



Office of the Commissioner
Environmental Services Department

MEMORANDUM

To: Members of Committee of the Whole

From: Erin Mahoney, M. Eng.
Commissioner of Environmental Services

Date: February 22, 2019

Re: Update on Water and Wastewater Research and Innovation

This memo provides an update to Regional Council on water and wastewater research activities and innovations undertaken in 2018.

Research programs increase knowledge and produce innovative solutions that assist Environmental Services staff in meeting and anticipating emerging regulatory and treatment challenges.

Since 2008, Environmental Services staff have been engaged in research and innovation that support protection of public health and the environment through:

- Increased understanding of emerging challenges and potential impacts
- Leveraging and implementing the latest technologies
- Mitigating risk in operations of water and wastewater facilities
- Optimizing processes to reduce chemical consumption and improve treatment quality
- Aligning with a complex and changing regulatory framework
- Advocacy for changes to legislation based on sound science

Strategic partnerships with regulators and agencies, industry experts, consultants, public utilities, and universities, allows for the development and implementation of innovative solutions to complex problems and challenges in the water and wastewater industry. These partnerships are outlined in Table 1 and enable us to more effectively manage risk and continue to deliver value for money.

Table 1
York Region Research and Innovation Partnerships and Initiatives

Partnership Type	Partner	Partnership Initiatives
Regulators and Agencies	Agriculture and Agri-Food Canada	<ul style="list-style-type: none"> • Antibiotics resistance associated with wastewater effluents • Water Reuse Demonstration Project
	Lake Simcoe and Region Conservation Authority	<ul style="list-style-type: none"> • Stormwater pond retrofits for Phosphorus offsets supporting the Upper York Sewer Solution • Lake Simcoe mussel monitoring • Source protection: road salt monitoring and education
	Ministry of the Environment, Conservation and Parks	<ul style="list-style-type: none"> • Terms of Reference: Determination of Minimum Treatment for Municipal Residential Drinking Water Systems Using Subsurface Raw Water Supplies • Pharmaceutical manufacturer emerging contaminant loading to sewers and wastewater facilities • Western Durham Nearshore Program • Advocacy and consultation
	Toronto and Region Conservation Authority	<ul style="list-style-type: none"> • Western Durham Nearshore Program: algae and nutrient study of Lake Ontario supporting Duffin Creek outfall
Industry Associations	American Water Works Association	<ul style="list-style-type: none"> • Leadership by staff (committees, industry manual development) • Adenosine Tri-phosphate and Coliform Analysis Comparison for Infrastructure Release for Service project • Disinfection by-product research: Organochloramines
	Canadian Water Network	<ul style="list-style-type: none"> • A nationwide consortium of municipal water leaders to undertake research in the areas of emerging contaminants, fiscal sustainability, nutrient management and water reuse

Partnership Type	Partner	Partnership Initiatives
Industry Associations (continued)	Global Water Leaders Group	<ul style="list-style-type: none"> • A global network of utility leaders sharing experience and innovative approaches in water and wastewater
	Ontario Water Works Association	<ul style="list-style-type: none"> • Advocacy, industry leadership; water quality, asset management and conservation
	Water Research Foundation	<ul style="list-style-type: none"> • Developing Guidance for Assessment and Evaluation of Harmful Algal Blooms, and Implementation of Control Strategies in Source Water (project) • Leading Water and Wastewater Utility Innovation (project) • Staff education through webinars and resource materials
Consultants	Black and Veatch, Canada	<ul style="list-style-type: none"> • Water Reuse Demonstration Project
	Jacobs Engineering Ltd.	<ul style="list-style-type: none"> • Groundwater Treatment Strategy • Georgina water treatment plant membrane life expectancy and metrics
	Stantec Consulting Ltd.	<ul style="list-style-type: none"> • Near real-time operational system performance by data analytics
Public Utilities	City of Toronto	<ul style="list-style-type: none"> • Corrosion Control Monitoring, Nitrification Monitoring and Prevention • Participant in Drinking Water Research Group, Natural Sciences and Engineering Research Council of Canada Chair
	Regional Municipality of Durham	<ul style="list-style-type: none"> • Phosphorus Reduction Action Plan at Duffin Creek • Participant in Drinking Water Research Group, Natural Sciences and Engineering Research Council of Canada Chair

Partnership Type	Partner	Partnership Initiatives
Public Utilities (continued)	Regional Municipality of Peel	<ul style="list-style-type: none"> • Treatment optimization, data sharing • Participant in Drinking Water Research Group, Natural Sciences and Engineering Research Council of Canada Chair
Universities	Drinking Water Research Group, University of Toronto	<ul style="list-style-type: none"> • Natural Sciences and Engineering Research Council of Canada Industrial Research Chair in Drinking Water • Natural Sciences and Engineering Research Council of Canada Collaborative Research and Development: Cyanotoxin control strategies in drinking water • Developing Guidance for Assessment and Evaluation of Harmful Algal Blooms, and Implementation of Control Strategies in Source Water (Water Research Foundation) • Schomberg Disinfection By-Product Formation Evaluation
	Trent University	<ul style="list-style-type: none"> • Emerging contaminants passive sampling program for water and wastewater
	University of British Columbia	<ul style="list-style-type: none"> • Keswick Water Resource Recovery Facility: Addressing Cold Water Treatment Challenges
	University of Sheffield, England	<ul style="list-style-type: none"> • Understanding of distribution system maintenance, biofilm growth and sediment mobilization and deposition
	University of Waterloo	<ul style="list-style-type: none"> • Keswick Water Resource Recovery Facility: Addressing Cold Water Treatment Challenges • Soil Resource Group: Water Reuse Demonstration Project

Research programs allow for more informed decisions through use of new technologies and approaches

York Region's water and wastewater systems are a complex network of infrastructure that supports balance between population growth and various operational and regulatory challenges. Environmental Services staff engage in research partnerships to assist in anticipating challenges and undertake initiatives to remain engaged and current with advances in technology. Projects that develop new design and operational processes using progressive technology and strategies to optimize operations at existing facilities and seek to mitigate potential risks to current conditions. Research has resulted in more informed decisions regarding water and wastewater operations through use of new technologies and approaches.

Benefits realized by York Region as a direct result of research programs and partnerships include:

- Increased understanding of membrane performance, lifespan and maintenance in both water and wastewater treatment applications
- Optimized operation of water filtration processes for water treatment applications
- Improved understanding of disinfection by-products and public health impacts
- Development of monitoring tools and techniques for biomass growth in filters and distribution pipes
- Development of a multi-barrier approach to mussel control and continuous mussel monitoring system
- Reductions in energy costs and greenhouse gas emissions from heat recovery projects
- Adoption of the One Water approach considering the water cycle as an integrated system to mitigate risks and promote excellent water quality source to tap and back again

Highlights from ongoing and future projects include:

Research to Enhance System Understanding and Anticipate Future Challenges

Assessment and Evaluation of Harmful Algal Blooms and Detection and Treatment of Blue-Green Algae Toxins

Led by the Drinking Water Research Group, this research will provide utilities with knowledge and tools for early detection and mitigation of algal impacts to drinking water treatment. Results have led to multiple accurate online tools for detection and shown treatment efficacy with conventional, membrane and oxidation processes at water treatment plants. York Region is also participating in a Water Research Foundation study to create guidance for utilities in the event harmful algal blooms threaten source water quality. This project is expected to deliver a guidance document, decision trees and recommendations for early warning systems, source control strategies and technology applications.

Anticipated Completion: 2019 and 2020

Mussel Control at Drinking Water Intakes

Building on previous research done by the Drinking Water Research Group and lake monitoring by Lake Simcoe Region Conservation Authority, Environmental Services staff have developed new monitoring techniques and are working towards trialing alternate chemical control strategies to reduce the impacts of invasive mussels (Quagga) on drinking water intakes and water treatment plants. The multi-barrier approach implemented is a combination of physical and chemical control strategies when monitoring indicates a mussel threat. Copper sulfate will be trialed as an alternative to chlorine for mussel suppression. Using a deterrent other than chlorine has potential to reduce disinfection by-products and taste and odour compounds in the drinking water. Results will be relevant to all Southern Ontario utilities with surface water plants as these invasive mussels are prevalent in most freshwater systems.

Anticipated Completion: Ongoing

Microplastics; source impacts and treatment capacities

Microplastics have emerged as a contaminant of concern for drinking water. York Region is participating in a microplastics sampling and treatment evaluation project with the Drinking Water Research Group. The project will look at the type (size and source) of plastic in the raw water and how it changes through plant treatment processes. Work will also be done to evaluate potential health impacts. This industry leading research will help to determine if this contaminant of concern poses a threat to drinking water and what can be done to mitigate that risk.

Anticipated Completion: 2021

Investigation of Alternative Groundwater Treatment Strategies

York Region commissioned the Groundwater Treatment Strategy in 2016 to evaluate treatment methods at groundwater wells that address iron and manganese in drinking water. The strategy looks at industry best practices with consideration of the Health Canada proposed health-based guideline for manganese. Recommended next steps will be based on a cost-benefit-feasibility assessment which could include upgrades to existing or new treatment facilities. Local municipal partners have been engaged to provide feedback on current distribution system management practices and water quality challenges. Bench scale testing has already led to process and water quality improvements in groundwater systems. Pilot work has shown that the type of distribution pipe and the method of treatment both have impacts on the growth of residual demanding biofilm. Recommendations around water quality and asset management in distribution systems from the study are being implemented through the newly formed York Region-Local Municipal Water Quality Committee.

Anticipated Completion: 2019

Investigating Emerging Contaminants at the Source

Environmental Services, under the York Region Sewer Use Bylaw, worked on a field research project with the Ministry of the Environment, Conservation and Parks and local business owners to assess wastewater discharges from pharmaceutical manufacturers and funeral homes as potential sources of emerging contaminants. International research has shown that pharmaceutical manufacturing facilities can be significant sources of pharmaceutical loading to wastewater treatment plants. The study found that pharmaceutical manufacturers in York Region discharge relatively large amounts of pharmaceuticals but, due to the high volumes of wastewater in the York Durham Sewage System, the concentrations downstream of manufacturers generally typical of those found across urban sewersheds. The study, which was published in the journal *Science of the Total Environment (January 2019)*, recommends that pharmaceutical manufacturers do more to prevent discharges of pharmaceuticals to the sewer. Staff continue to work with the funeral home sector in York Region and have submitted a manuscript to the journal *Environmental Pollution*. Staff are awaiting notice confirming publication in 2019.

Anticipated Completion: 2019

Emerging Contaminants Passive Sampling Program

York Region's Emerging Contaminants Committee has partnered with Trent University to develop and implement an emerging contaminants passive sampling program at select drinking water and wastewater facilities within the Region. The program has been designed to allow the Region to establish a baseline understanding of possible emerging contaminants including pharmaceuticals and personal care products within York Region. Emerging contaminant sampling is not a regulatory requirement.

Anticipated Completion: End of 2019

Organochloramines Research

York Region, through participation on an American Water Works Association subcommittee, will be engaging in research to enhance the understanding of organochloramines, a disinfection by-product associated with distribution systems. Current industry knowledge lacks an understanding of the disinfection capacity, the formation pathways and how to accurately measure organochloramines. In 2019, the American Water Works Association Committee along with the Drinking Water Research Group will apply to Water Research Foundation for project funding. Results will assist with improving water quality in distribution systems.

Anticipated Completion: 2020

Adenosine Triphosphate and Coliform Analysis as Risk Assessment Tool for New Infrastructure

This project, being led through the American Water Works Association, is intended as a preliminary study to determine if an adenosine triphosphate analysis is a suitable risk assessment analysis for operational guidance that may be used as an alternate method for releasing newly installed water mains for service, releasing mains for service after breaks, and releasing treated water storage reservoirs for service after cleaning, disinfection, and/or maintenance. York Region is participating in a project steering capacity. This project compliments Health Canada's anticipated guideline on adenosine triphosphate monitoring and the province's recognition of adenosine triphosphate for biological monitoring.

Anticipated Completion: 2020

Process and Energy Optimization Research Initiatives

Optimization of Biological Filtration

In partnership with the Drinking Water Research Group, a pilot is ongoing at the Georgina Water Treatment Plant to better understand biological filtration in the granular activated carbon filters with the goal of optimizing operations and improving water quality in the distribution system. Recent work focused on cyclical operation of the filters and new test methods have determined why this feast-famine operation removes the greatest amounts of organic carbon. Work has also been done to eliminate biofilters as a source of nitrogen based disinfection by-product. Ongoing monitoring efforts have included monitoring of the new filter for conversion to biofiltration and the efficacy of filter seeding. Utilizing these findings, improvements to biofilter performance are anticipated at the plant. Overall, use of biofiltration has resulted in lower disinfection by-products and greater distribution water stability.

Anticipated Completion: 2019

Monitoring Toronto's Corrosion Control Plan in the York Water System

The City of Toronto uses phosphates to prevent lead corrosion within old piping as part of the its Corrosion Control Plan. Phosphates are added to prevent lead from dissolving into drinking water. To better understand impacts, York Region actively monitors phosphorus throughout the York Water System. Results are regularly reported to the City, local municipalities and Public Health. Given current and anticipated lead regulatory levels, phosphate addition by the City of Toronto will continue into the future with seasonal adjustments to dosing.

Anticipated Completion: Ongoing

Optimization of Membrane Performance during Cold Weather Conditions

York Region is currently facilitating a federally funded research partnership with Suez (membrane manufacturer) and the universities of British Columbia and Waterloo to optimize the biological processes and membrane treatment at the Keswick Water Resource Recovery Facility. This partnership with internationally recognized experts in wastewater treatment will provide a strategy to better address cold water challenges. It has the potential to increase membrane life, advance operations and assist in improving the quality of water returned to Lake Simcoe. This inaugural project sets out the framework for industry leading wastewater research and better understanding of membrane performance in the Canadian climate.

Anticipated completion: 2020

Membrane Metrics and Performance Evaluation

The Region has recently completed a study with Jacobs to develop a system to evaluate and predict the remaining life of the Georgina Water Treatment Plant membranes through a comprehensive performance metrics "dashboard," rather than simply replacing membranes based on operational time or at the end of the warranty term.

The performance metrics include evaluation techniques to facilitate critical diagnostics of the performance and health of the membrane filtration system so that informed operational adjustments can be made to cleaning regimes and flux rates in order to prolong the lifespan of the membranes and avoid costly premature replacement.

Anticipated Completion: 2019

Heat Recovery and Water Reuse Initiatives

Effluent Heat Recovery and Reuse Project

Wastewater contains thermal energy that is typically discarded when the treated effluent is discharged. Findings from an energy audit at Keswick Water Resource Recovery Facility, highlighted the largest electric load was the immersion heater that warms the membrane clean-in-place solution. In 2017, a heat recovery feasibility study examined various heating alternatives, including: thermal solar, geo-thermal, natural gas boilers, and effluent heat recovery. The alternatives were compared based on capital and operational costs, operational flexibility, reliability, greenhouse gas emissions, and innovation. The heat recovery option included extracting heat from the treated wastewater stream and using that heat to warm the membrane clean-in-place solution. This option had the lowest life cycle cost, lowest annual energy consumption, and lowest greenhouse gas emissions. In 2018, a capital project was initiated to design and construct the system.

Anticipated completion: 2019

Water Reuse Research Demonstration Project

In 2018, Environmental Services launched the second phase of the Water Reuse Research Demonstration Project. Reclaimed water from the Mount Albert Water Resource Recovery Facility was used to irrigate a test plot of sod at an operating farm in Georgina for the 2018 growing season. The project is implemented by Black and Veatch Canada and an academic research team lead by Soil Resource Group with the University of Waterloo and Agriculture and Agri-Food Canada.

The team sampled throughout the growing season to evaluate the effects of reclaimed water on plant health, soil properties and water quality. The Ministry of Environment, Conservation and Parks also provided in-kind support of lab analysis of emerging contaminants for the 2018 growing season. Environmental Services received \$73,000 in funding from the Canadian Agriculture Partnership (provided by both Federal and Provincial governments) to conduct the second phase of the project. Staff have recently learned that the Region has been successful in their application for \$191,000 for phases 2 and 3 of this project from the Federation of Canadian Municipalities Green Municipal Fund. This additional funding allowed the project scope to expand to include perennial flower and seed germination trials. The project will continue for one more growing season in 2019 and will be followed by the third phase of the project which will include detailed analysis of the results and recommendations. Results will help York Region better understand the technical, regulatory and environmental implications of water reuse.

Anticipated Completion: 2020

York Region continues to promote shared knowledge and showcase excellence

Research and innovation initiatives have and will continue to improve plant operations, asset management programs and inform capital projects. Staff engagement with industry experts has created opportunities to modify practices to meet regulatory requirements as well as develop new programs and tools to anticipate the needs and challenges the industry faces.

Articles pertaining to research projects lead by York Region have been published in numerous manuals and journals, including American Water Works Association manuals, Water Research Foundation, and Water Environment Federation publications.

York Region staff have conducted presentations at various technical conferences of American Water Works Association, Ontario Water Works Association, Water Environment Association of Ontario, and the Water Environment Federation. York Region staff also participate in industry leadership programs such as the Water Environment Federation's Water Leadership Institute and are active members of local and international technical committees.

Our improved knowledge better positions York Region to advocate and respond to proposed advancements in regulatory requirements. These ongoing efforts demonstrate York Region's commitment to continuous improvement, leadership and operational excellence in the highly regulated delivery of water and wastewater services.

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Commissioner of Environmental Services

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