



# 2015 Canadian Municipal Water **PRIORITIES REPORT**

TOWARDS SUSTAINABLE AND RESILIENT  
WATER MANAGEMENT

Canadian Water Network's   
**Canadian Municipal Water Consortium**





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## Consortium Leadership Group Members





## key terms

*For the purposes of this report:*

**Municipal water management** refers to community water systems that are owned and managed by municipalities of any size, whether or not the private sector is utilized for services and products to carry out the mandate. This includes municipally-owned water utilities, as well as communities with a two-tier division of services (e.g. municipal/regional). The term encompasses the full set of activities focused on the management of drinking water, wastewater, stormwater and related activities involving urban watersheds.

**Resilience** is the ability to absorb, adapt to and/or rapidly recover from disruptive events.

**Sustainable communities** are not only adaptable and resilient, they focus on the environmental, social and financial requirements that make for an effective, responsible and safe community, both today and in the future.

# executive summary

In Canada, water touches every facet of our lives — connecting our economy, our ecosystems and the health of our communities. Addressing each of these areas through a “water lens” can lead to integrated approaches that can achieve more resilient communities across Canada.

In 2014, four priorities critical to water management decisions were identified by the Canadian Municipal Water Consortium’s (Consortium) Leadership Group (CLG). The value of these priorities was reaffirmed by the CLG in 2015 to guide national discussions on what municipalities need, want and can address in order to collectively move forward. This report expands upon each of the four priority areas, demonstrating how pursuit of key knowledge within them can lead to solutions.

## PRIORITY NO.1

### Integrated Risk Management

**Municipal water management is fundamentally an exercise in risk management.** The wide range of tasks managed includes many risks, but they are not typically addressed within a coordinated structure that facilitates management of those risks within a unified approach. Thus, opportunities for the most effective means to achieve successful mitigation and management can be missed.

#### **Key Insights:**

- Dealing effectively with the broad challenges posed by aging infrastructure, urbanization, population growth and climate change requires integrated strategic approaches that move beyond individual operational risks and include a consideration of strategic risks.
- To be successful, it is essential that these strategies develop a common understanding and language among those identifying and managing the risks.
- Issues such as flood control and source water protection may involve decisions made outside of local water utilities or management groups. They may also require a risk management approach that can involve other municipal departments and public and private sector groups who operate beyond municipal boundaries.

# PRIORITY NO.2

## Full Cost Recovery and Financing

**To a large degree, municipal water management has been a victim of its own success.** The largely hidden nature of what goes into ensuring successful delivery and management of community water supplies has resulted in difficulties ensuring that full costs of water management are both recognized and financed. Delivering reliable municipal water services requires considerable expertise and expense, yet is often undervalued by the public. Most municipalities face significant challenges from historic underfunding that leads to backlogs of infrastructure repair or replacement, while simultaneously facing greater system demands.

Municipal revenues for water management have historically been secured through a combination of customer fees for delivered water and a draw on the local tax base. Canadian municipalities are moving to more sophisticated fee structures that effectively account for the full suite of costs and more effectively match revenues to costs incurred, while incenting desired behaviour.

### **Key Insights:**

- Developing financially sustainable municipal water systems requires accounting for the full suite of costs to provide services both now and in the future.
- Effective strategies and financial models must cover those costs in ways that are fiscally responsible and provide a good “fit” with the social and cultural realities of the communities being served, which includes assuring affordability for all customers.
- Securing the necessary public and government support for water management investments requires a clear communication of the elements included in assessing the full cost of the systems that support water services.
- Many municipalities are moving toward rate structures that include a combination of charges to more sustainably support the full costs and more explicitly reflect the different services such as wastewater, stormwater and fire service fees.

# PRIORITY NO.3

## Wastewater Resource Recovery and Beneficial Use of Biosolids

### **Municipalities and governments are looking for better resource recovery strategies as increasingly stringent wastewater treatment requirements and social and financial drivers push for improved operations efficiency.**

There is a need to sift through various discussions and debates to weigh the options and select approaches that provide a good fit with operational, financial and socio-economic realities. This demands a credible articulation of the state of evolving knowledge that addresses current questions and concerns about resource recovery and biosolids. It is particularly true in relation to knowledge about the potential environmental and public health implications of contaminants associated with wastewater discharges or land-application of biosolids.

#### **Key Insights:**

- Finding the right fit between technology, community needs and management requires consideration of how options address overall community goals, coupled with trusted knowledge sources to inform considerations of safety and benefits.
- A national research strategy for water and wastewater, developed in response to the request from the Canadian Council of Ministers of the Environment, highlighted a desire for improved understanding and articulation of: a) the state of the knowledge for nutrient recovery from wastewater, and b) the fate and implications of trace substances in wastewater for recovery options.
- Substances present in water and soil at minute concentrations are more easily detected using advanced analytical techniques, leading to questions about their impact on human and environmental health.
- Research has indicated that wastewater treatment processes are capable of significantly decreasing the presence of some trace substances, and to date, studies have not suggested a basis for concern over impacts from appropriately managed agricultural applications of biosolids.
- Areas of interest for continued research include a better understanding of the impacts of trace substances present in wastewater discharge on aquatic ecology, and the potential impacts of cumulative or long-term exposure.

# PRIORITY NO.4

## Resiliency to Storms and Extreme Weather

### **Storms and extreme weather result in costly damages to property and infrastructure and can have impacts on environmental and public health.**

Municipalities are moving toward improved long-term planning models that include a combination of innovative green and grey infrastructure approaches and multi-level strategies to reduce the impacts of severe weather [see page 30 for definitions]. Use of predictive models based on historic conditions can be unreliable, therefore improved tools to predict intensity, duration and frequency of storms are now being generated. In addition, municipalities are looking to incorporate elements of resiliency to extreme or unexpected conditions for their water systems, as well as ensuring they can better mitigate risks associated with extreme weather.

#### **Key Insights:**

- Storm events cause particular concern for public health when they overload systems and untreated water from combined or sanitary sewers is discharged into a watershed that serves as municipal source water or recreation area.
- Proactive municipalities are implementing strategies and master plans that include public outreach to improve preparedness, response and outcomes to extreme weather.
- Variable weather conditions and fluctuations between extremes (e.g., floods and droughts) are driving an increased focus on options for municipalities to manage stormwater as a resource, and to identify the optimal combinations of grey and green infrastructure approaches.
- The range of options is decreased for communities that have established urban cores. More effective storm management in these areas requires innovative approaches.
- Anticipating the range of conditions that municipalities will face in the future requires improving the available prediction and analysis tools such as updated Intensity, Duration, Frequency (IDF) curves to support proactive planning.

Sharing experiences, research and solutions has incredible value, recognizing that application of the options will be specific to each region. The strategic framing of the priorities illustrates that achieving effective integration across challenge areas and groups is central to improving efficiency and resiliency moving forward.

This report takes an expanded look at each of the priority areas, highlighting the nature of the challenges, the research and advancements needed to address them, where progress is being made, and where the Consortium is focusing on establishing further success.



# introduction

**W**ater connects all facets of our lives in Canada, and managing it well can open the door to achieving resilient and sustainable communities. Effective water management — including drinking water, wastewater, stormwater and urban watersheds — is critical for socio-economic prosperity and environmental health. The Canadian Municipal Water Consortium (Consortium) is committed to enabling Canadian communities to maintain reliable water quality, access and availability, through effective management of affordable systems.

In 2014, the Consortium Leadership Group (CLG) produced the inaugural *Canadian Municipal Water Priorities* report, which set the scene by conveying the core challenges municipalities face in managing the many facets of water. It addressed the questions, “Where are we now?” and “What do we need to know to move forward?” in an effort to identify the nature of the challenges, and the best opportunities to address them.

The report provided a framework of key decision areas to consider in designing effective, integrated approaches for safe, reliable and sustainable water systems. The Consortium is using this framework to structure its discussions and identify where national collaboration on research and knowledge can best support strategic planning and investment.

This report builds on the inaugural 2014 *Canadian Municipal Water Priorities* report by elaborating on the nature of the challenges within these decision areas and the research and advancements that can address them, all within four national priority areas. These priorities were reaffirmed in 2015 by the CLG as key focus areas to advance national discussion, collaboration and action in municipal water management and guide the Consortium’s future activities.

# FRAMEWORK OF KEY DECISION AREAS

## **Determine drivers and constraints that impact success**

Identify the full range of key drivers and associated risks that impact progress in municipal water management.

## **Address the real costs of the systems we need**

Consider the true costs of operating and maintaining all the elements needed to achieve sustainable water systems and how to pay for them effectively and equitably.

## **Maximize resources through efficiencies, recovery and innovation**

Recognize where options for both resource efficiencies and recovery and innovations can provide a truly viable approach.

## **Prepare for future challenges by developing resiliency and adaptation strategies**

Increase resiliency and develop strategies for adapting to changing climate, demographics and socio-economic factors.

## National Priorities:

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01

**Examine existing frameworks and strategies to ensure integrated risk management includes the full breadth of drivers affecting municipal water.**

02

**Assess the state of knowledge and practice for full cost recovery and financing for water systems.**

03

**Identify the possibilities and implications of wastewater resource recovery and beneficial use of biosolids.**

04

**Determine what is practical and achievable for making municipal water systems more resilient to storms and extreme weather.**

In 2015, the Consortium continued to advance work within these four priority areas to better understand needs and opportunities on a path to solutions. Recently completed and current Consortium activities are listed in Appendix A [see page 39]. The content of this report builds on the findings of that work and sets the stage for moving forward within priority areas.

# SECTION 1 INTEGRATED RISK MANAGEMENT

**M**unicipal water management is at its core an exercise in risk management, and it presents a unique set of challenges. As the range of risks to be addressed is very broad, the organizational structures of public utilities generally do not lend themselves well to centralized risk management. Many of the factors impacting risks and management options are outside of the direct control of municipal water managers.

Municipal water management includes the maintenance and delivery of safe, reliable drinking water, appropriate wastewater treatment, protection of the aquatic environment and impact mitigation for storms and extreme weather events. However, municipal departments are not typically structured to consolidate oversight of all risks involved in these tasks through a single approach. Often, risk management for water utilities is siloed, involving multiple levels of management in both operational and strategic areas. Establishing more effective ways of managing the full suite of risks across systems is needed to deal with the current challenges posed by aging infrastructure, urbanization, population growth and climate change.

**R**egulatory requirements for municipal water systems draw on assessments that establish levels of tolerable risk, particularly in the areas of public and environmental health. Management of these risks within the prevailing regulatory framework (outside of federal lands and First Nations communities) is predominantly the responsibility of municipalities and their utilities, with oversight by relevant public sector authorities (typically provincial/territorial departments).

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## BEYOND OPERATIONAL RISK MANAGEMENT

Municipal risk management activities are typically focused on dealing with the most obvious and immediate operational risks (e.g., ensuring compliance with water quality regulations, infrastructure or procedural failure and ensuring protection against financial liability). However, regulators and managers also recognize a need for a long-term, integrated approach to water and more broadly defined risk management. Without this approach, comparing and prioritizing risks is difficult. It reduces the ability to identify important opportunities to more effectively manage risks by reaching outside of the normal scope of divisional operations. A broader, longer-term strategic framing of the risks that are facing municipal utilities includes the relevance of strategic risks (e.g., organizational or corporate factors) such as commercial, financial and reputational risks, infrastructure investments and maintaining adequate risk management with outsourcing, including public-private-partnerships.<sup>1</sup>

# The City of Calgary: Creating Value from Risk

The City of Calgary's Utilities and Environmental Protection (UEP) department is working to adopt industry best practices in risk management. In the past, risk was handled on an ad hoc basis by a series of strategies related to key issues identified in the City's business plan and budget. While there were many disparate strategies and frameworks to deal with issues as they arose, they weren't considered under a true enterprise risk management framework.

UEP recently participated in a series of Water Research Foundation collaborations related to risk, using Water Research Foundation's publication ***Risk Governance: An Implementation Guide for Water Utilities***<sup>1</sup> to partially guide their approach. In preparing their latest business plan, operational risk was separated from strategic risk. Operational risks will remain within the realm of frontline workers and any remaining risk will be dealt with at a strategic level.

A Risk Management Team has been reviewing current risk assessment tools used within the department and developing a risk taxonomy to standardize the language of risk.



PHOTO: PAUL FESKO

Previous risk management activity relied heavily upon mitigation and focused on actions to reduce likelihood and impact. To expand the discussion beyond mitigation, several questions are now being considered:

- Are we explicitly accepting the risk?
- Do we want to eliminate the source of the risk?
- Is there a way to exploit risk to our advantage?
- Does it make sense to transfer the risk – perhaps through insurance or business practices?

The ultimate goal of UEP's risk management strategy is to create value from risk. Next steps include: improving risk reporting, utilizing scenarios to enhance the

discussion of risk, exploring risk interconnections — and deepening the understanding of risk capacity and appetite (i.e., how much risk-taking is comfortable) within the department. In designing its integrated risk management strategy, UEP has made an explicit effort to learn from the best practices of others, including industries outside the water sector.

*Municipalities across Canada all have unique risks and governance structures, so the strategies applied in Calgary may not be directly transferable. However, learning from best practices from other industries and adapting them to suit the local context can be applied universally.*

For example, the City of Calgary's risk management team has developed an integrated framework for all municipal water services. The framework manages risks through a common lens and creates value by developing strategies that move beyond mitigating risk to include termination, exploitation and transfer or acceptance of risks [\[see page 12 - Creating Value from Risk\]](#).

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## **EFFECTIVE RISK MANAGEMENT STARTS WITH SHARED UNDERSTANDING**

Risk assessment techniques are built on a basic approach that outlines the suite of relevant hazards, their likelihood of occurrence and the anticipated consequences. Effective risk assessments predict the most likely or possible outcomes in the face of uncertainty and provide a basis for considering the most appropriate management options to achieve tolerable levels of risk. The key challenge is in properly assessing the many relevant risks and their implications in order to inform best choices for whether they are mitigated, transferred or accepted.

The first critical step in addressing risk assessment and management challenges is to develop a common language and understanding of core concepts about risk management among operators, managers, regulators and the public.<sup>2</sup> This will facilitate more productive stakeholder consultations to prioritize and establish a level of tolerable risk. Discussing when and where risks should be accepted, transferred or mitigated, including issues around understanding risks and allocating liability, will result in a clearer understanding of the full framing of risk management.

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## **MANAGING RISKS BEYOND MUNICIPAL BOUNDARIES**

Effective management of risks that are relevant to community water systems involves regulatory and management decisions that are beyond the scope and control of local water utilities. As a result, there is a need to ensure that integrated approaches can reach beyond the actions of municipal water system management and integrate them with broader activities, particularly with respect to watershed management and community growth. This will require effective coordination among public and private sector players involved in these related areas, particularly with regard to the issue of effective source water protection.

Impacts to both surface water and groundwater sources, and the significant risks posed by extremes in water quantity (e.g., droughts and floods) are a result of events and activities occurring within the watershed as a whole. These activities are often outside the control of a municipality, yet reducing the risk and impact of floods, drought or contamination through actions within the broader watershed may provide the most cost-effective options. For example, Canadian Water Network is working with Canadian and international experts to better understand the implications of forest management activities in catchment areas and their effects on downstream municipal water supplies [\[see page 14 - Wildfire Impacts on Water Supplies\]](#).

*CWN-SUPPORTED RESEARCH  
SOUTHERN ROCKIES WATERSHED PROJECT*

## **WILDFIRE IMPACTS ON WATER SUPPLIES**

Forested regions comprise the headwaters of the water supplies for hundreds of communities in the prairie provinces. Wildfires in these areas can lead to potential long-term impacts on drinking water supplies that affect water quality and stream health. Many water treatment plants are not designed to treat the range and magnitude of water quality challenges associated with wildfire. Recent increases in the magnitude of wildfire have generated interest in evaluating risk to downstream municipal drinking water supply and treatment systems.

Canadian Water Network supported an award-winning study by building on a decade of work in the Southern Rockies Watershed. The interdisciplinary research team, led by Dr. Uldis Silins, evaluated the magnitude and likelihood of wildfire occurrence in source water regions in Alberta and assessed the impact of these wildfires to downstream water utilities.<sup>3</sup>

The study analyzed historic wildfire data, identified the most vulnerable municipal waterworks and assessed the effects of wildfire on water quantity and quality (i.e., sediments/turbidity, organics, nutrients). A simulation modeling framework was used to evaluate the effectiveness of existing fire suppression strategies for safeguarding source water and treatment operations. The project provides evidence to show that historical suppression of wildfires in certain forested regions increases the risk of extensive and severe wildfires and provides a framework to analyze the efficacy, costs and economic benefits of current and potential wildfire mitigation strategies.<sup>4</sup>

Learn more about this work on Canadian Water Network's website:  
[cwn-rce.ca/project-library](http://cwn-rce.ca/project-library)

Flooding is a major risk for many communities. Although some mitigation can be realized through infrastructure and flood plain management, many other factors are outside of a community's control. Unlike other G8 countries, insurance protection against overland flooding (classified as a natural disaster) has not been offered to municipalities or homeowners in Canada. The financial ramifications of flooding fall on homeowners and government, while municipalities are challenged with implementing sufficient strategies to mitigate flood risk. In 2013, the viability of flood insurance coverage was explored by The Co-operators insurance company and resulted in two recommendations:

- Initiate a broad-based discussion on the actions necessary to improve flood and disaster risk management with key stakeholders, including government, insurers, brokers, bank investors, developers and homeowners.
- Conduct research on flood risk exposure levels across regions of Canada, prioritizing areas with high population densities. More work will need to be done to clarify uncertainties surrounding where risk should be transferred and who should accept risk.<sup>5</sup>

In February 2015, insurance provider Aviva announced the intent to offer a Canadian flood insurance product<sup>6</sup> and in May 2015, The Co-operators began offering overland flood damage protection to homeowners in Alberta.<sup>7</sup>

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## *Moving Forward*

For over a decade, Canadian Water Network has focused on supporting efforts to move from a reactive, compliance-based approach to more proactive management of risks related to water, particularly in the area of drinking water. The Consortium is now building on that work to broaden proactive risk management to all areas of municipal water management and support a more integrated approach.

Municipalities across Canada are currently undertaking work to better integrate and manage risks to water systems. To support this work, the Consortium is leading the development of a phased research program that will provide a comprehensive examination of applicable risk factors, followed by an analysis of strategies and approaches for integrating risk management for drinking water, wastewater and stormwater. The outcomes of this work will be applicable to municipalities, utilities, regulators, technology and service providers, as well as the finance and insurance sectors.

## SECTION 2 FULL COST RECOVERY AND FINANCING

The majority of Canadians have access to an abundant supply of safe and reliable drinking water, effective removal and treatment of wastes, and protection from floods or extreme weather. While considerable expertise and expense is needed to provide these services, they have gone somewhat unnoticed or underappreciated by the public. As municipalities grapple with a historical underinvestment in water infrastructure [[see page 17 - Water Infrastructure in Canada](#)] and increasing system costs, they face challenges with financial and social dimensions, including:

- Declines in fee-based revenues from decreasing water consumption due to successful conservation efforts (e.g. lawn watering restrictions, installation of low-flow toilets and showers).
- A growing backlog of maintenance and aging infrastructure issues.
- Increased demands on existing infrastructure and systems due to population growth and more frequent extreme weather events.
- Changing regulations that require costly upgrades to treatment plants.
- A legacy of inadequate water pricing that has led to over-extended, under-funded systems.



## WATER INFRASTRUCTURE IN CANADA

- > The cost of infrastructure needing repair or replacement for drinking water, wastewater and stormwater systems is estimated at over \$80 billion.<sup>8</sup>
- > 40% of wastewater plants and 30% of wastewater pipes are in fair to very poor condition, while 20% of drinking water plants and 15% of water mains are in fair to very poor condition.<sup>8</sup>
- > Almost half of Canadian municipalities that participated in the FCM report card survey have no data on the condition of their buried infrastructure.<sup>8</sup>
- > User fees only account for about 22% of all municipal government revenue.<sup>8</sup>
- > Only 1 in 10 Canadians think water systems in their community require major investment.<sup>9</sup>
- > 46% of Canadians have no knowledge about the condition of water treatment systems.<sup>9</sup>
- > 50% of Canadians have no knowledge about the condition of stormwater systems.<sup>9</sup>

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## **FULL COST ACCOUNTING AND RECOVERY: THE CHALLENGES OF FINANCIAL SUSTAINABILITY**

Developing financially sustainable municipal water systems requires the consideration of two main focus areas:

1. Accounting for full costs — Defining and assessing the full suite of costs to be borne by utilities and their operations.
2. Options for recovery — Determining effective financial models that can sustainably support water utilities, while also garnering public support.

No clear or single definition exists in Canada for what full cost recovery entails — largely because the full cost of delivering municipal water services varies significantly by region and municipality. In Canada, the vast majority of water systems are publicly owned.<sup>10</sup> Models for cost recovery and financing must provide a good “fit” both in terms of fiscal responsibility and the social and cultural realities of communities being served. The costs charged to users through rates and fees, even if financed through taxes or public-private partnerships, must be balanced with perceptions of the value of services provided and an understanding of what the public and industry are willing and able to pay.

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## **COMMUNICATING THE ELEMENTS OF FULL COST ACCOUNTING AND RECOVERY**

As municipalities develop rate structures to connect sustainable financing to utility requirements, clearly communicating what is included in the full costs will help customers better understand and support activities. Society’s willingness to pay is dependent on transparency of goals and approach, as well as the development of effective and tailored communication with decision makers and the public.

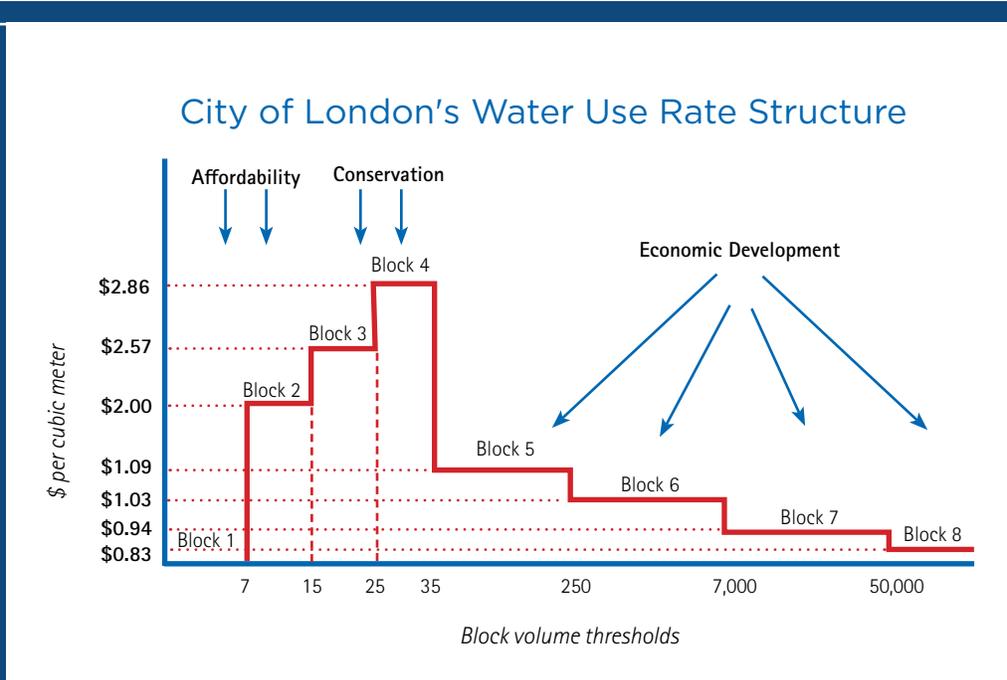
Accounting for the full cost of providing municipal water services typically includes consideration of current and future operational and maintenance costs and capital investment requirements. Full cost recovery can include generating sufficient revenue through customer rates, municipal taxes, industrial partnerships and/or government grants to fully finance all activities and investments. However, it is recognized that other elements may, and in many cases do, contribute to the costs of providing municipal water services that have not traditionally been included. For instance, source water protection activities or considerations of intergenerational equity and affordable access for low-income households are not consistently included in the discussion on full cost accounting.

# The City of London: The Value of Water

Historically, London Waterworks collected income from their customers based on volumetric use. Due to declining and unpredictable water consumption, the utility operated at a \$600,000 annual deficit for many years. In 2013, the municipality switched to a new rate structure that includes a combination of both fixed and volumetric use charges.

This structure includes a fixed delivery charge and a variable volumetric rate charge, described as a “humpback” structure (Figure 1). All customers pay a minimum fee to access water services each month that covers 25% of operating costs. The humpback rate is tiered for water and wastewater, and increases with volume until a defined threshold, after which the rate decreases for large volume users (e.g., the manufacturing industry).

With this structure, annual rate increases are anticipated to be maintained at or near the annual rate of inflation, while building adequate reserve funds and investing in a 20-year life cycle



**Figure 1. 2015 water use rate structure for the City of London’s water and wastewater services.**

plan. Although the utility has always operated on a full-cost recovery basis, capital expenditure deferrals in recent years resulted in an infrastructure gap. Once financial sustainability is secured in 2016, there will be adequate revenue to support long-term expenditure needs to reduce and effectively manage this gap. Prior to implementing the rate changes, London Waterworks created a **Value of Water** public education program to promote the intrinsic value of clean water, as well as the value of ensuring its safety, supply and delivery.

Program design included extensive public consultation, rebranding and a media strategy centered on the value (rather than the cost) of water services. A central tenet of the program was the notion that all customers would contribute fairly and equitably to water services,

and that the children of London would not be left with a legacy of poor water infrastructure.

The communications campaign included a website and direct mail to 110,000 customers, as well as newspaper notifications in multiple languages. Social media, radio, TV, billboards and bus advertising were used to broadcast marketing messages. Staff also followed up one-on-one with customers who had questions or concerns.

In 2014, the City of London received the 2014 Public Education and Awareness Water Efficiency Award from the Ontario Water Works Association in recognition of its success in engaging the public and changing public perception.

For more information visit:  
[www.london.ca/residents/water/water-bill/Pages/default.aspx](http://www.london.ca/residents/water/water-bill/Pages/default.aspx)

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## FINANCING OPTIONS

Municipal water systems have typically been financed through a combination of customer revenue (fees on water and sewer bills), general tax revenue (municipal property taxes and federal/provincial infrastructure support) and development charges. Although water rates have been gradually increasing in many cities, revenues from these rate increases alone may not be keeping pace with needs, particularly for capital-intensive upgrades. Municipalities are therefore looking for innovations in funding strategies, as well as investments from upper tiers of government to achieve sustainable systems.

Several Canadian cities are working to develop water systems that are sustainably self-financing over the long-term by generating enough revenues through their operations to cover costs without drawing on the general tax base [see page 19 - [The Value of Water](#)]. This type of financing model allows utilities to provide direct line-of-sight between fees paid and services received by residential and commercial customers. Although self-financing can result in pushback on fee increases over historical levels charged, the costs of service and supply become more explicit.

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### COMBINING VOLUMETRIC AND FIXED RATE FEE STRUCTURES

Most municipalities generate revenue through volumetric rates, which assess customer fees based on amount of water consumed. These systems appropriately adjust charges based on consumer use — as conservation increases, volumetric fee-based revenue declines. But many of the costs associated with operating water systems are either fixed or not significantly reduced as a result of changes in water consumption.

In order to better align fees with costs incurred, as well as address the limitations of volumetric fees, many municipalities are moving toward rate structures that include a combination of rates for different services, including wastewater and stormwater. Many rate structures also have fixed elements to provide a dependable baseline of revenues and to account for components of water services that are not dependent on volumetric usage (i.e., maintaining infrastructure, level of treatment, providing fire protection and others). Unlike other utilities (e.g. energy utilities), provinces and territories typically do not provide oversight in setting municipal water rates, which is a function of municipal councils. As such, there are highly variable rate structures across the country. However, in some cases provinces do provide regulation to protect the public's interest. For example, the Nova Scotia Utility and Review Board (NSUARB), a quasi-judicial agency, regulates drinking water rates to ensure full cost recovery for all water utilities in Nova Scotia. The NSUARB also mandates Halifax Water to achieve full cost recovery for all its services (drinking water, wastewater and stormwater) in accordance with the Public Utilities Act. Similar regulatory agencies also exist in Manitoba and Prince Edward Island. Alberta and British Columbia provide regulatory oversight for water supplied by utilities not owned by the municipality being serviced. Figure 2 [see page 23] demonstrates a range of monthly-billed rate structures for domestic water services currently in place across Canada.

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## FINANCING THROUGH TAXES

Not all municipalities rely on fee-based charges to generate their full budget requirements. In these cases, customers support the system costs through contributions to the centralized tax base. Addressing system costs becomes more directly related to municipal budgeting, with budget allocations being drawn from municipal tax revenues, government programs and industrial partnerships [see page 22 – Opportunities for a Greener City].

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## COMPARING RATES BETWEEN MUNICIPALITIES

Comparing rates between municipalities provides a good overview of the magnitude and range of fees charged to customers. However, these types of comparisons don't often highlight more complex and variable structures being used to support full cost recovery.<sup>10</sup> When comparing costs between municipalities, there are disparities and local realities for each system. Each municipality has chosen a different way of covering costs and has a unique combination of level of service, treatment processes, maintenance and upgrade requirements, fire protection, average consumption, population size, energy for distribution and collection, type and quality of source water and receiving water. For example, the City of Kelowna faces significant wildfire challenges and has implemented a fire protection charge that is higher than other cities.

The need to match available resources with total expenses — including accounting for the future — is a concern for all municipalities. All of this points to a need to more effectively demonstrate the full costs of operating the systems we need and how customers and the public are paying for them.

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## ADDRESSING AFFORDABILITY ISSUES

As communities move to better align recovery of the true costs of their systems with customer fees, there is a concern that adjustments may make provision of basic services out of reach for those unable to pay. Affordability of essential services is an important element for consideration and is being dealt with in different ways by different communities. Strategies to provide security for low-income customers include lifeline rates, partnerships with social agencies and customer assistance funds. Some municipalities are also implementing other pricing reforms, including seasonal surcharges, peak-load pricing or tiered rates based on zones. These types of rates are designed to offset rates for customers with lower incomes during the summer months (e.g., people not filling pools or watering lawns).

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## *Moving Forward*

In 2015, the Consortium will support municipalities in moving toward more robust and effective full-cost recovery and financing models for water management by expanding its initial assessment to include a broader inventory of options and approaches. The inventory will include determination of which costs are included and which are excluded in various full-cost models and help provide a more complete understanding of the different models being applied in Canada and their relative merits. The Consortium will also build on earlier work regarding valuation and willingness to pay, including examination of how mechanisms of public engagement can impact levels of support for awareness regarding the value of local systems and investment requirements.

## *MONTREAL'S AGING INFRASTRUCTURE*

# OPPORTUNITIES FOR A GREENER CITY

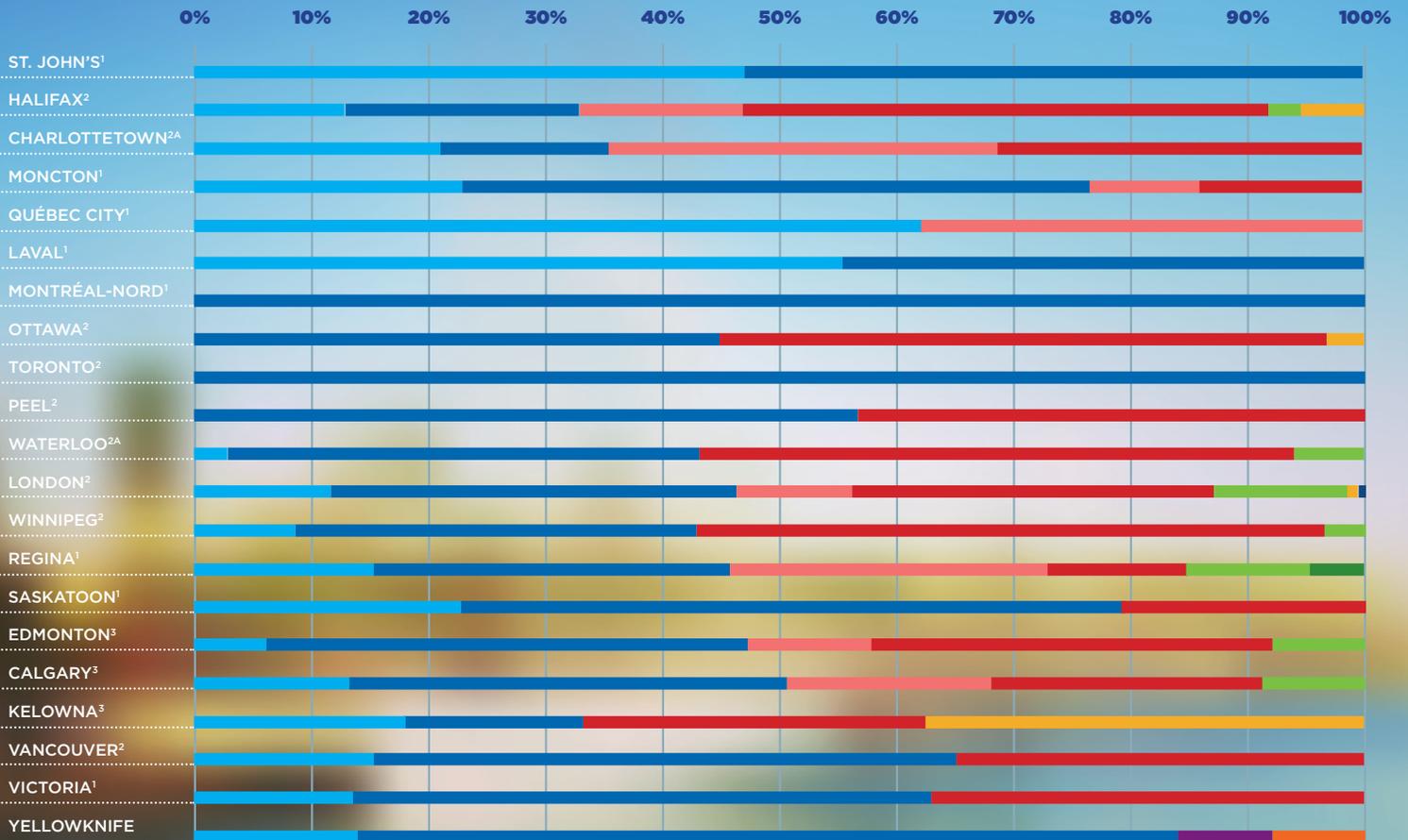
Montreal is one of Canada's most historic cities, where the average age of water mains is 60 years (and some are almost 100 years). Currently, the City owns \$40 billion in water infrastructure assets, including six drinking water treatment plants, 14 storage tanks, 750 km of transmission mains and 3606 km of distribution mains. Wastewater assets include a wastewater treatment plant, 50 retention basins, 689 km of interceptor and collector pipes and 4234 km of sewer pipes.

The City is in the process of major water infrastructure improvements, with upgrades to their large water treatment plants (\$300 million to date) that will include new treatment systems, including ozonation, UV disinfection and hypochlorite disinfection. An additional \$175 million of equipment will be replaced over the next three years, including electrical, pumping equipment and automated systems. The City has committed to maintaining service levels during the upgrades with no stoppages through an integrated risk analysis involving project engineers, operators and maintenance staff.

Montreal has developed an integrated intervention plan that covers water and sewer services, road maintenance and planning. The process involved many years of planning with stakeholders to develop innovative and feasible solutions, and will reduce the City's environmental footprint through leading-edge infrastructure. Once its wastewater upgrades are complete, the City will have the world's largest ozone wastewater disinfection plant and will reduce peak wastewater overflow in response to major precipitation events through underground storage structures and a drainage master plan.

The advances Montreal is making have been financed in part through federal and provincial funding and municipal property taxes requiring buy-in from government departments and the public to prioritize water-related projects over other needs. Water-related investments have increased 15 times from 2005 to 2015, and are projected to double again by 2019.

# RATE STRUCTURES OF RESIDENTIAL WATER SERVICES IN CITIES ACROSS CANADA



Assumption for a metered system with a 5/8" size pipe.  
 Volumetric component based on the national average – 25 m<sup>3</sup>

<sup>A</sup> groundwater as majority of drinking water source, all other surface water

<sup>1</sup> primary as majority of wastewater treatment

<sup>2</sup> secondary as majority of wastewater treatment

<sup>3</sup> tertiary as majority of wastewater treatment

- Drinking Water Flat Charge
- Drinking Water Volumetric Rate
- Wastewater Flat Charge
- Wastewater Volumetric Rate
- Stormwater
- Fire Protection Charge
- Recycling Charge
- Insurance Program Fee
- Infrastructure Levy
- Customer Assistance Fund

Figure 2. Rate structures of residential water services in cities across Canada.

# SECTION 3 WASTEWATER RESOURCE RECOVERY AND BENEFICIAL USE OF BIOSOLIDS

Wastewater is increasingly viewed as a resource with the potential to generate heat and energy, or act as an alternative source of water or valued chemicals, including nutrients such as nitrogen, phosphorus and carbon. The most recent work of the Consortium in this area has focused on the interest in solutions that can take advantage of nutrient recovery opportunities and address the appropriate handling or beneficial use of biosolids — the major residual product of wastewater treatment. Except for labour, energy costs far exceed other operational expenditures of most wastewater utilities. Therefore, this work is also being extended to consider how reduction of energy use and overall costs can be achieved through nutrient recovery and reuse.

In addressing the various options for resource recovery from wastewater, municipalities across Canada are challenged to move beyond buy-in for the overall concept to selection and communication of options that provide a clear fit with local conditions and realities. In the midst of much discussion and widely varying claims, they see a need for a clearer understanding of the range of potential risks and benefits associated with the available strategies, in order to effectively assess the possibilities. This is particularly true with respect to the potential for beneficial use of biosolids, where there is a need for an improved and credible articulation of the state of the knowledge and experience in this area. Increasingly stringent wastewater discharge regulations have heightened considerations of resource recovery options, including a need to address questions and concerns regarding various resource recovery approaches.

**B**ENEFICIAL USE OF BIOSOLIDS encompasses the full breadth of value-added biosolids management. The most common strategies include heat and electricity generation from incineration, agricultural land application and land reclamation.

**E**MERGING SUBSTANCES OF CONCERN (ESOCs) are substances present in water at relatively low concentration with a potential impact to public and environmental health that is not well understood. Other terms for substances in this category are emerging contaminants (ECs), micropollutants and trace organic compounds.

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## FINDING THE RIGHT FIT FOR MUNICIPAL UTILITIES AND COMMUNITIES

Nutrient recovery or biosolids management must provide an appropriate fit, not only for utilities, but for the communities they serve. Various technologies and approaches are available that make the potential for resource recovery from wastewater a reality. Capitalizing on the best opportunities will depend on understanding which solutions make the most sense, not only in terms of potential resource recovery, but in terms of risks, costs, operations and public support. Decisions on resource recovery may involve broader public and market interests (e.g., recovery of nutrients or fertilizers or chemicals for reuse), or support sustainable community resource management plans, but do not always have a clear benefit or business case when viewed only in the context of utility operational efficiencies or costs.

Some municipalities are addressing the need to more effectively consider the broader value of resource recovery options by moving toward integrating management across all waste streams; incorporating household and industrial waste management, organic household waste and recycling with consideration of nutrient recovery and biosolids from wastewater. Although operationally separate, the fact that full waste management services are typically managed by the same municipalities presents opportunities for integrating approaches. Conversely, an inability to deploy options that have been identified as safe, appropriate and economically-feasible can result when there is lack of sufficient public support due to concerns about potential health or environmental problems (e.g., current debates over beneficial use of biosolids). A trusted source on the state of the knowledge, with respect to the costs and benefits of various options in these areas, is important to ensure that solutions can move forward to achieve a good fit with overall community needs and support.

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## STATE OF KNOWLEDGE ON WASTEWATER

In response to a request articulated by the Canadian Council of Ministers of the Environment in 2010, Canadian Water Network led the development of the *National Agenda for Municipal Wastewater and Biosolids Research*.<sup>11</sup> Two main focus areas emerged from that national consultation, including:

- 1) the need to better understand and articulate the state of the knowledge regarding the potential to achieve beneficial nutrient recovery from wastewater, and
- 2) the need for a better understanding of the overall fate of trace substances in wastewater and biosolids, and the implications for the viability of resource recovery management and technology options.

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## NUTRIENT RECOVERY FROM WASTEWATER

In 2014 and 2015, the state of knowledge regarding options available for nutrient removal and recovery in wastewater treatment processes was assessed. A national consultation workshop was held as part of this assessment to bring forward national issues regarding effective nutrient removal, recovery and reuse, and to elevate stakeholder discussion on practice and policy options, risks and opportunities for improved nutrient removal, and recovery and reuse in the Canadian context. The synthesis report and national consultation workshop reviewed and analyzed current knowledge and research available on processes and conditions required for effective nutrient removal and recovery from municipal wastewater treatment effluents and process streams. This work provided an interpretation of the technical, economic and social feasibility for implementing these practices in Canada.<sup>12</sup>

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## TRACE SUBSTANCES IN WASTEWATER AND BIOSOLIDS

The development of novel analytical techniques has enabled more effective detection of a much larger number of chemicals (including pharmaceuticals, industrial compounds and household products), as well as viruses and bacteria at extremely low levels in water, waste streams and the general environment. Detection of trace substances in wastewater effluent and biosolids raises questions about their potential environmental and public health relevance for resource recovery or reuse. The importance of considering the relevance of an expanding list of chemicals that are present at very low levels, and the uncertainties surrounding their interactions and impacts, has fueled the drive for better understanding in this area. Several recent Consortium projects have been addressing this need for better information with regard to trace chemicals [see page 27 - [Removing Trace Substances during Wastewater Treatment](#)].

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## EMERGING SUBSTANCES OF CONCERN IN BIOSOLIDS

The current state of knowledge with respect to the application of biosolids to agricultural land indicates a low risk to human and environmental health in terms of viruses and bacteria, as well as emerging substances of concern (ESOCs).<sup>13</sup>

Viruses and bacteria typically do not reach groundwater when applied to soil, and concentrations in water collected from tile drainage or surface runoff are much lower than those found in treated wastewater effluents. However, researchers note that most of the recent work in this area has focused on assessing individual chemicals on model organisms, rather than interactions among ESOCs, viruses and bacteria. The next steps for research will include assessing environmental effects monitoring and/or cumulative effects monitoring to assess the combined effects of various ESOCs and nutrients from biosolids on ecosystems.<sup>13</sup>

A full assessment of the best options for biosolids as a resource will likely require government or industry-led mechanisms to support ongoing consideration of how and where elements of a diversified portfolio of municipal biosolids management could best benefit other sectors, including agricultural land application. To be of most value, research and knowledge advancements need to be provided in a way that directly supports cross-sector considerations, including the development of regulations, protocols and targets for land application of biosolids in the full range of soil and climate conditions. Ultimately, biosolids management strategies will require public support to be sustainable [see page 28 - [Biosolids Management: Washington, DC](#)].

*CONSORTIUM-SUPPORTED RESEARCH*

## REMOVING TRACE SUBSTANCES DURING WASTEWATER TREATMENT

Emerging substances of concern (ESOCs) are substances that occur at low concentrations in wastewaters, for which potential effects on humans or the environment are an issue. Some ESOCs (e.g., endocrine disruptors) are receiving increasing attention to better determine the significance of potential impacts to aquatic organisms or humans following exposure. Recent research led by Dr. Wayne Parker, at four sites across Canada, examined the removal of ESOCs in common wastewater treatment processes over a range of climatic and seasonal conditions.<sup>14</sup>

Results indicated that wastewater treatment plants with improved nitrogen removal may facilitate enhanced removal of ESOCs compared to more conventional treatment. For example, upgrading treatment to include biological nutrient removal may provide improved ESOC removal, thus reducing the environmental impact of wastewater effluent.

Small communities that employ lagoon-based technologies can benefit from photolytic destruction of some ESOCs. The extent of improvement appears to depend upon the operating conditions, as the performance of the treatment trains changed when the operation was switched from winter to summer operating conditions. Therefore, regional climatic conditions should be taken into account when considering the appropriate technology for improved removal of ESOCs.

Learn more about this work on Canadian Water Network's website:  
[www.cwn-rce.ca/project-library](http://www.cwn-rce.ca/project-library)

# Biosolids Management: Washington, DC

The District of Columbia Water and Sewer Authority (DC Water) operates Blue Plains Advanced Wastewater Treatment Plant (Blue Plains), the largest advanced wastewater treatment facility in the world. The plant provides wastewater collection and treatment services for more than two million customers in the Washington metro area and treats up to 370 million gallons of sewage each day.

In the past, Blue Plains produced 1,200 tons of Class B biosolids (treated sludge that may still contain pathogens) each day. Settled solids are dewatered and treated with lime, then distributed to farmers for land application. Challenges include inconsistent biosolids, odour issues, aging facilities, limited storage capacity, high operating and maintenance costs, rising transportation costs and increasingly restrictive environmental regulations.

In 2015, Blue Plains transitioned to a biosolids management system that employs thermal hydrolysis and anaerobic digestion. There are a number of environmental and economic benefits, including:

- Stable Class A biosolids with less odour (50% reduction in volume)
- Daily cost savings (100 tons/day of lime eliminated)
- Energy savings from methane



gas collection

- Reduced traffic; lower carbon footprint
- Increased public acceptance
- Increased market interest in the end product

While planning for a new solution, DC Water evaluated various options and solicited input from regulators and the general public. Software was used to rank options based on acceptability, cost and odour. Anaerobic digestion was initially identified as the preferred option, but was determined to be prohibitively expensive. Research continued over a number of years, and eventually thermal hydrolysis was identified as a low-odour, cost-effective process. This technology had been considered earlier, but was still in the early stages of development. Performance, maintainability and reliability have since been proven in European facilities.

DC Water invests considerable effort in maintaining social license for biosolids land application. They maintain a general subscriber

list and issue a monthly report about incidents (i.e. odour, truck accidents, spills) and compliance. Staff attend public hearings with farmers to answer questions about quality and safety concerns, and neighbours adjacent to land applications are provided with an information package. Managers also take steps to educate local politicians and work closely with regulators. The utility also successfully advocated for external inspection of land applications to help build public trust.

*Although the regulatory structure is different, Canadian municipalities looking to implement a biosolids management program can learn two important things from DC Water's experience:*

- 1) Information is changing rapidly in this field.
- 2) Understanding and obtaining social license is critical to success.

For more information visit: [dcwater.com/education/biosolids.cfm](http://dcwater.com/education/biosolids.cfm)

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## Moving Forward

One of the key questions currently impacting choices about resource recovery options is assessing the potential environmental and public health implications of contaminants resulting from wastewater discharges or land application of biosolids. Ongoing Consortium research is supporting the need for better information and tools to assess impacts to the environment from trace contaminants occurring downstream of wastewater treatment plants.

Further work is also being done to assess the capacity for wastewater treatment to mitigate impacts, as well as techniques to directly investigate any measurable impacts to the environment from trace substances in biosolids and wastewater effluent and nutrient recovery [see page 39 – Appendix A]. In 2015, the Consortium will consider the implications of this leading research to inform its next steps, including a better understanding of the financial viability of resource recovery and reuse, utility and scalability of new technologies, and public acceptance of management approaches to better frame knowledge dissemination and develop new studies.



# SECTION 4 RESILIENCY TO STORMS AND EXTREME WEATHER

Climate change considerations bring into sharper focus a well-known reality for water managers: average precipitation and temperature really don't tell the story. It is the degree and frequency of more extreme conditions that can drive system requirements, risks and costs. Canadian municipalities are contending with the increased occurrences of extreme weather that cause major and costly damage to property and infrastructure, and threaten public and environmental health. In addition to flooding and drought, communities are dealing with ice storms and record-breaking cold snaps that result in frozen and damaged infrastructure, as seen in the winter of 2014-15 across central and eastern Canada. Most communities are recognizing that it is not *if* but *when* and *how often* events like major storms, droughts or extreme temperatures will impact them.

The increasing pressure to deal with the impacts of extreme weather experienced by municipalities is causing them to shift from traditional approaches and move beyond incorporating typical safety margins for system design based on historic expectations. Going forward, there is a need for more thoughtful planning to improve the resiliency of systems that anticipate conditions that deviate from past norms. The CLG identified two main areas for work within this priority area in 2015, both focused on flooding and the impacts of extreme storms: environmental and public health impacts, and property and infrastructure damage.

**G**REEN INFRASTRUCTURE describes management approaches that focus on use of naturalized (biological and/or geological) elements like constructed wetlands, bioswales and rain gardens to manage water flow or achieve treatment goals.

**G**REY INFRASTRUCTURE refers to more traditionally constructed water management structures, including dams, pipes, sewers and holding tanks to remove, control or store water.

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## IMPLICATIONS OF COMBINED SEWER OVERFLOW FOR PUBLIC AND ENVIRONMENTAL HEALTH

For many cities, a major concern during storms is sewer overflow when system capacity is exceeded, resulting in significant environmental and public health risks. This is particularly problematic for older communities with combined storm and sanitary systems. Overflow from sanitary or combined sewer systems during storms introduces untreated municipal waste and urban runoff to local watersheds, as well as potential contact with local residents.<sup>15</sup> The impacts become more substantial when untreated water from combined sewers is discharged into a watershed that serves as municipal source water or a recreation area.

Failure of systems to adequately protect public health in the wake of extreme storms has been a significant factor in a number of major drinking water outbreaks around the world, particularly in smaller systems.<sup>16</sup> A growing understanding about the impacts of combined sewer overflow on environmental and public health is driving municipalities across Canada to implement plans to reduce or eliminate this type of infrastructure.

## PROPERTY DAMAGE

In addition to major flooding, extreme storms can cause damage to buildings and infrastructure (e.g., significant power outages). Proactive municipalities are responding with comprehensive strategies and master plans that employ a spectrum of management approaches, including public outreach on how property- and community-level approaches can improve preparedness, response and outcomes to extreme weather.<sup>17</sup>

The scale of extreme weather impacts, aging infrastructure, development on flood plains and larger investment in property components exposed to flood risks (i.e., finished residential basements) have led to increasingly costly and catastrophic impacts. This is reflected in the dramatic increase in insurance claims over the past two decades [see Figure 3 below].

### Cost of Water Damage in Canadian Provinces



**Figure 3. Comparison of the average cost of water damage home insurance claims from 2003 – 2013 in Canadian provinces.<sup>18</sup>**

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## MANAGEMENT APPROACHES FOR STORMWATER USE AND MITIGATION OF FLOODING IMPACTS

Water management strategies include mechanisms for both storage and flood management to ensure that when water is needed, it is in the right place and in the right condition. Population growth and increasing urbanization, combined with more frequent extreme weather events, results in communities experiencing both too much and too little water at different times (e.g., winter storms, damaging floods and summer droughts). As a result, there is increased need to focus on options that treat stormwater as a resource, ensuring more secure year-round supplies for both the public and environment, rather than an exclusive focus on removing water after storms. This discussion is extending consideration of how stormwater management and approaches like innovative green infrastructure and low-impact development (LID) can not only help reduce negative impacts, but also contribute to more efficient use of water resources in communities. Although LID represents the minority of stormwater management approaches in Canada, it is being built into future city plans nationwide.

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## BALANCING GREY AND GREEN INFRASTRUCTURE

Often initiated in response to major droughts and floods, protection against extreme weather events has typically involved significant grey infrastructure construction projects and active management of major drainage systems (e.g., dams, reservoirs, managed rivers or channel systems and storage structures), as well as the relocation of vulnerable infrastructure. But it is often impractical to relocate whole segments of communities to avoid flooding risk, particularly as the delineations of flood plains are changing (e.g., the impact of the June 2013 storm on downtown Calgary). Designing major infrastructure solutions for such cases can be massively expensive. These projects may also meet with significant public resistance when large, costly elements are proposed to accommodate relatively rare extreme events. Due to climate change, there is an increased likelihood and frequency of extreme weather, but uncertainty remains in predicting extreme events. Therefore, communities are looking for innovative options, including green infrastructure, which can provide dual benefits of reducing the overall impacts of extreme weather events, and also effectively managing less severe, more frequent storm conditions [[see page 33 - Room for the River](#)].



## Room for the River: Increasing Resiliency to Flooding

In 2007, after experiencing two near-flood events in short succession, and anticipating a high likelihood of future repetition, the Netherlands developed **Room for the River**, a project that would allow the Rhine River and its branches to discharge 16,000m<sup>3</sup>/s of water without the risk of flooding. Capacity is being increased at 34 locations by lowering floodplains, deepening river beds and relocating dikes further inland. The €2.3 billion project is slated for completion in 2016 by the central government, working in collaboration with the provinces, regional water boards and municipalities.

The decision to widen the river rather than reinforce engineered dikes was a dramatic shift in approach, as dikes have been the primary method of water

management throughout most of Dutch history.

**Room for the River** will require relocation of homes, farmland exchange and redevelopment of natural and industrial areas. Because public acceptance is key to the project's success, a wide range of stakeholders have been involved in the design and implementation.

One innovative solution originated from the Overdiepse Polder Association, where dairy farmers located in a low-lying tract of reclaimed land were going to be affected by redevelopment. Together with the province of North Brabant, the Association devised an idea to construct eight mounds on which they could rebuild their farmhouses. The farms have now been relocated without compromising capacity, and in

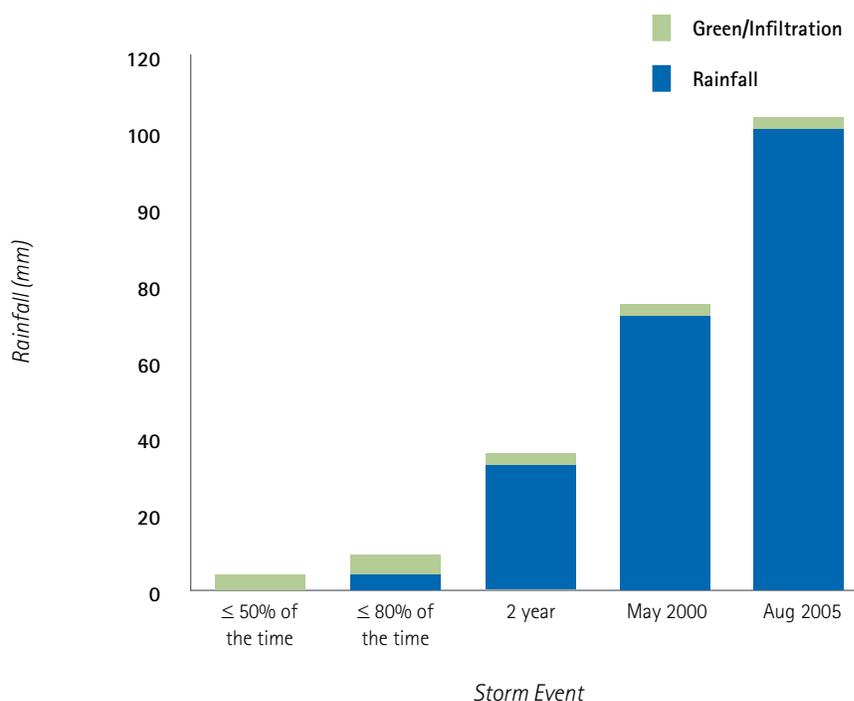
2013, the Association was awarded a Water Innovation Prize.

*This concept is now being considered as a possible solution to large-scale flooding internationally and in Canada. Prompted by the extreme flooding that occurred in 2013, the City of Calgary is adopting a similar program along the Bow, Elbow and Red Deer Rivers. Input from public and private sectors was solicited by Alberta WaterSMART to adapt **Room for the River** to suit a Calgary context and was submitted to the Government of Alberta. The City of Calgary has already gathered public input on a redevelopment plan for the former Highland Park Golf Course, located in a valley that once contained a tributary to Nose Creek.*

For more information visit:  
[ruimtevoorderivier.nl/english/](http://ruimtevoorderivier.nl/english/)

Achieving the best balance of options to address more frequent storm events, as well as rare, potentially destructive extreme weather events, involves a consideration of the best combined applications of “grey” managed or built infrastructure and “green” low-impact development techniques. The goal for municipalities striving to achieve practical, resilient systems is to combine these approaches — by enabling effective management of ongoing challenges of variable weather conditions, while providing the necessary infrastructure to deal with extreme flooding and drought conditions. For example, the level of wet-weather flow control that can be expected from green infrastructure for a range of storm events in Toronto [see Figure 4 below]. The outstanding question for water managers in designing combined approaches is how to best determine the applicability of different techniques for their local conditions, and what combinations of techniques best balance the costs and benefits, while garnering public support.

### Green Infrastructure Flow Control



**Figure 4. Projected wet weather flow control provided by green infrastructure in comparison to a range of storm events in Toronto.<sup>19</sup> Total rainfall is represented by the full height of each bar, while green infrastructure and infiltration account for ~5 mm of rainfall (green bar).**

In Toronto, storms in August 2005 and July 2013, each with rainfall in excess of 100 mm falling over a short time period, represented storm return frequencies exceeding the one in 100 year expectations and caused significant and widespread surface and basement flooding from sewer backups. While new land development provides an opportunity to upgrade designs and systems, integrating the necessary controls for extreme storms within existing and older communities is particularly challenging. In these cases, a full assessment of options that can address local conditions and the constraints of built-out areas is required. As experienced in Toronto, limited opportunities are generally available to make significant changes to achieve more effective overland flow control and more costly underground storage infrastructure is often required.

## *CWN-SUPPORTED RESEARCH*

# INNOVATIVE APPROACHES TO STORMWATER MANAGEMENT

Emerging changes in land use and climate are resulting in conventional stormwater management systems in urban watersheds that are no longer adequate to deal with increased runoff and flooding events. The conventional approach focuses on rapid drainage and removal of stormwater runoff from all urban surfaces without addressing the problem of contaminants from urban land use activities. CWN-funded research by Dr. Hans Schreier found that to reduce these impacts requires a major shift to focus on runoff detention, temporary storage and infiltration of runoff water that also reduces contamination.<sup>20</sup>

Property owners can participate in retaining precipitation and delaying the runoff from their properties. This can be accomplished by using green roofs, harvesting roof water for outdoor and indoor use, improving soil conditions, reducing impervious surfaces, planting urban trees and establishing rain-gardens.

The next level of innovation is at the neighbourhood scale, where runoff from impervious surfaces and contaminants from transportation are more intense. Reducing these impacts can be accomplished by redesigning roads and parking lots so that the runoff water is directed into swales, sand filters, retention ponds and wetlands.

Ultimately, all runoff and pollution ends in the watershed and in the lowland floodplain. Key solutions at this scale are to establish wide riparian buffer zones that allow the river to establish a natural channel, which along with associated wetlands, acts as a filter and storage systems for sediment and water and allows contaminants to be contained before they reach the river. This also requires a new approach for how to deal with extreme flooding events. Designating temporary storage areas in topographically appropriate sites within the watershed can help reduce the flood risk problem dramatically.

No single action will be able to address all issues, but a combination of actions at the property, neighbourhood and watershed scale will be the best recipe for success.

Learn more about this work on Canadian Water Network's website:  
[cwn-rce.ca/project-library](http://cwn-rce.ca/project-library)

Research led by Dr. Hans Schreier at the University of British Columbia provides an assessment of the capacity of innovative stormwater techniques and how they can be applied at different scales (property- community- or watershed-level) to achieve best results [[see page 35 – Innovative Approaches to Stormwater Management](#)]. This nested approach sets out opportunities and solutions at multiple levels: the individual property level, community/city planning level and whole watershed level. A combination of these approaches will be needed to provide the best coverage for flood risk mitigation.

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## ENHANCING LONG-TERM PLANNING AND PREDICTIONS

Long-term planning can support proactive management of threats, clarify resource options and improve infrastructure capacity. Making municipal water systems more resilient to storms and extreme weather requires consideration of options that are both practical and achievable and make sense over the long term. Such planning requires a combination of management tools, including climate change predictions, event forecasting, watershed management, risk management and harnessing grey and green infrastructure for storage, diversion and protection.

The key to supporting community decisions is a combination of improving predictive tools to better characterize the potential impacts of extreme events and better understanding of the capability of approaches to mitigate these impacts. This is also an area of overlapping and shared interest with those responsible for regional, provincial and national predictions, planning and management.

With changing climatic conditions, municipal water management requires updated tools that can better describe the likely intensity, duration and frequency (IDF) of storm events to allow for more robust predictions for local and regional changing climate and weather events. A Consortium-supported project led by Dr. Slobodan Simonovic updated the IDF-curve approach for predicting the likelihood of storms and developed a publicly available prediction tool based on location-specific historical data [[see page 37 – Improving Intensity-Duration-Frequency curves for Canada](#)].

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### *Moving Forward*

Although wastewater costs currently dominate infrastructure financing challenges in Canada, costs related to stormwater are already significant and likely to increase. Municipalities recognize storms and extreme weather as a major challenge for water management that require better information to support decisions regarding the best combination of approaches that can meet their needs. In 2015, the Consortium will focus on innovative approaches and establish improved capacity to identify and consider the relative merits and trade-offs of both grey and green approaches to stormwater management.

*CONSORTIUM SUPPORTED RESEARCH*

## **IMPROVING INTENSITY-DURATION-FREQUENCY (IDF) CURVES**

Municipal water management in Canada is heavily dependent on the use of intensity, duration and frequency (IDF) curves in the planning, design and operation of municipal water infrastructure. Other watershed management activities also rely on the use of IDF curves, including those related to water supply, water quality management and flood control. A research team, led by Dr. Simonovic of Western University, focused on updating IDF curves under a changing climate and developing a web-based publicly-accessible tool.<sup>21</sup>

One of the primary aims of the project was to standardize the IDF update process and make the results of current research on climate change impacts on IDF curves accessible to everyone. The selection of effective climate change adaptation options at the local level could then be used to advance the decision making capabilities of municipalities, watershed management authorities and other key stakeholders, as well as creating a direct link between municipalities and the research community.

The tool integrates a user interface with a Geographic Information System (GIS). By creating or selecting a station, the user can carry out statistical analysis on historical data, as well as generate and verify possible future change based on a methodology using a combination of global climate modeling outputs and locally observed weather data.

Learn more about this work on Canadian Water Network's website:  
[cwn-rce.ca/project-library](http://cwn-rce.ca/project-library)

The national priorities developed by the CLG provide perspective to the current landscape of Canadian municipal water management and articulate where progress is important and possible. The Consortium is advancing research and knowledge sharing within these priority areas to provide critical input to the national discussion on what municipalities need, want, and can address.

This approach recognizes that the challenges facing municipal water management in Canada are similar: understanding and managing the risks to our systems, achieving full cost recovery and financing, sustainably managing wastewater and the resources it contains, and addressing changing climate and weather conditions. As such, there is value in sharing experiences, research and solutions — nationally and internationally — recognizing that application of the right options will be different for each jurisdiction.

The Consortium's strategic framing of the key priorities illustrates that achieving effective integration of risks, costs and options are central to improving efficiency and resiliency moving forward. In order to respond effectively to needs, integration is required across various community sectors and government departments.

Most water solutions are specific to each region, and achieving tailored solutions to community needs hinges on engaging diverse stakeholders. The increase in information flow over the last decade, coupled with a trend toward a customer-focused approach, is putting a premium on the ability to effectively communicate the rationale behind recommended solutions. Ensuring access to the appropriate knowledge, addressing specific questions and relying on trusted sources are all critical to supporting communities making choices that are effective and achieve broad support. Moving towards more integrated approaches also increases the likelihood of support, making the process more efficient and inclusive.

In 2014-2015, the work of the Consortium has reaffirmed the importance of the national priorities and the approach to address them. The Consortium is driving success by continuing to build on each priority area, while also considering emerging challenges. Optimal management of a resource as integral as water leads to strengthening our economy, our ecosystems and the health of our communities. It is the foundation of achieving resilient and sustainable Canadian communities.

# appendix A

## CURRENT OR RECENTLY COMPLETED CONSORTIUM-SUPPORTED RESEARCH PROJECTS

Priority Area	Principle Investigator	Project Title	Institution	Project End Date
Risk	McBean	<i>Development of an integrated risk management framework for municipal water systems</i>	University of Guelph	Summer 2015
Risk	Herrera	<i>Development and validation of a model to forecast lead levels in municipal drinking water</i>	University of Western Ontario	Fall 2015
Risk	Gagnon	<i>Adopting drinking water safety plans in Canada's small- and medium-sized communities</i>	Dalhousie University	Fall 2014
Risk	Silins	<i>Management of wildfire risk to municipal waterworks in Alberta</i>	University of Alberta	Winter 2016
Risk	Issac-Renton	<i>Innovation to application: Creating a pipeline for validation and update of emerging water testing technologies</i>	University of British Columbia	Fall 2014
Risk	Dorner	<i>Source water protection in surface waters: Evaluating novel monitoring strategies for the prioritization of threats and the prevention of waterborne disease outbreaks</i>	École Polytechnique de Montréal	Fall 2015
Risk	Jackson	<i>The nexus of transportation and ecology: Improving resilience of urban ecosystems through robust guidelines on road-valley crossings</i>	University of Toronto	Summer 2015
Risk	Prévost	<i>Examining potential short- and long-term impacts of partial lead service line replacements on lead release in drinking water distribution systems</i>	École Polytechnique de Montréal	Fall 2015
Full Cost	Renzetti	<i>Extending municipal water demand forecasting capacities by incorporating behavioural responses to pricing and other policy measure</i>	Brock University	Summer 2015
Full Cost	Dupont	<i>Valuing water quality changes within a water quality ladder framework</i>	Brock University	Summer 2015
Wastewater and Biosolids	Jamieson	<i>Design and optimization of waste stabilization ponds for remote northern communities</i>	Dalhousie University	Fall 2015
Wastewater and Biosolids	Farahbakhsh	<i>Sustainable water and wastewater treatment and management in Indigenous communities through a bottom-up participatory approach</i>	University of Guelph	Fall 2015
Wastewater and Biosolids	Oleszkiewicz	<i>Options for improved nutrient removal and recovery from municipal wastewater in the Canadian context</i>	University of Manitoba	Spring 2015
Wastewater and Biosolids	Parker	<i>Integrated sorption technologies for recovery of nitrogen and phosphorus from anaerobic membrane bioreactor permeates</i>	University of Waterloo	Fall 2015

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# appendix A

## CURRENT OR RECENTLY COMPLETED CONSORTIUM-SUPPORTED RESEARCH PROJECTS

(CONTINUED)

Priority Area	Principle Investigator	Project Title	Institution	Project End Date
Wastewater and Biosolids	Ghoshal	<i>Environmental risks of engineered nanoparticles in municipal biosolids applied to agricultural lands</i>	McGill University	Summer 2015
Wastewater and Biosolids	Price	<i>Impacts of alkaline stabilized biosolids application on fate and transport of emerging substances of concern in agricultural soils, plant biomass and drainage water</i>	Dalhousie University	Summer 2015
Wastewater and Biosolids	McCarthy	<i>Land application of municipal biosolids: Assessment of ecological impacts and characterization of priority ESOCs</i>	Ryerson University	Fall 2015
Wastewater and Biosolids	McCarthy	<i>Assessment of the potential risks associated with the application of municipal biosolids to agricultural land in the Canadian context</i>	Ryerson University	Winter 2015
Wastewater and Biosolids	Kidd	<i>Assessing tools to determine level of concern due to effects of emerging contaminants from municipal wastewater effluents on aquatic biota</i>	University of New Brunswick	Fall 2015
Wastewater and Biosolids	Servos	<i>Application and assessment of tools to determine the level of concern of emerging contaminants from municipal wastewater effluents on aquatic biota in the Grand River</i>	University of Waterloo	Spring 2015
Wastewater and Biosolids	Fournier	<i>Endocrine disruption of emerging compounds in municipal wastewaters: Impacts to wild fish in the St. Lawrence River</i>	Institut national de la recherche scientifique	Spring 2015
Wastewater and Biosolids	Hecker	<i>Aquatic impact assessment of municipal effluents</i>	University of Saskatchewan	Summer 2015
Wastewater and Biosolids	Zhou	<i>Recovering the energy in municipal wastewater with membrane centered processes</i>	University of Guelph	Fall 2015
Resiliency to Extreme Weather	Simonovic	<i>Computerized tool for the development of intensity-duration-frequency curves under climate change</i>	University of Western Ontario	Winter 2015

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