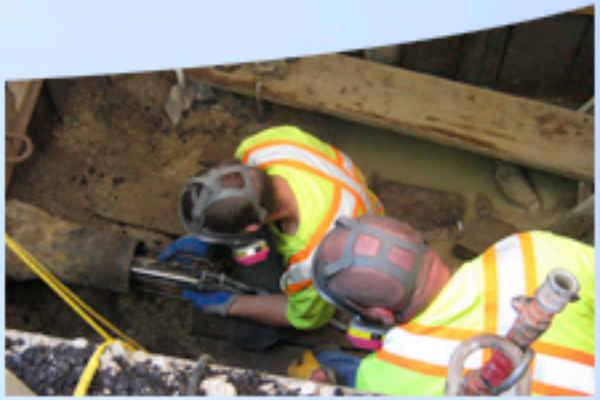
SHOWCASING WATER INNOVATION

Communities Adopting Innovative and Sustainable Water Management

Final Report 2015



Ontario

CONTENT

1.0 Preface 1

2.0 Impact by Numbers 2

3.0 Quotes 4

4.0 Overview 7

5.0 Highlights 11

5.1 Power of Partnerships 11

5.2 Saving Costs 12

5.3 Supporting Innovative Technologies 14

5.4 Preparing for Climate Change 15

5.5 Solutions for Small and Remote Communities 16

5.6 Improving Stormwater Management 17

5.7 Improving Drinking Water Systems 18

5.8 Improving Wastewater Systems 19

5.9 Protecting the Great Lakes 20

5.10 Creating Green Jobs 21

6.0 Insights 22

7.0 Conclusion 24

8.0 Showcasing Water Innovation Partners 25

Appendix – Project Summaries 27

1.0 PREFACE

Water is essential for communities – for life, economic strength and recreation. Managing it well is not only imperative but it is an opportunity to create resilient and livable communities.

Our communities are on the forefront of change. They face unprecedented challenges including fiscal pressures, aging infrastructure, and threats from extreme weather. Collaboration and innovation can meet these challenges, improving water management and maximizing the value of investments. Through Showcasing Water Innovation, progressive communities across Ontario used innovation and collaboration to pioneer cost effective approaches to sustainable water management – demonstrating the art of the possible.

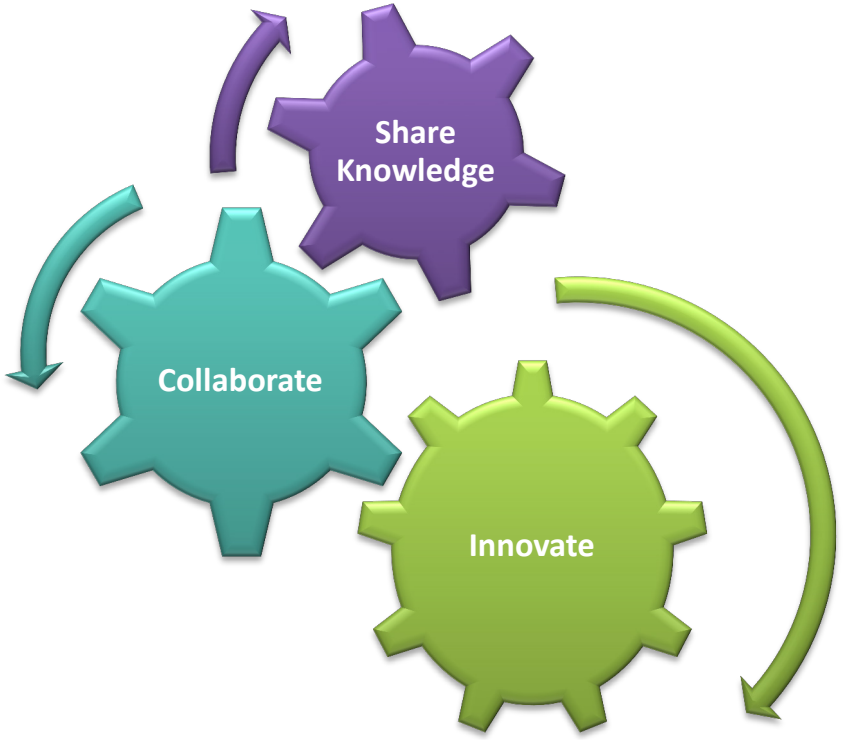
The Government of Ontario's Showcasing Water Innovation program supported 32 projects in communities across Ontario – from the far North to Southern Ontario. A $17 million investment by the government leveraged an additional $35 million creating a total investment of $52 million in innovation. These projects enabled communities to optimize existing infrastructure, defer capital investments, stabilize operating costs, prioritize water investments, conserve water, and lower energy use and carbon emissions. The new approaches and innovative technology solutions are helping these communities create "utilities of the future".

Showcasing Water Innovation was conceived to fund a small number of high value projects, and showcase these projects to all Ontario communities. This report shares what the communities did, the results, and lessons learned along the way. We hope these pioneering communities will inspire others to plan and implement their own innovative water management projects. The vision of drinkable, fishable, and swimmable waters is shared by many communities, and new directions for water management will ensure Ontario communities are vibrant, sustainable places to live.

We invite you to read this report and consider the opportunities and benefits of innovation in water management. We're inspired by these innovative communities – we hope you are, too.

Sincerely,

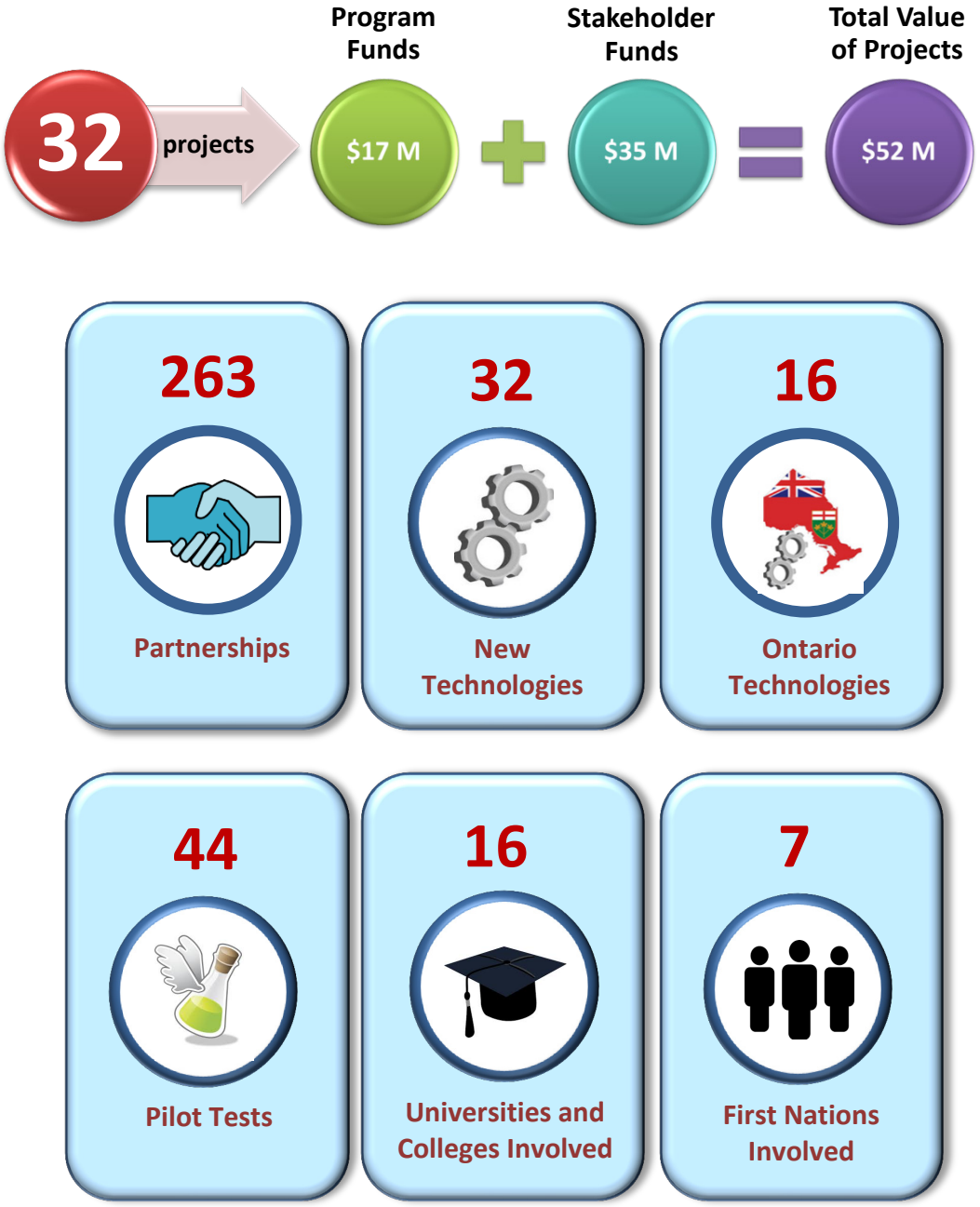
The Showcasing Water Innovation Team



2.0 IMPACT BY NUMBERS

The Showcasing Water Innovation program was a catalyst, enabling communities to pioneer integrated sustainable water management solutions. Some of the impacts of Showcasing Water Innovation are:

- 32 pioneering communities supported
- Leveraged over $35 million, from a $17 million provincial investment
- 263 partnerships formed
- 44 pilot tests undertaken
- 32 new technologies piloted
- 16 Ontario technologies piloted
- 16 University/College partners
- 7 First Nation partners



Sharing the Learning

To have a significant and enduring impact, a goal of the program was knowledge transfer and capacity building. It is hoped that sharing project knowledge will inspire and encourage other Ontario communities to replicate Showcasing Water Innovation projects or other innovative projects in their own communities. Examples of knowledge sharing to date are:

- 63 case studies on sustainable water management solutions
- 175 media publications
- 169 workshops and webinars
- 66 conferences
- 53 tours and public events
- 32 reports, plans, studies
- 24 videos

* Includes hosting, presenting, information booths
† Includes news releases, journal/media articles, interviews, posters, videos

3.0 QUOTES

Project participants share their thoughts on the program:

"Guelph is the largest municipality in Canada that relies solely on groundwater, so water has always been a top priority for us. The Showcasing Water Innovation program was a catalyst in our municipality for technologies that help us save water, energy, and costs. What's more, it fostered networks with other municipalities and the private sector – networks that will live on as we continue to strive for water innovation."

Mayor Cam Guthrie, City of Guelph

"The Showcasing Water Innovation program has played a significant role in providing safe and reliable drinking water supply to the members of our community of Constance Lake First Nation. It has been an important factor in us securing a new water treatment plant. This program has spurred a new era towards the health and community growth of our First Nations."

Chief Ricky Allen, Constance Lake First Nation

"Showcasing Water Innovation has been a great example of MOECC getting behind new approaches and technologies, not only with funding but with institutional support. Clearly demonstrating and promoting the benefits of such projects helps Ontario communities become better generators and clients of innovation."

Brenda Lucas, Executive Director,
Southern Ontario Water Consortium

"The Regional Municipality of York was very pleased to participate in the Showcasing Water Innovation Project with the Ministry of Environment and Climate Change, University of Toronto and technology leaders. This SWI project in particular helped the Region and its partners better understand treatment options for managing emerging micropollutants. By truth-testing innovative treatment technologies, we were able to remain closely connected with the latest developments in the industry and continue to achieve regulatory excellence."

Erin Mahoney, Commissioner of Environmental Services,
Regional Municipality of York

"The Showcasing Water Innovation Program was able to provide the Municipality of North Grenville with the ability to test an innovative new technology, the BioMagTM technology. This pilot project identified the potential uses for a non-conventional option for expanding capacity at a waste water treatment plant. The program can help provide all municipalities with new information on how this technology may assist when determining what options to proceed with."

Mayor David Gordon, Municipality of North Grenville

"The Showcasing Water Innovation program gave companies a critical forum to demonstrate their technologies in real projects and packaged these results in case studies that resonate with customers - leading to real sales results and Ontario technologies achieving market traction in Ontario and abroad."

Peter Gallant, President and CEO, WaterTAP Ontario

"As a First Nation, water resources management must balance our heritage, traditional values of our Elders and economic needs of our children and future generations. The Showcasing Water Innovation program supported our community by enabling us to incorporate an innovative, low impact technology that ensured we met both economic and ecological values."

Norman R. Jaehrling, Chief Executive Officer,
Pic Mobert First Nation Anishinabek

"Bringing scientists, innovative small businesses, and a community together to focus on water solutions has had a tremendous impact that will outlive the Showcasing Water Innovation program. Creating mutually beneficial collaborations between the public and private sectors will be this program's legacy."

Brent Wootton, Director and Senior Scientist , Centre for Alternative Wastewater Treatment, Fleming College

"Innovation lies in the creatively and collaboration of people. The Grand River Watershed Water Management Plan showcases these traits. It brought Water Managers together from across the watershed to create a joint, voluntary plan to collectively manage the water resources. The plan allowed water managers to set a new course of best value solutions for water management in the Grand River watershed."

Joe Farwell, Chief Administrative Officer,
Grand River Conservation Authority

"The Ontario Clean Water Agency was delighted to support the implementation of sustainable water management practices in Ontario communities by participating in the Showcasing Water Innovation program. Projects sponsored by the program have been widely recognized at industry conferences throughout North America and affirm Ontario's leadership in the water and environmental sector."

Rob Andrews, President and CEO,
Ontario Clean Water Agency

"The Showcasing Water Innovation program provided Envirologics with the opportunity to demonstrate the benefits our novel Tomahawk water main cleaning technology right here in Ontario. The program provides Ontario municipalities with opportunities to pilot home-grown innovations that can deliver significant cost and time savings for the renewal of their aging drinking water assets."

Randy Cooper, President, Envirologics

"The Showcasing Water Innovation program was instrumental in supporting the development of a water quality trading system that will provide a way to lower phosphorous discharged into Lake Simcoe and its tributaries. Phosphorus Offsetting is an innovative approach to achieve water quality goals sooner and at a reduced cost."

Mike Walters, Chief Administrative Officer,
Lake Simcoe Regional Conservation Authority

"The First Nation is encouraged by the participation and support provided by the Showcasing Water Innovation program, and their technical specialist staff in support of achieving a long term solution to our water supply issue."

Wayne Turner, Chief Executive Officer,
Attawapiskat First Nation

"The SWI program gave Lake Simcoe watershed stakeholders a rare opportunity to get ahead of the regulatory curve on the environmental issue of pharmaceuticals and personal care products, and led to much-needed new information on the costs of upgrading municipal wastewater treatment to target these compounds."

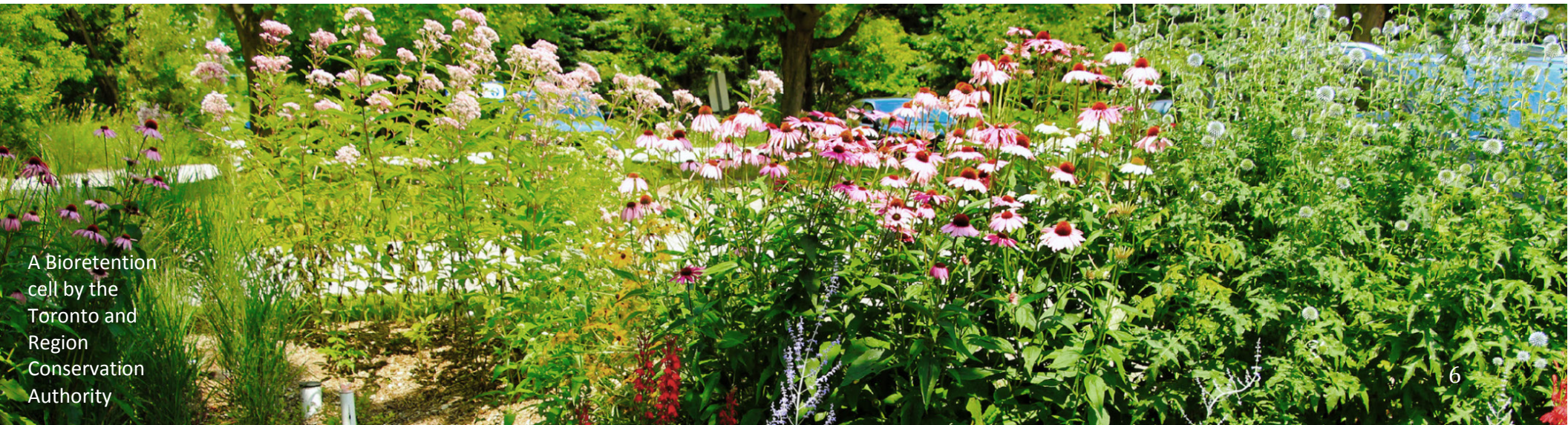
Ron Hofmann, Associate Professor,
Department of Civil Engineering, University of Toronto

"The Showcasing Water Innovation program helped support the City of Kitchener's impervious area-based stormwater utility - Canada's first. Funding acted as a catalyst for collaboration between the City, community partners and sectors to develop educational material and a way forward to protect our drinking water through better stormwater management."

Mayor Berry Vrbanovic, City of Kitchener

"The Showcasing Water Innovation project afforded us the opportunity to push the limits of our technology by placing it into new applications. Over the course of the project we have gained important knowledge that has allowed us to make significant improvements to our technology."

Josh Clark, Owner and Aquatic Ecologist,
Terrapin Water



A Bioretention cell by the Toronto and Region Conservation Authority

4.0 OVERVIEW

The Showcasing Water Innovation program is Ontario's $17 million commitment to fund innovative, cost-effective solutions for managing drinking water, wastewater and stormwater systems. Launched in April 2011, the program funded 32 cost-share projects valuing over $50 million to Ontario cities, towns and First Nation communities. The program funded innovative projects such as water use mapping, new drinking water and wastewater treatment technologies, and low impact development stormwater management practices.

Background

In March 2010, the Premier of Ontario launched a new five-year Open Ontario Plan to strengthen Ontario's economy and create more jobs for Ontario's families. Included in the plan was the Water Opportunities Act, 2010, which laid the foundation to make Ontario the North American leader in the development and sale of new technologies and services for water conservation and treatment by:

- Fostering innovative water, wastewater and stormwater technologies, services and practices in the private and public sectors;
- Creating opportunities for economic development and clean-technology jobs in Ontario; and
- Conserving and sustaining water resources for present and future generations.

Showcasing Water Innovation was created to complement the Water Opportunities Act and the Open Ontario Plan to encourage early adoption of innovative and cost effective approaches and technologies for advancing water management. The objective of Showcasing Water Innovation was to fund a small number of projects in a representative set of Ontario's communities that:

- Showcase integrated and sustainable water technologies, services, practices or a combination of these;
- Produce results and knowledge that are applicable to other communities in Ontario;
- Demonstrate the positive impacts of collaboration through partnerships; and
- Provide opportunities for demonstrating the market potential and success of innovative technologies and practices in real community settings.

Individual projects could receive funding for up to 50% of eligible project costs to a maximum of $1,000,000 per project. Eligible funding recipients were municipalities, local services boards, non-profit organizations, public institutions, conservation authorities, and Aboriginal communities. The business sector was encouraged to partner with eligible applicants to test their innovative technologies and approaches.

The Projects

The Showcasing Water Innovation program supported a wide range of project types and recipients, and took place in communities throughout Ontario (Figures 1 and 2).

This report provides an overview of the program, and provides project highlights and insights. To learn more about the 32 projects, please refer to the one-page summaries of each project in the appendix. Summaries include links to detailed project case studies produced by funding recipients.

Communities worked together in the Cities of Kitchener and Waterloo to increase uptake of low impact development stormwater practices.

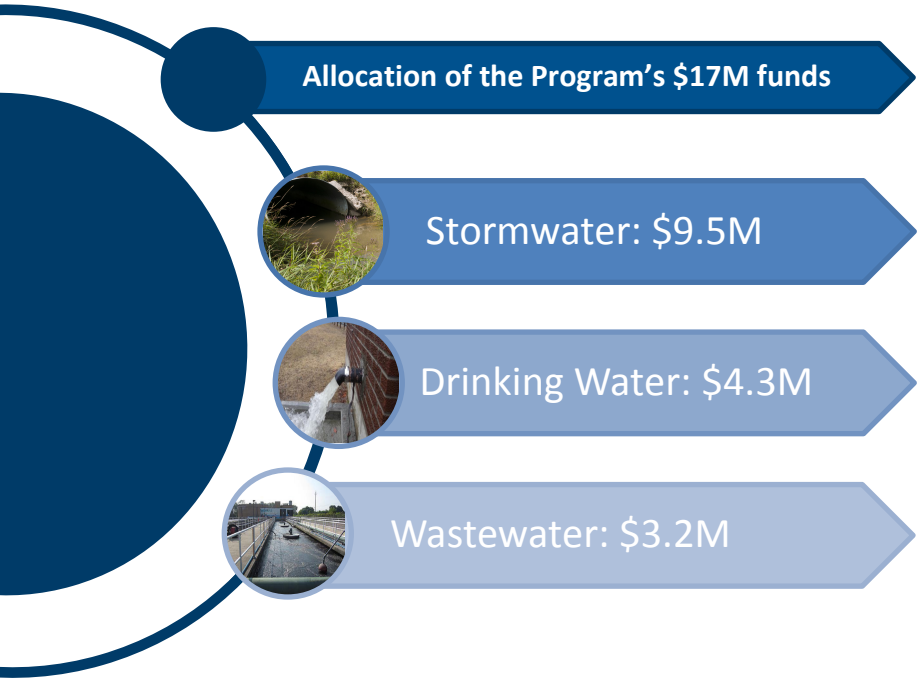


Figure 1: Number of Projects for each Recipient Type

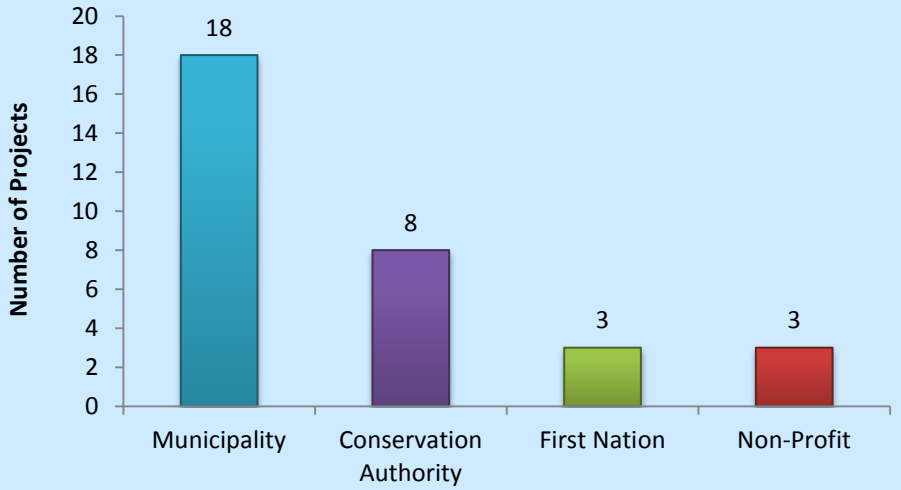
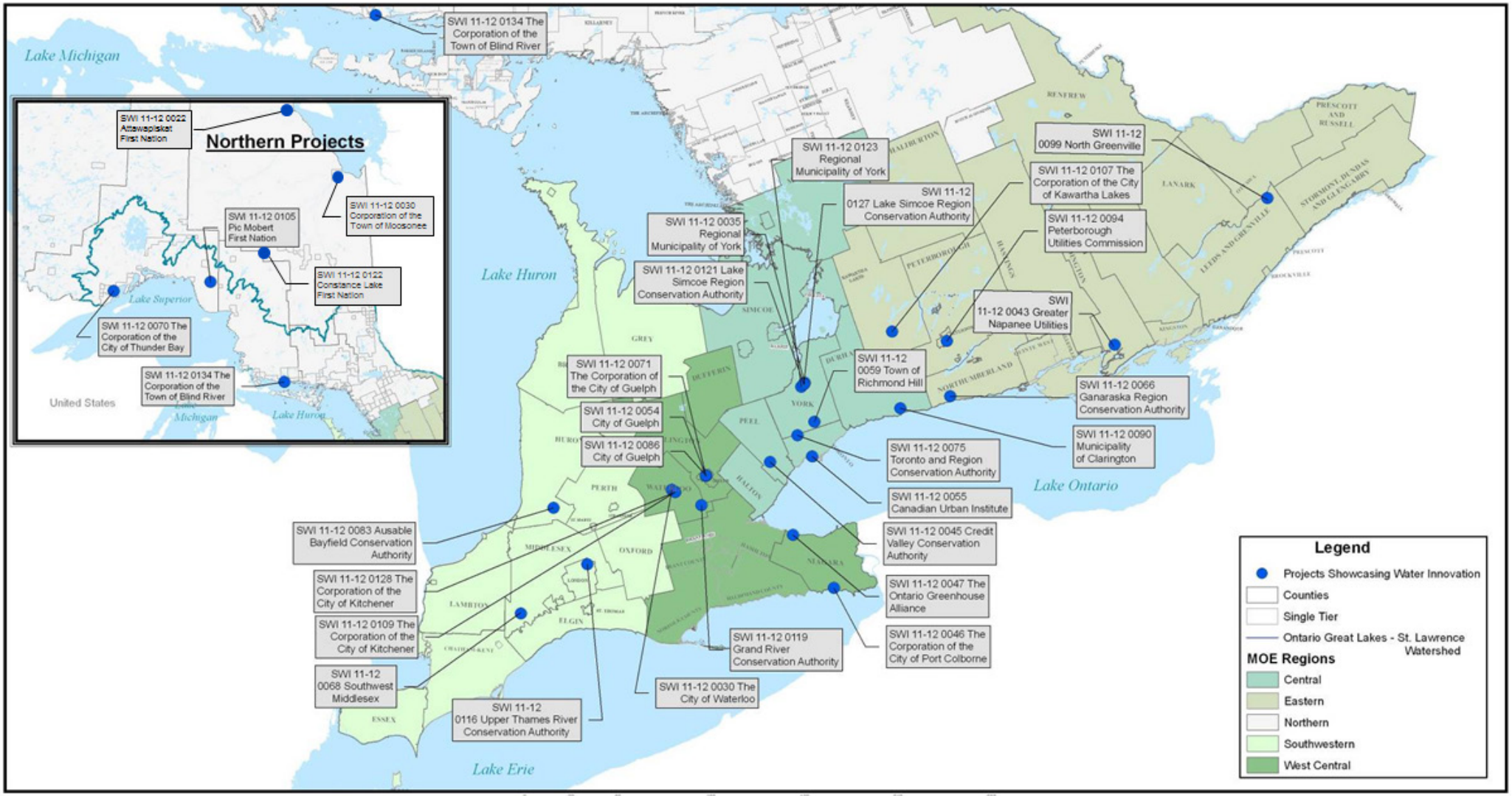


Figure 2: Map of the 32 Showcasing Water Innovation projects across Ontario



Project Outcomes

Communities increasingly recognize that sustainability means not only the environment, but also the economy and society at large. The combined benefits of a holistic project not only improve the quality of Ontario's water systems, but also the well-being of communities. The diverse range of projects supported by Showcasing Water Innovation led to a wide range of environmental and socio-economic outcomes (refer to Figures 3 and 4).

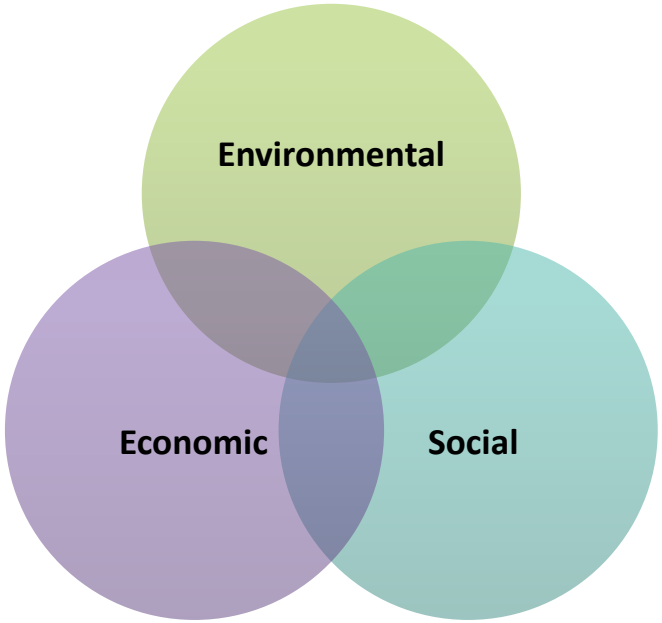


Figure 3: Environmental Outcomes

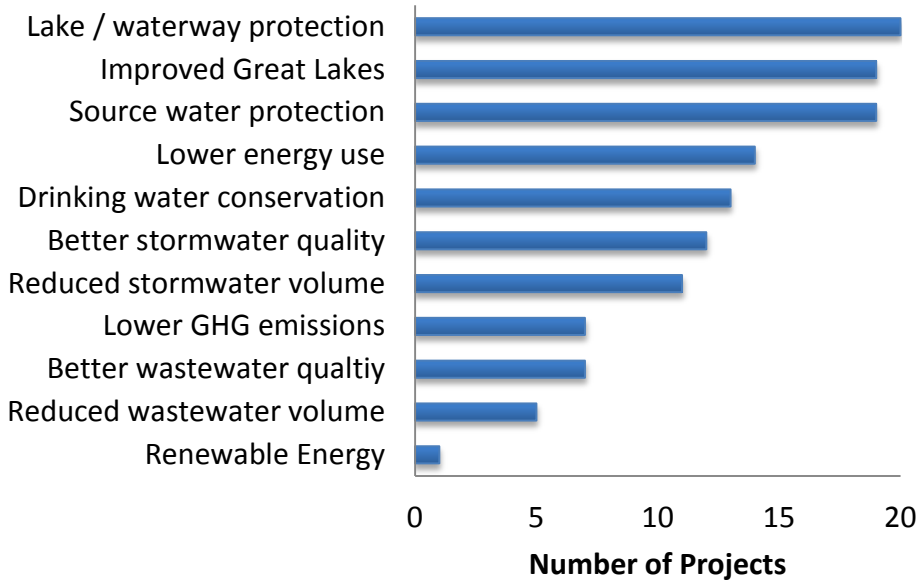
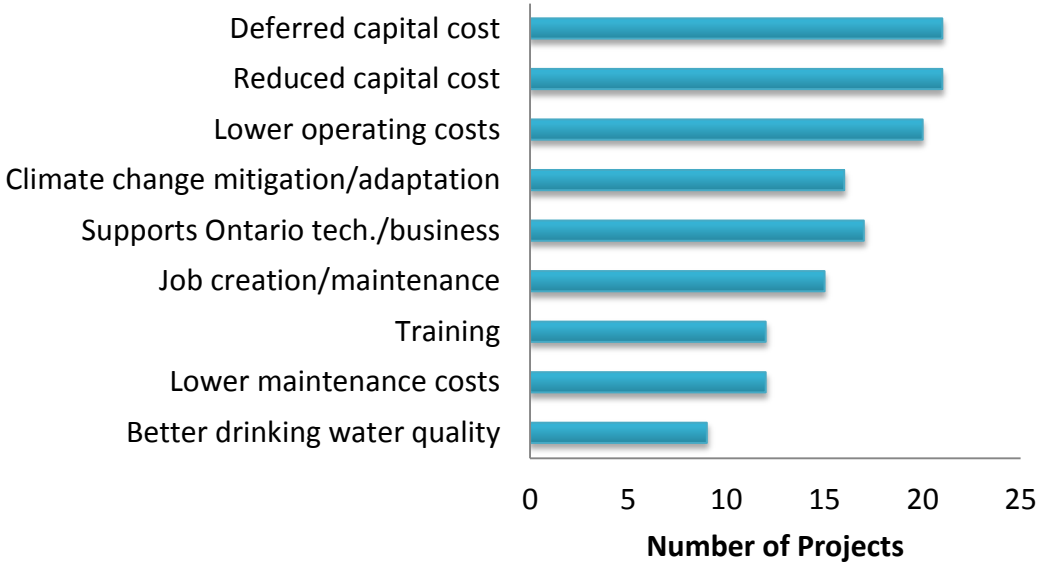


Figure 4: Socio-economic Outcomes



5.0 HIGHLIGHTS

Innovate
Collaborate Inspire

5.1 Power of Partnerships

Showcasing Water Innovation projects were built on partnerships. It is the broad spectrum of partners working collaboratively that brings value, and has a critical role in fostering innovation. Municipalities, communities, utilities, academia, technology solution providers, and others in the water sector, bring different experiences and perspectives but share a vision to solve water management challenges. Collaboration among diverse groups such as these produces solutions and creates benefits for all those involved.

The value of partnerships was demonstrated effectively through Showcasing Water Innovation. The program required each funding recipient to have at least one partner with the aim that partners draw on each other's resources to accomplish goals that neither could achieve alone. In total, the 32 projects resulted in 262 partnerships.

An example of a strong partnership was the project by the Regional Municipality of York on removal of micropollutants from wastewater. York partnered with the University of Toronto's Drinking Water Research Group to test how advanced oxidation processes used in drinking water treatment could remove micropollutants in wastewater. The partnership is notable because it is an example of how a municipality used expertise and resources from Ontario's academic sector to help address a real world challenge.

The water sector is transforming. This important transformation requires a collaborative problem solving approach - particularly in today's budget and resource constrained environment.

The Grand River Conservation Authority established a partnership with the US Environmental Protection Agency to help develop an optimization program for wastewater treatment plants.

5.2 Saving Costs

Costs for building, maintaining and operating water, wastewater, and stormwater systems place significant pressure on municipal budgets throughout Ontario. The 2012 Infrastructure Report Card by the Federation of Canadian Municipalities[1] estimated the cost of replacing Canadian water-related infrastructure rated as 'fair' to 'very poor' would be:

Innovative thinking is needed to create cost-effective solutions that mitigate current and future infrastructure debt. Examples of cost savings from the Showcasing Water Innovation projects are described below.

Capital Costs

The Grand River Conservation Authority created a watershed-wide wastewater optimization program that aims to help municipalities get the best performance out of their existing infrastructure. Optimizing existing infrastructure can save money by deferring or even eliminating capital costs. For example, the cities of Guelph and Brantford, and Haldimand County recently saved or deferred a total of $42.5 million through their optimization programs.

The watershed wastewater optimization program enables a community of practice by sharing information and providing technical assistance on optimization. Enhancing operator skills has been accomplished through workshops and technical assistance, while municipal knowledge of their treatment system capabilities has been increased by doing performance evaluations of treatment plants. The conservation authority is continuing to grow their program, and the ministry is taking lessons learned from their project to build a provincial optimization program that could benefit municipalities across Ontario.

Operating Costs

Effectively managing capital and operation costs for water, wastewater and stormwater systems is important as any savings get passed on to system users, saving residents money and making the community more competitive for business. A great example of a city using innovation to improve water services, address climate change and save costs is the City of Guelph (see projects on pg. 15).

"The Cities of **Guelph** and **Brantford**, and **Haldimand County** ... **saved** or **deferred** ... **$42.5 million** through their **optimization** programs."

[1] Canadian Infrastructure Report Card, 2012, Federation of Canadian Municipalities (http://www.canadainfrastructure.ca/downloads/Canadian_Infrastructure_Report_Card_EN.pdf)

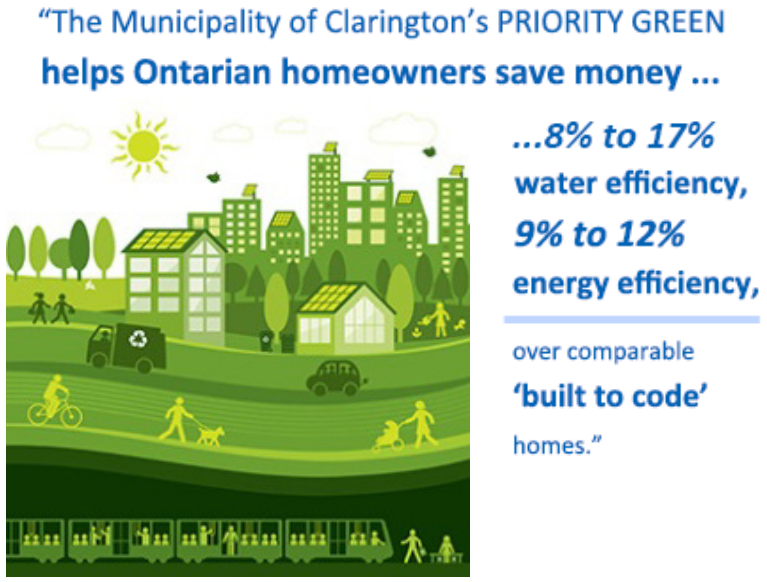
Another example is the City of Thunder Bay's project that is saving operating costs by installing turbo blowers at the city's Atlantic Avenue wastewater treatment plant. Preliminary results show that the blowers reduce energy demand by at least 25%, with the side benefit of reducing greenhouse gas emissions.

Homeowner Costs

Projects like the Municipality of Clarington's Priority Green helps Ontarian homeowners save money. Clarington's project is evaluating water and energy saving devices and practices in new homes. They are also creating a sustainable development approvals process to encourage developers to use these technologies in new developments. Preliminary data shows water efficiency improvements of 8 – 17% and energy efficiency improvements of 9 – 12% over comparable, "built to code", homes.

Maintenance costs

Often the life cycle cost of a new technology is uncertain because there is limited or no information on long term maintenance. Showcasing Water Innovation projects led by the Credit Valley Conservation Authority and the Toronto and Region Conservation Authority contribute to the body of knowledge on innovative stormwater management practices by evaluating maintenance costs and producing guidance on operations and maintenance of Low Impact Development practices.



5.3 Supporting Innovative Technologies

At the heart of sustainable water management is the emergence of new innovative water management approaches and technology solutions that stretch utility dollars, improve performance, reduce lifecycle costs, protect the environment and create green jobs. Technology innovation can address challenging water management problems and puts communities on a more sustainable path - the most progressive communities are embracing these new approaches.

A key objective of Showcasing Water Innovation was to support early adopters of new technologies and the businesses that created them by showcasing innovative technologies. Thirty-two new technologies were used in the program, including established technologies adapted to new settings. An example of supporting technologies was the use of Envirologic Inc.'s Tomahawk pipe cleaning process in Napanee and Peterborough. Those communities were early adopters of this technology and enabled Envirologics, an Ontario company, the opportunity to test their product and improve it based on the lessons learned through Showcasing Water Innovation.

Another example is the Municipality of North Grenville's project that tested the BioMag™ treatment system at the Kemptville Water Pollution Control Plant. The BioMag™ process promises to increase treatment capacity within a small footprint, reducing expansion and upgrade costs by 25% over other alternatives. A third example provided to the right, shows how The Ontario Greenhouse Alliance tested new technologies to reduce or eliminate wastewater discharges from greenhouses.

The Ontario Greenhouse Alliance (TOGA)

TOGA is a strategic partnership of Ontario's greenhouse vegetable and flower growers that advocates for greenhouse agriculture as a sustainable indoor farming ecosystem. TOGA used its Showcasing Water Innovation project to see if greenhouses could recycle 100% of nutrient feed water, and find a beneficial use for feed water recycling residues. Currently, water recycling is limited by buildup of growth limiters in reused nutrient feed water. Project results showed the three technologies (capacitive deionization, membrane capacitive deionization, and membrane separation) were capable of removing limiters and would improve recycling efficiency. Testing in a real-world setting enabled the technology companies to refine their technology, and greenhouse operators were shown the "art of the possible" for water recycling and minimizing waste.

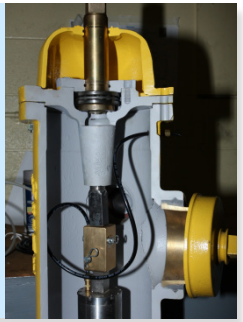
5.4 Preparing for Climate Change

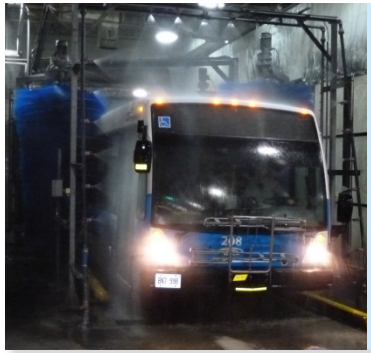
Over half of the Showcasing Water Innovation projects addressed climate change mitigation and adaptation through a variety of mechanisms. Mitigation is reducing the magnitude of climate change, and was accomplished by Showcasing Water Innovation projects that reduce energy use, create renewable energy, and address the water-energy nexus. Adaptation is improving resiliency to climate change, and was accomplished by Showcasing Water Innovation projects that improve water efficiency, manage stormwater better, and address water management on farms.

One example of how a community is addressing both climate change and water management is the City of Guelph, as described to the right.

Installation of a novel process at Guelph's wastewater treatment plant will lower energy use by approximately 600 kilowatt hours/day, reduce greenhouse gas emissions by 95 tonnes/year, save the city $17,000 per year **and** reduce nitrate loads to the river by 325 kilograms /day.

Improving the efficiency of the Guelph's drinking water distribution system will help save the equivalent of 118 tonnes of carbon dioxide emissions per month and reduce monthly energy power cost by 26% to pump water to users.





Collecting and reusing rainwater in the city's bus wash facility will help buffer the city's stormwater system from future extreme weather events. The system is capable of capturing 13,500 litres of water per rain event, and over the first four months of operation there was a 33% reduction in municipal water use by replacing it with captured rainwater.

Credit: Winston Neutel/The Canadian Press/AP

5.5 Solutions for Small and Remote Communities

Small and remote communities face significant challenges for their water systems including technical, financial and logistical. Their primary need is cost effective and affordable water management solutions with minimal operations and maintenance. Solutions are available, but often times these communities lack the resources, human and financial, to implement them.

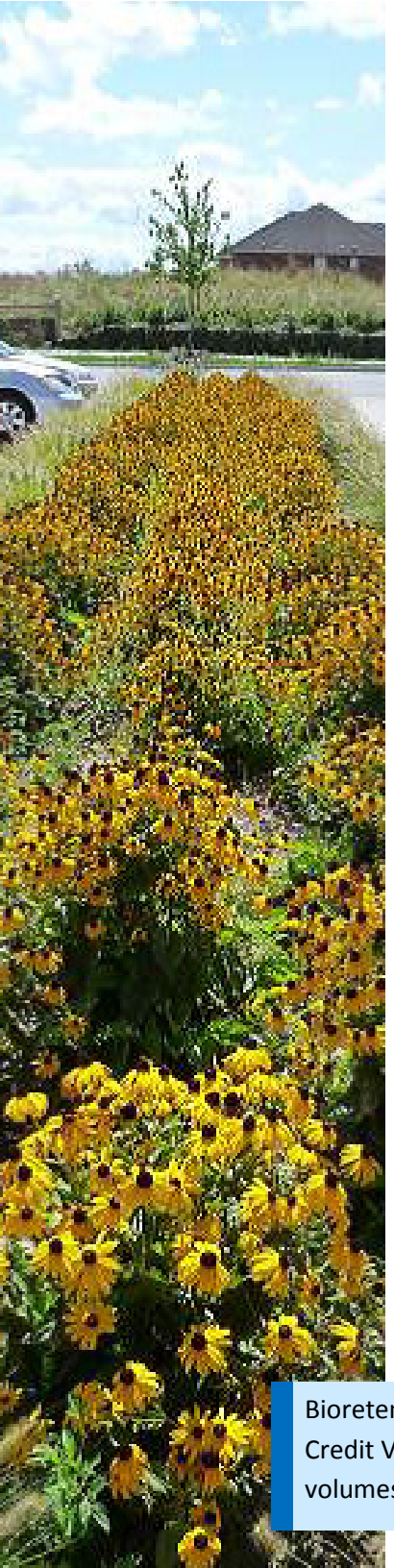
Showcasing Water Innovation supported projects in small and remote communities including three First Nation communities in Northern Ontario: Pic Mobert First Nation; Constance Lake First Nation; and Attawapiskat First Nation. In total, eight projects were supported in communities with populations under 10,000 not including projects that involved many communities such as those led by conservation authorities and amalgamated municipalities.

Constance Lake First Nation

This Showcasing Water Innovation project had two components:

1. *Install an innovative technology in their new drinking water treatment plant*. The selected technology was an innovative green sand filter that efficiently removes iron and manganese in their source water, with advantages over other green sand filters including a smaller footprint, lower operating costs, and reduced chemical handling.
2. *Develop a plan for the community's future water needs*. The water plan was a community-based effort and included an assessment of Constance Lake, which has had challenges with blue-green algae in its drinking source.

The First Nation demonstrated patience and perseverance with the many obstacles they encountered. The end result is a new water plant with innovative technology and a plan that will serve the community for many years into the future.



Bioretention cell at O'Connor Park, Mississauga led by Credit Valley Conservation Authority reduces stormwater volumes and pollutants.

5.6 Improving Stormwater Management

Stormwater management includes collecting, conveying and treating rainwater and snowmelt from urban and rural areas to minimize the impact of runoff on lakes and rivers. Finding new and better ways to manage stormwater is a growing area of interest. Urbanization is increasing the amount of hard surfaces where water can run off, Ontario has a large and important agricultural sector, and climate change is altering rain and snowfall patterns.

A total of 16 projects directly involved developing and/or implementing novel technologies or approaches for stormwater management.

These projects ranged from retrofitting stormwater ponds with new technologies, constructing low impact development practices, engaging and educating the public, harvesting rainwater, predicting stormwater impacts, and creating new frameworks to support better stormwater management. Outcomes include reduced stormwater volume, improved water quality, enhanced resiliency of aging infrastructure to climate change impacts, enhanced awareness of issues, and uptake of innovative practices.

Stormwater pond retrofit to be an 'offline' pond with pre-treatment and real-time monitoring – Town of Richmond Hill.

Floating wetlands installed in a stormwater pond in the City of Kawartha Lakes to help reduce stormwater pollutants, in particular, nutrients.

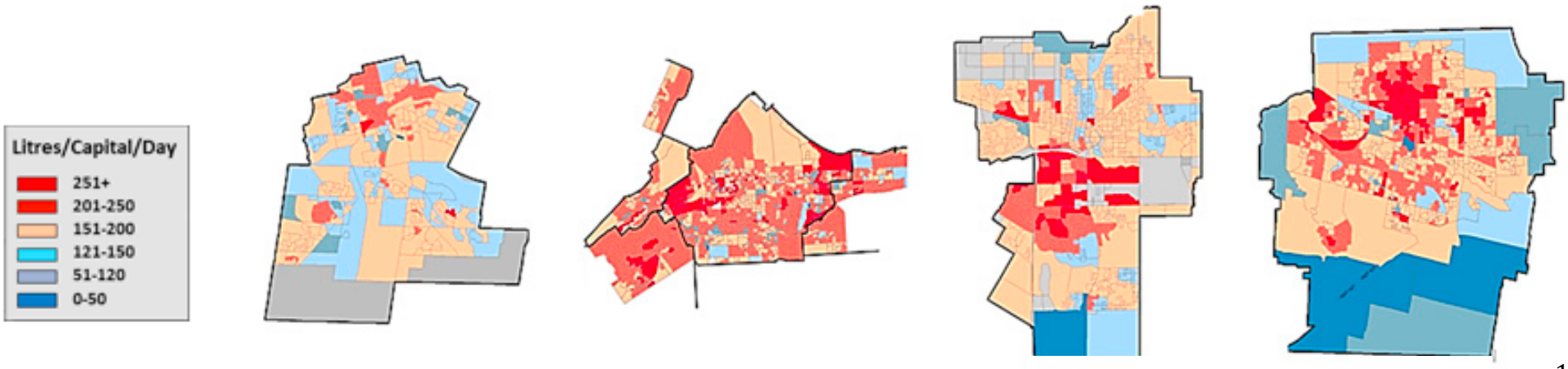
5.7 Improving Drinking Water Systems

Many Showcasing Water Innovation projects addressed drinking water challenges. These projects included, for example, water use mapping, finding leaks in distribution systems, and testing out new technologies for drinking water treatment in remote communities. One project led by the City of Thunder Bay included a partnership with Lakehead University to test the "bi-functional" technology created at the university. The technology was pilot-tested at a membrane water treatment plant owned by the city, and the partners were able to show a 50% reduction both in waste production and chemical use, along with an improvement in the membrane cleaning process. The knowledge gained from testing the technology in a real world setting will help commercialize this made-in-Ontario technology.

Another project, led by the Town of Moosonee – a Northern Ontario community – installed advanced water meters in all of the town's residences and businesses. Immediately following installation of the water meters, the town saw a 20% reduction in water use and also decreased the volume of water going to the town's wastewater treatment facility. The project not only freed up the capacity of the drinking water system but with the wastewater facility nearing capacity, the reduced wastewater volumes could defer a costly expansion.

Canadian Urban Institute (CUI)

CUI's project on water use mapping combined data analysis with mass marketing tools to help municipalities engage the public on water conservation. Four municipalities, Barrie, Guelph, Hamilton, and London had over 200 data sets integrated into spatial databases to identify areas of the cities with high and low water use. Layering demographic information on water use patterns, CUI applied market segmentation and created key messages for water conservation that will have the greatest overall impact. Participating municipalities are currently using the information to support their water conservation programs, land use planning, and asset management.



Barrie Hamilton Guelph London

5.8 Improving Wastewater Systems

Well-functioning municipal wastewater systems protect human health and the environment. Showcasing Water Innovation projects addressed many aspects of wastewater services including increasing treatment capacity, improving performance, and lowering costs.

The City of Thunder Bay was faced with significant electrical costs for treating wastewater. Much of the electrical demand for wastewater treatment is providing air to the microorganisms that break down sewage. The cost-saving solution for the city was to replace 17 conventional air blowers with energy efficient turbo blowers at the Atlantic Avenue Wastewater Treatment Plant, which will reduce electrical use by up to 30%. Preliminary results show an electrical savings of 25% with only partial utilization of the new blowers, and the city expects they may exceed their expected savings once the system is fully operational.

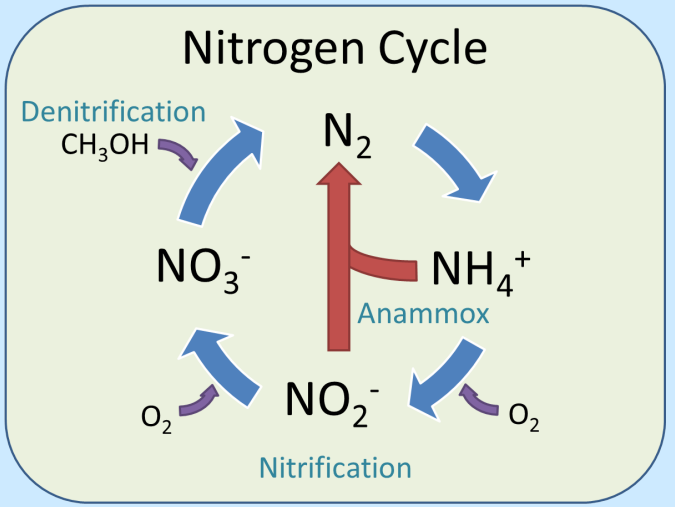
Many other projects addressed wastewater indirectly such as Moosonee's example on the previous page, and stormwater management projects reducing the risk of wastewater bypasses and overflows – highlighting the integrated nature of water management.

Performance evaluation at a Grand River wastewater treatment plant as part of an optimization program.

Using Biology to Save Costs

The City of Guelph installed a unique process to reduce energy and greenhouse gas emissions at its wastewater treatment plant. Named the Anammox process, this process takes advantage of a recently found biological pathway that "short circuits" the traditional nitrogen cycle to break down ammonia. Most wastewater treatment plants turn ammonia into nitrate in their aeration basins, which is a significant energy demand and cost. The Anammox process saves energy by breaking down ammonia with much less oxygen than in an aeration basin.

The city expects to save about 600 kilowatt hours of electricity per day, and lower greenhouse gas emissions by installing the Anammox process to treat ammonia coming from the sludge digestion process.



5.9 Protecting the Great Lakes

The Great Lakes provide drinking water, a quality of life and prosperity in Ontario. That is why the Government of Ontario is taking steps to protect and restore the Great Lakes with actions such as creating Ontario's first Great Lakes Strategy, introducing the Great Lakes Protection Act in the legislature, and renewing the Canada-Ontario Agreement on Great Lakes Water Quality and Ecosystem Health.

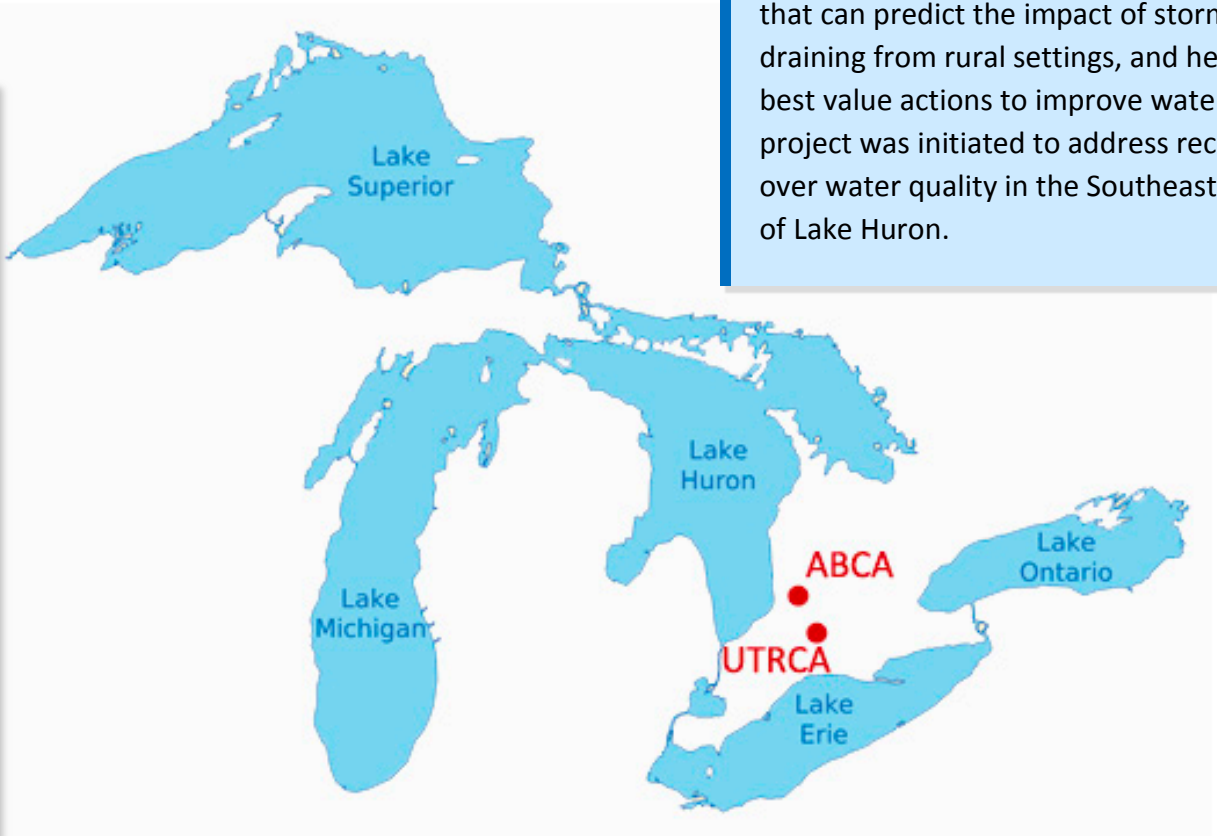
Many Showcasing Water Innovation projects protect and improve the Great Lakes through optimizing wastewater treatment, managing stormwater better, and improving the quality of water from agricultural operations. One project, led by the Grand River Conservation Authority brought together watershed stakeholders – municipalities, provincial and federal governments, and First Nations – to work together and commit to a list of holistic actions for a Grand River Water Management Plan. The actions in the plan not only improve the Grand River, but also Lake Erie where the river drains.

Ausable Bayfield Conservation Authority (ABCA)

Ausable Bayfield sought to create a better way to predict the impact of drainage from rural areas. Partnering with an Ontario software developer and other conservation authorities, ABCA created a Rural Stormwater Management Model that can predict the impact of stormwater draining from rural settings, and help determine best value actions to improve water quality. The project was initiated to address recent concerns over water quality in the Southeast shores area of Lake Huron.

Upper Thames River Conservation Authority (UTRCA)

Upper Thames had a multi component project that looked at several best management practices to keep soil and nutrients on agricultural land. Projects included reducing soil erosion, holding water on tile drain fields when needed, restoring agricultural land to wetlands, and removing nutrients from water before it drains into waterways. The learning from the suite of projects will inform future actions to protect and restore the Thames River, which drains into western Lake Erie.



5.10 Creating Green Jobs

Undertaking innovative projects involves a level of risk to allocate funds, staff and time to try something new. The Government of Ontario, through Showcasing Water Innovation, took on some of the inherent risk in innovation to incent innovators and share the burden if a project didn't work as expected.

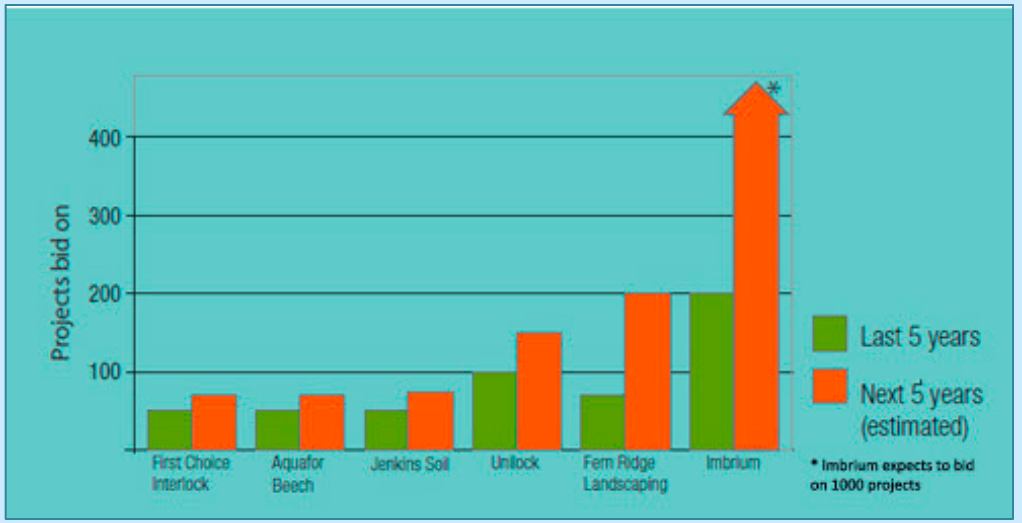
Program funding for projects was used in a variety of areas, such as staff salaries and hiring contractors to work on innovative projects. Additionally, 14 projects supported training of highly qualified professionals through partnerships with colleges and universities.

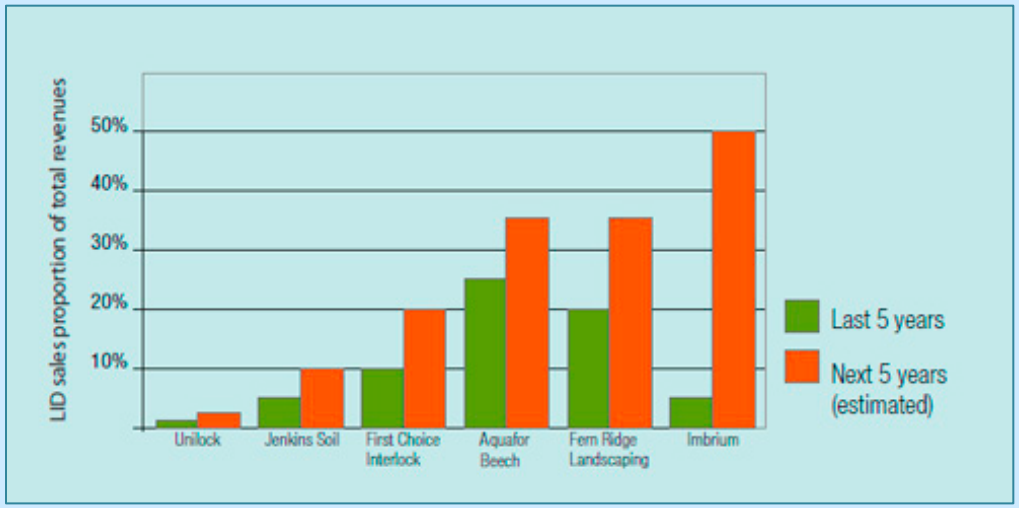
As part of Credit Valley Conservation Authority's Showcasing Water Innovation project, a survey of local businesses looked at the trends for low impact development business (Figure 5). The survey showed business owners expect growth in this area. Showcasing Water Innovation projects supports this growth through demonstration of innovative stormwater management practices such as low impact development, and producing guidance to help practitioners implement it.

QUICK FACT

The Cities of Kitchener and Waterloo's RAIN program trained 115 contractors in six workshops on how to install and maintain low impact development storm water management and landscaping features.

Figure 5: Estimated green project bids over the next five years
(*Top*: Bids on projects; *Bottom*: Percentage of sales in total revenue).





6.0 INSIGHTS

Ontario Communities want Innovation

Ontario communities have a strong appetite for innovation. After only a short application period, the ministry received 111 applications from across Ontario, including 39 in communities with less than 10,000 people, and five in First Nation communities.

Many communities supported by Showcasing Water Innovation are continuing to innovate, expanding their Showcasing Water Innovation projects or creating new innovative projects. For example, the City of Kitchener's stormwater pond sediment reuse project has continued to pilot beneficial reuse scenarios and now includes partnerships with neighbouring municipalities. The Credit Valley Conservation Authority's project was also expanded by growing its monitoring of innovative stormwater practices and creating new initiatives based on learning.

Smart Communities

Communities and utilities are moving dramatically toward a smart city ideal. The proliferation of smart devices and utility automation coupled with the expanded use of data analytics is transforming delivery of drinking water, wastewater and stormwater services. These advances are reshaping how communities manage water so that they can be more efficient, resilient and make the right decisions. For example, the Canadian Urban Institute integrated data from a number of sources to identify areas in communities for targeting water conservation programs. The communities involved in the institute's project have gone on to use the information to support programs such as land use and asset management planning.

Watershed-oriented

Embracing a systems approach for watersheds to better maintain, protect and restore water resources will ensure a sufficient supply of high quality water now and in the future. All watershed stakeholders including drinking water, wastewater and stormwater managers should collaborate to maximize positive environmental and public health outcomes at a watershed scale. The Grand River Conservation Authority's project exemplifies watershed-based planning by facilitating collaboration among watershed stakeholders, creating a practical action plan that will protect and improve the Grand River.

Innovation is difficult, but possible

Trying something new means projects will not follow a standard path. This requires perseverance and patience by everyone involved. Organizations at all levels should cooperate to pursue cost savings, improve the environment, and protect public health. That benefits everyone. Government and other agencies should continue to find ways to remove or lower barriers and practices that impede or prevent sustainable water management.

Supporting innovative technology solutions

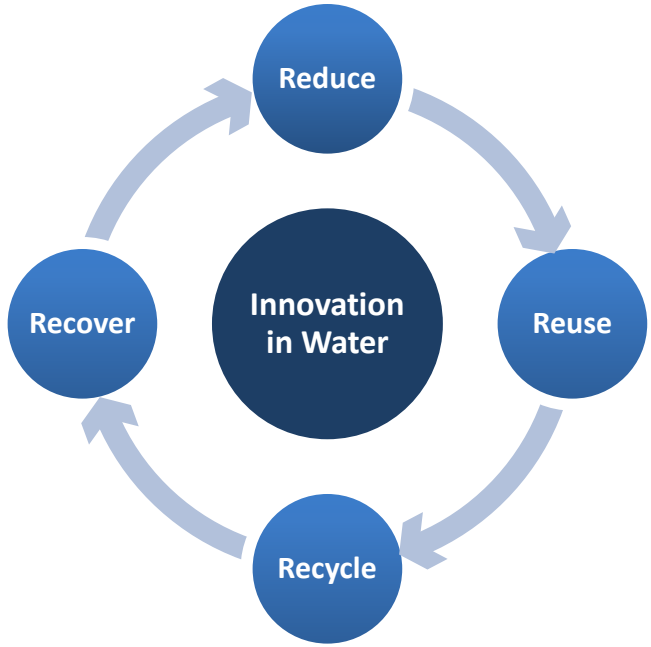
Any change can be difficult because there is always uncertainty when a new path is carved. Water, wastewater, and stormwater managers are often conservative decision makers because they are responsible for public funds. Showcasing Water Innovation lowered uncertainty by sharing costs, reducing risk and making innovation possible. Also, Showcasing Water Innovation provided opportunities to field test new technologies. One technology, used as part of the City of Guelph's water distribution project, is a pressure sensor that can be integrated into fire hydrants. The sensor is being developed by a start-up company located in Chatham-Kent, Ontario and Showcasing Water Innovation provided the company the opportunity to partner with Guelph as an early adopter of the technology. Based on the results of the project, the sensor is being improved and additional sensors are being added to quantify other distribution system metrics.

Local Community Knowledge

The ideas for Showcasing Water Innovation projects were the products of people working in the community who know what their communities need. The firsthand experience of local people working on the ground to address their community's water challenges is a valuable resource that can be tapped for innovative solutions. Those people can be scientists, engineers, treatment plant operators, managers or other stakeholders. Programs like Showcasing Water Innovation provide the opportunity for innovative ideas, enabling those people working on the ground to make their community a better place.

Circular Economy

The economy of the future will be circular. In the water sector, water, nutrients, heat, energy, metals and other water connected resources will be reused and not discarded. Some Showcasing Water Innovation projects contribute to the circular economy, while others set the stage for the future. One example is The Ontario Greenhouse Association project that challenged technologies to recycle 100% of the water used to feed greenhouse plants. Other examples are the City of Waterloo's and the City of Guelph's projects that use rainwater to replace precious drinking water and save costs.



7.0 CONCLUSION

Water is fundamental for our environment, local economies and health of our communities. While there are significant water challenges ahead, there is cause for optimism and pioneering communities are leading the way.

The progress made by Showcasing Water Innovation communities is strong evidence that new approaches to sustainable water management are possible. Ontario communities are prepared to lead, and are motivated to work with others in the water sector to find cost effective and innovative water management solutions that are sustainable.

These communities and their partners know it is imperative to invest in forward looking solutions that leverage the surge of innovation in the water sector, realizing the potential of their water resources for today and future generations.

Showcasing Water Innovation was a one-time program to support innovation in Ontario. The next step for the program is to continue sharing project information with other communities, and follow long term outcomes. These communities and those inspired by Showcasing Water Innovation make the program a success, and build a pathway to a future of sustainable and resilient water management.

8.0 SHOWCASING WATER INNOVATION PARTNERS

The following is a list of partners involved in the Showcasing Water Innovation Program through project recipients:

ACURO Infrastructure
AECOM Canada Ltd.
Agriculture and Agri-Food Canada
Alton Grange Association
Alton Legion
Alton Mill
Alton Scout Troup
Alton Village Association
APG Neuros Inc.
Aquafor Beech Ltd.
Armstrong Manufacturing Inc.
Avensys Solutions Inc.
Bernardi Building Supply
BP Canada Energy Group ULC
Brimar Contracting Ltd.
Bronte Horticultural Society
Brookfield Residential Properties Inc.
Building Industry and Land Development Association
C3 Water Inc.
Caesar's Infrastructure Services Inc.
Calgon Carbon Corporation
Calstone Inc.
Canadian Mortgage and Housing Corporation
Canplas / recover® Greywater Systems
Carillion Canada
Central Lake Ontario Conservation Authority
Centre for Alternative Wastewater Treatment
CH2M Hill
Chatham-Kent Public Utilities Commission
Chippewas of the Thames First Nation
City of Barrie
City of Brampton
City of Brantford
City of Calgary
City of Cambridge
City of Guelph
City of Hamilton
City of Kitchener
City of London
City of Markham
City of Mississauga
City of Oakville
City of Toronto
City of Waterloo
Cloverleaf Garden Club
Conestoga College
Conservation Ontario
County of Brant
County of Dufferin
County of Wellington
Credit Valley Conservation Authority
Department of Fisheries and Oceans
Durham College
Durham Region Home Builders Association
EAML Engineering Co. Ltd.
Earth Rangers
Ecobee
EMCO
Enbridge
Enviro Stewards Inc.
Envirocan Wastewater Treatment Equipment Co. Ltd.
Envirologics Engineering Inc.
Environment Canada
Eramosa Engineering Inc.
Evoqua Water Technologies LLC
Feherty and Associates Ltd.
Fern Ridge Landscaping
Filtrexx Canada Inc.
First Green Energy Ltd.
Fleming College
Flynn Canada Inc.
Freeman Associates LLC
Ganaraska Region Conservation Authority
Gauley Associates Ltd.
General Electric Canada Co. Inc.
Geosyntec Consultants Inc.
Gerald D. Brown Plumbing and Gasfitting Service
GO Transit
Grand River Conservation Authority
Green Communities Canada
Green Glade Senior Public School
Green Roofs for Healthy Cities
Grey Sauble Conservation Authority
H2Flow Equipment Inc.
Haldimand County
Halminen Homes
Hanson Pipe & Precast Inc.
Healthy Lake Huron Executive Steering Committee
Holcim Canada Inc.
Honda Canada Inc.
Hydrant Network Solutions Inc.
IMAX Co.
Imbrium Systems Inc.
Interlocking Concrete Pavement Institute
International Erosion Control Association
Intracorp
IOWAT
J&S Electric Inc.
J.A.K. Electrical Contractors Ltd.
Jane-Finch Mall
Jeffery Homes LLC
Kawartha Region Conservation Authority
Keilhauer
Kresin Engineering Co.

8.0 SHOWCASING WATER INNOVATION PARTNERS

Lake Simcoe Conservation Foundation
Lake Simcoe Region Conservation Authority
Lake Simcoe Watershed Municipalities
Lakehead University
Local Enhancement and Appreciation of Forests
Lower Thames Valley Conservation Authority
Mahiikinuk Construction
Maitland Valley Conservation Authority
Maple Contracting
Martino Contractors Ltd.
Maxxam Analytics Inc.
Milton Horticultural Society
Mosaik Glenway Homes Inc.
Municipality of Chatham-Kent
Municipality of Port Hope
Mushkegowuk Council
Neptune Technology Group Inc.
New Way Plumbing & Heating
Northern Waterworks Inc.
Northumberland County
Nova Plumbing
Nuna Construction
Onedia First Nation
Ontario Centres of Excellence
Ontario Clean Water Agency
Ontario Federation of Agriculture
Ontario First Nations Technical Services Corporation
Ontario Ministry of Agriculture, Food and Rural Affairs
Ontario Ministry of Natural Resources and Forestry
Ontario Ministry of Transportation
Ontario Tire Stewardship
Panasonic Co.
Peel District School Board
Pickseed
POLIS Water Sustainability Project
Portico Church
Power Pipe® Drain Water Heat Recovery Systems
PUC Services Inc.
Queen's University
Rattray Marsh Protection Association
REEP Green Solutions
Regional Municipality of Durham
Regional Municipality of Halton
Regional Municipality of Niagara
Regional Municipality of Peel
Regional Municipality of Waterloo
Regional Municipality of York
Regional Power Inc.
Riverwood Conservancy
Ryerson University
SanEcoTec Ltd.
Saugeen Valley Conservation Authority
Schollen and Company Inc.
Seneca College
Shelby Environmental Services Ltd.
Silver Carpentry
Six Nations of the Grand River
Sobey's Inc.
St. Clair Conservation Authority
Sustainable Housing Foundation
SWC Canada Inc.
Terrafix® Geosynthetics Inc.
Terrapin Water
The Municipal Infrastructure Group Ltd.
ThermaGreen
Toronto and Region Conservation Authority
Town of Ajax
Town of Caledon
Town of Cobourg
Town of East Gwillimbury
Town of Erin
Town of Halton Hills
Town of Innisfil
Town of Mono
Town of Newmarket
Town of Orangeville
Town of Richmond Hill
Township of Amaranth
Township of Centre Wellington
Township of East-Garafraxa
Township of Uxbridge
Tribury Construction Inc.
Unifay-Fedar Investments
Unilock
Unitarian Church of Mississauga
University of Guelph
University of Ontario Institute of Technology
University of Ottawa
University of Toronto
University of Waterloo
Velcan Forest Products Inc.
Veridian Connections
Walkerton Clean Water Centre
Walmart Inc.
Walpole Island First Nation
Water Canada
Water Matrix Co.
Water Research & Innovation Network
Waterloo University
WaterTAP Ontario
Western University
Wilfred Laurier University
WSP Global Inc.
XCG Consultants Ltd.
York University

APPENDIX: The Projects

Showcasing Water Innovation Project Index

Community Name	Project type	Page
Attawapiskat First Nation	Drinking water	28
Ausable Bayfield Conservation Authority	Stormwater	29
Blind River, Town of	Drinking water	30
Canadian Urban Institute	Drinking water	31
Clarington, Municipality of	Drinking water, stormwater, wastewater	32
Constance Lake First Nation Band Council	Drinking water	33
Credit Valley Conservation Authority	Stormwater	34
Ganaraska Region Conservation Authority	Stormwater	35
Grand River Conservation Authority	Drinking water, stormwater, wastewater	36
Greater Napanee Utilities	Drinking water	37
Guelph, City of	Drinking water	38
Guelph, City of	Stormwater	39
Guelph, City of	Wastewater	40
Kawartha Lakes, City of	Stormwater, wastewater	41
Kitchener, City of	Stormwater	42
Kitchener and Waterloo, Cities of	Stormwater	43
Lake Simcoe Region Conservation Authority	Stormwater	44
Lake Simcoe Region Conservation Authority	Stormwater	45
Moosonee, Town of	Drinking water	46
North Grenville, Municipality of	Wastewater	47
Peterborough Utilities Commission	Drinking water	48
Pic Mobert First Nation	Renewable energy	49
Port Colborne, City of	Drinking water	50
Richmond Hill, Town of	Stormwater	51
Southwest Middlesex, Municipality of	Drinking water	52
The Ontario Greenhouse Alliance	Wastewater	53
Thunder Bay, City of	Wastewater, drinking water	54
Toronto and Region Conservation Authority	Stormwater	55
Upper Thames River Conservation Authority	Stormwater	56
Waterloo, City of	Stormwater	57
York, Regional Municipality of	Wastewater	58
York, Regional Municipality of	Stormwater	59

ATTAWAPISKAT FIRST NATION

Category: Drinking Water

Challenge: **Formation of disinfection by-products** from treating source water with **high natural organic matter** content and seasonal variability.

Solution: **Pilot test an innovative nanofiltration system**, the FYNE system, to remove organic matter from raw water before disinfection. Attawapiskat, Ministry of the Environment and Climate Change and Aboriginal Affairs and Northern Development Canada partnered to pilot test the system for 12 months to assess the impact of season variability of the source water.

Results:

- The FYNE membrane did an **excellent job of removing natural organic matter**. The maximum disinfection by-products anticipated to form in the FYNE membrane filtered water is less than 50 µg/L (by-product potential test), compared to the target of 80 µg/L.
- The majority of the parameters analyzed were well below standards with the exception of iron, manganese and sodium. A post-limestone contactor significantly reduced iron and manganese to below standards; however sodium levels remained essentially the same.
- Operational issues included frequent membrane cleaning, equipment wear and breakdowns, and biofilm growth.
- Results from the piloting experience indicated the FYNE membrane could not fully comply with disinfection performance criteria, so at present, the FYNE system may only be used for natural organic matter removal.
- The capital cost to retrofit the existing water treatment plant with a 1,600 m^3/day (maximum day demand) FYNE membrane system was estimated at $12.2 million with an annual operational cost of $535,000/year.
- Based on the results of the 12-month study, the community is pursuing other options including optimizing the existing system, and seeking new source water

Case Study: http://bit.ly/1TqwMFp

Complete “plug and play” FYNE pilot system used in the study.

AUSABLE BAYFIELD CONSERVATION AUTHORITY

Category: Stormwater

Challenge: A new tool was needed for rural areas to **better implement effective stormwater management practices** to slow runoff down, store it, and filter it to improve water quality.

Solution: **Create a Rural Stormwater Management Model (RSWMM)** to help conservation and stewardship professionals, drainage engineers, landowners, and communities identify the best value projects to reduce rural stormwater impacts.

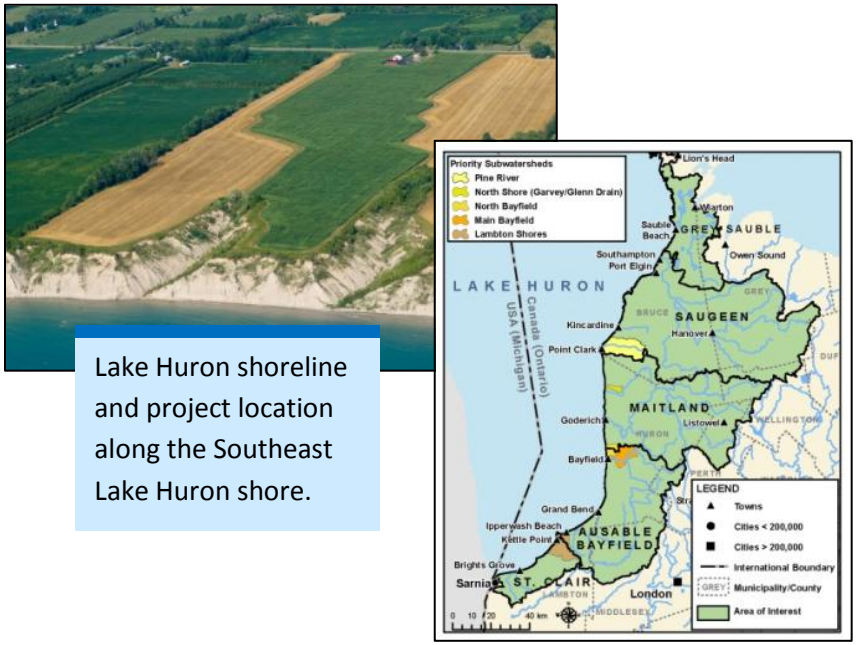
Results:

RSWMM builds upon PCSWMM, which is a spatial decision support system for US EPA SWMM5, one of the most widely used models for stormwater, wastewater and watershed modeling. The RSWMM project:

- Prioritizes stormwater management areas
- Incorporates field-scale treatment and best management practices for stormwater and erosion and sediment control
- Compares the impacts of potential projects on water quantity and quality
- Allows rural watershed managers to better evaluate, prioritize, design and implement soil and water conservation projects to protect Lake Huron
- Informs and improves local long-term monitoring of weather, stormwater, and water quality and quantity
- The project included adding or upgrading five monitoring stations in sentinel watersheds. Monitoring data from these stations was used to develop RSWMM, and will be used in the future for further model development and watershed health assessments.
- The project was a partnership among governments and agencies that participate in the Healthy Lake Huron: Clean Water, Clean Beaches initiative. Partners are using and working on improving this powerful new model as an important decision-making tool.

Case Study: http://bit.ly/1LbQBgx

Website: www.ruralstormwater.com



Lake Huron shoreline and project location along the Southeast Lake Huron shore.

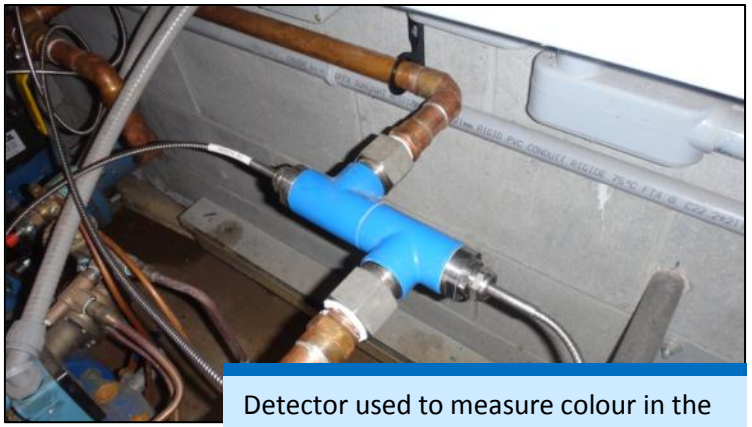
TOWN OF BLIND RIVER

Category: Drinking Water

Case Study: http://bit.ly/1NRnn82

Challenge: **Initial water quality from Blind River's wells can be poor.** Current practices to flush municipal drinking water wells use a substantial amount of water and are not based on water quality parameters. Poor quality raw water could lead to impacts on plant operations and drinking water quality.

Solution: Install an **automated system for flushing the town's drinking water wells** that uses water quality sensors to switch from flushing to treatment.



Detector used to measure colour in the incoming well water. Colour was found to be the best measure to determine when to switch from flushing.

Well water being flushed at the test well, #6.

Results:

- Automated flushing equipment has been installed on one of the water supply wells.
- The automated system works as expected. However, the lens on the sensor used to control flushing is clouded, impacting operation of the system.
- The town is considering measures to address the clouding of the monitoring sensor.
- If fully implemented at the town's five wells, the automatic flushing system would:
  - Improve drinking water quality;
  - Lower operating costs from reduced chemical use and longer life of the dual media and granular activated carbon filters
  - Reduce wastewater production because of lower backwashing requirements.

CANADIAN URBAN INSTITUTE

Category: Drinking Water

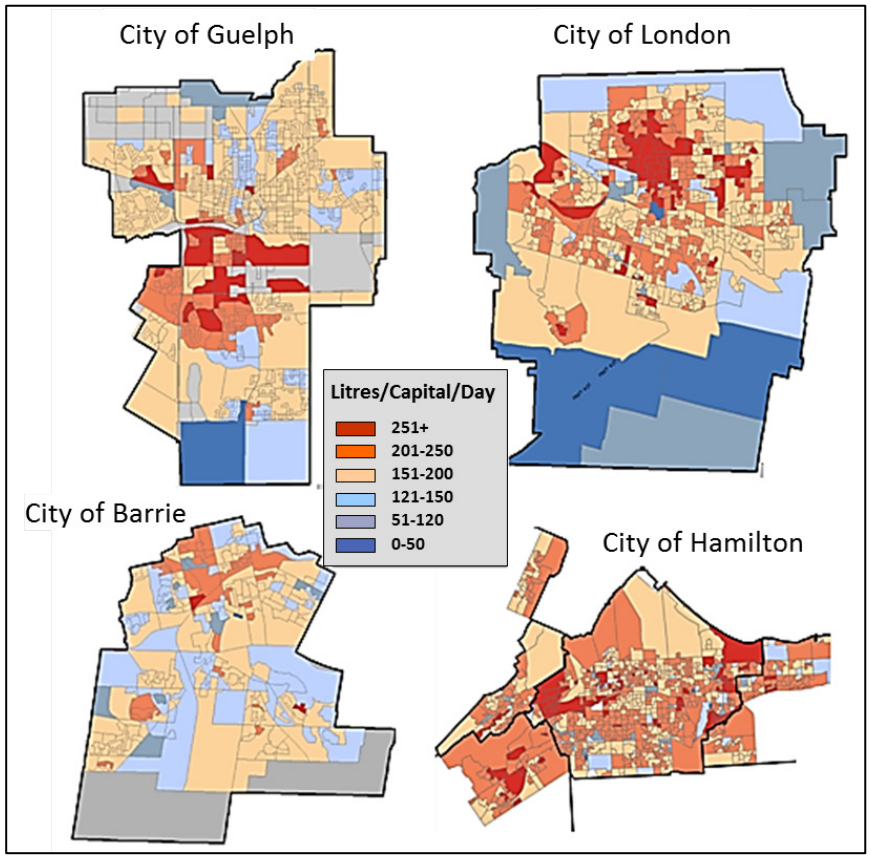
Challenge: Many municipalities have limited resources for water conservation initiatives and must create effective and targeted programs to **encourage efficient use of water**.

Solution: Created a water use analysis tool to **identify locations and ways to market water efficiency for the best results.** The project included identifying and analyzing data, market segmentation, creating key marketing messages, and mapping results. The tool was tested in the cities of **Guelph, London, Barrie and Hamilton**.

Results:

- The Water Mapping project combined over **200 datasets** into integrated and spatially referenced databases and summary tools for each municipality.
- **Water maps** were developed for each city to identify neighbourhoods of high and lower water use.
- **Market segmentation was applied** to identify six target water user groups.
- **Key messages were developed** with associated media channels to promote conservation to the water user groups.
- Water Maps, the integrated database and target segments are currently in use in participating municipalities to support: developing water conservation programs and evaluating their market potential; budget and demand forecasting, land use planning; asset inventories (water meters); sensitive customer identification for emergency response; evaluation of customer response to price increases (demand elasticity); and targeted communications and community engagement campaigns.

Case Study: http://bit.ly/1TxFyRL



Water use maps in the participating cities.

MUNICIPALITY OF CLARINGTON

Category: Drinking Water, Wastewater, Stormwater

Challenge: **New development** is putting strains on infrastructure and the natural environment, requiring a more sustainable approach to meet the needs of growing communities.

Solution: Clarington created the Priority Green Clarington initiative to **promote sustainability and innovation in residential development**. The program includes evaluating best practices and innovations for water and energy efficiency, and creating incentives to encourage the development community to include best practices in their developments.

Results:

- Clarington partnered with Brookfield Residential, Halminen Homes and Jeffery Homes, to construct **six "green" homes** (two per builder) with enhanced water and energy efficient equipment, appliances, fixtures and faucets (collectively referred to as "green practices") that exceed Building Code requirements. Comprehensive monitoring of the performance of each home under actual lived-in conditions was carried out. The project aimed to achieve a 15% energy efficiency improvement and 15% - 20% water efficiency improvement over the 2012 Building Code requirements.
- Preliminary data shows **water efficiency improvements** of 8 – 17% and **energy efficiency improvements** of 9 – 12% over models of comparable homes built to the minimum Building Code specifications.
- Average daily water consumption of 119 litres per capita per day, which is well below the current Region-wide average of 230 litres per capita day.
- Average monthly electrical consumption of 468 kilowatt hours per month, as compared to a typical average of 800 kilowatt hours per month for a family of four in Ontario.
- Work on green development standards, guidelines and incentives for new homes and neighbourhoods is ongoing, as well as integration into municipal planning policies.

Case Study: Under development, more information and reports available at: www.prioritygreenclarington.com

Drain water heat recovery system (left) and a grey water tank (right).

CONSTANCE LAKE FIRST NATION

Category: Drinking Water

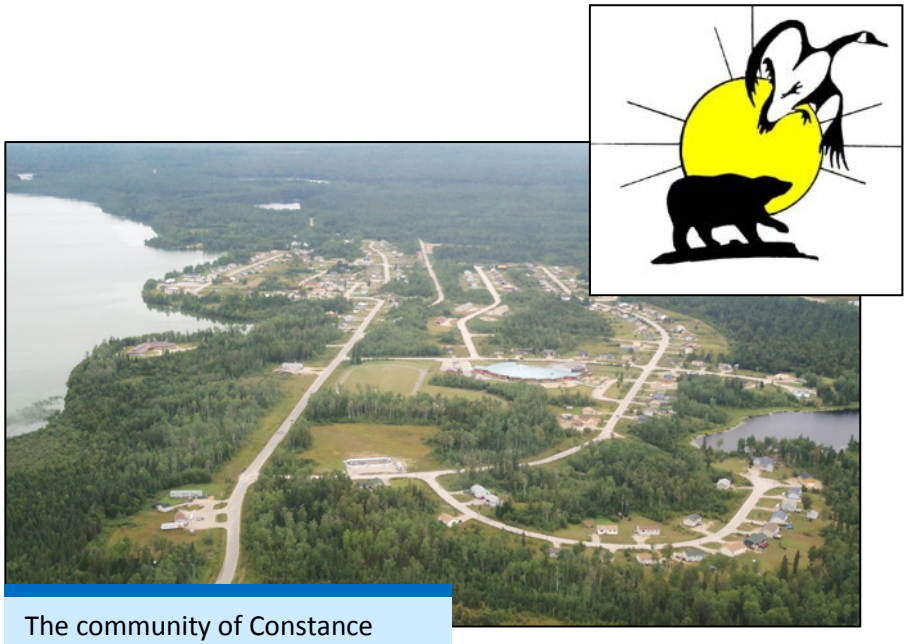
Challenge: Historically, **blue-green algae** contaminated the First Nation's surface water supply, leading the community to switch to a groundwater source. However, the groundwater source has iron and manganese in elevated levels that could not be treated by the existing water treatment plant.

Solution: Constance Lake First Nation sought an **innovative technological solution** for their drinking water treatment needs and also developed a water management plan to ensure sustainable water management into the future.

Results:

- Ministry funding for innovative technology was leveraged to build a **new water plant**, funded by Aboriginal Affairs and Northern Development Canada and the First Nation.
- Implementation of an **innovative green sand filter** in the new water treatment facility will address the elevated levels of iron and manganese in the groundwater. Advantages of the filter include:
  - Lower capital cost and footprint size;
  - The chemical requirements result in lower operating costs and simplified chemical handling;
  - Lower labour costs; and
  - Reduced maintenance costs.
- A **Water Management Plan**, complete with an Implementation Plan, recommended funding sources, and a one, two, and five year workplan was delivered to CLFN on February 27, 2015. The Action Plan includes options for developing a CLFN-based local or regional supply and maintenance business for water-related equipment.

Case Study: Under development.



The community of Constance Lake First Nation.

CREDIT VALLEY CONSERVATION AUTHORITY

Category: Stormwater

Challenge: Urbanization is straining environmental health, in part due to the increase in paved surfaces. These surfaces prevent rainwater from filtering into the ground and result in more stormwater, increased flooding and pollution that drains directly into waterways. **Low Impact Development (LID)** is a new way of managing stormwater. LID mimics the natural water cycle, allowing water to filter into the ground, reducing stormwater and pollution. LID techniques have proven successful in other jurisdictions, but there is **limited experience and slow adoption in Ontario.**

Solution: Create and publicize **demonstration sites** that show the benefits of LID to stormwater practitioners, regulators and the public. Use information from the demonstration sites and other LID sites in Ontario to create **guidance documents** that help municipalities and property owners implement LID.

Results:

- Implemented and monitored 12 demonstration sites to showcase LID technologies on industrial-commercial lands, road rights-of-way, and public and residential lands. Information was collected on LID construction, performance (stormwater volume and quality) and maintenance, and summarized in case studies.
- Provided **cost-effective stormwater control** even **during large storms, reducing stress off aging municipal stormwater infrastructure**
- **Reduced pollutant loading** into Lake Ontario
- Guidance documents were created to help stormwater practitioners implement LID in their communities:
  - *Grey to Green Road Retrofits:* Optimizing Infrastructure Assets Through LID
  - *Grey to Green Business and Multi-Residential Retrofits:* Optimizing the Bottom-line Through LID
  - *Grey to Green Grey to Green Public Lands Retrofits:* Optimizing Parks, Public Buildings, Schools and Places of Worship through LID
  - *Grey to Green Residential Retrofits:* Optimizing Residential Buildings and Scapes through Low Impact Development
  - *Grey to Green Municipal Retrofits:* Guide to Optimizing Infrastructure Assets and Reducing Risk Through LID

Case studies and guidance documents available at:
http://bit.ly/1RulUIU

LID in road right-of-ways in Mississauga (Elm Drive, left; Lakeview Road, right).

GANARASKA REGION CONSERVATION AUTHORITY

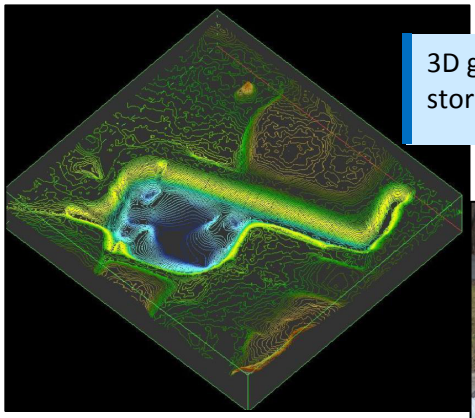
Category: Stormwater

Challenge: Flood line mapping completed in Ontario during the 1970's and 1980's is becoming dated. As a result of this outdated information, the current **risk of flooding is not fully understood**. Many new flood management issues are becoming evident, such as the flooding of a number of houses in the Town of Cobourg in January 2009. Robust data is needed to predict flooding and erosion, and design effective management practices.

Solution: Use **new technologies** to provide high quality topographic data, including **flood line mapping**, to support sustainable stormwater management practices.

Results:

- Used new technologies including LIDAR, Pixel Autocorrelation, and RTK GNSS to provide high quality topographic data, and applied the technologies in **three case studies**:
  - *Brook Creek Erosion Study:* Detailed survey information combined with state-of-the-art 3D geospatial modeling was used for a comprehensive erosion control study in the Town of Cobourg. The study's information enables effective decision-making for the community. http://bit.ly/1CAko1w
  - *Innovative Approaches in Flood Damage Reduction:* Provides enhanced understanding of storm water infrastructure, with options developed for future actions by the Town of Cobourg. The use of high quality mapping and innovative survey technology allowed for accurate determination of storm events that impact houses along rivers and streams. http://bit.ly/1M6vbDi
  - *Innovative Approaches in Modernizing Floodplain Mapping:* Geospatial components captured using the latest technology was shown to meet and exceed traditional floodplain mapping standards. This provides engineering analysis with a new stable footing for analyzing results. Floodplain mapping with this approach produces highly defensible results with unprecedented levels of accuracy and precision. http://bit.ly/1Sjtz7Z



3D geospatial model of a stormwater management pond.

Brook Creek erosion affecting a road.

GRAND RIVER CONSERVATION AUTHORITY

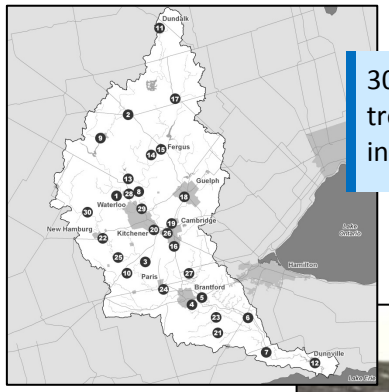
Category: Drinking water, stormwater, wastewater

Challenge: The Grand River watershed has had a Water Management Plan since 1932, with the latest completed in 1982. Renewed concerns brought on by **persistent and intensifying watershed challenges** such as population growth, agricultural intensification and climate change led watershed partners to agree to update the Plan.

Solution: **Update the Grand River Watershed Water Management Plan** and align the actions of the Plan's partners to achieve their shared goals – improve water quality, ensure water supplies, reduce flood damages and build resiliency to deal with climate change.

Results:

- Finalized in September 2014, the Plan was endorsed by 27 municipalities, Six Nations of the Grand River, Environment Canada, the ministries of Environment and Climate Change, Natural Resources and Forestry, and Agriculture, Food and Rural Affairs, and the Grand River Conservation Authority Board in 2014. Of the **163 actions** listed in the Plan, partners are already advancing over 120 of them. Lessons learned from the planning process can be found at: http://bit.ly/1gxiF2I
- The Grand River **Simulation Model** assessed future water quality conditions based on various wastewater treatment and rural/urban runoff management scenarios. The model shows summer phosphorus concentrations in the river are expected to decrease as a result of planned wastewater treatment upgrades and optimization. Case study: http://bit.ly/1HXSdLT
- Advanced GIS technologies and approaches identified locations for **soil and nutrient management**. The approach identified areas with a high likelihood of gully erosion with a high degree of accuracy (90%) when verified in the field. Case study: http://bit.ly/1HXTjak
- The conservation authority's watershed-wide **wastewater optimization program** provided valuable skills development to operators and managers of municipal wastewater treatment plants, and created a community of practice. Case study: http://bit.ly/1surSbG



30 wastewater treatment plants in the watershed.

Runoff from a field carries valuable soil and nutrients.

GREATER NAPANEE UTILITIES

Category: Drinking water

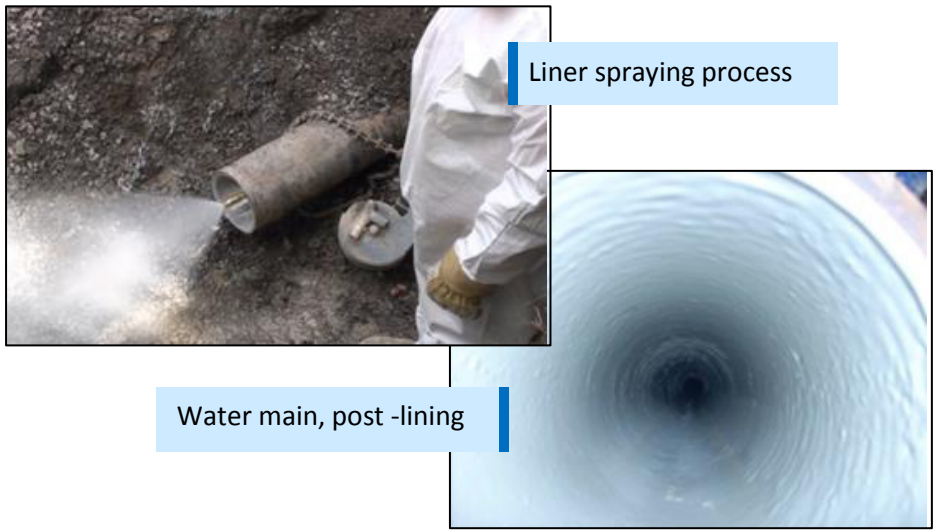
Challenge: In some areas of Napanee, the drinking water distribution system was experiencing operational challenges due to **tuberculation in pipes**. This resulted in reduced fire flows, low chlorine residuals, and poor aesthetic water quality. Replacing water mains was an option; however, since all non-drinking water infrastructure was in good or excellent condition, no capital improvements were projected within the next five years.

Solution: The municipality decided to pilot two **"trenchless technologies"** to rehabilitate the water mains of concern. After initial challenges with pipe preparation, the Ontario-based "blown stone" Tomahawk technology by Envirologics, Inc. was brought in and used to remove tuberculation. Once completed, a sprayed-in-place pipe (SIPP) technology was used line the pipes. ACURO, under a license agreement and partnership with a service provider, provided the polymeric-based resin for the rehabilitation.

Results:

- *Water Quality* –Significant **improvements to chlorine residuals** were noted at "dead end" sections of the water distribution system. Free chlorine residuals have risen dramatically since completion. The number of complaints about 'rusty water' has dropped from 73 to zero.
- *Hydraulic Capacity/Fire Protection* - Significant **increase in NFPA rated fire flows**. Fire flows in the rehabilitated area have risen as much as 3,293 litres per minute.
- *Structural Integrity of Water Mains* - **Two water main breaks** have occurred since the completion of the project. One occurred immediately after commissioning, and after review, it was determined to be due to operator error during the lining process. The cause of the second water main break was undetermined.
- *Water Leakage* - Subsequent water audits do not indicate any noted improvements since the completion of the project, possibly due to the short sections of pipes lined.
- *Pipe Preparation* – A key takeaway for this project is the importance of **effective pipe preparation**. The Tomahawk technology was implemented with great success.

Case Study: http://bit.ly/1fuNnt5



Liner spraying process

Water main, post -lining

CITY OF GUELPH

Category: Drinking water

Challenge: The City of Guelph is a growing community of over 120,000 people who are supplied with water from a limited local groundwater and spring collector system. The water supply and distribution system is one of Guelph's largest electricity uses with an **annual electricity bill of approximately $1 M**, based on 2011 electricity rates.

Solution: Improve distribution system efficiency and **create a "smart" water system** using a suite of technologies to improve system monitoring and operations. The smart water network included:

- Demonstration of patented hydrant pressure transmitter technology;
- Addition of power monitoring at each facility within the water supply and distribution system;
- Implementation of permanent District Metered Areas; and
- Identification of an energy efficient operational strategy using predictive modelling and collaboration with operators.

Results:

As of January 2015, the program has been successfully integrated into the City of Guelph's operations. High level results include:

- **Saving up to 7.3 per cent monthly energy use** per cubic metre pumped, equivalent to a reduction of 118 tonnes of carbon dioxide emissions;
- **Saving up to 26 % monthly energy power cost** per cubic metre pumped;
- Demonstrating an Ontario–made technology that is now selling in a competitive market; and
- Deferral of water supply capital infrastructure through reduction of water loss.

Case Study: http://bit.ly/1Cvegaf

Installation of a flow meter for a District Metered Area.

Fire flow testing prior to installing the hydrant pressure transmitter.

CITY OF GUELPH

Category: Stormwater; drinking water

Challenge: The City of Guelph is one of Canada's largest municipalities reliant on a **finite groundwater supply**. In an effort to reduce water use, the city sought ways to reduce demand for municipal operations.

Solution: The City of Guelph's Water Services department initiated a series of civic facility water use audits in 2009. These audits showed great potential for **reducing water use** associated with bus washing at the Guelph Transit facility through the implementation of water efficiency improvements that included a rainwater harvesting system and wash process spray nozzle retrofits.

Results:

Results of the Guelph Transit Bus Wash Rainwater Harvesting System include:

- More efficient **spray nozzles reduced the amount of water needed to wash buses by 25 %** with a one year payback period (1.9 million litres a year worth about $6,225 annually).
- Naturally soft rainwater can wash buses with **25 % less chemicals** than municipal water (naturally hard).
- **Rainwater reuse reduced the municipal water needed to rinse buses by 33%**. Over the first four months of operation, 120,000 litres of rainwater were captured. Extrapolating this over one year and using historical weather data as a guide, an estimated 480,000 litres of rainwater is expected to be used in place of municipal water, annually.
- Up to **13,500 litres of stormwater per rain event is captured**, reducing surges to local infrastructure and reducing associated quantity and quality impacts.

Case Study: http://bit.ly/1UKOGnJ

Guelph Transit bus washing facility.

The InterPak Engineered Rainwater Harvesting System is a complete modular rainwater harvesting system developed by InterPump Supply Limited in Fergus, Ontario

CITY OF GUELPH

Category: Wastewater

Challenge: **High ammonia** in a sidestream from the biosolids digestion process adds significant oxygen demand on the wastewater treatment process. This increases treatment costs and decreases the reliability of the treatment facility to meet its effluent ammonia target.

Solution: Construct a full-scale **sidestream treatment process** that will use Anammox organisms to remove ammonia in the sidestream. Additionally the city will investigate, at pilot-scale, the effectiveness of seeding Anammox organisms from the sidestream process into a mainstream reactor for additional ammonia removal. Anammox microorganisms are a consortium of naturally-occurring bacteria that "short circuits" the metabolic process of converting ammonia into nitrogen gas, reducing the amount of oxygen required in the process.

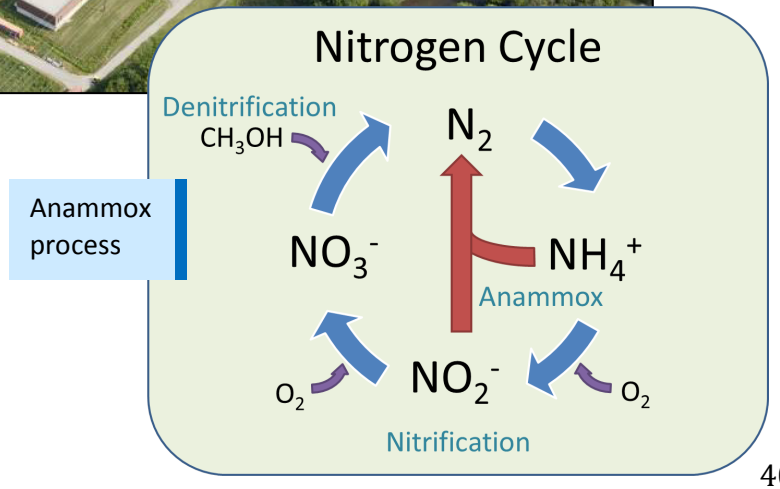
Results:

Construction of the sidestream treatment process is underway with completion in the summer of 2015. Anticipated outcomes include:

- **Reduction of approximately 25% of the ammonia** load to the facility
- Approximately **600 kWh of electricity will be saved** per day. This equates to $17,000 in energy savings per year
- Nitrate load to the Speed river from the wastewater treatment plant's effluent will be **reduced by approximately 325 kg of nitrate per day**
- Reducing ammonia load **frees up capacity** of the plant and helps to defer the planned plant expansion
- Expect **lower GHG emissions** from N_2O emissions and electricity requirements per year

Case Study: Under Development

Guelph wastewater treatment plant.



CITY OF KAWARTHA LAKES

Category: Wastewater; stormwater

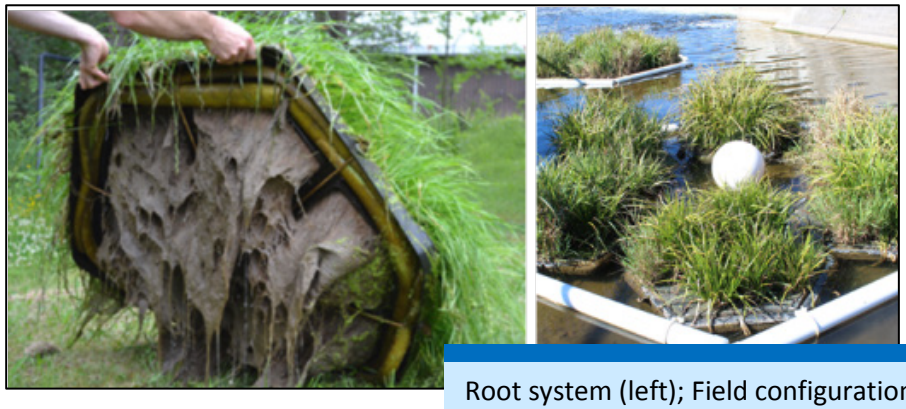
Challenge: The City of Kawartha Lakes is challenged with **nutrient loading and discharge** into the storm water pond located in Coboconk, Ontario as well as from two large waste stabilization ponds located in Omemee and Coboconk.

Solution: A joint study between the City of Kawartha Lakes, the Centre for Alternative Wastewater Treatment at Fleming College, Queens University, and Wilfrid Laurier University was initiated in the summer of 2012 to investigate the performance of PhytoLinks™, a **floating wetland technology** (FWT) designed and developed by Terrapin Water (formerly C&M Aquatics), an Ontario company based in Owen Sound.

Results:

- *Structural integrity of the floating platform* - Field trials identified structural changes to **enhance the durability** of the floating platform, especially over winter months
- *Vegetation* - **Seeding and germinating in an offsite nursery location improved growth and vegetative cover** compared to seeding on site.
- *Nutrient Uptake* - **Nitrogen uptake by plants was approximately five to six times greater than phosphorus**, with most of the uptake associated with roots and less in the above water shoots. Nutrient uptake by roots correlated positively with the nutrient status of the test site. Also, shoots underwent normal senescence at the end of summer, releasing most of the accumulated nutrient into the water unless the shoots were harvested. Most of the root mass remained over the winter and did not have the same level of senescence.
- *Microorganisms* - Project findings suggest that the **presence of root biofilms enhances both the density and metabolic diversity of microorganisms**, which likely increases treatment potential. Metabolic diversity of the biofilms developed in lagoon systems was less diverse than found in natural systems.
- *Water Quality* - The PhytoLinks™ installations did not impact water quality of the test sites. The surface coverage of the sites by PhytoLinks™ cells was generally less than 0.3% and believed to be too low to achieve significant treatment, particularly in locations where there was significant water flow.

Case Study: http://bit.ly/1JUzzVx



Root system (left); Field configuration of FWT cells (right).

CITY OF KITCHENER

Category: Stormwater

Challenge: Stormwater management (SWM) ponds are widely used in Ontario to control the quality and quantity of stormwater runoff in our cities. To function as designed, **periodic sediment removal from ponds** is required. Often sediment is disposed of at a landfill site due to the presence of contaminants which limit disposal options. The Waterloo Region currently has one active landfill with an estimated capacity of 15 years, based on an annual disposal rate of approximately 20,000 tonnes. Total sediment to be excavated from SWM ponds within the Region over the next 15 years is estimated to be 350,000 tonnes, which would, alone, exceed the capacity of the landfill.

Solution: Pilot test a **beneficial use study for SWM sediments** as an alternative to disposing them at a landfill. This involved using sediments from Kitchener's Victoria Park Lake, which receives drainage from over 1,400 ha of mixed residential and industrial/commercial/institutional land. Additionally a study was carried out to determine the feasibility of a program and/or facility for sustainable management of sediments and impacted soils.

Results:

- SWM pond sediment was found to be **potentially useful as a compost amendment or for land application**.
- Levels of certain contaminants in the Victoria Park Lake sediment stockpiles decreased over time; however, these sediments **may not be suitable for re-use as a soil** within the current regulatory context.
- Stockpiles had decreases in polyaromatic hydrocarbons, and, **in general, nutrients were not in an available form for microorganisms**. Amending stockpiles with nutrients, aerating, and tarping (for heat retention and anoxic conditions) had mixed results, with aeration having the most significant impact. Addition of sediment to compost had favourable results. Samples met both the CCME and the Ontario Compost Guidelines/Standards for metals – there are no limits for other contaminants of concern.
- A more systematic approach is needed for collecting and consolidating quality and quantity data on stormwater pond sediments and excess soils. The city is continuing to collect data and assess the feasibility of alternative uses to sediments.

Case Study: http://bit.ly/1O1sjVR

Excavators removing sediment from Victoria Park Lake.

CITIES OF KITCHENER AND WATERLOO

Category: Stormwater

Challenge: Municipal capital budgets are unable to keep up with the growing demand for traditional "grey" stormwater infrastructure. Green stormwater infrastructure (also known as **Low Impact Development**) has been identified as a potential solution. However, implementation of green infrastructure has challenges: lack of familiarity and track record in an Ontario context, regulatory approvals, and the **need to engage individual property owners in lot-level action**. Barriers for individual property owners include lack of knowledge, low motivation, high upfront costs, and ongoing maintenance.

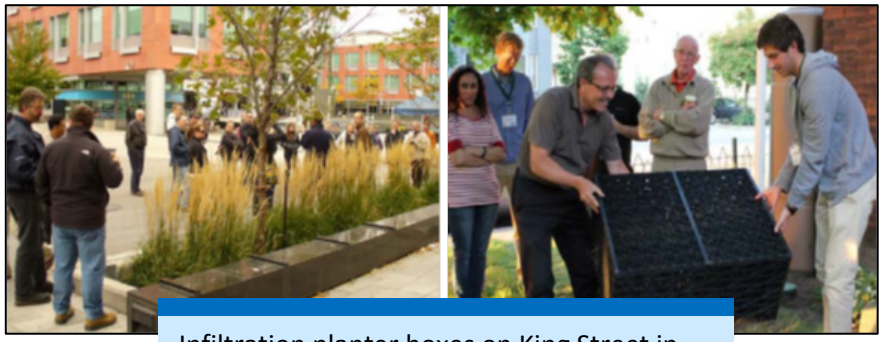
Solution: To address this challenge, the Cities of Kitchener and Waterloo implemented RAIN, a **community-based social marketing campaign to develop, test, and implement a strategy for mobilizing installation of green stormwater infrastructure**, including retrofits on individual properties. RAIN in Kitchener and Waterloo was a four-partner project including the two cities, local non-profit REEP Green Solutions, and national non-profit Green Communities Canada. The program complements the stormwater utility and credit system in Kitchener and Waterloo.

Results:
RAIN is a community-based social marketing program that engages property owners in action and long-term behaviour change based on three key messages: *Slow it Down, Soak it Up, Keep it Clean.*

Project outcomes include:

- 7,765 people engaged at 128 events;
- $676,595 in stormwater credits issued to homes and businesses;
- 115 service providers trained;
- 553,664 cubic metres of rainwater diverted in 2013;
- RAIN Home Visit developed and delivered to 260 homes;
- RAIN Business Visit developed, tested as an expansion to the RAIN Home Visit initiative;
- Knowledge sharing/online library established for stormwater practitioners;
- RAIN model communicated to other jurisdictions at 33 events;
- Replication of the RAIN model is underway in other cities;
- 6 demonstration sites created in highly visible locations.

Case Study: http://bit.ly/1O7j3jK



Infiltration planter boxes on King Street in Kitchener (left); Contractor training event (right).

LAKE SIMCOE REGION CONSERVATION AUTHORITY

Category: Stormwater

Challenge: **Phosphorous discharges** from urban stormwater management facilities can be a significant source of phosphorous. This can be the result of a design that primarily controls stormwater quantities, or a lack of maintenance of the facility. In the Lake Simcoe watershed, actions are being taken by all levels of government to reduce phosphorous discharges into Lake Simcoe, and innovative solutions are needed to achieve phosphorous reduction targets.

Solution: Retrofit three stormwater management ponds, originally designed for stormwater quantity control, with **technologies that remove soluble phosphorous** in a treatment train approach. Compare and contrast the effectiveness of the three innovative technology approaches.

Results:

Retrofit 1: Typical forebay and main cell with the installation of an oil/grit separator and a red sand filter media chamber. The expected phosphorous reduction is **23 kg/year** for the 155 hectare catchment.

Retrofit 2: Typical forebay with the installation of several wetland cells and a "sorbtive" media chamber. The expected phosphorous reduction is **16 kg/year** for the 18.5 hectare catchment.

Retrofit 3: Engineered wetland component included in the treatment train. The expected phosphorous reduction is **25 kg/year** for the 19.3 hectare catchment.

- The total cost of all three projects including design, consulting and construction fees was **$2.2 million dollars**.
- The majority of pre and post construction monitoring results show a reduction in phosphorus discharges.
- The treatment train approach is an effective way of improving the water quality by passing water through the various components of the treatment train.
- **Cost-saving approaches** were used in the projects, including the incorporation of excess clean fill material for re-grading on site adjacent to the retrofitted pond.

Case Study: http://bit.ly/1J9ikdv

Construction at retrofit #1, George Richardson in Newmarket (left); Post construction at retrofit #2, Colony Trial in East Gwillimbury (right).

LAKE SIMCOE REGION CONSERVATION AUTHORITY

Category: Stormwater

Challenge: **Excessive phosphorus runoff** impairs Lake Simcoe water quality, harms the aquatic ecosystem, and diminishes recreational enjoyment. The Lake Simcoe watershed is projected to add approximately 12,290 hectares of new growth between 2014 and 2041. Even after accounting for required on-site stormwater and phosphorus control measures, new development will contribute approximately 5 tonnes/year of phosphorus to the Lake.

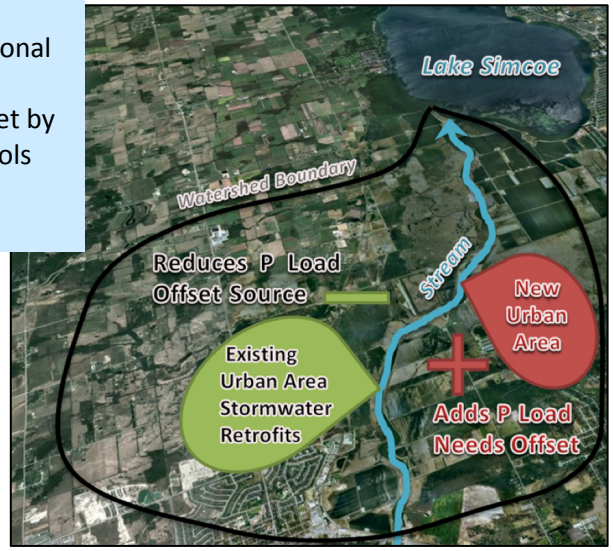
Solution: Design a **phosphorus offset program** for the Lake Simcoe watershed to address nutrient loading from urban development. The first phase of the program (five years) would offset any phosphorous discharges from new urban development with retrofits of existing stormwater facilities to enhance nutrient removal performance. The project was initiated by the Lake Simcoe Region Conservation Authority, with contributions by the City of Barrie and Regional Municipality of York.

Results:

- The first phase of the program would impact 2,778 hectares of urban expansion that would result in a total residual phosphorus load of 1.05 tonnes/year in a business as usual scenario.
- To meet offset demand (adjusting for a 2.5:1 offset ratio), it would be necessary to implement an average of 29 to 30 retrofit projects per year during Phase I. This corresponds to an estimated $91.8 million in project costs, not including $400,000/year in administrative costs and initial two-year monitoring costs of $520,000. During Phase I, these costs would be covered by purchase commitments from land developers.
- The preliminary estimate is that load offset purchases would cost approximately $32,200 per hectare of development area or about **$1,820 per residential unit**. The cost estimate for offset purchases per unit can vary depending on unit density within the site.
- Critical to the offsetting program will be establishing a Lake Simcoe "zero-export" policy for new development/re-development, and entering into agreements for offset purchases and retrofits projects.

Case Study: http://bit.ly/1UVinTb

New development and re-development contributes additional phosphorus load, which can be offset by stormwater controls elsewhere in the watershed.



TOWN OF MOOSONEE

Category: Drinking Water

Challenge: The Town of Moosonee has aging infrastructure and limited resources. Prior to the project, it had a flat-rate billing system for water users that did not **promote conservation** or provide the information to assess water use in the community.

Solution: Install **automated water meters** at all water service connections. Automated meters help the town with its limited resources because they reduce staff resources for meter reading and billing. Also, the water meters will help the town to collect data it needs to address its aging infrastructure and effectively promote water conservation.

Results:

- *Installation Compliance:* The town wished to have 100% compliance for installations. The vast majority of customers complied with the program, and those that did not initially comply, eventually had meters installed. The installation process helped identify historical errors and omissions and illegal connections.
- *Water Conservation:* A six month analysis following installation showed an approximate **20% reduction in water production** when compared to the same period the year prior to installations.
- *Treatment Costs:* The water treatment plant must continue to operate 24 hours/day, therefore reductions in electrical costs cannot be expected. However, the **cost of chemicals to treat water went down 20%** according to an analysis 6-months following water meter installation.
- *Water Leaks:* The water meters enable the town to report to customers when there is a suspected water leak in their private water system. The town expected building owners would repair leaks in response to this information. However, after six months of monitoring, the number of accounts with leaks did not change.
- *Wastewater:* The **volume of wastewater decreased** after meter installation. This is important because the town's sewage lagoons are nearing full capacity, and reduced flow could defer expansion.

Case Study: http://bit.ly/1J9ivWg

Example of an automated water meter installed in Moosonee.

MUNICIPALITY OF NORTH GRENVILLE

Category: Wastewater

Challenge: Currently, the Kemptville Water Pollution Control Plant is operating at approximately 50 % of its annual average flow capacity. However, peak flows can exceed the peak flow capacity, requiring **expansion of the facility where there is limited land area**. An influent equalization facility was recommended to reduce projected peak flows and minimize the footprint of an expansion. However, this solution still required a significant increase in footprint and acquisition of land.

Solution: The municipality's consultants, XCG, identified another option, the opportunity to use the relatively new BioMag™ treatment system at the Kemptville WPCP. **The BioMag™ technology is a small footprint process**, ideally retro-fitted within a treatment facility's secondary treatment train to provide an overall increase in capacity and improve effluent quality, potentially reducing or eliminating the need for flow equalization and land acquisition.

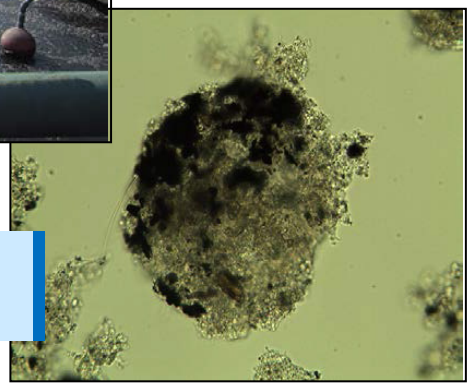
Results:

Based on the results of a 10-week full-scale pilot demonstration, conversion of the existing Kemptville WPCP process to a BioMag™ treatment system is a technically feasible option:

- It was **capable of meeting the performance targets** of 10 mg/L, 10 mg/L, and 0.3 mg/L for cBOD5, TSS, and TP, respectively.
- Conversion of the existing treatment system to BioMag™ could **increase capacity** of the Kemptville WPCP secondary treatment train from its current capacity of 4,510 m^3/d up to 9,000 m^3/d.
- The estimated capital cost of converting the two existing secondary treatment trains to BioMag™ is $2.7 million. This is approximately **25% less than the estimated cost to expand secondary treatment using a conventional process**.
- Additional operation and maintenance costs are $79.78 per 1,000 cubic metres of wastewater treated.

Case Study: http://bit.ly/1J9iAZQ

Aeration basin at the Kemptville WPCP.



Biosolids floc with magnetite incorporated (dark material).

PETERBOROUGH UTILITIES COMMISSION

Category: Drinking Water

Challenge: The water infrastructure in Peterborough dates as far back as 1883. As it reaches the end of its useful life, certain **water main sections will become structurally deficient** and must be replaced, or refurbished to extend their life. In Peterborough, structural integrity of deteriorated water mains is typically addressed by replacing pipes. This is costly, requires the removal and replacement of surface structures (e.g. roads and sidewalks), is disruptive to the public, and is challenging in restrictive work areas. One alternative is to use cement mortar liner; however, this method does not rehabilitate the structural properties of the pipes.

Solution: The utilities commission collaborated with a service provider to pilot test the use of ACURO Infrastructure's proprietary **sprayed-in-place polymer-based liner product for restoring water mains**. The liner promises to restore the structural integrity of the water mains, extending their life 50-75 years at a reduced cost compared to replacement.

Results:

A total of 635 metres of 150 millimetre water mains were structurally lined using the ACURO product.

- The minimum liner thickness was achieved throughout the length of the lined mains, with some exceptions at the top of the water mains.
- Due to the relatively short lengths of pipe lined, it was not always possible to field check changes in water quality or flows. A companion study in Napanee identified positive fire flow improvements with increases from 110 to 680%. An increase of 200% was measured in one of the two Peterborough sites, but no increase could be observed in the other.
- Capital Cost Savings: The alternative to structurally lining a water main is to replace the water main. Replacing a water main on either of the two sites in Peterborough would cost approximately $800 per metre. The average actual cost of structurally lining these two streets was $662 per metre. This results in a **savings of $138 per metre**, or a total savings of $94,800. Based on this study, lining versus replacement cannot be justified solely on economics.

Case Study: http://bit.ly/1D5Zx0r

Water main before cleaning and lining (left) and Post lining (right).

PIC MOBERT FIRST NATION

Category: Renewable energy

Challenge: White Lake is a man-made lake that was created when the forest industry constructed a regulating dam in the mid-1940s, approximately eight kilometres south of the Pic Mobert community site. Over time, this artificially regulated lake has developed and now supports new values and interests including White Lake Provincial Park, cottages, and recreational areas. Currently, the existing **dam for White Lake requires significant investment to avoid a failure**. The First Nation investigated the feasibility of rebuilding the dam and operating it to regulate water levels and generate electricity. However, the project was **not feasible unless it captures energy from compensation flow** from the dam. Compensation flow is water that passes by a hydroelectric dam for environmental or aesthetic reasons and is not normally used for generating electricity.

Solution: **Install microturbines** to generate energy from the compensation flow.

Results:
Construction is well underway and set for completion and commissioning in 2016. Expected benefits include:

- Preservation of a drinking water supply for the First Nation community;
- More consistent water levels in White Lake throughout the year, potentially improving habitats;
- Enhanced biologic engineering in the White River through the incorporation of ponding and habitat creation downstream of the White Lake dam;
- Reduced risk of flooding in the Recipient's community, White Lake Provincial Park and cottages located on White Lake through better management of flood flows; and
- Maximization of the energy potential of water passing through the White River watershed and onto existing and planned water power facilities on the lower White River.

More broadly, the project could provide a model and benefit the owners of other regulating dams by showing them how to incorporate micro-turbines into existing and new regulating dam developments, and demonstrating the benefits. **Currently, there are approximately 90,000 regulating dams in North America that could benefit from this technology,** including 2,600 in Ontario.

Case Study: Under development

Community members visiting the construction site.

CITY OF PORT COLBORNE

Category: Drinking Water

Challenge: The City of Port Colborne in the Regional Municipality of Niagara has a **major unaccounted for water problem**, with 30% of the water purchased from the Region being "lost", and a calculated Infrastructure Leakage Index of 8.7. Lost water has a significant cost to the municipality, with $2.1 million lost in 2013 and $1.5 million in 2014.

Solution: Create off-line and on-line software tools to centralize and analyze water usage data, enabling real time detection and calculation of water losses. The tools integrate data from the city's water billing system (water meters), the SCADA system, and from various authorized, unbilled uses (e.g., main breaks, system maintenance, firefighting etc.). The tools automatically calculate, in real time, water losses and potential revenue losses city wide and by zone. The continuous on-line monitoring of flows and pressures in the distribution system provides staff with **real-time information to pinpoint leakages or unauthorized water usages**, and respond in a timely manner to minimize repair time and subsequent water loss.

Results:

Work is ongoing with the project. Considerable challenges were encountered reconciling datasets needed for the tools.

Field testing found that water losses are not attributed to watermain breaks or water service leaks. The tools helped to identify the city's water loss values that are apparently losses primarily due to unauthorized consumption, metering inaccuracies, and data handling errors.

To investigate the magnitude of apparent losses, a portable flow meter was placed at an industrial site to quantify suspected non-revenue water. The monitoring revealed that this **single industrial site accounted for over three percent of the city's water loss**, amounting to $105,960.44 in lost revenue.

Case Study: Under Development

Portable water meter located at an industrial site to quantify unaccounted for water.

TOWN OF RICHMOND HILL

Category: Stormwater

Challenge: There were several major issues with the state of Rumble Pond that indicated the need for an upgrade. Rumble Pond, an online pond with Patterson Creek flowing through it, was built in the 1980s to manage runoff from an adjacent 44 hectare residential area. Over the past few decades it had filled in with sediment, which has resulted in **reduced water quality and quantity control**. The original design of the pond and the need for maintenance were negatively impacting the natural environment.

Solution: The project includes a number of special features, including:

- Remotely controlled **adjustable valves** that allow for additional sediment settling time;
- Redesign of the pond as an **offline facility** and realignment of Patterson Creek to remove the structure as a fish barrier and improve the creek's baseflow water quality;
- **Pre-treatment** technologies including the use of oil-grit separators followed by a Jellyfish® Filter System for additional sediment removal;
- **Phosphorus removal** with Sorbtive® media along a section of the pond perimeter path; and
- **Real-time monitoring** for optimal SWM facility operation, such as water level, flow, turbidity and temperature for the facility, and turbidity for the receiving watercourse.

Results:

Expected results of the project include:

- **Improved level of quantity and quality** control of stormwater discharged:
  - Lower temperature impact on Patterson Creek
  - Reduced pollutant discharges, including phosphorous
- **Improved fish habitat** by removing a fish barrier;
- Extended period between **maintenance** for the detention pond;
- Control the **outlet release rate** to allow for extended detention (weather permitting); and
- Provide the local community with a **recreational space**.

Case Study: http://bit.ly/1J9iLEx

Rumble Pond as an offline facility (left); Realigned Patterson Creek (right).

MUNICIPALITY OF SOUTHWEST MIDDLESEX

Category: Drinking Water

Challenge: Chlorine disinfection in drinking water distribution systems may result in the formation of **disinfection by-products** (DBPs), such as Trihalomethanes (THMs), at levels that can be harmful to human health. THM levels in Southwest Middlesex's drinking water distribution system have been increasing and getting close to regulatory limits.

Solution: **Pilot test a stabilized form of hydrogen peroxide for secondary disinfection** instead of using chlorine or chlorine based disinfectants (e.g. chloramines) as a means of arresting DBP formation. The stabilized hydrogen peroxide, Huwa San Peroxide (HSP), is a product originating in Belgium that has been used in Europe since 2004. HSP is also used in Canada by the company SanEcoTec in many different applications including private and public drinking water, animal husbandry and greenhouse water irrigation.

Results:

As the project progressed, the issue was raised of a possible reaction between HSP and **tuberculation in old cast iron watermains**, potentially causing localized coloured water conditions. These types of watermains exist in the community of Glencoe within Southwest Middlesex.
In an attempt to remediate the pipes, the watermains were swabbed to remove tuberculation. However, swabbing was only effective on marginally tuberculated pipe and several sections of watermain had significant tuberculation.

Over concerns of coloured water, the municipality decided to terminate the pilot test, and the municipality is seeking alternative solutions to address DBP formation in its water distribution system.

HSP was recently used successfully as a secondary disinfectant in Killaloe, Ontario a community with a large number of new water mains. This demonstrated that HSP could be an alternate secondary disinfectant in Ontario. Future work on using HSP should focus on verifying the impact of HSP on tuberculated pipes in the field, and seeking pipe remediation methods that are compatible with HSP use.

Case Study: http://bit.ly/1JZCtpn

HSP dosing equipment (left); Tuberculated cast iron pipe found on Main Street in Glencoe (right).

THE ONTARIO GREENHOUSE ALLIANCE

Category: Wastewater

Challenge: Typically, greenhouse vegetables and flowers are fertilized using a dilute nutrient solution, which is often recycled. However, **100% recycling of greenhouse nutrient solutions is not possible** because plants selectively take up nutrients causing certain ions to accumulate and limit plant growth.

Solution: The Ontario Greenhouse Alliance **pilot tested technologies to remove growth limiters in recycled nutrient solutions**. Removing "limiters" will increase the ability to recycle the nutrient solution, and reduce the amount of wastewater produced by greenhouse operations. Additionally, methods were sought to manage any residual (waste) produced by the technologies.

The three technologies were:

- Capacitive deionization - AMEC/ENPAR Technologies
- Membrane capacitive deionization - H20z Reuse Solutions
- Membrane separation - Savery Canada

Results:

All three systems succeeded in removing most limiters, thus improving recycling of the nutrient solution. Percent removal of select limiters in the pilot tests are shown in Table 1.

Table 1: Removal efficiencies of select limiters as percentages with standard deviations in parentheses. Highest efficiencies in bold.

	ENPAR-ESD	H2Oz	Savery	
			50-60% recovery	90% recovery
Sodium	**81** (5)	53 (11)	-2 (31)	0 (2)
Sulphate	90 (6)	63 (17)	94 (11)	**97** (1)
Chloride	**85** (9)	80 (9)	30 (5)	19 (3)
Carbonate	**52** (70)	43 (10)	31 (20)	31 (22)

A second part of the project was finding a method of disposing of the residuals produced by the technologies, including recovery of any value in the residual. It was found the residuals can be handled and treated effectively, but further study is required on recovering value.

Case Study: http://bit.ly/1LfiiVS

Greenhouse tomatoes receiving nutrient solution (right); ENPAR capacitive deionization unit (left).

CITY OF THUNDERBAY

Category: Wastewater, Drinking Water

Challenge: **A substantial amount of energy is needed to provide water and wastewater services** in the City of Thunder Bay, making up a large fraction of the cost to deliver these services. It is important to maintain affordability of these vital community services.

Solution: **Implement and pilot test energy and cost saving measures** at the City of Thunder Bay's wastewater and drinking water treatment systems. This included installing energy efficient turbo blowers at the Atlantic Avenue Water Pollution Control Plant, and collaborating with Lakehead University to pilot test an innovative water treatment technology, a bi-functional electrode, at the Bare Point Water Treatment Plant.

Results:

Wastewater Treatment

The city replaced 17 conventional air blowers with four energy efficient turbo blowers as part of upgrades to the aeration systems at the Atlantic Avenue facility. Preliminary results show a **reduced electrical energy demand of over 25% in the aeration processes**. Future integration of the turbo blowers for the filter scouring process will provide additional savings, pending completion of the project. Additional benefits of the conversion to turbo blowers are reduced noise and maintenance.

Water Treatment

The bi-functional electrode combines light and electrical current to remove contaminants from water, integrating two advanced water purification methods, photochemical degradation and electrochemical oxidation. The electrode promises to reduce process wastewater generation and the amount of chemicals used for cleaning ultrafiltration membranes. Based on the results of the bi-functional electrode pilot test, a **50% reduction in wastewater production and 50% reduction in chemical use** can be achieved, along with an improvement in the membrane cleaning process.

Case Study: Under development.

Aeration building at Thunder Bay's Atlantic Avenue Water Pollution Control Plant.

TORONTO AND REGION CONSERVATION AUTHORITY

Category: Stormwater; Drinking Water

Challenge: Many new technologies and practices for water conservation and stormwater management are available. However, **widespread adoption can be slow** because users are not aware of the technologies, the performance hasn't been proven or there is reluctance to be an early adopter.

Solution: **Demonstrate and promote new water conservation and stormwater practices in residential and industrial/commercial/institutional contexts**. Document results and produce information that makes it easier for users to adopt them.

Results:

The Living City Campus at Kortright. TRCA's centre for urban sustainability where green technologies and practices are showcased, tested and taught. Showcasing Water Innovation project accomplishments include:

- Enhancing the centre's demonstration of green parking lot practices: http://bit.ly/1C3hfkV
- Retrofitting a cistern with a prototype ozone and filtration treatment system: http://bit.ly/1FPzJ9V
- Enhancing on-site education and industry training: www.thelivingcitycampus.com
- The Living City Campus Virtual Tour website: http://tour.thelivingcitycampus.com

Sustainable Neighbourhood Retrofit Action Plan (SNAP). SNAP is a neighbourhood-scale approach for promoting implementation of lot level stormwater management and water conservation practices: http://bit.ly/1M4l3du

New Development Sustainable Stormwater Practice Evaluations

Residential Lot Level Stormwater Management Practices: http://bit.ly/1KK8uEq

Industrial/Commercial - Honda Campus: http://bit.ly/1ESEhe8

Low Impact Development Retrofits

County Court Boulevard road right-of-way: http://bit.ly/1ux2dzN

Calstone, Inc. stormwater retrofit: http://bit.ly/1eMsEA4

Low Impact Development Stormwater Practice Inspection and Maintenance Guide. A guidance document to help managers of stormwater infrastructure design efficient and effective inspection and maintenance programs: http://bit.ly/1HzFUn9

Bioretention cell at the Kortright Centre visitor parking lot.

UPPER THAMES RIVER CONSERVATION AUTHORITY

Category: Stormwater; Drinking Water

Challenge: The Thames River drains a large part of southern Ontario. The Lake Erie Lakewide Management Plan identified the Thames River as a priority river delivering **excess phosphorus to Lake Erie.**

Solution: Create a water management plan and implement projects that demonstrate "**the art of the possible**" in water management.

Results:

Better Data. Improve information to make the right decsions:

- High accuracy GPS field surveys for hydraulic modeling: https://www.youtube.com/watch?v=vlYq9UYDMiE
- Automated process to estimate precipitation: https://www.youtube.com/watch?v=vUzCfznr_Sk

Water Quality Assessment. A study was completed to better understand nutrient and sediment sources, fate, and delivery throughout the Thames River system so actions are targeted toward best value solutions: http://bit.ly/1NYHeAN

Agricultural Best Management Practices. Design and test rural best management practices to reduce nutrient discharges into the Thames River:

- Sub irrigation drainage control structures to control draining from tiled agricultural fields: https://www.youtube.com/watch?v=dkD_FMXo19Q
- Agricultural building runoff management and erosion: https://www.youtube.com/watch?v=kpNYM73bjBY
- Agricultural land converted in wetlands: https://www.youtube.com/watch?v=e3ZWXYiCFrI
- Phosphorus filter installed at a truck wash facility: https://www.youtube.com/watch?v=3igW_JlvOfc
- Treatment system for bunker silage at a dairy farm: https://www.youtube.com/watch?v=n_UrqHI_A90
- Erosion and sediment control:
  - http://bit.ly/1fubhoI
  - http://bit.ly/1LWgOAr

Communications

- Bring together watershed stakeholders for a technical symposium on issues related to water quantity and quality in the Thames watershed: http://thamesrevival.webnode.com/resources/swi-symposium/

Project website: www.thamesrevival.ca

Red sand phosphorous filter to treat bunker silage at a dairy farm.

Agricultural drainage control structure for a constructed wetland.

CITY OF WATERLOO

Category: Stormwater, Drinking Water

Challenge: Many communities in Ontario have aging municipal water infrastructure that is in need of replacement or upgrading. Innovative solutions with multiple outcomes are needed to efficiently use limited funds and address **future challenges such as climate change**.

Solution: Create a **rainwater harvesting system** at the City of Waterloo's Service Centre site to reduce potable water use and stormwater discharges, and use this system as a model for water conservation and sustainable stormwater management. A rainwater harvesting system reduces drinking water demand and the amount of stormwater discharged into the city's sewers.

Results:

Construction of the rainwater harvesting system is proceeding. To date, a modular eight cell cistern has been installed. Expected outcomes of the project include:

- **Replace approximately 50% of the current non-potable water demands** at the City Service Centre (wash bay, greenhouse, and other onsite/offsite operational uses) with stormwater collected in the cistern;
- **Collect up to 450 cubic meters of stormwater** per rainfall event when the tanks are empty rather than disposal into a pond;
- **Increase climate change resiliency** by preserving the drinking water supply and buffering the city's stormwater system from extreme events; and
- Create an example of rainwater reuse that demonstrates its feasibility and benefits to other city operations and industrial/commercial sites.

Case Study: Under development.

Tank installation at the Waterloo service centre site.

REGIONAL MUNICIPALITY OF YORK

Category: Wastewater

Challenge: Micropollutants, which include **pharmaceuticals, endocrine disruptors, personal care products and household cleaners, are a growing concern** because high concentrations could negatively affect aquatic ecosystems. While not currently regulated in Ontario, a proactive step is to find an effective and economical solution to reduce micropollutants in the environment.

Solution: Demonstrate a UV-based advanced oxidation process (AOP) that could reduce micropollutant release into the environment. Also, explore methods to make this process more cost-effective by combining coagulation and activated carbon adsorption with the UV-AOP treatment.

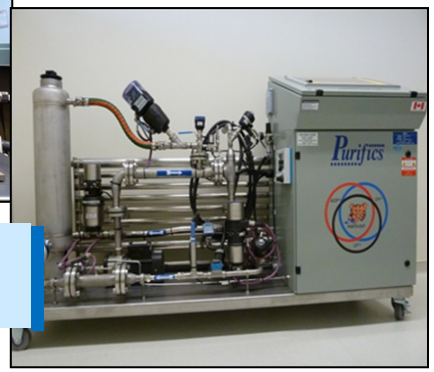
Results:

The study used effluent from the secondary treatment process at the Keswick Water Pollution Control Plant (WPCP). The Keswick WPCP is an extended aeration facility with tertiary membrane filtration and UV disinfection.

- Some micropollutants were effectively removed (>90 per cent) with UV alone. However, UV doses were about 100 times more than required for typical UV disinfection for drinking water treatment.
- Compounds, such as caffeine and carbamazepine required AOP (hydrogen peroxide or titanium dioxide) for removal.
- Pre-treatment of wastewater with coagulation or carbon adsorption reduces the concentration of organic matter and decreases the AOP dose requirements, improving the effectiveness of the process. However, for this study, the cost of pre-treatment did not justify the benefits. The lowest overall cost was obtained with a high peroxide concentration (20 mg/L). The high peroxide level improves efficiency of the process.
- Overall, using UV-AOP for micropollutant removal is costly. Targeting a 90 per cent removal of carbamazepine increases the overall treatment plant costs (20 year Net Present Value) by 40 per cent according to this study.
- These results are for this study. Results may vary depending on wastewater characteristics and the wastewater treatment processes.

Case Study: http://bit.ly/1KUB3hO

Calgon Carbon Rayox® advanced oxidation batch reactor.



Purifics® UV- Titanium dioxide reactor.

REGIONAL MUNICIPALITY OF YORK

Category: Stormwater; Drinking Water

Challenge: **Water conservation** is a key priority in York Region. To date, the Region has saved approximately 25.8-million litres per day through its *Water for Tomorrow program*. However, more savings are needed to meet ambitious water saving targets set out in the Region's Long Term Water Conservation Strategy. Meeting these targets requires innovative and progressive efforts across all sectors.

Solution: The Regional Municipality of York, in partnership with the Town of Newmarket, Lake Simcoe Region Conservation Authority, Toronto Region Conservation Authority, and Mosaik Homes tested a fast-track municipal review and approvals process titled "Innovative Sustainable Development Approvals" (ISDA) as a **market-based incentive for water conservation and stormwater quality and quantity management practices in new construction**. The primary goal of the ISDA project was to reduce indoor water use per household by a minimum of 25 per cent above the Ontario Building Code, with other goals including:

- Eliminating need for a stormwater pond;
- Protecting watersheds and surface waters;
- Mitigating nutrient loadings to surface waters, in particular, phosphorus loadings to Lake Simcoe; and
- Reducing stormwater overland flows through enhanced at-source infiltration.

Results:
Collaboration among project partners led to positive outcomes for the Mosaik development in Newmarket:

- **25 % reduction per home in indoor water use** over the Ontario Building Code
- **25 % reduction per home in energy use** over the Ontario Building Code;
- **8 % more phosphorous removed** from stormwater over current provincial requirements;
- **10 % to 16 % more total suspended solids removed** over current provincial requirement; and
- **Capture of 9.5 mm or less event-based rainfall**, accounting for about 82 % of annual rainfall events.

Performance monitoring will continue to verify the results listed above.

Case Study: http://bit.ly/1UKDhEn

The development includes a natural wetland feature that works with other site features to eliminate the need for a stormwater pond.