A Watershed-wide Wastewater Optimization Program:

Performance-based wastewater management can improve water quality

Confirming coagulant dosage in the Paris Wastewater Treatment Plant

High Level Results

- A community of practice was developed among wastewater treatment operators, supervisors and managers to improve process control and achieve higher quality effluent
- Conducted Comprehensive Performance Evaluations (CPE) at four wastewater treatment plants.
- Participating municipalities demonstrated latent capacity, higher effluent quality and a deferral of infrastructure capital costs. For example, Haldimand County deferred over $10M in capital infrastructure costs

"It's always good to do better"
Jim Ellis, Public Works Manager
Township of Southgate

Project Context

The Grand River watershed has a population of about 985,000 (2014) that is expected to reach 1.53 million by 2051. There are 30 wastewater treatment plants that discharge their treated effluent into rivers in the watershed. Significant population growth will result in more wastewater being discharged into these rivers. Consequently, it becomes imperative that wastewater effluent be high quality and municipalities become diligent in achieving high performance. This will ensure that river health continues to improve and watershed communities will continue to prosper.

The watershed-wide optimization program demonstrates how performance-based management of wastewater plants can defer capital costs while improving effluent quality.

Challenge

With 30 wastewater treatment plants discharging into the Grand River and its tributaries (Figure 1), there is a need to find cost-effective solutions that result in improved wastewater treatment plant performance using existing infrastructure. Better performance can mean better effluent quality for both the river and Lake Erie.

Leading municipalities in the Grand River watershed have demonstrated latent capacity and improved performance of their wastewater treatment plants through investing in optimization. Infrastructure upgrades are overwhelmingly costly, especially for small rural municipalities. Wastewater optimization allows municipalities to better manage their assets while enhancing the performance of their plants.

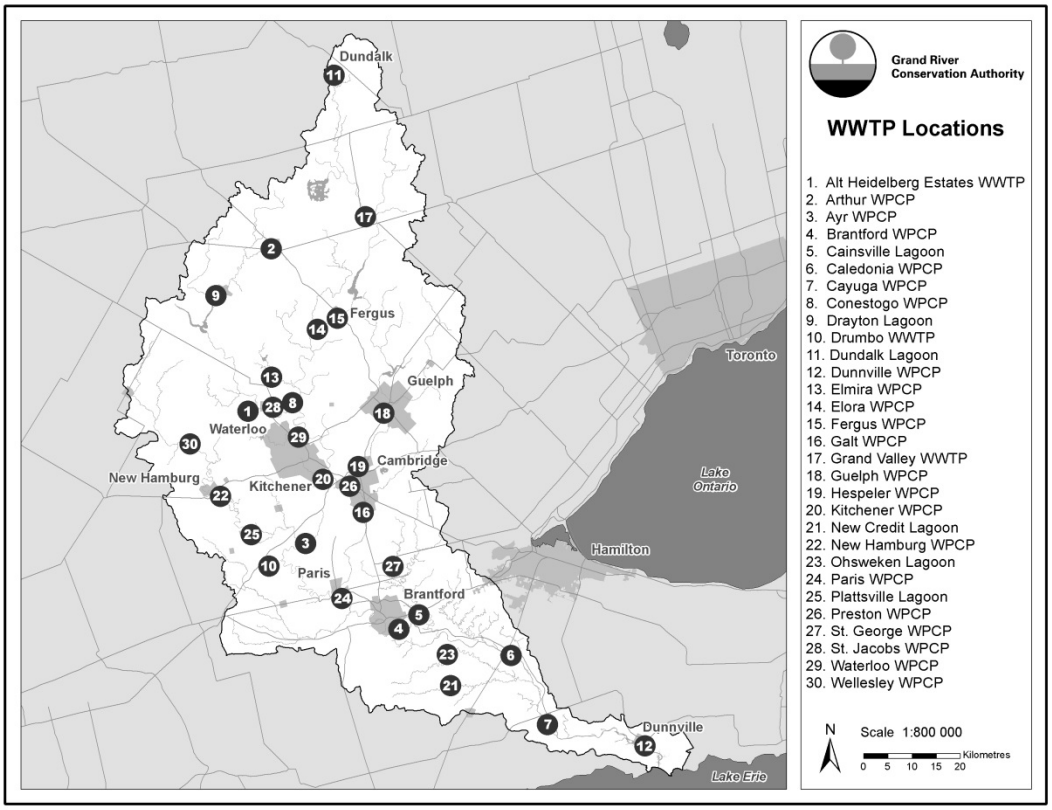

Figure 1. Location of the 30 wastewater treatment plants (WWTP) in the Grand River watershed.

Project Goals

The Ontario Ministry of Environment and Climate Change's Showcasing Water Innovation program provided an opportunity to continue to develop the watershed-wide wastewater optimization program to demonstrate improved performance at wastewater treatment plants in the Grand River watershed. In addition, the program aims to demonstrate good asset management to effectively tap the full potential of existing wastewater infrastructure and defer possible costly upgrades.

Optimization is a continuous improvement process which invests in skills development and continuous improvement of operators and managers to manage wastewater treatment processes more effectively. The goal of the optimization program is to achieve high quality wastewater effluent, economically, with existing infrastructure. The watershed-wide program aims to enable wastewater managers and operators at all of the wastewater treatment plants in the watershed with the tools and approaches to improve effluent quality. Improved process control means improved effluent quality which, in turn, improves the health of the rivers in the Grand River watershed.

Solution

Improved process control to achieve improved effluent quality can be achieved through engaging wastewater operators and managers and enabling them with better tools and approaches for making decisions. The United States Environmental Protection Agency (USEPA) developed an approach in the 1980's, and later endorsed by the Ministry of the Environment (now Ministry of the Environment and Climate Change (MOECC)) in the 1990's, that is recognized as a Best Practice to improve plant performance.

The approach, called the Composite Correction Program (CCP), involves two steps to evaluate and address performance-limiting factors impacting plant performance. It focuses on four key areas that impact any facility's ability to achieve the desired level of performance. The first step is the Comprehensive Performance Evaluation (CPE) and the second step, if applicable, is a comprehensive technical assistance program (CTA).

The Grand River Watershed-wide Wastewater Optimization Program (WWOP) uses the CCP approach to evaluate the capability and performance limiting factors of the wastewater treatment plants in the watershed to improve effluent quality. The tools and approaches in the CPE allow plant performance to be assessed by reviewing the plant design, and the administration, operations and maintenance practices of the plant. If the plant is deemed to be capable, improved process control through better operations, administration and/or maintenance practices can improve effluent quality (Figure 2).

A lot of time and effort is required to perform a CPE on a particular plant. Since the goal for the watershed-wide program was to engage operators and managers of wastewater treatment plants across the watershed, a series of performance-based, hands-on training workshops were held to develop operator skills, enhance their knowledge and support the development of a community of practice in the watershed.

To assist with the evaluation of each plant's performance and capacity, workshops focused on CCP tools like the calculation of average daily wastewater flows as a percentage of rated capacity; per capita influent flow; the ratio of peak day flow to annual average flow; and per capita loading (e.g. phosphorus, nitrogen, etc.) to the plant. Participants were encouraged to apply the techniques to their own facilities and report the information back to the community of practice. Data were gathered from

plants across the watershed to develop watershed-specific information to compare performance.

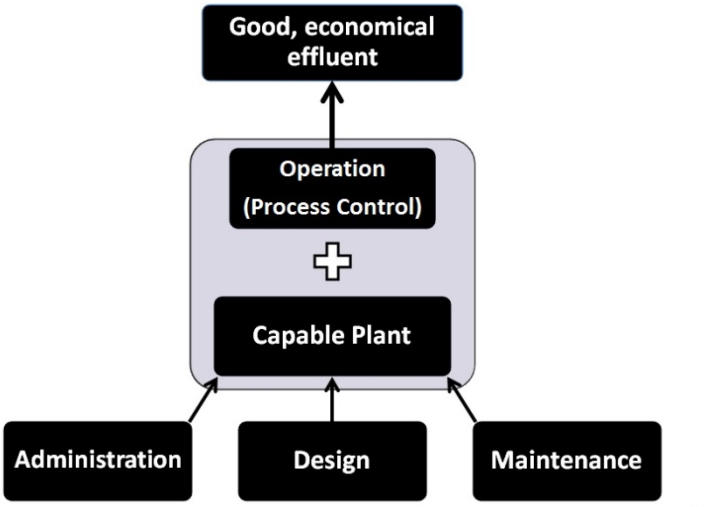

Figure 2. The Comprehensive Performance Evaluation takes into consideration the design, administration, operation and maintenance of a wastewater treatment plant to determine whether the plant is capable. A capable plant can be optimized to achieve better performance.

In addition to the workshops, Comprehensive Performance Evaluations (CPEs; the initial phase of the CCP) were carried out at four wastewater treatment plants. These CPEs served as training opportunities as the teams were composed of staff from MOECC, GRCA and watershed municipalities. Each team was led by an experienced facilitator, who provided guidance on the CPE protocol. Each CPE produced recommendations to improve process control and maintain excellent effluent quality.

Results

The watershed-wide wastewater optimization program builds upon the successes from leading watershed municipalities. Most notable is the impressive work completed by the Haldimand County and City of Guelph. Optimization of the wastewater treatment plants in these municipalities has been successful in deferring substantial capital costs. For example, Haldimand County, a small rural municipality with less than 9,000 ratepayers, was able to defer more than $10M in capital upgrades to the Caledonia wastewater treatment plant by evaluating and optimizing the treatment process. The City of Guelph avoided a $5M capital upgrade to UV disinfection by optimizing the existing chlorination/dechlorination system to meet proposed Environment Canada guidelines.

Table 1. Summary of the approach, lessons learned and benefits of optimizing the Caledonia wastewater treatment plant in Haldimand County, Ontario.

	Assessment of the Wastewater Treatment Plant
Objectives	Apply the CCP to better understand the capabilities of existing infrastructure and performance limiting factors to produce high quality, economical wastewater effluent.
Strategy	Foster a collaborative working relationship between county staff and the contract operator Evaluate operational, administrative and maintenance best practices Identify latent capacity and opportunities to re-rate the plant
Cost	Minor increase in operations costs including: 1. $39K/yr for staffing, lab analysis and sludge hauling 2. 540 person – hours / yr for county and contract staff to support CCP activities 3. $45K/yr for Optimization Consultant support
Benefits	Deferral of $10.7 M for infrastructure costs Improved asset management Improved effluent quality; benefits to river and downstream communities Empowered plant operators to make better decisions based on better data and enhanced knowledge
Challenges	Optimization requires a shift in thinking and cultural change in management Existing contracts with contract-operators were impacted by additional CCP activities Some data were not collected or easily available.

Building on these successes, the Grand River WWOP has led to the creation of a community of practice in the watershed by bringing together wastewater operators, supervisors and managers at four workshops to learn about plant optimization concepts. Case studies, like the work done in Haldimand described above, were shared with participants at these workshops. The workshops for the Showcasing Water Innovations Program built on the previous three workshops held in the watershed in 2010-2011. The workshops provided valuable opportunities for training and Continuing Education Units were offered as an incentive to encourage participation.

In addition to the workshops, staff from watershed municipalities participated in and completed CPEs at four volunteer wastewater treatment plants. These CPEs also provided valuable hands-on training opportunities for wastewater staff. This led to the development of local capacity to conduct more CPEs in the watershed.

Information on plant performance measures was collected for 25 of the 30 plants in the watershed; eight of the 11 municipalities who own and operate wastewater treatment plants participated in the watershed optimization program. An example of a plant performance measure is the 'per capita influent flow' – the amount, in litres, of sewage that flows into a wastewater treatment plant per person in the municipally serviced area. Figure 3 illustrates the per capital flows for the 25 wastewater treatment plants in the watershed.

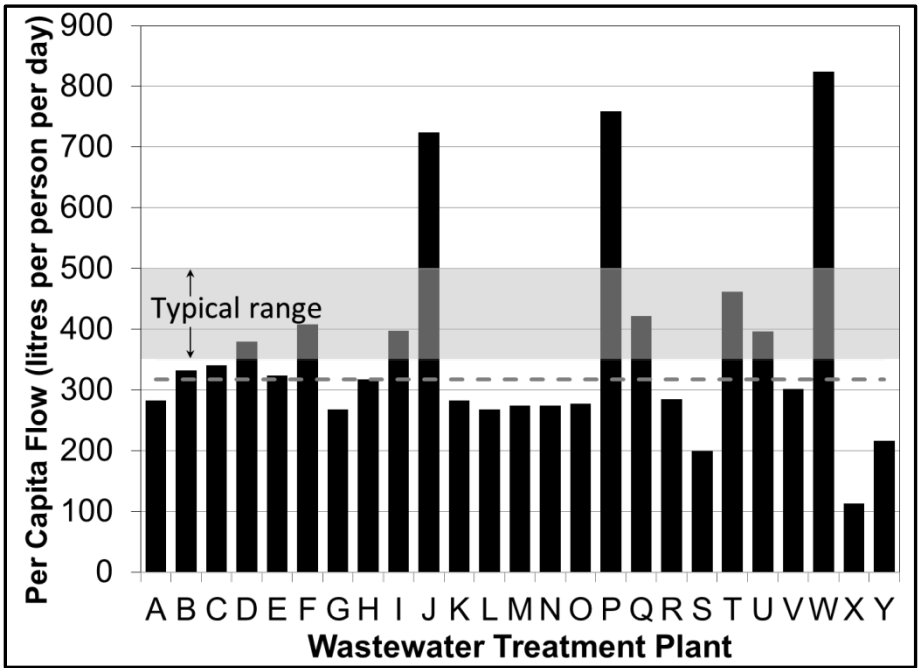

Figure 3. The amount of sewage flow generated by each person (i.e. per capita) per day in each municipality serviced by the wastewater treatment plants (e.g. A, B, C, etc). This metric helps to identify and quantify major industrial inputs or inflow and/or infiltration into the wastewater collection system. The dashed line indicates the watershed median value, which is much lower than the typical range.

Comprehensive performance evaluations (CPEs) were completed for four plants. Although each plant that was evaluated was deemed to be a capable plant and producing high quality effluent, recommendations were made for each plant to improve process control and maintain a high level of performance in the future. All municipal water managers who participated in the CPEs felt that there was significant value in conducting a CPE at their plant as their staff improved their knowledge of the plant and its operations.

Historical performance of wastewater treatment plants across Ontario and within the Grand River watershed was reviewed. This information was used to develop reasonable and achievable voluntary performance-based targets for wastewater treatment plants in the watershed. Interim and final targets were established for final effluent total phosphorus and ammonia concentrations. The voluntary performance targets are

documented in the Grand River Watershed Water Management Plan. A watershed reporting process was started for compiling performance measures.

The optimization of wastewater treatment plants in the Grand River watershed has huge potential for improving river water quality. The Grand River Simulation Model (GRSM) – a river water quality model that predicts in-river water quality based on nutrient concentrations and aquatic plant growth, was used to assess whether water quality in the river would improve if the ten largest wastewater treatment plants in the watershed adopted these voluntary targets through the optimization program. See the Case Study: Wastewater management planning in the Grand River Watershed for the results of the scenario which showed a significant improvement in river water quality as a result of optimized performance in wastewater treatment plants.

Lessons Learned

Leadership is critical. Creating a community of practice that shifts the typical way things are done requires leadership. Leadership is required at the top (senior Ministry regulators, municipal water managers); at the ground level (i.e. operators); and all levels in between (e.g. wastewater supervisors, Ministry technical support staff).

Small investments in improving operations can defer major capital costs. Municipalities have demonstrated that improving operator skills and investing in better data collection can help defer major infrastructure upgrades. The CCP can be part of a good Asset Management Plan that allows municipalities to achieve better value from existing infrastructure.

Training is wanted and needed. Wastewater operators want training. Continuing Education Units (CEUs) are required for water treatment operators but are not required for wastewater operators. An overwhelming number of wastewater operators commented on the need for ongoing operator training to improve skills and knowledge. The watershed wide wastewater optimization program could meet this need moving forward.

Voluntary targets are not compliance limits. Municipalities are concerned that voluntary performance targets will be adopted by the regulator, Ministry of the Environment and Climate Change, as compliance limits. Wastewater optimization goes beyond compliance and achieves high performance. There is a need to align municipal, watershed and provincial wastewater management goals to achieve high performance to improve water quality in the river and Lake Erie.

Next Steps

Wastewater optimization is considered a best practice in the Grand River Watershed and is identified as a key action item in the Grand River Watershed Water Management Plan. Consequently, there is a commitment among municipal water managers and the province to continue to support the program and report on the voluntary performance targets and overall progress as part of the Plan. Additional training opportunities will be

developed over the next three years, until 2017, to continue to engage and develop the community of practice for the watershed-wide wastewater optimization program.

Application for Ontario communities

The Grand River WWOP serves as a pilot project for other parts of the province. The tools and approaches developed in the Grand River program can be applied in other areas where surface water quality is impacted by treated wastewater effluent. It has been instrumental in creating interest within the MOECC to spread the concept throughout Ontario.

The CCP has proven to be a cost-effective way to manage and make better use of existing wastewater infrastructure. It can be a tool used by all municipalities as part of a good asset management plan. Municipalities using the CCP tools can easily illustrate whether the plant is limited by maintenance or administration which warrants investment in operations, or design which necessitates further infrastructure investment. CCP evaluations can aid the province in identifying those plants in need of infrastructure investments. The CCP supports the Ministry of Infrastructure's "Building Together" plan in that good asset management practices allow for all levels of government to achieve better value from existing public infrastructure and set future priorities.

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