Virtual Dialogues

Bringing cross-sector perspectives to Canada's water leaders

Pursuing Co-benefits to Advance Water Management

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The term "co-benefits" has been used widely since the 1990s (Mayerhofer & Gupta, 2016). The Intergovernmental Panel on Climate Change (IPCC, 2014) defined co-benefits as positive effects that a policy or measure aimed at one objective might have on other objectives. In the context of municipal strategies, co-benefits approaches have predominately focused on reconciling environment and development goals (e.g., climate change mitigation and adaptation action plans and initiatives) (Mayerhofer & Gupta, 2016). Co-benefits approaches have been growing in popularity in the environmental sector over the past two decades (IPCC, 2014).

The value of co-benefits to water, wastewater and stormwater utilities

The merits of taking a co-benefits approach have been widely acknowledged across sectors by economic, environmental and utility experts. Planning with co-benefits in mind provides opportunities to increase system and operational resilience, emergency preparedness, efficiency and financial sustainability. Here are some examples of what water, wastewater and stormwater utilities possibly stand to gain from taking a co-benefits approach:

- Enhanced infrastructure and system resilience across public and private sectors
- Improved ability of water systems to prepare for, withstand, adapt and rapidly recover from disruptive events and unforeseen disasters
- Achieving complementary goals shared by other municipal departments and sectors
- Long-term financial sustainability
- Strengthened community trust, safety and well-being
- Justification of capital investments and better City Council and community buy-in
- Alignment of local goals with broader, national goals
- Opportunities for cross-sector collaboration and coordination, including Master Plans
- Reduction of local greenhouse gas emissions

In 2018, Canadian Water Network (CWN) appointed a national expert panel to review Canada's challenges and opportunities in addressing contaminants in wastewater. The panel defined co-benefits through the lens of the water sector as follows: Co-benefits arise when actions designed to achieve one objective, such as urban flood mitigation measures, also provide benefits to another objective, such as reducing contaminant loading to receiving waters (CWN, 2018).

CWN's 2018 national expert panel report shared a case study on co-benefits related to the Lake Simcoe Phosphorus Offset Program, an initiative implemented as part of a broader strategy to reduce phosphorus loading in Lake Simcoe. Intended to find equitable, time-sensitive, and cost-effective ways to reduce phosphorus, this collaborative program has yielded several co-benefits for the local community's economy and ecosystems, including *"reduced flood risk, increased community resilience to climate change, enhanced groundwater recharge and the addition of green jobs to the local economy"* (CWN, 2018).

A 2019 report prepared by CWN for the Federation of Canadian Municipalities (FCM) scanned high-level decision trends in Canada's municipal water sector. The report identified that energy consumption was one of the main costs for water utilities across the country. Minimizing the energy required for pumping, distribution and treatment processes can often result in a number of co-benefits, including increased operational efficiency and opportunities to achieve complementary goals shared by other municipal sectors. Better utilization of wastewater components to generate heat, biogas and electricity are also linked to greenhouse gas (GHG) reduction (FCM, 2018).

Canadian water, wastewater and stormwater utilities continue to face challenges such as aging infrastructure, changing demand use patterns, and increasing residential and commercial development, which threaten long-term financial sustainability and resilience. Utilities also continue to navigate uncertainty such as climate change, contaminants of emerging concern, and more recently, the COVID-19 pandemic. Many municipalities/utilities are now turning to a co-benefits approach for future planning and preparedness. As a result, we are beginning to build a greater understanding of how actions taken to benefit the water, wastewater and stormwater utility yield broader co-benefits both within and across sectors.

Harnessing Co-Benefits Across the Water Sector

Initiatives that yield co-benefits across sectors can help build resilience to uncertainty that may impact utility maintenance, operations and the provision of services. Co-benefits approaches provide opportunities to increase system resilience and preparedness, operational resilience and efficiency, and financial sustainability.

System Resilience and Preparedness

The provision of water, wastewater and stormwater services are critical and essential services. The U.S. Department of Homeland Security (2019) has designated the water/wastewater sector as one of the nation’s four essential lifeline functions, noting that the reliability of these systems is “so critical that a disruption or loss of one of these functions will directly affect the security and resilience of critical infrastructure within and across numerous sectors.” Further, the International Risk Governance Council (2018) has stated that any form of external shock to an interconnected system, such as the water sector, may result in a variety of unanticipated and uncontrolled feedback and cascading effects that could result in unanticipated side effects.

Many cities across the country are experiencing more extreme precipitation events due to climate change. As these cities continue to grow and develop to accommodate population growth and urban densification, an increasing number of impermeable areas and hard surfaces often result (e.g., roads, parking lots, sidewalks and buildings). This creates runoff that carries harmful contaminants, contributes to urban flooding, and threatens the health and well-being of residents. Factors such as these challenge many urban sewer and stormwater systems that were not designed to accommodate the frequency of high-volume storm events we see today and can be overwhelmed resulting in combined sewer overflows (CSOs). For instance, in 2017, Statistics Canada reported over 164 million cubic meters of untreated sewage and stormwater was discharged into receiving waters from CSOs across the country.

In a 2020 report, Partners in Project Green described how natural and green infrastructure initiatives aimed at mitigating the impacts of severe flooding on municipal stormwater systems yield additional co-benefits. They noted that rain gardens, bioswales, rain harvesting systems and green roofs can result in less sediment and waste accumulating in storm and sewer systems. Natural infrastructure may also mitigate the impact of contaminants found in urban water runoff (e.g., heavy metals, plastic waste and road salt) on drinking water sources. Additional social, environmental and economic co-benefits may also be realized, such as “providing cleaner air, sequestering carbon from the atmosphere, reducing energy costs for buildings and homeowners, and even increasing property and rental values” (Partners in Project Green, 2020).

Increasing system resilience continues to be a top priority for public and private water utilities across Canada (FCM, 2018). The ability to prepare for, withstand, adapt and rapidly recover from disruptive events, attacks, accidents or naturally occurring disasters is essential to economic, social, environmental and political stability (U.S. Department of Homeland Security, 2019). The IPCC (2014) has stated that the consideration of co-benefits can help enable transformational change that can lead to sustainable systems for future generations, economies and environments.

Case Study: The City of Vancouver's Rain City Strategy

Challenges

The City of Vancouver experiences a higher frequency and volume of rainfall (160 days/year and 1200-1600 mm/year) than most other Canadian Cities (City of Vancouver, 2019). Like many other urban municipalities across the country, Vancouver faces challenges from combined sewer overflows (CSOs) and contaminants from urban rainwater runoff. In 2018, over 33 billion litres of combined sewage were released into receiving waters (City of Vancouver, 2019). Factors such as aging infrastructure, population growth, fiscal limitations, sea level rise, and a high percentage of impermeable surface areas all further exacerbate the risk of flooding and render the city susceptible to urban rainwater runoff from roads, rooftops and other impermeable surfaces. This runoff makes its way into receiving bodies and contains a cocktail of contaminants that can impact water quality and ecological health in receiving waters.

Strategy

Given the importance of clean water to healthy, resilient cities and ecosystems, the City of Vancouver has embarked on an ambitious strategy related to rainwater management, particularly in the context of climate change and changing precipitation and temperature patterns. They are reimagining and transforming how they manage rainwater through the Rain City Strategy. The goal of this strategy is to improve water quality, increase resilience and enhance livability through healthy urban ecosystems. Their unique "Ask, Try, Do" approach has included extensive stakeholder engagement and the development and implementation of solutions-focused pilots and prototypes. The City is now in the process of creating a novel standard of practice with the implementation of 46 recommended programs and enabling initiatives aimed at achieving six core objectives (Figure 1) to improve water management through green rainwater infrastructure in three categories: i) streets and public spaces, ii) buildings and sites, and iii) parks and beaches.

Figure 1. City of Vancouver Rain City Strategy 2019 – Core Objectives

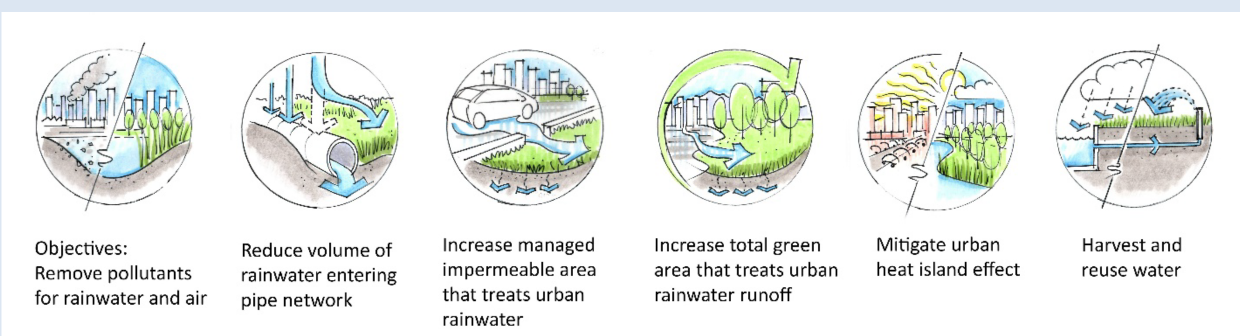

Image courtesy of the City of Vancouver

Typically, municipalities focus on capturing and transporting stormwater as quickly as possible through an extensive network of underground conveyance infrastructure to treatment plants or direct discharge into receiving waters. This can often be energy-intensive, costly, and present numerous environmental and climate resilience challenges. The City of Vancouver's Rain City Strategy prioritizes capturing rainwater where it falls and then using both engineered and ecological processes to remove pollutants and gradually allow rainwater to be reused, returned to the atmosphere or absorbed back into the ground to recharge aquifers. Approaches such as these deliver greater value for money while simultaneously reducing pressure on existing conveyance infrastructure, with the potential to avoid or defer upgrades to support growth, address flooding or handle increased volumes due to climate change. Research conducted through the Rain City Strategy has identified many case studies for which there is economic advantage in integrating piped infrastructure with green infrastructure solutions. Overall system costs, as well as costs and risks associated with water management of public/private infrastructure, have been demonstrably reduced. In addition, cross-sector collaboration has created a greater culture of shared responsibility.

A Co-Benefits Approach to Mitigation and Adaptation Measures

The Rain City Strategy seeks to drive transformational change through a concerted effort to shape and prioritize long-term, lasting initiatives for more holistic and integrated approaches to rainwater management and the use of green rainwater infrastructure. Some of the transformative directions that have been identified include:

- Supporting climate mitigation and prioritizing resilience to the threats and impacts of climate change
- Enabling communities and natural systems to thrive through watershed-scale planning, implementation and revitalization efforts
- Creating a culture of collaboration
- Driving innovation through digitalization
- Improved intersectionality that enhances equity and reconciliation with Indigenous Peoples through urban water management
- Mobilizing action through investment in education, partnerships and capacity-building

The City of Vancouver is anticipating several co-benefits from the Rain City Strategy. The combination of green rainwater infrastructure solutions and traditional piped infrastructure can reduce overall system costs, disperse fiscal responsibility, improve the provision of water services, contribute to economic development, create employment opportunities, reduce energy consumption, and generate cost savings for heating and cooling local buildings.

Ongoing engagement with corporate and community stakeholders (e.g., city staff, industry professionals and the public) can yield intellectual and social co-benefits such as knowledge mobilization, better public awareness, a stronger community connection to water, the promotion of physical activity and well-being, and training/capacity building with internal and external stakeholders.

Environmental and health co-benefits that may be realized include a reduced urban heat island effect and fewer heat stress events, and the preservation of habitats and biodiversity. Natural and green infrastructure can improve air and water quality, increase pollination and provide pest control (Australia State of the Environment, 2016). Better integration of natural and green infrastructure in urban environments also holds the potential to reduce greenhouse gas emissions and improve air quality, which may lead to improved quality of life overall. The Rain City Strategy is geared towards enabling co-benefits that will contribute to shaping a more equitable and livable city and create a culture of resilience that is embraced not just across the public sphere, but on a corporate level across the municipality and all its departments.

> "A holistic and integrated urban water management approach can do much more than serve the basic water needs of a community. It embraces all water as a valued resource and leverages cost-effective investments in water and rainwater management to support diverse ecosystems and community needs and aspirations."
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> City of Vancouver Rain City Strategy

Learn more about the City of Vancouver's Rain City Strategy at: vancouver.ca/home-property-development/green-infrastructure-documents-and-policies.aspx

Operational Resilience and Efficiency

Operational efficiency and resilience have often been linked to reduced costs and the ability to effectively respond to disruptive events. One of the major sources of uncertainty for municipal water and wastewater systems is the cost of energy (CWN, 2018). Energy consumption across many American municipalities accounts for as much as 40% of the operating costs of drinking water treatment plants (United States. Environmental Protection Agency, n.d.), and between 25% to 60% of the operating costs of wastewater treatment plants (Wallis-Lage, 2013). Activated sludge aeration, for example, which is conventionally part of wastewater treatment, is an energy-intensive process that may represent more than 50% of a treatment plant's total energy use (Tchobanoglous et al., 2014).

Increasing operational resilience and efficiency of energy use has the potential to achieve a number of co-benefits, including a reduction of GHG emissions, resilience to fluctuating energy costs, minimizing waste by-products, reducing the incidence of cost-intensive system errors (e.g., leakage) and better monitoring and tracking levels of service. Many municipalities/utilities across the country have been adopting practices over time to improve operational resilience across many levels of service, including:

- Energy efficiency audits
- New or upgraded technologies such as advanced metering infrastructure, SCADA systems, artificial intelligence, monitoring dissolved oxygen levels, high-efficiency blowers, membrane aerated bioreactors, integrated fixed-film sludge and anerobic granular sludge
- Upgrades to and investment in aging infrastructure such as sewer/stormwater/water mains, service lines and treatment plants
- Investment in intellectual and human capital such as staff skills inventories and contingency planning, employee training and development
- Business continuity planning such as evaluating levels of service and risk and vulnerability assessments (CWN, 2020)

In March 2020, CWN initiated a strategic sharing group for Canadian utility leaders on management responses to the COVID-19 pandemic. Many utilities identified being challenged with the emerging need to maintain physical distancing. In response, utilities across the country modified work arrangements (e.g., remote work or staggered or alternating shifts). A variety of co-benefits were reported. Staff were working productively from home in some cases, the flexibility of working from anywhere created opportunities for better work-life balance, and administrative operations were increasingly becoming more streamlined and efficient because of pivoting to virtual platforms and technologies.

Financial Sustainability

Utilities across the country are contending with significant challenges that impact long-term financial sustainability. Costs associated with unexpected events or events that exceed typical contingencies are difficult to predict and quantify. Most of Canada's current infrastructure was not designed for the more frequent and intense rainfall, flooding, drought, wildfires, ice storms and fluctuating temperatures we have been experiencing in the last decade. Further complicating matters is low public awareness of the complexity of considerations, decisions and practices, or the nature and consequences of financial underinvestment. Consequently, public resistance to rate or tax increases to support additional system investments and more complete cost recovery is common.

The City of Vancouver has indicated that the cost of integrated water infrastructure will cost billions of dollars within the coming decades (City of Vancouver, 2019). They have also found that obtaining funding for new or upgraded technologies is challenging. Similarly, CWN's 2018 report Balancing the Books: Financial Sustainability for Canadian Water Systems also noted that future investment in the nation's aging infrastructure will be in the billions.

By planning with a focus on co-benefits, goals within and across several sectors can be achieved. Mayrhofer et al. (2016) contend that co-benefits open a "window of opportunity" because they align broader goals with local goals. More specifically, co-benefits that help achieve local goals may also contribute to the achievement of overarching goals on a national scale, helping build the case for capital investments. To support this concept, Alves et al. (2019) determined that when conducting cost-benefit analyses for urban flood risk management, measures that consider co-benefits in addition to primary goals yield benefits that exceed the initial costs.

Case Study: Region of Waterloo Surface Water Quality Monitoring Program

Challenges

The Region of Waterloo (Region) is an upper-tier municipality in Ontario that works closely with seven local municipalities to provide municipal drinking water and wastewater services. The Region is at the heart of the Grand River watershed, the largest watershed in southern Ontario. The Grand River is a drinking water source (in addition to local groundwater) and receives treated wastewater effluent from 10 of the Region's 13 wastewater treatment plants. Some of the most productive agriculture in southern Ontario also resides within the Region's boundaries. The population is rapidly growing and is now approximately 617,000 residents (Region of Waterloo, 2019).

The Grand River's health reflects multiple stressors, including runoff from urban areas, agricultural drainage and treated wastewater effluents. Monitoring and research efforts by the Region, local researchers and the Grand River Conservation Authority provided multiple lines of evidence that highlighted the deteriorating water quality downstream of the large wastewater treatment plants — in particular, high levels of ammonia, which can be toxic to aquatic organisms and low dissolved oxygen levels. Research also highlighted high levels of pharmaceuticals and synthetic estrogen in the wastewater effluent discharged into the Grand River, as well as increased occurrence of intersex fish downstream of the largest wastewater treatment plant in Kitchener. In some locations, the absence of fish altogether was reported.

Strategy

As a result of the Region of Waterloo's Wastewater Master Plan update (Earth Tech Canada, 2007), the Region of Waterloo committed to implementing an approximate $800 million capital program to improve the robustness and effluent quality of their wastewater facilities over the past decade. Included in the Region's capital program were secondary treatment upgrades to full nitrification and odour management at their larger treatment facilities, with the ultimate goal to improve effluent quality and the overall health of the Grand River. The Region also committed to develop and implement a surface water quality monitoring program for the Grand, Nith and Speed rivers to monitor the impact of the capital upgrades on the health of the watershed. The monitoring program's objective was to collect data over the long-term to monitor the changes in river health upstream and downstream of the treated wastewater effluent discharge points.

Around the same time, local researchers showed a growing interest in the cumulative effects of multiple watershed stressors on aquatic health in the Grand River. Researchers from the University of Waterloo examined a range of biological indicators that could detect and monitor ecological changes from watershed stressors from across the watershed as part of Canadian Water Network's Canadian Watershed Research Consortium. This research aimed to develop a regional (or broader watershed scale) monitoring framework that could help assess and manage cumulative effects by determining long-term mitigation strategies (Servos, 2016). This research complemented the Region's surface water quality monitoring program and included broader watershed considerations.

Co-benefits of the Surface Water Quality Monitoring Program

The wastewater treatment plant upgrades led to significant reductions in ammonia levels, increased dissolved oxygen and improved overall water quality in the Grand River — all desired outcomes of the wastewater treatment plant upgrades that justified the significant capital investments. Further, the Region's Surface Water Quality Monitoring Program also identified several unanticipated co-benefits:

- Collaborating with local researchers and watershed managers helped to leverage the Region's monitoring program to broaden and deepen the collective knowledge and understanding of the health of the Grand River.
- The Region was able to show to their councillors and ratepayers that the aquatic health of the Grand River was improving, by using information from multiple research and monitoring programs that corroborated the findings in their water quality monitoring program.
- Fluctuations in river water quality also signaled potential issues in the wastewater treatment plant that helped to inform process changes in the plant.
- Long-term monitoring data provided an improved ability to identify possible impacts from the wastewater treatment plants in response to a changing climate.
- Although plant upgrades were not designed with the intention to eliminate synthetic estrogens in the treatment process, it was found that the nitrification process, which has been demonstrated to effectively degrade these types of compounds, played a role in mitigating the prevalence of estrogen compounds in the wastewater effluent.

> "These co-benefits further justify to Regional Council, the public and rate payers that maintaining and investing in wastewater infrastructure is crucial to the overall health of our waterways that are used as a source of drinking water and recreation, while garnering continued support and collaboration from the academic community, the Grand River Conservation Authority and the Ontario Ministry of Environment, Conservation and Parks."
>
> Trevor Brown, Manager of Wastewater Operations, Region of Waterloo

Social Co-Benefits

Residents and customers remain the water sector's core stakeholders. The provision of water, wastewater and stormwater services to this stakeholder group, especially during catastrophic events and other times of uncertainty — such as the COVID-19 pandemic — are critical to strengthen trust and ensure public health and safety. Effective and reliable measures for water, wastewater and stormwater management and treatment help reduce or eliminate risks linked to waterborne illnesses, which enhance livability, well-being and health (Gouldson et al., 2018). Considerations for how to best provide essential services are a shared responsibility between utilities, municipalities, governments and other non-government organizations (U.S. Department of Homeland Security, 2019). As highlighted in the City of Vancouver Rain City Strategy case study, the social co-benefits that arise from resilient, accessible and affordable water systems are essential. They develop a sense of community through feelings of belonging, a sense of accountability through defining levels of service, and a sense of control and autonomy through public consultation and customer engagement.

Moving Forward with Co-Benefits in Mind

The case studies provided in this document highlight how co-benefits approaches can yield a variety of positive outcomes for water, wastewater and stormwater utilities. Investment and operational decisions need to be made, despite the future uncertainty of climate change, emerging contaminants and other challenges. Creative approaches to water management that result in co-benefits are gaining momentum, but require the participation of multiple departments, sectors and organizations. Additionally, co-benefits are often captured across a number of different municipal departments and sectors and contribute to stronger, more resilient cities overall. A more integrated, cross-department/cross-sector approach from the outset can accelerate outcomes and result in transformational change that persists far into the future.

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