Lakeshore WTP Phase 3A Expansion, InnServices Utilities Inc.

2019 OWWA Award of Excellence for Water Efficiency

Lakeshore Water Treatment Plant (WTP) Phase 3A Expansion (26 to 38 ML/d), 46% more treated water capacity, 57% less waste.

Signature

I, Rama Badam, certify the validity of the information provided in this report, and agree that it may be shared and posted on the OWWA website.

Rama Badam, P.Eng., Senior Project Manager
Phone: 705-431-8611 Ext. 4632
Email: rbadam@innservices.co

InnServices Utilities Inc.
2101 Innisfil Beach Rd.
Innisfil, On L9S1A1

Summary

The Lakeshore WTP expansion is a key contributor to the advancement of the Town of Innisfil (Town) Water Conservation and Efficiency Strategy (WCES), which highlights initiatives aimed at meeting ambitious conservation targets of reducing fresh water use by 10% by 2019. The WTP expansion alone contributed to a reduction of 10% of fresh water use despite capacity being increased by 46% from 26 to 38 ML/d. This efficiency was achieved by retrofitting the conventional plant with a high recovery membrane treatment process that reduced waste sent to the Lakeshore Water Pollution Control Facility (WPCF) by 57% (635 m3/day).

Executive Summary

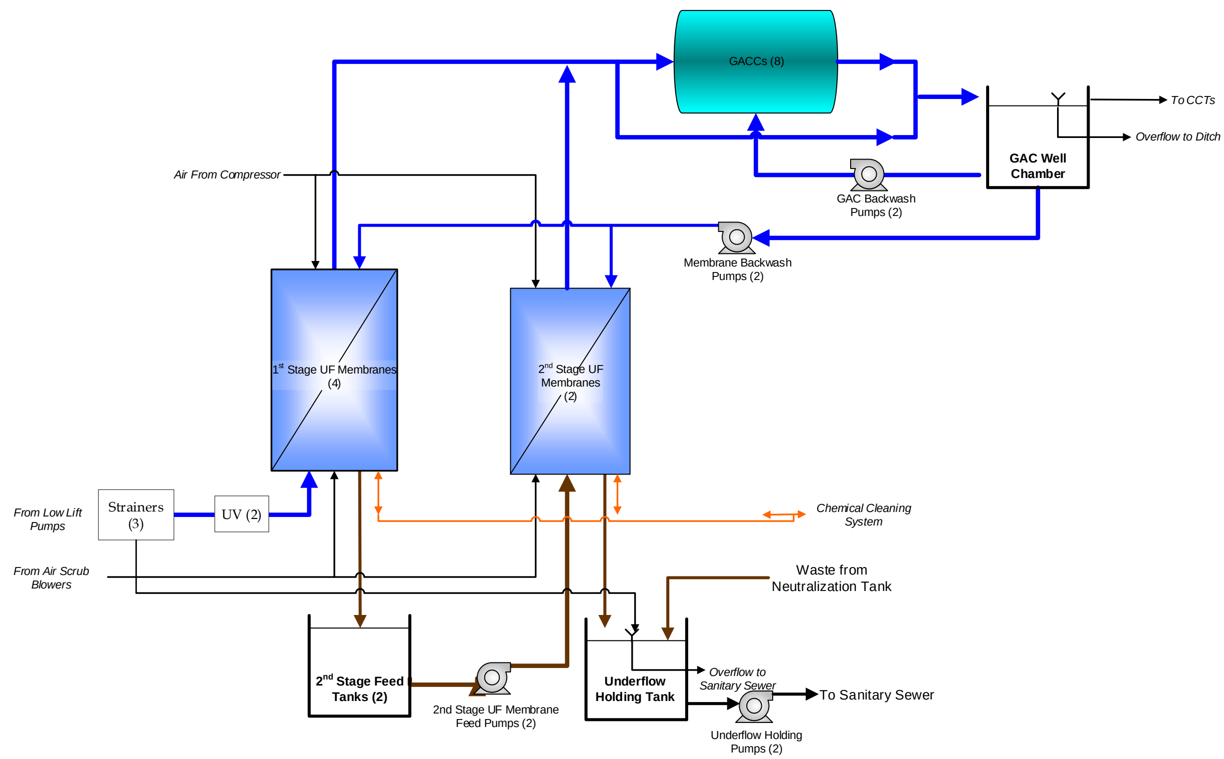
In 2014, the Town's Council approved a newly developed Water Conservation and Efficiency Strategy (WCES), thereby adopting targets for water demand and extraneous wastewater flow reduction. The WCES provided numerous recommendations and included a roadmap of conservation-based initiatives to be implemented, aimed at meeting the conservation targets. These initiatives include a toilet replacement program, a rain barrel program, a 'Kidoons' Network collaboration, a smart metering program, an outdoor watering conservation by-law, and by far the most significant, an expansion to the Lakeshore WTP, which would decrease the amount of waste sent to the WPCP from the WTP by 57% (635 m3/day).

The Lakeshore WTP is owned and operated by the Town's utility, InnServices Utilities Inc. (InnServices), It is located at 2155 25th Side Road in Innisfil, Ontario, and supplies the community's drinking water from Lake Simcoe. In 2018, the Lakeshore WTP Phase 3A Expansion was completed, and increased the plant's capacity to 38ML/d by way of a two-stage high recovery UF system that greatly reduced the amount of wastewater sent to the Lakeshore WPCP.

The two-stage 'high recovery' UF system replaced the plant's original granual media filtration system. The first stage UF membranes filter a pre-treated water stream with a 95 percent recovery efficiency (i.e., 95 percent of pre-treated water is filtered through the first stage UF membranes, and 5 percent is captured on the feed side of the first stage UF membranes and ultimately backwashed). The second stage UF membranes are used to reduce waste sent to the sanitary sewer by filtering the reverse filtration waste water stream (backwash) created by the first stage UF membranes. The use of the second stage UF membranes increases the recovery efficiency of the membrane system to 99.25 percent or greater.

In contrast, the average recovery for the previous treatment process varied seasonally between 90-95%.

A schematic of new treatment system is provided below.



Background

In 2011, the Town of Innisfil received a letter from the Ministry of the Environment, Conservation and Parks (MECP) in response to the Town's submission of documentation for the proposed Lakeshore Water Pollution Control Plant (WPCP) Expansion, to which two Part II Orders were issued. The MECP's letter outlined that the Town was required to develop a WCES in compliance with the Lake Simcoe Protection Plan Policy 5.3, and include within, a strategy for the reduction of inflow and infiltration into the Town's wastewater collection system.

Shortly thereafter, the Town developed a comprehensive WCES that highlighted several conservation-based initiatives that would drive conservation target achievement. These initiatives, among others, included a toilet replacement program, a rain barrel program, a 'Kidoons' Network collaboration, a smart metering program, an outdoor watering conservation by-law, and by far the most significant, an expansion to the Lakeshore WTP.

The targets outlined within the WCES were as follows:

1. Reduce annual peak day water demand by 10% by the year 2019
2. Reduce annual average day water demand by 10% by the year 2019 (which would defer the need for expansion of the Town's wastewater treatment plant)
3. Reduce wastewater collection systems peak inflow and infiltrations by 33% by the year 2019

A short summary of each of the WCES programs is outlines below:

Toilet Replacement Program – initiated in 2015
Program targeting local homes and businesses constructed prior to 1996. Residents can apply for a maximum of 2 toilet replacements / household (replacement with high-efficiency toilets). Toilet replacement in houses/buildings on municipal water and sewer was completed in multiple phases: a) single-family residential dwellings (2015); b) single-family and multi-residential dwellings (2016); c) industrial, commercial, and institutional buildings (2017); and, d) all single-family and multi-residential dwellings and ICI (2018).

Rain Barrel Program – initiated in 2016
InnServices partnered with RainBarrel.ca to offer residents rain barrels and accessories at a low cost, with a portion of proceeds going to a local volunteer organization. This was promoted through a variety of channels – the vendor and Town of Innisfil website, social media, and presence at local environmental-themed events. Educational materials were handed out extolling the virtues of water conservation, along with applications for the Toilet Replacement Program (see above).

Kidoons Network Collaboration
Funds were approved for the development of an educational environmental conservation program targeted at school-age children. The program includes short videos and a booklet that provides information on rural and urban water supply, wastewater treatment, and conservation and efficiency tips. InnServices has also branded one of its vehicles with their conservation mascot, Grandfather Frog.

Smart Metering Program – initiated in 2016
Funding for a 4-year water meter change-out program was approved, which would enable InnServices to detect abnormal residential consumption or system tampering. The retrofit began in September 2016 and will continue through 2019.

Outdoor Water Conservation By-Law – enacted in 2016
A By-Law (051-16) was passed that restricted the use of municipal water from a hose, pipe, sprinkler or permanent irrigation system under three pre-defined conditions, namely Advisory, Ban and Emergency.

Inflow and Infiltration Reduction – initiated in 2014

CCTV inspections of older areas within the collections system are conducted annually and are used to identify the need for manhole relining, main repairs, manhole rehabilitation, lateral repairs, and lateral removal.

<u>Lakeshore WTP Phase 3A Expansion</u> – initiated in 2016
Once the development of the WCES began, the Lakeshore WTP expansion project was identified as a high-potential contributor to achieving the newly-set water saving and wastewater reduction targets. Prior to receiving the letter from the MECP (described above), the Town had already completed a Municipal Class Environmental Assessment and issued an Environmental Study Report (ESR) to expand the Lakeshore WTP in several phases. The ESR recommended a treatment process with coagulation, flocculation, dissolved air flotation, granular media filtration, ultraviolet reactors with advanced oxidation, and chlorine. The expansion was to be implemented by twinning the existing low lift pump station at the beachfront and adding a green field treatment and residual management building within the treed area at the north end of the WTP property.

During the conceptual design phase, the Town re-evaluated the approach recommended in the ESR, based on: a) water saving and wastewater reduction potential; b) revised water demand projections; and, c) the impacts of expanding the building footprint within an environmentally sensitive area.

As a result, the Jacobs solutions and technology team worked closely with the Town to come up with a solution that better met the Town's needs from an economic, social and environmental perspective. This solution better staged planned WTP expansions with population growth (Phase 3A, 3B and 3C at 38, 55 and 85 ML/d, respectively), and addressed the Town's concerns as noted above. The Phase 3A expansion approach relied on highly efficient treatment processes and maximized the use of existing assets. The approach would reduce capital, operating, and lifecycle costs, as well as delay the need for capital investment at the WPCP.

The new treatment process consists of fine strainers, two-stage ultrafiltration membrane filtration, UV disinfection, GACCs, and chlorine disinfection. The majority of the process units were to be built within the existing building footprint, and the rest was to be installed in a small building extension built on the south-east side.

The revised approach met all of the Town's goals, as noted below:

1) **Implement a high-recovery process.** The high-recovery process reduced treatment-generated wastewater by 95% and allowed deferral of required upgrades to the WPCP (a WPCP expansion would have had a much higher capital cost requirement compared to WTP upgrades). The high-recovery system allowed InnServices to advance the WCES goal of reducing the wastewater collection systems peak inflow and infiltrations by the year 2019.

2) **Construct a system that would require minimal future upgrades.** The revised approach included the construction of infrastructure for build-out capacity (85ML/d), while providing equipment for the Phase 3A capacity (38ML/d). This approach met the Town's anticipated construction window with a marginal increase to overall capital budget.

3) **Minimize additional footprint.** The smaller footprint reduced impacts to neighbouring residents, treed areas, and recreational facilities.

4) **Complete project within original timeline and budget**. The revised approach was conducive to a construction timeframe within the original 2.5-year window, as well as a reduced capital investment.

Over the course of the last 2.5 years, the Jacobs site team has worked diligently with InnServices and General Contractor Maple Reinders Constructors Ltd. (MRCL) to oversee the construction and commissioning of the innovative new recommended solution and complete the WTP's Phase 3A expansion (capacity now at 38 ML/d). Careful construction sequencing was exercised to enable the achievement of critical construction milestones while maintaining active water production year-round, which proved especially challenging during high demand season.

Detailed description of the program and its results

When the revised design approach was being investigated, a Public Information Centre (PIC) was held at the Town of Innisfil Town Hall to educate the public about the new proposed treatment system and its many benefits. Residents were informed about the new system's high efficiency features, as well as its lesser impact to social/cultural and natural environments.

Once PICs were complete, the plant's major systems were solidified, as described below.

<u>Fine Strainers</u>

Raw water is pumped to the WTP through a 900-mm raw watermain that enters the plant via a concrete raw water valve chamber located at the south-east side of the facility. The first unit process at the WTP is auto-wash fine strainers. This pre-treatment system consists of three (3) fine strainers operating in parallel and is designed to remove particulates >300 microns in size to protect the UF membrane modules.

<u>UV Disinfection</u>

UV disinfection is provided as a primary barrier to inactivate *Giardia* and *Cryptosporidium*. Water flows through the fine strainers to a common header that then splits into two (2) separate UV reactor feed lines (each feed line leads to one (1) UV reactor). The UV reactors discharge into the first stage UF membrane feed header.

<u>Membrane Filtration</u>

Membrane filtration is a pressure-driven, liquid-phase separation process which uses microporous membranes to remove contaminants from the water. The membrane treatment process forces the pre-treated water stream through the UF membranes, leaving contaminants behind on the feed side of the membrane. The filtered water, or permeate, can pass through the pours of the membranes and continue through the treatment plant.

The UF membrane filters are arranged in two stages (1st stage membranes and 2nd stage membranes) to increase recovery efficiency of the overall UF system. Pre-treated water (i.e., fine screened and UV treated) flows to the 1st stage UF membrane filters. The 1st stage UF membrane filters recover approximately 95 percent of the feed water as permeate (i.e., will achieve 95 percent recovery). The remaining 5 percent of the water is spent backwash water, which is directed into the 1st stage UF backwash waste tanks (also known as the 2nd stage UF feed tanks). The 2nd stage UF membrane filters convert 85-90 percent of the 1st-stage UF backwash waste water into permeate, bringing the overall recovery of the UF membrane system to greater than 99.25 percent. Permeate from both 1st and 2nd membrane stages is blended prior to chlorine disinfection. Spent backwash water from the 2nd stage UF membrane filters is equalized in an underflow holding tank and pumped to the sanitary sewer.

Membranes are backwashed and air-scoured to remove suspended solids every 15 to 30 minutes. Once every 4 days on the first stage UF membranes and once every day, on the second stage UF membranes, a maintenance clean (sodium hypochlorite, heat is optional) will remove additional organic and biological foulants. Once every 42 days (first stage UF membranes) and once every 30 days (second stage UF membranes), back-to-back cleans (sodium hypochlorite clean, heated; citric/sulfuric acid clean, heated) are performed to remove organics and dissolved solids, respectively.

Both 1st and 2nd stage UF membranes filter water in the same manner. During a filtration cycle, the membrane trains filter feed water through polymeric hollow fibers. The membrane filters will operate in dead-end filtration mode and therefore will not generate waste while the membrane train is filtering water. The permeate from each of the two membrane stages discharges into a common header that can feed the GACCs. The 1st stage membranes operate continuously. The 2nd stage membranes operate in batch mode based on the water level in the 1st stage UF backwash waste tanks (also known as the 2nd stage UF feed tanks).

<u>GAC Contactors</u>

GACCs are used for taste and odor control. The GACCs are operated at the discretion of the Operators.

<u>Chlorination</u>

Primary chlorination is provided in the CCTs. There are three CCTs.

<u>High-Lift Pumping</u>

The high-lift pumping station is designed to pump adequate finished water to the InnServices distribution system.

Results

According to the table below, waste has been reduced by 57% between 2017 (when conventional filtration was used) and 2018 (when membrane filtration began). In other words, the average daily treatment-generated wastewater savings observed since start-up of the new high-recovery UF system is 635 m3/day, as shown in the table below which compares the average filtrate and backwash flows from both the UF membrane system (membrane filtration) and conventional system (granular media filtration).

Lakeshore WTP Phase 3A Expansion, InnServices Utilities Inc.

2019 OWWA Award of Excellence for Water Efficiency

Backwash Waste Reduction from High-Recovery UF Membrane System

	High-Recovery UF Membrane Filtration		
	Average Filtrate Flow [m^3/d]	Average Backwash Waste [m^3/d]	Backwash Waste Savings [m^3/d]
Mar, 18	10071	551	367
Apr, 18	10665	501	412
May, 18	14298	715	306
Jun, 18	12787	700	392
Jul, 18	11846	730	380
Aug, 18	12820	946	172
Sep, 18	11435	393	855
Oct, 18	9236	238	1290
Nov, 18	10601	264	954
Dec, 18	9698	168	1122
Jan, 19	10548	204	801
Feb, 19	10723	240	574
12-Month Average	**11227**	**471**	**635**

	Conventional Filtration (Media)	
	Average Filtrate Flow [m^3/d]	Average Backwash Waste [m^3/d]
Mar, 17	9349	918
Apr, 17	10145	913
May, 17	10546	1021
Jun, 17	10612	1092
Jul, 17	12268	1110
Aug, 17	12418	1118
Sep, 17	11453	1248
Oct, 17	10233	1528
Nov, 17	10190	1218
Dec, 17	10041	1290
Jan, 18	10220	1005
Feb, 18	9944	814
12-Month Average	**10618**	**1106**

Notes

1. *Stage 1 (primary) UF-membrane system commissioned on March 12, 2018*
2. *Stage 2 (secondary) UF-membrane system commissioned on September 27, 2018*
3. *'Backwash waste' is the total wastewater sent to sanitary, although filtration backwash makes up large majority*

Transferability

The two stage UF filtration systems like the one used at the Lakeshore WTP have already been implemented as a powerful water conservation strategy within other Ontario regions, including the City of North Bay, the City of Barrie and the City of Greater Sudbury.

Public/staff education

The plant has been presented to various interest groups, including Operators from other regions who are interested in implementing this type of system at their own facility. It has also been used to educate junior engineers, as well as train Operators from both water and wastewater teams. The facility intends to offer targeted tours for high school students and other young audiences, to advance water treatment and efficiency knowledge in youth. The system contains a few features that will help with this effort, including see-through modules on some of the UF filtration skids which will contribute to learning during educational plant walk-throughs.