Developing a Stormwater Quality Management Standard (QMS)

in Light of a Changing Climate

SEED DOCUMENT TO SUPPORT NATIONAL STANDARD DEVELOPMENT

Prepared for: Engineers Canada
Date: November 2018

Funded by: Standards Council of Canada / Conseil canadien des normes

Administered by: engineerscanada / ingénieurscanada

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About This Study

This project seeks to understand the role and scope of a risk and quality management standard that could be developed to assist municipalities, engineers and other professional practitioners in designing, operating, maintaining and continuously improving stormwater management systems—both today and in light of a changing climate.

Between January and June, 2018, research was conducted via a literature review, scan of best practices, select interviews with key experts and consultations with stakeholders across the country to understand:

- The current state of stormwater (SW) planning and management and how it may be challenged by climate change
- Best or emerging practices to address future needs of stormwater management (SWM) in light of a changing climate
- Levels of support for a national stormwater quality management standard (SW QMS) and the benefits it could bring
- What a national SW QMS standard might look like in Canada

Existing relevant guidelines, standards and best practices were identified, compiled and reviewed. These include provincial stormwater and flood management guidelines, select municipal stormwater design standards, existing international risk and quality management standards, and some of the best practices to integrate climate change considerations into SW planning and management that municipalities are already employing.

This seed document summarizes the research findings and makes recommendations concerning the scope, intended users and potential components of a future national SW QMS.

A special thank you to the following expert reviewers, who contributed their time, expertise and guidance during the development of this document:

- Barbara Robinson (Norton Engineering Inc.)
- Jeff Walker (CSA)
- Yehuda Kleiner (NRC)
- Ehsan Roshani (NRC)
- Natalia Moudrak (Intact Centre on Climate Adaptation)
- Nathalie Bleau (Ouranos)
- Dirk Nyland (British Columbia Ministry of Transportation and Infrastructure)

This project is funded by the Standards Council of Canada and administered by Engineers Canada.

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1 Introduction

Standards offer municipalities a way to reduce risks of infrastructure failure and related damages, reduce liability associated with regulatory non-compliance and support continual improvement within municipal operations. While there are national standards for drinking water and wastewater systems with clearly defined levels of service, similar standards for stormwater do not exist. Indeed, there are no standards or methods for municipal staff, engineers and other relevant decision makers to determine acceptable levels of risk associated with stormwater management systems or set appropriate levels of service.[1]

This report presents initial research findings to-date on the potential for a national SW QMS and the next steps arising from the suggestions and concerns heard. Specifically, this report:

- Sets the context and summarizes challenges that municipalities experience today in managing their stormwater systems, as well as how these challenges will worsen in the future due to climate change (Section 2)
- Details a range of legal, environmental, social and economic risks municipalities and other stakeholders could face, or have faced in recent history, for failing to adequately manage stormwater and incorporate climate change considerations into their decision-making (Section 3)
- Maps out the landscape of provincial and municipal stormwater guidance, existing Canadian and international standards, and select best practices in municipal stormwater management that could offer helpful guidance in the development of a SW QMS (Section 4)
- Identifies gaps in existing standards and stormwater management practices uncovered in the research to-date (Section 5)
- Discusses the potential benefits of a SW QMS (Section 6)
- Begins to explore what a national SW QMS could look like in terms of its scope, intended users, jurisdictional applicability and proposed sections of a framework (Section 7)

Finally, Section 8 outlines the next steps in the standards development process in pursuit of a future SW QMS. It is hoped that this seed document acts as an effective background document identifying the problem, providing a solid research foundation and envisioning a framework standard that would help manage risks and improve stormwater management and climate adaptation across Canada.

[1] Amec Foster Wheeler and Credit Valley Conservation. 2017. National Infrastructure and Buildings Climate Change Adaptation State of Play Report. Prepared for the Infrastructure and Buildings Working Group, part of Canada's Climate Change Adaptation Platform. https://engineerscanada.ca/sites/default/files/ibwg_sop_2017.pdf

Value of Voluntary Standards

Under the Pan-Canadian Framework on Clean Growth and Climate Change, Standards Council of Canada (SCC) is ensuring the national standardization system is positioned to protect the health and safety of Canadians in the face of a changing climate. SCC is working with its accredited Standards Development Organization (SDO) to ensure the requirements of infrastructure standards are "climate-ready", and that standardization is ready and poised to help support the Canadian clean tech industry through accelerated commercialization.

As the environment is a shared jurisdiction and standardization can impact national economic strategies and national, regional and international trade agreements, it is important to have nationally harmonized standards. The use of recognized standards and their implementation by regulators facilitates the alignment of standards across Canada, serves as a credible framework for rulemaking, and provides a valuable tool for benchmarking environmental public policy. Going forward, the challenge for the standardization community will be balancing stakeholders' desire for quick solutions and tools that can influence and support climate policy with the realities of the time it takes to develop or update standardization tools.

The pillars of the accredited standards development process include:

- **Multi-stakeholder participation**: Regulators, Industry, Civil Society, Consultants, Academics, etc.
- **Balance of interests**: Representation of interest categories in the development of standards (typically, but not limited to: general interest, producers, regulators and users)
- **Geographic representation**: Technical committees include Canadian geographical representation appropriate to the subject area covered by the standard
- **Consensus-based decision-making**: Uses a deliberate, rules-based process and seeks substantial agreement among stakeholders
- **Transparent and Inclusive**: Public, member body review of drafts
- **Availability in both official languages**: Published simultaneously in both of Canada's official languages if the standard and stakeholders indicate the need for both official languages
- **Current**: Standards have to be reaffirmed, revised or withdrawn at least every 5 years

Regulatory harmonization across jurisdictions, along with taking a leading role in setting international standards, will both strengthen Canadian sectorial growth and environmental outcomes.

2 Setting the Context: Urban Stormwater Planning and Management Today and Tomorrow

Those responsible for urban stormwater planning and management in Canada are experiencing growing challenges. Incidences of stormwater systems being pushed beyond their limits due to combinations of severe rainfall and flooding, aging infrastructure, increasing urban densification and reduced permeable structures are challenging stormwater management. Certain projections suggest that these incidences may become more frequent in the future due to climate change. While today's stormwater management systems are generally designed based on historical trends, climate data and projections suggest that history can no longer adequately guide stormwater planning, investing and management. Decision makers need to move beyond a reactive approach and forge a proactive plan to improve the resilience of our infrastructure.

Special Characteristics of Stormwater Systems

- Total assets are often not well understood by owner municipality
- Infrastructure crosses public and private ownership lines
- Responsibility for planning and management is shared among many provincial ministries, municipal departments and, sometimes, conservation authorities, with no clear lead
- Does not lend itself to a uniform level of service applicable to all systems and locations

In Canada, responsibility for stormwater infrastructure design, construction, operation, maintenance and monitoring is distributed across provincial authorities, local municipalities, conservation and regulatory agencies, often with no clear lead (including both engineering and building departments, which operate under entirely different regulations). Decision makers operate under a patchwork of laws, policies and regulations concerning erosion and floodplain management, among other things—none of which directly and consistently govern stormwater management. Decision makers and the engineers and practitioners who support them are faced with managing older infrastructure in need of both repair and upgrading, ensuring new infrastructure will be resilient to future climate conditions and understanding how to obtain and use data on possible changes to future volumes, frequency and types of stormwater. While various potential methods exist, there is no standard or methodology to assess level of risk and level of service for stormwater management systems. Those responsible for stormwater are seeking guidance on evaluating risk, incorporating climate change into stormwater management, and determining a feasible level of service for existing and future development in light of these changes.

Detailed below are existing challenges of urban stormwater management today and emerging challenges in light of climate change.

2.1 Challenges in Stormwater Management Today

Large and small communities across Canada are struggling to define and maintain levels of service, cover costs of replacing aging infrastructure and ensure today's stormwater systems can handle the inputs they are seeing. The following are challenges stakeholders experience with respect to stormwater management today:

- **Varying level of service for stormwater**. Currently, there is no consistent understanding of what "level of service" means in the context of stormwater and no standard for how to assess appropriate levels of service and risk. This challenge relates to both water quantity and water quality. Some municipalities adopt targets and others do not. Furthermore, unlike drinking water and wastewater systems that have strict federal guidelines, stormwater has evolved and depending on the age of development there may be combined sewers (sanitary sewage and stormwater combined in one pipe), no stormwater control for flooding, no water quality control or water balance.
- **Lack of a sustainable funding mechanism**. Most municipalities do not have dedicated stormwater funding or financing and instead must rely on the general tax base. Other water systems such as drinking water and wastewater have strict federal regulations, resulting in political will on the part of councillors and senior managers to develop dedicated funding mechanisms. Stormwater, on the other hand, does not have similar clear policies or regulations that would drive a dedicated fund. In some jurisdictions, development charges for greenfield development cover water and wastewater upgrades, but do not cover stormwater management system upgrades.
- **Aging historical infrastructure and inadequate existing infrastructure for current needs**. Because of different service levels across a municipality, some areas (particularly those built prior to 1970s) may be more vulnerable to high intensity storms that we are seeing today—before we even layer on future climate change impacts. A large portion of infrastructure is also aging and reaching the end of its service life, exacerbating this stress.
- **Increasing urbanization, intensification and densification.** Higher population densities in urban areas reduce surface storage area and permeable surfaces and increase pressure on aging stormwater systems. Intensification in existing urban areas can pose a risk because existing stormwater management issues are exacerbated. At the same time, there is opportunity to build in stormwater management considerations with new developments and to bring the existing stormwater management system up to today's standards.
- **Politics.** Political issues can create challenges. Councillors must balance the conflicting interests of their constituent base, including from those constituents who demand similar levels of attention regardless of their neighbourhoods' actual risk profiles.
- **Lack of understanding by leadership.** Municipal senior managers and councilors are interested in understanding legal and insurance issues; however, most of the time, they do not have technical stormwater backgrounds. This results in a gap in understanding how the various issues are dealt with on the ground. For example, flooding and spills have immediate, obvious impacts, which lead to prioritization and action. But when it comes to water quality, it is hard to understand the long-term impact.

- **Shared responsibility of service for sanitary and stormwater systems.** Many municipalities have a shared service model whereby sanitary services are administered by the upper tier or regional municipality and stormwater services are administered by the lower tier municipality. This shared model confuses the division of responsibility for stormwater and contributes to a lack of clearly defined roles and responsibilities related to stormwater management systems.[2] In some cases, stormwater infrastructure is not considered to be as important as sanitary infrastructure, so is then not prioritized or is installed with poor practices.
- **Silos.** A "silo" mentality in many organizations that prevents stormwater groups from working with their counterparts in development, engineering and operations.
- **Use of proprietary water treatment technologies is not standard.** Stormwater quality treatment standards are mainly focused on the removal of particulate bound contaminants (total suspended solids). Many technologies are being designed and tested for removal of dissolved nutrients which is a growing concern in Canada resulting in algal blooms in freshwater lakes. These proprietary water treatment units could be adopted on a wider scale to better understand the water quality improvement aspects.

All of these factors lead to less emphasis on the need to invest in stormwater infrastructure.

2.2 Challenges in Stormwater Management in Light of Future Climate Conditions

Climate change and associated impacts add an additional layer of complexity to the challenges described above. A vast collection of literature and data is available about weather and climate in Canada. *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation* provides a synopsis of past climate trends and anticipated changes that are expected under a changing climate for all areas of Canada.[3]

Stormwater management systems are generally impacted by the depth, intensity and duration of precipitation events, which are projected to be more intense and frequent under climate change conditions. The projected changes in precipitation events include increases in annual average precipitation, changes in seasonal average precipitation, more precipitation falling as rain/freezing rain rather than snow and more extreme precipitation. These changes increase the risk of flooding and short duration high intensity (SDHI) precipitation events, which are currently projected to become about twice as frequent by mid-century over most of Canada.Temperature variation due to climate change could also impact stormwater systems.

Changes in the type, timing and amount of precipitation, as well as temperature variation resulting from climate change, could result in the following consequences:[4]

- More frequent freeze / thaw cycles

[2]Green Communities Canada. 2016. Final Report to Places to Grow Implementation Fund Roads and Runoff: Implementing Green Streets in the Greater Golden Horseshoe. https://www.placestogrow.ca/content/ggh/Roads_and_Runoff_Final_Report_web.pdf
[3] Warren & Lemmen, 2014. Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation. Natural Resources Canada. http://www.nrcan.gc.ca/environment/resources/publications/impacts-adaptation/reports/assessments/2014/16309
[4]Amec Foster Wheeler and Credit Valley Conservation. 2017. National Infrastructure and Buildings Climate Change Adaptation State of Play Report. Prepared for the Infrastructure and Buildings Working Group, part of Canada's Climate Change Adaptation Platform. https://engineerscanada.ca/sites/default/files/ibwg_sop_2017.pdf

- Changes in inflow / infiltration rates
- Capacity of culverts, ponds and storm sewer systems exceeded
- Increased risk of flooding of low-lying infrastructure and underground facilities
- Urban overland flooding
- Sewer backups and basement flooding
- Slope instability and erosion
- Reduced precipitation and drought
- Impacts on biological systems
- Reduced service life and increased repair, maintenance, energy costs
- Infrastructure damage and loss
- SDHI events producing larger floodplains for highly urbanized watersheds such that a larger portion of existing structures are captured within in a floodplain
- More winter precipitation resulting in earlier algal blooms

These climate impacts, coupled with other changing conditions such as increasing urbanization and aging infrastructure, create significant need for improvements to many stormwater management systems.

One of the most effective ways to reduce flood risk and address the impacts of climate change is to build resiliency in existing and new municipal stormwater infrastructure. Working towards a stormwater management standard that incorporates guidance on how to integrate climate change considerations in new and existing stormwater systems could help to build resiliency in a way that is consistent across regions.[5]

3 Risks of Inadequate Stormwater Management in a Changing Climate

Governments, developers, engineers and other professional practitioners make decisions, investments and policies that have a direct impact on the safe and effective management of stormwater. Climate change is posing increasing risks to the systems and potentially new liabilities for those who manage them. Historical practices may no longer adequately protect people and infrastructure from harm. The following subsections detail some of the risks decision makers face if stormwater is not properly managed in light of a changing climate.

3.1 Legal Risks

The rise in extreme weather events across the globe is putting a strain on municipal infrastructure and has brought increased attention to stormwater management from a legal risk perspective. The resulting damage to personal property and human health may create legal liabilities, most likely in the form of

[5] Amec Foster Wheeler and Credit Valley Conservation. 2017. National Infrastructure and Buildings Climate Change Adaptation State of Play Report. Prepared for the Infrastructure and Buildings Working Group, part of Canada's Climate Change Adaptation Platform. https://engineerscanada.ca/sites/default/files/ibwg_sop_2017.pdf

nuisance and negligence lawsuits.[6] Recent class action lawsuits—both after extreme rainfall events and on a recurring basis due to alleged systemic problems—have shone light on how some of these standards and systems are out of date and failing to protect the public interest.

A variety of decision makers have been sued in negligence cases around major flood events and systemic flooding issues. Defendants have included municipalities, conservation authorities, provincial governments, developers and construction companies, among others. While many assume that the alleged negligence relates to stormwater system design, in most cases it is actually other stages of decision making (e.g. maintenance, monitoring, operation, emergency response, improvement) that are targeted by plaintiffs. Indeed, plaintiffs have argued that such defendants were negligent in the following ways:

- Negligent in the design and construction of stormwater systems
- Negligent in the approval of development plans and failure to enforce building codes
- Negligent for failing to conduct adequate inspection of construction
- Negligent for failing to maintain and improve stormwater management systems
- Negligent for failing to enforce a bylaw that required downspout disconnection
- Negligent for failing to adequately supervise systems (i.e. ignoring alarms)

Table 1 offers a few examples of stormwater management and flood-related lawsuits in Canada. Such lawsuits, if successful, could result in costly awards or settlements.

Table 1 Examples of Stormwater Management and Flood-Related Lawsuits in Canada and the U.S.

Case Name (Year)	**Description** (damages, cost and settlement amounts have been included where available)	**Nature of Negligent Act**
Cerra v. City of Thunder Bay (2013), CV-12-0253	This **$300M** class action seeks damages and other relief for the class as a result of alleged negligence by the defendant, The Corporation of the City of Thunder Bay, in the repair, inspection, and maintenance of the Atlantic Avenue Water Pollution Control Plant, as well as the operation and supervision of the Plant during the May 28, 2012, rainfall event in Thunder Bay (alarms were allegedly ignored). Trial is expected to commence early 2018.	Negligent repair, inspection, maintenance and supervision (i.e. ignoring alarms) (alleged[7]).

[6]Municipalities can no longer be sued for a nuisance related to “the escape of water or sewage from sewage works or water works” in Ontario; however, nuisance-related claims are still a risk for municipalities outside of Ontario. *Municipal Act*, SO 2001, c 25, s 449(1).

[7] “Alleged” indicates that the legal claim was settled; withdrawn or still ongoing, meaning there has been no formal finding of negligence by a court.

Case Name (Year)	**Description** (damages, cost and settlement amounts have been included where available)	**Nature of Negligent Act**
McLaren v. Stratford (City) (2005) 2005 CanLII 19801	Major flood in the City of Stratford after severe rainfall in 2002 left many with sewage in basement. Plaintiffs claimed negligence in design, construction operation and maintenance of system. Class certified by court in 2005.[8] Settled in 2010, 8 years after the flood. Stratford settled for **$7.7M**, after already spending **$1.3M** in emergency relief and then upgraded the system to a 250-year storm standard.	Negligent design, construction, operation, maintenance (alleged).
Lissack v Toronto, [2008] OJ No 5563	City's storm sewer backed up following heavy storm and flooded the plaintiff's basement. The plaintiff brought an action in negligence for damages against the City of Toronto. Court found that the City breached its duty of care by failing to maintain and improve stormwater management systems.	Negligent for failure to maintain and improve stormwater management systems (ruling[9]).
Oosthoek v. Thunder Bay (1996) 1996 CanLII 1530 (ONCA)	Plaintiffs' basements flooded due to a storm in Thunder Bay. Plaintiffs brought an action alleging that the City knew of problems and acted negligently in failing to address them. The problem of basement flooding had been identified in a 1965 engineering report. In or around 1987, the City passed a bylaw requiring downspout disconnection. The City was found liable for the flooding caused by the overloaded combined sewers. The City's negligence was based on its failure to enforce the bylaw it passed requiring downspout disconnection from the sewage system.	Negligent for failing to enforce a bylaw that required downspout disconnection.
Scarborough Golf & Country Club v. Scarborough (City) (Ont. C.A.) 66 O.R. (2d) 257 [1988] O.J. No. 1981	The plaintiff golf course sued the City of Scarborough and a conservation authority (CA) in negligence, nuisance and violation of riparian rights for damage caused by flooding. The plaintiff alleged that the City and CA's actions caused a creek within the course to become twice as wide and twice as deep, eroded the banks, and resulted in flooding of large parts of the course during heavy rainfall events. The plaintiff's claim against the CA was dismissed but the City was found liable in negligence. The court found that the storm sewer facilities and urbanization of the lands owned by the City were the cause of the golf course flooding and erosion. It also held that the City knew of the consequences its system would have on the plaintiff golf course when planning and constructing its system and its drainage was unreasonable.	City was found negligent for failing to implement reasonable drainage practices.

[8]Class certification refers to a court's finding that a group of individual plaintiffs can be recognized as a "class" because the issues they are bringing before the court are common enough to be decided together.
[9] "Ruling" indicates a formal finding of negligence was made by a court.

As changes in climate occur and potential impacts on municipal stormwater systems become better understood, the law can provide valuable guidance on standards of practice and diligent decision-making in light of climate-adjusted information. The following learnings based on negligence principles can assist municipalities and others who are involved in stormwater management to ensure thoughtful and diligent stormwater management practices.[10]

To minimize risk, municipalities can:

- Consider revisiting policies and practices around stormwater infrastructure design, operation, inspection and maintenance to ensure that such practices are appropriately considering changing information
- Ensure active, valid policy decisions are being made and documented with respect to stormwater management decisions and systems, including existing processes, even if a decision is made that changes are too costly given risks and current resource
- Coordinate approaches across municipalities to set a clear industry standard, which can help to demonstrate a reasonable standard of care was met

First, certain government decisions will be protected from liability in negligence. A valid governmental *policy* decision will generally not attract liability in the context of a negligence claim, whereas government decisions that are *operational* in nature are still exposed to liability in negligence.[11] In light of this, municipalities are advised to consider key issues and make clear, documented and defensible policy decisions to protect themselves from liability rather than opting for a "head in the sand" approach.[11]

Second, industry standards and standard practices can also assist in dispelling a negligence claim by showing that the defendant had followed the general practices of those in similar situations and thereby met the applicable standard of care. Therefore, an important tool for showing that the standard of care has been met is demonstrating that a municipality has met the standard of practice followed in other, similarly situated municipalities. Coordination between municipalities could thus assist in mitigating risk by setting a clear industry standard. To ensure that industry standards are adequate to address the increasing risks that climate change presents, it may be prudent for managers of municipal water systems to work together to define clear industry standards that utilize available climate change-adjusted information to help mitigate potential liability.

Finally, some legal cases do not result in a finding that the municipality, province or other defendant was negligent. But even in these cases, the municipality may still experience "costs" by way of reputational harm and using up valuable staff time spent defending a legal claim as opposed to carrying out daily responsibilities.

[10]Zizzo Allan, *Stormwater Management in Ontario: Legal Issues in a Changing Climate*, 2014. https://cvc.ca/wp-content/uploads/2014/05/Stormwater-Management-in-Ontario_Legal-Issues-in-a-Changing-Climate_2014.04.29.pdf

[11] The Supreme Court of Canada has described *policy* decisions as involving a weighing of social, political and economic factors. Courts have found the following types of decisions to be policy decisions: the development of a bylaw and a decision to inspect or not inspect infrastructure. Budgetary decisions are also, generally speaking, policy decisions protected from suit. One exception to this general rule is that government policy decisions will not be protected if they were made in bad faith. Government decisions that are *operational* in nature, on the other hand, are still exposed to liability in negligence. Operational decisions are decisions made practically implementing policy decisions on the basis of administrative direction, professional judgment and technical considerations. Courts have found the following types of decisions to be operational, and subject to claims in negligence: highway safety inspections; electric utility systems to receive incoming calls related to repairs; and city officials' failure to enforce a bylaw passed to address flooding caused by sewer backup. Zizzo Allan, *Stormwater Management in Ontario: Legal Issues in a Changing Climate*, 2014. https://cvc.ca/wp-content/uploads/2014/05/Stormwater-Management-in-Ontario_Legal-Issues-in-a-Changing-Climate_2014.04.29.pdf

A deeper analysis of relevant negligence principles is included in Appendix 9.6.

3.2 Environmental, Health & Safety

Climate change and inadequate stormwater management systems can have significant impacts on the environment, and human health and safety. Extreme rainfall events can flood homes, damage property and spread toxic molds, which negatively impact indoor air quality.[12] Such events can also negatively impact groundwater, surface water and drinking water sources, through increased risk of spill-out and pollution. For instance, according to the *Report of the Walkerton Inquiry*, one of the many factors that contributed to the deadly outbreak of E. coli in Walkerton in 2000 was the heavy rain that assisted the transport of manure into the drinking water supply.[13] These events can also create health impacts by way of body contact infection and mental distress.[14] Finally, inadequate stormwater management systems can affect environmental and ecosystem health, disrupting natural hydrologic processes, causing erosion, and impacting aquatic and terrestrial habitats.[15] While heavy rainfall events have always occurred, climate change increases the frequency and severity of these events, further exacerbating the risks they present.

Changes in temperature can also impact microbial ecosystems and human health and safety. Vulnerable populations such as the elderly, youth and children are particularly susceptible to climate-related impacts and have lower capacities to respond. A more thoughtful understanding of how extreme weather and flooding specifically impact these populations is required to ensure communities are best prepared.

3.3 Economic Risks

In addition to social, environmental and legal risks, improper stormwater management in a changing climate can also have significant economic impacts. The Bank of Canada issued a recent statement, calling climate change "one of the biggest challenges facing Canada and the world in the 21st century", estimating that the cost of inaction could be between $21-43 billion per year by 2050.[16] In 2013, insured losses related to catastrophic events rose to a record-breaking $3.4 billion, largely due to flooding in Southern Alberta and Toronto.[17] In 2016, this amount increased to $5 billion.[18]

With the increased severity and frequency of flood and water-related events in recent years, water damage claims are becoming more common. It is estimated that the Canadian insurance industry pays approximately $1 billion each year in claims, mostly due to water damage.[19]

Where coverage is not offered through private insurance, government disaster relief programs have provided relief to some provinces and individuals. As a result of catastrophic events over the last few

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[12] Environmental Commissioner of Ontario, *Feeling the Heat: 2015 Greenhouse Gas Progress Report*, 2015. https://eco.on.ca/reports/2015-climate-change-report-feeling-the-heat/
[13] Environmental Commissioner of Ontario, *Feeling the Heat: 2015 Greenhouse Gas Progress Report*, 2015. https://eco.on.ca/reports/2015-climate-change-report-feeling-the-heat/
[14] Dana Decent, *The Mental and Physical Human Health Impacts of Residential Basement Flooding and Associated Financial Costs: Interviews with Households in Southern Ontario,* Canada, 2018. http://hdl.handle.net/10012/13366
[15] Environmental Commissioner of Ontario, *Looking for Leadership: The Costs of Climate Inaction, 2014 Greenhouse Gas Report*, 2014 http://docs.assets.eco.on.ca/reports/climate-change/2014/2014-GHG.pdf
[16] Bank of Canada, "Thermometer Rising—Climate Change and Canada's Economic Future", remarks by Remarks Timothy Lane, Deputy Governor, Finance and Sustainability Initiative, Montréal, Quebec, March 2, 2017. http://www.bankofcanada.ca/2017/03/thermometer-rising-climate-change-canada-economic-future/
[17] Insurance Bureau of Canada, *2018 Facts of the Property and Casualty Insurance Industry in Canada*, 2018 http://assets.ibc.ca/Documents/Facts%20Book/Facts_Book/2018/IBC-Fact-Book-2018.pdf
[18] Insurance Bureau of Canada, *2018 Facts of the Property and Casualty Insurance Industry in Canada*, 2018 http://assets.ibc.ca/Documents/Facts%20Book/Facts_Book/2018/IBC-Fact-Book-2018.pdf
[19] Insurance Bureau of Canada, "Water," 2017. http://www.ibc.ca/qc/disaster/water

years, the Federal Disaster Financial Assistance Arrangements (DFAA) paid out $673 million for flood damage, representing 75% of their weather-related expenditures.[20] Unless we find a way to reduce the impacts of our changing climate, the costs to insurers, communities and individuals will continue to increase.

Climate hazards can directly impact city's assets and services as described above. They can also lead to indirect economic impacts such as making it more difficult for a municipality to attract capital and access financing. For instance, credit rating agencies are starting to incorporate climate change factors into credit ratings for sovereign bonds.[21] Moody's recently acknowledged that a lack of action on climate change adaptation puts cities and states at greater risk of default, which warrants downgrades in ratings. Historical experiences with and damages from flooding and extreme weather events were among the climate change indicators the rating agency considered.

A SW QMS can offer municipalities a way to reduce risks of infrastructure failure and related damages, reduce liability associated with potential negligence lawsuits and regulatory non-compliance and support continual improvement within municipal operations.

4 Existing Guidelines, Standards and Best Practices

A future SW QMS should seek to incorporate existing provincial requirements and build on the guidance, standards and best practices that already exist. The following sub-sections map out the current landscape of provincial and municipal guidance; potentially relevant Canadian and international standards; and emerging best practices in stormwater planning and management.

4.1 Provincial Stormwater and Municipal Design Guidance

This project considered provincial guidance on stormwater management design, which is generally based on a mix of criteria for flooding, erosion, water quality and water balance. It also looked at municipal stormwater design standards and guidelines, which provide design criteria for consultants to adhere to when sizing municipal storm sewer systems. Flood management standards were also reviewed.

These instruments provide a baseline for stormwater planning and management in Canada but are inconsistent and do not generally take into account climate change. A future SW QMS would seek to build on this guidance and better incorporate climate adaptation considerations by drawing on some of the risk and quality management standards and best practices we discuss below.

[20] Office of the Parliamentary Budget Officer, *Estimate of the Average Annual Cost for Disaster Financial Assistance Arrangements due to Weather Events*, 2016. http://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/2016/DFAA/DFAA_EN.pdf
[21] Christopher Flavelle, "Moody's Warns Cities to Address Climate Risks or Face Downgrades," *Bloomberg*, November 29, 2017, https://www.bloomberg.com/news/articles/2017-11-29/moody-s-warns-cities-to-address-climate-risks-or-face-downgrades

Table 2: Provincial and Municipal Stormwater Guidance and Floodplain Definitions

Category	Description	Examples
Provincial Guidance on Stormwater Management Design	Stormwater design is generally based on a mix of criteria for flooding, erosion, water quality and water balance. Included below is a brief summary of the varying standards across Canadian provinces.	Nova Scotia's Water resources management strategy BC's A Guidebook on Stormwater Planning Ontario's Stormwater Management Planning and Design Manual
Municipal Stormwater Design Guidelines	Municipal design standards provide design criteria for consultants to adhere to when sizing municipal storm sewer systems (major and minor systems).	City of Halifax, Design and Construction Specifications (2016 Edition) City of Saint John, Storm Drainage Design Criteria Manual City of Moncton, Design Criteria Manual for Municipal Services Document Greater Vancouver Regional District Integrated Stormwater Management Planning Template
Floodplain Definitions	Different floodplain (and floodplain-like) definitions exist across Canada.	Nova Scotia's two zone approach (floodplain 1:20 and flood fringe 1:100) Ontario's definitions (Hazel-Centered, Timmins-Centered, maximum observed or 100-year)

See Appendices 9.1- 9.3 for a more detailed list of the guidelines and definitions reviewed, as well as brief descriptions of each.

4.2 Existing Canadian and International Standards

A range of existing Canadian and international standards related to risk management, quality management, water and climate change adaptation were also reviewed as part of this study. While many of these are not specific to stormwater systems, they can offer helpful direction as to elements to be incorporated into a future stormwater standard.

A future SW QMS may wish to build on these standards, include excerpts of such standards or reference them directly within the QMS.

Table 3: Existing Canadian and International Standards

Category	Description	Examples
Risk Management	A risk management standard provides a framework to evaluate the potential consequences of risk in terms of economic performance and professional reputation, environmental, safety and societal outcomes. Risk management standards assist organizations to perform well in environments of uncertainty.	ISO 31000 – Risk Management Ontario Provincial Hazard Identification and Risk Assessment (HIRA) International Council for Local Environmental Initiatives (ICLEI) - Building Adaptive and Resiliency Communities (BARC) Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol
Quality Management	Quality management standards provide the framework for developing and maintaining quality management systems (QMS). A QMS is a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives.	AS/NZS ISO 9001: 2016: Quality management systems (QMS) – requirements ISO 19011 – Guidelines for Auditing Management Systems
Environmental Systems	Standards related to environmental management and environmental systems provide organizations with the framework to ensure their infrastructure operations do not negatively impact the environment (e.g. water/watersheds). These also assist in meeting regulatory compliance requirements and continually improving the system based on performance monitoring.	ISO 14001 – Environmental Management Systems ISO 14031 – Environmental Management: Environmental Performance Evaluation Nutrient Management Act Nutrient Management Strategy
Flood Resiliency		CSA Z800-18 – Basement Flood Protection (to be published) Developing Best Practices for Flood Risk Reduction: Existing Residential Communities Preventing Disaster Before it Strikes: Developing a Canadian Standard for New Flood-resilient Residential Communities CSA W1006 – Flood Resilient Design for New Residential Communities (in development) Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in British Columbia

Stormwater-Related	Stormwater-related standards provide specifications for the design, construction, materials, inspection and monitoring of various aspects of stormwater management infrastructure.	CSA W200 – Design of Bioretention Systems (to be published) CSA W201 – Construction of Bioretention Systems (to be published) CSA B184 SERIES – Polymeric subsurface stormwater management structures CSA/ICC B805 – Rainwater Harvesting Systems (to be published) CSA W202 – Erosion and Sediment Control, Inspection and Monitoring (to be published) CSA PLUS 4013 – Technical guide: Development, interpretation and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners
Other Water-Related	Standards describing the process of delivery and management of other types of water, such as drinking water and wastewater systems, are useful in providing an assessment of water systems as they relate to customer expectations and how to build service improvements.	Ontario Drinking Water Quality Management Standard ISO 24510/ CAN/CSA Z24510 – Activities relating to drinking water and wastewater services – Guidelines for the assessment and for the improvement for the service of users ISO 24511/ CAN/CSA Z24511 – Guidelines for the Management of Wastewater Utilities and Assessment of Wastewater Services to drinking water and wastewater services

Climate Change Adaptation	Climate change risks have a direct impact on infrastructure that is already stressed. These standards attempt to bring structure around climate change information, assessing climate change risk and vulnerabilities in infrastructure, and provide guidance on how to integrate climate change considerations into standards themselves.	Standardization Guidance for Weather Data, Climate Information and Climate Change Projections International Council for Local Environmental Initiatives (ICLEI) – Building Adaptive and Resilient Communities (BARC) Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol The Climate Bonds Initiative's (CBI) new Water Infrastructure Standard CEN-CENELEC Guide 32 – Guide for addressing climate change adaptation in standards (2016)
Sustainable Communities	Sustainable community standards define and establish methodologies for a set of indicators to steer and measure the performance of city services and quality of life.	ISO 37120 – Sustainable Development of Communities Indicators for City Services and Quality of Life

See Appendix 9.4 for a more detailed list of the standards reviewed, as well as brief descriptions of each.

4.3 Emerging Best Practices

Many provinces and municipalities are already taking steps to improve stormwater planning and management and incorporate climate change adaptation into their practices. The following charts highlight select best practices being employed across Canada at each stage of stormwater infrastructure decisions-making (i.e. planning, design, operation, etc.) to better prepare stormwater systems for a changing climate.

Table 4: Emerging Best Practices in Stormwater Planning and Management

Category	Best Practice	Case Study
Planning	Use of cost-benefit analysis to compare and prioritise stormwater planning, design and management options considering future climate impacts	***City of Surrey's Approach to Climate Adaptation*** The City of Surrey used cost benefit analysis to understand ratios for each adaptation option under consideration, which allowed them to compare options such as backflow prevention (180:1) and modifying overland flow paths (20:1).

Category	Best Practice	Case Study
Asset Management	Apply an integrated asset management approach	***Ontario MOI's Asset Management Toolkit and municipal water sustainability plans requirements of the Water Opportunities Act*** In December 2017, Ontario introduced *Ontario Regulation 588/17: Asset Management Planning for Municipal Infrastructure,* under the *Infrastructure for Jobs and Prosperity Act, 2015*, and committed $25 million over five years to offer a suite of resources. Resources will include: platforms to spread knowledge and best practices, a toolkit to help municipalities develop a strategic asset management policy; the provision of in-person expert asset management plan assessments and localized action plans for small municipalities; and direct support to municipalities to help them complete asset management planning activities, such as condition assessments, levels of service measurements and lifecycle costing.
Risk Management	Take a risk-based approach to stormwater management, including consideration of climate change	***City of Surrey's Climate Change Rainfall Adaptation Strategy*** In the *Climate Change Rainfall Adaptation Strategy for Surrey*, the City of Surrey took the following approach: (1) evaluate performance of existing systems; (2) understand risks and impacts of climate change (or changing rainfall) on those systems using various scenarios; and (3) develop and evaluate adaptation options to address impacts.
	Conduct climate change vulnerability assessment on stormwater management systems	***City of Welland's Climate Change Vulnerability Assessment*** The City of Welland conducted a climate change vulnerability assessment of its combined stormwater and wastewater system using climate projections for 2020 and 2050.
Design	Stress test existing stormwater infrastructure to withstand future climate conditions and extremes	***City of Ottawa's Sewer Design Guidelines*** The City of Ottawa's *Sewer Design Guidelines* require that new stormwater infrastructure design is stress tested to withstand future climate conditions and extremes. The City will consider design alternatives to increase resilience where needed. Design options are selected based on context, target specific risks and seek to optimize effectiveness while minimizing cost.
	Create standardized IDF curves for various regions produced at the provincial level that incorporate	***Newfoundland and Labrador's Standardized Updated IDF Curves*** Newfoundland and Labrador has updated its IDF

Category	Best Practice	Case Study
	climate projections	curves based on the IPCC's most recent climate models. It has also standardized these IDFs for use by municipalities across the province.
	Offer fast-track development approvals where more stringent stormwater design requirements are met	***Province of Quebec's Approach to Development Approvals*** The province of Quebec has implemented an approach whereby developers who meet more stringent stormwater design criteria such as quality control (80 % removal for total suspended solids), erosion control and quantity control up to a 100 year return period receive fast-tracked development approvals.
	Incorporate Low Impact Development (LID) practices in new development areas and retrofit existing development areas	***Ontario's Low Impact Development Stormwater Management Guidance Manual*** Ontario's *Low Impact Development Stormwater Management Guidance Manual* is a tool for understanding the design criteria and performance requirements of stormwater management projects. The manual defines stormwater volume control requirements in Ontario; presents the criteria to select water budget and water modeling tools for use in Ontario; establishes guidelines and processes for groundwater protection from infiltration-based LID best management practices; and presents a process to reflect future climate scenarios and assess climate change risks and vulnerabilities.
	Conduct dual analysis of minor management systems	***New York City's Resiliency Design Guidelines v2.0*** For managing stormwater from larger storms such as at the 50- and 100-year recurrence intervals, New York City is increasingly considering the role of streets and open space in managing flow (i.e. taking a dual drainage design approach). The City is piloting projects to test this dual drainage approach.
	Consider levels of service / performance targets to manage the complete spectrum of rainfall events	***British Columbia's Stormwater Planning, A Guidebook for British Columbia and Beyond the Guidebook, Context for Rainwater Management and Green Infrastructure in British Columbia*** These guidebooks reference performance targets to managing the complete spectrum of rainfall events from rainfall capture (infiltration best management practices) for small storms, runoff controls for large storms (storage) and flood risk management for the

Category	Best Practice	Case Study
	Use procurement policies to require improved stormwater management design and consideration of climate change[22]	extreme storms (ensure that the drainage system can safely convey extreme storms to the receiving water course). ***Infrastructure Canada's Climate Lens*** Applicants seeking federal funding for new major public infrastructure projects are now required to consider climate change risks in the location, design, and planned operation of a project as a condition to receive infrastructure funding. To carry out these assessments, applicants must apply the new Climate Lens and associated guidance.
Operation	Employ a service-level approach to asset management to understand how the level of service is changing Use sewer use bylaws to require private homeowners to take lot-level flood risk reduction measures	***City of Regina's Service-Level Approach to Asset Management*** Regina's approach to asset management sets out a process to establish a baseline level of service indicators to determine if service levels in the City are increasing, decreasing or staying constant. ***City of Thorold's Sewer Use Bylaw*** The City of Thorold requires homeowners to disconnect improper connections (i.e. downspout and foundation drain connections to sanitary sewer laterals) at their own expense or be subject to a fine. The bylaw specifies that the only connection to sanitary sewers should be the home's sewer lateral and foundation drains should discharge via a sump pump to a storm private drain connection or the home's yard where the water can be drained over the ground.
Monitoring and Inspection	Develop a detailed maintenance and monitoring plan to meet compliance obligations and ministry approval requirements	***Halifax Regional Water Commission's Acceptance Submission Requirements*** Halifax Regional Water Commission's *Design and Construction Specification* includes acceptance submission requirements that require certain "checks" before the Commission takes ownership of the stormwater system. The requirements include a Closed Circuit Television (CCTV) inspection and report, pipe test report, manholes test and inspection report, driveway culvert sizing tables and an "as-constructed" certification performed by a third party service provider. A report is submitted that captures all system deficiencies and a plan to address them.

[22] Such policies could extend to assuring the impact of a new infrastructure on local stormwater management is neutral or of net benefit as a condition of design approval or building permit.

Category	Best Practice	Case Study
Maintenance	Perform preventative, scheduled maintenance in addition to corrective maintenance Modify maintenance if inspection shows that frequency should be increased or decreased	***City of Calgary's Stormwater Management and Design Manual*** The City of Calgary's *Stormwater Management and Design Manual* highlights the importance of both "preventative" and "corrective" maintenance. Preventative maintenance is scheduled maintenance that includes visual and video inspections, record keeping, and analysis of the data compared to previous complaints and problems. Corrective maintenance is unscheduled and usually in response to extreme events or emergency situations. Corrective actions are to be completed immediately to reduce flood potential, limit municipal liability, prevent personal injury and protect the environment. ***City of Coquitlam's Stormwater Management Policy and Design Manual*** The City of Coquitlam's *Stormwater Management Policy and Design Manual* states that maintenance schedules for individual facilities should be modified if maintenance activities and inspections show that maintenance frequency should be increased or decreased.
Forecasting and Early Warning Systems	Forecast flooding using the most up to date climate projections	***Province of New Brunswick's New Flow Forecast Model*** The Province of New Brunswick, Department of Environment and Local Government is working with the National Research Council and the University of Waterloo to develop a new flow forecast model. The program provides residents with information about potential flood risks, ice jams and river water levels.
Emergency Response	Prepare Emergency Response Plans that clearly outline roles and responsibilities and incorporate flooding (i.e. not just fire hazards)	***The City of Greater Sudbury's Community Flood Management Plan*** The City of Greater Sudbury's *Community Flood Management Plan* is to prepare for the most efficient deployment of resources for: 1) effective intra-agency and inter-agency cooperation and communication before, during, and after a flood event; and 2) a coordinated response consistent with prevailing conditions and information provided by external agencies including the NDCA Flood Forecasting and Warning System, local dam operators, and/or other sources. It also seeks to define: 1) the roles and responsibilities of City departments and supporting agencies involved in a flood emergency; and, 2) the procedures to be utilized in minimizing the effects of a flood emergency in the City of Greater Sudbury.

Category	Best Practice	Case Study
Auditing	Conduct internal audits to assess system's performance and identify opportunities for innovation and improvements on an ongoing basis	***Metro Vancouver's Integrated Liquid Waste Resources Management Plan*** As part of the *Integrated Liquid Waste Resources Management Plan of British Columbia*, Metro Vancouver is to undertake an annual internal audit of best practices of the liquid waste management program and environmental management system to identify opportunities for innovation and improvements.
Adaptive Management	Plan for ongoing monitoring of stormwater assets to ensure their effectiveness in line with the most up to date climate projections Consistently evaluate the quality of the standard to ensure it is effectively achieving the goals it was created to achieve	***City of Toronto's Wet Weather Flow Management Guideline*** City of Toronto's *Wet Weather Flow Management Guideline* includes a post-construction monitoring program that is intended to assess removal efficiencies and overall system performance. Part of the program is to include a remedial plan to improve the efficiency of the system's performance to meet the level of service that it was designed to provide under the Ministry's approval. ***City of Calgary's Standardized Feedback Forms for Designers*** City of Calgary has standardized submissions and automated forms available online. Staff uses a consistent form/approach to provide feedback to the designers. That allows for performing statistics on the various topics. The feedback from these statistics is like a performance check for the municipality that identifies insufficiencies in the standard based on the quality of submissions.

5 Gaps in Existing Standards and Stormwater Management Efforts

Despite the fact that certain relevant and helpful standards and best practices exist, stormwater management and adapting our stormwater systems and practices to climate change still requires improvement. The following are key gaps identified by the literature review and stakeholder interviewers where current practices, guidelines and standards fall short.

- **Lack of understanding around what "level of service" means for today's standards and future climate change standards.** A high priority gap in current practices is that there is no consistent understanding of what "level of service" means in the context of stormwater quantity and quality. Many municipalities appear to be using the 100-year-flood event for major systems and a 2- to 5-year flood event as the level of service for minor systems.

- **Need for improvement around stormwater quality management and requirements.** Stormwater quality requirements are usually focused around particulate bound nutrients and metals. The focus should also include dissolved nutrients and metals. The use of proprietary filtration systems to remove dissolved contaminants should also be widely adopted and explored.
- **Surface water quality guidelines are needed.** These should clearly define the in-stream requirements that must be matched by upstream infrastructure owners and operators through infrastructure master plans.
- **Limited best practices in operation and maintenance standards.** Operation and maintenance requirements for existing stormwater infrastructure are not well-understood. Guidance exists for basic operation and maintenance and inspection needs, but there are no strict requirements set out to enforce requirements or drive rigorous practices. Operation and maintenance may be well-understood when it relates to sewers and catch basins, but when it comes to stormwater infrastructure such as ponds, wetlands and other LID, practices are very weak. For a significant period of time, there were no consequences for failure to maintain stormwater systems due to a lack of reporting requirements and enforcement. However, recent case law has shown that courts may now willing to step in (see section 3.1 above). Even in the limited circumstances in which developers are required to incorporate LID approaches, there are no requirements for landowners to maintain those LID systems.
- **Inadequate assumption protocols.** Assumption (i.e. standard inspection protocols for municipalities before they take ownership of stormwater management systems from developers) need to be improved. This is often the stage at which stormwater management and planning starts to break down.
- **No early warning / alarm systems.** Climate change increases the frequency of SDHI storms. These are much different than hurricane storms, which come with days of warning. In existing urban areas, where rivers / creeks respond very quickly to SDHI events, there is added stress on emergency management services and little time to evacuate populations in the flood prone areas (i.e. riverine and urban overland flood areas). More guidance and best practices on the use of early warning systems is needed.
- **Limited best practices in emergency response standards.** There is a need for more education, best practice guidance and potential standardization of emergency response practices for both during- and post- an extreme event. These best practices may include evacuation plans that take into account flooding hazards (as opposed to just fire hazards) and a methodology to complete a detailed forensic accounting that captures the true direct and indirect costs / risks associated with flooding to inform future investments. A SW QMS could also address this need.
- **Lack of guidance around coordinating watershed targets with stormwater management.** Stakeholders indicated that discussions around stormwater planning and management rarely feature water quality issues, but that this is an important related topic that needs to be prioritized. Best practices need to be investigated where tablelands and in-stream targets are balanced to support watershed services such as water supply, reduced wastewater bypass, reduced erosion, in-stream water quality and water balance, as well as to protect aquatic habitats.
- **Limited best practices related to financing stormwater management.** Many noted a lack of resources as a key barrier. Understanding best practices and available options for sustainably

financing stormwater management is a gap that needs to be filled and could potentially be addressed through a national standard.

- **Goals and objectives related to ecosystem health and management.** Municipalities were unsure of their roles and responsibilities related to ecosystem health and biodiversity and how these issues interact with climate risk, stormwater management and drinking water and wastewater systems.
- **Lack of documentation and a formal policy articulating approach to stormwater management.** Although some municipalities take a progressive approach to addressing climate risks and integrating climate change considerations into stormwater management, they still lacked a formal policy or standard documenting their approach. Without a policy, they felt less able to protect themselves against legal liability and justify decision-making to council and the public.
- **Lack of understanding in construction and development community.** The sector may not fully appreciate the importance of good stormwater design and construction, such as careful stormwater pipe construction in new subdivisions.[23]
- **Lack of guidance and understanding around how to best use climate information and address climate risk.** Stakeholders expressed a need for a standardized process to bring climate change information to a local level, understand climate risk to their systems and meaningfully integrate climate data into design parameters.

6 Potential Benefits of a SW QMS

Research and consultations indicated broad support for a national SW QMS in Canada. A national standard could help to address several of the challenges and gaps described above, propagate best practices and enable a consistent approach to stormwater management across the country. The following were identified as potential benefits of a SW QMS:

- **Builds climate change considerations into decision-making and reduces the risks of flooding**. A standard could provide a step-by-step process to build climate change considerations into decision-making and reduce the risks of flooding. It could help to lay out clear roles and responsibilities, identify check-in points for environmental risks and mitigate environmental and health-related disasters.
- **Provides a methodological approach to SW management, problem-solving and making better decisions.** A standard could help to: (i) identify and manage risk based on context- and location-specific economic, technical/engineering and legal considerations; (ii) identify potential gaps in the systems; and, (iii) determine the appropriate level of service based on these factors. Applying a standard could also offer a way of economically approaching problems and better understanding the opportunity costs of making decisions.
- **Helps to justify decision making to the public**. A standard could provide clarity, transparency and justification for each decision. Municipalities would benefit from being able to point to a

[23] Norton Engineering, Inc., *Project to Address Unacceptable Inflow and Infiltration (I/I) in New Subdivisions, Phase 1 Final Report 2015 to 2017,* 2017, http://www.nortonengineeringinc.ca/I&I%20in%20NS%20Final%20Report%202017_Oct%2016%202017.pdf

standardized, established policy or approach that is not personal or political when communicating decisions to the public.

- **Provides the business case for sufficient resource requirement (financial and personnel).** By developing a QMS for stormwater, municipal staff would have a tool to engage, educate and gain commitment from their councils and higher levels of government. This could help secure investment (as well as enhanced engineering, operations and management practices) for the design and long-term operation of stormwater infrastructure systems.
- **Provides a process to clearly define roles and responsibilities around stormwater management**. A SW QMS would provide a process to clearly define roles and responsibilities of municipal staff and other partner organizations/agencies (e.g. conservation authorities, regional municipalities, external consultants, etc.). An articulated standard or strategy would also provide clarity and consistency on a policy / approach across staff (which can sometimes range in the tens of thousands of individuals) and ensure a consistent understanding of expectations. A standard could also create an implementation / operational plan.
- **Works towards consistency across the country**. A SW QMS could level the playing field among municipalities across the country and encourage municipalities that are “hold outs” to upgrade their systems and practices. This type of consistency could help reduce the potential for expensive mistakes, increase efficiency and provide a tool to assist engineers and other professional practitioners with their efforts to prepare the systems to cope with a changing climate. It could also support private sector participants that do not operate in only one jurisdiction.
- **Fills gaps in existing guidance and promotes best practices**. Other benefits of a QMS include providing a process to enhance understanding of system operations and identify opportunities for improvement. The tool could also help with sharing best practices to inform the development of standards for professional practice.
- **Addresses water quality issues related to stormwater.** A number of municipalities highlighted that water quality issues are not discussed and that no advanced thinking has gone into how to address these issues. A standard could not only help to get this topic on the table; it could go further and provide clarity around best practices and relevant levels of service.
- **Helps address pushback from developers**. A SW QMS would communicate the importance of stormwater-related issues, set mandatory minimums and diffuse the “stand-off” between municipalities and developers. There has been particular pushback around runoff volume targets in certain jurisdictions.
- **Demonstrates diligence in decision-making, conscious policy decisions and a high standard of care to protect against legal liability**. A SW QMS could provide a standardized guiding process to design, operate and maintain, inspect and assume stormwater systems to meet regulatory requirements, emphasize thoughtful policy decision-making, and demonstrate a high standard of care. It could also provide a documentation protocol to ensure all changes and decisions made in policy, operations and budget are well documented and identify steps for municipalities to internally audit the QMS.
- **Motivates action and promote proactive management.** A SW QMS would move current conversations into action.

- **Supports continual improvement within municipal stormwater operations, maintenance, and monitoring in light of climate change**.

The stakeholders who would benefit most from a national SW QMS include small municipalities, local governments in general, policymakers and decision makers on the ground, practitioners, council and the public.

7 Towards a National SW QMS

A standardization process in the form of a SW QMS would provide a consistent process for decision makers responsible for the design, operation, maintenance and management of stormwater systems. It could fill gaps in existing stormwater planning and management and reduce the environmental, legal and economic risks described above. That said, a standard would need to demonstrate flexibility to accommodate varying local conditions and must carefully target different audiences. This section explores what a future SW QMS might look like in terms of scope, intended audience, jurisdictional applicability and proposed sections of a framework.

7.1 Guiding Principles

Elements of a future SW QMS should seek to address the risks, fill existing gaps and accommodate the unique challenges that climate change presents. They should also consider and allay the various concerns voiced by stakeholders, such as those related to flexibility, innovation and applicability to local contexts. Understanding which approaches and best practices would be appropriately incorporated into a national SW QMS will require careful screening against well-defined criteria.

Addressing Climate Change Adaptation in Standards

Climate change risk management is different from traditional risk management due to the uncertainty around specific climate change details and its impact on municipal stormwater infrastructure. There is uncertainty around the frequency and severity of climate change, the timeframe within which changes will occur, and the effectiveness of adaptation solutions currently available. While climate science and modeling continue to improve, they still face limitations in making precise predictions about the future especially for SDHI rainfall events.

Given these uncertainties, the literature and experts on this subject caution standard writers from adopting changes that would be too prescriptive and instead recommend focusing on risk assessment and objective/outcome-based approaches. They emphasize that climate change risk management should be rooted in flexibility and a continuous learning process in order to manage uncertainty and allow for course corrections. Climate change risk management also requires frequent review and updates to incorporate the latest climate science, as well as continuous monitoring and re-evaluation of adaptation options as information and conditions change. Tools such as vulnerability assessments and scenario planning are very helpful in planning for uncertainty. Vulnerability assessments consider possible exposures to risk under a range of possible future trends and conditions. Meanwhile, scenario planning explores alternative futures and assesses strategies for reducing vulnerability in a range of different futures, allowing an organization to be prepared as conditions change.

In light of the project findings to-date, the gaps and opportunities identified and input from stakeholders, the following are preliminary, suggested criteria that could be used to screen best practices and guide the development of a SW QMS. These criteria were selected in consideration of the unique risks and challenges related to stormwater and climate change.

- ✓ **Flexible.** The standard will allow for flexibility in approach and favour process- and risk-based elements over prescriptive requirements. It will also be applicable in a range of environments. The standard must take into account the geography, logistical challenges and limitations, climate, environmental conditions, and cultural considerations of smaller communities and those communities with limited financial capacity and competing priorities.
- ✓ **Science and data-based.** The standard is based on data and methods informed by the best available, actionable climate science and includes a plan, program, or methodology for further data gathering and analysis. It also relies on future projections rather than historical data. The standard should provide guidance on how a municipality may address future climate projections or references to where they can look for help.
- ✓ **Supports or fills gap for existing standards**: The standard will support / address barriers to existing standards being appropriately applied. Rather than reinventing the wheel, the standard should use or reference accepted standards (e.g. on how to conduct risk management).
- ✓ **Effective at reducing relevant risks**. The standard will address risks and impacts related to stormwater and climate change.
- ✓ **Simple and cost-effective**. The standard must be simple to understand and apply. The application of the standard must be demonstrably cost effective and reasonable. It should lead to future economic gains and/or mitigate damage and associated financial losses.
- ✓ **Evergreen**. The standard will incorporate components that encourage and allow for review, assessment and continual improvement. The standard should also be designed such that new information, technology and practices can be incorporated as they emerge.

All of the best practices[24] highlighted above and included in the proposed framework below have been screened using these criteria.

7.2 Scope

The following chart summarizes which topics stakeholders generally perceived to fall within and outside of the scope of a potential SW QMS, with a few caveats described below.

Category	In Scope	Out of Scope
Type of Infrastructure	New and existing Built and green/natural infrastructure Public (i.e. municipally-owned and managed) Full-life cycle of infrastructure	Lot-level* Commercial and industrial*

[24] While the general best practices were screened using the criteria, the specific case studies applying the best practices were not carefully considered against the criteria. For instance, the general best practice of performing preventative maintenance *could be* based on science and data; however, this does not mean that a particular city that performs preventative maintenance has based its preventative maintenance schedule or practices on science and data.

Type of Water	Stormwater	Drinking water** Wastewater** Coastal (i.e. sea level rise)
Type of Community /Geographical Application	South of the 60° parallel Urban and suburban communities	North of the 60° parallel Rural communities Remote communities
Scale	Community (region, municipality, indigenous community)	Individual project or infrastructure component

**These would be included if and when they are considered part of or affect the municipality's system.*
***These would be included insofar as they intersect with stormwater.*

Further stakeholder consultation on whether and to what extent lot-level, commercial and industrial infrastructure should be included within the scope of a SW QMS would be helpful.

In the context of lot-level infrastructure, some stakeholders believed that other mechanisms such as sewer use bylaws or basement flood protection standards (e.g. CSA Z800) were sufficient to address these issues. Other stakeholders did not agree and indicated that private-side issues needed more attention. They indicated that excluding lot-level construction would leave out a very large percentage of development and noted that inspection practice around private-side infrastructure were in significant need of improvement.

Further consultation on whether and to what extent drinking water and wastewater should be included in the scope of a SW QMS is also recommended. A number of stakeholders believed coordination of sanitary and stormwater was necessary and that it would not be adequate to include wastewater insofar as it impacts stormwater systems. Stakeholders raised the issue of combined stormwater/sanitary sewer systems and suggested including guidelines for the design of new systems and the rehabilitation of existing systems for those communities that have combined systems.

Key questions and discussion points:

Type of Infrastructure

- To what degree should private-side / lot-level issues be included?
- Would it be sufficient to reference Canadian flood resilient community standards and / or relevant sewer use bylaws to address private-side issues?
- To what degree should commercial and industrial lands be considered?
- Would it be sufficient to include private-side residential, commercial and industrial infrastructure only if and when they are considered part of or affect the municipality's system?

Type of Water

- To what degree should sanitary sewers / wastewater be included?
- Would it be sufficient to consider wastewater only insofar as it impacts stormwater systems?
- How should combined stormwater / sanitary sewer systems be addressed?

Type of Community

- To what degree should rural communities be included?

7.3 Intended Users and Audience

This standard would be aimed at, but not restricted to, the following users:

- **Governments (federal, provincial, municipal):** Governments at all levels must better understand the risks and opportunities related to stormwater planning and management. Policy and decision-makers can use this standard for better planning, policymaking and decision making. Municipal Inspectors can be more informed as to what to look for in the field.
- **Builders / Developers**: Builders and developers should factor improved stormwater management and climate resiliency into infrastructure design and construction. This standard can provide guidance around planning, design and construction of stormwater systems.
- **Technical Practitioners**: Engineering, design, planning and other technical practitioners within and external to government play integral roles in stormwater planning, design and management. This standard can be used to better identify and manage risk, as well as integrate best practices.

It could also be instructive for a broader audience, including the following stakeholders:

- Trades Persons
- Home and Property Owners
- Property and Casualty Insurers
- Banks/Credit Unions/Mortgage Lenders

- Credit Rating Agencies
- Lawyers
- Real Estate Brokers/Agents
- Home Inspectors
- Securities Commissions
- Institutional Investors
- Educational Institutes

Key questions and discussion points:

- Should any intended users be added or removed?
- Should any broader audience groups be added, removed or included in the intended users list?

7.4 Level of Jurisdiction

The SW QMS would be developed at the federal level but applied at the municipal level. The standard would need to leave room for regional realities and the different contexts of each jurisdiction.

Provinces and territories would also play a role in relation to a SW QMS. As administrators of municipalities, their support for a national standard would be crucial for the implementation and effective administration of the standard.

Key questions and discussion points:

- How should the standard be designed to ensure that regional realities and different municipal contexts are sufficiently accommodated?

7.5 Level of Service

One of the most pressing issues a SW QMS should seek to address is providing guidance on how to determine stormwater-related level of service. Figure 1 shows the results of a webinar survey of approximately 30 relevant stakeholders across Canada.

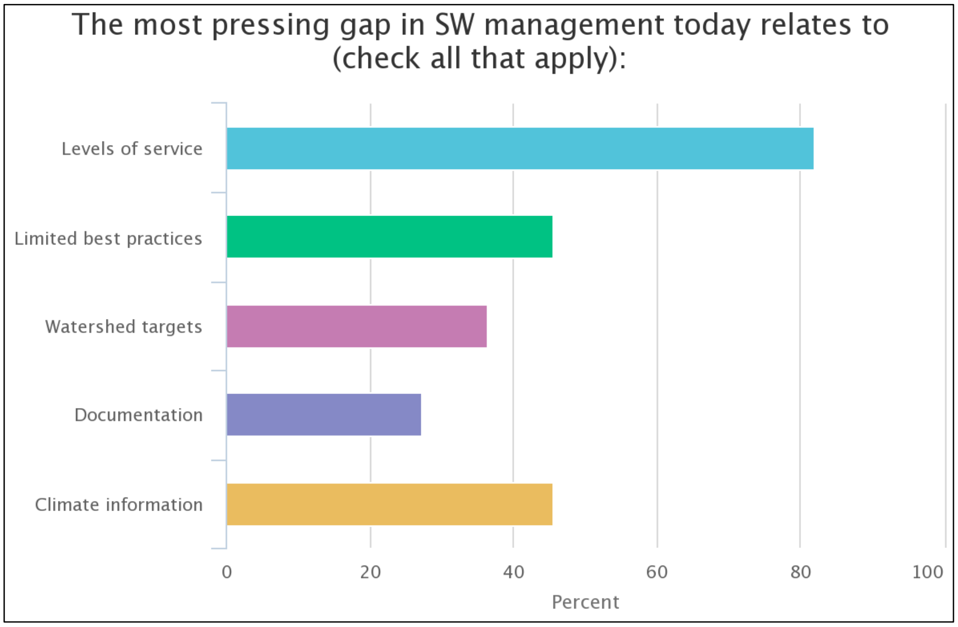

Figure 1: Most pressing gap a SW QMS should seek to address

Due to the high levels of interest in and significant gaps relating to levels of service, this subsection offers specific focus on potential level of service guidelines or goals for stormwater. Research and stakeholder consultations to-date have not uncovered recommended ways to approach determining the appropriate level of service for stormwater quantity or quality; however, a number of helpful considerations and questions were raised to guide future discussions.

For greater clarity, level of service determinations would not be the same across the country due to different jurisdictional contexts and acceptable levels of risk. But the approach to determining appropriate levels of service could be consistent.

Potential parameters for water *quantity* targets and level of service determinations could include:

- Flood level or return period level of service
- Normal drainage level of service
- Emergency management level of service
- Erosion control
- Ecological health

- Aquatic health
- Considerations related to not transferring risk to downstream municipalities
- Preservation of natural hydrology (runoff and volume)
- Maintenance of natural groundwater regime
- Maintenance of adequate base flows

Potential parameters for water *quality* targets and level of service determinations could include:

- Carrying capacity and quality of the receiving water body
- Swimming quality
- Ability to navigate
- Ecological health
- Aquatic health
- Riparian vegetation health
- Drinking water quality
- Geomorphology
- Nutrients
- Suspended solids
- Metals
- Pathogens
- Organic chemicals

Key questions and discussion points:

- Which parameters should stormwater quantity and quality levels of service include?
- How can we use in-stream targets to form the basis of a level of service for stormwater?
- What should in-stream flow targets consider (e.g. preserving natural hydrology of a receiver, providing a certain amount of base flow to a stream, etc.)?[1]
- Would levels of service be different for new development (e.g. 100-year climate change-influenced design) compared to retrofit on existing development (e.g. based on cost-benefit analysis)?

7.6 Proposed Sections of a Framework Standard

A SW QMS is envisioned to be a process-based, risk-based standard similar to the Ontario's Drinking Water QMS and ISO standards. It should be flexible in that it should mostly provide the framework around which stormwater management is properly managed. It should also take into consideration differences in local conditions, municipality size, staff expertise, and resources.

An effective SW QMS would need to strike the proper balance between voluntary and mandatory elements. Figure 2 shows the results of a webinar survey of approximately 30 relevant stakeholders across Canada.

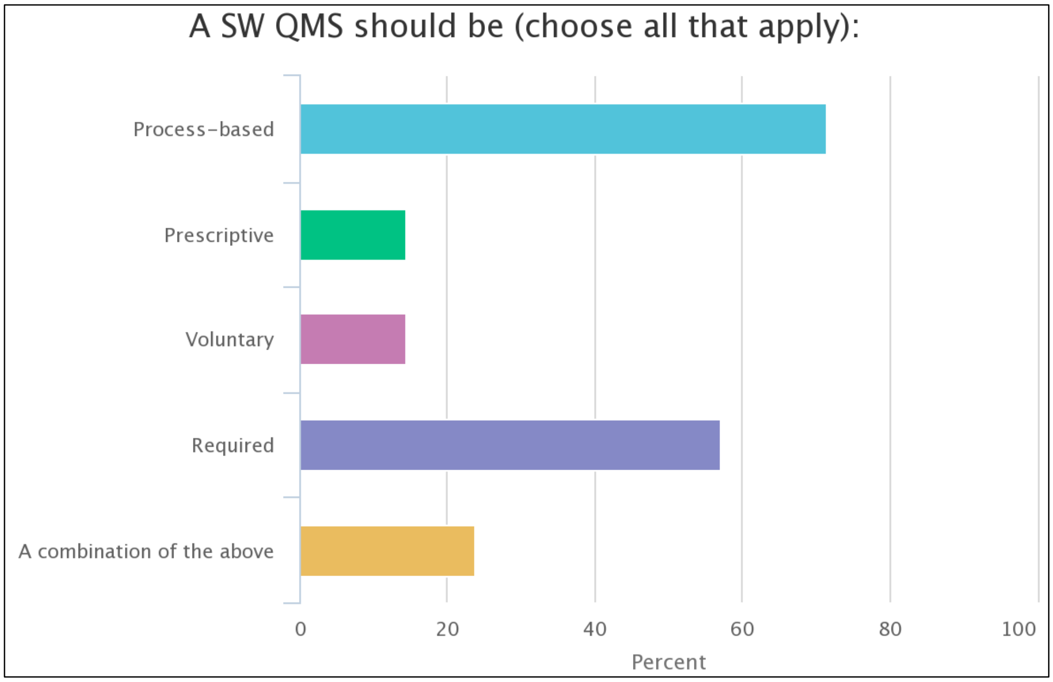

Figure 2: Nature of a SW QMS

For example, using the SW QMS may not optional, but the sophistication of the document management system could depend on the complexity of the stormwater assets. Similarly, having a systematic risk management process may not be optional, but the elements of concern could be municipality-specific. A municipality should not be limited to or by a QMS but should instead have the flexibility to scope the standard (and the steps to be included within the standard) based on their individual needs. Municipalities could prioritize risks and "quick wins" and look for opportunities to leverage existing policies and programs.

Based on the literature, stakeholder interviews, gaps and best practices reviewed, potential sections of a framework standard are outlined below.

Table 5: Potential Sections of a SW QMS

Framework Section	Sub-sections / Issues to Cover	Best Practice	Example of Best Practice in Practice	Potentially Relevant Existing Standard
Set Scope and Context				
Goals and Objectives	New infrastructure Existing infrastructure			
Roles and Responsibilities				
Planning	Watershed planning Flood planning Policy linkages (building codes, sewer use bylaws, procurement policies, provincial requirements)	Use of cost benefit analysis to compare and prioritise stormwater planning, design and management options considering future climate impacts	*City of Surrey's Approach to Climate Adaptation*	
Asset Management	Traditional asset management Natural asset management	Apply an integrated asset management approach	*Ontario MOI's Asset Management Toolkit*	
Risk Management	Compliance obligations Risk assessment (physical, legal, environmental, economic) Climate change vulnerability assessments Risk treatment/management	Take a risk-based approach to stormwater management including consideration of climate change Conduct climate change vulnerability assessment on stormwater management systems	*City of Surrey's Climate Change Rainfall Adaptation Strategy* *City of Welland's Climate Change Vulnerability Assessment*	ISO 31000 – Risk Management Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol
Design	Levels of service for quality and quantity Intensity duration frequency curves Low-impact development	Consider levels of service / performance targets to manage the complete spectrum of rainfall events	*BC's Stormwater Planning, A Guidebook for BC and Beyond the Guidebook*	CSA Z800-18 – Basement Flood Protection (to be published) CSA W1006 – Flood

Framework Section	Sub-sections / Issues to Cover	Best Practice	Example of Best Practice in Practice	Potentially Relevant Existing Standard
	Stormwater / rainwater volume control targets Infiltration / Inflow targets Dual drainage modeling Redevelopment/retrofits	Stress test existing stormwater infrastructure to withstand future climate conditions and extremes Create standardized IDF curves for various regions produced at the provincial level that incorporate climate projections Offer fast-track development approvals where more stringent stormwater design requirements are met Incorporate LID practices in new development areas and retrofit existing development areas Conduct dual analysis of minor management systems Use procurement policies to require improved stormwater management design and consideration of climate change	*City of Ottawa's Sewer Design Guidelines* *Newfoundland and Labrador's Standardized Updated IDF Curves* *Province of Quebec's Approach to Development Approvals* *Ontario's LID Stormwater Management Guidance Manual* *New York City's Resiliency Design Guidelines v2.0* *Infrastructure Canada's Climate Lens*	Resilient Design for New Residential Communities (in development) CSA W200 – Design of Bioretention Systems (to be published) CSA/ICC B805 – Rainwater Harvesting Systems (to be published) CSA PLUS 4013 – Technical guide: Development, interpretation and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners
Construction				CSA W201 – Construction of Bioretention Systems (to be published)

Framework Section	Sub-sections / Issues to Cover	Best Practice	Example of Best Practice in Practice	Potentially Relevant Existing Standard
Operation		Employ a service-level approach to asset management to understand how the level of service is changing	*City of Regina's Service-Level Approach to Asset Management*	
Monitoring and Inspection	Assumption (i.e. standard inspection protocols for municipalities before they take ownership of stormwater management systems from developers) Data management Flow monitoring and analysis Enforcement	Develop a detailed maintenance and monitoring plan to meet compliance obligations and ministry approval requirements Use sewer use bylaws to require private homeowners to take lot-level flood risk reduction measures	*Halifax Regional Water Commission's Acceptance Submission Requirements* *City of Thorold's Sewer Use Bylaw*	CSA W202 – Erosion and Sediment Control, Inspection and Monitoring (to be published
Maintenance		Perform preventative, scheduled maintenance in addition to corrective maintenance Modify maintenance if inspection shows that frequency should be increased or decreased	*City of Calgary's Stormwater Management and Design Manual* *City of Coquitlam's Stormwater Management Policy and Design Manual*	

Framework Section	Sub-sections / Issues to Cover	Best Practice	Example of Best Practice in Practice	Potentially Relevant Existing Standard
Forecasting and Early Warning Systems		Forecast flooding using the most up to date climate projections	*Province of New Brunswick's New Flow Forecast Model*	
Emergency Response		Prepare Emergency Response Plans that clearly outline roles and responsibilities and incorporate flooding (i.e. not just fire hazards)	*The City of Greater Sudbury's Community Flood Management Plan*	
Documentation and Reporting		None identified		
Auditing		Conduct internal audits to assess system's performance and identify opportunities for innovation and improvements on an ongoing basis	*Metro Vancouver's Integrated Liquid Waste Resources Management Plan*	AS/NZS ISO 9001: 2016: Quality management systems (QMS) – requirements ISO 19011 – Guidelines for Auditing Management Systems
Adaptive Management		Plan for ongoing monitoring of stormwater assets to ensure their effectiveness is in line with most up to date climate projections	*City of Toronto's Wet Weather Flow Management Guideline*	

Key questions and discussion points:

- Which sections should apply to which users?
- What factors should be considered when determining the level of service for water quantity and quality?
- Which of the existing standards listed in Appendix 9.4 should be referenced directly in the SW QMS and in which sections would these be referenced?
- Which aspects of the standard would be mandatory (e.g. considering the potential impacts of climate change) and which would be voluntary guidance (e.g. sample best practices)?
- Clear performance metrics are likely needed so the design community knows what to aim for. Which sections would include such performance requirements?

7.7 Complementary Initiatives to the Development of a SW QMS

While there appears to be sufficient tools and data to pursue the development of a SW QMS, the standard would benefit from the following complementary initiatives.

- **Adequate funding.** Many stakeholders pointed to the importance of consistent, dedicated and predictable funding to support improvements in stormwater management. Such funding or revenue streams could come from stormwater fees, development charges or other incentives. Whether or not guidance and best practices around financing stormwater management would be a component of the standard requires further exploration.
- **Stakeholder consultation.** Stakeholders expressed the importance of socializing the concept of a SW QMS among a variety of relevant stakeholders, such as the development industry, engineers and municipalities.
- **Baseline data development.** Development of critical infrastructure inventories including the evaluation of vulnerabilities and identification of priority at-risk areas, based on the projected impact due to climate change, is needed.
- **Climate data and modeling.** Good quality, regionally-downscaled, trustworthy and forward-looking climate data and projections are key to properly integrating climate change into stormwater planning and management. More guidance or assistance in modeling the impacts of climate change on stormwater systems is also needed, though such guidance could be included in the standard itself.
- **Better tools that describe geology, hydrology and quantify climate impacts.** Stakeholders expressed a need for better analytical tools that describe the geology and hydrology of sewers, catch basins, manholes, etc. Studies of enhanced infiltration systems to determine how they are working over the long-term and their impacts on groundwater quality were noted as being needed. Tools to quantify climate impacts on systems were also discussed.
- **Risk mapping.** High quality, regional risk profiles (e.g. new flood zone mapping) are required.
- **Technical solutions.** Industry will need sufficient technical solutions that are practical, affordable and maintainable.
- **Stormwater-related education and training.** Actual knowledge with respect to stormwater management is very sparse. Significant effort is needed across the country to raise the level of expertise in the profession.
- **More insurance, government and industry cooperation.** Stakeholders discussed the need for enhanced cooperation between the public and private sectors, with a particular emphasis on the insurance industry working with municipalities to share data in a mutually beneficial way.
- **Better liaising between stormwater professionals and other engineering specialties.**
- **Better understanding of costs.** Finally, stakeholders indicated that there is a need to better understand the incremental benefit and incremental cost of upgrading stormwater systems beyond current standards to incorporate climate change adaptation. Additional investments

require a clear return on investment and municipalities require better tools to understand costs and run cost-benefit analyses.

As an initial step, a state of play or inventory should be carried out to understand what currently exists for each of the items listed above and whether any of the items are necessary pre-cursors before further standards development is required. These issues should continue to be considered throughout the standard's development process to ensure that users of the standard have the tools and information they need to apply it.

8 Next Steps

Following the publishing of this seed document, SCC plans to commit additional funding towards the development of a national standard based on the seed document by an accredited standards development organization. A high-level overview of the accredited standards development process is demonstrated in Figure 3 below.

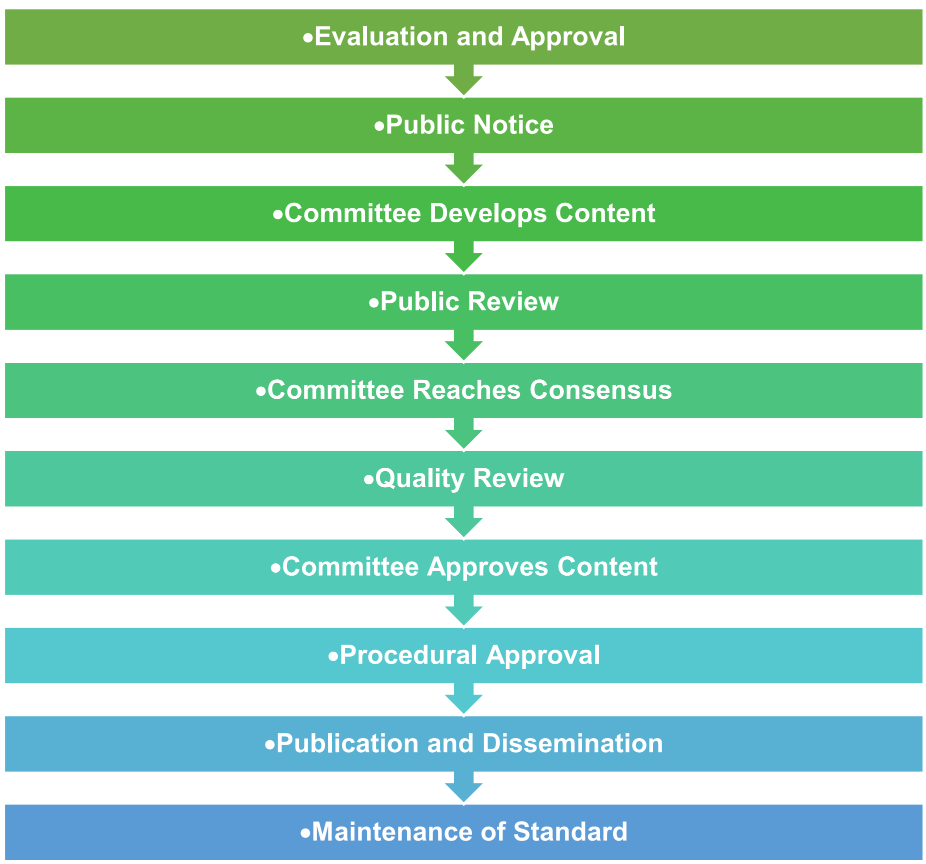

Figure 3: Standards Council of Canada Accredited Standards Development Process

SCC will work with Engineers Canada and other key stakeholders to ensure the standard will meet the needs of the intended users and audience identified.

9 Appendix

9.1 Select Provincial Guidance on Stormwater Management Design (Canada)

Stormwater design is generally based on a mix of criteria for flooding, erosion, water quality and water balance. Included below is a brief summary of the varying standards across Canadian provinces.

Province	Description of Guidance
Nova Scotia	Water resources management strategy we released in 2010 which is a 10 year strategy and not specific to stormwater but identifies that changes to the natural water cycle are possible in part due to climate change (more intense storms). Document indicates that province must be prepared for changes in the amount of precipitation during storms, and changes in storm frequency and intensity. Identifies that intense storms cause more erosion, and don't give the ground enough time to absorb the water that replenishes groundwater aquifers. An action outlined in the management strategy for the protection of the quality and quantity of the water is "Update current guidance for storm water management and sediment control to improve protection of water quality from land development activities.
Ontario	Stormwater Management Planning and Design Manual provide technical and procedural guidance for the planning, design, and review of stormwater management practices as baseline for ministry approval.
Saskatchewan	Provincial Stormwater Guidelines to provide a high-level technical guidance to municipal authorities, individuals and consultants who plan to develop and implement drainage systems for stormwater in urban/built-up municipal areas, commercial and industrial areas using site specific stormwater management solutions.
Alberta	Stormwater Management Guidelines form the basis of stormwater management planning and design and operation for authorities, designers and developers by outlining available methodologies and concepts including defined water quantity and quality objectives as well as techniques to achieve them. The manual emphasizes on the importance of ongoing maintenance.
British Columbia	A Guidebook on Stormwater Planning provides a framework for effective stormwater management that is usable in all areas of the province structured to meet the information needs of different audiences: from senior managers and elected officials to those professional planning and engineering staff who are tasked with implementing early action to land developers and the consulting community.
Quebec	The Stormwater Management Guide presents different approaches and techniques for reducing the hydrological consequences of urbanization and the Manual for the Calculation and Design of Municipal Stormwater Management Works.

9.2 Select Municipal Stormwater Design Guidelines (Canada)

Below are select municipal stormwater guidelines stemming from the Provincial guidelines presented above. The municipal design standards provide design criteria for consultants to adhere to when sizing municipal storm sewer systems (major and minor systems).

Municipality	Description
City of Halifax	Design and Construction Specifications (2016 Edition): The manual provides guidance for designers of municipal services systems (water, wastewater and stormwater) to meet an acceptable level of service for new developments.
City of Saint John	This Storm Drainage Design Criteria Manual is intended to provide guidance and direction to Consultants and City of Saint John staff in relation to the design of storm drainage infrastructure within the City.
City of Moncton	Design Criteria Manual for Municipal Services Document provides guidance for designers in the design of standard municipal services offering an acceptable level of service while constructing sustainable infrastructure to be owned and operated by the City of Moncton.
City of Ottawa	Sewer Design Guidelines: This guide has been prepared for designers and the development industry in the design of municipal sewer systems to order to meet City of Ottawa standards.
City of Saskatoon	Design and Development Standards Manual, Section Seven – Service Connections (2018)
City of Edmonton	Design and Construction Standards Volume 3 – Drainage: The standard provides direction on the level of service for the City of Edmonton to meet stormwater management goal or providing adequate drainage for urban areas.
City of Calgary	Stormwater Management and Design Manual: The manual provides comprehensive design requirements for stormwater management systems.
City of Coquitlam	Stormwater Management Policy and Design Manual: This Policy and Design Manual outlines the stormwater management policies and design criteria for the City of Coquitlam.
City of Surrey	Guide for Interpreting the City of Surrey's First Cycle on Integrated Stormwater Management Plans (2007 to 2016)
City of Toronto	Wet Weather Flow Management Guidelines
City of Barrie	Storm Drainage and Stormwater Management Policies and Design Guidelines
Greater Vancouver Regional District	Integrated Stormwater Management Planning Template

9.3 Floodplain Definitions (Canada)

The watershed system includes floodplains which are areas adjacent to water bodies that experience periodic inundation and require management standards for riverine or coastal flooding in Canada. Stormwater can directly impact and further exacerbate riverine flooding and possibly coastal flooding incidences if not controlled at source and can also result in urban overland flooding and sanitary flooding. This section briefly describes provincial standards for watershed management, with a specific focus on floodplain definitions, across Canada.

Province	**Floodplain Definition**
Newfoundland and Labrador	An area adjacent to a lake, river, seashore etc. which is inundated or covered with water on average at least once in 100 years. Note that a flood plain is considered to be an integral part of a body of water as defined above because it includes "the land usually or at a time occupied by that body of water" and "whether that source usually contains water or not."
Nova Scotia	The 100-year flood has been used to delineate and designate flood plains. The two zone approach has been used where future development is prohibited in the floodway, defined by the 20-year flood, but is permitted in the flood fringe if adequate flood proofing is carried out.
New Brunswick	Most of the flood risk mapping for New Brunswick was developed in the 1970s. There is current no provincial initiative to systematically update the existing flood risk mapping. The mapping depicts two-zones including a Floodway and a Flood Risk Area where the floodway is designed for the 1:20 year flood and the flood risk area is designed for the 1:100 year flood for 8 designated areas.
Prince Edward Island	Runs a Coastal Erosion and Flooding Assessment program for shoreline properties and the risk assessment is performed through subdivision approvals and development permits. Coastal Flood Risk is characterized in relation to sea level rise where properties that are low lying within less than 2 meters of the coast are at most risk and have the highest probability to flood from a small storm surges with a 10% chance of happening in any year. Properties with an elevation higher than 2 meters from the coast but less than 4 meters are at moderate risk and may flood with larger storm surges with the likelihood of occurring at least once every 25 to 100 years.
Quebec	The floodplain is divided into two zones, the floodway, where further development is discouraged, and the flood fringe where flood proofed development is possible. However, there are some exceptions. With Ministerial approval, “derogation" permits a specified project to be undertaken within a specified area of the floodway.
Ontario	The standard for defining the flood plain along small lakes and large rivers is the same standard used for rivers (Hazel-Centered, Timmins-Centered, maximum observed or 100-year) whichever is applicable.
Manitoba	Uses a two-zoned concept but it is founded more in the type of flood protection that can be used. The floodway fringe is defined as the area which, if removed from the active flow zone, would raise the water level by less than 0.3m. -The design event for critical infrastructure, such as the City of Winnipeg, is the event that can be justified through a benefit cost analysis. It is currently the 1:700 year event for Winnipeg.
Saskatchewan	Development is prohibited in the floodway of the 1:500 year flood elevation of any watercourse or water body and that new development in the flood fringe of a 1:500 year flood are flood proofed to an elevation 0.5 metres above the 1:500 year flood elevation.
Alberta	Established a two zone approach including a floodway and flood fringe areas. In Alberta, the design floods are the 1:100 year floods.

British Columbia	A 200-year flood to define the flood risk area, but divides it into two zones, the floodway, where further development is discouraged, and the flood fringe where flood proofed development is possible. Metro Vancouver is in the midst of developing a new Wastewater Treatment Plant at Lion's Gate. The flood assessment to establish the Flood Construction Level (FCL) did incorporate the potential for climate change to influence Sea Level Rise, storm surge and rainfall.
Nunavut and Northwest Territories	Follow a 1:100 year regulatory flood standard.

9.4 Existing Standards (Canada and International)

A range of existing standards related to, risk management, environmental systems, water, sustainable communities, and climate change adaptation exist in Canada and internationally. These can offer helpful direction as to elements to be incorporated into a future stormwater QMS.

Category	Description
Risk Management	**ISO 31000 – Risk Management** • Develop a risk management framework, process and implementation plan. • Establish the context that encompasses the objectives, stakeholders and the diversity of risk criteria. **Hazard Identification and Risk Assessment** • Attempts to assist emergency managers to help prevent, prepare, mitigate, respond and recover from a myriad of hazards. **ISO 19011 – Guidelines for Auditing Management Systems** • The standard provides guidance on auditing management systems, including principles of auditing, managing an audit program, conducting the audit program, evaluation of competence of individuals involved in the audit process, person managing the audit program, auditors and audit teams.
Quality Management	**AS/NZS ISO 9001: 2016: Quality management systems (QMS) – requirements** • This International Standard promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements. This standard outlines that, within a quality management system, it is important to understand the 'requirements', added value, obtaining results of process performance and effectiveness and continual improvement of processes or the 'system' based on objective requirements.
Environmental Systems	**ISO 14001 – Environmental Management Systems** • Provides organizations with a framework to protect the environment and respond to changing environmental conditions in balance with socio-economic needs. • Provides specific requirements that an organization can set to meet certain outcomes for protecting/preventing/mitigating adverse impacts, fulfill compliance obligations, enhance performance, and promote a life cycle perspective. **ISO 14031 – Environmental Management: Environmental Performance Evaluation** • Environmental performance evaluation (EPE) and environmental audits are

	complementary tools that can be used to assess environmental performance and make improvements. • EPE is used to collect and assess data/information to provide current evaluation of performance, audits are used to verify whether objectives and targets are being met and audits are performed to ensure conformity with regulatory compliance obligations. **Nutrient Management Act** • Provides for the management of materials containing nutrients in a way to enhance protection of the natural environment and provide a sustainable future for agricultural operations and rural developments. **Nutrient Management Strategy** • Requires any building project relating to livestock/manure storage to have an approved nutrient management strategy.
Flood Resiliency	**CSAZ800-18 – Basement Flood Protection (to be published July 2018)** • The guide provides a scope of solutions for private property owners/homeowners to implement to minimize the risk of basement flooding due to climate change • The scope of the guide includes both new and existing buildings and provides mitigation measures and best practices to reduce risk of flooding and the potential damages if a flood was to occur. • The document covers all private side issues related to both sanitary and storm systems. **Developing Best Practices for Flood Risk Reduction: Existing Residential Communities** • The guide provides approaches that are technically-feasible, cost effective and environmentally sustainable to reduce flood risk in existing residential communities in Canada. • The guide outlines common flood risk challenges for existing residential communities, a framework for selecting priority flood risk areas and reduction works and also identified best practices for flood risk reduction. • The guide also provides best practices to be considered for flood risk reduction **CSA W1006 - Flood Resilient Design for New Residential Communities (in development)** • This standard will provide requirements and recommendations for the design and construction of new residential communities that will address the following types of flood hazards; riverine flooding, overland flooding, storm and sanitary sewer surcharge, drainage system failures, and groundwater seepage. **Preventing Disaster Before it Strikes: Developing a Canadian Standard for New Flood-resilient Residential Communities** • The guide provides twenty (20) best practices that can be incorporated into the design and construction of new communities (low-rise, greenfield developments) to ensure they are build flood-resilient. • The guide considers flood hazards such as riverine and overland flooding, storm and sanitary sewer surcharge, drainage system failures and groundwater seepage. The guide does not include coastal and unique flood hazards such as potential dam failures. **Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate in British Columbia** • The guidelines are directed towards Qualified Professionals to carry out flood assessments. • The guidelines summary the professional practice related to legislated flood

	assessments. • These guidelines are directed to flood assessments for proposed development (institutional, commercial, industrial, and resource development; associated and non-associated infrastructure; emergency response; and in some situations existing residential development). • These guidelines do not address other potential natural hazards such as landslides, soil erosion, and subsidence or snow avalanches, except as related to flooding.
Stormwater-Related	**CSA W200 – Design of Bioretention Systems (to be published)** • The standard provides guidance on design requirements for Bioretention systems to provide water quality and quantity benefits to downstream areas and overall flood mitigation. The standard covers roles and responsibilities after implementation of Bioretention areas, design elements to be considered, media characteristics, system sizing and technical specifications. **CSA W201 – Construction of Bioretention Systems (to be published)** • The standard provides guidance on construction of Bioretention systems to ensure the integrity of the design to provide water quality and quantity benefits for downstream systems. The standard covers roles and responsibilities for construction of these Bioretention systems including materials, material handling, sequencing, civil considerations, landscape considerations and risk management. **CSA B184 SERIES – Polymeric subsurface stormwater management structures** • The standard provides guidance on polymeric substances and accessories used for subsurface stormwater management structures to provide stormwater runoff collection, detention, retention and infiltration. The standard provides specifications on the requirements of the subsurface design materials, manufacturers, structural integrity (loading) as well as proper installation and maintenance of these polymeric substances. **CSA/ICC B805 – Rainwater Harvesting Systems (to be published)** • The standard provides guidance on the design, materials, installation, and operation of rainwater harvesting systems for both residential and commercial applications that use potable and non-potable water. It specifies requirements for prescriptive and performance-based approaches to using rainwater and/or stormwater as the input for harvesting systems. **CSA W202 – Erosion and Sediment Control, Inspection and Monitoring (to be published)** • The standard provides guidance on the inspection and monitoring aspects of erosion and sediment control projects as a result of construction and development. The standard provides guidance on roles and responsibilities, communication tools and procedures, multi-stage target assessment, and other considerations such as water quality and at-risk species. **CSA PLUS 4013 – Technical guide: Development, interpretation and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resources practitioners** • The guideline provides guidance for professionals with a role in the planning, design, management, inspection, and regulation of stormwater, drainage, wastewater, and flood management systems. It is intended to be a mere resource to provide the understanding of the derivation and application of rainfall IDF information in water systems planning and design for current and future climate change scenarios. This guideline is being revised to add additional section(s) that would provide guidance on how to incorporate climate

	change into the formulation and application of IDF information. **Province of Quebec Stormwater Management Guide** • The guide presents various approaches and techniques to reducing the impacts of urbanization on the hydrological regime. The guide presents the criteria for managing stormwater through 1) quantitative control, 2) qualitative control, 3) erosion control and 4) groundwater recharge to maintain base flows. The guide states that stormwater management plans shall be integrated with the watershed needs incorporating control elements from upstream to downstream. **Province of Quebec Manual of Calculation and Design of Municipal Stormwater Management Works** • The manual is complimentary to the Stormwater Management Guide. It sets out the criteria for the design and calculation of stormwater management works, which, if met, will allow the party to be exempt from obtaining an environmental certificate of authorization. The exemption is allowed only when all compulsory reduction criteria are met including total suspended solids and flow rates.
Water	**Ontario Drinking Water Quality Management Standard** • As set in the Safe Drinking Water Act, owners and operating authorities of residential drinking water systems are required to establish a QMS. The process includes the development of an operational plan which includes roles, responsibilities, authorities etc. Other components included under the operational plan include development, implementation, maintenance and continual improvement of the QMS. **ISO 24511/ CAN/CSA Z24511 - Guidelines for the Management of Wastewater Utilities and Assessment of Wastewater Services** • The standard provides the objectives of a wastewater utility, guidelines for its management and service assessment criteria and example performance indicators. • All elements to be established should take into account legal requirements, land/urban planning and human settlement policies, expectations of users and stakeholders, the physical and management components of the wastewater facility, financial resources available and affordability. **ISO 24510/ CAN/CSA Z24510 - Activities relating to drinking water and wastewater services - Guidelines for the assessment and for the improvement for the service of users** • This standard specifies the elements of drinking water and wastewater services of relevance and interest to users. The scope of the standard includes services assessment criteria and examples of performance indicators.
Climate Change Adaptation	**International Council for Local Environmental Initiatives (ICLEI) - Building Adaptive and Resiliency Communities (BARC)** • This tool guides local government practitioners through a process of initiation, research, planning, implementation and monitoring for climate adaptation planning to assist communities in adapting to the impacts of climate change through the development of a Municipal Climate Change Adaptation Plan. **Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol** • Addresses engineering concerns with infrastructure risks to climate change impacts. **CEN-CENELEC Guide 32 - Guide for addressing climate change adaptation in standards (2016)** • Provides guidance on addressing aspects of climate change adaptation in European

	standardization documents. This Guide is applicable to product (including design), service, infrastructure and testing standards. It is intended to be applicable to both "climate-influenced products" and "climate resilience products". It is primarily intended for standard writers and aims to enable them to identify relevant climate impacts and to include climate change adaptation considerations in new or revised standardization documents. This Guide explores potential relevance of climate change and potential impacts of climate change on each stage of life cycle -- acquisition, production, use, and end-of-life (different iterations of these stages for material products, services, testing, and infrastructure). **Standardization Guidance for Weather Data, Climate Information and Climate Change Projections**[25] • The report provides an overview of the collection, management and use of weather and climate data across Canada based on the key climate data sources. The report is intended to demonstrate how weather and climate change projections data is used by engineers in infrastructure design values and the challenges and opportunities associated with that. The report is intended to move towards a standardization system to ensure informed decisions about infrastructure projects. The main recommendations from the report were to 1) develop a national data portal, 2) develop guidelines and best practices to help engineers cope with climate change uncertainties and 3) develop climate change design parameters for engineers. **The Climate Bonds Initiative's (CBI) new Water Infrastructure Standard** • The Water Criteria lay out the requirements that water infrastructure assets and/or projects must meet to be eligible for inclusion in a Certified Climate Bond. The guiding principle for the Climate Bonds Standard is that certified assets and projects must be in line with limiting global warming to no more than 2˚C, ideally no more than 1.5˚C, and support climate resilience of the asset and surrounding environment.
Sustainable Community	**ISO 37120 - Sustainable Development of Communities Indicators for City Services and Quality of Life** • Establish definitions and methodologies for a set of standardized city indicators to steer and measure delivery of city services, quality of life and assist in setting targets and monitoring achievements. International standard developed for a holistic and integrated approach to sustainable development and resilience. Provides a uniform approach to what is measured and how to measure.

9.5 Stakeholders Consulted in the SW QMS Seed Document Development Process

- Barbara Robinson (Norton Engineering Inc.)
- Jeff Walker (CSA)
- Yehuda Kleiner (NRC)
- Ehsan Roshani (NRC)
- Natalia Moudrak (Intact Centre on Climate Adaptation)
- Nathalie Bleau (Ouranos)

[25] Standards Council of Canada, "New Report: Standardization Guidance for Weather Data, Climate Information and Climate Change Projections," 2017. https://www.scc.ca/en/news-events/news/2017/new-report-standardization-guidance-for-weather-data-climate-information-and-climate-change

- Dirk Nyland (British Columbia Ministry of Transportation and Infrastructure)
- Scott Mathers (City of London)
- Nick Gollan (City of Kitchener)
- Peter Nimmrichter & Ron Scheckenberger (Wood (formerly AMEC Foster Wheeler))
- Bert Van Duin (City of Calgary)
- Kevin Gray (Halifax Water)
- David Blades (Halifax Water)
- Peter Duncan & Shannon O'Connell (Halifax Regional Municipality)
- Robert J. Muir (City of Markham)
- John Kinkead (J. Kinkead Consulting)
- Carrie Baron (City of Surrey)
- Hiran Sandanayake (City of Ottawa)
- Amir Ali Khan (Government of Newfoundland and Labrador)
- Gilles Rivard (Northwest Hydraulic Consultants)
- Twyla Kowalczyk (The City of Calgary)
- Muneef Ahmad (City of Mississauga)
- Chris Rol (Insurance Bureau of Canada)
- Elise Pare (WSP)
- John Nemeth (Peel Region)
- Samantha Brickman (Kitchener)
- Art Kastelein (formerly Township of Langley)

9.6 Legal Primer on Stormwater Liability

Stormwater management is a shared responsibility among various provincial ministries, municipalities and (in some provinces) conservation authorities. These actors are all charged with working together to ensure that stormwater systems are properly functioning and adequately adapting to a changing climate.

As changes in climate occur and potential impacts on municipal stormwater systems become better understood, the law can provide valuable guidance on standards of practice and diligent decision-making in light of climate-adjusted information. Similarly, the law can be an important driver to adapt, as it imposes duties and responsibilities on a wide range of actors involved in water management and flood prevention—from government, to conservation authorities, to developers, and down to individual homeowners. A better understanding of potential legal liabilities can assist municipalities and others who are involved in stormwater management to ensure thoughtful and diligent stormwater management practices.[26]

Legal Landscape

In common law jurisdictions like Canada (except for Quebec), the legal obligations related to stormwater management are derived from two main sources:

1. Legislation (federal, provincial, municipal); and

[26]Zizzo Allan, *Stormwater Management in Ontario: Legal Issues in a Changing Climate*, 2014. https://cvc.ca/wp-content/uploads/2014/05/Stormwater-Management-in-Ontario_Legal-Issues-in-a-Changing-Climate_2014.04.29.pdf

2. The common law (or "judge-made" law) developed by the courts.

Other "soft" instruments such as codes, policies, plans, standards and guidelines also play a role in delineating and informing the duties and responsibilities outlined in legislation and the common law.

Legislation

Legislation includes statutes, regulations, and municipal by-laws. These laws govern activities the government has deemed worth regulating.

A statute (or an act) is a formal written law passed by a legislative body that governs a country, province/state or city. Statutes are prescriptive and clearly require or prohibit certain actions. A party who violates a provision of a statute could be prosecuted and exposed to penalties such as fines or imprisonment. Other mechanisms to ensure statutory requirements are met include instruments such as permits, approvals, and inspections.

Regulations are enacted under statutes and provide specific rules meant to carry out the provisions of its parent statute. Regulations are usually enforced by a regulatory agency formed to carry out the purpose or provisions of the parent statute.

Common Law

How statutes are interpreted and applied is often clarified through the common law. Common law refers to the body of law that is derived from court decisions as opposed to statutes. It is also known as "judge-made law". Types of common law include tort law, contract law, criminal law, and family law.

In addition to serving an interpretive function, the common law can impose legal requirements where a statute does not specifically deal with an issue. Income cases, courts have even decided that common law requirements exceed statutory requirements, meaning that compliance with legislation is not always enough to ensure protection against liability. Common law legal requirements are not as clearly prescribed as statutory requirements and will depend on the elements of the offence alleged and the circumstances of each case. There is always a risk that a person or government will be subject to a challenge based not only on legislation but also on the common law (for example, by way of a negligence or nuisance claim).

Tort law is an area of common law that allows plaintiffs to seek compensation for harms caused by the unlawful acts of others. The law of negligence, which refers to careless conduct that causes loss to another, is the most common and arguably the most important field of tort law as it governs most activities of modern society. To be found negligent, a plaintiff must establish that the defendant owed it a duty of care and breached the relevant standard of care (see below for more discussion on standard of care). The plaintiff must also show that the defendant's act or omission caused or contributed to the harm suffered, resulting in damages to the plaintiff.

Figure 4 illustrates the relationship between statutory and common law, demonstrating that they are two different streams of law that can sometimes interact.

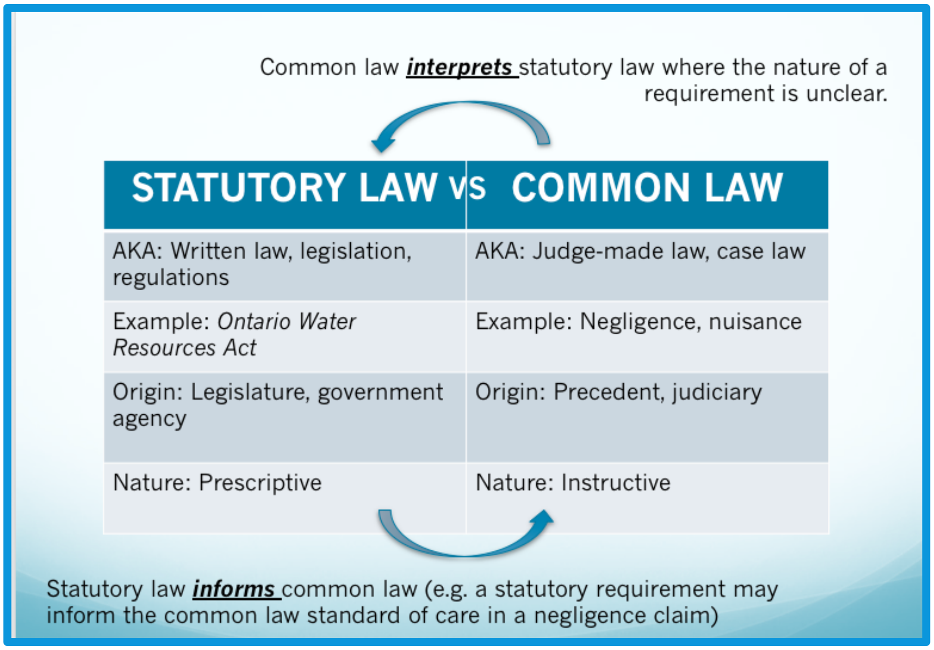

Figure 4: Interaction Between Statutory and Common Law

Other Instruments

Codes, policies, plans, standards and guidelines are also part of the system of instruments that govern stormwater management in Canada. While most of these “soft” instruments are not legally enforceable in and of themselves, they can be given legal force when referenced in legislation or through other legal instruments. Two key roles that these instruments play related to legal responsibilities and potential liability include:

- Providing technical guidance on how to meet legislative requirements
- Informing the standard of care a defendant may be held to in a negligence claim

See the call out box below entitled *“Other Key Definitions*” for more detail regarding these instruments and how they are used.

Other Key Definitions

Policy: A course or principle of actions adopted and declared by a government. A policy may or may not be legally enforceable depending on how it is referenced by legislation or considered by a court.

Code: A set of rules that specify the standards for a particular sector or type of activity (e.g. building codes, electrical codes). Often those operating under a code will be required to prove that they have met the standards prescribed before receiving an approval or permit.

Standards: Technical or performance specifications related to a product, service or process. Standards are often voluntary and should be distinguished from performance or technical specifications that are required by law.

Guideline: A rule or instruction that describes how something should be done. For instance, a guideline may provide instruction on how to satisfy a legal requirement or meet a standard. Guidelines are not generally legally enforceable.

Codes of practice: A set of written regulations issued by a professional association or an official body that explains how those working in that profession should behave. Codes of practice may or may not be legally enforceable.

Common Law (Negligence)

A variety of actors, including municipalities, provincial governments and conservation authorities could be sued in negligence for harm caused by a flooding event. Under tort law, a party being sued (i.e. a defendant) may be found negligent if the plaintiff demonstrates that:

- the defendant owed the plaintiff a duty of care;
- the defendant breached the relevant standard of care;
- the plaintiff suffered harm; and
- the defendant's act or omission caused or contributed to the harm suffered.

If a defendant is found negligent, they may be required to compensate for the plaintiff's damages.

This section provides a deeper dive into the elements of negligence and makes links to potential liability around stormwater management and flooding.

Duty of Care

In a negligence claim, the court will first ask whether the defendant owed the plaintiff a "duty of care." The answer to this question depends on:

- whether there was a sufficiently close relationship between the parties such that the defendant would owe some sort of responsibility to the plaintiff (e.g. neighbor to neighbor, company to consumer, government to citizens); and
- whether the harm suffered by the plaintiff was a reasonably foreseeable consequence of the defendant's act.

For government defendants, case law shows that courts will generally determine it is reasonably foreseeable that citizens may be harmed by a particular governmental decision related to the provision of services and that there is sufficient proximity between citizens receiving services and the governmental provider of these services.

Changing information, including as related to climate change, could increase the number and size of lawsuits against municipalities, as those who are owed a duty (i.e. residents who have an expectation a municipality will manage stormwater) become more vulnerable, particularly if the potential impacts of climate change that could be avoided are reasonable foreseeable.

Even if a court determines that a government owes a duty of care to its citizens, the court may decide that certain policy decisions are exempt from claims of negligence. Government defendants are subject to a special test under the negligence analysis to determine whether or not the government decision in question is shielded from liability.

> Municipalities are advised to consider key issues and make clear, documented and defensible policy decisions to protect themselves from liability rather than opting for a "head in the sand" approach.

A valid governmental *policy* decision will generally not attract liability in the context of a negligence claim.[27] This "protection" of certain decisions is based on recognition that governments must be free to act in the best interest of public policy without having to be concerned with the potential for negligence claims. The Supreme Court of Canada has described policy decisions as involving a weighing of social, political and economic factors. Courts have found the following types of decisions to be policy decisions: the development of a by-law and a decision to inspect or not inspect infrastructure. Budgetary decisions are also, generally speaking, policy decisions protected from suit. Municipalities therefore do not need to change all possible standards and processes and upgrade all of their infrastructure in light of climate change information; it is acceptable, after considering the risks, to determine that a particular action or investment is not worth the cost (i.e. have a considered policy).

Government decisions that are *operational* in nature, on the other hand, are still exposed to liability in negligence. Operational decisions are decisions made practically implementing policy decisions on the basis of administrative direction, professional judgment and technical considerations. Courts have found the following types of decisions to be operational, and subject to claims in negligence: highway safety inspections; electric utility systems to receive incoming calls related to repairs; and city officials' failure to enforce a bylaw passed to address flooding caused by sewer backup.

[27] One exception to this general rule is that government policy decisions will not be protected if they were made in bad faith.

Standard is Reasonableness, Not Perfection

Municipalities do not need to change all possible standards and processes and upgrade their entire infrastructure in light of climate change information to avoid liability. It is acceptable, after considering the risks, to determine that a particular action or investment is not worth the cost (i.e. have a considered policy). To minimize risk, however, municipalities should at least "turn their minds" to stormwater related standards, processes and infrastructure; if information suggests that there may be increased risk to persons or property from those standards, process, or infrastructure.

Unfortunately, the distinction between policy and operational decisions is not always clear. In light of this, municipalities are advised to consider key issues and make clear, documented and defensible policy decisions to protect themselves from liability rather than opting for a "head in the sand" approach.[20]

Standard of Care

The most significant aspect of the negligence test in many cases is whether the defendant breached the standard of care. Determinations of the appropriate standard of care are fact- and case-specific; however, some guiding principles have emerged to help courts determine the applicable standard of care. For instance, a court may consider the following factors:[28]

- statutory requirements and guidance
- industry codes of practice
- general industry/sector custom and practice
- actions of other, similarly situated, authorities

It is important to note that while all of these factors *inform* the applicable standard of care, none of them are determinative indicators of the applicable standard of care.

Industry standards and standard practices can assist in dispelling a negligence claim by showing that the defendant had followed the general practices of those in similar situations. Therefore, an important tool for showing that the standard of care has been met is demonstrating that a municipality has met the standard of practice followed in other, similarly situated municipalities. Coordination between municipalities could thus assist in mitigating risk by setting a clear industry standard.

That said, industry practices will only be helpful in informing the standard of care when these practices themselves are not inherently risky. In other words, following industry standards may help prevent liability, but the standards themselves will need to be reasonable in the circumstances. If the standards

[28] *Ryan v Victoria (City),* [1999] 1 SCR 201 at para 28; *Vizbaras v Hamilton (City)* 2005 CanLII 49207at para 58 (Ont Sup Ct J).

themselves are “fraught with obvious risks”, a court may not see following them as evidence the standard of care was met.

Applying the principles outlined above to stormwater management and climate change, it is possible that standards applicable to water management that do not take into consideration climate change-adjusted data and other known threats could be found to be “fraught with obvious risks”. An important tool for showing that the standard of care has been met is demonstrating that a municipality has met the standard of practice followed in other, similarly situated municipalities. It may be prudent for managers of municipal water systems to work together to define clear industry standards that utilize available climate change-adjusted information to help mitigate potential liability.[29]

Acts and omissions giving rise to potential negligence are judged against a standard of care applicable at the time the act or omission was made. This means that design and construction decisions are generally subject to the standard of care applicable at the time of the design. It is common misconceptions that negligence is most frequently claimed in relation to these design/built decisions. In actuality, inspections, maintenance, repairs, and other process decisions are more likely to be the types of acts that attract negligence claims. These ongoing practices are likely to be judged against a currently applicable standard of care, which may include considerations of changing information. Relying on outdated standards or processes could therefore be negligent if new information suggests that they should be reconsidered, even if the standards and processes were not negligent before the new information came to light.

[29] Environmental Commissioner of Ontario, *Feeling the Heat: 2015 Greenhouse Gas Progress Report*, 2015. https://eco.on.ca/reports/2015-climate-change-report-feeling-the-heat/