

Report to Civic Works Committee

To: Chair and Members
Civic Works Committee
From: Kelly Scherr, P.Eng., MBA, FEC
Deputy City Manager, Environment & Infrastructure
Subject: Wastewater Treatment Operations Energy Savings Report
Date: March 29, 2022

Recommendation

That, on the recommendation of the Deputy City Manager, Environment & Infrastructure, the following report describing the achievements of the Wastewater Treatment Operations Division in reducing energy consumption **BE RECEIVED** for information.

Executive Summary

Purpose

This report describes the projects undertaken by the Wastewater Treatment Operations Division to reduce electricity and natural gas consumption at the City's wastewater treatment plants and pumping stations.

Context

The Wastewater Treatment Operations Division is the largest consumer of electricity and the second largest consumer of natural gas among City services and facilities. Through dedicated energy-saving projects and operational strategies the division has been able to achieve significant reductions in both consumption and cost, benefitting the City and the environment.

Linkage to the Corporate Plans

This project supports the 2019-2023 Strategic Plan through the following:

- Building a Sustainable City,
- Build infrastructure to support future development and
- Protect the environment.

The Wastewater energy projects identified in this report also support City's Corporate Energy and Demand Conservation (CDM) Plan. Identifying opportunities to improve Energy Efficiency within corporate operations and infrastructure is one of the key strategies in City's CDM Plan. Additionally, a primary goal of the 2019-2023 CDM Plan is to reduce the corporation's overall energy use by five percent or 8,500 equivalent megawatt-hours (eMWh) from 2019 to 2023.

Analysis

1.0 Background Information

1.1 Previous Reports Related to this Matter

- Civic Works Committee – May 14, 2019 – Contract Award: Tender T19-36: Greenway Organic Rankine Cycle Engine Installation.
- Civic Works Committee – May 14, 2019 – Greenway Wastewater Treatment Plant Organic Rankine Cycle Equipment Installation Budget Allocation.
- Civic Works Committee – July 17, 2018 – Clean Water and Wastewater Fund Project Budget Adjustments.
- Civic Works Committee – June 7, 2017 – Clean Water and Wastewater Fund – Purchase of Major Organic Rankine Cycle System Components for Power Generations at the Greenway Wastewater Treatment Plant.
- Civic Works Committee – September 9, 2013 – Biosolids Disposal Assessment.
- Civic Works Committee – May 14, 2012 – Tender T12-46: Greenway Pollution Control Centre Dewatering Project, Project ES2095.

2.0 Discussion and Considerations

Wastewater is an unavoidable product of society and it has the potential to cause significant harm to human health and the environment if left untreated. Municipalities have an obligation to provide adequate treatment of their wastewater in order to limit those negative impacts. However, the conveyance and treatment of wastewater represents a significant cost to municipalities and consumes large amounts of energy. For example, wastewater treatment in the City of London costs more than \$100 million annually and accounts for approximately 30% of the total electricity consumed collectively by the City's facilities and infrastructure.

While the recent commissioning of the Organic Rankine Cycle power generation system at Greenway marks a significant accomplishment that will contribute in a significant way to the City's energy saving goals, it is in fact simply an exclamation mark on a decade of successful energy conservation projects. Energy reduction has long been a priority for the Wastewater Treatment Operations Division. With the visibility and support that Council's declaration of a climate emergency has provided, the reduction of greenhouse gas emissions has also come to the forefront.

The purpose of this report is to highlight the major improvement projects that have been undertaken by Wastewater Treatment Operations over the past 10 years and present the overall savings that have been achieved to date.

In addition to the significant energy savings from major projects, Wastewater Treatment Operations is continuously engaged in smaller energy efficiency projects such as lighting retrofits and heat recovery for heating and ventilation applications, all of which contribute to the overall energy and greenhouse gas savings goal.

2.1 Sludge Dewatering to Reduce Natural Gas Consumption for Incineration

The City of London operates five wastewater treatment plants. Together, these plants treated more than 71 billion litres of wastewater in 2021 with the treatment process generating over 17,000 dry tonnes of waste solids annually. These waste solids require safe disposal.

Solids disposal for all of the City's plants is conducted at Greenway Wastewater Treatment Plant. Solids trucked from the smaller satellite plants, plus those generated

at Greenway, are dewatered and then incinerated. Historically, dewatering was accomplished through the use of belt filter presses which were capable of increasing the solids content of the biosolids from about 4% solids to approximately 22%. Removal of water prior to incineration is important, since excess water inhibits combustion. With a feedstock at 22% solids, the incineration process consumed approximately \$600,000/year in natural gas in order to ensure complete combustion of the waste material.

In 2014 the City completed the installation of decanting centrifuges capable of producing much drier “cake”. The new centrifuges regularly produce solids contents in the 26%-27% solids range, which allows the sludge to burn autogenously, meaning without the use of supplementary natural gas to fuel the incinerator. Centrifuges also offer operational benefits through the elimination of managing recycled newsprint as a feedstock additive, reduced odour control costs and reduced maintenance effort. Some of these savings have been partially offset by higher electricity and chemical consumption, but the goal of reduced natural gas consumption was met. Approximately 1.18 million m³ less natural gas has been consumed annually. Even considering that electrical consumption increased an estimated 1,025 MWh with the operation of the centrifuges, the project still results in a net CO_{2e} reduction of over 3,580 tonnes per year.

The City worked with Union Gas throughout the design of this project, and received an incentive of \$90,000 in recognition of the gas savings realized, although this is a relatively minor amount considering the \$12.5 million in capital that was expended to build the new dewatering system. Annual operational savings total over \$240,000 per year.

2.2 Turbo Blowers for Increased Efficiency in Bioreactor Processes

An essential part of the wastewater treatment process is aeration. Following an initial solids removal stage, wastewater enters a “bioreactor”, where air is forced into the tanks to provide enough oxygen for biological processes to take place that remove nutrients from the wastewater. Aeration is critical, but is also energy intensive. In general, aeration is considered to be responsible for 40-50% of the total electrical consumption in a typical wastewater treatment plant.

Historically, equipment called multi-stage centrifugal blowers were used at the City's plants to provide air to the bioreactors. These blowers were often oversized at the time of design and were throttled in order to better match airflow rates to process demands. This combination makes for a very inefficient process. Beginning in 2012, Wastewater Treatment Operations pursued a new technology called turbo blowers. Turbo blowers are reported to be 30-40% more efficient than typical centrifugal blower installations and include enhanced turn-down capabilities allowing them to slow down or speed up to match demand.

Since 2012, through multiple capital projects, the Division has replaced the duty blowers at four out of five treatment plants. This has resulted in a total reduction of approximately 6,340 MWh per year, equivalent to 1,400 tonnes CO_{2e}, and resulting in an estimated savings of \$950,000 annually. The City was also able to access funding from the provincial and federal government through the Clean Water and Wastewater Fund (\$1.90M) and incentive money through the Independent Electricity System Operator (\$1.10M) as a result of the energy savings realized.

2.3 Organic Rankine Cycle – Generating Electricity from Waste Heat

As described previously, in order to safely dispose of the City's waste solids, the Wastewater Treatment Operations Division incinerates the dewatered solids at Greenway. A by-product of the incineration process is heat which was lost through the facility's exhaust stack. Some of this heat had been captured and used to heat areas of the plant, but the remaining wasted heat energy represented an opportunity for the City.

The earliest investigations into utilizing waste heat for power generation were undertaken in 2012, but the design and procurement of an Organic Rankine Cycle power generation system for Greenway began in earnest in 2018. Commissioning was completed in October 2021, when the system began producing power generated from the waste heat discharged from the Greenway incinerator. This accomplishment represents the culmination of nine years of study, procurement, design and construction. Over this time, almost \$18 million was invested by the City, leveraging Federal and Provincial funding through the Clean Water and Wastewater Fund (\$4.42M) and the Federal Gas Tax (\$4.5M), currently known as the Canada Community-Building Fund.

It is expected that the power generated by the Organic Rankine Cycle system will be capable of offsetting a quarter of the power consumption at Greenway, the City's largest wastewater treatment plant, saving a projected \$600,000 per year in electricity costs. The energy consumption reduction achieved through this project alone, expected to total 3,600 MWh per year, accounts for over 40% of the City's 2019-2023 Corporate Energy Conservation and Demand Management Plan's overall target. There will also be an incentive paid to the City by the Independent Electricity System Operator based on the performance of the system over its first year. This incentive is projected to reach over \$700,000.

In terms of greenhouse gas emissions, the reduced energy will cut the City's greenhouse gas emissions by an estimated 800 tonnes of CO₂ per year - the equivalent of taking 200 cars off the road. In addition, Operations staff are working to optimize operation of the incinerator to both increase power production capability while also targeting a reduction of greenhouse gas emissions in the incinerator flue gas discharge. The results of these efforts will become clear in the coming months and years.

3.0 Net Results and Financial Impact

While much of this information has been presented in the preceding sections, it is worthwhile to consolidate the results of the efforts of the Wastewater Treatment Operations team has been able to achieve overall. Examining how the City was able to leverage funding sources also provides useful information to help future initiatives across the City.

Before the sludge dewatering project was completed, the Wastewater Treatment Operations Division was consuming an estimated 2,000,000 m³ of natural gas and 43,600 MWh of electricity annually. With the improvements made since then, consumption in 2021 was 446,000 m³ of natural gas and 39,000 MWh of electricity. This represents reductions of 49% and 10% respectively in less than ten years.

The results are summarized in the table below, with decreases shown in parentheses.

	Natural Gas (m ³)	Electricity (MWh)	Project Cost	Funding and Incentives Received	GHG (tonnes CO ₂ e per year)	Operational Savings (per year)
Pre-2014 (average)	2,000,000	43,600	-	-	15,740	-
Sludge Dewatering	(1.18M)	1,025	\$12.5M	\$90k	(3,580)	\$240k
Turbo Blowers	-	(6,340)	\$4.5M	\$3.0M	(1,400)	\$950k
ORC	-	(3,750)	\$18M	\$8.9M	(800)	\$600k
Total	(1.18M)	(9,065)	\$35.0M	\$11.99M	(5,780)	\$1.79M
% Change	-59%	-21%	-	-	-37%	-

To put these achievements in perspective, the 9,065 MWh reduction in annual electrical consumption offsets the average electrical consumption of 1,147 London homes while the 5,780 tonnes of CO₂e emissions that were eliminated are the equivalent of taking 1,445 cars off the road.

An important observation can be made when examining the sludge dewatering project: Projects that focus on greenhouse gas reduction often come with an increase in electrical consumption. This is because at the current time the Ontario power grid produces relatively low greenhouse gas emissions. Decisions at the project level often have to choose between energy or greenhouse gas reduction as the goal. Based on the City's declaration of a climate change emergency, the priority will be placed on GHG reduction where such a choice arises with an understanding that the capital and operating cost premium are acceptable for this purpose.

The projects described in the report cost over \$35.0M in total. Even considering the \$1.79M in annual operational savings that are projected to be achieved, it becomes clear that business case alone is not always enough to justify environmentally oriented projects. By pursuing and obtaining almost \$11.99M in external funding, City staff were able to make these projects financially viable.

While the City has been able to take advantage of funding and grant programs the offset the premium cost of these projects, those may not always be available. Advocacy by City representatives to describe the critical role that funding from senior levels of government plays in enabling municipalities to pursue greenhouse gas and energy reduction strategies is crucial for ensuring that the type of progress described in this report can continue to be made.

Conclusion

The Wastewater Treatment Operations Division is a strong supporter of the City's goals for greenhouse gas and energy use reduction. As one of the largest contributors of both, the Division bears a burden of opportunity if corporate-wide goals are to be met. Through significant efforts on the part of City staff in multiple Divisions, great strides have been made in recent years that contribute in a substantial way to corporate goals for both energy reduction and greenhouse gas reduction.

The information presented in this report shows how much can be accomplished, but it also highlights the challenges associated with including environmental priorities in capital projects. Even though the pursuit of energy saving and greenhouse gas reduction projects typically comes at a premium cost, those priorities will still guide decision making as the Division continues to provide efficient and effective wastewater treatment for the City of London's residents and businesses.

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