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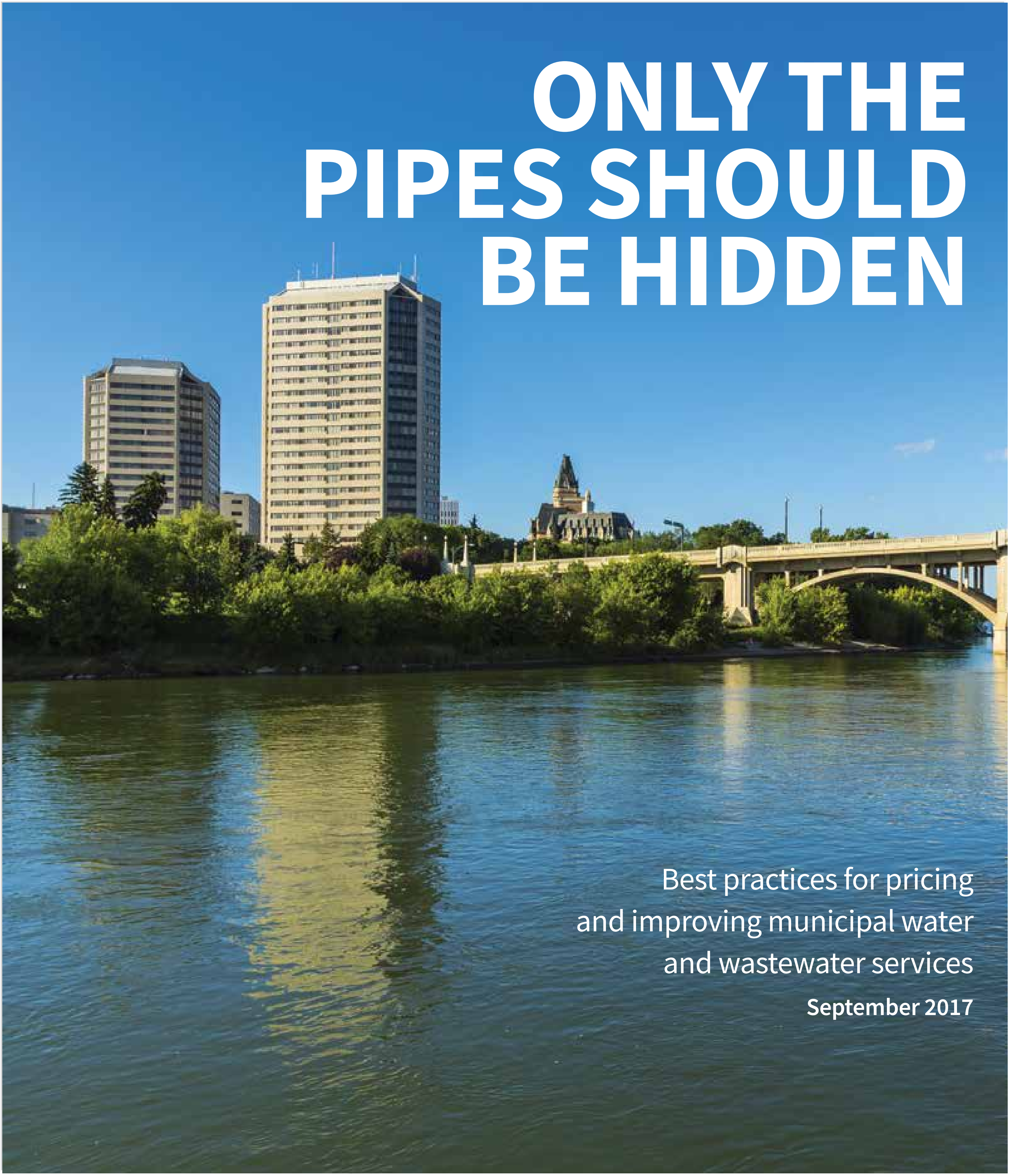
Practical solutions for growing prosperity



ONLY THE PIPES SHOULD BE HIDDEN

Best practices for pricing and improving municipal water and wastewater services

September 2017

CANADA'S ECOFISCAL COMMISSION

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DEDICATION

This report is dedicated in memory of Dr. Steven Renzetti, one of Canada's foremost environmental economists. Steven had a deep commitment to scholarly excellence and was an internationally renowned expert on water pricing and conservation. Through countless journal articles, books, and columns, Steven helped improve Canadian water policy in immeasurable ways. His research was grounded by an unwavering sense of humility and generosity; and despite his many commitments, he was ever approachable.

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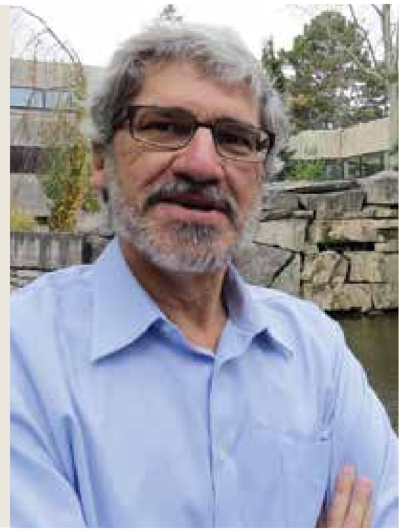
He will be dearly missed.



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The views and opinions expressed in this report do not necessarily reflect those of the Committee members nor their affiliated organizations. Any potential errors in this report are attributable to Canada's Ecofiscal Commission and not the Expert Advisory Committee.

EXECUTIVE SUMMARY

Picture a somewhat typical Canadian town. Its residents often visit the nearby lake to swim, boat, and fish. The lake also supplies drinking water to the local families and businesses. Fresh water seems plentiful, though hot and dry weather during the summer months has required the local council to limit watering lawns and washing cars. Further, beach closures and fishing restrictions seem to be a new normal for a few weeks each summer due to poor water quality.

The municipality is a growing and prosperous hub, a significant engine of economic activity in the region. Yet keeping up with growing infrastructure demands has been a challenge for the local government. Recent investments have helped, but a substantial infrastructure gap persists. Meanwhile, given the town's growing population and water use, upgrades to the aging wastewater treatment plant are required to keep the local lake clean and safe.

What might tie these threads together? Perhaps a surprising answer: user fees for water and wastewater services.

User fees make economic and environmental sense

User fees might sound technical and boring. Yet when we look deeper, the story of user fees for water and wastewater is important for thousands of Canadian municipalities. User fees can link engineered systems and natural freshwater assets with how we use and manage these assets in fiscally and environmentally sustainable ways.

Many Canadian municipalities have already taken significant steps toward better managing their water and wastewater services through user fees. Yet opportunities remain to go even further, particularly in jurisdictions still relying on other financing approaches.

This summary explains why user fees matter and provides our bottom-line guidance to policy-makers. For a deeper look at the engineering, economics, and policy details of user fees for water and wastewater services, including five comprehensive case studies, see the full report.

We take water and wastewater services for granted

Canadians value clean water. For many of us, water is a core part of our national identity, and we take great pride in Canada having one of the largest supplies of renewable fresh water on the planet. Most Canadians have access to world-class water services.

Despite our vast endowment of fresh water, many local ecosystems are becoming overdrawn or polluted—particularly in Canada's most densely populated areas. Contrary to popular belief, our water is becoming an increasingly scarce resource. And providing and maintaining clean water comes at a considerable cost.

The infrastructure that provides and treats our water has tremendous value. It underpins all the economic activity associated with cities and towns. These infrastructure assets are also closely linked to the value of our natural freshwater assets, such as lakes, rivers, and aquifers. When managed sustainably, water and wastewater systems can provide valuable services to our economy for future generations.

Yet we often take these assets—the sophisticated engineering systems as well as the natural freshwater assets—for granted. When we run the tap, flush the toilet, or buy goods and services supported by freshwater, how often do we consider the reservoirs, pipes, water-treatment plants, and natural ecosystems on which those actions depend?

The price we pay for water services doesn't reflect the full cost of providing them

Relative to other countries, Canadians pay very low prices for water and wastewater services. So perhaps it is unsurprising that we take our most precious natural resource for granted. With few exceptions, the price charged on our monthly or quarterly water bills does not reflect the true cost of providing the service, thus hiding its true value.

Charging less than the full cost of water and wastewater services has important implications for municipalities. First, it **poses risks to freshwater supplies**. We typically consume more water when it is cheaper (or unpriced), which contributes to wasteful consumption and water shortages. Consuming more water also results in more wastewater that requires expensive treatment. Overuse of the system means a heavier burden on both natural water assets and engineered infrastructure.

Charging less than the full cost has also contributed to **infrastructure gaps**. Some municipalities have old or insufficient infrastructure because their water revenues do not cover the full costs of the services. In turn, they lack the resources to build and maintain their systems. This can result in leaky or inefficient pipes, placing more stress on the overall system. Another possibility is inadequate water or wastewater treatment.

Infrastructure gaps also pose direct **risks for water quality**. With few exceptions, water needs to be treated before we can drink it, which often requires expensive, sophisticated technologies. If treatment infrastructure fails, it can result in illness or even death. Similarly, wastewater treatment plants minimize the risks associated with releasing harmful wastewater into surrounding watersheds. When under-treated, wastewater can pollute our waterways, leading to beach closures or illness.

Canadian municipalities have made significant progress on each of these challenges in recent years. And the relative importance of these challenges varies across different municipalities. Yet in all cases, ensuring that our water and wastewater systems are sustainably managed is a continuous process. This report draws on success stories in Canadian municipalities, while highlighting opportunities for further improvement.

Well-designed user fees can improve conservation, fund infrastructure, and protect water quality

When compared with other revenue tools, user fees are the best way to finance our water and wastewater systems. If designed well, they can align the price of using water services with the full cost of providing them. They generate revenue to fund essential infrastructure and even the protection of natural assets. They also create an incentive to use water more carefully, which reduces utilities' operating and capital costs.

User fees also have other benefits. Unlike other revenue tools, they can help water utilities become financially self-sufficient. This allows them to set prices that align with their core objectives and make more informed decisions about long-term capital and operational planning.

Well-designed user fees can ensure that clean water is affordable for low-income households

Although fees for water and wastewater services represent a very small portion of household budgets, concerns over the affordability of water—especially for low-income families—are important. Yet user fees can be designed to ensure that everyone has access to clean water. Municipalities can, for example, provide a basic allotment of water to all users or can provide targeted cash rebates to households. Such adjustments can improve fairness while achieving the other core objectives.

Municipalities can customize their approach based on their own context

Many Canadian municipalities face common challenges when it comes to the provision of water and wastewater services. At the same time, municipalities face local issues that are unique.

We describe 10 best practices for municipalities designing water and wastewater user fees. Many municipalities have already taken great strides toward implementing these best practices; others still have room to improve. While each best practice may not apply to each Canadian municipality, the overall collection provides a useful roadmap for improving performance across the country.

BEST PRACTICE #1
Installing water meters for all residential and commercial users

Water meters have proven benefits. Metering allows water utilities to measure water demand over time and across different users—households, businesses, and institutions. This information allows water utilities to quickly and more accurately identify leaks and improve efficiency, and it also helps with long-term planning.

Water meters are also necessary for implementing volume-based ("volumetric") user fees. Widespread metering for all households and businesses maximizes these benefits.

For example, Ottawa installed smart meters for all its households in 2011, which gives the city high-resolution data on the time and use of water. This allows the city to charge users in part based on their levels of water use, but also to quickly identify and fix leaks, and improve infrastructure planning.

BEST PRACTICE #2: Estimating all private and social costs using a lifecycle approach

Before a municipality can develop a strategy to recover its full costs, it must understand the nature of these costs. This requires water utilities to develop a comprehensive asset-management plan. At a minimum, these plans should consider all the private costs (i.e., the costs borne by the water utility) associated with engineered infrastructure: operating, maintenance, and administration costs; research and development expenditures; existing and future capital costs; historical underinvestment; and outstanding debt obligations. When possible, asset-management plans should also consider social costs (i.e., the costs borne by society), such as the cost of protecting the natural assets that are the ultimate source of our water.

Unlike any other Canadian municipality, Gibsons, British Columbia, is pushing to include natural ecosystems within the valuation of its infrastructure. If formalized, the economic value of its pristine aquifer would be treated like any other asset with an estimable value. The costs of protecting its aquifer—or the costs of degrading it—would then be included within its cost- recovery framework. A significant obstacle to this practice exists, however: national accounting standards set by the Public Sector Accounting Board currently prevent municipalities from including natural assets in their audited financial statements.

BEST PRACTICE #3: Estimating existing and future revenues from all sources

Asset management is only one half of developing a full-cost-recovery strategy. The other half is determining existing and likely future revenues. This requires looking at all sources of revenue, including user fees, development fees, fire-protection charges, property taxes, and government grants.

Forecasting revenues was a first step in the adjustments that the City of Ottawa made to its water and wastewater fees. Until recently, the city relied almost exclusively on volumetric fees, which, on one hand, helped reduce consumption and improve system efficiencies. On the other hand, such a heavy reliance on volumetric user fees made revenues highly unpredictable due to gains in conservation and other changes in demand. This process helped identify a critical issue in terms of recovering costs.

BEST PRACTICE #4: Identifying the funding gap and developing a full-cost-recovery strategy

With an asset-management plan in place and a comprehensive understanding of current and likely future revenues, municipalities can estimate their funding gap. Municipalities that have already made progress toward fully recovering their costs with user fees are likely to have smaller gaps. By contrast, the gap will be larger in communities with infrastructure investment backlogs or where future infrastructure costs are expected to increase dramatically.

Gibsons, British Columbia, recently completed 25-year and 100-year plans for maintaining and replacing its infrastructure. These plans informed a series of future rate increases.

BEST PRACTICE #5: Relying on user fees to help close the funding gap

Of all the different financing instruments, user fees are the most flexible and practical revenue tool available to municipal water utilities. User fees can recover the full spectrum of private and social costs. If well designed, they can provide a clear price signal to encourage water conservation, especially when households and businesses have regular feedback on their consumption and can see how reducing their water use can save them money. User fees can also provide a stable and reliable revenue source, allowing municipalities to plan for the long term. Industry organizations, governments, and academics recommend and support this approach.

The City of Montréal highlights a significant opportunity for improvement: it is the only large Canadian city that does not charge user fees for its water and wastewater services. Despite major improvements over the past decade, such as upgrades to its aquaduct system, Montréal's water and wastewater system is among the oldest in the country. Water meters are being installed on industrial, commercial, and institutional buildings; however, nearly all households remain unmetered, which is a clear obstacle to the introduction of volumetric user fees. Widespread metering and the adoption of user fees could help improve financial and environmental outcomes.

BEST PRACTICE #6:
Using a multi-rate structure to achieve multiple objectives

A multi-part user fee is the best way to balance the objectives of encouraging water conservation and achieving full-cost recovery. The fixed portion allows utilities to recoup some of their fixed costs and provides stable and predictable revenues. The volumetric portion can recover variable costs and maintain a price signal to drive conservation.

The City of Ottawa recently shifted toward such a model in order to ensure it could recover costs. It uses a rate structure that combines volumetric and fixed pricing to both recover costs and encourage households and businesses to reduce their water use.

BEST PRACTICE #7:
Tailoring rates to the local context

Designing user fees to mesh with local context helps ensure that they are cost-effective and environmentally sustainable. Municipalities can tailor rates for different user classes based on water demand, location, required infrastructure, new developments, and type of use, ensuring that user fees more accurately reflect the costs that each type of user imposes on the system. They can also tailor rates to address local environmental pressures.

The District of Tofino, British Columbia, is prone to water shortages in summer—due to the natural weather cycle as well as the inflow of seasonal tourists. In response to historical shortages, it charges higher volumetric prices for water between April and September.

BEST PRACTICE #8:
Integrating relief for low-income water users

Ensuring water remains affordable, particularly for low-income households, is a key policy challenge. Two approaches can ensure that low-income households have affordable access to water:

- Municipalities can provide a basic allotment of water within the fixed portion of the user fee. Within this allotted amount, the cost to households for consuming one additional litre of water is zero.
- Municipalities can provide low-income households with assistance on their water bills. With this approach, all water users—regardless of income—pay the full amount of user fees upfront.

The Town of Battleford, Saskatchewan, employs the first approach. Each quarter, it includes a basic allotment of 30 cubic metres included within its fixed rate of $135. Daily, this is approximately 330 litres per household at a cost of about $1.50.

BEST PRACTICE #9:
Making adjustments over time—in a predictable and transparent way

User fees can be adjusted over time, as conditions change. The best rate structure today may not be the best structure in the future. Events such as higher-than-forecasted reductions in water demand or an economic downturn necessitate re-evaluating water rates to mesh with the changing context. As a best practice, water and wastewater rates should be reviewed annually and adjusted accordingly.

At the same time, a predictable and transparent process for adjusting the rate structure can help individuals and businesses plan over time. Sudden changes in rates can hinder planning but also create vocal opposition. Similarly, keeping the rate structure simple can make it easier for water users to understand and respond to the price signal.

After completing its comprehensive asset-management plan, the Town of Gibsons implemented a series of rate increases to close its funding gap. The goal is to fully close its funding gap by 2024, after which rate increases will be limited to the overall rate of inflation, approximately 2% annually.

BEST PRACTICE #10:
Complementing user fees with other tools, especially for small municipalities

Relying on user fees as the primary tool for improving the financial and environmental sustainability of municipal water and wastewater systems can help achieve economic and environmental objectives. Other tools, however, can be valuable complements to user fees.

For example, municipalities can provide better information to water users through more frequent bills or even real-time feedback on their use, facilitated by adopting advanced metering technology. The recent federal regulations for treating wastewater set mandatory minimum standards for effluent quality. Similarly, provincial regulations set minimum standards for how municipalities protect and treat drinking water. In some circumstances, grants from federal and provincial governments may have a useful role to play.

The City of St. John's, Newfoundland and Labrador, expects federal and provincial grants to finance a large share of its long-term capital plan. This highlights both the opportunities and the challenges of relying on other financing tools. The city is reeling from an economic downturn and may struggle to make upgrades in the absence of outside assistance. Over time, however, relying on grants can create barriers to increasing future user fees, as households may become accustomed to artificially low rates. This reliance limits the self-sufficiency and autonomy of the municipality and may also reduce incentives for conservation.

Complementary policies may be particularly important for small municipalities, as they face several constraints that larger municipalities do not. Infrastructure in small municipalities is generally older and in greater need of repair. Smaller municipalities may have less financial capacity to make necessary infrastructure investments, or may lack the managerial and technical capacity required for integrated and robust long-term planning. In these cases, performance-based grants from federal and provincial governments can help small municipalities lay the groundwork for moving toward full-cost recovery through user fees.

Reliable and timely information is always needed for the development of sound economic and environmental policy. For the effective design of user fees for municipal water and wastewater services, detailed data on water use is essential. One current challenge for improvements in Canadian water policy is that a broad collection of water-related data, once gathered in a systematic manner by Environment and Climate Change Canada, has been discontinued.

Recommendations for a path forward for water and wastewater user fees in Canada

Drawing on these 10 best practices, we make six recommendations with the aim of improving the financial and environmental sustainability of our country's water and wastewater systems:

1. Municipalities should rely on multi-rate user fees to recover costs and encourage conservation.
2. All municipalities should develop an asset-management plan and full-cost-recovery strategy.
3. Municipalities should include natural assets within their asset-management and cost-recovery strategies.
4. The Public Sector Accounting Board should identify ways to broaden the financial framework to include natural assets.
5. Provincial and federal governments should encourage municipalities to adopt the best practices described in this report.
6. The federal government should reinstate the Municipal Water and Wastewater Survey.

Municipal user fees are one part of a much broader set of water policy issues

Municipal water and wastewater systems face significant challenges moving forward, and well-designed user fees are a key part of the solution.

But despite their importance, municipal water and wastewater systems comprise a small part of the entire water system. Also important are the issues that this report does not discuss, including the value of water as a resource, water access in First Nations communities, pollution from non-point sources, and other issues regarding water quality and quantity.

Tackling these issues goes far beyond the scope of municipal water systems. It requires rigorous, integrated, and multi-disciplinary research and a broader dialogue about how we manage and value water as a society. The Ecofiscal Commission will explore some of these issues in future reports.

To start this complex conversation, however, this report has focused on municipal user fees—one crucial tool for aligning water's price with its true value and helping us manage our most precious natural resource. Water and wastewater services might be largely hidden, but the price we pay for them should be in plain sight.

CONTENTS

1 INTRODUCTION

Canadians have a complex relationship with water. For many of us, water is a core part of our national identity: we take great pride in the fact that Canada has one of the largest supplies of renewable fresh water on the planet. With some important exceptions, we have access to world-class water services, and at very low prices.

But we must not take our water for granted. Despite Canada's vast endowment of fresh water, many local ecosystems are becoming overdrawn or polluted—particularly in Canada's most densely populated areas. Contrary to popular belief, our water is becoming an increasingly scarce resource. And the provision and maintenance of reliable and clean water comes at a considerable—albeit sometimes hidden—cost. The prices we pay for water and wastewater services are often artificially low, hiding their true value.

The recent water crisis in Flint, Michigan, and Canadian examples such as Walkerton and Attawapiskat, illustrate the disastrous consequences that can occur when we underinvest in or poorly operate our water systems.

Canadians deserve to know that their most precious natural resource is being managed efficiently and sustainably.

Our supply and use of water comprise many complex and interconnected issues—including agricultural run-off, bulk exports, and large-scale industrial use and pollution—but this report focuses only on municipal water and wastewater systems. Given the millions of Canadians who rely every day on the success of these systems, the stakes are especially high when designing smart water policy for our municipalities.

Municipal water systems provide clean drinking water to households and businesses and collect and treat the wastewater we flush down our drains and toilets. These water systems are marvels of modern engineering, with extensive infrastructure in the form of water purification facilities and vast networks of pipes, valves, and pumps.

When it comes to the economics of municipal water and wastewater—and how we pay for the infrastructure that provides these services—Canadian municipalities have made considerable progress. Increasingly, Canadian municipalities are relying on user fees to finance their systems, thus creating a price signal helping to drive conservation and providing revenue to build and maintain the necessary infrastructure.

Despite this steady progress, however, Canadian municipal water systems face significant challenges. The prices Canadians pay for water and wastewater services are some of the lowest in the world and do not reflect the full costs. Further, the costs of building and maintaining the necessary infrastructure are increasing, as many municipalities have aging infrastructure that will require significant investments in the coming decades. In cases where municipalities have relied too heavily on per-unit ("volumetric") fees, falling water consumption has meant less stable revenues for water utilities.

At the same time, some of the natural ecosystems on which municipal water systems depend are becoming stressed. By international standards, Canadians are heavy water users.

Population growth, urbanization, and low water levels during summer months pose risks to the sustainability of water supplies.[1]

Moreover, the waste and chemicals that go down our drains can degrade natural ecosystems, despite best efforts by municipalities to use more sophisticated treatment technologies. When undertreated, this wastewater affects the quality of our lakes, rivers, and oceans.

User fees sit at the nexus of cost recovery, water conservation, and water quality. If designed well, they have the potential to drive solutions to all three issues.

The prices we pay for water and wastewater services are often artificially low, hiding their true value.

This report examines how well-designed user fees can help municipalities generate clear economic and environmental benefits by ensuring their residents have access to safe, clean, sustainable water services. While not a panacea for all municipal water problems, we argue that user fees should play a central role in overall water policy. Unlike other financial or environmental policies, user fees establish a direct link between the costs of the service and the price paid by households and businesses using the water. They allow municipalities to set rates that fully recover their costs. At the same time, they create incentives for improving water conservation and water quality. The report draws on success stories in Canadian municipalities, while highlighting opportunities for further improvement.

One of our key findings is that the *design* of user fees matters. To balance core objectives—such as achieving full-cost recovery, encouraging water conservation, and maintaining clean and affordable water—user fees must be designed to accommodate the local context. In most municipalities, this requires a “multi-rate” approach to designing user fees, whereby water users pay a fixed dollar amount plus an amount that rises with water use (the volumetric rate). This approach allows municipalities to keep water and wastewater services affordable for low-income households. Municipalities can, for example, include a basic allotment of water within its fixed fee or provide targeted cash rebates. Such adjustments can improve fairness, while achieving the other core objectives.

The report is organized as follows. Section 2 provides important context on the engineering, financing, and regulation of municipal water systems, and elaborates on the key fiscal and environmental challenges affecting water systems. Section 3 explores the economics of municipal water systems, and considers how user fees can help improve fiscal and environmental outcomes. Section 4 takes a closer look at how five Canadian municipalities have designed and implemented user fees. Building on these findings, Section 5 describes best practices for municipal policymakers. Section 6 provides our policy recommendations and next steps.

Finally, note that this report touches on only one of many complex issues regarding water policy. Other critical issues—such as clean water in First Nations communities and the economic value of water—are outside our scope. The goals of this report are specifically and narrowly focused on exploring the role of well-designed user fees in improving the fiscal and environmental sustainability of municipal water and wastewater systems.

[1] Climate change exacerbates each of these challenges, as municipalities cope with more frequent and severe flooding and drought. These new risks will require significant and costly investments in resilient infrastructure.

2 THE COMPLICATED WORLD OF MUNICIPAL WATER

Municipalities each face different local water issues. Canada has over 3,000 municipalities, and each relies on different (though often shared) watersheds for its drinking water and for discharging wastewater.

Each municipality must also balance the unique water needs of residents, businesses, industry, and agriculture. The condition and age of water infrastructure differ across municipalities, and each municipality is responsible for implementing provincial and federal regulations that pertain to water management (Ayoo & Horbulyk, 2008).

At the same time, Canada's municipal water systems share many similarities (see Box 1). Municipalities of all sizes strive to meet similar objectives—to provide high-quality water services at a low cost, and to ensure that service levels are sustainable over time. Moreover, the engineering systems that deliver and treat drinking water and wastewater have similar components across municipalities (CWN, 2018; Haider et al., 2013).

Other common municipal challenges include financing water systems, balancing environmental challenges such as water scarcity and ecosystem damages, and preparing for the threats and opportunities posed by climate change. Small rural communities face additional challenges, such as declining populations, resource-dependent economies, and limited technical capacity.

This section explores these similarities and highlights the complicated nature of municipal water and wastewater systems. We examine three components of the system in more detail:

Natural assets provide valuable ecosystem services.

Rivers, lakes, forests, aquifers, and wetlands provide natural storage and filtration for the water that is ultimately pumped, treated, and consumed by end users. These ecosystems play a major role in regulating the quantity and quality of fresh water.

1. **Providing Municipal Water and Wastewater Services:** First, we look at the *water flows* within the system of water and wastewater infrastructure—from source to tap, and tap to sewer—and how these flows can be affected by water scarcity and climate change.
2. **Paying for Municipal Water and Wastewater Services:** We next look at the *financial flows* that underpin how municipal water systems are financed, including the challenges with paying for increasingly complex water systems.

Box 1: Overview of Municipal Water and Wastewater Systems

Canadian provinces have primary jurisdiction over water resources and are responsible for ensuring that residents have access to clean and safe water. Provinces grant municipalities the authority to own and manage drinking water, wastewater, and stormwater systems and set the overarching regulatory framework for service delivery.

The federal government also plays an important role in setting standards for wastewater and drinking water. Provincial and federal governments provide grants to municipalities to help finance infrastructure projects (Hill et al., 2008; Slack, 2009).

Within this governance framework, municipalities are responsible for the day-to-day operations and long-term planning of their water systems. Most water systems in Canada are publicly owned and operated. Some are operated through municipal departments, while others operate as arm's-length water agencies or commissions. See CWN (2014) for how different governance structures can affect the management of water utilities.

The population and density of municipalities vary widely, and affect how municipalities build, maintain, and finance their water systems. While two-thirds of Canadians live in medium-sized (30,000–99,000 people) or large-sized (100,000+ people) municipalities, the remaining one-third of Canadians are spread across thousands of small municipalities. In fact, more than half of Canadian municipalities are towns and villages with fewer than 5,000 people (Environment Canada, 2011). Most municipal water systems in Canada are therefore small and rural.

3. **Managing Water Quality:** Finally, we look at the *quality of water* at each stage of the water system, including the close connection between clean water and the state of infrastructure, finance, and environmental regulations.

This conceptual framework illustrates the different systems, and how these systems interact. It sets the stage for our analysis in later sections.

2.1 PROVIDING MUNICIPAL WATER AND WASTEWATER SERVICES

We start with the physical elements of municipal water systems. Figure 1 below shows a simplified diagram of these elements and how they are linked together. The figure highlights key elements of the water system, including treatment facilities, distribution infrastructure (e.g., pipes), stormwater infrastructure, and water users. We consider policy implications for each.

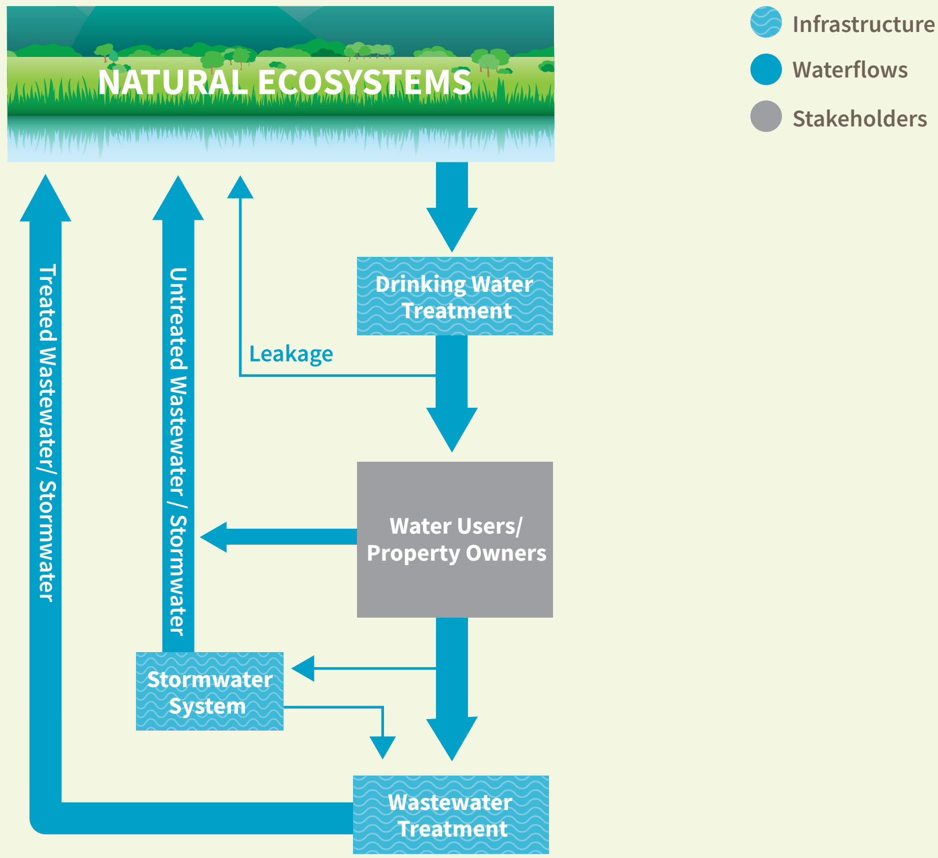
Our focus is on *municipal* water systems

Figure 1 shows the boundaries of the municipal water system. This includes the water supplied and used within the municipal system by residential, commercial, institutional, and industrial users, and the resulting wastewater flows. The system also includes the natural ecosystems that are the source of drinking water and the receiving bodies for wastewater. These systems provide natural filtration for the water that is ultimately pumped, treated, and consumed by end users, and play a major role in regulating the quantity and quality of fresh water (Bennett & Ruef, 2016).

Across the thousands of municipalities in Canada, approximately 90% of households receive water and wastewater services from their municipalities. The remaining 10% of households are self-supplied and are not connected to a municipal utility. An even smaller number (less than 1%) have their water hauled into the community. Generally, municipalities that provide drinking-water services also provide wastewater services. The residential sector is the largest consumer of municipal water, at roughly 60% nationally (Environment Canada, 2011).

Municipal water systems are only part of the story, however. They account for just 13% of all water withdrawals in Canada; the remaining 87% are self-supplied by households and the electricity, manufacturing, and agricultural sectors. When we consider the

Figure 1: Water Flows Through Municipal Water Systems



This figure provides a simplified illustration of municipal water and wastewater systems. It illustrates how water from natural ecosystems is pumped from its source to water treatment facilities and is then delivered to water users (households and businesses) through vast networks of underground pipes. After it is used, wastewater is collected through underground sewer systems and, in most municipalities, is treated before being returned to the watershed. The blue arrows represent flows of water, with larger flows represented by wider arrows (not to scale). A portion of treated water is lost due to infrastructure leaks, fire protection, and system maintenance. Stormwater management is also an integral part of municipal water systems. It sometimes overlaps with wastewater treatment but is not a focus of this report.

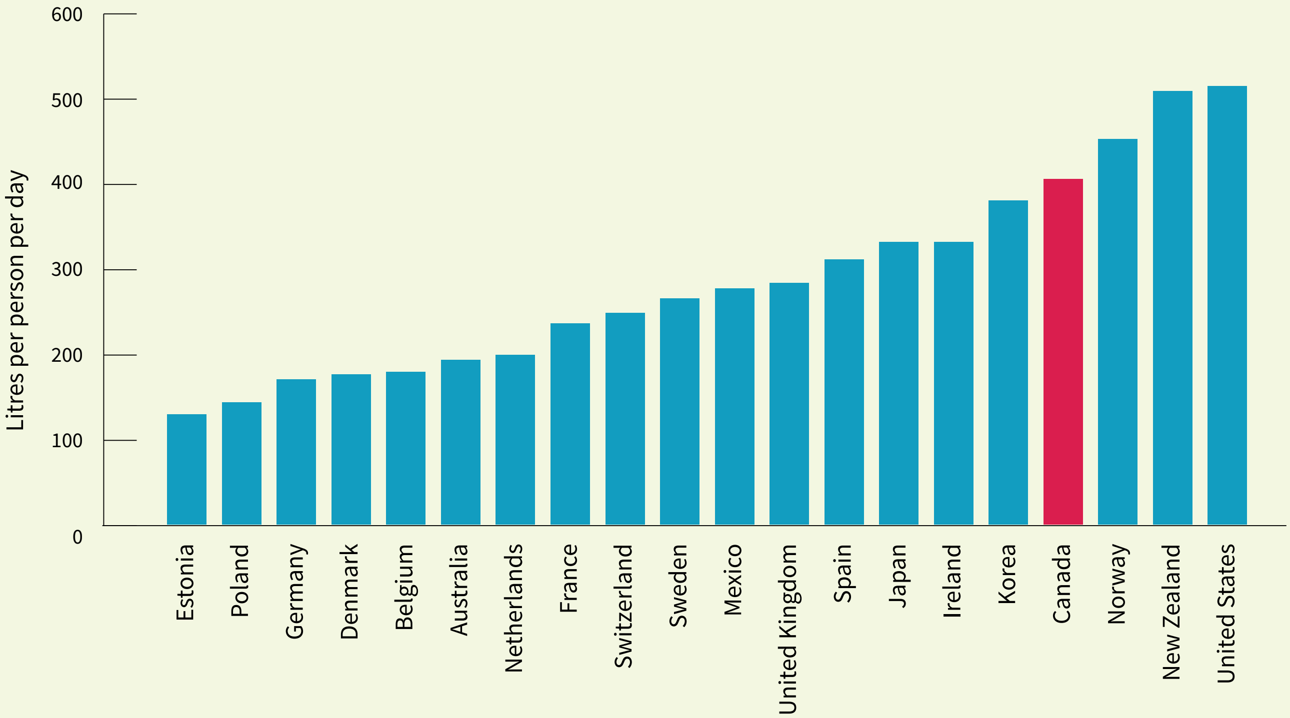
entire hydrological system, each competing use of water—and the time and space in which it is used—shapes water issues in Canada (Statistics Canada, 2017a).

Municipal wastewater has several sources. As of 2009, 82% of Canadian households were connected to municipal wastewater systems, which accounted for 65% of all municipal wastewater flows in Canada.[2] The remaining 35% of wastewater flows originate from commercial, industrial, and institutional users, stormwater, and groundwater infiltration (Statistics Canada, 2015a). Importantly, municipal systems collect and treat only a portion of all wastewater discharged into the environment. Other major sources include, for example, agricultural run-off or wastewater from industrial facilities treated on-site.

This report focuses solely on municipal water and wastewater systems, and excludes all other users and producers of water and wastewater. Although municipal systems comprise only one slice of total water use, they are an important area of focus. Municipal water and wastewater systems are typically operated by a single

[2] The remaining 18% of household wastewater is privately managed through septic systems or haulage.

Figure 2: Municipal Water Consumption in 2013 (daily, per capita)



This figure shows the amount of water used for municipal supply across 20 countries on a daily per capita basis. Canada ranks fourth highest, at roughly 405 litres. This metric includes all water users connected to the public water system (i.e., residential, institutional, business, and industrial users). Note that this graph includes only water withdrawals for the municipal supply; when considering all water withdrawals, the U.S. and Canada are the two biggest water users in the world (Statistics Canada, 2017a). Data are from 2013 or the latest available year.

Source: OECD, 2015

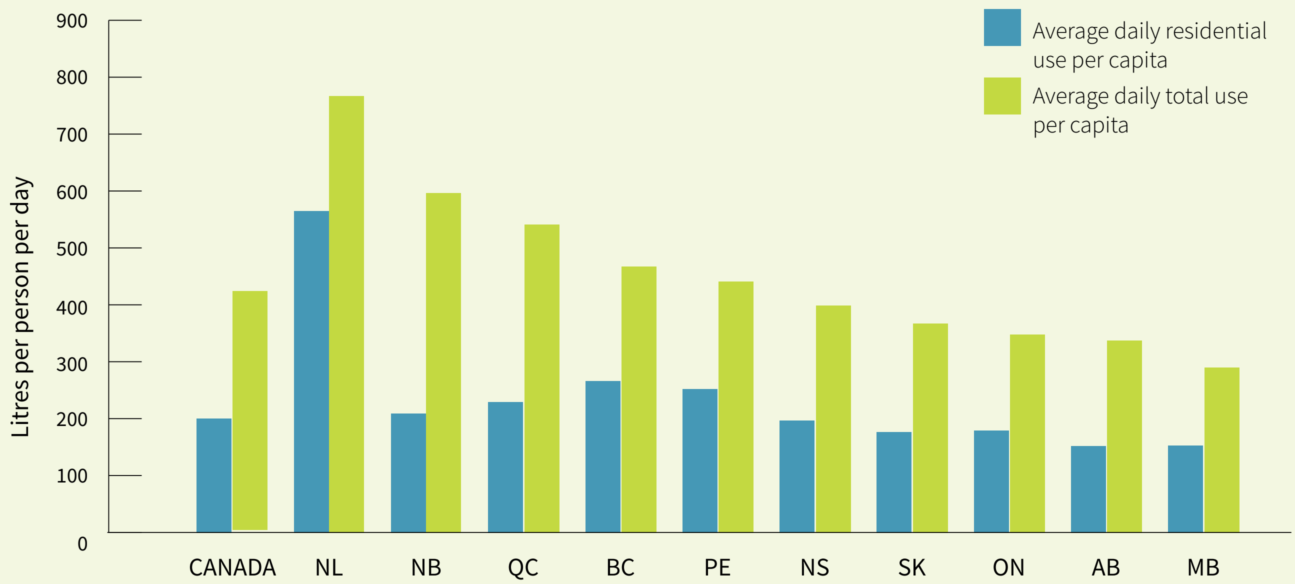
provider (i.e., a water utility), and are responsible for building and maintaining vast networks of capital-intensive, publicly owned infrastructure. They are responsible for providing the water and wastewater systems that underpin public health. Improvements in how municipal water systems operate can therefore generate significant benefits for millions of Canadians.

As illustrated in Figure 1, stormwater infrastructure also plays an important role in municipal water systems. However, it is mostly outside the scope of this report. Stormwater systems include the network of storm drains, sewers, and culverts that collect rainfall and run-off, and act as a form of flood management. While stormwater systems are vital, they are not a focus of this report. Many of the challenges facing stormwater management are different than for drinking-water and wastewater services. In addition, the capacity to charge user fees to recoup the costs of stormwater systems is different than for water and wastewater services (Wright, 1997; O'Neill & Cairns, 2016).

Despite gradual improvements, Canadians are still heavy water users

We start with water *consumption*. On a per capita basis, Canadians are some of the heaviest water users in the world. In a comparison of 20 countries within the Organization for Economic Co-operation and Development (OECD), Canada ranks fourth highest in terms of per capita water use. As illustrated in Figure 2, per capita water use from public water systems in Canada is more than twice those

Figure 3: Municipal Water Consumption in 2013, by Province (daily, per capita)



This figure shows the average daily residential and total per capita consumption of water, by province. The difference between residential and total is the amount used by industrial, commercial, and institutional (ICI) users, plus losses (leaks) from the distribution system. Newfoundland and Labrador has the highest per capita residential water use, more than 600 litres per day, while residents in Manitoba and Alberta use less than one-third that amount. (Figures 2 and 3 are not directly comparable as they are based on different data sources.)

Source: Statistics Canada, 2013

in Germany, Belgium, Australia, and the Netherlands (OECD, 2015; Statistics Canada, 2017a).[3]

In a comparison of 20 countries within the OECD, Canada ranks fourth highest in terms of per capita water use.

Rates of water consumption in Canada—both in total, and for residential consumers only—are different across provinces. As illustrated in Figure 3, total per capita water consumption is highest in eastern Canada. Water consumption in Newfoundland and Labrador, for example, is more than double the water consumption in the Prairie provinces. Consumption is also different across municipalities within provinces. In British Columbia, for example, households in the Town of Elkford used roughly 1,400 litres of water per day in 2016, while households in Abbotsford used only 200 litres per day (Honey-Rosés et al., 2016).

Across all provinces, however, water consumption levels have fallen over the past two decades.[4] At its peak, the average Canadian household used 343 litres of water per day in 1999. By 2013, the daily per capita level of residential water consumption had fallen to 223 litres—a drop of 35%. Despite this progress, Canada is still among the world's biggest consumers of water on a per capita basis (Statistics Canada, 2017a).

[3] To accurately measure (and charge for) the volume of water used, most Canadian municipalities require that each building (or unit) be equipped with a water meter. Rates of household water metering are particularly low in Newfoundland and Labrador, Prince Edward Island, Quebec, and British Columbia (Environment Canada, 2011; ECCC, 2017a). Roughly 57% of Canadian households were metered in 2009, while the rate of water metering for commercial units was higher, at 87%. The prevalence of water meters appears to have increased since 2009. Generally, water metering is also more common in urban municipalities (Brandes et al., 2010; Environment Canada, 2011).

[4] The fall in overall water consumption is attributed to many factors, such as buildings and appliances with improved water efficiency standards, increasing use of water meters, higher water prices, and changing attitudes.

Box 2: Canada's Leaky Pipes

Municipal water distribution networks are enormous. Most infrastructure is buried underground, which makes it difficult to appreciate its size and complexity. Toronto and Calgary, for example, manage watermain systems that are roughly 6,000 and 4,600 kilometres in length, respectively.

Given the size, length, and age of water distribution networks, it is unsurprising that municipal water utilities lose a portion of treated water due to leakages. As water mains age, they become more susceptible to leaks and breakages. Detecting and repairing leaks can also be a practical challenge when infrastructure is buried under roads, sidewalks, and properties.

Data from Statistics Canada (2017a) indicate that roughly 13% of municipal water is lost in distribution systems before it reaches users. The amount lost from leaks depends on the condition and size of water infrastructure, the level of water pressure, and whether municipalities employ a leak-detection program. The City of Montreal, for example, loses 30% of its water, whereas the City of St. Albert loses only 5% to 8% (City of St. Albert, 2012; Ville de Montréal, 2016a). Most countries in the OECD experience losses in the range of 10% to 20% (OECD, 2009).

What is the cost of leaked water? Utilities spend a lot of money treating and delivering water that is ultimately lost. The Halifax Regional Water Commission, for example, estimates that its water-loss control efforts save $650,000 per year in chemicals and electricity costs, and save an additional $500,000 per year from reduced water main breaks (HRM, 2016). Repairing leaks also reduces the cost of water purchases for municipalities that buy their water from a bulk (regional) supplier. Fewer leaks also reduce the risk of water contamination (Yates, 2014).

Water scarcity and climate change are genuine threats

Municipal water use has broad implications for the supporting ecosystems. Canada is a relatively water-rich country, withdrawing less than 5% of its renewable supply of fresh water each year. On a per capita basis, Canada has the second largest supply of renewable fresh water in the world. Despite this overall abundance, however, water supplies in many regions are stressed (Environment Canada, 2013; Statistics Canada, 2017a).

Geography and climate change are major factors causing water scarcity. Roughly 66% of Canada's population lives within 100 kilometres of the U.S. border, yet much of our freshwater lies hundreds of kilometres further north. Water is also unequally distributed across provinces. Alberta, for example, has roughly 10% of Canada's population but only 2% of Canada's freshwater supply (City of St. Albert, 2012; Statistics Canada, 2017a).

In some areas, the growing demand for water from population growth, urbanization, and agriculture exceeds the watersheds' natural rate of replenishment, which is compounded by seasonal droughts. A portion of treated drinking water is also lost due to leaks, which increases overall water use and represents a waste of valuable resources (see Box 2).

Water is unequally distributed across provinces. Alberta, for example, has roughly 10% of Canada's population but only 2% of Canada's freshwater supply.

Between 1994 and 1999, roughly one-quarter of Canadian municipalities faced water shortages (Bakker & Cook, 2011). More recently, data from Environment Canada (2009a) suggest that eight percent of municipalities had water shortages in 2009. Water shortages are most pronounced in Canada's dry regions, such as southern Ontario, southern Saskatchewan, southwestern Manitoba, and the Okanagan Valley in British Columbia (Lemmen et al., 2008; Mitchell, 2016; Statistics Canada, 2017a).[5]

Even water-rich regions can experience seasonal shortages. In 2016, for example, British Columbia's Southwest Coast, the entire province of Nova Scotia, and parts of Prince Edward Island experienced historically low levels of precipitation, sparking mandatory water-use restrictions (Burke, 2016; Ross, 2016). Unusually hot and dry temperatures in 2016 also forced several communities across Canada to implement voluntary water restrictions, including Sudbury, which is home to over 300 lakes (Lui, 2016). Other municipalities, such as those in Metro Vancouver, implement summer water-use restrictions from May to October as a preventive measure.

The costs of these water shortages can be substantial. The immediate consequences are on public health and sanitation when water is rationed during times of severe drought. Water shortages can also impose significant economic costs on agriculture, fisheries, and industry in terms of lost output and employment (Morrison et al., 2009; Statistics Canada, 2017a). The recent drought in California, for instance, created $2.2 billion (US dollars) in economic damages in 2014 alone (Howitt et al., 2014).

Scientists expect climate change to intensify the frequency and duration of water shortages in Canada (Brandes & Curran, 2016; Renzetti & Dupont, 2015; Statistics Canada, 2017a). Many municipalities in British Columbia and Alberta, for example, rely on snowmelt for their water and are already experiencing the effects of warmer temperatures and less runoff (Bakker & Cook, 2011; BCWWA, 2013a). In the longer term, a warmer and drier climate will make it costlier for some municipalities to protect critical water sources or to find, deliver, and treat water from new water sources.

Municipal water systems also affect the quality of our water

Water becomes wastewater once it is flushed down drains and toilets; sewer systems then collect wastewater and transport it to treatment facilities. Once treated, wastewater is released into surrounding waterways, except for a small number of municipalities that still discharge raw sewage. The City of Winnipeg, for example, treats all its wastewater before discharging it into the Red River, which eventually flows into Lake Winnipeg. By contrast, the small town of Sainte-Pétronille discharges raw sewage into the St. Lawrence River (CBC News, 2015a).[6]

Discharged wastewater returns to surrounding watersheds, but is typically less clean than when the water was initially withdrawn. Generally, the level of pollution from wastewater depends on the different types of effluent, the level of treatment, and the size of the receiving body of water. In non-coastal communities, for example, wastewater can be discharged into waterways that also serve as sources of drinking water for downstream communities. We return to water quality issues later in this section.

2.2 PAYING FOR MUNICIPAL WATER AND WASTEWATER SERVICES

The costs associated with building, maintaining, and operating water systems are complex and growing. In some cases, municipalities are adequately managing these complex demands. In other cases, however, municipalities are failing to maintain and replace aging water and wastewater infrastructure, all while facing additional challenges from population growth, increasingly stringent regulations, climate change, and expectations for higher service standards. Water users also expect higher levels of customer service from their utilities (AWE, 2014).

Figure 4 layers the financial flows onto our previous diagram of the municipal water system. It illustrates the budgetary constraints that pose a key challenge for municipal governments and water utilities in supporting these systems. Financial flows include the expenditures on building and maintaining water infrastructure, as well as the different sources of revenue. We examine each part of these financial flows.

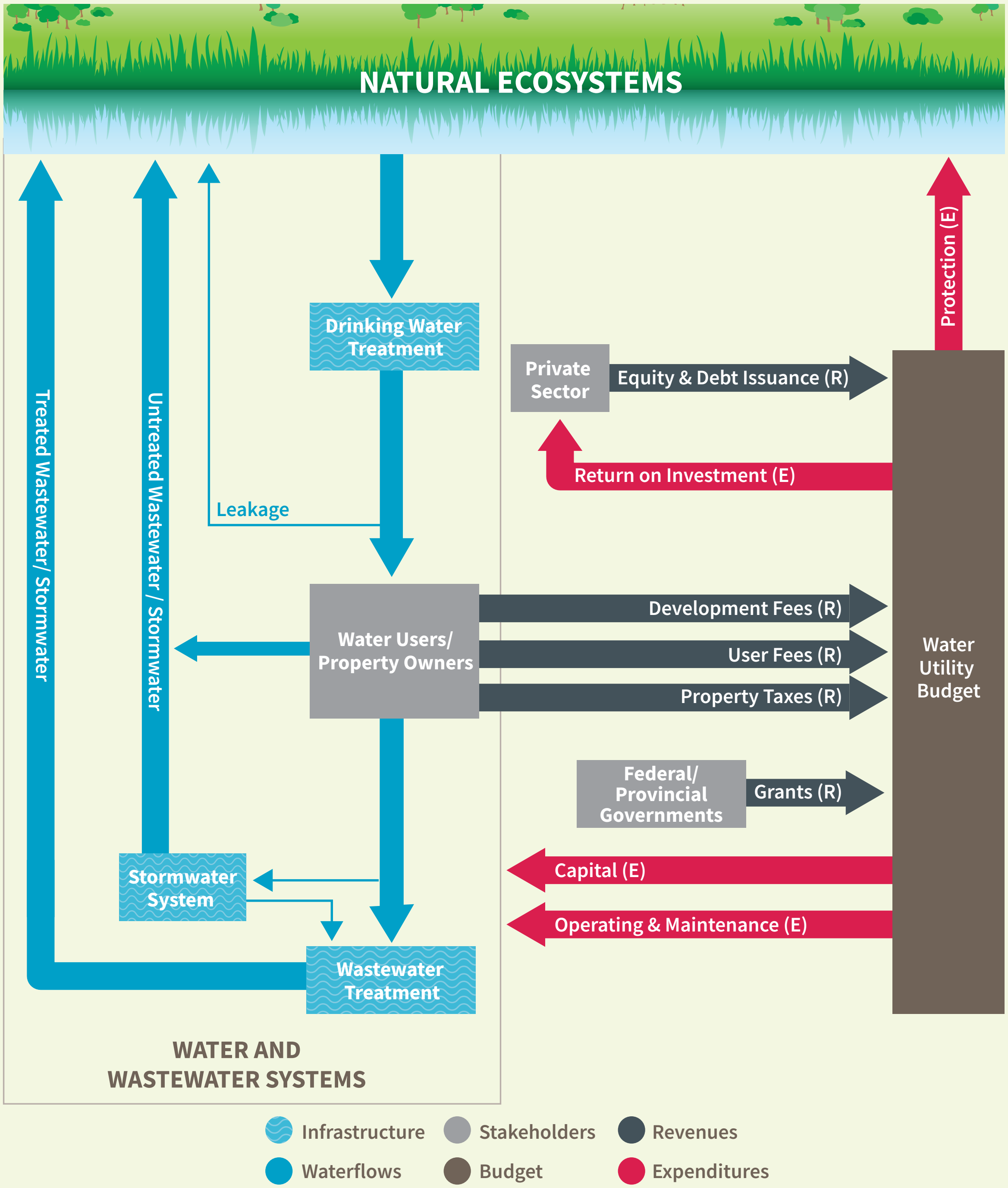
Municipalities can fund water systems using different revenue tools

Figure 4 illustrates the primary revenue instruments used to finance municipal water systems. It also shows how these instruments are directly or indirectly connected to the end user. User fees, for example, are paid directly by the end user: the more water used, or the higher the level of service, the bigger the water bill. Property taxes, by contrast, are indirectly related to the water user. While all property owners (and renters) are water users, property taxes are unrelated to the amount of water consumed by any given household or business.

5 The ratio of withdrawals from surface fresh water to the amount replenished through natural processes (the water yield) is used as a key indicator for determining the stress on water supplies. In August 2013, ratios of water withdrawals to water yield were above 40% in the Assiniboine-Red and Great Lakes drainage regions, and were between 20% and 40% in the South Saskatchewan and Okanagan-Similkameen drainage regions. Such high ratios indicate high risk of future water shortages (Statistics Canada, 2017a).

6 The impact from wastewater on local watersheds depends on several factors, such as the size of the municipality, the level of treatment, and the size/health of the receiving body. The town of Sainte-Pétronille has a population of roughly 1,000 people and discharges its untreated wastewater into the St. Lawrence—one of the largest rivers in Canada. Winnipeg, by contrast, has a population of over 1 million people but discharges its wastewater into the much smaller Red River.

Figure 4: The Municipal Water System and How it is Financed



This figure illustrates the financial flows required to fund and maintain the physical infrastructure for water and wastewater systems. The red arrows indicate expenditures (E) and the dark grey arrows indicate revenues (R). Overall, total financial flows are constrained by the water utility budget: greater expenditures on the water system require greater revenues, either from user fees, property taxes, financial reserves, development fees, federal or provincial grants, or the issuance of equity or debt to the private sector. (The size of each arrow does not reflect the size of the flow.)

Table 1: Primary Revenue Sources for Municipal Water Systems

Revenue Source	How is the revenue collected?	Advantages	Limitations
User Fees	Water users pay a fixed and/or variable fee for the service. Utilities may also charge smaller, one-time fees for specific services (e.g., fire protection)	Based on user-pay principle and encourages conservation. Relatively stable source of revenue, which can also be used to underwrite debt or equity financing or generate financial reserves.	Provincial legislation and Canadian case law require that charges cannot exceed the costs of the service. Revenues must be earmarked to pay for water-system costs.
Development Fees	One-time fees levied by municipalities for specific costs associated with new development.	Based on user-pay principle (i.e., growth pays for increases in infrastructure costs).	Provincial legislation requires that charges must reflect growth-related capital costs. Revenues must be earmarked (i.e., reserve fund).
Grants	Federal and provincial governments provide grants to municipalities.	Helps fund large, capital-intensive projects. Can alleviate local funding constraints, particularly for smaller communities.	Not based on user-pay principle. Most grants are project-specific and are not a stable source of revenue.
Property Taxes	Municipal property owners pay charges based on their property's assessed value.	Relatively stable source of revenue. Higher-income households pay more for water and wastewater services.	Not based on user-pay principle. Does not promote conservation, full-cost recovery, equity, or economic efficiency.

Table 1 elaborates on the primary revenue sources available to municipal water utilities, including user fees, development fees, grants, and property taxes. This sets the stage for our assessment in Section 3 of the tradeoffs across revenue instruments. Revenue sources such as debt, equity, and financial reserves, are slightly different than the others and so are not included in the table.[7]

In practice, municipalities use different combinations of these financing instruments to generate revenue, and the mix of instruments can change over time. Historically, municipalities relied mostly on revenue from property taxes to finance water services, complemented by some federal or provincial grants (Dewees, 2002).

In larger cities, an estimated 80% of water utility revenues are derived from user fees.

In the past two decades, however, municipalities have begun a shift toward charging user fees to pay for water and wastewater systems. This is especially common in larger cities, where an estimated 80% of water utility revenues are derived from user fees (CWN, 2018).[8] Outside of large cities, however, the proportion of revenues coming from user fees is smaller; small municipalities receive a larger share of funding through federal and provincial grants.

Though federal and provincial grants remain an important revenue source, these transfers have decreased as a share of GDP from their peak in the 1980s and 1990s (Bazel & Mintz, 2014; Slack, 2009). The federal government's most recent funding program—the Water and Wastewater Fund—is helping to reverse this trend as it provides $2 billion over the 2016–2021 period (Infrastructure Canada, 2017). Other provincial grant programs are providing additional support, such as Alberta's Municipal Water and Wastewater Partnership program ($106 million) and New Brunswick's Clean Water and Wastewater Fund ($20 million) (Government of Alberta, 2017; Government of New Brunswick, 2016).

Funding structures also vary across provinces. Municipalities in Ontario, for example, are not permitted to use property taxes to finance water and wastewater services. Nearly all municipalities in Western Canada charge user fees for water services to generate revenues, while municipalities in Quebec still rely heavily on property taxes (Fenn & Kitchen, 2016).

[7] Debt and equity issuance is ultimately underwritten by either general revenues or revenues from user fees. They enable municipalities to raise funds in the present, with the obligation to repay the principal (and interest) in the future. Debt is amortized, meaning the cost (interest and principal) is spread over a series of future payments. Equity financing is when the private sector provides financing in return for some ownership of assets or claim on the revenue. Financial reserves operate in the opposite manner: they accrue from setting aside a share of revenues from previous years.

[8] This estimate by the CWN was derived from the Canadian National Water and Wastewater Benchmarking Initiative. The sample size is 34 municipalities, most of which are bigger cities.

Financial and environmental sustainability requires full-cost recovery

To achieve financial sustainability, water utilities must collect enough revenue to cover their full costs. This concept is referred to as *full-cost recovery*. It means that water utilities generate sufficient and consistent revenues to pay for the past, current, and future costs of providing water and wastewater services (Fenn & Kitchen, 2016). Municipalities have made significant progress on recovering a greater portion of their costs; however, there is still room for improvement.

Moving toward full-cost recovery has several benefits. It ensures that municipalities have the necessary funds to invest in infrastructure to keep the system in a state of good repair. It also encourages municipalities to take a life-cycle approach to asset management, which requires the forecasting of costs and revenues over several decades. Doing so helps municipalities to smooth costs over time, avoiding sudden fee increases to water users.

Full-cost recovery also helps reduce overall costs. If revenues fall short of costs, the resulting funding gap directly undermines service levels (FCM, 2006). Repairing infrastructure is costlier as it ages, which means that deferring investments can increase overall costs. Funding gaps can also have serious knock-on effects that can drastically increase the risk of contamination, overuse, and environmental degradation.

Though the concept of full-cost recovery appears straightforward, some ambiguity is inevitable. It is not always clear *which* costs are being considered. Due to evolving service needs of municipalities, improved accounting methods, and a growing awareness of environmental impacts, the definition of full-cost recovery has broadened over time.

It is useful to think of full-cost recovery along a spectrum. Figure 5 illustrates the full set of costs associated with municipal water and wastewater systems. In practice, municipalities have recovered these costs to a varying extent. The various costs can be grouped into two main categories:

- *Private costs* are those that must be paid directly by the water utility.[9] They include annual operating and maintenance costs, in addition to the longer-term capital costs associated with building infrastructure. Capital costs include historical underinvestment (e.g., projects that were required, but never built), along with future costs (e.g., projects that will be necessary to accommodate population growth). Private costs are, in part, determined by the level of service provided by water and wastewater utilities.
- *Social costs* are broader in scope and are borne by society. They include the costs associated with maintaining natural (non-engineered) assets, such as lakes, rivers, streams, and aquifers. Social costs also include the economic value of water as a resource: as the local supply of water becomes scarcer, less is available for other uses (e.g., washing a car, supporting commercial activities, or supporting ecosystems).

While private costs are clearly under municipal jurisdiction, social costs may be broader. Some social costs are the responsibility of municipalities (e.g., protecting drinking-water sources), while others are under provincial jurisdiction (e.g., the value of water as a resource) and federal jurisdiction (e.g., water quality). These complexities are one reason why achieving genuine full-cost recovery—where all private and social costs are accounted for—is a challenge. This report considers only full-cost recovery as it pertains to municipal jurisdictions.[10]

Water utility revenues have historically not kept pace with private costs

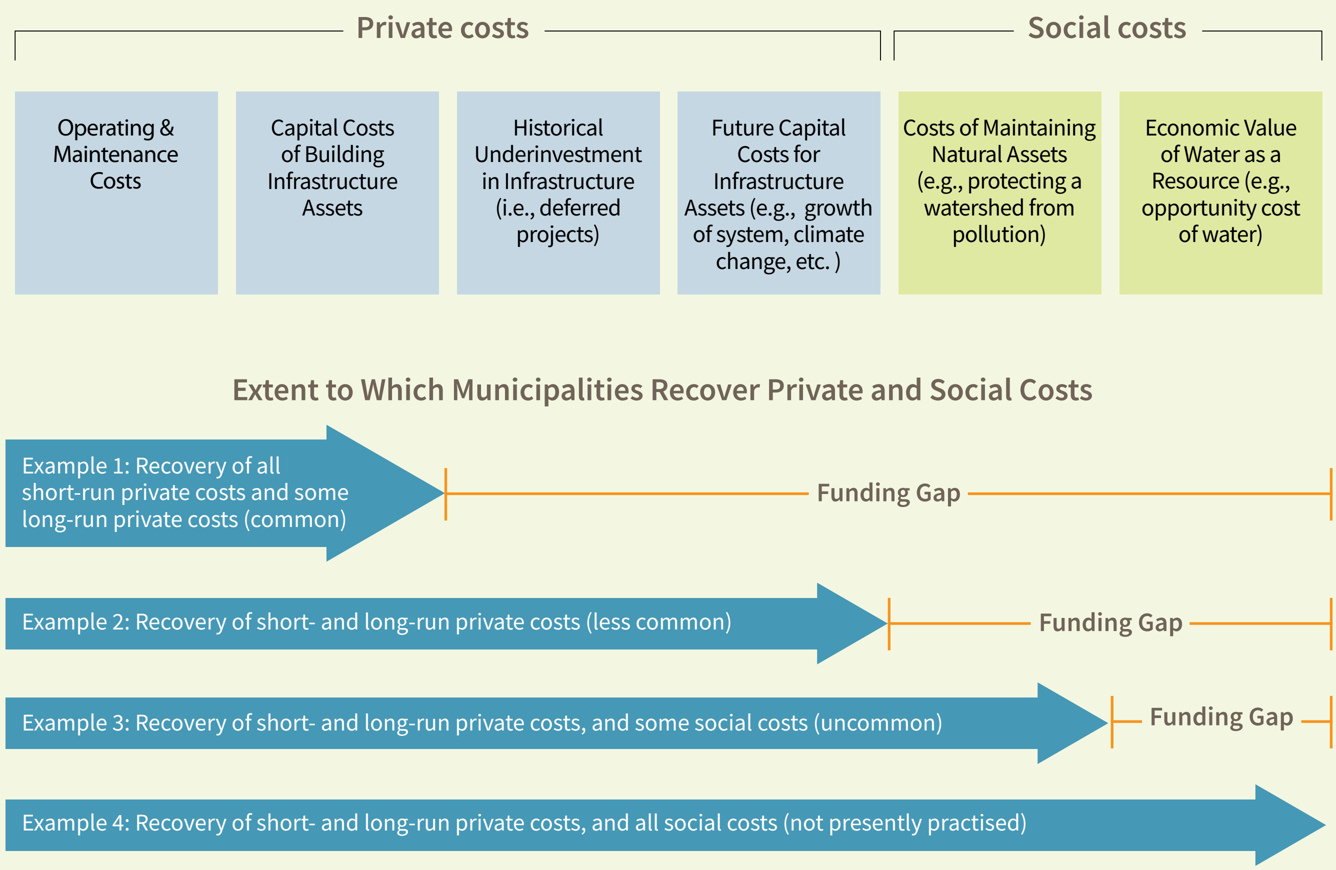
Historically, water utilities have not generated enough revenue to cover their private costs. Prior to the late 1990s and early 2000s, water utilities considered a relatively narrow subset of private costs. In many cases, municipalities only accounted for operating and maintenance costs (Fenn & Kitchen, 2016).

Municipalities have, however, moved toward recovering more costs over the past decade. As of 2009, national accounting standards set by the Public Sector Accounting Board (see Box 3) require water utilities to include the first two cost components in Figure 5 in their financial statements (CWN, 2018). Municipalities must now assess and include the costs associated with building, maintaining, and operating engineered infrastructure over their expected lifespan. For many municipalities, this means measuring and including costs that were previously excluded (PSAB, 2007).[11] This has helped improve municipal asset management and, by extension, cost recovery.

But despite these improvements, municipalities still often fall short of recovering all private cost components shown in Figure 5. Municipalities are not required to estimate and include historical underinvestment and future capital costs in their financial

[9] Note that we define private costs as those directly borne by water utilities, even though most water utilities in Canada are publicly owned and operated.
[10] Future work by the Ecofiscal Commission may look at the role of provincial governments in charging appropriate rates for water to recover all social costs.
[11] See PSAB standard 3150 http://www.municipalaffairs.gov.ab.ca/documents/ms/PSAB_3150_4_toolkit_full_document.pdf

Figure 5: Spectrum of Costs for Municipal Water and Wastewater Systems



This figure shows the spectrum of costs associated with municipal water and wastewater systems. Private costs refer to the costs incurred directly by the municipal water utility, such as the costs associated with building, maintaining, and operating the water and wastewater infrastructure. Social costs are those associated with managing the natural ecosystems that provide critical services, such as lakes, rivers, and aquifers. Full-cost recovery is possible only when water utilities generate enough revenue to cover each of these cost components; otherwise, funding gaps will exist.

statements.[12] This does not prevent municipalities from including these costs within their cost-recovery framework; however, because accounting standards do not require municipalities to measure these costs, they are often excluded.[13]

The historical underinvestment in infrastructure has, for example, created a significant problem. Prior to the recent changes in accounting standards, many municipalities were using an incomplete accounting framework for asset management and cost recovery. In some cases, infrastructure upgrades and maintenance were not properly budgeted for, meaning municipalities generated insufficient revenue to pay for these costs. In other cases, projects required to keep the system in a state of good repair were deferred, making upgrades and repairs costlier in the future.

[12] Historical underinvestment and future capital costs are difficult to estimate and are therefore difficult to reconcile with accounting standards. This is a primary reason municipalities are not required to include these costs within their financial statements.

[13] The American Water Works Association and the Canadian Water and Wastewater Association recommend a broader definition of cost recovery, which includes all the private costs shown in Figure 5, including historical underinvestment and future capital costs (CWN, 2018). These recommendations, however, are non-binding for municipalities.

Box 3: The Role of National Accounting Standards

Accounting standards play an important role in the extent to which municipalities recover their costs.

The Public Sector Accounting Board (PSAB) has been central in these efforts. PSAB is a national arm's-length body and sets accounting standards for municipalities (and other public-sector entities). It determines how municipalities report their costs in their audited financial statements, which are then used by municipal policy-makers to determine how much revenue they need to generate to recover costs.

PSAB does not have the jurisdiction to require that municipalities achieve cost recovery. This is provincial jurisdiction.

Funding gaps from historical underinvestment accumulated over time (Bakker, 2010; NRTEE, 1996; Renzetti, 2009; Sawyer et al., 2005).[14] A recent study by FCM et al. (2016), for example, estimates that the replacement value of water and wastewater assets showing deterioration or failure is an estimated $51 billion. When we consider the value of assets that are deficient (or worse), this number increases to $142 billion. Critically, the longer these investments are delayed, the costlier they become to upgrade or replace (AWE, 2014; Kitchen & Fenn, 2016).

The estimates from FCM, however, understate the magnitude of municipal funding gaps. They exclude several of the private-cost components in Figure 5, including future capital costs, such as accommodating population growth, adapting to climate change, and improving service levels (CWN, 2014). These estimates also exclude the future infrastructure required to meet increasingly stringent federal and provincial regulations.

The size of our funding gap:

FCM estimates that the replacement value of water and wastewater assets that are showing deterioration or failure, or are deficient, is an estimated $142 billion. Critically, the longer these investments are delayed, the costlier they become to upgrade or replace. The City of Winnipeg, for example, recently approved 9.2%, 8.9%, and 7.4% rate increases for water and wastewater for 2017, 2018, and 2019, respectively, to help close its funding gap.

Accounting for the value of natural assets

Municipal accounting standards also exclude social costs associated with municipal water and wastewater systems. As a result, current estimates of municipal costs tend to be too low.

Cost-recovery frameworks have historically excluded the value of natural ecosystems—the rivers, lakes, wetlands, and aquifers that represent the foundation of our water systems, and which are valuable assets. The existing accounting framework recognizes only the direct costs associated with building, maintaining, and operating engineered assets.[15]

As with engineered assets, natural assets can provide genuine goods and services, such as water storage, filtration, flood mitigation, and the water itself. The specific characteristics of these different goods and services depends on the type of ecosystem (i.e., a wetland, forest, or river), its geography, and how people access and use these natural assets.

[14] The funding gap in investment for water and wastewater infrastructure—often referred to as an "infrastructure deficit"—can be defined in different ways. In the broadest sense, the gap in infrastructure investment is the total replacement value of assets not operating optimally, plus the cost of any infrastructure that a jurisdiction requires but has not yet built (Compton et al., 2015). A narrower definition might include only the work required to keep existing assets in a state of good repair. Regardless of the definition, caution should be used when interpreting these estimates. The sources for these estimates often have a vested interest in creating large numbers to build the case for increased federal and provincial funding.

[15] The exception are natural resources that have been purchased by the municipality. In these cases, natural resources *can* be treated like tangible assets; however, most municipal natural assets do not fit this definition

Most people view natural assets as essentially "free." As these assets become damaged and less abundant, however, their true value emerges.

Human activity can have large impacts on the value of these assets through land use, urbanization, and pollution. Unlike engineered infrastructure, where the economic value of an asset is typically equal to its upfront capital cost, most people view natural assets as essentially "free." As these assets become damaged and less abundant, however, their true value emerges. The economic value of a natural asset is, at a minimum, the present discounted value of the flow of goods and services it provides over time. The fact that many of these goods and services are neither priced nor traded in explicit markets in no way reduces their importance or their value. By using our ecosystems sustainably, these assets can be maintained, thus delivering valuable goods and services for many years into the distant future (Hein et al., 2016).

Excluding natural ecosystems from municipal accounting frameworks has implications for recovering costs. Yet ecosystem degradation (such as pollution or water scarcity) does impose real costs, even if the system does not account for them. Allowing natural assets to depreciate due to environmental damage means we must replace them with expensive engineered assets (e.g., building more elaborate water treatment plants to clean contaminated water) or engage in costly remediation and clean up.

2.3 MANAGING WATER QUALITY

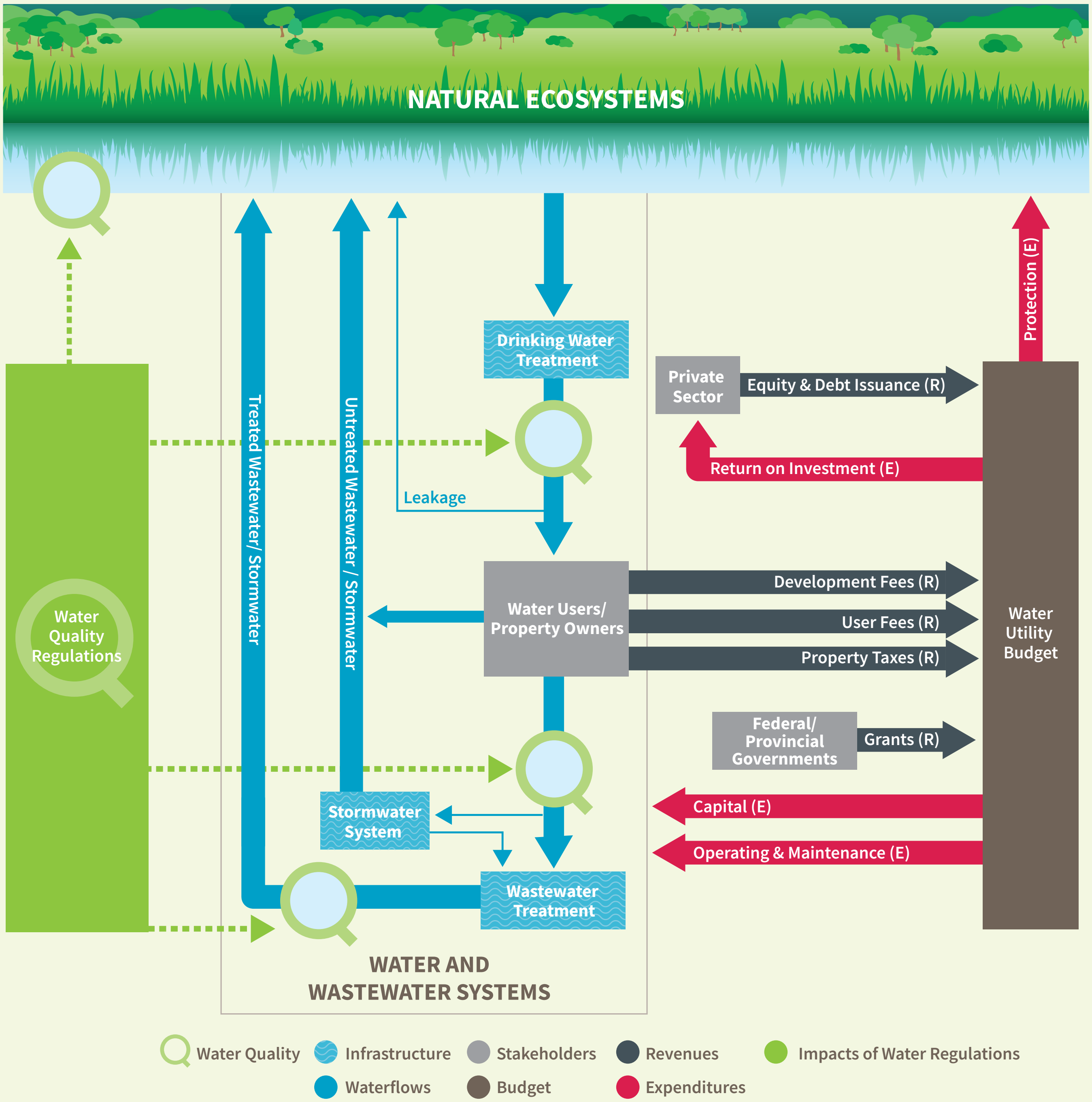
Finally, we consider the role of water *quality* in our conceptual framework. The condition of infrastructure directly affects water quality; so too does the condition and health of natural ecosystems. Further, the financial cost of building and maintaining infrastructure has implications for municipal budgets. Natural factors also affect water quality (e.g., geology, soils and flow rates), but here we focus on human-related impacts to water quality.

Canadians place tremendous value on clean water, though not always in economic terms (RBC, 2017). It is essential for life, but it is also a critical input for economic activity. We drink it, we play in it, we fish in it, and we get immense value from simply knowing it exists as part of Canada's natural landscape. To some, water is a part of their cultural identity. Protecting the quality of our water is of immense importance.

Figure 6 illustrates how water quality interacts with municipal water systems. In this report, we view water quality as a stock, meaning its quality at a point in time. This is a different view from that of water and financial flows that occur over time. In each stage of the water system (e.g., ecosystems, treatment facilities, and end users) there is a certain level of water quality. In some cases, the quality is high (e.g., potable drinking water), in others the quality is low (e.g., untreated wastewater).

The figure also shows the links between infrastructure, water quality, and water quality regulations. We discuss each of these elements in turn.

Figure 6: The Municipal Water System, Financial Flows, and Water Quality Stocks



The figure illustrates water quality at different points in the water system. Water quality is directly affected by infrastructure and environmental regulations. Adopting more sophisticated drinking-water and wastewater treatment technologies, for example, can improve water quality. At the same time, water quality can affect the costs of building and maintaining infrastructure. Poorer water quality, for example, can require more sophisticated and costly treatment technologies.

Box 4: The Water Tragedy in Flint, Michigan

The ongoing crisis in Flint, Michigan, is a reminder of the devastating impacts that poor water quality can have on a community.

In April 2014, Flint, a city of 100,000 residents, changed water utility providers, who in turn switched the city's drinking-water supply from Lake Huron and the Detroit River to the Flint River (Butler et al., 2016). After the switch, improper treatment and aging infrastructure resulted in a series of contamination events that continue to affect Flint's residents.

In the weeks and months following the switch, residents began complaining about the taste and odour of their drinking water; elevated bacteria levels led to boil water advisories; and testing revealed elevated levels of lead and copper. Somewhere between 6,000 and 12,000 children were exposed to lead at levels considered dangerous to human health (Goovaerts, 2017; Rana, 2016; Zahran et al, 2017). Suspensions, firings, and criminal indictments followed. The total social cost of the crisis has been estimated at $400 million (US dollars) (Muennig, 2016).

Protecting water quality requires infrastructure as well as regulations

Begin at the top of Figure 6 with drinking-water treatment. Canadians generally enjoy some of the highest quality drinking water in the world. But with few exceptions, municipalities must treat their water before it can be consumed.

Infrastructure is essential for providing clean water, and so too is the watershed. Compromised infrastructure can increase the risk of contaminated water, which can cause sickness and death. The contamination outbreaks in communities like North Battleford, Attawapiskat, Walkerton, and Flint, Michigan (see Box 4), are tragic reminders of the potential human costs. But incidents need not be catastrophic to impose costs: drinking-water advisories, although preventative, compel residents to spend time and money boiling water or purchasing bottled water (Dupont & Jahan, 2012).

In Canada, provincial and federal regulations play a critical role in ensuring minimum standards for drinking water and directly influence the type of infrastructure that municipalities build and operate. Each provincial government also maintains its own drinking-water regulatory standards for monitoring and testing, construction approvals, laboratory certifications, and public notifications (CCA, 2009).[16] Many provincial regulations were overhauled or re-evaluated after the Walkerton crisis in 2000, which led to changes in water quality regulations and standards across Canada (Bertels & Vredenburg, 2004).[17]

At the beginning of 2015, at least 1,838 Canadian communities were under drinking-water advisories, most of which were caused by poor infrastructure.

Despite improvements in drinking-water infrastructure and more stringent regulations, communities still experience problems with the quality of their drinking water. And many of these problems stem from having inadequate infrastructure. At the beginning of 2015, for example, at least 1,838 Canadian communities were under drinking-water advisories, most of which were caused by poor infrastructure. Some of these drinking-water advisories have been in place for over a decade and disproportionately affect small, rural, and First Nations communities (Chan, 2015; Eggertson, 2015; ECCC, 2016a).

[16] Provincial standards are based on the Guidelines for Canadian Drinking Water Quality, which were developed by the Provincial-Federal-Territorial Committee on Drinking Water (Health Canada, 2017).

[17] In 2000, Walkerton's drinking water became contaminated with E. coli. Seven people died from the outbreak, and approximately 2,300 residents became ill (Ontario Government, 2005).

Wastewater treatment is improving but remains a leading cause of water pollution

Municipal water systems directly impact water quality, as shown in Figure 6. Although most municipalities in Canada treat wastewater before discharging it, municipal wastewater remains a leading source of water pollution. Other leading causes of water pollution include industrial wastewater, nutrient run-off, and stormwater (Environment Canada, 2014a; Statistics Canada, 2017a).

Municipal wastewater originates from the waste and chemicals that households and businesses put down their drains and toilets. It can contain high concentrations of grit, debris, suspended solids, pathogens, decaying organic waste, nutrients, and hundreds of different chemicals. Pollutants from wastewater can accumulate over time, particularly in cases where the receiving body is small or when the wastewater mixes with high concentrations of pollution from other sources (Environment Canada, 2014; Elgie et al., 2016).

When undertreated, municipal wastewater can increase pollution levels and degrade natural ecosystems, contributing to drinking-water contamination, fish and shellfish contamination, eutrophication, and beach closures. In this respect, everyone pays the price for insufficiently treated wastewater (Holeton et al., 2011).

Wastewater treatment processes vary across municipalities and have improved over time.[18] On average, the share of wastewater receiving primary, secondary, or tertiary treatment increased from 1983 to 2009 (ECCC, 2017b). Primary treatment is the most basic type of treatment and removes solids, while secondary treatment also removes biological waste. Tertiary treatment is the most sophisticated type of treatment and removes nutrients and suspended matter from wastewater.

Only a small number of municipalities still discharge raw sewage, a practice more prevalent in coastal provinces, such as British Columbia, Nova Scotia, Quebec, and Newfoundland and Labrador.[19] In fact, the share of raw sewage discharges decreased from 20% to 3% from 1983 to 2009 (ECCC, 2017b). Victoria and Esquimalt in British Columbia, for example, do not have a wastewater treatment plant, and discharge 80 to130 million litres of raw sewage into the Juan de Fuca Strait every day (Hutchinson, 2016). In Quebec, 100 small communities still discharge raw sewage into surrounding waterways (CBC News, 2015a).

Federal and provincial regulations are an important factor in improving the quality of municipal wastewater. The 2012 Federal Wastewater Systems Effluent Regulations (WSER) require high-risk wastewater systems (i.e., those with no treatment) to build secondary treatment facilities by 2020 (Environment Canada, 2012). Approximately 23% of municipal wastewater facilities will require upgrades to comply with these regulations (Statistics Canada, 2017a). Other provincial regulations, such as Quebec's Municipal Wastewater Sanitation Regulations, mirror or exceed the recent federal regulations (Gouvernement du Québec, 2014). These regulations will ensure that no municipality can discharge raw sewage after 2020.

Even with increasingly stringent regulations and sophisticated treatment facilities, municipalities can end up discharging raw or undertreated sewage. In some cases, municipal wastewater facilities receive contaminants they were not designed to treat, such as compounds from pharmaceuticals and personal care products (Holeton et al., 2011).

Combined sewer and wastewater infrastructure—in which sewage and rainwater runoff use the same network of pipes—can also lead to discharges of raw or undertreated wastewater. In these situations, heavy rains can overwhelm treatment facilities and force the sewage/rain mixture to be released into the waterways. The WSER requires that municipalities report the volume of these outflows (Holeton et al., 2011).

Heavy rains in Toronto in 2013, for example, resulted in more than 1 billion litres of raw sewage being released into Lake Ontario in one day (CBC News, 2015b). In Halifax, heavy rains and a series of mechanical failures in 2009 resulted in millions of litres of raw sewage being discharged into the Halifax harbour every day for over a year (Auld, 2009, Bousquet, 2009). Scientists predict that this type of extreme flooding—and the consequent health and safety risks—will increase in severity and frequency due to climate change (McMichael et al., 2006; Trenberth et al., 2015; Arnell & Gosling, 2016).

Water quality affects the cost of water infrastructure

Water and wastewater infrastructure is costly to build and maintain, but it becomes even costlier when water sources are compromised. Dirtier water requires more sophisticated, expensive treatment. In some cases, local water sources that are too polluted may force

18 The quality of effluent typically improves with higher levels of treatment; however, the quality of effluent can vary across treatment levels and facilities, and even within single facilities.

19 The cumulative impacts to the environment from discharged wastewater is different in each municipality, depending on the level of treatment and the characteristics of the receiving body. Wastewater discharged into larger bodies of tidal waters, for example, likely pose a smaller environmental risk than wastewater going into a small lake or stream.

municipalities to use sources that are located farther from the community, increasing transportation and distribution costs.

The small village of La Marte, Quebec, for example, has had a boil-water advisory since 2000 because its water supply is contaminated with fecal coliform. After 22 attempts to find a new well, the village located a new source—two kilometres away. This upgrade requires the construction of a $6 million aqueduct, which the village plans to finance through debt issuance (Bérubé, 2016).

The small village of La Martre, Quebec has had a boil-water advisory since 2000 because its water supply is contaminated.

The health of natural ecosystems has a direct impact on drinking-water quality and the cost of treatment. Aquifers, wetlands, lakes, and streams provide unpriced though valuable water purification services. When these ecosystems become degraded, municipalities often replace them with costly engineered alternatives (Bennett & Ruef, 2016), such as the aqueduct in La Marte.

Although the value of natural ecosystems is not currently considered within the cost-recovery framework, provinces and municipalities are taking steps to protect natural ecosystems. Source-water protection programs, for example, identify and reduce risks to local water supplies and help ensure that water resources are sustainably managed. Such programs can involve many different tools, such as active monitoring, land-use regulations or by-laws, regulation of hazardous substances, forest management practices, and voluntary measures. Municipal programs are often mandated by provincial regulation and form part of integrated water strategies (Simms et al., 2010).

Climate change exacerbates the threats to water quality

Climate change poses additional risks to the quality of municipal drinking water. As average temperatures increase, so do evaporation rates in surface waters, which can reduce overall water supplies and increase the concentration of pollutants and nutrients. Moreover, greater storm intensity can increase turbidity and pathogen levels, which can further increase the treatment costs for drinking water (Statistics Canada, 2017a; Delpla et al., 2009).

Without adequate and resilient infrastructure, climate change also poses problems for wastewater systems. More severe precipitation events increase the likelihood of sewer back-ups and flooding. In Toronto, Montreal, and Calgary, for example, recent extreme weather events imposed significant costs to the water utilities, property owners, and the economy as a whole. Severe precipitation also increases the likelihood of untreated outflows from combined sewer systems, which poses additional risk to the water quality in surrounding watersheds (Herrador et al., 2015; Madoux-Humery et al., 2016; Statistics Canada, 2017a).

Canada's coastal municipalities face the additional threat of rising sea levels and larger storm surges. These events increase the risk of saltwater infiltration of fresh-water sources, which can permanently affect their quality (Barlow & Reichard, 2010; BCWWA, 2013a).

2.4 USER FEES AS AN ECOFISCAL SOLUTION

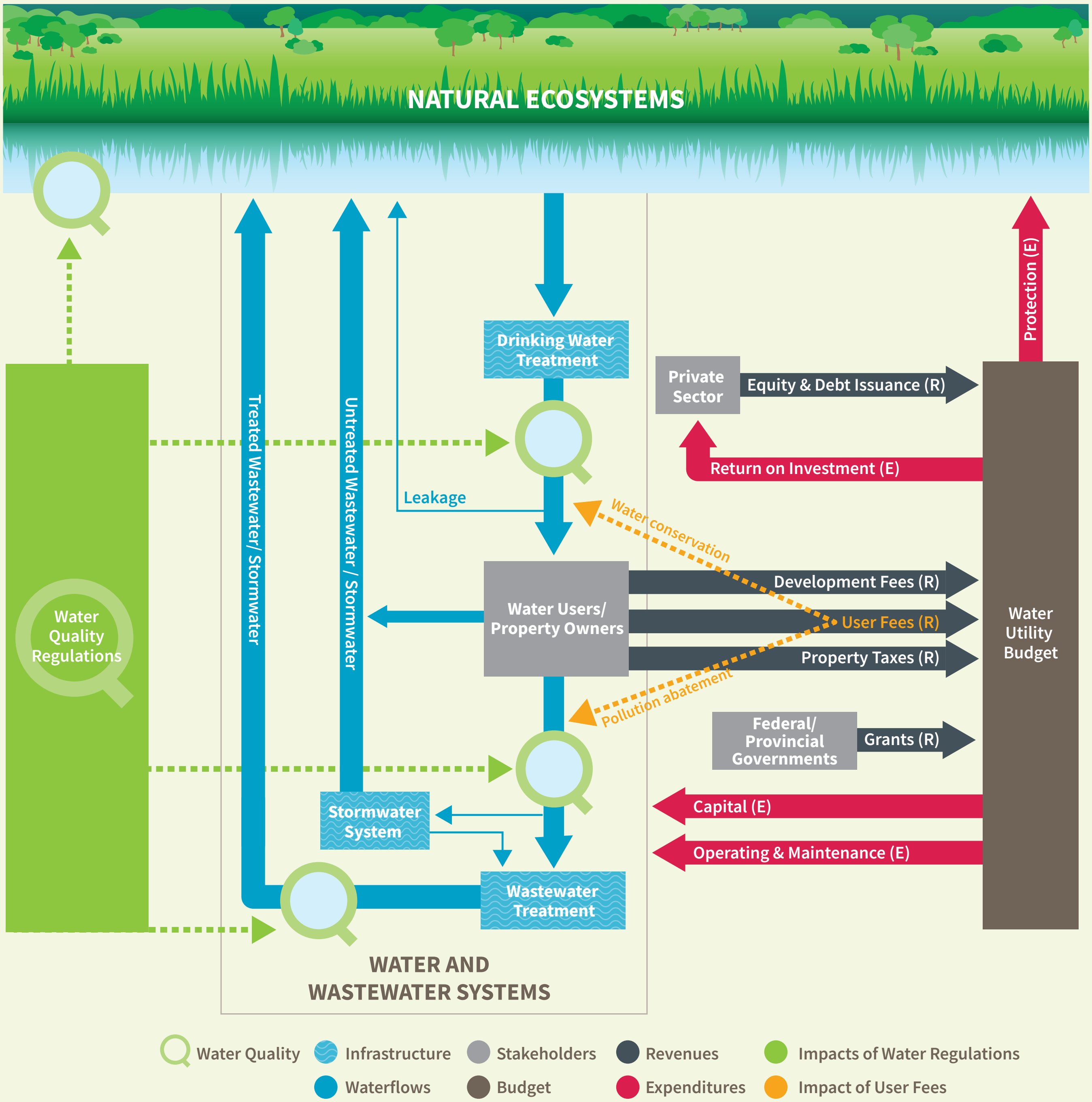
We have so far explored three interconnected problems facing municipal water systems:

1. Canadians consume relatively large quantities of water, which is especially problematic in those regions where clean water is becoming scarcer.
2. Municipalities struggle to fund and maintain the infrastructure necessary to provide sustainable water and wastewater services.
3. Insufficient infrastructure compromises the quality of drinking water and wastewater, which often has negative effects on the value of our natural assets.

These are complex and dynamic problems, complicated by climate change and urbanization. A full set of policy options and solutions to address them may be similarly complex.

One policy tool, however, sits at the nexus of addressing these three problems: user fees. Figure 7 illustrates how user fees have implications for financial flows, water quantity, and water quality. The next section takes a closer look at how user-fees work, and why they should play a greater role in Canada's municipal water systems.

Figure 7: User Fees Sit at the Nexus of Municipal Water Systems



The figure above shows each of the different layers of our model: water flows and the physical water system, financial flows, and the state of water quality throughout the water system. User fees sit at the nexus of municipal water systems. They are both a source of revenue and a price signal that incentivizes water conservation and pollution abatement.

3 USER FEES AND THE ECONOMICS OF MUNICIPAL WATER SERVICES

User fees can both generate *revenue* and act as an important *price signal*, which is why they sit at the nexus of solutions to the major financial and environmental challenges facing municipal water utilities. These two functions of user fees can help water utilities recover costs, encourage water conservation, and maintain clean and safe water. While user fees alone are not a panacea for all municipal water problems, they do have a key role to play.

User fees for water and wastewater are not all the same—and their design is crucial to their operation. Smart design can help municipalities balance multiple, sometimes competing objectives. Poor design can weaken both economic and environmental outcomes.

This section explores the benefits of user fees as a tool to improve cost recovery, water conservation, and water quality. We show how the economics of water and wastewater services point to user fees—particularly user fees with mixed-rate structures—as a solution for municipalities. We also assess important challenges municipalities can face in implementing user fees, including legal, economic, and governance barriers, as well as concerns about the affordability of water services.

3.1 A PRIMER ON USER FEES

User fees are monetary charges for goods or services provided by municipalities, paid by individuals, households, or businesses. Municipalities have a long history of charging user fees for garbage collection, access to recreational facilities, concession sales, and water and wastewater. These municipal services are particularly suited for user fees, as their consumption (or use) can be measured and charged accordingly (Ontario Government, 2005; Althaus & Tedds, 2016).

Legal constraints around how user fees can be applied distinguish them from taxes. According to Canadian case law, the amount charged through user fees must reflect the costs of providing the service, cannot exceed those costs (within a reasonable limit), and the revenues must be clearly earmarked for paying for the service.[20] Unlike tax revenues, user fees cannot go into the municipality's general revenues.

From a legal perspective, the primary objective of user fees must be cost recovery. Municipalities can implement user fees with additional objectives—such as water conservation—but, from a

[20] Municipalities can generate surplus revenues if they are designated for financial reserves. These reserves are then used in future years to help pay for capital projects, or to offset unexpected drops in revenue.

legal perspective, the fee must first and foremost be implemented to recover costs. However, as we discuss later in this section, it is unclear to what extent municipalities can employ user fees to help cover the social costs we described in Figure 5 (Althaus & Tedds, 2016).

Municipalities that employ user fees base them on the private costs of building, operating, managing, and maintaining, water and wastewater infrastructure. Residents and businesses are billed monthly or quarterly based on the costs of providing drinking water, and are typically charged a separate fee for wastewater.[21] Importantly, user fees do not represent the economic value of the water itself; they represent only the direct costs associated with providing the service.

User fees do not represent the economic value of the water itself; they represent only the direct costs associated with providing the service.

Municipalities can choose between different types of user fees for water and wastewater. User fees can be a fixed amount or can be volumetric—varying with the amount of water used. For reasons discussed throughout this section, the optimal design of user fees typically incorporates both a fixed and volumetric component (Brandes et al., 2010).

Fixed fees are the most basic type of user fee; residents and businesses are charged a fixed amount, regardless of the amount of water used. Fixed fees therefore do not require water meters on households and businesses. In some cases, the fixed amount is based on the size of the connection (with higher fees for bigger connections). Municipalities often levy other smaller, one-time fixed fees that are unrelated to consumption levels, such as fees for new water connections, water meter installation, and fire-protection services (AWE, 2014).

Volumetric water fees come in three varieties. Because the amount charged depends on the amount of use, all three varieties require the use of water meters. *Constant unit rates* are the most common type of volumetric fee. Higher water use results in a more expensive water bill; however, whether a household uses 10 cubic metres per month or 1,000 cubic metres, the customer pays the same amount for each unit. The City of Regina, for example, charges households \$1.88/m^3 for drinking water and \$1.68/m^3 for wastewater. These volumetric charges are in addition to its fixed rate (City of Regina, 2017).

Increasing block rates charge higher per-unit fees for greater quantities of water consumed. To keep this type of rate structure simple, water utilities typically establish a few different "blocks" of water use. The City of Kelowna, for example, charges households a fee of \$0.43/m^3 for the first 30 cubic metres used per month, \$0.58/m^3 for additional use up to 80 cubic metres per month, and \$0.87/m^3 for all additional water used beyond 80 cubic metres per month. Kelowna also charges a monthly fixed fee of \$12.53 (City of Kelowna, 2017).

Finally, *declining block rates* decrease as the amount of water consumed increases. Users still pay for incremental water consumption but they pay a smaller rate for volumes consumed above defined thresholds. Declining block rates are often used for large water users and to encourage economic development. The City of Hamilton, for example, charges all in-city water users (residential, commercial, industrial) based on a decreasing block schedule, charged monthly. Users pay \$0.77/m^3 for the first 28 cubic metres used per month, \$0.76/m^3 for additional amounts used up to 1416 cubic metres per month, \$0.73/m^3 for amounts up to 67,960 cubic metres per month, and \$0.49/m^3 for any additional monthly water use. Rates are also higher for suburban and rural areas (City of Hamilton, 2017).

Volumetric user fees can also be designed with specific incentives to encourage conservation. A municipality can introduce a rate for excess use, for example, charging water users a higher price for consumption above a given threshold. Municipalities can also implement seasonal surcharges, where consumers pay less for water during wetter seasons and more during the drier summer months (Renzetti & Dupont, 2017). Lastly, water can be charged based on the time of day to reduce peak demand, similar to how electricity is priced in some provinces.

In addition to charging fixed or volumetric fees for water and wastewater, user fees can be designed to create direct incentives for reducing pollution. This type of user fee, called an *over-strength charge*, is typically applied only to the wastewater from large industrial emitters. Fees are often specific to each pollutant that a facility emits and based on the weight or volume of the discharged pollutant. We return to over-strength charges below.

These design choices—i.e., fixed fees, volumetric fees, or specific charges that incentivize conservation or pollution abatement—have important implications. As the next sections explore, these design

[21] These wastewater fees can be a fixed or variable amount, or a combination of the two. And because wastewater is typically unmetered in most municipalities, volumetric wastewater rates are typically set as a percentage of drinking-water use. In Regina, for example, wastewater rates are set at 89% of drinking-water rates; whereas wastewater rates in Charlottetown are more than double the volumetric rate for drinking water (City of Charlottetown, 2012; City of Regina, 2017).

Box 5: Price Elasticity: How Water Users Respond to Changes in Price

Measuring *price elasticity* isolates how consumer demand responds to changes in price. Demand for a good or service is considered elastic when it is sensitive to changes in the price and inelastic when it is less sensitive to changes in price.

For example, if the price of a good increases by 10% and the quantity demanded falls by 15%, then demand is considered relatively elastic. If the price of a good increases by 10% and the quantity demanded falls by only 5%, then demand is relatively inelastic. If the quantity demanded for a good is entirely unresponsive to changes in its price, demand is said to be *perfectly inelastic*.

Demand for water is responsive to prices, but relatively inelastic in most cases (Brandes et al. 2010; CMAP et al., 2012). Several estimates find that the mean elasticity for household water demand is between -0.2 and -0.6, meaning that a 10% increase in the price of water results in a 2% to 6% decrease in the quantity demanded. In the short run, elasticity estimates tend to be at the lower end of this range, between -0.2 and -0.4. The response to higher water prices becomes stronger (more elastic) over time, as consumers have more time to change their behaviour and adopt conservation measures. Better information on the cost savings of conservation can also augment the pricing signal (Olmstead et al., 2007; Dalhuisen et al., 2003; Epsey et al., 1997; US EPA, 2003; Nauges & Thomas, 2003; Althaus & Tedds, 2016; AWE, 2014).

The price elasticity for industrial water use is estimated to be higher than for households. The US EPA, for example, estimates that the price elasticity of industrial water demand is roughly -0.5 to -0.8. This means a 10% increase in price would result in a 5% to 8% decrease in consumption (US EPA, 2003). Businesses may economize by reassessing where and by how much they can reduce their water consumption (Renzetti, 2009).

Price elasticity can be different at different price levels: the higher prices get, the more elastic demand becomes (Brandes et al., 2010). As the price rises, water users become more responsive to price changes: households may choose to use less water for non-essential purposes such as watering their lawns or washing their cars.

The price elasticity of water demand is also influenced by income. Demand is more elastic for lower-income households, as they are generally more sensitive to changes in price due to tighter household budgets (Howe, 2007).

Given the low price elasticity, if a water utility relies exclusively on volumetric rates, an increase in the price of water should result in a relatively small reduction in use and thus an increase in total revenue. However, other factors that drive conservation can reduce overall demand and cause revenues to decline.

choices affect the extent to which municipal water utilities balance the three objectives of revenue generation, water conservation, and improved water quality.

3.2 USER FEES AS A CONSERVATION TOOL

As we discussed in Section 2, Canadians pay some of the lowest prices for water and wastewater in the world. Not coincidentally, we are also some of the biggest per capita users of water. Charging user fees for water and wastewater that reflect the full private and social costs of providing the service would encourage greater conservation. But the benefits would not just be environmental—greater conservation can also improve the efficiency of the entire water system by reducing operating and capital costs.

User fees can encourage households and businesses to use less water

Water is essential for life, public health, and commerce. Yet beyond a certain threshold, much of the water we use is discretionary or even wasteful. Environment Canada (2010), for example, estimates that half of Canadians' daily consumption of water is wasteful. The

Box 6: The Importance of Metering

Installing water meters is necessary for measuring water as an essential, yet scarce resource. Meters allows water utilities to measure the throughput of the water system and provide water users with feedback on their use.

With volumetric user fees, water meters allow utilities to charge users based on the extent to which they use water services, similar to how household power meters allow electricity utilities to charge based on total consumption (Boyle et al., 2013).

Water meters can also provide data on water use, leaks, and the distribution network more broadly (Brandes et al., 2010). Newfoundland and Labrador, for example, has the lowest rate of metering in the country (Environment Canada, 2009b). Not coincidentally, it also has the highest percentage of unknown water use (72%) (Statistics Canada, 2017a).

The economic case for installing water meters is different in each community and depends on local factors. A key challenge is the high up-front cost of installation, especially in smaller communities where costs are spread over a narrower rate-base.

Still, municipalities of all sizes in Canada have adopted universal metering. Metering infrastructure can pay for itself over time by reducing leaks and consumption and deferring the need for costly system expansions (Morgan, 2006; Mutchek & Williams, 2014; Waller & Scott, 1998).

presence of such discretionary consumption suggests that higher prices could affect water use.

Environment Canada estimates that half of Canadians' daily consumption of water is wasteful.

The more residents pay for water and wastewater services, the greater incentive they have to use less. Detailed studies provide evidence that households and businesses do respond to higher water and wastewater prices by using less water (Dalhuisen et al., 2003; Dupont & Renzetti, 2001; Kitchen & Slack, 2016; Williams & Suh, 1986). The magnitude of the response is referred to as the price elasticity of water demand (see Box 5).

User fees, in other words, let water users see the direct link between water use and the costs of producing, treating, and delivering water services (AWE, 2014). When priced on a volumetric basis, they provide a marginal incentive to conserve—each additional unit of water saved represents an incremental amount saved. This price response typically becomes stronger over time, as higher water and wastewater rates encourage households and businesses to replace their appliances and machinery with more water-efficient technologies.

The price of water is not the only factor that affects water demand (Renzetti et al., 2015). Household characteristics typically have a strong effect, such as household size, income, and education level (Dupont & Renzetti, 2013). So too do cultural factors, such as lifestyle and personal attitudes (Howe, 2007).

Plumbing and building codes also have a large impact on water consumption. The National Plumbing Code, for example, specifies efficiency requirements for new water appliances, which have become more stringent over time (NRCC, 2016). Provincial building codes have also tightened the requirements for low-flow appliances in new buildings (BMA, 2017).

All of this suggests that user fees are only one part of the policy solution in managing conservation—though an important one.

Gains in conservation from user fees depend on their design

The type of user fee directly affects the price signal to consumers, and therefore plays a key role in water conservation. All else equal, volumetric user fees encourage higher rates of conservation than fixed user fees (Brandes et al., 2010). One of the main reasons is that volumetric fees charge users for additional water consumption, strengthening the incentive to conserve. Volumetric fees also require water meters on each household or business, which provides regular feedback to customers on their water use (see Box 6). Separate volumetric user fees for wastewater provide an additional signal to consumers that using more—or in this case, wasting more—is costlier.[22]

Canadian households with volumetric user fees used 65% less water than unmetered households with fixed rates.

Based on data from Environment Canada (2011), Canadian households with volumetric user fees used 65% less water than unmetered households with fixed rates. Similarly, a study in Quebec found that municipalities with volumetric fees used 74% less water than those with fixed fees (Minardi, 2010).[23]

Different types of volumetric fees can also generate different conservation responses. Increasing block rates and constant unit rates tend to generate the largest response in water demand, as people pay increasing rates for greater consumption (Baerenklau et al., 2013; Brandes et al., 2010; Olmstead et al., 2007; Renzetti, 2009).[24] Decreasing block rates, on the other hand, tend to provide a weaker conservation signal. In each case, the pricing signal from each type of rate structure depends on how it is designed (see Box 7).

User fees can help reduce operating, maintenance, and capital costs

In addition to the environmental benefits, water conservation can also reduce the costs of municipal water systems. Some of these cost savings are immediate: lower demand, for example, reduces the need for pumping and treatment. This can save water utilities the cost of chemicals and energy used for treating water and wastewater, and can also reduce greenhouse gases (City of Guelph, 2016; Brandes et al., 2010).[25] User fees—while not the only driver of water conservation—play a major role in these gains. The combination of water meters and volumetric user fees can also help reduce water leakage, which improves cost recovery and conservation efforts.

In growing communities, water conservation can reduce the costs of building new water and wastewater infrastructure. Each water system is built to accommodate peak water use, which is typically during the summer months (Dewees, 2002). When the price of water and wastewater does not fully reflect private and social costs, the result is an artificially high level of demand (Brandes et al., 2010). Municipalities then overbuild infrastructure to accommodate excessive demand, increasing overall costs (Fenn & Kitchen, 2016).

Improving conservation also means water utilities in growing communities can defer finding new water sources when faced with increased demand (CMAP et al., 2012). Utilities can stretch existing supplies and do more with less, which helps protect watersheds and reduce costs (AWE, 2014). In Westminster, Colorado, for example, water conservation allowed the community to defer infrastructure upgrades, which saved residents approximately 80% on their water bills.

User fees are one of the most cost-effective ways to conserve water

Municipalities use several measures to improve water conservation. Some of these measures are preventative, such as information campaigns that encourage mindful water use or government rebates for adopting low-water technologies. Other policies are reactive, often during times of water shortages, including restrictions on the recreational use of water or bans for watering gardens, lawns, and golf courses.

While some policies can be effective at encouraging conservation, user fees can generally be designed to achieve conservation at a lower cost (Mansur & Olmstead, 2012). User fees

[22] Installing wastewater meters—separate from drinking-water meters—might increase overall efficiency. This is because some water does not end up in the sewer and wastewater system (i.e., outdoor water use). Having wastewater meters would ensure that households and businesses pay an amount that more accurately reflects the amount of wastewater produced. It is unclear, however, whether these gains in efficiency would offset the cost of installing wastewater meters.

[23] While the observed differences in water use cannot solely be explained by volumetric pricing, the findings nonetheless provide strong evidence that volume-based rates influence demand (Brandes et al., 2010).

[24] In practice, the conservation signal for constant unit and increasing block rates may be similar. This is because most increasing block rates have only three, sometimes four, price categories. The threshold between rate categories is so large, most people comfortably fall into one of these categories, signalling no clear risk of falling into the next pricing block (Brandes et al., 2010).

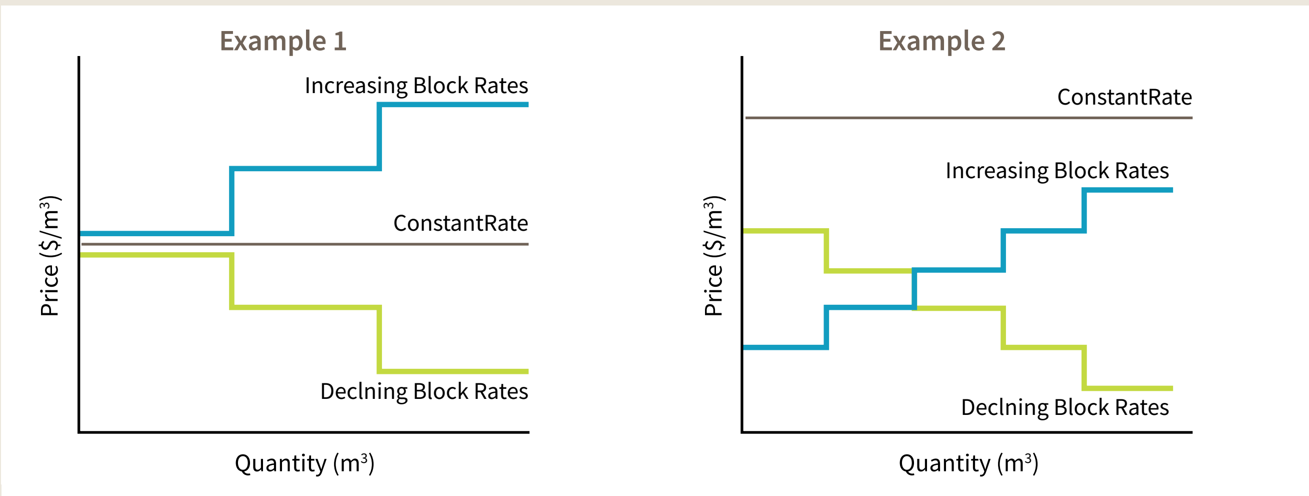
[25] Wastewater treatment plants require significant amounts of energy. In Ontario, for example, the energy required to pump, treat, and distribute water and wastewater represents one-third to one-half of a municipality's total electricity consumption. Water conservation therefore offers significant potential for energy savings, and reductions in GHG emissions (Maas, 2009).

Box 7: The Design of Volumetric Fees Affects the Price Signal

Different volumetric fees provide different incentives. All else equal, increasing block rates provide the strongest price signal by reflecting the increased costs associated with consuming more water. However, the strength of the price signal ultimately depends on how fees are designed.

Example 1 below shows the three different rate types starting at the same price. In this configuration, increasing block rates provide a stronger price signal that increases over time relative to the other two rate structures.

In Example 2, however, the three rates have different starting points. In this configuration, the constant rate provides a relatively strong price signal. The declining block rate starts at a higher price than the increasing block rate, providing a stronger signal for the first two blocks. The size of each incremental block is also much smaller in the second example, which provides a more frequent signal to consumers.



Across all volumetric fee structures, the price level is the key factor in determining the strength of the price signal (Sawyer et al., 2005). A higher price will typically result in greater conservation. The fee structure also matters for increasing and decreasing block rates. These incremental changes can approximate the marginal costs of providing the service.

help allocate water by giving people flexibility in choosing how they respond to higher prices (Howe, 2007). For some water users, an increase in price encourages them to conserve. For these people, the amount they save on their water bill is worth more to them than the value of the water they conserved. Others may not change their habits at all; to these people, the value of using the water is greater than the cost savings from conserving. Overall, this flexibility results in conservation occurring at the lowest total cost.

By contrast, other conservation policies are typically less flexible and have a higher economic cost. Water restrictions, for example, mandate that all water users, regardless of how they value water, must reduce their consumption by a given amount (Mansur & Olmstead, 2012; Renzetti, 2009). And rebates for water-saving technologies and information campaigns can result in significant conservation gains but typically only at high cost.

By contrast, user fees generate revenue while simultaneously conserving water (Brandes et al., 2010; Platt & Delforge, 2001).[26]

That user fees can achieve conservation at lower cost does not imply that other conservation policies are not effective or useful. In fact, other conservation policies can be important complements to user fees (Bruneau et al., 2013; EEA, 2017). Providing water users with more information on their consumption, for example, helps them make more informed choices about their water use. It can also clarify the cost of providing the service (AWE, 2014). Similarly, rebates and subsidies can help low-income households adjust to higher water prices, and can provide incentives to landlords to install water-saving technologies.[27]

Combining universal metering and user fees with other conservation measures is common across Canadian municipalities. The City of Guelph, for example, has several different conservation programs in addition to having volumetric user fees (City of Guelph, 2016). The City of Leduc (2015) also integrates user fees with a suite of complementary policies, such as voluntary lawn-watering restrictions, educational resources, and rebates for water-smart appliances.

Finally, some communities will inevitably face water shortages in the future—even if they set user fees at levels sufficient to achieve full-cost recovery. In these cases, achieving cost-effectiveness will (rightly) be of lower priority relative to the immediate concerns of ensuring that residents have access to water. These cases may call for emergency measures, such as water-use restrictions.

3.3 USER FEES AS A REVENUE GENERATOR

User fees generate revenue to recover costs. They can help municipalities reach full-cost recovery and reverse the effects of decades of underinvestment in infrastructure. User fees can also make water utilities more financially independent, less reliant on funding sources from outside the local government.

Yet there is a tension between the revenue and pricing functions of user fees. If municipalities lean too heavily on volumetric user fees, the combined impact from higher prices and other conservation measures may result in less revenue. Conversely, higher fixed fees may be better for ensuring stable revenues but they provide a weak price signal to drive conservation.

This section assesses the benefits of user fees as a revenue-generating tool. We also look at how the tension between conservation and revenue generation can be addressed through smart design—striking a balance between fixed and volumetric fees.

User fees allow municipal water utilities to align cost recovery with long-term objectives

User fees create a direct link between municipal water utilities and the costs of providing the service (Fenn & Kitchen, 2016; Drummond Commission, 2012). These linkages give water utilities a degree of control and autonomy that is not possible with other revenue tools (BCWWA, 2013b). User fees are designed and set by water utilities, which allows the alignment of cost recovery with other core objectives. Having more control over revenues also allows water utilities to make more informed decisions about long-term capital and operational planning, and helps avoid large and unexpected jumps in rates.

User fees can also improve the overall accountability of how municipal water systems are financed. Unlike other revenue tools, user fees allow residents and businesses to see exactly what they are paying. With better information on the costs of service, water users have a better idea of how water services operate and therefore have a direct stake in ensuring their efficient operation (Bazel & Mintz, 2014).

Lastly, charging user fees to recover costs can benefit small municipalities, which generally have fewer technical and managerial resources at their disposal. By generating revenues from user fees, small municipalities can acquire the technical and managerial expertise required to make basic improvements, such as installing water meters or developing asset-management plans (US EPA, 2006). The challenge, however, is that municipalities often need this technical expertise *before* introducing user fees.

Municipalities can achieve full-cost recovery while driving conservation

We have seen that conservation has both environmental and economic benefits. But when setting rates, water utilities must balance conservation and economic efficiency with cost-recovery objectives, which often pull in different directions. Higher volumetric fees, for example, encourage more conservation, which may undermine revenue generation.

[26] The price signal from user fees can be a more powerful signal to conserve than other measures. Research by Dupont and Renzetti (2013), for example, finds that water and wastewater pricing has a stronger effect on the adoption of water-saving technologies than non-pricing measures.

[27] The tenant-landlord relationship is an example where neither party has a clear incentive to invest in water-saving technologies. The landlord may be hesitant to invest in new low-flow toilets because they are more expensive, and the savings would be realized by the tenants. Alternatively, tenants have little incentive to invest in new water-saving technologies, as they do not own the property. Regulations for water-efficient appliances, however, helps reduce this issue in the long term. As older appliances begin to fail, landlords have no choice but to replace them with new, more efficient appliances.

The flexibility of user fees allows municipalities to directly address these often-divergent objectives. In fact, using a combination of fixed and volumetric fees—known as a multi-rate approach—is common (FCM, 2006).[28]

Adopting a multi-rate user fee allows utilities to design the fee in a way that closely aligns with the cost structure, thus encouraging efficiency (Coase, 1946; Porcher, 2014). Roughly 90% of municipal water system costs are fixed and do not vary with the amount of water provided, such as the costs associated with building and maintaining the infrastructure (CWN, 2018; FCM, 2006). Recovering some or all of these fixed costs with a fixed fee ensures water utilities have sufficient and stable revenues.

Roughly 90% of municipal water system costs are fixed. Roughly 10% are variable

A much smaller portion of municipal water costs is variable (roughly 10%), such as energy and chemicals, which change with the amount of water treated, processed, and delivered. To cover these variable costs, a municipality can levy a volumetric fee in addition to the fixed fee. This volumetric component maintains the price incentive to drive conservation.

Striking the optimal balance between fixed and volumetric user fees can be challenging. Recovering a utility's fixed costs with a fixed user fee provides a high degree of revenue stability; however, because most costs are fixed, equating fixed costs to the fixed fee would provide a negligible price signal. Relying mostly on volumetric fees, by contrast, can provide a strong price signal but it can also result in unpredictable revenues.

Most municipalities with multi-rate user fees have addressed this issue by setting a fixed fee that is lower than the amount required to fully recover fixed costs. The remainder is generated through a volumetric fee to ensure that households and businesses have a clear incentive to conserve. While the optimal ratio of fixed to volumetric fees will differ in each municipality, the FCM (2006) recommends that municipalities concerned with both efficiency and conservation should have a fixed fee that represents no more than 15% of total revenue.

Fixed versus variable costs:

The Cape Breton Regional Municipality generates roughly 70% of its revenue from volumetric charges and 28% from fixed fees.

An example of the challenge in striking this balance is provided by London, Ontario. Prior to 2012, London's variable water and wastewater fee recovered roughly 99% of its total costs, even though fixed costs represent only 60%–80% of total costs (BMA, 2012). Revenues were therefore extremely sensitive to changes in consumption. From 2001 to 2015, total water consumption dropped by 26%, resulting in recurrent budget deficits (BMA, 2017). Since 2013, London has increased its fixed user fee to provide greater revenue stability. Volumetric-based revenues now account for roughly 70% of revenues instead of 99%—which aligns more closely with industry best practices (BMA, 2017; FCM, 2006).

We return to the design of user fees in Sections 4 and 5, where we take a closer look at the opportunities and challenges with designing an effective multi-rate approach.

3.4 IMPROVING WATER QUALITY THROUGH USER FEES

Well-designed user fees can improve water quality. Many of the improvements come from increased conservation and adequate and well-funded infrastructure.

Conservation gains from user fees impact water quality in different ways

User fees for water and wastewater strengthen incentives to conserve water, which can affect water quality in different ways. Conservation in turn has several key benefits.

First, conservation diminishes stress on the local ecosystems that support the municipal water system (BCWWA, 2013a). The capacity of ecosystems to purify water, for example, is weakened when water levels are drawn past certain thresholds. Doing so therefore increases health risks and costs of treating drinking water and threatens biodiversity.

[28] When setting prices, utilities sometimes consider both average and marginal costs. The distinction between these two different types of costs highlights the important tension between economic efficiency and cost-recovery. Rates based on marginal costs (e.g., the cost associated with treating/delivering the next unit of water) can maximize economic efficiency, yet do not necessarily recover all costs. Conversely, rates based on average costs (e.g., the total capital and operating costs of the system divided by either output or number of connections) can fully recover costs, yet can distort incentives for consumers and result in a less economically efficient outcome (AWWA, 2017; McNeill & Tate, 1991).

Box 8: Using Industrial Over-Strength Charges to Cover Costs and Reduce Pollution

To help cover the costs of treating industrial sewage, a small number of municipalities have introduced over-strength charges.

This type of user fee charges industrial emitters based on the type and volume of their effluent. These charges are in addition to other user fees for water and wastewater. Rates are based on the properties of each major class of pollutants and approximate the costs to municipalities for treating the pollution.

Over-strength charges often kick in only after an emitter exceeds a specified concentration of pollution. The City of Calgary, for example, charges over-strength fees—in addition to regular wastewater fees—when their lab tests show that a business is releasing concentrations of wastewater above the allowed limits (City of Calgary, 2017). The City of Brantford applies over-strength fees in a similar manner; the city enters an "over-strength discharge agreement" with each emitter that exceeds the city's allowable limits (City of Brantford, 2014).

Although over-strength fees are primarily used to recover the costs of treating industrial-grade pollution, they can play an important role in pollution abatement. Depending on the pricing design, over-strength fees send a direct signal to firms to reduce the amount of waste going into the municipal system. To reduce compliance costs, firms have an incentive to reduce the amount of pollution emitted or to build and operate their own wastewater treatment system.

The application of over-strength fees is still relatively new in Canadian municipalities, partly because their use requires technical by-laws and substantial data and analysis on the effluents of individual emitters. In addition, most industrial wastewater emitters are not connected to a municipal grid. In these cases, municipal over-strength charges are not applicable, yet the problem of pollution from industrial wastewater remains.

Future work by the Ecofiscal Commission will look specifically at the problem of industrial wastewater and the application of over-strength fees.

Second, water conservation equips water systems to better handle extreme precipitation events, which in turn helps avoid discharging raw sewage into natural water systems. As discussed earlier, many municipalities with combined wastewater and stormwater infrastructure end up discharging raw sewage when water systems become overwhelmed by heavy rainfall. Conservation driven by higher user fees can reduce the throughput in the water system, thereby leaving spare capacity available for heavy rainfall. In addition, the revenues generated from user fees can be recycled back into improving wastewater infrastructure to reduce the likelihood of untreated overflows.

Impacts from water conservation also cut the other way. User fees for water and wastewater incentivize households and businesses to use less water, but not necessarily to pollute less. People may use less water, but the volume of household or industrial cleaners, or the amounts of human waste, likely remain the same. Water conservation can therefore increase the concentration of pollution within the water system, meaning the water becomes more expensive to treat. It could also increase the corrosion of water pipes, leaving municipalities with higher and earlier replacement costs. In these cases, regulations on industrial and household products may be more appropriate.

User fees can also be designed to specifically improve water quality from industrial facilities. Industrial wastewater typically contains much higher concentrations of pollutants than residential or commercial wastewater (Government of Ontario, 2016). And because most municipal wastewater treatment plants were not designed to treat such high concentrations of heavy metals and organics, industrial effluent can increase the costs for municipalities to properly treat the wastewater. To deal with these issues, and to provide a financial incentive to reduce industrial wastewater, municipalities can implement over-strength charges (see Box 8).

Revenues from user fees help pay for infrastructure improvements

User fees for water and wastewater help recover the costs specifically related to the infrastructure that provides the service. The revenues help ensure that water and wastewater systems are adequately funded to maintain consistent and safe levels of service and reduce the risk of infrastructure failure.

Better wastewater infrastructure also has impacts on downstream communities. Because wastewater can be a major contributor to pollution, adopting sophisticated treatment technologies can reduce the likelihood of contamination to drinking water for communities that use the same water sources for drinking, fishing, and recreation.

3.5 CHALLENGES WITH REFORMING USER FEES IN CANADA

The previous sections explored the economic and environmental case for charging user fees for municipal water and wastewater. We examined how using a multi-rate structure for user fees can improve full-cost recovery, water conservation, and water quality. We also examined how greater conservation driven by user fees can reduce the stress on the natural ecosystems that support our municipal water.

But if the case for user fees is so strong, why are so many Canadian municipalities reluctant to charge water and wastewater rates that reflect the full private and social costs of providing the service? Here we explore some of the key barriers to reforming user fees.

Municipalities still rely on outside funding for water and wastewater systems

The share of municipalities that charge user fees for water and wastewater is increasing. Despite this trend toward user fees, however, most municipalities still rely on funding instruments that are external to municipal water systems. In Quebec, for example, most municipalities rely on property taxes or other charges based on property values (see the Montreal case study in Section 4). In these cases, municipalities can improve economic and environmental outcomes by shifting toward user fees.

Another source of external funding—common in municipalities across Canada—is provincial and federal grants. These funds help pay for capital projects and serve the broader objective of ensuring that Canadian municipalities have comparable levels of water and wastewater services.

One problem with grants as they currently exist, however, is that they can distort municipalities' incentives. Canadian case law suggests that user fees can be set to cover only the (net) costs of the water system, which means any funding that comes from grants can no longer be collected through user fees. This can discourage municipalities from setting rates that reflect full private and social costs (AWWA, 2017). Similarly, municipalities may be hesitant to raise the funds needed to pay for required infrastructure upgrades if they know provincial and federal grants are available (Slack, 2009).

User fees are typically set at levels too low to fully recover costs

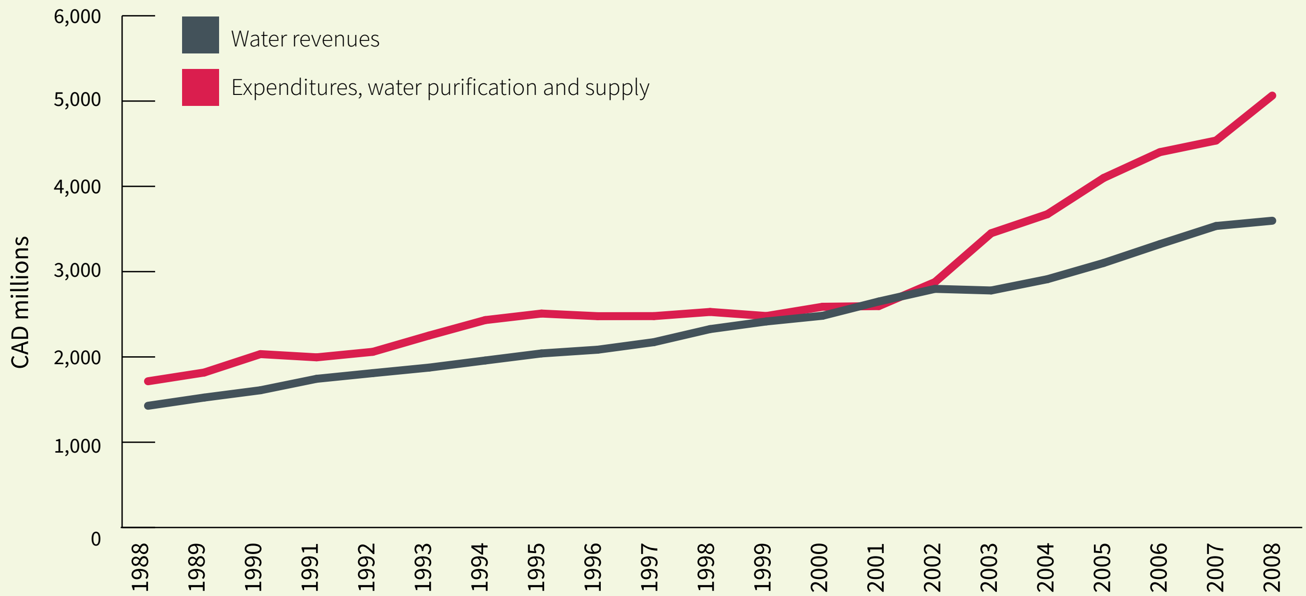
The price charged for water and wastewater is typically below the full private and social costs associated with providing the services (Brandes et al., 2010; CWN, 2018; Fenn & Kitchen, 2016). Figure 8 shows the total revenues that municipal water utilities collect from drinking-water user fees (blue) and the expenditures on water treatment and supply (red).

Expenditures and revenues were approximately equal for a brief period in 2001–2002; however, the gap widened significantly in the following years. This gap likely reflects the boost in infrastructure spending, which increased at a faster rate than the increases in water rates. At the same time, reductions in water consumption likely contributed to reduced revenues in municipalities using volumetric fees.

The gap between expenditures and revenues in Figure 8 shows that users are not paying the full cost of water service. For several reasons, however, the real gap is even larger than what appears in the figure. First, the data include only actual expenditures and exclude historical underinvestment and future capital costs to accommodate population growth (Renzetti, 2009). Second, actual operating and maintenance budgets have typically been inadequate for the genuine needs; adequate levels of spending would produce a larger gap for the actual revenues shown.[29] Third, Figure 8 excludes social costs. These are the costs associated with degraded ecosystems, water scarcity, and the additional risks posed by climate change.

[29] Renzetti (1999) finds that user fees for water and wastewater were only one-third and one-sixth of the estimated marginal costs of providing the service, respectively.

Figure 8: Municipal Revenues and Expenditures for Drinking Water



This figure shows the total municipal revenues from user fees for drinking water and the total expenditures for drinking-water systems. The gap between revenue and expenditures began to widen after 2002, which could indicate that user fees were not increased to levels necessary to match the rising costs. Due to limitations of the Statistics Canada data, the figure excludes revenue and expenditures related to wastewater.

Source: Statistics Canada, 2009

The size of the real gap between the price charged to users and the full costs of water services is therefore larger than the figure suggests. Analysis of the Niagara region by Renzetti and Kushner (2004) finds that when all private and social costs are considered, people are paying rates that are 16%–55% too low for full-cost recovery.

Municipalities face institutional constraints when designing user fees

Municipalities have the authority to charge user fees to recover the private costs associated with providing water and wastewater services (Althaus & Tedds, 2016). This includes the private costs of building, maintaining, and operating the engineered infrastructure of water and wastewater systems.

Whether municipalities are legally permitted to include social costs within the user fee framework is less clear. According to Canadian case law, user fees must demonstrate a clear link between the price charged and the costs of operating and maintaining water systems. Demonstrating this link is straightforward for private costs; however, social costs are less tangible, with benefits often extending beyond the users directly involved.

Another constraint relates to the accounting methodologies that municipalities use when determining their costs. When evaluating the costs of water and wastewater systems, municipalities must follow the standards set by the Public Sector Accounting Board. These standards do not allow municipalities to include the costs of degradation to natural assets in their financial statements (Town of Gibsons, 2015).

The implications of these constraints are significant. If legal and accounting frameworks prohibit municipalities from including environmental costs when setting user fees, municipalities cannot charge prices that reflect the full private and social costs of providing the service (CMAP et al., 2012). A comprehensive evaluation framework is, in other words, a prerequisite to progressing further toward full-cost recovery. We return to these challenges—and solutions—in Sections 4 and 5.

Conservation and cost-recovery objectives may not align

From a broad societal perspective, water conservation is an important objective. Conservation ensures that water is used efficiently by discouraging wasteful consumption, which, in turn, reduces infrastructure costs. Water conservation also makes water systems more resilient to shortages and ensures that future generations have access to water.

Yet water conservation is rarely the primary objective of municipal water utilities. The primary objective is typically to provide the highest quality water and wastewater services at the lowest possible cost (Haider et al., 2013). Water utilities, in other words, operate like many other non-profit businesses, whose priority is generating sufficient revenue for the services they provide. This priority is also driven by the legal constraints on how municipalities apply user fees, which must, first and foremost, be levied to recover costs.

The divergence in objectives—between water utilities and broader society—can have significant economic and environmental implications. In fact, as we saw earlier in this section, water conservation can undermine cost recovery.

The extent to which these objectives diverge differs across municipalities. Some water utilities recognize water conservation as a core objective, but often frame the issue from a cost-recovery perspective. Reducing water consumption can reduce the size and scale of infrastructure required to operate the system, which saves costs, especially in the long term. Likewise, seasonal pricing may make sense from a cost-recovery perspective if water shortages impose additional costs on a water utility.

Fairness concerns are important but can be addressed through smart design

The transition toward a user-pay water system raises concerns about household fairness. Moving toward full-cost recovery through user fees means that people pay directly for their water and wastewater services. For some communities, this requires shifting from a subsidized funding approach—where costs are paid through property taxes and federal/provincial grants—to one where the costs are upfront to the user. People in communities where user fees are already the primary funding source may have to pay more as rates approach the full cost of service delivery (AWE, 2014).

The major fairness concern with user fees is about users' ability to pay for water and wastewater services. Fully recovering costs through user fees may, for example, place a greater financial burden on low-income households (Althaus & Tedds, 2016). This is especially relevant in municipalities that have historically delayed or deferred investment in their water systems, so efforts to fully recover costs require significant increases in the amount that households pay for their water services (Mack & Wrase, 2017). The same may be true in smaller communities, which must spread large infrastructure costs over a smaller revenue base.

Although fees for water and wastewater make up a very small portion of household budgets, the affordability of water will continue to be a challenge for municipal water utilities.[30] This is especially true if water and wastewater rates are to be increased to reflect full private and social costs.

These issues can be addressed through smart design of user fees. One approach is to include a basic allotment of water within the fixed portion of the user fee. This approach is used in Kamloops, British Columbia, where the water utility includes 90 cubic metres of drinking water within its monthly fixed fee of $34 (equal to 1,000 litres per household, per day). The basic allotment decreases to 45 per cubic metre during the spring and summer months (City of Kamloops, 2017).

Another approach is to provide low-income households with financial assistance for their water bills. Toronto Water, for example, offers a rebate on water and wastewater bills for low-income households or for persons with disabilities who consume less than 400 cubic metres of water each year (1,100 litres per day, per household) (City of Toronto, 2017).

Paying more for water and wastewater may have competitiveness implications

Municipal water and wastewater services are essential inputs for many businesses, such as restaurants, manufacturers, and breweries. Ensuring the sustainable management of water and wastewater infrastructure is therefore in the interest of both businesses and the communities in which they operate. However, the shift to full-cost recovery may result in higher prices for water and wastewater services. This transition raises concerns about the competitiveness of businesses connected to municipal water and wastewater systems.[31]

[30] Expenditures on water and wastewater make up less than 1% of Canadians' household expenditures (Statistics Canada, 2017c). In 2015, for example, Albertans spent the most on water and wastewater services, at 0.78% of household expenditures—roughly $854 per year for the average household.

[31] According to Statistics Canada (2017a), municipalities supply roughly 12% of all water withdraws to the manufacturing sector.

Generally, competitiveness refers to the extent to which an individual firm can succeed in its business environment. A firm's competitiveness depends on multiple factors; rates for water and wastewater are only one factor among the larger and complex collection of competitiveness pressures.[32]

User fees for water and wastewater, however, represent a relatively small portion of most businesses' total costs. Firms in the manufacturing sector, for example, are more likely to be connected to municipal grids than other water-intensive sectors, such as agriculture, mining, and forestry. Yet less than 2% of manufacturing firms' total expenditures are on utilities, which includes expenses for heat, light, water, electricity, and telecommunications (Statistics Canada, 2015b). For most manufacturers, therefore, the portion spent on water and wastewater is considerably less than 2%.

Still, rate increases for water and wastewater services will affect different businesses in different ways. Some businesses can pass most cost increases onto consumers through higher prices. In these cases, the impact from higher water and wastewater rates will likely be small.

Competitiveness concerns are more pertinent for businesses that are unable to pass on cost increases, such as those competing in markets that extend beyond their local municipality. Even in these cases, however, given that Canada currently has among the lowest water and wastewater rates in the world, the impacts from rate increases will likely be much less important than changes in other competitiveness pressures.

Small communities face challenges that bigger cities do not

Achieving financial sustainability through user fees is particularly challenging for small communities (Furlong & Bakker, 2008). Building and maintaining high-quality water and wastewater systems requires large capital expenditures, regardless of the population being served. The total cost of building a new wastewater treatment plant, for example, is similar whether it serves a small town of 5,000 residents or a larger one of 50,000.

With a smaller revenue base, these large capital costs can be far more expensive on a per capita basis for small communities. This is a key reason larger cities have made greater progress in achieving full-cost recovery (BCWWA, 2015). Larger cities can spread capital costs over a much broader revenue base, meaning the incremental impact for each household and business is small. In Ontario, for example, several small municipalities have voiced concern that the increase in water rates necessary to achieve full-cost recovery would be unaffordable for its residents (Watson and Associates, 2012).

These challenges are amplified in small rural municipalities with declining populations (CCME, 2009). Water and wastewater infrastructure in these communities was built to accommodate peak demand—perhaps during a time when the population was bigger. And because water infrastructure has a lifespan of 50–100 years, the municipality is forced to pay for maintaining an overbuilt system, at a higher cost to rate payers.

Moving toward sustainable municipal water systems

Municipalities have made significant progress toward implementing a user-pay/full-cost recovery model for their water and wastewater systems. Municipalities across Canada—and in other countries around the world—demonstrate that the barriers discussed above can be overcome. They continue to press ahead with achieving greater financial and environmentally sustainable water systems.

The path toward greater financial and environmentally sustainable water systems is not uniform. Each municipality faces its own unique set of political, economic, environmental and engineering challenges, making the transition different in every community. For any municipality, however, achieving financial and environmental sustainability is a dynamic process that requires continual improvement. As our next section explores, user fees play a critical role in these efforts.

[32] Other competitiveness pressures include: corporate income-tax rates, foreign-exchange rates, input prices, government regulations, wage rates, the proximity to key markets, the quality of supply chains, the creativity of management, and the ability to recruit and retain qualified workers.

4 CASE STUDIES

This report has developed the case for charging user fees for water and wastewater systems. Different municipalities, however, face different local contexts with different constraints and priorities. Specific examples highlight the real-world complexities of designing and implementing user fees.

This section considers five case studies.[33] Each one describes the water-management regime in a different Canadian municipality and draws lessons from its experience. These lessons have implications for other municipalities—across a range of contexts and circumstances—considering implementing or adjusting systems of user fees. Section 5 will synthesize these broader findings with a set of best practices.

[33] These five case studies are based on publicly available information as well as interviews with city officials.

ST. JOHN'S CASE STUDY

4.1 ST. JOHN'S, NEWFOUNDLAND & LABRADOR

The City of St. John's has grown and transformed significantly over the last two decades. Its population flattened in the 1990s due to a combination of emigration and falling birth rates, but an oil and gas boom in the 2000s reversed this trend. The city is now growing slowly but steadily, with a metropolitan population of 212,000 (City of St. John's, 2011; 2017a).

Population growth, aging infrastructure, and upcoming major capital upgrades pose significant fiscal challenges for the city's water and wastewater systems. Current revenues cover operating costs for water and wastewater services, but not capital costs. St. John's has identified $536 million in spending for its water and wastewater systems over the next eight years, most of which has not been secured. These investments, if made, will reduce the risk of infrastructure failure and improve the city's water quality (City of St. John's, 2015a).

Residential water users in St. John's are unmetered. Nearly all households pay one fixed annual fee of $580 ($48 per month) for water and wastewater services. There is a small additional charge for water and wastewater services on property taxes, which is directed to general revenues. Commercial properties are typically metered and pay for water and wastewater services through a combination of volumetric fees and fixed fees (City of St. John's, 2017b). Table 2 provides a sample of water and wastewater rates in St. John's.

St. John's has identified $536 million for water and wastewater infrastructure upgrades over the next 8 years.

Despite these challenges, St. John's has made substantial investments in its water and wastewater infrastructure over the past two decades. The city also adopted an effective regional infrastructure model to provide water and wastewater services to surrounding communities.

Table 2: 2017 Water and Wastewater Rates, St. John's

Year	Fixed Residential Fee	Base Fee for a Medium-Sized Industrial User (4" connection)	Volumetric Fee (Industry only)
2012	$51/month	$935/month	$0.88/m^3
2013	$51/month	$748/month	$1.32/m^3
2017	$48/month	$745/month	$1.25/m^3

This table shows the changes to the rate structure since 2012 in St. John's. In 2013, the city reduced fixed fees by 20% for industrial users and increased volumetric fees by 50% to more accurately reflect the cost of service. The residential fixed fee decreased by 6% between 2012 and 2017, which includes both water and wastewater services.

Source: City of St. John's, 2013; City of St. John's 2017b

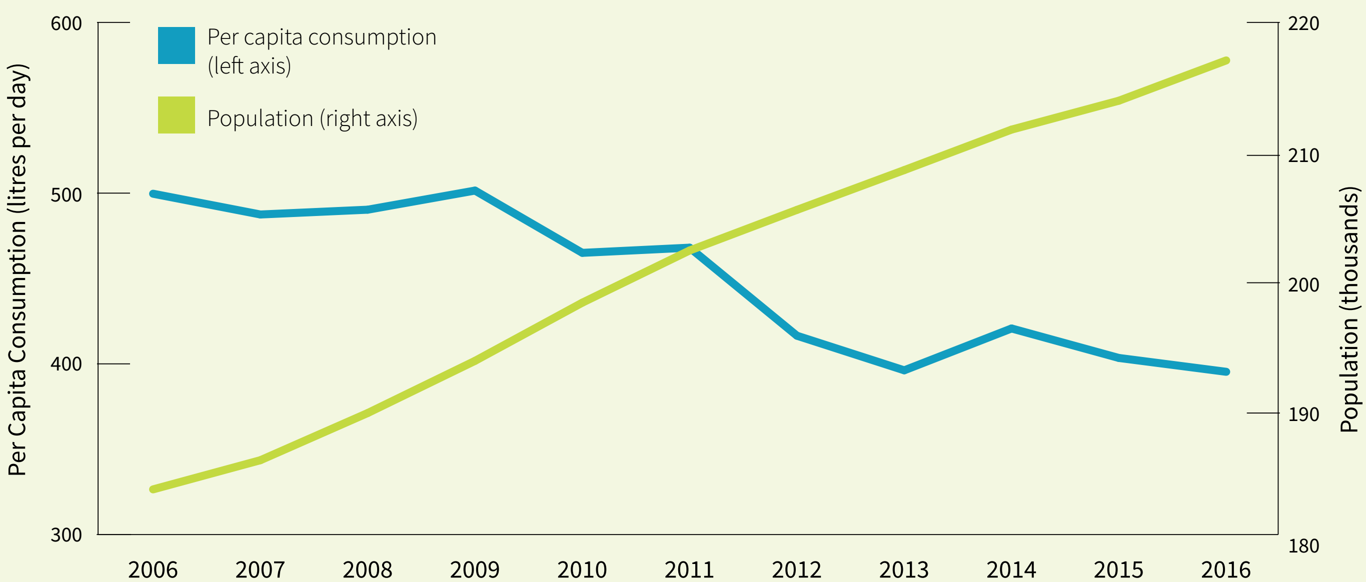
Lessons from St. John's

St. John's must overcome several challenges in moving closer to full-cost recovery, but its regional planning serves as an excellent model for medium-sized Canadian cities.

1 Without a universal metering policy, the effectiveness of conservation efforts and infrastructure improvements are unclear.

Even with steady population growth, the total volume of water treated by St. John's water plants has fallen 7% overall and 21% per capita since 2006 (see Figure 9). Improvements in water-efficiency standards and conservation efforts likely contributed to this decline—similar to other municipalities across Canada. Without universal metering, however, it is impossible to understand the precise source of these conservation gains.

Figure 9: Population and Per Capita Water Consumption in St. John's



This figure illustrates that as the population of St. John's has increased, per capita water use has decreased. In the absence of widespread metering, however, the extent to which residential or commercial users are conserving is unclear.

Source: City of St John's, 2017a

2 Municipalities may have opportunities to benefit from scale economies by linking major capital projects with those in neighbouring communities. Provinces can help.

St. John's provides treated drinking water, wastewater services, or both, to 80,000 people in the surrounding communities of Mount Pearl, Paradise, Portugal Cove-St. Philips, and Conception Bay South. These communities pay for the full cost of treatment and service delivery. This fully metered regional distribution system offers economies of scale for capital-intensive infrastructure (i.e., treatment plants), thereby allowing lower per capita costs than would otherwise be possible.

A regional system is particularly beneficial for smaller municipalities, who often lack the tax base to fund capital-intensive projects on their own but can help fund larger-scale projects. Two surrounding communities contributed to the capital construction costs of St. John's regional wastewater treatment plants (City of St. John's, 2015b).

The provincial government is playing an important role in facilitating the development of regional infrastructure in Newfoundland and Labrador. In March 2017, it announced a new cost-sharing system for this very purpose (Municipalities Newfoundland and Labrador, 2017). Regional projects that support water, wastewater, and disaster mitigation will receive support from the province for up to 90% of capital costs. The previous maximum was 80%. This model creates an incentive for municipalities to engage in regional infrastructure planning—particularly those that rely heavily on grants.

Different regional systems can fit different community needs.

Since 2013, the Alberta Central East (ACE) Water Corporation's regional system has provided drinking water to nine communities. The system is still expanding, and will eventually provide services to 18 communities in three counties. The corporation is owned by 13 member municipalities.

3 Grants can assist in paying for much needed infrastructure, but can create obstacles to increasing user fees to fully reflect private and social costs.

St. John's has a number of upcoming water and wastewater infrastructure projects that require significant capital funding. A large portion of the city's water mains are old and need to be replaced: as of 2009, 23% of the city's water mains were between 50 and 75 years old, and an additional 17% were over 75 years old (Environment Canada, 2009a). The funding required to upgrade and replace this aging infrastructure will grow in the coming years, and the city's current funding model will not be able to address this required increase in spending.

St. John's first 10-year capital plan, released in 2015, identified $536 million for water and wastewater infrastructure upgrades. St. John's has yet to secure financing for these expenditures but intends to rely largely on grants. The recent downturn in commodity prices has also damaged the local economy and suppressed any political appetite to increase municipal fees and taxes to further fund these projects (City of St. John's, 2015b, 2016).

Relying on grants has advantages in this context. St. John's is reeling from an economic downturn and may struggle to make upgrades itself without provincial and federal assistance. Such funding will ensure the city can maintain (or enhance) service levels while relieving pressure to raise these funds on its own (which would be costlier).

But relying on grants also has disadvantages. Canadian case law on the application of user fees suggests that the capital costs covered by grants cannot be included within the municipality's user-fee structure, which means St. John's can potentially keep water and wastewater rates artificially low for users. Over time, relying on grants undermines the financial self-sufficiency of the municipality and can create political barriers to increasing water and wastewater fees. For example, households may become accustomed to artificially lower rates, thus weakening long-run water conservation.

MONTRÉAL CASE STUDY

4.2 MONTRÉAL, QUEBEC

The City of Montréal provides water and wastewater services to the residents and businesses on the Island of Montréal. The Island comprises 15 different municipalities—the largest of which is the City of Montréal—and has a population of approximately 2 million people (Statistics Canada, 2017b).

Despite significant improvements over the past decade, Montréal's water and wastewater system is among the oldest in the country (Michaud, 2016; Neill, 2016). It is also the only large metropolitan area in Canada where most households do not have water meters. Water and wastewater rates typically include a "water tax," which is a fixed fee, and a "special tax" for water services, which is determined by property values. Further, households have varying fee structures and water costs across the island due to its complex governance structure (Ville de Montréal).

Montréal is in the process of reforming its water and wastewater system, which includes installing water meters on industrial, commercial, and institutional (ICI) water users and plans for substantial investments over the next decade. Reforms also include the recent decision to charge municipalities on a volumetric basis for the bulk water they buy from the City of Montreal.

It is unclear, however, whether future reforms will include installing water meters and charging users fees for households. In 2016, a municipal task force recommended that Montreal explore ways to expand the application of water metering and user fees, but the city has not indicated whether it will implement these recommendations (Ville de Montréal, 2016b). At a minimum, the city has signalled that it will harmonize the way it collects revenue for water and wastewater services across its boroughs and the other municipalities.

Lessons from Montréal

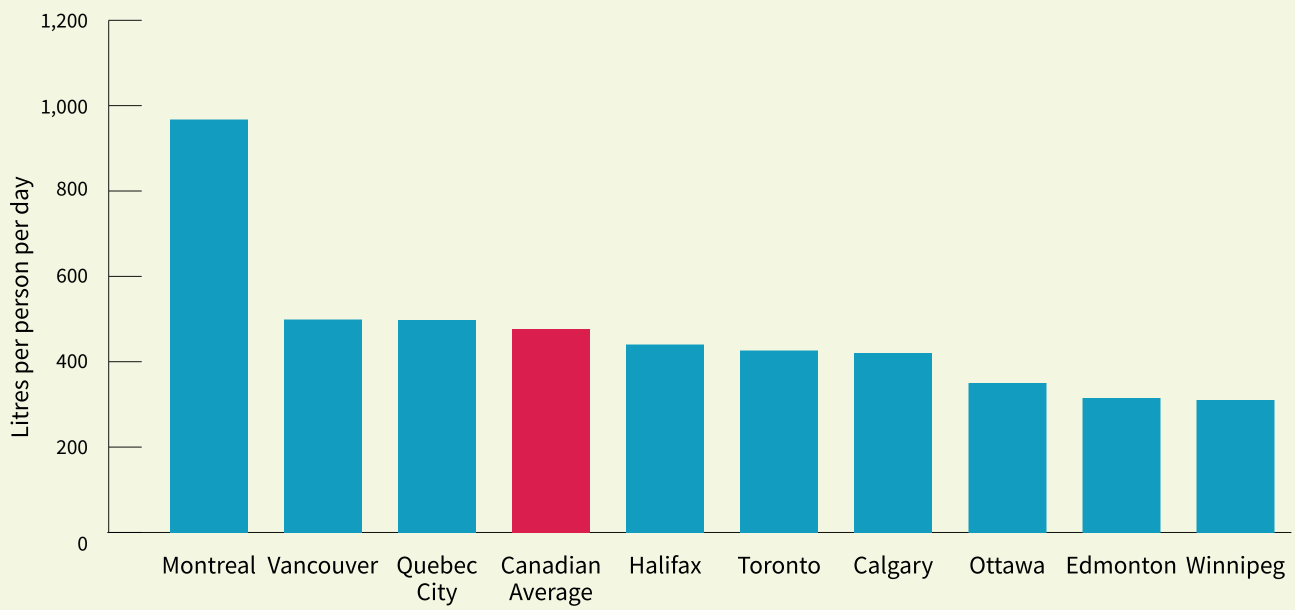
Despite recent improvements, Montréal faces several challenges with its water and wastewater system. Adopting user fees could help improve both financial and environmental outcomes.

1 Infrastructure gaps have implications for both water quantity and quality.

Montréal has made significant investments in its water and wastewater system in recent years but continues to have a large infrastructure gap. As of 2009, 26% of the city's water mains were over 75 years old, and as much as 60% of its water infrastructure will reach the end of its service life by 2020 (Environment Canada, 2009a; Brodhead et al., 2014). The city has ambitions to close its infrastructure gap by 2026, financed through grants, financial reserves, and debt (Riga, 2016). Montréal's current three-year capital plan has identified $900 million in required investment for water and wastewater (Ville de Montréal, 2016a, 2017c).

The age and condition of Montréal's water and wastewater system have a significant impact on its operations. Up to 30% of the drinking water in the city's pipes is lost through leaks, which greatly increases the volume of water that must be withdrawn, treated,

Figure 10: Per Capita Water Consumption in Major Canadian Municipalities, 2009



The figure shows the overall water volume (per person, per day) produced by treatment plants in major Canadian cities. Production levels are from 2009, taken from the Municipal Household Water and Wastewater Survey. Per capita water consumption in each of these cities has decreased since 2009. In Montréal, for example, water use decreased from 978 litres per person per day in 2009, to 801 litres in 2016. These data include all water consumed by households and businesses, in addition to system losses (leaks).

Source: Environment Canada, 2009b; Ville de Montréal, 2017d

and distributed (Ville de Montréal, 2016a; Canada West Foundation, 2011). In addition to the risk of contamination and damage to connected infrastructure, this leakage adds significantly to operating costs, including energy usage (ECO, 2017).

Montréal is currently on pace for a 20% reduction in water use by 2020 from 2011 levels.

Montréal has nonetheless made progress on water conservation. On a per capita basis, water consumption decreased by 28% between 2001 and 2016. Using a combination of targeted repairs and maintenance, metering for ICI water users, and long-term financial planning, Montréal is currently on pace for a 20% reduction in water use by 2020 from 2011 levels ((Ville de Montréal, 2017d; 2017f). Efforts at the provincial level, such as the Quebec Government's Drinking Water Strategy, have also played a key role in these improvements (Gouvernement du Québec, 2011).

However, as illustrated in Figure 10, Montréal consumed about double the amount of water of other major Canadian municipalities in 2009 (Environment Canada, 2009a). While Montréal’s above-average leakage rate partly explains some of this gap, other factors may also play a role, such as the lack of metering on households and ICI users, and the absence of a clear price signal for most users. As of 2016, daily per capita water consumption in Montréal was 801 litres.

Montréal's infrastructure challenges have also affected its water quality. Legacy lead piping and preventative boil-water advisories, for example, have continued to affect a number of communities (Ville de Montréal, 2017e; CBC News, 2013).[34] In 2013, for example, a 24-hour boil-water advisory related to over-withdrawal from a major reservoir affected 1.3 million Montréal residents (CBC News, 2013). On three occasions over the past 15 years, the city released billions of litres of sewage into the St. Lawrence River due to the risk of infrastructure failure—most recently in 2015 (Cyr et al., 2015; CBC News, 2015b).[35]

2 Installing water meters and shifting to a user-pay approach can generate both economic and environmental benefits.

In 2012, Montréal relaunched a program to install water meters on all industrial, commercial, and institutional (ICI) users by 2022 (Ville de Montréal, 2017f). The city has installed over 10,000 water meters to date, covering roughly 44% of all ICI users. Once complete, this program will provide detailed data on water consumption across ICI users and will improve the city's leak detection and repair. It will also allow the city to expand its use of volumetric fees, which currently only apply to ICI users in specific boroughs.

Despite these improvements, households on the island are largely unmetered and are charged fixed rates for water and wastewater services, offering no clear link between price and consumption. As we saw in Section 3, users are more likely to consume (or waste) more water when they do not pay directly for the service. Montréal's use of property values to determine fees for water and wastewater may also mean that households actively conserving water effectively subsidize the consumption of those who are less conservation-oriented.[36]

Adopting universal metering and user fees for *all* users could address these issues and reduce costs. Building on existing efforts to meter ICI users and charge on a volumetric basis for bulk water purchases at the municipal level, universal metering would allow municipalities on the island to track usage more effectively and would aid in the long-term planning and management of water and wastewater assets. Moreover, volumetric fees offer a choice to water users as to whether, and by how much, they curb their water use. The resulting conservation gains could reduce the overall and peak demand of the water system, saving the city on long-term expenditures.

The transition to user fees could also provide revenue stability and help reduce the city's large infrastructure gap. A carefully designed multi-part user fee could be key. The fixed fee could provide a predictable source of revenue, while the volumetric component could maintain the price signal to water users. Revenues would also be earmarked solely for the utility, and rates could be set at levels necessary to pay for Montréal's ambitious capital plans. Lastly, user fees could help protect water quality on the island by ensuring that the city has the necessary revenues to properly treat water and wastewater and reduce the risk of infrastructure failure.

Installing water meters and shifting to a user-pay approach for all water users, however, will take time. Other municipalities in Canada have struggled with similar challenges, but none have tried to solve them all at once. Municipalities on the island are making progress; building on these efforts will continue to deliver economic and environmental benefits.

[34] Montréal is planning to remove all lead piping by 2026 (Ville de Montréal, 2017e). However, much of this lead piping is on private property and is not the responsibility of the city.

[35] Despite the large volumes of wastewater discharge from Montréal, the size of the St. Lawrence River significantly reduced the risk of adverse effects on downstream communities.

[36] In some cases, this effect may be partially offset by the progressive nature of property taxes. Higher-value properties pay more for water and wastewater fees but also may be larger water users.

3 Adopting a user-pay approach would have important implications for fairness.

Shifting to a user-pay approach raises legitimate concerns that low-income households may end up spending a greater share of their income on water and wastewater. Under Montréal's current system, households with higher assessed property values pay more for their water and wastewater. If the amount people pay through their property values is correlated with household income, higher-income households pay more for water and wastewater services than lower-income households.

Yet the implications for fairness in shifting to a user-pay model are not clear cut. Montréal's current system provides no financial incentive for households to conserve. Volumetric user fees would provide households with a greater incentive to reduce their water use, thereby offsetting the impact of price increases. Moreover, because households are not metered in Montréal, it is impossible to know how the city's existing system affects low-income households. Widespread adoption of water meters would help identify the impacts on water consumption across different socioeconomic groups.

The design of user fees would also provide opportunities for Montréal to directly address fairness concerns (Leroux et al., 2014). Montréal could design a multi-part user fee where the fixed amount includes an affordable basic allotment; the volumetric component would ensure that those who use less water, pay less.[37] Alternatively, Montréal could issue rebates to low-income households or help subsidize the adoption of water-efficient technologies. In fact, a municipal task force in Montréal proposed a similar solution: introducing credits to households that keep their consumption below a certain threshold (Ville de Montréal, 2016b). The shift to user fees could also be paired with a commensurate decrease in property taxes, depending on the individual funding needs of municipalities.

Canada's largest city already offers a water rebate program.

In Toronto, certain low-income earners who consume less than 400m^3 of water each year are eligible to apply for the city's water rebate program. Because eligibility is tied to consumption levels, Toronto's metering policy is essential to the success of the program.

[37] Business groups have also raised this concern, arguing that user fees would be fairer, since their water bills would reflect actual water use (CBC News, 2016).

4 Complex governance structures need not be an obstacle to reform.

The Island of Montréal comprises 15 different municipalities; the largest is the City of Montréal, which covers over half of the island's geography and consists of 19 different boroughs. The City of Montréal provides centralized water and wastewater services to its 19 boroughs and the 14 other municipalities on the island. Each municipality and borough is responsible for the operation and maintenance of its secondary water lines (Trent, 2012; Ville de Montréal, 2017a).

This complex governance structure poses coordination challenges if all municipalities on the Island are to shift to a user-pay system. The City of Montréal, the boroughs, and the municipalities have the authority to levy different types of charges for water and wastewater services (Ville de Montréal, 2016c).[38] Moreover, the municipalities are at different stages with water metering.

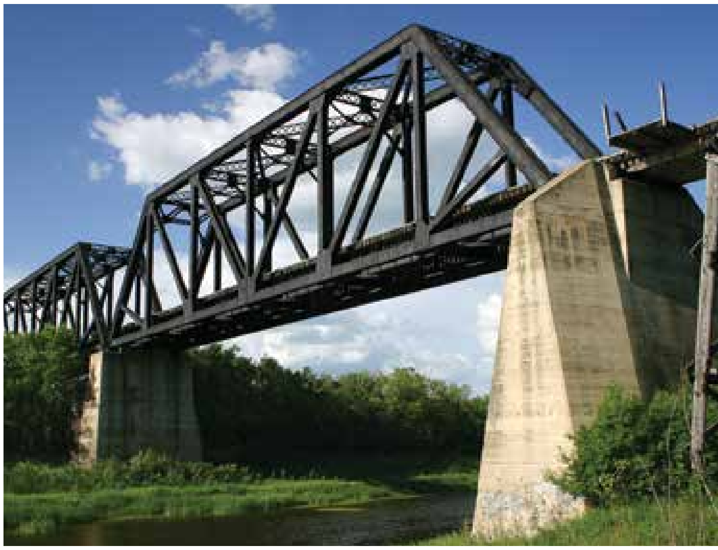
But municipalities need not all move at once to make progress. Indeed, metering and volumetric user fees for ICI users is far more common than it was 10 years ago, and two municipalities have household metering and charge volumetric fees (in addition to a fixed fee). Beaconsfield, for example, has a universal metering policy and charges both fixed and volumetric user fees for its drinking water (Ville de Beaconsfield, 1987; 2016).

Although a coordinated shift to user fees across the island might be ideal from an economic perspective, an incremental process with some municipalities relying on user fees and others relying on property-based tools may be needed for the interim.

Universal metering already exists on the Island of Montréal.

Beaconsfield is a successful example of universal metering on the Island of Montréal. The municipality charges user fees for its water and wastewater: an annual fixed fee of $40, plus $1.04 per cubic metre of water consumed.

[38] This regionalized approach to supplying water is not uncommon in Canada. The Capital District of Victoria and Metro Vancouver are wholesalers, distributing water to different municipalities. Each municipality then determines its water prices based on the wholesale cost of supply and other local factors. In Montréal's case, use of different rates across the island may be efficient if they reflect different costs in each municipality (Renzetti & Dupont, 2009).



THE BATTLEFORDS CASE STUDY

4.3 THE BATTLEFORDS, SASKATCHEWAN

The Battlefords is a region in west-central Saskatchewan divided by the North Saskatchewan River, comprising the Town of Battleford and the City of North Battleford. Over the last decade, the combined population of the two municipalities has grown to almost 19,000 following 15 years of decline. North Battleford is roughly three times larger than Battleford, with 14,300 residents (Wilson & Sagynbekov, 2014; SBS, 2011; Statistics Canada, 2017d, 2017e).

Battleford and North Battleford use different water sources and manage their water and wastewater systems separately. Both face several challenges, spanning infrastructure gaps, boom-bust economic cycles, and water supply issues (Jameson et al., 2008).

Lessons from the Battlefords

The Battlefords' water and wastewater systems illustrate some of the issues facing smaller municipalities.

1 Asset-management plans and regular rate reviews can help reduce the risks associated with infrastructure gaps.

Battleford relies exclusively on groundwater and uses a mix of block fees, fixed fees, and infrastructure fees (see Table 3). All user classes pay fixed fees of $135 per quarter ($45/month) for water and wastewater, which includes a water allowance. Wastewater is not metered, so the charges reflect the volume of drinking water consumed by the user. On top of these fixed fees, there is a quarterly infrastructure charge for households and businesses of $51, which Battleford earmarks for spending on water and wastewater infrastructure. Surplus revenues are held in the town's Water and Sewer Reserve Fund (Town of Battleford, 2016, 2017a). Battleford's

<table>
<tr><th colspan="3">Table 3: Price Tiers for Residential Water Users in Battleford</th></tr>
<tr><th>Rate Type</th><th>Water</th><th>Wastewater</th></tr>
<tr><td>Flat Fee</td><td>$84/quarter</td><td>$51/quarter</td></tr>
<tr><td colspan="3">Volumetric Fee (per quarter)</td></tr>
<tr><td>< 30m³</td><td>$0/m³</td><td>$0/m³</td></tr>
<tr><td>30–100m³</td><td rowspan="2">$1.10/m³</td><td>$0.25/m³</td></tr>
<tr><td>> 100m³</td><td>$0.50/m³</td></tr>
<tr><td colspan="3">Source: Town of Battleford, 2016; 2017a</td></tr>
</table>

Table 4: Prices for Residential Water Users in North Battleford

Rate Type	Water	Wastewater
Volumetric Fee	$1.44/m^3	$1.20/m^3

Source: City of North Battleford, 2017b

largest challenge at present is its infrastructure gap. The town last adjusted its water and wastewater rates in 2012 and has experienced persistent revenue shortfalls. Approximately 80% of the town's underground pipes are at the end of their useful life, and will cost as much as $30 million to replace—an amount that is roughly eight times larger than the town's 2017 capital budget (Town of Battleford, 2017b).

Further, the town does not have a municipal asset-management plan, which makes it more difficult to prioritize infrastructure replacement projects and deliver services at the lowest cost (Brown et al., 2014). Full-cost recovery functions best when backed by an asset-management plan. In tandem, they can ensure adequate revenues and their appropriate allocation and reduce the likelihood of costly and unexpected repairs.

North Battleford, by contrast, has not had the same issues with funding its infrastructure, even though its water and wastewater rates are lower than those in Battleford (see Table 4). With a larger population, North Battleford can spread capital costs over a larger tax base. It is also able to use debt to finance major capital projects, including new water and wastewater treatment facilities (City of North Battleford, 2013, 2016, 2017a, 2017b).

North Battleford's finance committee has a long-term capital plan and increases user fees according to capital requirements, most recently by 4.5% in both 2016 and 2017—in part to service its existing debt. Updating rates regularly to ensure that they reflect short- and long-term system requirements has enabled North Battleford to strike a balance between financial sustainability and effective service delivery.

2 Problems with water quality can increase costs.

North Battleford has experienced two significant drinking-water supply shocks over the past two decades. The North Saskatchewan River, which supplies one of the city's two treatment plants, is considered a high-risk source, vulnerable to contamination and the effects of climate change (Government of Saskatchewan, 2002; City of Leduc, 2014). Drawing drinking water from a high-risk source can require more sophisticated and costly treatment that increases the risks associated with infrastructure failure (Delpla et al., 2009; Grigg, 2016).

In 2001, a parasite in the North Saskatchewan River made it through North Battleford's water treatment system, leading to thousands of illnesses (Government of Saskatchewan, 2002; Hrudey & Hrudey, 2002). Investigations cited a reactive approach to infrastructure maintenance and engineering failure brought about by poor oversight as root causes. The city and the provincial government made major changes to hiring, inspection, and transparency requirements in the aftermath (Jameson et al., 2008).

The second incident came in July 2016, when a Husky Energy pipeline spilled approximately 250,000 litres of crude oil into the North Saskatchewan River upstream of the Battlefords. North Battleford's river water treatment plant was forced to shut down, and the city lost 100 litres per second of delivery capacity. Battleford was unaffected, as it exclusively uses groundwater for its drinking-water supply.

Saskatchewan's water quantity affects its water quality.

Southern Saskatchewan experienced extreme drought conditions in the summer of 2017. These dry conditions have led to several problems, including low crop yields, contamination from toxic blue-green algae, and excessively saline water supplies (potentially fatal to livestock).

North Battleford's response to the oil spill was effective, but came at a substantial cost (Cairns, 2016a). First, the city entered into a contract with Battleford to purchase part of its excess water supply—an additional 20 litres per second.[39] The pipeline supplying water stayed in operation until December 2016, when it was shut down due to cold temperatures and reduced water demand. Battleford began supplying water again in April 2017 to meet increased seasonal water demand. Husky compensated North Battleford for the costs of the spill (including a $3.5 million "pre-payment") but has not disclosed a full breakdown of payouts (Cairns, 2016b; Mandryk, 2017).

North Battleford has experienced two significant drinking-water supply shocks over the past two decades.

These two events highlight how poor water quality can increase operating costs considerably (Yusa et al., 2015). Events such as drought, high turbidity, and contamination highlight the importance of effective long-term planning and of adequate financial and resource capacity to respond to emergencies.

3 Municipalities whose economies are subject to boom-bust cycles face additional challenges in closing their infrastructure gaps.

Given the Battlefords' proximity to resource-based communities, large swings in economic activity create additional challenges for managing water and wastewater systems.

A fluctuating population can make it difficult to manage assets and plan future capacity requirements, especially in smaller municipalities. The real risk is of small communities overbuilding to accommodate population growth that is not sustained, which can lock them into maintaining excess capital stock. Battleford's population declined by 10% between 1991 and 2006 and grew by 20% between 2006 and 2016. North Battleford experienced an even longer period of decline. Its population fell by 11% between 1986 and 2006 and grew by 8.5% between 2006 and 2016 (SBS, 2011). As an example of the strain this puts on capital requirements, Battleford's water treatment plant typically operates at 60% capacity; it was overbuilt to accommodate anticipated population growth.

Over the past decade, economic volatility and high demand for skilled labour in Saskatchewan have led to rapidly escalating construction costs. Between 2010 and 2014, non-residential construction costs increased by 30%. Such cost increases challenge small municipalities—especially boomtowns—to offer competitive wages or to budget accurately for the future (Saskatchewan Construction Association & Ministry of Economy, 2013).

To the extent possible, small municipalities that are exposed to rapid inflation in costs should consider them in their asset-management plans. For instance, North Battleford accommodates this uncertainty into its long-term planning, updates projections annually once projects are placed in its five-year capital plan, and has been increasing rates over the last several years to ensure it can meet future capital requirements.

[39] Battleford's water treatment plant was overbuilt to accommodate future population growth and usually operates by using only about 60% of its capacity. The additional demand raised the plant's capacity utilization to about 80%, which allowed it to treat water more effectively and at lower cost.

OTTAWA CASE STUDY

4.4 OTTAWA, ONTARIO

Ottawa is a geographically large and sprawling city, one of the least densely populated cities in Canada. The city, which amalgamated with 11 nearby townships and regional municipalities in 2001, maintains a large network of water and wastewater infrastructure relative to its population size (Statistics Canada, 2016).

Since amalgamation, Ottawa has introduced a series of reforms to improve and modernize its water and wastewater systems. These include the introduction of advanced metering technology, fixed fees, and redesigned stormwater fees. Ottawa historically relied on volumetric fees, which helped reduce consumption and improve system efficiencies but also created consistent revenue shortfalls. To strike a better balance between conservation, fairness, and revenue stability, Ottawa approved significant changes to its user-fee system in October 2016 (City of Ottawa, 2008; 2016).

Lessons from Ottawa

Ottawa's recent reforms covered every aspect of its water and wastewater systems. We take three lessons from its experiences.

1 Advanced metering technologies improve service delivery and environmental outcomes.

In 2002, Ottawa implemented its Water Loss Control Program, a combination of supply- and demand-side policies designed to improve the effectiveness and efficiency of the city's existing infrastructure network (OCMBP, 2008). From 1984 to 2000, 25% of the water in Ottawa's system generated no revenue; the city paid to treat and transport this water but could not sell it because it was lost through leakage, used for fire protection, or flushed for line inspections. Five years into the program, system losses dropped to 15% (City of Ottawa, 2008, 2010).

Following several successful pilots and city-wide projects, Ottawa adopted a universal metering policy in 2011. It used advanced metering technology, which enables two-way communication between the utility and end user. The technology provides hourly readings and identifies discrepancies between flow rates, which helps pinpoint leakages in the system and allows for faster repair (Godwin, 2011). Advanced metering has allowed the utility to better project future growth in the water system, identify peak use patterns, and monitor the effects of targeted water conservation measures (City of Ottawa, 2010, 2016).

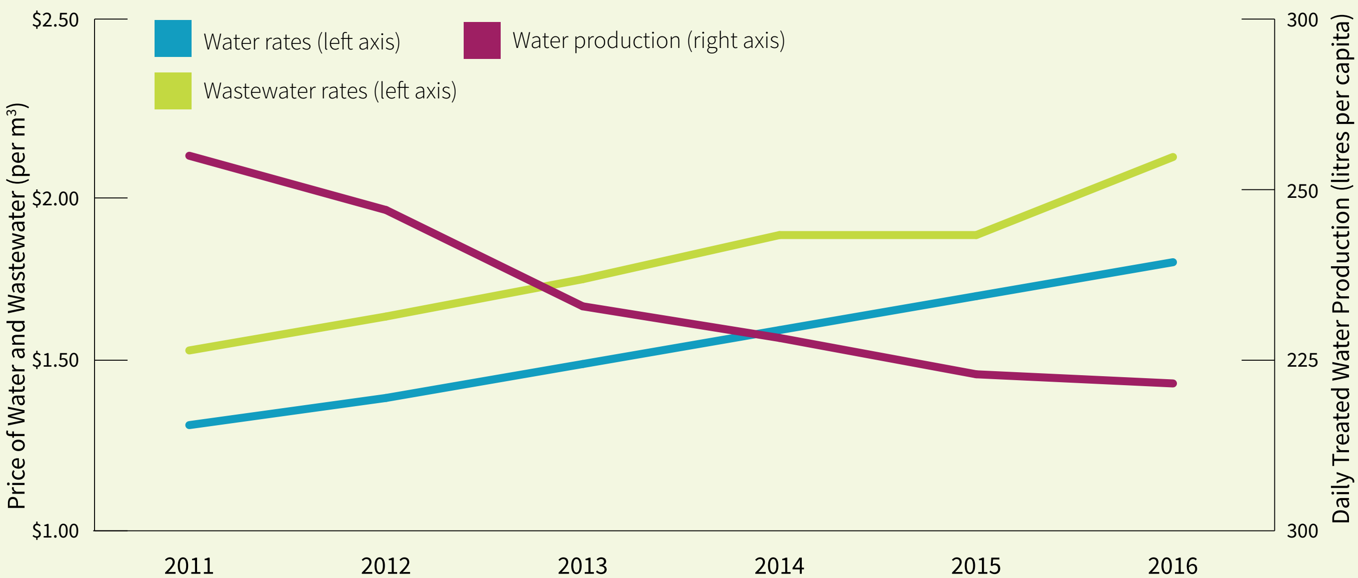
Smart metering is gaining traction in Canada.

Household and businesses in the Halifax Regional Municipality have had analog water meters since the 1950s. The city, however, is upgrading to smart meters over the next four years. This will help save an estimated $1 million per year in reduced operational costs, and will improve feedback to customers.

2 Relying too heavily on volumetric fees undermines cost recovery.

Until 2017, volumetric fees generated 92% of Ottawa's total water revenues.[40] This heavy reliance on volumetric pricing made revenues very sensitive to changes in water consumption. In contrast, roughly 90% of the utility's costs were invariant to the volume of water provided. As shown in Figure 11, total water use fell by 8% between 2011 and 2016, which contributed to annual revenue shortfalls of $4 to $19 million, even in the presence of steady annual rate increases. Water and wastewater fees rose by 36% from 2011 to 2016, or about 6% annually (City of Ottawa, 2011, 2015, 2016, 2017a, 2017b).[41]

Figure 11: Water Use and Water Prices in Ottawa (2011–2016)



The figure shows the gradual increase in water and wastewater fees between 2011 and 2016. The 6% increases for 2013, 2014 and 2015 were announced in February 2013, which may help to explain the sharp decrease in water production in 2013. Water production includes water use, fire suppression and system loses.

[40] Fire supply charges and user fees for specific one-time services covered the remaining 8%.

[41] All else equal, such an increase in user fees should have increased Ottawa's total revenues due to the relatively inelastic demand for water (refer to Box 5). Yet Ottawa experienced revenue shortfalls between 2011 and 2016. These shortfalls can be explained by factors beyond the increase in user fees. Over 2012–2016, Ottawa began to spend more on debt servicing and contributions to capital and operating costs. Higher rates for water and wastewater helped offset some of these cost increases, but were not enough to eliminate the shortfall. Moreover, other factors likely contributed to reduced water consumption, such as the measures outlined in the City's Water Efficiency Strategy.

This revenue uncertainty undermined Ottawa's ability to plan for the long term and fully recover costs. Despite efforts to forecast these fluctuations, rates of water conservation were consistently larger than Ottawa anticipated. However, other contributors beyond higher rates are likely responsible, including improved availability of water-efficient appliances, changes to building codes, seasonal factors, and greater conservation awareness (City of Ottawa, 2016). To address these financial challenges, all user classes will pay flat fees beginning in 2018. Fixed water and wastewater fees will be set at $9.14 and $8.11 per month, respectively, with higher fees for larger meters. In addition to the flat fee, Ottawa is replacing its constant rates with a four-tier increasing block rate (see Table 5). The per-unit rate in every tier of the new rate structure is lower than the previous constant volumetric rate.[42]

In essence, Ottawa has lowered its volumetric fee in exchange for the greater revenue certainty that comes with higher fixed fees (City of Ottawa, 2016).

Table 5: Volumetric Water and Wastewater Rates in Ottawa (as of 2018)

Volume (per month)	<6m³	7–25m³	26–180m³	>180m³
Old Water Rate	$1.891/m³			
Old Wastewater Rate	$2.212/m³			
New Water Rates	$0.721/m³	$1.441/m³	$1.586/m³	$1.768/m³
New Wastewater Rates	$0.624/m³	$1.248/m³	$1.373/m³	$1.545/m³

Source: City of Ottawa, 2017a; 2016

3 Source water protection is essential to maintaining water quality and is critical for cost recovery.

Ontario passed its *Clean Water Act* in 2006. Developed in response to the Walkerton tragedy, its objective is to protect existing and future water sources from contamination and depletion. Under the Act, municipalities are responsible for implementing and enforcing local policies to manage drinking-water threats and managing land use to mitigate risk to water sources (City of Ottawa, 2017c).

Ottawa's source water protection plan has four major components. First, it prohibits specific future land uses (such as landfills) near drinking-water sources. Second, it requires proactive management of municipal services like sewers and road maintenance so they do not affect drinking-water sources. Third, it establishes multi-barrier safeguards to reduce the risk posed by hazardous substances, such as fuels. Fourth, it encourages voluntary actions from residents and businesses near high-risk regions (City of Ottawa, 2017c).

A small portion of Ottawa's water budget (1.2%) is dedicated to "Water Quality." The city separates this line item from treatment costs and embeds it in its user fees (City of Ottawa, 2017d). However, most of these source-protection measures are regulatory and do not require municipal funds. Some funding may be required for ongoing monitoring and surveying. For municipalities, preventing highly contaminated water from entering their systems is a cost-saving measure, and they can generally implement preventive measures with modest financial resources.

[42] The new flat fees do not include a basic allowance of water, but the first 6 cubic metres of monthly consumption are highly discounted relative to other price tiers. Ottawa defines 6 cubic metres as the minimum amount of water necessary to meet basic human needs, referred to as a "lifeline rate" (City of Ottawa, 2016). The absence of any basic allowance ensures that there is a price signal to incentivize conservation at any level of consumption.

GIBSONS CASE STUDY

4.5 GIBSONS, BRITISH COLUMBIA

Gibsons is a small town located north of Vancouver, on British Columbia's Sunshine Coast. It has a population of 4,600, and is accessible only by ferry, private boat, or float plane (Sunshine Coast Regional District, 2015). The town is one of the few Canadian municipalities that provides untreated, ready-to-drink water to its residents, sourced from an underlying aquifer. Its residents pay a fixed fee, in addition to a three-tier increasing block rate.

Despite its size, Gibsons is on the leading edge of water and wastewater management in Canada. With the adoption of its Eco-Asset Strategy in 2014, Gibsons became the first municipality in North America to extend its asset-management framework to include natural assets. Doing so created a more complete framework for full-cost recovery through user fees and improved the overall sustainability of its water and wastewater system (Town of Gibsons, 2016a).

Despite its small size, Gibsons is on the leading edge of water and wastewater management in Canada.

Lessons from Gibsons

Gibsons' progressive approach to managing its water and wastewater system has received international attention. Yet the town faces obstacles in moving forward with fully recognizing the value of its natural assets.

1 Asset-management and full-cost recovery plans are key for fiscal sustainability.

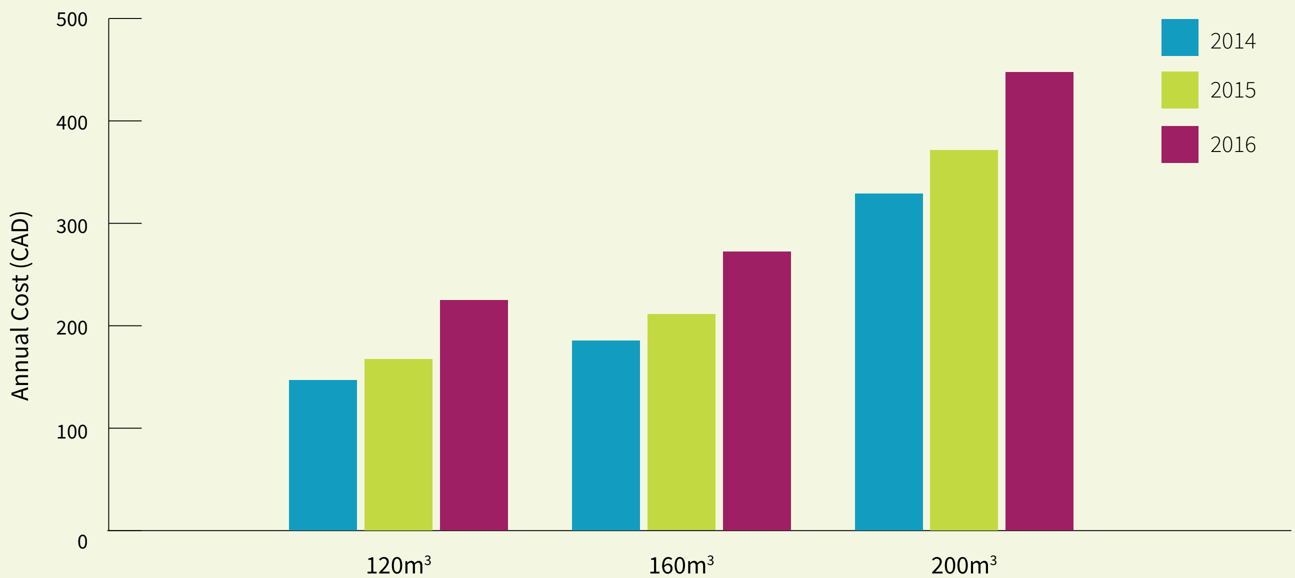
The Town of Gibsons, like other municipalities across Canada, faces significant financial constraints. Most of its infrastructure dates from the 1960s and 1970s and will require replacement in the coming years. Declining water consumption has also reduced revenues. Population growth is putting additional pressure on its infrastructure and resources.

To address these challenges, the town completed a comprehensive asset-management plan in 2016, which looks at the replacement value of its infrastructure over time horizons of 25 and 100 years. Overall, these analyses identified the average annual cost of replacement and repair, and the revenues required to cover these costs.

Based on these analyses, it became clear that existing revenues were insufficient to pay for future upgrades and maintenance. In 2014, for example, revenues from user fees only covered two-thirds of its total costs. While reserve funds and provincial/federal grants helped fill part of this gap, Gibsons' goal is to become financially self-sufficient, funded primarily through user fees.

Gibsons recently implemented a series of rate increases to close its funding gap. As shown in Figure 12, water rates for single-family households increased by between 36% and 53% from 2014 to 2016, depending on average household water use. These rate changes reflect the cost requirements in their asset-management plan. The goal is to fully close the funding gap by 2024, after which rate increases will be limited to the overall rate of inflation, approximately 2% annually (Town of Gibsons, 2016b).

Figure 12: Annual Cost of Water Services in Gibsons (Single-Family Household)



This figure shows the annual cost of water services for a single-family household in Gibsons from 2014 to 2016. Annual costs increased by 53% for households in the first consumption block, by 47% for those in the second block, and by 36% for those in the third block. By integrating future expected costs into its water fees, the town hopes to stabilize fees by 2024, after which increases will be limited to the overall rate of inflation.

Source: Town of Gibsons, 2016b

2 Valuing natural ecosystems is consistent with the asset-management framework.

Gibsons' work on valuing its natural assets began with its underlying aquifer, which provides "free" water storage and filtration. In 2009, the town initiated a study to evaluate the health of its aquifer and assess its value.

The study had two main objectives. The first was to survey the aquifer's characteristics to better understand its size, geology, and rate of replenishment. The second was to estimate the costs of finding and building a new water source if the aquifer became overdrawn or contaminated. Overall, it found that the aquifer could provide a reliable source of water for the foreseeable future and was providing water services at a fraction of the cost of an engineered alternative (Town of Gibsons, 2015).

These findings were a springboard for Gibsons' Eco-Asset Strategy, developed in 2014. The strategy highlights the town's significant funding pressures in the coming decade and outlines how including the value of natural assets alongside traditional engineered assets can reduce infrastructure costs while maintaining high levels of service. It also recognizes how the principles of prudent asset management for natural assets mirror those for engineered assets.[43]

Gibsons has integrated these concepts within its asset-management strategy and cost-recovery framework. The value of natural ecosystems is formally recognized in its asset-management strategy, allowing the town to recover the costs associated with

[43] These principles include asset valuation and assessment, demand forecasting, operations and maintenance budgeting, and regular monitoring and evaluation. As with the prudent management of engineered assets, natural assets are best assessed with an integrated, life-cycle approach (Town of Gibsons, 2014).

maintaining some of its natural assets. Monitoring the aquifer, for example, requires an annual budget of $28,000. These costs are included within the town's existing user-fee structure for water and wastewater and were part of the rate increases in 2014 (Town of Gibsons, 2015).

3 Barriers still prevent the full and explicit recognition of natural assets.

Despite significant progress over a relatively short period, Gibsons faces barriers in fully implementing its Eco-Asset Strategy. According to national accounting standards— developed and enforced by the Public Sector Accounting Board—municipalities cannot include the value of natural assets within their financial statements. These standards only recognize engineered infrastructure as tangible assets (PSAB, 2007). Similar limitations apply to U.S. municipalities, the standards being determined by a national accounting organization.

These accounting standards prevent Gibsons from fully integrating the estimated value of natural ecosystems into its asset-management plan (Town of Gibsons, 2016c). To make this limitation explicit, Gibsons included a note in its 2016 financial plan, acknowledging the value of broadening its financial framework to include natural assets and the need to manage these assets sustainably.

Valuation of natural assets is underway elsewhere in BC.

The David Suzuki Foundation estimates that ecosystems in Howe Sound, northwest of Vancouver, deliver at least $792 million in services annually. This includes $302 million from the filtering, retention and storage of water (2014 Canadian dollars).

4 Integrating the value of natural ecosystems is the missing piece for full-cost recovery.

Including the value of natural ecosystems within existing asset-management strategies and full-cost recovery frameworks has several benefits.

First, recognizing both engineered and non-engineered assets provides a complete framework for recovering private and social costs and helps reduce risk. By identifying natural assets in the same way as engineered assets, a mechanism is created to properly budget for the necessary investments to maintain all capital assets. Doing so helps a municipality manage critical natural ecosystems sustainably by explicitly embedding their value within the cost-recovery framework (Natural Capital Coalition, 2014).

This approach can also reduce costs through integrated asset planning. Just as traditional asset-management plans reduce the likelihood of costly and unexpected repairs from poorly managed infrastructure, making upfront investments in natural capital can eliminate (or defer) the need to build costlier engineered alternatives. In fact, this is the primary reason Gibsons integrated natural capital within its asset-management framework—the town can significantly reduce the size of its capital budget while maintaining a high level of service. And unlike engineered assets, which depreciate over time, well-managed natural assets can actually increase in value (Town of Gibsons, 2015, 2016a).

Lastly, integrating the value of natural ecosystems within existing asset-management and cost-recovery framework can help align objectives. As we saw in Section 3, municipal water utilities often prioritize cost recovery before conservation. Yet when natural assets are included within the asset-management and full-cost recovery frameworks, these objectives become more closely aligned. The costs of overdrawing water from Gibsons' aquifer, for example, would be embedded within the financial framework—in addition to the costs already included within user fees for monitoring and surveying the aquifer. The same approach could be used for preventing water pollution.

While Gibsons is unable to fully move forward with its plans to include the value of its essential ecosystems, momentum is building. Within Canada, the Municipal Natural Assets Initiative (MNAI) has played a key role in advancing the practice of formally valuing natural assets. The initiative supports municipalities in refining and replicating Gibsons' approach by providing tools and supports to help local governments measure and manage their natural capital (Town of Gibsons, 2016a). Currently, five MNAI pilot projects are underway—three in British Columbia and two in Ontario—with plans to double this number by the end of 2017 (Brooks et al., 2015).

5 BEST PRACTICES IN DESIGNING USER FEES

This section identifies 10 best practices for implementing and designing user fees for water and wastewater. It draws on the theory from Section 3 and the case studies from Section 4.

This report has discussed many of the objectives that inform user-fee design, including cost recovery, water conservation, and water quality. Other objectives are also important, including equity, affordability, rate simplicity, and legality (CMAP et al., 2012). The best practices presented here can help municipalities balance their competing objectives.

This section is intended as a *general* guide. As such, the best practices do not necessarily apply to all municipalities. While certain best practices—such as universal metering and full-cost-recovery strategies—are broadly relevant, others can change according to the local context and level of service. Each municipality has different priorities and objectives that affect whether certain best practices are appropriate.

5.1 LAYING THE GROUNDWORK

We start by considering prerequisites for well-designed user fees: implementing universal water metering and developing a strategy to define and recover private and social costs. Fundamentally, these best practices are about improving how municipalities measure and manage their water and wastewater. The benefits of these actions, however, extend well beyond implementing user fees. They represent an important shift to a more sustainable approach to managing municipal water systems and provide better information for water users, governments, and utilities.

BEST PRACTICE #1
Installing water meters for all residential and commercial users

Water meters have proven benefits. Metering allows water utilities to measure water demand over time and across different users (i.e., households, businesses, institutions). This information allows water utilities to quickly and more accurately identify leaks, improve efficiency, and plan over the long term (Boyle et al., 2013; CMAP et al., 2012). Water meters are also necessary for implementing volumetric user fees. Installing meters for *all* households and businesses maximizes these benefits.

Advanced metering technologies have improved dramatically over the past decade and so has the business case for them.

Municipalities have options in *how* they install water meters. Some municipalities, such as Vancouver, have taken an incremental approach, and require water meters on all new and renovated buildings (Sieniuc, 2015). Other municipalities, such as Ottawa and Fredericton, require meters to be installed on all units—new and old.

Box 9: The Benefits of Advanced Metering Infrastructure (AMI)

Advanced metering infrastructure (AMI) is an electronic form of water metering that enables two-way communication between the utility and end user. Compared to conventional metering, AMI offers additional economic and environmental benefits (AWWA, 2017).

In the short term, it can reduce the costs of reading and aggregating data from conventional meters. More advanced technologies can also identify leaks faster and more precisely than conventional metering systems. In Sacramento, California, AMI technology helped identify leaks in nearly 1,000 single-family homes and reduce daily water use by 48 litres per person (CDWR, 2016).

In the longer term, using AMI can help improve asset management, allowing municipalities to defer major capital projects (Beal & Flynn, 2015). AMI provides high-resolution data in real time on water consumption and asset performance, giving engineers accurate information on where and when future upgrades are needed (Godwin, 2011; Sprang et al., 2015).

Municipalities can also use AMI to improve customer service and conservation programs. Water users receive detailed and timely information on their water use, allowing them to see how changes in water use could affect their water bill. AMI can also be used to design conservation-oriented user fees that assign prices based on household characteristics (AWWA, 2017; Baerenklau et al., 2013). Several Canadian cities are deploying AMI technologies, such as Ottawa, Miramichi, Regina, and Halifax (Cheung, 2009).

Despite its advantages, AMI may not be practical or cost-effective in every community. AMI is more expensive than conventional metering, and many of the benefits occur over the long term. Furthermore, the benefits often depend on the local context.

For these reasons, municipalities should evaluate the different metering technologies available. This is especially true in municipalities installing water meters for the first time or where water meters are being upgraded. Pilot projects can be an effective way to test the applicability and cost-effectiveness of AMI. Provincial and federal grants can also help fund the installation of water meters.

Installing water meters on all households and businesses allows municipalities to charge all water users based on the cost of service, and avoids having different rates for metered and unmetered properties. In Vancouver, for example, roughly 80,000 homes (96% of all residential properties) are without water meters; metered households pay volumetric and seasonal rates, whereas unmetered households pay fixed rates (City of Vancouver, 2015). On the other hand, transitioning to universal metering over a longer period can avoid a bigger upfront cost.

Municipal utilities must also choose between types of metering technology. The technologies available have improved dramatically over the past decade and so too has the business case for more advanced metering technologies (Beal & Flynn, 2015). Technologies such as advanced metering infrastructure (AMI) collect data in real time, offering additional economic and environmental benefits (see Box 9).

BEST PRACTICE #2
Estimating all private and social costs using a life-cycle approach

Before a municipality can develop a full-cost recovery strategy, it must understand the nature of its costs. This requires water utilities to develop a comprehensive asset-management plan. At a minimum, these plans should consider all private costs associated with providing water and wastewater services: operating, maintaining, and administering the infrastructure;

the capital costs of building the infrastructure, including the historical underinvestment and future capital costs; and any other expenditure of the utility, such as research and development or payments on outstanding debt obligations (CMAP et al., 2012; FCM, 2006; US EPA, 2006).

Asset-management plans can also include the value of natural assets. The Gibsons case study illustrates how including natural assets can lead to a more complete framework for full-cost recovery with potentially significant economic and environmental benefits. Though national accounting standards currently prevent municipalities from explicitly including these costs in their financial statements, estimating these costs can nonetheless help municipalities' planning. Municipalities should, however, be aware of the complexities associated with valuing natural assets that overlap with other jurisdictions (provincial and/or municipal).

Long-term planning is an especially important component of asset management. Municipal water infrastructure assets are long-lived—sometimes exceeding 100 years—which, almost by definition, requires a life-cycle approach when estimating their costs. At the same time, managing water resources in a way that promotes long-term sustainability will ensure that future generations have access to the same (or better) level of municipal water service. Including natural assets within this framework will also help align cost recovery and conservation objectives (AWWA, 2017; Sprang et al., 2015).

Technology plays an important role in full-cost accounting. In addition to advanced metering technologies, emerging software and data-management programs allow municipalities to collect and analyze enormous volumes of data, which leads to better-informed decisions around infrastructure maintenance and replacement. It also allows water utilities to identify costs for each user class within the water system (AWWA, 2017).

Best practices in asset management are readily available from the American Water Works Association, the International Standards Organization, and the Federation of Canadian Municipalities, among others. They typically require integrating engineering, financial, and climatic data and other planning documents (e.g., business and financial plans, environmental systems management) (CMAP et al., 2012). Other organizations, such as the World Bank, the Natural Capital Coalition, and the Municipal Natural Capital Initiative have more information on including natural assets within asset management.

BEST PRACTICE #3
Estimating existing and future revenues from all sources

Asset management is only one-half of developing a full-cost recovery strategy. The other half is quantifying both current and expected future revenues. This requires looking at all sources of revenue, including user fees, development fees, fire protection charges, property taxes, and government grants (AWWA, 2017).

Similar to asset-management plans, revenues should be forecast over time. Population growth, rate changes, climate, and the impacts from non-pricing policies should all be considered. Generally, municipalities should review revenues annually, supported by a five- to ten-year projection of future revenues; projections beyond this horizon are typically of less value due to greater uncertainty. As with full-cost accounting and water metering, emerging technologies can provide a higher level of resolution for this type of analysis. The Town of Gibsons, for example, relied on modelling work by the private sector to help with its asset-management plan and revenue forecasts.

BEST PRACTICE #4
Identifying the funding gap and developing a full-cost recovery strategy

With an asset-management plan in place and a comprehensive understanding of current and likely future revenues, municipalities can estimate their funding gap. This will identify the extent to which water and wastewater rates need to increase to reach full-cost recovery.

The funding gap will be different in each municipality. Municipalities that have already made progress toward full-cost recovery with user fees are likely to have smaller gaps. By contrast, the gap will be larger in communities with infrastructure investment backlogs or where future infrastructure costs are expected to increase dramatically. In either case, closing the gap quickly can minimize the costs associated with continued infrastructure deterioration and the related impacts to water quality and quantity (AWWA, 2017; Ontario Government, 2005).

Once the gap is identified, a municipality can develop a strategy to recover its private and social costs. This strategy would define goals and objectives, evaluate different funding alternatives, and communicate them with citizens. This was the approach taken in both Gibsons and North Battleford. Full-cost recovery strategies may also include the option of amalgamating with other nearby water systems, such as the municipalities neighbouring St. John's.

Due to a lack of municipal-level data, we unfortunately cannot estimate the funding gap in each municipality and cannot identify the price required to reach full-cost recovery. However, research by Renzetti and Kushner (2004) in the Niagara region found that rates for water and wastewater would need to increase by 16% to 55% to recover all private and social costs. This analysis—although based on only one municipality—provides a rough approximation of the type of rate increase necessary.

BEST PRACTICE #5
Relying on user fees to help close the funding gap

Of all the different financing instruments described in this report, user fees are the most flexible and practical revenue tool available to municipal water utilities. User fees can recover the full spectrum of private and social costs. If well designed, they can provide a clear price signal to drive water conservation. User fees can also provide a stable and reliable source of revenue, allowing municipalities to plan for the long term. Industry organizations, governments, and academics recommend and support this approach (AWWA, 2017; Kitchen & Slack, 2016; Brandes et al., 2010; Renzetti, 2009).

User fees are the most flexible and practical revenue tool available to municipal water utilities and can recover the full spectrum of private and social costs.

Municipalities can also employ revenues generated by user fees to back the issuance of debt or equity, important tools for financing infrastructure projects. The revenues from user fees can underwrite the repayment of debt for capital projects or provide a return on investment for private-sector investors. In this way, the amortized costs of issuing debt and equity are included within water and wastewater user fees and financed over several years. Using debt and equity financing in this way can also help improve intergenerational equity—ensuring that improvements to the water system are financed by the generation that receives the benefits. As we saw in Section 4, North Battleford is a small municipality that has taken this approach. It has relied on debt to finance major capital projects and raised water fees to cover the costs of servicing this debt.

User fees, however, may not be the only funding tool required to reach full-cost recovery. This may be particularly true for small municipalities with narrower revenue bases, or in municipalities that are struggling economically. In these cases, federal and provincial infrastructure grants—or even property taxes—can play an important role in ensuring that Canadian municipalities receive comparable levels of service. In addition, development charges will continue to be an important (albeit small) source of municipal revenue to help pay for connecting new developments to the water grid.

The collection and sharing of information is also critical to the shift toward fully recovering costs through user fees. Providing households and businesses with information on how user fees work—and how municipalities pay for their water and wastewater systems—can improve the policy's overall effectiveness and durability. The financial savings from conserving water, for example, become clearer when households and businesses have regular feedback on their consumption. Installing advanced water metering technologies can help in these efforts.

5.2 DESIGNING THE USER FEES

Just as the choice of revenue tool matters, so too do design details. Rate-setting is driven by the objectives and constraints in each community. A design that works in one community may not work for another (CMAP et al., 2012).

Our focus here is on higher-level best practices that support objectives of fiscal and environmental sustainability. See AWWA (2017) and BCWWA (2013b) for a detailed, step-by-step guide to rate-setting.

BEST PRACTICE #6
Using a multi-rate user fee to achieve multiple objectives

Section 3 identified an important tradeoff facing municipalities: encouraging water conservation while also achieving full-cost recovery.

A multi-part user fee is the best way to balance these objectives. The fixed portion allows utilities to recoup some of their fixed costs and provides stable and predictable revenues. The volumetric portion can recover variable costs and maintain a price signal to drive conservation.

The weight given to fixed versus volumetric user fees has implications for revenue generation, the conservation response from users, and affordability (Sprang et al., 2015). As illustrated by the Ottawa case study, relying too heavily on volumetric rates can undermine revenue stability (and therefore cost recovery), particularly as Ottawa employed other policies to reduce water use. Relying heavily on fixed rates, on the other hand, as in St. John's, weakens the incentive to conserve and undermines the overall cost-effectiveness of service delivery.

To strike the right balance between fixed and volumetric fees, municipalities can forecast how different rate combinations will affect revenues and conservation. Finding the right balance can take

Seasonal pricing helps Tofino manage water fluctuations.

The District of Tofino is one of a few Canadian municipalities to use seasonal pricing, which is an additional charge to water users during the dry summer months. This signals the higher marginal costs associated with strained water supplies.

time. Ottawa refined its fee structure over several years. This effort to strike a better balance between fixed and volumetric user fees is a tension that every city must manage.

BEST PRACTICE #7
Tailoring fees to the local context

Designing user fees to mesh with local context helps ensure that they are cost-effective and environmentally sustainable. We address two major dimensions: tailoring fees for different user classes and for different environmental pressures.

User fees encourage cost-effective service delivery by charging water users for what they consume. They are also typically more equitable—across households and businesses—since rates can be based on users' demands on the system (AWE, 2008; AWWA, 2015).

The most common approach in Canada is to charge different rates for commercial and residential users.[44] Separating user classes into even more specific categories can lead to more efficient and equitable outcomes. It ensures that user fees accurately reflect the costs that each type of user imposes on the system. Utilities can distinguish user classes based on water demand, location, required infrastructure, new developments, and type of use (CMAP et al., 2012). See AWWA (2017) for a detailed guide for aligning user classes with costs.

User fees can also be designed to address environmental pressures. For example, adopting a seasonal rate structure can help municipalities that are prone to water shortages. Seasonal pricing applies an additional charge to water users during the dry summer months, signalling the higher marginal costs associated with strained water supplies and capacity expansion (CMAP et al., 2012).[45] The District of Tofino, for example, charges commercial users $1.30/m^3 from October to March, and increases the rate to $1.80/m^3 from April to September when the town is more susceptible to water shortages (District of Tofino, 2015).

Other rate designs are emerging in areas that experience extreme drought, such as California. One such rate design is called "increasing block rate water budgets." This design uses the same principle of increasing block rates—where consumers are charged at higher rates for increased use—but also establishes water budgets for each water user. These budgets are based on what the utility deems as the efficient level of water use for each user, based on data about household characteristics (e.g., size, number of people, lot size, etc.) (Baerenklau et al., 2013).

BEST PRACTICE #8
Integrating relief for low-income water users

Ensuring that water remains affordable for low-income households is a key challenge. To some extent, these concerns can be addressed through a volumetric fee because households influence some control over their bill for water and wastewater by consuming less. But for many households, this relief may not be enough.

There are two main ways to further ensure that low-income households have affordable access to water. The first is to include a basic allotment of water within the fixed portion of the user fee. Within this allotted amount, the cost to households for consuming one additional litre of water is zero. This approach is used in Battleford where the water utility includes 30 cubic metres of drinking water for its quarterly fixed fee of $84 (which amounts to about 330 litres per household per day).

Halifax Water, via the Salvation Army, provides up to $250 every 24 months in assistance to qualifying low-income households.

The second approach is to provide low-income households with assistance on their water bills. With this approach, all water users—regardless of income—pay the full amount of user fees. Low-income households then receive a partial rebate to help cover costs. Halifax Water, for example, provides up to $250 every 24 months in assistance to low-income households (HRWC, 2017).

[44] Most municipalities charge lower rates for larger users of water due to economies of scale (i.e., the per-litre costs of supplying commercial users are typically lower than costs for supplying residential users).

[45] But seasonal pricing may have limits in areas with severe water shortages. It could, for example, result in price increases that are unacceptably high (Wichman, 2016). In these cases, it makes sense to combine seasonal pricing with water-use restrictions.

Each option has advantages and disadvantages. Providing direct financial assistance allows water utilities to consider affordability concerns after rates have been designed to achieve other core objectives, such as revenue generation and conservation. All water users therefore face the same price signal to conserve. Basic allotments, by comparison, provide everyone with a discounted amount of water, regardless of their ability to pay. This can diminish cost-effectiveness, as customers are charged even if they do not use the full amount. In addition, determining an "essential" amount of water is challenging.

BEST PRACTICE #9
Making adjustments over time—in a predictable, transparent way

User fees can be adjusted over time, as conditions change. The right fee structure today may not be the best one in the future. Municipalities can manage some of this risk by adopting earlier best practices, such as completing asset-management plans and forecasting future revenues (AWWA, 2017). These best practices force municipalities to consider future circumstances and to design user fees accordingly.

Even with thorough municipal planning, however, circumstances inevitably take unexpected turns. Events such as higher-than-forecasted reductions in water demand or an economic downturn necessitate re-evaluating water rates to mesh with the changing context. As a best practice, water and wastewater fees should be reviewed annually and adjusted accordingly (AWWA, 2017 CMAP et al., 2012).

At the same time, a predictable and transparent process for adjusting the fee structure can help individuals and businesses plan over time. Sharp, sudden changes in fees can hinder planning but also create opposition. Similarly, keeping the fee structure simple can make it easier for water users to understand and respond to the price signal.

BEST PRACTICE #10
Complementing user fees with other tools, especially for small municipalities

Relying on user fees as the main plank for improving the financial and environmental sustainability of municipal water and wastewater systems can help achieve economic and environmental objectives.

To strengthen the price signal, municipalities can use a range of tools to complement user fees.

Providing better information to water users, for example, is a powerful and cost-effective tool. This could include simple measures, such as billing every month instead of billing quarterly, so that water users have more frequent feedback on their use. Alternatively, municipalities can provide water users with real-time feedback on their use, facilitated by adopting advanced metering technology. Households and businesses can then clearly see the link between using less and paying less.

Provincial and federal regulations are also important complements to user fees. Regulations for drinking water and wastewater are critical for maintaining a baseline for service standards. The recent federal regulations for treating wastewater, for example, will prohibit municipalities from discharging raw sewage. Provincial regulations set minimum standards for how municipalities protect and treat drinking water. User fees can help pay for the infrastructure necessary to meet these requirements.

Complementary policies may be particularly important for small municipalities, as they face several constraints that larger municipalities do not. Infrastructure in small municipalities is generally older and in greater need of repair. As we saw with the Battlefords' case study, smaller municipalities may have less financial capacity to make necessary infrastructure investments or may lack the managerial and technical capacity required for developing integrated, robust long-term planning.

Provincial and federal regulations may also have a disproportionate effect on financial and human resources in small communities. Stringent water quality regulations, for example, may require significant upgrades to existing infrastructure and strain municipal budgets (even if such regulations are beneficial). Small municipalities may be unable to include these additional costs within user fees, as they may result in prohibitively high costs for residents.

Provincial and federal grants can help offset some of these pressures. A survey of Ontario municipalities, for example, found that many municipalities can charge user fees that reflect the full cost of service, but federal and provincial grants may be required to fully achieve this goal (Watson and Associates, 2012). Grants may be particularly useful in helping small municipalities pay for the fundamentals of sustainable water management, including universal water metering and asset management planning.

The conditions of support from provincial and federal governments also matter. Relying on outside assistance means that municipalities are not sustainably financed (AWWA, 2015). If the long-term goal is self-sufficiency for municipalities based on revenues from user fees, provincial and federal policies should be targeted and temporary. That can push municipalities toward adopting best practices in water management, and toward self-sufficiency. The Town of Gibsons, for example, aims to be completely self-sufficient by 2024, relying primarily on user fees to finance water and wastewater services.

5.3 GOVERNANCE CONSIDERATIONS

The extent to which municipalities implement the best practices discussed above depends largely on the broader governance context. While municipal governments are the owners, operators, and stewards of their water systems, they have limited authority. Provincial governments provide infrastructure funding and set the regulations and standards that municipal water utilities must implement. The federal government plays a less direct role, setting overarching environmental regulations, collecting data, and providing funding for infrastructure.

Best practices in governance, though crucial, are well beyond the scope of this report. Unlike other best practices—which have been developed over decades, and are based on robust research and analysis—governance issues for municipal water and wastewater are a relatively new area of research. Governance issues are also influenced by the dynamics of Canadian federalism, so what works in other countries may not work in Canada. Even within Canada, what works in one province may not work in another.

The key challenge with provincial and federal governance is striking the right balance between stringency and flexibility. Policies need to be stringent enough to ensure that all municipalities are making progress but they must also provide municipalities with enough flexibility to respond effectively to local issues.

Stringent policies can push municipalities to adopt best practices, such as full-cost recovery or universal metering. Ontario, for example, has tried to implement several reforms to push municipalities toward full-cost recovery. In response to the Walkerton crisis, the province enacted legislation that would have required water utilities to operate on a cost-recovery basis, including operation, maintenance, and capital costs. The full extent of the regulations was never adopted, due, in part, to opposition from municipalities (Fenn & Kitchen, 2016). Municipalities argued that the proposed regulations would prevent them from tailoring policies to their local context (Watson and Associates, 2012). The government does, however, require municipalities to submit financial and sustainability plans to the province.

Provincial governments can also regulate how municipalities design and implement user fees for water and wastewater. In Nova Scotia, for example, the government created the quasi-judicial Utility and Review Board (NSURB) in 1992, which supervises all utilities in the province. The Board must approve any changes that municipalities make to their water and wastewater fees and ensure that they recover “all reasonable and prudent” costs (NSURB, 2013. Prince Edward Island, Manitoba, Saskatchewan, and Alberta each have similar rate-approving bodies (Furlong & Bakker, 2008).

Just as provincial and federal policies can ensure that municipalities adopt best practices, these policies can be restrictive. Having a provincial authority review and approve municipal fee structures, for example, may diminish local accountability. The same argument might also apply to regulations that require municipalities to achieve full-cost recovery through user fees. In both cases, provincial policies may fail to recognize local issues and restrict the autonomy of local councils. Provincial regulatory bodies may also delay the time it takes for municipalities to make changes to their water and wastewater rates.

Flexible policies, by contrast, can help pull municipalities toward best practices, such as providing technical support or conditional financial incentives. Governments can, for example, make grant funding conditional on municipalities meeting basic asset-management and long-term planning requirements, or, as we saw in the St. John’s case study, incentivizing regional development of infrastructure. This approach requires less intervention and gives municipalities more flexibility in achieving their goals.

Some provincial and federal programs distribute and award grants based, in part, on these criteria. The federal government’s Water and Wastewater Fund, for example, provides grants for municipal projects that improve asset management, upgrade infrastructure to meet federal regulations, or employ new and emerging technologies (Infrastructure Canada, 2017). Similarly, the Alberta Municipal Water and Wastewater Partnership grant program requires municipalities to include details of their existing rate base and the extent of their water metering (Government of Alberta, 2017).

In sum, governance issues have important implications for the extent to which municipalities implement best practices for their water systems. While this section has highlighted only a few of these key considerations, the overall issue deserves more study.

6 RECOMMENDATIONS

Based on the analysis in the preceding sections, we close with six recommendations for municipal, provincial, and federal governments. If followed, these recommendations will improve the financial and environmental sustainability of our country's water and wastewater systems.

RECOMMENDATION #1:
Municipalities should rely on multi-rate user fees to recover costs and encourage conservation.

Multi-rate user fees should be the primary mechanism for how municipalities finance their water and wastewater systems. Rates should stem from asset-management and full-cost recovery strategies, and should be set at levels that fully recover costs. Universal metering would allow for ongoing policy evaluation. While municipalities should design their water and wastewater user fees according to their unique contexts, the best practices in Section 5 offer broad insights on striking the right balance between the fixed and volumetric component of the fees. The fixed component of the user fee should ensure revenue stability, even against continued improvements in water conservation. The volumetric component of the user fee should ensure that municipalities provide a robust price signal to water users. This will drive conservation, improve fairness, and help reduce costs. Cities should identify the different balance between fixed and volumetric fees depending on their own priorities.

User fees can also be used in conjunction with other financing tools. The revenues they generate can be used for leveraging private investment through issuing debt or equity. Well-designed user fees provide a reliable and steady revenue stream, which can help utilities finance large capital projects. This can also reduce reliance on grants from provincial and federal governments. Municipalities should explore each of these options when planning new capital projects.

RECOMMENDATION #2:
All municipalities should develop an asset-management plan and full-cost recovery strategy.

Developing an asset-management plan and full-cost recovery strategy is a crucial first step toward sustainable water and wastewater management.

Municipal asset-management plans should take stock of infrastructure using a life-cycle approach and consider the costs of maintaining and replacing assets as they age.

Developing a full-cost recovery strategy is the opposite side of the same coin. Municipalities should assess existing sources of revenue and determine whether they are sufficient to finance its asset-management plan. Doing so will identify funding gaps and thus determine whether municipalities need to increase revenue streams.

Some municipalities have already taken this step, but many have yet to act. It is a necessary first step for improving management of municipal water and wastewater systems.

RECOMMENDATION #3: Municipalities should include natural assets within their asset-management and cost-recovery strategies.

To the extent possible, municipalities should include natural assets within their asset-management and full-cost recovery strategies. Doing so provides a more complete framework for managing water and wastewater systems. It makes environmental objectives explicit (e.g., conservation, water source protection) and aligns these objectives with existing objectives, such as cost recovery. Because valuation techniques for natural assets are still emerging, municipalities should begin with a relatively narrow and manageable scope. This might include looking at one natural asset that provides an essential service, such as an aquifer, lake, or river. Municipalities should also start with valuing natural assets that are located within the community. As valuation techniques become more sophisticated, municipalities can begin to look at shared natural assets.

RECOMMENDATION #4: The Public Sector Accounting Board should identify ways to broaden the financial framework to include natural assets.

Municipalities are currently prevented from fully implementing Recommendation #3. According to national accounting standards, municipalities can only include engineered assets in their financial statements, which excludes the value of natural assets and the costs of protecting them.

The Public Sector Accounting Board is ultimately responsible for setting the accounting framework for municipalities. As such, the PSAB should identify ways to broaden the financial framework to include natural assets. This would allow municipalities to move ahead with integrating natural assets within the existing accounting framework.

But modernizing accounting standards to include natural capital will take time, and should be carefully evaluated. National and international accounting standards can take years to develop, especially considering the significant potential scope of natural capital. While the techniques to estimate the value of natural ecosystems are continually improving, integrating them into standardized financial accounts poses several challenges. For example, these standards will need to identify ways to account for assets that overlap across jurisdictions—between municipalities, or between municipalities and provinces.

The PSAB can look to other organizations in developing the necessary expertise, such as the United Kingdom's Natural Capital Committee, the international Natural Capital Protocol, and the World Bank's Waves Program. Although provincial and federal governments cannot directly influence the standards set by PSAB, governments can assist in providing the research and analysis on the methods and techniques for valuing natural assets. The PSAB can also work with municipal governments that have already begun to value their natural assets.

RECOMMENDATION #5: Provincial and federal governments should encourage municipalities to adopt the best practices described in this report.

User fees may not be the appropriate tool for recovering *all* costs of the water system. Provincial and federal grants can play an important role in funding capital projects. This may be particularly true in small municipalities or in areas facing economic hardship.

At the same time, relying too much on grants is problematic. Relying on grants may keep user fees too low to recover costs, leading to wasteful water use. Such low rates may also make it more challenging to increase rates over time.

Federal and provincial governments should use grants to encourage municipalities to adopt best practices for managing water and wastewater services. They should adopt clear criteria for distributing grants to municipal water utilities. Communities that have developed or are in the process of developing robust asset-management and cost-recovery strategies should be prioritized for grants. So should municipalities that can clearly demonstrate how they intend to charge user fees to help pay for the costs of operating, maintaining, and replacing this infrastructure. And in some cases, federal and provincial governments should use grants to enable municipalities to implement best practices, for example by building capacity to support asset management planning or by supporting efforts to install water meters.

Federal and provincial governments have already made progress in this direction. The federal government's Clean Water and Wastewater Fund, for example, provides funding for municipalities to initiate and improve asset management plans. It even offers funding for projects that protect natural capital.

RECOMMENDATION #6:
The federal government should reinstate the Municipal Water and Wastewater Survey.

The Municipal Water and Wastewater Survey (MWWS) provided invaluable data on the state of municipal water and wastewater systems in Canada. However, because the survey was eliminated in 2011, governments and researchers have much less information on the progress that has taken place over the past decade. As such, the federal government should ensure that Environment and Climate Change Canada has the necessary resources to reinstate the survey.

Reinstating the MWWS would allow government and researchers to better track trends in water management. In particular, reinstating the MWWS would help identify the extent to which municipalities are implementing best practices, such as those recommended in this report. It would shine light on critical trends, such as water consumption, metering, the price of water and wastewater, and the application of other non-pricing policies.

An alternative to reinstating the MWWS is to broaden Statistics Canada's existing Survey of Municipal Drinking Water Plants (SMDWP). The SMDWP provides a portion of the data covered under the MWWS but is ultimately narrower in scope. Combining the data covered in both surveys could also reduce duplication and make it easier for municipalities to complete the survey.

7 CONCLUSIONS

Canada's municipal water and wastewater systems face significant challenges moving forward, and well-designed user fees are a key part of the solution. They provide a direct link between the cost of service and the end user—those who use more water pay more on their monthly bills. A multi-rate user fee can ensure that municipal water utilities generate enough revenue to cover their costs while also maintaining a price signal that drives conservation by consumers. User fees can also be designed to be fair, so that low-income households have access to affordable water.

Municipal water and wastewater systems provide an invaluable service to Canadians. How we pay for these services has clear implications for the quality of the water we drink and for the health of our nation's watersheds. Simply put, municipal water systems are too important to take for granted. Paying the full cost for these services will help ensure that Canadians continue to benefit from clean and accessible water for generations to come.

Despite their importance, municipal water and wastewater systems comprise a small—albeit important—part of the entire water system. Equally important are the issues that this report did not discuss, including the value of water as a resource, water access and quality in First Nations communities, and pollution from non-point sources. Tackling these larger issues goes far beyond the scope of municipal water systems. It requires rigorous, integrated, and multi-disciplinary research and a broader dialogue about how we manage and value water as a society.

The Ecofiscal Commission will continue to explore some of these issues in future reports. To start this complex conversation, this report focuses on municipal user fees—one crucial tool for aligning water's price with its true value and helping us to conserve our most precious natural resource. Water and wastewater infrastructure might be hidden. The price we pay for them should be in plain sight.

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