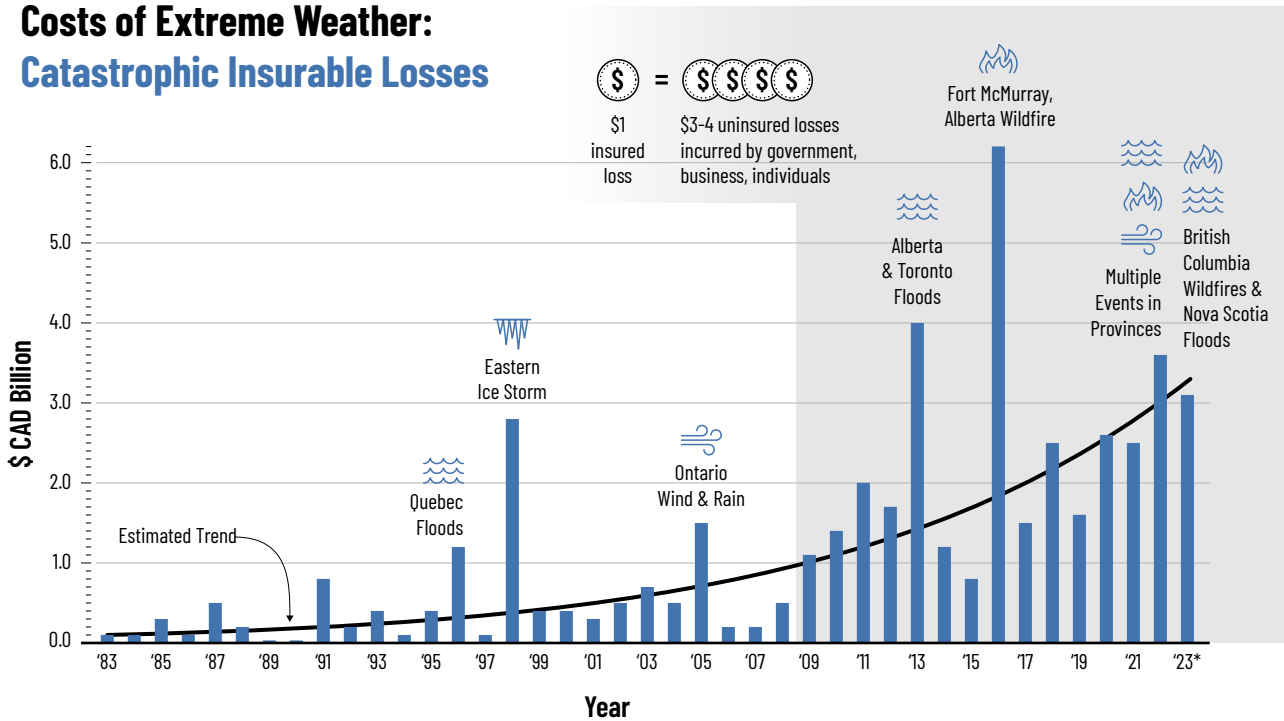
In addition to impacts on the housing market, businesses may also be impacted. The costs of flooding to businesses can vary depending on the scale of the event, the industry, the size of the company, as well as the measures in place to reduce risks. Importantly, this also includes the effectiveness of measures implemented by the municipalities in which the business is located. Some potential financial impacts on businesses are outlined in Table 1. Ultimately, unmanaged impacts of extreme weather events, like flooding, can result in

As urban flood risks increase, municipalities that are exposed and not appropriately prepared for flooding may be less attractive to businesses, with knock-on impacts on the local economy.

negative impacts on cash flows, which can lead to a reduction in the per-share value of a publicly traded company's stock.⁹

As urban flood risks increase, municipalities that are exposed and not appropriately prepared for flooding may be less attractive to businesses, with knock-on impacts on the local economy.

Costs of Extreme Weather: Catastrophic Insurable Losses



Source: IBC Facts Book, PCS, CatIQ, Swiss Re, Munich Re & Deloitte

*2023 preliminary values in 2023\$ CAD, corrected for inflation and per capita wealth accumulation.

Figure 1: Catastrophic insurable losses, Canada 1983 - 2023

Table 1: Potential financial impacts of flood risk on businesses

Costs	Description
Insurance Costs	Companies may face increased flood insurance costs and raised premiums. In high-risk locations, coverage may be unavailable or unaffordable.
Direct Property Damage and Opportunity Costs	Floods may damage buildings, equipment, inventory, and other physical assets. For damage not covered by insurance policies, the expenses incurred for repairing or replacing these assets can be substantial, directly impacting a company's financial health. The need to address flood damages also represents an "opportunity cost" to a business. Resources—both time and money—that are diverted to repairs and recovery could have been allocated to other beneficial initiatives (e.g., equipment and facility upgrades, business expansion). The "opportunity cost" reflects the fact that the resources are now unavailable, and the business misses out on the associated benefits.
Investment in Adaptation	To prevent future losses, companies may need to invest in flood resilience measures to protect their assets. These measures may be associated with upfront financial costs. It is important to note that early adaptation is more cost-effective than both late and no adaptation. ¹⁰
Health and Safety Costs	Employee health and safety might be compromised during flood events and companies may incur costs related to ensuring employee well-being, medical expenses, or even potential liabilities if safety measures are inadequate. The toll of time missed from work due to flooded homes extends beyond economic losses, causing mental distress for affected individuals, disrupting both personal and work lives. From a business perspective, this absenteeism directly impacts productivity, compacting a year's worth of workdays lost per employee into a condensed period.
Business Interruption	Floods often disrupt operations, halting or reducing activities, which results in delayed production, missed deadlines, increased operating costs, and revenue losses.
Supply Chain Disruption	Companies reliant on suppliers and/or distributors may face disruptions in the supply chain leading to delays in receiving products/services, impacting production schedules and sales.
Market Share and Reputation	Extended disruptions or negative community impacts can reduce market share and damage a company's reputation, impacting long-term profitability.
Regulatory Compliance and Fines	Failure to comply with environmental regulations or safety standards related to flooding can lead to fines and legal expenses.

1.2 Types of Flooding

Most flooding in Canada can be described in the following broad types:¹¹



Intense rainfall flooding (pluvial flooding) is the temporary inundation of normally dry land, independent of an overflowing body of water. This includes floods triggered by heavy rain falling within a short amount of time, and floods that occur when drainage systems are overwhelmed by rainfall. Intense rainfall flooding is unpredictable and can occur across Canada. Pluvial flooding can lead to groundwater flooding, which occurs when water levels underground rise to, and surpass, surface level.



River flooding occurs when the flow of water in a river or stream exceeds its channel and overspills its

banks. This is a natural process, and occurs seasonally in response to snowmelt, as well as at other times of the year. However, many municipalities are located along rivers and are susceptible to this type of flooding, particularly where development is on river floodplains.



Coastal flooding occurs when seawater or freshwater—in the case of large lakes—inundates the land. Coastal municipalities are susceptible to this type of flooding where development is on coastal floodplains.

Flood risk in urban areas across Canada is expected to increase, due to more intense and frequent rainfall events driven by climate change. Coastal flooding is expected to increase in many areas of Canada due to local sea level rise. Particularly, Atlantic Canada is at increased risk of damage from larger storm surges and waves, due to the loss of sea ice from a warming climate.¹²

There are also other types of flooding, for example flooding associated with ice jams, dam failures, and tsunamis, which are not covered by this Check-Up. The role of permafrost is also not addressed.

1.3 Gaps in Current Flood Preparedness

According to Canada’s National Risk Profile, approximately 83% of the Canadian population live in urban areas, and about 80% of major Canadian cities are located wholly or in part in flood zones.¹³ In the report, a capability assessment identified critical needs to reduce flooding risk, including:

- Effective coordination among different levels and departments of government to manage flood risk.
- Opportunities to accelerate and scale-up the deployment of nature-based flood risk solutions.
- Clear communication of flood risk information.
- Greater awareness among residents of their personal flood risk.

In support of the last point, a separate 2020 survey found that 94% of Canadians living in high-risk areas remain unaware of their flood risk.¹⁴

At the local level, many Canadian municipalities are lagging in climate adaptation (reducing climate impacts) when compared to climate mitigation (reducing greenhouse gases). As an indicator, the Federation of Canadian Municipalities released a report on their “Municipalities for Climate Innovation Program” showing that of the participating municipalities, 94 have developed mitigation plans, with 70 in the implementation stage, while only 62 have developed adaptation plans, of which 46 are in the implementation stage (Figure 2).¹⁵ It is also notable that there are around 3,600 local governments in Canada,¹⁶ and FCM itself has over 2,000 members. Reporting members therefore only represent a small sample.

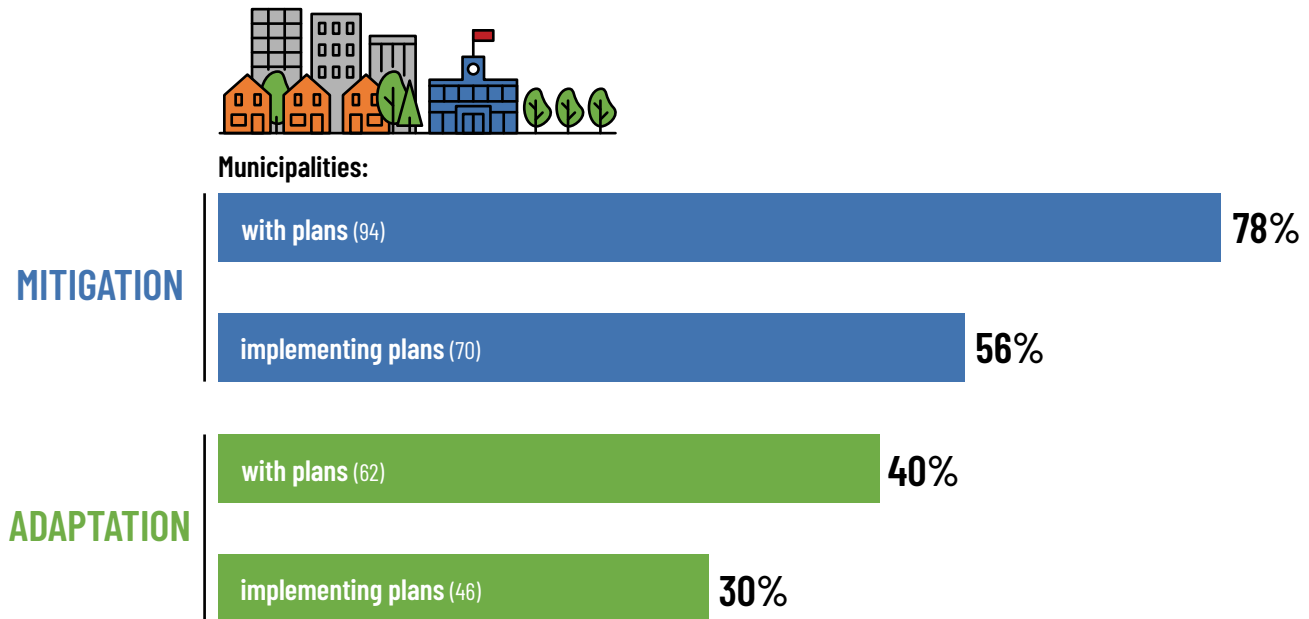


Figure 2: Progress on Mitigation and Adaptation Plans reported under the Municipalities for Climate Innovation Program (MCIP)¹⁷

In relation to the flood preparedness of 16 major Canadian cities, a recent study indicated that: (1) between 2015 and 2019/2020, there was limited overall progress in the state of flood preparedness (the average score remained unchanged at C+), and (2) comparing different cities, there was significant variance in terms of their level of flood preparedness (scores ranged from B+ to D).¹⁸ While some major cities are making progress on reducing flood risks, progress remains slow. The study results also suggest that reliance on flood exposure data alone is not a robust method to assess actual flood risk, since it does not account for differences in the level of effort applied by municipalities to limit the consequences of flooding.

1.4 Supporting Municipalities

Much work is still needed to reduce municipal flood risks. Some of this work is supported by the recent launch of the National Adaptation Strategy, which set several quantifiable, time-bound targets for adaptation. The following targets are directly relevant to municipal flood risk management:

- By 2025, 60% of Canadians, including northerners and Indigenous Peoples, are aware of the disaster risks facing their household.
- By 2025, 50% of Canadians have taken concrete actions to better prepare for and respond to climate change risks facing their household.
- By 2027, 80% of coastal communities and 60% of businesses located in coastal regions are implementing adaptation actions to increase climate resilience and reduce the economic impacts of climate change.
- By 2030, 80% of public and municipal organizations have factored climate change adaptation into their decision-making processes.

Funding is provided by the federal government, as well as via provincial and territorial government funding programs, however, it is often allocated on a competitive basis. This means that municipalities that apply must have the resources (i.e., time, staff, knowledge) to complete a convincing application. Small and medium-sized municipalities may not have these resources, or the fundamental understanding of flood risk required to know what actions they need to undertake.

In parallel, the Government of Canada Adaptation Action Plan, published in 2023, expanded the Green Municipal Fund by up to \$530 million to support community-based adaptation initiatives in collaboration with the Federation of Canadian Municipalities. The national Disaster Mitigation and Adaptation Fund¹⁹ also received a top-up of \$489 million over 10 years to continue to help municipalities and townships build new infrastructure to increase the resilience of communities.²⁰

Funding is provided by the federal government, as well as via provincial and territorial government funding programs, however, it is often allocated on a competitive basis. This means that municipalities that apply must have the resources (i.e., time, staff, knowledge) to complete a convincing application. Small and medium-sized municipalities may not have these resources, or

the fundamental understanding of flood risk required to know what actions they need to undertake.

While there is considerable emphasis on, and benefit from flood mapping activities, it is important to note that many actions can be undertaken without detailed mapping. For example, there are opportunities to embed existing flood resilience standards in municipal documents (e.g., Official Plans, municipal by-laws), as demonstrated in “The Municipal How-to Guide for CSA Community Water Standards”, which includes suggested example language for different documents.²¹ Existing programs are also available to guide municipalities in implementing adaptation solutions on the ground, such as Green Shores for Local Governments.²²

1.5 The Role of the Municipal Flood Risk Check-Up

The Municipal Flood Risk Check-Up has been developed to support Canadian municipalities—including small and medium municipalities that may have less resources—in preparing for heavy rainfall, river, and coastal flooding.

The Check-Up is a self-assessment questionnaire with 50 questions on flood exposure and flood preparedness (see [Appendix B](#)). This report documents the development of the Municipal Flood Risk Check-Up (Section 2), including review of existing standards, guidance, and tools (Section 3); inputs provided by over 50 contributors (Section 4); a description of the Check-Up, its development and use (Section 5); and ideas for scaling-up use of the Check-Up to reduce flood risk (Section 6).

The Check-Up will be useful to municipalities of all sizes that are charged with ensuring the safety of residents, maintenance of public infrastructure, and continuity of community

operations (e.g., transport, water supply and treatment facilities, and emergency services). Organizations with an interest in assessing the flood risk profile of municipalities, such as municipal insurers, institutional investors, securities commissions, and credit rating agencies, may also find the Check-Up useful.

The Check-Up and the report are freely available and may be useful in identifying appropriate questions and information that may be requested from municipalities in order to assess flood risk.



2. Method: Developing the Check-Up

Developing the Municipal Flood Risk Check-Up involved a combination of desktop research and analysis, combined with engagement with a variety of interested parties.

2.1 Desktop Research and Analysis

The focus of desktop research and analysis was on understanding current practices relating to municipal flood risk management in Canada. Specific tasks were to:

- Collate and review key national standards and guidance relating to management of flood risk in Canada.
- Review existing tools that have been designed to support municipal climate adaptation and flood risk management in Canada.

2.2 Engagement with Interested Parties

Over 50 interested parties from British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia and Prince Edward Island, contributed to the development of the Check-Up tool and report. Contributors included representatives from municipalities of different sizes, the Federation of Canadian Municipalities (FCM), federal and provincial governments, national standards agencies, provincial municipal organizations, asset management organizations, watershed management organizations, and non-governmental organizations (NGOs). Representatives of Intact Public Entities (IPE) generously provided insight into how flood risk is currently assessed as part of their role as municipal insurers. Research perspectives from the United States were kindly shared by members of The Water Research Foundation. All contributors are listed in the acknowledgements at the start of this report.

Interested parties were engaged throughout the development of the Municipal Flood Risk Check-Up, which included the following stages:

- **One-on-one meetings** to gather individual insights into municipal flood risk management practices and needs (January 2023 onwards).
- **Participation in an online workshop** to shape the structure and technical content of the Check-Up tool (February 2023)—see [Appendix A](#) for details.
- **Review of the Check-Up tool** in Excel, the rating system, and supporting information, with collection of comments using online surveys (October to November 2023).

Interested parties were also invited to review and provide comments on this report.



3. Review of Existing Standards, Guidance and Tools

This section presents key international and national standards, guidance, and practical tools for flood risk management that provided direction for developing the Municipal Flood Risk Check-Up.

3.1 International Standards for Risk Management (ISO 31000)

ISO 31000 is a family of standards relating to risk management published by the International Organization for Standardization (ISO). The publication ISO 31000:2018 – Risk Management — Guidelines provides the principles, framework, and guidelines for managing any form of risk, including flooding (Figure 3).²³

According to the ISO 31000 process, **risk assessment** is at the heart of risk management

(Figure 3). In the context of flooding, this is accomplished by understanding flood hazards, as well as analyzing vulnerabilities. However, to reduce risks, it is important to implement **risk treatment** strategies. In the context of flooding, this may include (1) the use of built or natural infrastructure measures to slow down, store, divert or soak up water, and (2) “non-structural” measures, such as land-use planning regulations, insurance incentives or public communication to reduce potential flood damages.

It is important to note that the ISO 31000 risk management framework is an ongoing process meant to continually improve risk management. This is accomplished through communication and consultation, recording and reporting, and monitoring and review. **The Municipal Flood Risk Check-Up has been developed to reflect the risk management framework** (see Section 4).

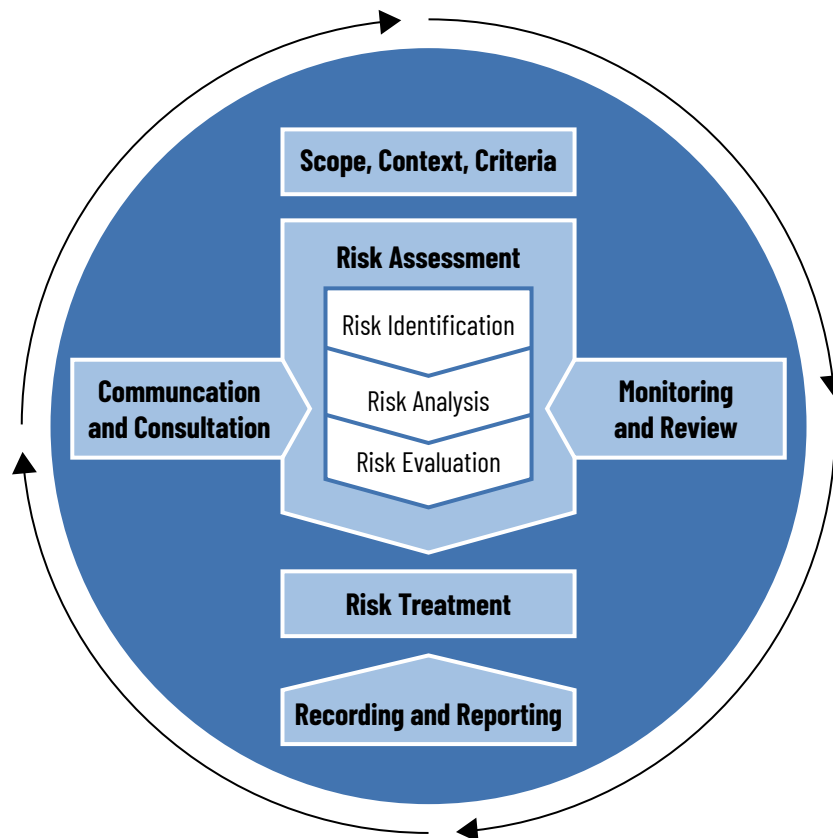


Figure 3: ISO 31000 Risk Management (adapted from International Organization for Standardization, 2018)

3.2 Canadian Flood Risk Management Standards and Guidance

Flood risk management requires interventions at multiple levels: from the localized protection of individual homes to the management of natural processes at the watershed scale.²⁴ While Canada's municipalities have direct responsibilities for flood risk management within their municipal boundaries, they also play a central role in reducing flood risk at all scales (Figure 4).

Several national standards and guidelines to improve flood resilience at different scales have already been developed (Table 2). A **full list** is being compiled and maintained by Infrastructure Canada.²⁵

Since 2018, a number of National Standards of Canada (NSCs) have been developed to support flood resilience (Table 2). NSCs are developed through a rigorous process that involves subject matter experts who are members of accredited Standards Development Organizations.

Many standards and guidelines have been developed as part of established climate resilience programs, such as:

- The *Resilient Infrastructure Standards Program* (2016-2021)²⁶, and now the *Standards to Support Resilience in Infrastructure Program* (2021-2028), led by the Standards Council of Canada.²⁷
- The *Climate-Resilient Buildings and Core Public Infrastructure Initiative (CRBCPI)* (2016-2021)²⁸, and now the *Climate Resilient Built Environment (CRBE) Initiative* (2021-2026)²⁹, led by the National Research Council of Canada, funded by Infrastructure Canada.

The documents are the result of the collaboration of hundreds of multidisciplinary experts across the country, from both the public and private sectors, comprising thousands of hours of volunteer time.

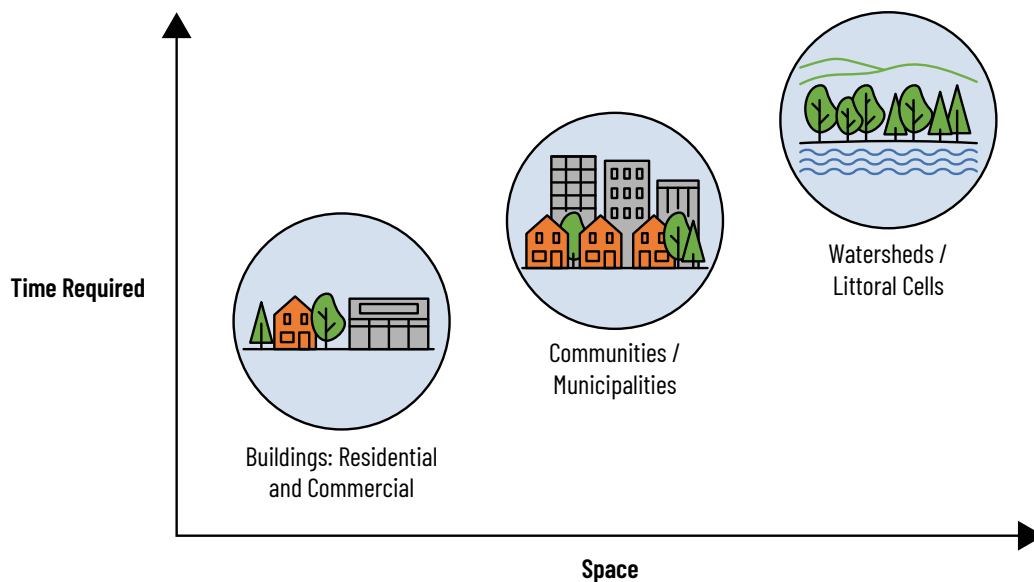


Figure 4 : Three levels of flood risk management - the horizontal axis reflects the physical space involved, and the vertical axis reflects the time typically necessary for carrying out actions (adapted from Eyquem, 2022)³⁰

Table 2: Selected national flood resilience standards and guidance that informed development of the Municipal Flood Risk Check-Up

Level of Application	Publication	Date and Type	Content
Buildings	Water on the Rise: Protecting Canadian Homes from the Growing Threat of Flooding. ³¹	2018 Free Guidance	Practical measures for basement flood protection for residents to reduce their flood risk.
	CSA Z800-F18 Guideline on basement flood protection and risk reduction. ³²	2018 CSA Standard	Measures to reduce the risks of basement flooding, and to mitigate the adverse effects on property, public safety, and public health in case of a flood event. Covers existing, new, rebuilt, and renovated houses in rural and urban settings.
	Ahead of the Storm: Developing Flood-Resilience Guidance for Canada's Commercial Real Estate. ³³	2019 Free Guidance	20 measures that can be implemented by commercial real estate owners and managers to enhance flood-resilience. Supported by BOMA Canada and REALPac.
Communities and Municipalities	Weathering the Storm: Developing a Canadian Standard for Flood-Resilient Existing Communities. ³⁴	2019 Free Guidance	Outlines a prioritization framework for selecting areas within communities that should be targeted for flood risk management measures.
	CSA W210:21 Prioritization of flood risk in existing communities. ³⁵	2021 National Standard of Canada	Framework that supports assessment and decision-making regarding flood risk-reduction at the community level, for existing communities.
	Preventing Disaster Before It Strikes: Developing a Canadian Standard for Flood-Resilient Residential Communities. ³⁶	2019 Free Guidance	20 best practices to design and build new residential communities that are more flood resilient.
	CSA W204:19 Flood resilient design of new residential communities. ³⁷	2019 National Standard of Canada	Compliance criteria and guidance on the design of flood-resilient new residential communities as it relates to greenfield development.
	CSA W211:21 Management standard for stormwater systems. ³⁸	2021 National Standard of Canada	Provides a standardized guidance process to manage a stormwater system, given a changing climate and hydrologic conditions.

Level of Application	Publication	Date and Type	Content
Watersheds and Coasts	Nature-Based Solutions for Coastal and Riverine Flood and Erosion Risk Management. ³⁹	2021 Free Guidance	Review of the use of nature-based solutions across Canada, including recommendations, case studies, and a review of international technical guidance.
	Managing Flooding and Erosion at the Watershed-Scale: Guidance to Support Governments Using Nature-Based Solutions. ⁴⁰	2023 Free Guidance	Review of watershed management and flood risk management practices in Canada and provides recommendations for future flood risk reduction using nature-based solutions.
	Rising Seas and Shifting Sands: Combining Natural and Grey Infrastructure to Protect Canada's Coastal Communities. ⁴¹	2021 Free Guidance	Outlines the range of practical measures that can be used to protect coastal communities on Canada's East and West coasts from flooding and erosion, combining grey infrastructure and nature-based solutions.
All Scales	Getting Nature on The Balance Sheet: Recognizing the Financial Value Provided by Natural Assets in A Changing Climate. ⁴²	2022 Free Guidance	Outlines actions that are being taken to manage natural assets in Canada, methods established for valuing the services natural assets provide, and steps that can be taken to recognize and value these services in accounting and decision-making.
	CSA W218:23 Specifications for natural asset inventories. ⁴³	2023 National Standard of Canada	Outlines requirements for creating and reporting a natural asset inventory, a key element of the overall process of managing natural assets.

3.3 Existing Flood Risk Management Evaluation Tools

Several practical tools exist to support municipalities in planning and implementing flood risk management actions and self-assessing municipal performance. An overview of the tools identified and reviewed to inform development of the Municipal Flood Risk Check-Up is presented in Table 3.

Table 3: Practical tools supporting municipal flood risk management

Tool	Use	Scope
Prioritization of Flood Risk in Existing Communities, CSA Group ⁴⁴	<ul style="list-style-type: none"> • Foundational assessment details provided in standard CSA W210:21. • Application and method left up to the user. • Questionnaire not readily useable. 	Canadian communities
Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk, Intact Centre on Climate Adaptation ⁴⁵	<ul style="list-style-type: none"> • Self-assessment of flood risk preparedness according to set criteria. • Ratings (A to E) assigned using qualitative scales. • Undertaken twice to benchmark progress. • Does not assess flood hazard or exposure. • Questionnaire not readily useable. 	Large Canadian cities
The Municipal How-to Guide for CSA Community Water Standards, CSA Group ⁴⁶	<ul style="list-style-type: none"> • Step-by-step process to identify where National Standards of Canada can support flood resilience. • Includes draft language demonstrating how and where Standards can be referenced in key municipal documents, (e.g. official plans, development by-laws). 	Canadian Municipalities
Community Rating System, Federal Emergency Management Association (FEMA), United States ⁴⁷	<ul style="list-style-type: none"> • Voluntary incentive program to recognize and encourage floodplain management practices that exceed the requirements of the National Flood Insurance Program in the US. • Potentially a similar approach could be adopted in Canada to reward flood prepared communities. 	Communities in the United States of America (available in English only)
Building Adaptive and Resilient Communities (BARC) Online Tool, ICLEI Canada ⁴⁸	<ul style="list-style-type: none"> • Designed to assist communities developing a community climate change adaptation plan. • User-friendly online repository of information that guides users in achieving each of the five milestones of the BARC program. • Recommended to be completed before using the Cost of Doing Nothing Toolbox (below). 	Canadian Municipalities
Cost of Doing Nothing (CODN) Toolbox, ICLEI Canada ⁴⁹	<ul style="list-style-type: none"> • Provides a template for understanding the cost of doing nothing. • Supports building a business case for municipal climate adaptation funding. 	Canadian municipalities

Tool	Use	Scope
Climate Adaptation Maturity Scale, Federation of Canadian Municipalities ⁵⁰	<ul style="list-style-type: none"> • Tool for municipalities to assess and enhance their climate adaptation practices. • Self-assessment on how municipalities incorporate climate adaptation in policy, human resources and governance, and risk management capacity. 	Canadian municipalities
Risk Return on Investment Tool (RROIT), Credit Valley Conservation and Climate Risk Institute ⁵¹	<ul style="list-style-type: none"> • Multi-flood hazard tool to support evidence-based, cost-effective decisions to reduce flood and erosion risks under existing and future climate scenarios. • Assesses the ROI associated with each mitigation solution, or a combination of mitigation solutions. • Currently online, desktop application in development. 	Canadian municipalities (available in English only)
The Coastal Adaptation Toolkit, CLIMAtlantic ⁵²	<ul style="list-style-type: none"> • An assessment on flooding and erosion issues to help identify the most suitable options to manage those issues at a specific site in a community. • Options include land use planning tools as well as coastal interventions and engineering tools. 	Atlantic coastal communities (primarily for community staff and elected officials)
Resilience Self-Assessment Tool for Water Assets in the context of Climate Change, CERIU ⁵³	<ul style="list-style-type: none"> • An assessment for municipalities on the climate vulnerabilities of water assets, considering hazards such as heavy precipitation, storms, and drought. • A draft roadmap is generated upon completion of the tool, guiding users to practical guides. 	Canadian municipalities (available in French only)
Public Infrastructure Engineering Vulnerability Committee (PIEVC), ICLR and Climate Risk Institute ⁵⁴	<ul style="list-style-type: none"> • Protocol designed to help factoring climate change impacts into plans for design, operation, and maintenance of public infrastructure. • Risk-based approach by specific infrastructure asset element. • High Level Screening Guide also available. 	Infrastructure owners and managers
Holistic Approaches to Flood Mitigation Planning and Modeling under Extreme Events and Climate Impacts, The Water Research Foundation ⁵⁵	<ul style="list-style-type: none"> • Summary of the state-of-the-practice with 15 utility holistic flood management case studies in North America and Europe. • Methodologies relevant to integrated planning framework for flood management at the community level. 	Municipalities in the United States of America (available in English only)
Enhancement of Resilience to Extreme Weather and Climate Events: Proactive Flood Management, The Water Research Foundation ⁵⁶	<ul style="list-style-type: none"> • Interactive pocket guide for enhancement of wastewater and stormwater utility resilience to extreme weather and climate events. • Assists utility users selecting datasets, methods, models, and tools appropriate to their flood conditions and management objectives. 	Municipalities in the United States of America (available in English only)



4. What We Heard: Needs in Municipal Flood Risk Management

This section summarizes key insights and input provided by contributors during one-on-one meetings and an online workshop. These insights were used to shape development of the Municipal Flood Risk Check-Up.

4.1 Insights into Current Practices and Lessons Learned

Key themes that arose in discussions with contributors regarding their experiences in managing flood risk within a municipal context are summarized below.

Small and medium municipalities should be considered a key target audience.

Small and medium-sized municipalities typically have less resources to understand and manage flood risk, and frequently do not have flood risk mapping or specialist staff dedicated to flood risk management. They would particularly benefit from a tool that provides additional guidance and support without the need for in-depth technical knowledge.

Appropriate land use planning is key to manage flood risk.

Municipalities are typically responsible for implementing land use planning regulations that are set by provinces and differ between provinces. Several participants identified the need to routinely incorporate climate change scenarios into land use planning to manage flood risk.

Climate change scenarios need to be fully considered in flood risk assessment.

Participants stressed the need for a proactive approach focused on anticipating future climate scenarios, rather than based on historical data. There is a recognized need to update flood mapping to reflect current

projections for climate change and its impacts.

There is growing understanding of risks from heavy rainfall flooding.

Flood mapping has historically focused on river and coastal flooding, however, many municipalities are actively working to better understand heavy rainfall flooding, particularly in the context of climate change. Several municipalities are working with topographical data (such as LiDAR), to map potential heavy rainfall flood risks. In certain areas, intense rainfall (pluvial) flood mapping is being funded by the federal government's Flood Hazard Identification and Mapping Program (FHIMP).⁵⁷

Asset management planning is key for implementing infrastructure solutions.

Embedding flood risk management measures into asset management planning is key to maintaining levels of service, particularly with aging municipal infrastructure. This will also help municipalities incorporate flood risk management as part of long-term infrastructure investment.

Natural infrastructure needs integrating into flood risk and asset management.

Many municipalities are already working on natural asset management to understand the role and value of natural assets, and the ecosystem services they provide in municipal flood risk management. Grey, natural, and green infrastructure should all be considered as part of municipal asset management planning. Experiences with innovative practices, such as converting public green space into water retention facilities, could be shared between municipalities and with the public.

Municipalities need to work with others.

River and coastal flooding processes often operate

beyond municipal boundaries. Flood management responsibilities are also shared among government agencies, municipalities, and other entities, including watershed management organizations. Municipalities need to work together, and with other organizations and levels of government to ensure a streamlined and coordinated approach. A watershed or regionalized approach to emergency response planning may also be beneficial.

Communication and public engagement are key areas for improvement.

There is an urgent need for effective communication tools to engage residents in understanding and managing flood risks. Flood risk management also needs to apply an equity lens, addressing vulnerable populations in both urban and rural contexts.

4.2 Shaping the Check-Up Tool: Workshop Outputs

Contributors were engaged at an online workshop on February 22, 2023, providing an opportunity to shape the development of the Municipal Flood Risk Check-Up. The focus was on the overall structure, terminology, and feedback on a draft list of questions. Details of the workshop are contained in [Appendix A](#). A summary of the key feedback received is summarized in this section.

Overarching Comments

Participants indicated that the tool should:

- Be easy to use, without need for in-depth specialist knowledge, or additional costs.
- Frame flood risk management as a continual process supporting ongoing action to manage risk.

- Lead users to take positive actions to understand and reduce flood risk, based on best practices, standards, and guidance.
- Encourage multiple staff members, departments, and other organizations to provide input to gain the fullest understanding of flood exposure and flood preparedness possible.
- Deliver outputs that help municipal staff communicate with elected officials and support investment in flood risk management action.
- Provide a visual display of results to support communications.

Structure

Workshop participants were asked to comment on two key approaches relating to flood risk management: the ISO 31000 Risk Management Framework ([Section 3.1](#), Figure 2), and a conceptual matrix combining flood exposure and flood preparedness (Figure 5).

		Level of Flood Preparedness		
		HIGH	MEDIUM	LOW
Level of Exposure to Flood Hazards	LOW	LOW	LOW	MEDIUM
	MEDIUM	MEDIUM	MEDIUM	HIGH
	HIGH	HIGH	HIGH	HIGH

Figure 5: Conceptual matrix combining flood exposure and flood preparedness

Participants highlighted that different elements of these two approaches were useful, and recommended they were combined in the Municipal Flood Risk Check-Up, as follows:

- Integrate use of a matrix as an easy to understand, visual way of combining flood exposure and flood preparedness.
- Align with the structure of the ISO 31000 Risk Management Framework to frame flood risk management as a continual process, including the need for communication, documentation, and regular review. This is not accomplished using a matrix approach alone as it appears work is complete once municipalities have achieved a low risk rating.
- Include rating of performance at different stages of the risk management process to enable municipalities to understand where they are on their risk management journey, and to compare themselves with other municipalities. Ratings should be based on readily available information.
- Refer to “reduction of risks” rather than “treatment of risks”. “Risk treatment” identified in the ISO 31000 Risk Management Framework appears final and does not reflect the ongoing efforts that are required, or the fact that risks are not eliminated in many cases.
- Clearly identify actions that can be taken to reduce risk and next steps.
- Balance simplicity of assessment with obtaining sufficient information to make the self-assessment useful.
- Address both river and coastal flooding specifically.
- Align the assessment with information municipal insurers consider when developing policies, allowing municipalities to explain their flood management strategies.
- Include the importance of long-term capital improvements, operational warning systems, and efficient maintenance management.
- Incorporate social vulnerability assessment.
- Consider different time horizons and the need to update information.

4.3 Links to Municipal Insurance

Based on feedback from participants it is understood that:

- Municipal insurance policies are developed based on specific municipal circumstances. Some municipalities purchase insurance directly from an insurance provider, and others are part of insurance pools that use their size to negotiate competitive premiums for their members. Some municipalities and pools also choose to self-insure certain risks.
- Flood risk is only one aspect that is considered in developing a municipal insurance policy. This is typically a package covering liability, legal expenses, and others, such as automobile, equipment breakdown, cyber insurance, and property insurance. Flood risk is not a specific line item in this type of insurance policy and is rather a factor

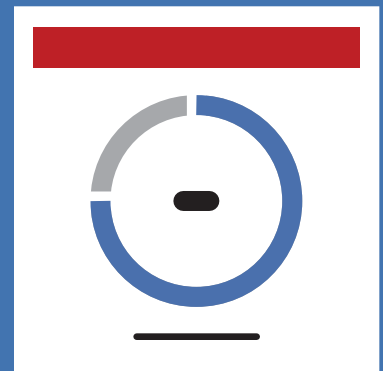
Content

Workshop participants were presented with a draft list of questions to review on flood exposure and flood preparedness. Specific feedback points included the need to:

used to determine the property insurance element that feeds into the overall policy.

- Insurers also play a role in supporting municipalities in reducing their flood risks, for example by providing seminars, webinars, training opportunities, newsletters, and collated information.
- Municipal insurers do not currently offer specific rebates for flood preparedness actions. However it is something they and municipalities are interested in discussing to incentivize action to reduce risks.
- The Check-Up can benefit both municipal insurers in developing policies, and municipalities in communicating flood risk actions to their insurer.

The Check-Up can benefit both municipal insurers in developing policies, and municipalities in communicating flood risk actions to their insurer.



5. The Municipal Flood Risk Check-Up

5.1 Overview

The Municipal Flood Risk Check-Up is a spreadsheet tool that is **free to download**. The tool has been developed to support Canadian municipalities—including small and medium municipalities that may have limited resources—in preparing for heavy rainfall, river, and coastal flooding.

It is a self-assessment questionnaire with 50 questions relating to flood exposure and flood preparedness. Municipalities are encouraged to use the Check-Up to:

1. **Gain** an understanding of flood exposure, even where flood mapping is not available.
2. **Benchmark** and document current flood preparedness, drawing on Canadian guidance and standards.
3. **Document** progress towards reduction of municipal flood risk over time.
4. **Access** a library of key resources on flood risk and preparedness, including National Standards of Canada.
5. **Demonstrate** municipal flood preparedness to interested parties.
6. **Prioritise** actions for different flood types and at different scales.
7. **Inform** future investment planning and funding applications.
8. **Anticipate** and answer questions that may be asked by municipal insurers in developing insurance policies.
9. **Contribute** to objectives and targets identified in Canada's National Adaptation Strategy.
10. **Support** municipal staff and service delivery.

5.2 Scope and Use of the Check-Up

The Municipal Flood Risk Check-Up can be used to help understand, assess, and plan action to reduce **intense rainfall, river, and coastal flood risk**. Other types of flooding, for example associated with ice jams, dam failures, and tsunamis, are not covered by this Check-Up tool. Additionally, the role of permafrost is not covered by this tool.

The Check-Up is designed as a tool that is accessible and useful to all municipalities, including those of small and medium size. Assessment of flood exposure and flood preparedness is largely based on qualitative benchmarks and application of best practices. It does not replace detailed, quantitative assessment of flood risk, including flood mapping.

- For municipalities at the beginning of their flood risk management journey, the tool can provide a robust first step in assessing needs and prioritising actions.
- For municipalities with existing flood mapping and established flood risk management practices, the tool provides a useful way of objectively benchmarking progress. Findings from flood mapping can be integrated into the assessment by answering the additional quantitative questions when prompted.

The Municipal Flood Risk Check-Up may be used to assess flood risks within a **whole municipality** or within **specific areas** of a municipality. It is recommended that the user define the area of interest prior to starting the assessment. Larger municipalities may choose to complete multiple assessments for different areas.

All municipalities are strongly recommended to **complete the assessment as a team**, involving relevant municipal staff and other organizations

external to the municipality (e.g., water and wastewater utilities, watershed management organizations), to answer the questions with the best available knowledge.

The usefulness of the outputs will depend on the accuracy of the responses provided.

The assessment should be completed regularly, for example once a year, to document progress in preparing for and reducing flood risk and to allocate resources for future action. **It is important to note that a low flood exposure score or high flood preparedness score does not indicate that flood risk has been eliminated—flood risk management is an ongoing activity that will require sustained municipal action.**

It is important to note that a low flood exposure score or high flood preparedness score does not indicate that flood risk has been eliminated—flood risk management is an ongoing activity that will require sustained municipal action.

5.3 Format and Structure












The Municipal Flood Risk Check-Up has been designed as a standalone spreadsheet. There are several advantages to this approach:

- **Analysis:** the responses to the questions can be readily analyzed to provide an overview of flood exposure and flood preparedness, highlighting key areas of risk, strengths and need for improvement.
- **Collaboration:** the tool can be readily shared electronically, or saved at a central location, and worked on by several users at once.
- **Accessibility:** the tool is freely available for download by any user and does not require any access permissions. Most users will have access to software to edit spreadsheets.
- **Control:** the user retains control of the data entered into the tool, as with any other spreadsheet file. No data is collected or shared with any third party and no outside party has access to the answers.

Alternative formats, including online surveys and interactive websites, were considered but did not offer these same advantages.

The spreadsheet consists of ten worksheets, labelled, and organized as indicated in Table 4.

Table 4: Structure of the Municipal Flood Risk Check-Up

Category	Sheet Name		Description
Introduction		Start Here	Provides the user with information on how to complete and use the Check-Up.
Questions		Section I: Flood Hazard and Exposure - Identifying Potential Risks	Provides a basic assessment of how municipalities may be exposed to flood hazards using qualitative indicators.
		Section II: Flood Preparedness - Analysing Risks	Assesses the level of understanding of heavy rainfall, river, and coastal flood risk, providing the basis for effective action.
		Section III: Flood Preparedness - Reducing Risks	Evaluates the degree to which measures have been implemented to reduce flood risks.
Results		Scorecard	Summarizes responses to all questions and sub-section averages.
		Web Diagrams	Provides a visual presentation of all ratings, grouped by section and flood type.
		Overview	Assesses the results, overall and by flood type.
		Background Calculations	Provides insight into how ratings are calculated in the analysis (editable with password).
Resources		Supporting Information	Practical guidance on key concepts used in the Check-Up.
		Glossary	Definitions of key terms.
		References	Direct links to key references.

5.4 Question Design

The 50 questions of the Municipal Flood Risk Check-Up are divided into “flood hazard and exposure” (Section I) and “flood preparedness” (Sections II and III):



Section I: Flood Hazard and Exposure – Identifying Potential Risks (16 questions)



Section II: Flood Preparedness – Analysing Risks (12 questions)



Section III: Flood Preparedness – Reducing Risks (22 questions)

The Check-Up ultimately combines all sections to provide an overall rating.

The sections have been designed to mirror elements of the ISO 31000 Risk Management framework ([see Section 3.1](#)) with “reducing risks” representing “risk treatment” based on feedback from the online workshop. The Check-Up analyzes responses for each section to provide ratings for identifying, analyzing, and reducing risks. This is the process at the heart of risk management and is to be undertaken alongside other elements of the ISO 31000 framework— communication and consultation, recording and reporting, and monitoring and review.

Sections I, II, and III, are organised into four parts based on flood type:




- A.** Combined Flood Hazards
- B.** Intense Rainfall/Sewer Flooding
- C.** River Flooding
- D.** Coastal or Shoreline Flooding (including Great Lakes and tidal portions of the St-Lawrence River)

Responses to the questions are standardized to facilitate completion of the questionnaire. Potential responses are:

- **High, Medium and Low Ratings:** to be selected based on the guidance provided in the sections.
 - For flood exposure: “High” denotes a factor contributing to a higher level of flood hazard exposure, and “Low” denotes a factor contributing to a lower level of flood hazard exposure (the desired outcome).
 - For flood preparedness: “High” denotes a factor contributing to a higher level of flood preparedness (the desired outcome), while “Low” denotes a factor contributing to a lower level of flood preparedness.
- **Unsure:** to be selected when there is insufficient information to select a High, Medium, or Low response. To take a conservative approach to risk management, an “unsure” response is considered either as “High” exposure or “Low” preparedness.
- **Not applicable (N/A):** to be selected only where river or coastal/lake flood questions are not applicable, based on the responses to Section I. Combined flood hazard and intense rainfall flooding are risks considered common to all users, therefore the “N/A” option is not offered in the drop-down menus. River and coastal/shoreline flooding related questions can be answered N/A following the initial responses in Section I.

The design of the questions is based on existing national guidance and standards. The key resources used to develop the Check-Up are highlighted in Table 5. The resources relevant to specific questions are detailed in [Appendix B](#).

Table 5: Key Resources Used to Develop the Municipal Flood Risk Check-Up

Section	Overview and Key Resources Used
 <p>Section I: Flood Hazard and Exposure - Identifying Potential Risks</p>	<ul style="list-style-type: none"> • Provides a basic assessment of flood hazard and exposure based on qualitative indicators for intense rainfall, river, and coastal/shoreline flooding. • Draws heavily on the foundational assessment of the National Standard of Canada CSA W210:21 Prioritization of Flood Risk in Existing Communities,⁵⁸ which was developed based on the guidance publication “Weathering the Storm: Developing a Canadian Standard for Flood-Resilient Existing Communities.”⁵⁹
 <p>Section II: Flood Preparedness - Analysing Risks</p>	<ul style="list-style-type: none"> • Assesses the application of best practices to analyse and evaluate flood risks, including climate change scenario analysis, vulnerability assessments, strategic planning, and flood risk mapping assessment. • Draws heavily on the benchmarking of flood preparedness undertaken for major Canadian cities in 2015 and 2019/2020.⁶⁰ Additional key resources relate to natural asset management, watershed management, and coastal flood risk management.
 <p>Section III: Flood Preparedness - Reducing Risks</p>	<ul style="list-style-type: none"> • Assesses the application of best practices to reduce flood risks, including implementation of strategic plans, grey and natural infrastructure solutions, land use planning, operations and maintenance and emergency management. • Draws on the benchmarking of flood preparedness undertaken for major Canadian cities in 2015 and 2019/2020.⁶¹ Additional key resources relate to municipal adaptation capacity, natural asset management, watershed management, and coastal flood risk management.

5.5 Results

As users choose responses to the questions in Sections I, II and III, the results are automatically analyzed and presented in three results worksheets:



Scorecard

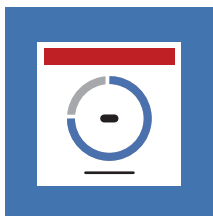
Shows the responses to each question and calculates an average rating for each sub-section. Averages are calculated by converting each response to a numerical score between 1 and 3 (Low = 1, Medium = 2 and High = 3) and averaging. Non-applicable questions are excluded from the average. By default, an average score of below 1.5 is classified as “Low”. An average score between 1.5 and 2.15 is classified as “Medium”. A score that is higher than 2.15 is classified as “High” to take a conservative approach to risk management. Where questions have been broken into different components, the components have been weighted so that the result is combined into one response.

As questions are completed, the corresponding response becomes coloured, using the colour-scheme that is established in the Check-Up for the standardized responses – “High”, “Medium”, “Low”, “Unsure” and “N/A”. The scorecard provides a detailed overview of all the responses provided in the Check-Up, and the colouring allows users to see trends at a glance and appreciate how different aspects of flood exposure and flood preparedness are currently affecting their overall flood risk performance.



Web Diagrams

Provides web diagrams, grouped by section and flood type, showing the Low, Medium, and High ratings on a scale of 1 to 3 for each aspect assessed in the Check-Up (Low = 1, Medium = 2 and High = 3).



Overview

Compiles ratings of flood exposure and flood preparedness, providing an overall score and by different flood risk types. A series of rings, matrices and pyramid diagrams are used to visualize and combine the ratings to form an overall representation of municipal flood risk. Results are presented for:

- The overall assessment (considering all questions)
- A breakdown of the assessment considering:
 - A.** Combined Flood Hazard questions
 - B.** Intense Rainfall/Sewer Flooding questions
 - C.** River Flooding questions
 - D.** Coastal or Shoreline Flooding questions



Background Calculations

Details on how ratings are calculated based on responses, including weightings for questions that have multiple parts and boundaries between “High”, “Medium” and “Low” ratings. This section can be made editable by unprotecting the sheet (In Excel, select the “Review” menu/select “Unprotect sheet”/enter the password “FloodRisk2023”).

The worksheets are designed to be printable so that users can document and share their results.

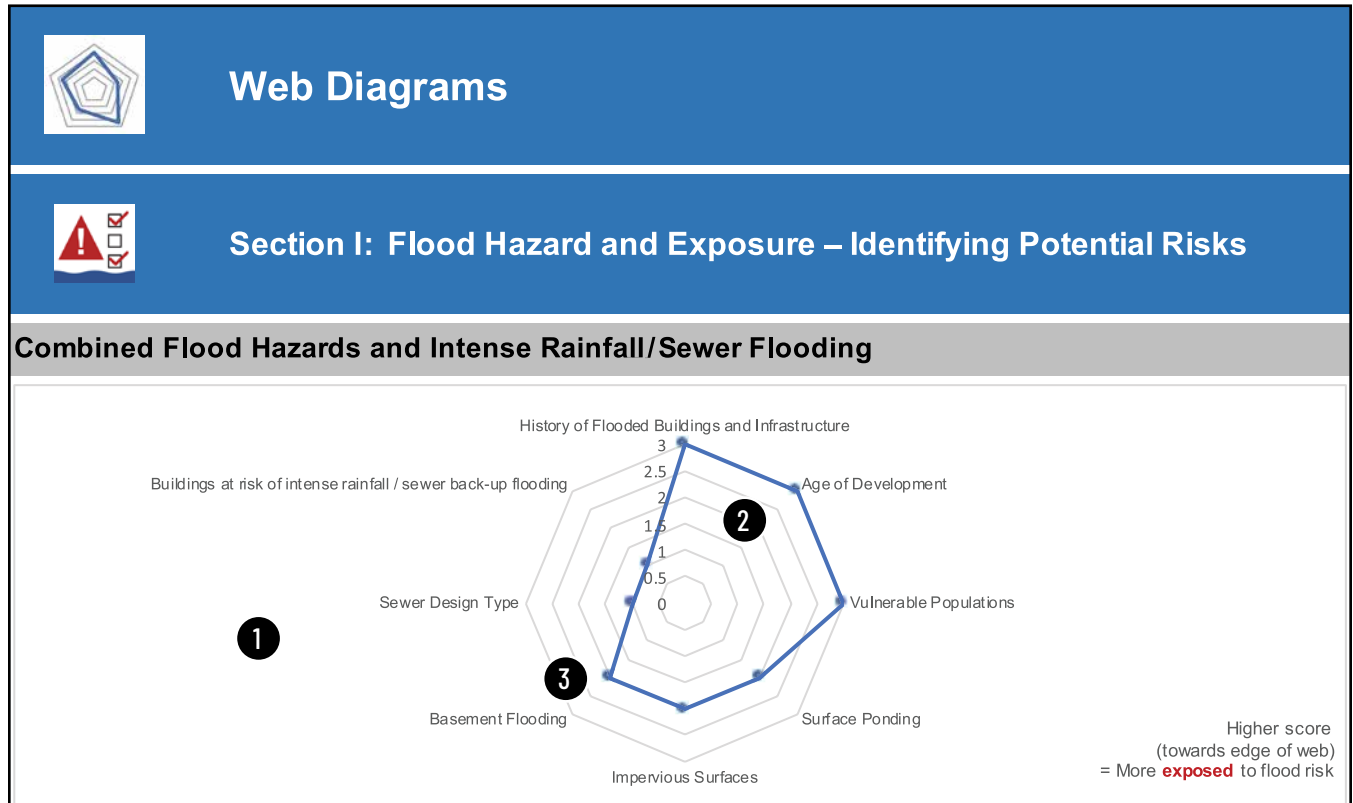
Figure 6: Understanding the Scorecard

Scorecard								
Section I: Flood Hazard and Exposure – Identifying Potential Risks							4	
Sub-section	Question		Rating				Sub-Section Rating	
A: Combined Flood Hazard 1	A1	History of Flooded Buildings and Infrastructure	High	Medium	Low	Unsure	N/A	High
	A2	Age of Development	High	Medium	Low	Unsure	N/A	
	A3	Vulnerable Populations	High	Medium	Low	Unsure	N/A	
B: Intense Rainfall / Sewer	B1	Surface Ponding	High	Medium	Low	Unsure	N/A	Medium
	B2	Impervious Surfaces	High	Medium	Low	Unsure	N/A	
	B3	Basement Flooding	High	Medium	Low	Unsure	N/A	
	B4	Sewer Design Type	High	Medium	Low	Unsure	N/A	
	B5	Buildings at risk of intense rainfall / sewer back-up flooding	High	Medium	Low	Unsure	N/A	

1. First column shows the subsection of the assessment.
2. Second column contains the questions asked in each subsection.
3. The ratings highlight the answers selected for each question.
4. Subsection rating is the average score obtained in each subsection.
5. In Section I, ‘Low’ rating means a lower level of flood hazard exposure (the desired outcome).
6. In Section II and III, ‘Low’ means a lower level of flood preparedness (unprepared).

Section II: Flood Preparedness - Analysing Risks								
Sub-section	Question		Rating				Sub-Section Rating	
A: Combined Flood Hazard	A1	Climate Change Projections	Low	Medium	High	Unsure	N/A	Medium
	A2	Strategic Stormwater Management Plan	Low	Medium	High	Unsure	N/A	
	A3	Socio-Economic Assessment	Low	Medium	High	Unsure	N/A	
	A4a	Infrastructure - Electrical Power	Low	Medium	High	Unsure	N/A	
	A4b	Infrastructure - Telecommunications	Low	Medium	High	Unsure	N/A	
	A4c	Infrastructure - Transportation	Low	Medium	High	Unsure	N/A	
	A4d	Infrastructure - Drinking Water	Low	Medium	High	Unsure	N/A	
	A4e	Infrastructure - Wastewater	Low	Medium	High	Unsure	N/A	
	A4f	Infrastructure - Food	Low	Medium	High	Unsure	N/A	

Figure 7: The Web Diagrams



1. Each web diagram displays the results, on a scale of 1 to 3, for each indicator. Scores are higher towards the outside of the web and indicate more exposure to flood risk for Section I.
2. Examples shows exposure to risk is higher for 'history of flooded building and infrastructure', 'age of development', and 'vulnerable populations'.
3. Example shows exposure to risk is smaller considering 'sewer design type'.
4. In Section II and III, higher scores towards the outside of the web indicate more preparedness for flood risk.

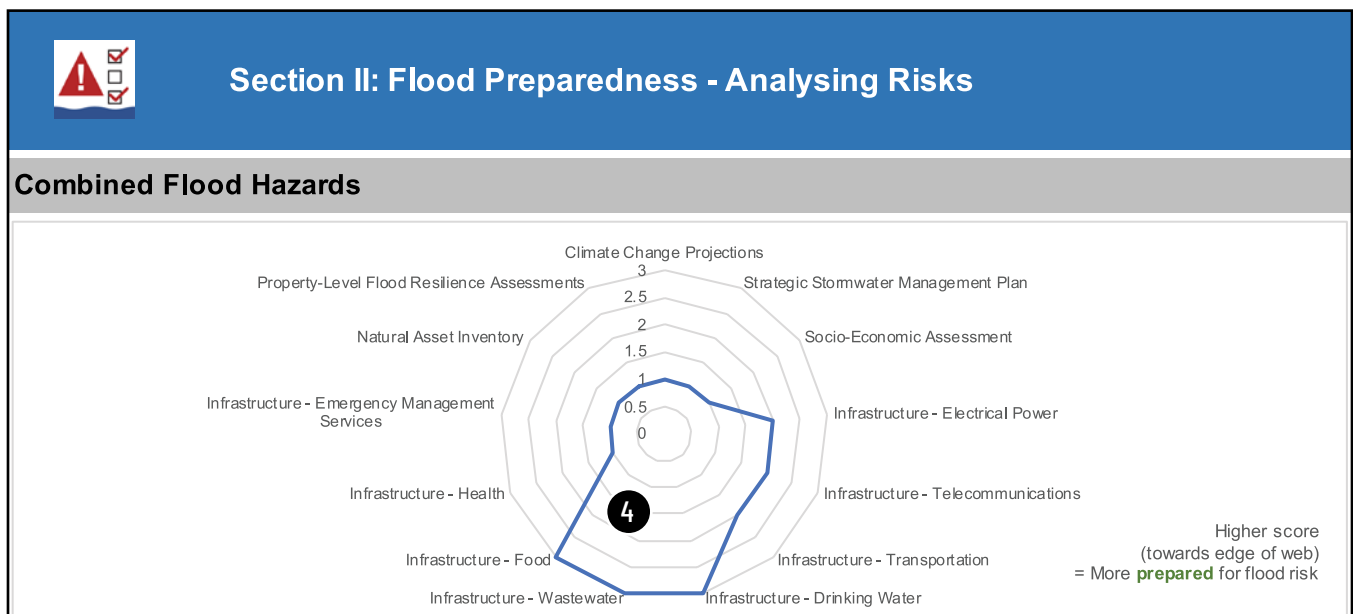
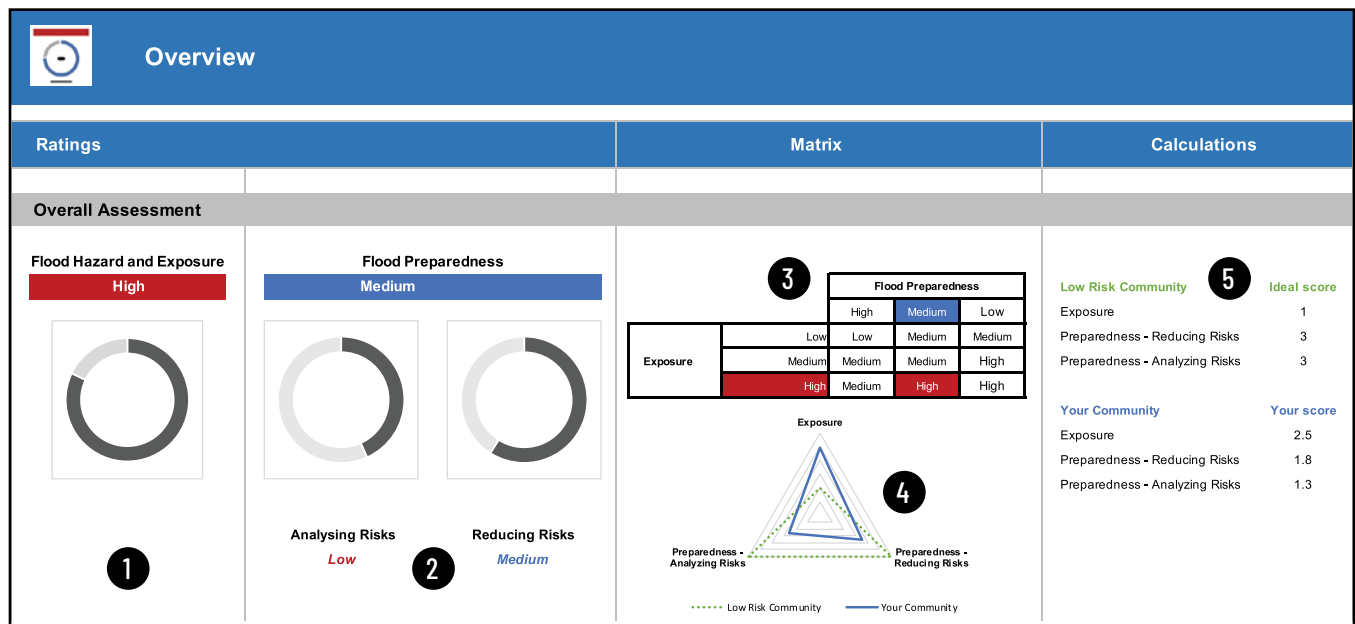


Figure 8: Overview of the Assessment Results



1. Visual indicators of flood exposure rating (Section I).
2. Visual indicators of flood preparedness ratings - subdivided into risk analysis (Section II, on the left) and risk reduction (Section III, on the right).
3. Matrix combining flood exposure rating (Section I) and flood preparedness rating (Section II and III).
4. Pyramid-style visual comparison of the three Section ratings obtained (blue line), compared to the ideal ratings (dotted green line). More "risky" ratings result in a narrower-based, taller pyramid.
5. Display of scores on a scale of 1 to 3. This is not a precise quantitative assessment. Scores are a qualitative performance indicator included to monitor progress over time.

Note that the above metrics are provided for the overall assessment, as well as by type of flooding:

- A. Combined Flood Hazards
- B. Intense Rainfall/Sewer Flooding
- C. River Flooding
- D. Coastal or Shoreline Flooding

5.6 Resources

The Check-Up provides users with additional resources to support their understanding of the questions asked, and to support further action to manage and reduce flood risk. The additional worksheets are:



Supporting Information

Information describing key concepts and best practices, presented directly in the Check-Up for ease of reference. Each section provides a definition, links to key resources and background information to assist users in their understanding of the questions being asked.



Glossary

A list of definitions of key terms, taken predominantly from Canadian standards and guidance. Hyperlinks to the definitions are located alongside the questions where the terms are used. For ease of navigation, users can click on the hyperlinks to navigate to the definition, and then click on links that take them back to the section where they were working.



References

A list of key references with direct hyperlinks for ease of access.



6. Moving Forward Together: Supporting Municipal Action

The Municipal Flood Risk Check-Up is a practical tool that can help accelerate action to reduce flood risk across Canada. Reducing flood risk is in the interest of all parties that live and work in municipalities, including residents, businesses, governments, and financial institutions. While municipalities act on the front lines, other parties have a key role to play in supporting them.

6.1 Empowering Municipalities

The Municipal Flood Risk Check-Up can be used as a catalyst for action to reduce flood risk within municipalities by:

- **Bringing** municipal staff together across departments to take action on flood risk.
- **Encouraging** cross-sector and multidisciplinary collaboration.
- **Increasing** internal knowledge and understanding of flood risk management.
- **Providing** easy access to key standards, guidance, and best practices, including National Standards of Canada.
- **Enabling** benchmarking and documentation of progress over time to support continual improvement in flood risk management.
- **Distilling** information into a format that can be readily communicated to elected officials and City Managers, and funding agencies.
- **Informing** conversations with municipal insurers.
- **Demonstrating** how nature-based solutions and natural asset management are integral to flood risk management.
- **Serving** as a tool to strengthen partnerships with the private sector and community groups.

Completion of the Check-Up itself is an excellent first step in the flood risk management journey. To make a significant change, municipalities will need to use the Check-Up to identify, prioritize and complete additional actions to understand, manage and reduce flood risk.

It is highly recommended that municipalities undertake communication and consultation, recording and reporting, and monitoring and review activities to maximize the benefits of the tool (as set out in ISO 31000 Risk Management – [see Section 3.1](#)) **This includes, for example, completing the Check-Up and using it on a regular basis to identify priorities to inform asset management planning, annual budgeting and other multi-year strategies.**

Completion of the Check-Up itself is an excellent first step in the flood risk management journey. To make a significant change, municipalities will need to use the Check-Up to identify, prioritize and complete additional actions to understand, manage and reduce flood risk.

6.2 Other Users

The Check-Up may be beneficial to any organization with an interest in assessing the flood risk profile of municipalities and their associated disclosures. This includes, but is not limited to:

- Municipal insurers
- Institutional investors
- Securities commissions
- Credit rating agencies

The Check-Up may also provide a useful starting point for a system, similar to FEMA's Community Rating System in the United States,⁶² incentivizing community flood risk management actions as part of the national flood insurance program that was announced by the federal government in Budget 2023.⁶³

6.3 Scaling-Up Use of the Check-Up

In Canada there are around 3,600 local governments.⁶⁴ A key challenge is to raise awareness and encourage use of the Municipal Flood Risk Check-Up among potential users to accelerate widespread action.

Many different organizations already established relationships with municipalities and have a key role to play in raising awareness, providing information, and encouraging the use of the Municipal Flood Risk Check-Up to reduce flood risk. These include:

- **Federation of Canadian Municipalities (FCM):** members include more than 2,000 municipalities and 20 provincial and territorial municipal associations. Together, they represent more than 92% of all Canadians from coast to coast to coast.⁶⁵
- **Standards Organizations:** the Standards Council of Canada and the standards development

organization, CSA Group, have already identified the need to increase the uptake of available flood resilience standards and are actively working to increase awareness among municipalities.

- **Provincial and territorial municipal associations:** in Canadian provinces and territories, municipal associations actively support their members through collaboration, training, events, and regular communications.
- **Municipal insurers, insurance pool operators and financial institutions:** have privileged relationships with their clients and members, and a mutual interest in reducing risk.
- **Professional associations:** a wide range of professionals work within, and support, municipalities in areas such as accounting, financial analysis, management consulting, engineering, and planning and design of flood risk solutions.
- **Regional climate service providers:** regional knowledge networks share information across Canada, including Pacific Climate Impacts Consortium (PCIC) and Pacific Institute for Climate Solutions (PICS) (British Columbia), ClimateWest (Alberta, Manitoba, and Saskatchewan), CLIMAtlantic (Atlantic Canada), Ouranos (Quebec) and the Ontario Resource Centre for Climate Adaptation (ORCCA).
- **NGOs:** numerous NGOs actively partner with municipalities in projects, including some directly related to flood risk-management.

Tackling flood risk requires a whole-of-society approach. Support from these organizations will be critical to operationalize the Municipal Flood Risk Check-Up to make change on the ground. By facing flooding together, we can make lives better and safer.

Appendix A: Online Workshop – Overview

This appendix provides an overview of the virtual workshop held on February 22, 2023. The workshop was attended by 30 subject matter experts from across Canada. Attendees are recognized in the acknowledgements list at the beginning of this report.


Stated Workshop Goals

1. Review structure of the assessment tool and terminology, and questions to assess different elements of risk identification, evaluation, and treatment.
2. Capture additional subject matter expertise regarding assessment of municipal flood risk.
3. Collaborate on draft framework production.


Workshop Activities

Context Setting	<ul style="list-style-type: none"> • Welcome and Introduction • Project Need and Progress to Date (presentation by Joanna Eyquem) • Workshop Overview (presentation by Mélie Monnerat)
Group Task #1	<p>Structure of assessment tool and terminology</p> <ul style="list-style-type: none"> • Participants were asked to work in four small groups of 7-8 people, focused on intense rainfall (1 group), coastal (1 group) and river flooding (2 groups). • Input was gathered through facilitated discussion relating to questions: <ol style="list-style-type: none"> 1. What are the advantages and disadvantages of using the ISO Risk Management Framework or risk matrix approaches for measuring progress in flood risk management? 2. What terms should we use, and what should we avoid?
Group Task #2	<p>Review of questions to assess different elements of risk identification, evaluation and treatment and innovative approaches</p> <ul style="list-style-type: none"> • In the same groups, participants were asked to discuss the following questions: <ol style="list-style-type: none"> 1. Are there elements you would move between risk identification, risk analysis and risk treatment? 2. Are there elements that should be added/removed? 3. Are there innovative approaches you would recommend, especially for small municipalities?
Review and Structured Plenary Discussion	<ul style="list-style-type: none"> • Full group discussion on the following questions: <ol style="list-style-type: none"> 1. What are key enabling factors that have helped you progress on flood risk management ? 2. Who would use this tool within municipalities according to your perspective? 3. How do city leaders prioritize urban flood risk at present? 4. How can we help move it up the list?
Closing	<ul style="list-style-type: none"> • Next Steps and Closing Remarks


Appendix B: Key Sources Used to Develop Check-Up Questions


 Section I: Flood Hazard and Exposure – Identifying Potential Risks	Key Source(s)
A: Combined Flood Hazard Exposure	
Question A1 – History of Flooded Buildings and Infrastructure: How would you categorise the occurrence of flooding according to historical records?	CSA W210:21 Prioritization of flood risk in existing communities
Question A2 – Age of Development: Stormwater management has been increasingly well integrated into urban planning and development over time. Select the period of urban development that best applies to the area you are assessing.	
Question A3 – Vulnerable Populations: How would you categorise the exposure of vulnerable populations according to historical flood records and current understanding of social vulnerability?	
B: Intense Rainfall/Sewer Flood Exposure	
Question B1 – Surface Ponding: How would you categorise the contribution of topography to surface ponding in the municipality?	CSA W210:21 Prioritization of flood risk in existing communities
Question B2 – Impervious Surfaces: How would you categorise the extent of impervious surfaces vs natural/vegetated surfaces?	
Question B3 – Basement Flooding: How would you categorise the presence of basements and occurrence of basement flooding in the past 10 years?	
Question B4 – Sewer Design Type How would you best categorise the sewer system type?	
*Question B5 – Buildings at risk of intense rainfall/sewer back-up flooding: Based on your assessment, what percentage of buildings do you estimate are at risk of intense rainfall / sewer back-up flooding?	Adapting to Rising Flood Risk


*Optional quantitative question if updated flood mapping is available.


 Section I: Flood Hazard and Exposure – Identifying Potential Risks	Key Source(s)
C: River Flood Exposure	
Question C1 – Watercourses: How would you categorise the presence of watercourses and occurrence of river flooding to date?	
Question C2 – Proximity to River Floodplain Areas: How would you categorize development in relation to river floodplain areas? (either regulatory floodplain areas, or areas estimated to be river floodplains based on other data – e.g., topography, historical flood extents).	CSA W210:21 Prioritization of flood risk in existing communities
*Question C3 – Buildings at risk of river flooding: What percentage of buildings do you estimate are at risk of river flooding (e.g., 1 in 100-year floodplain, taking into account climate change projections)?	Adapting to Rising Flood Risk
*Question C4 – Buildings at high-risk of river flooding: What percentage of buildings do you estimate are at high-risk of river flooding (e.g., in the current 1 in 20-year floodplain)?	
D: Coastal or Lake Shoreline Flood Exposure	
Question D1 – Shorelines How would you categorise the presence of shorelines and occurrence of coastal flooding to date?	CSA W210:21 Prioritization of flood risk in existing communities
Question D2 – Proximity to Coastal or Lake Shoreline Floodplain Areas How would you categorize development in relation to coastal or shoreline floodplain areas? (either regulatory floodplain areas, or areas estimated to be coastal or shoreline floodplains based on other data – e.g., topography, historical flood extents).	
*Question D3 – Buildings at risk of coastal/lake flooding What percentage of buildings do you estimate are at risk of coastal/lake flooding (e.g., 1 in 100-year floodplain, taking into account climate change projections)?	Adapting to Rising Flood Risk
Question D4 – Buildings at high-risk of coastal/lake flooding What percentage of buildings do you estimate are at high-risk of coastal/lake flooding (e.g., in the current 1 in 20-year floodplain)?	


*Optional quantitative question if updated flood mapping is available.


 Section II: Flood Preparedness – Analysing Risks	Key Source(s)
A: Combined Flood Hazard Preparedness	
Measure A1: Climate Change Projections The municipality has analysed a range of climate change projections and the likely impacts on different types of flood risk.	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
Measure A2: Strategic Stormwater Management Plan The municipality has a current strategic stormwater management or drainage plan that identifies key flood risks, including the impacts of climate change (completed or reviewed in the last 5 years).	
Measure A3: Socio-Economic Assessment The municipality has undertaken socio-economic vulnerability assessment to identify the exposure of vulnerable populations to flooding and integrated the findings into flood risk assessments and climate adaptation planning.	
Measure A4: Critical Infrastructure Vulnerability Assessment The municipality has access to an up-to-date risk assessment to identify the vulnerability of critical infrastructure systems to flooding (completed or reviewed in the last 5 years).	
Measure A5: Natural Asset Inventory The municipality has an up-to-date inventory of natural assets (completed or reviewed in the last 5 years) and has an understanding of their role in managing flood risk.	<u>CSA W218:23 Specifications for natural asset inventories</u>
Measure A6: Property-Level Flood Resilience Assessments The municipality subsidises or encourages property-level flood resilience assessments.	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
B: Intense Rainfall/Sewer Flood Preparedness	
Measure B1: Rainfall Flood Risk Maps The municipality has an up-to-date risk assessment of rainfall flooding, including the impacts of climate change (completed or reviewed in the last 5 years), AND the flood risk maps have been made public.	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
Measure B2: Sewer-Backup Flood Risk Maps The municipality has an up-to-date risk assessment of sewer back-up flooding, including the impacts of climate change, AND the flood risk maps have been made public (completed or reviewed in the last 5 years).	

 Section II: Flood Preparedness – Analysing Risks	Key Source(s)
C: River Flood Preparedness	
Measure C1: Watershed Management The municipality is actively engaged in flood risk management at a watershed-scale, working with other municipalities and organizations where watershed boundaries extend outside of the municipality's own jurisdiction.	<u>Managing Flooding and Erosion at the Watershed Scale</u>
Measure C2: River Flood Risk Maps The municipality has an up-to-date river flood risk assessment, including the impacts of climate change (completed or reviewed in the last 5 years), AND flood risk maps have been made public	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
D: Coastal or Lake Shoreline Flood Preparedness	
Measure D1: Strategic Coastal/Shoreline Management The municipality is actively engaged in strategic coastal/shoreline management planning that directly addresses flood risk for sections of coast/shoreline within its jurisdiction.	<u>Rising Seas and Shifting Sands</u>
Measure D2: Coastal/Lake Flood Risk Maps The municipality has an up-to-date risk assessment of coastal/lake flooding, including the impacts of climate change, AND the flood risk maps have been made public (completed or reviewed in the last 5 years).	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>

 Section III: Flood Preparedness – Reducing Risks	Key Source(s)
A: Combined Flood Hazard Preparedness	
Measure A1: Climate Adaptation Plan The municipality has developed a climate adaptation plan that includes specific actions to reduce relevant flood risks.	<u>MCIP: Climate Adaptation Maturity Scale</u>
Measure A2: Critical Infrastructure The municipality, or others, have secured funding, developed plans and are implementing necessary flood mitigation measures to protect key infrastructure and services to a desired level. The municipality is aware of the actions taken where they do not have jurisdiction.	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>

 Section III: Flood Preparedness – Reducing Risks	Key Source(s)
<p>Measure A3: Flood Risk in Asset Management Planning The municipality has an asset management plan that addresses the impacts of climate change on flood risk and the investments required to maintain appropriate levels of services in relation to flood protection.</p>	<p><u>MCIP: Climate Adaptation Maturity Scale</u></p>
<p>Measure A4: Natural Asset Management The municipality has an asset management plan that addresses the role of natural assets in managing flood risk. The plan includes the investments required for protection, rehabilitation and management of natural assets to maintain appropriate levels of services in relation to flood risk management.</p>	<p><u>CSA W218:23 Specifications for natural asset inventories</u></p>
<p>Measure A5: Home Flood Resilience The municipality provides residents with information that indicates whether a property is located in a flood-prone area, alongside property-level resilience measures that can be taken (e.g., distribution of infographics, campaigns by post, radio, television, public information events etc.)?</p>	<p><u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u></p>
<p>Measure A6: Commercial Real-Estate Flood Resilience The municipality provides commercial real-estate owners and tenants with information that indicates whether a property is located in a flood-prone area, alongside property-level resilience measures that can be taken (e.g., distribution of infographics, campaigns by post, radio, television, public information events etc.)?</p>	<p><u>Ahead of the Storm: Developing Flood-Resilience Guidance for Canada’s Commercial Real Estate.</u></p>
<p>Measure A7: Emergency Management Response The municipality has prepared a robust emergency management response plan for relevant types of flood risk, including measures to ensure communications continuity.</p>	
<p>Measure A8: Flood Forecasting and Alert Systems The municipality has prepared a robust emergency management response plan for relevant types of flood risk, including measures to ensure communications continuity.</p>	<p><u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u></p>
<p>Measure A9: Climate Adaptation Officer The municipality has a full-time “Climate Adaptation Officer” or equivalent, who is responsible for delivering flood risk reduction actions (as part of climate adaptation duties).</p>	
<p>Measure A10: Municipal Staff and Council Capacity Municipal Staff and Council are equipped with the mandate, knowledge, training, and tools needed to support flood risk reduction actions.</p>	<p><u>MCIP: Climate Adaptation Maturity Scale</u></p>
<p>Measure A11: Non-Emergency Operational Activities that support flood preparedness The municipality maintains non-emergency operation (e.g., on overland drainage systems, catch basin cleaning programs, etc.) for relevant types of flood risk, including measures to ensure communications continuity.</p>	<p><u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u></p>

 Section III: Flood Preparedness – Reducing Risks	Key Source(s)
B: Intense Rainfall/Sewer Flood Preparedness	
Measure B1: Stormwater Management System The municipality has upgraded the stormwater drainage system to provide sufficient capacity to address the impacts of climate change, including grey and natural infrastructure measures where appropriate.	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
Measure B2: Sanitary Sewer System The municipality has upgraded the sanitary sewer system to provide sufficient capacity to address the impacts of climate change.	
Measure B3: Basement Flood Protection The municipality works actively to encourage uptake of basement flood protection measures.	
Measure B4: Backwater Valves – New Homes The municipality mandates the installation of backwater valves for newly constructed homes.	
Measure B5: Backwater Valves – Existing Homes The municipality subsidises the installation of backwater valves in existing homes.	
C: River Flood Preparedness	
Measure C1: River Floodplain Regulation The municipality has up-to-date regulatory floodplain mapping, prohibits development, and re-development in the floodplain, and ensures development does not make flood risk worse (e.g., downstream).	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
Measure C2: River Flood Management The municipality, or organizations upstream, have implemented appropriate flood mitigation measures, including grey and natural infrastructure solutions, their maintenance, and non-structural solutions, to reduce river flooding of buildings and critical infrastructure or serious threat to public safety.	<u>Managing Flooding and Erosion at the Watershed Scale</u>
Measure C3: High-Risk River Floodplain Areas The municipality has engaged with communities in high-risk river floodplain areas, and identified appropriate risk management solutions, including living with the risk and planned relocation.	

 Section III: Flood Preparedness – Reducing Risks	Key Source(s)
D: Coastal or Lake Shoreline Flood Preparedness	
Measure D1: Coastal/Lake Shoreline Floodplain Regulation The municipality has up-to-date regulatory floodplain mapping AND prohibits development, and re-development in the floodplain, AND development that makes existing flood risk worse.	<u>Climate Change and the Preparedness of 16 Major Canadian Cities to Limit Flood Risk</u>
Measure D2: Coastal/Shoreline Flood Management The municipality, or organizations adjacent, have implemented appropriate flood mitigation measures, including grey and natural infrastructure solutions, their maintenance, and non-structural solutions, to avoid coastal/lake flooding of buildings and critical infrastructure or serious threat to public safety.	<u>Rising Seas and Shifting Sands</u>
Measure D3: High-Risk Coastal/Shoreline Floodplain Areas The municipality has engaged with communities in high-risk coastal/shoreline floodplain areas (e.g., in the current 1 in 20-year floodplain) and identified appropriate risk management solutions, including living with the risk and planned relocation.	

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