2020 Watershed Overview of Wastewater Treatment Plant Performance

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Glossary of Terms

ADF

Average daily flow

cBOD

Carbonaceous 5 day biochemical oxygen demand

GRCA

Grand River Conservation Authority

MECP

Ontario Ministry of the Environment, Conservation and Parks

TAN

Total ammonia nitrogen

TBOD

Total 5 day biochemical oxygen demand

TKN

Total Kjeldahl nitrogen

TP

Total phosphorus

TSS

Total suspended solids

UIA

Un-ionized Ammonia

WWOP

Watershed-wide Wastewater Optimization Program

WWTP

Wastewater treatment plant

Executive Summary

Since 2010, the Grand River Conservation Authority (GRCA) has been working collaboratively with municipal partners and the Ministry of the Environment, Conservation and Parks (MECP) to develop a Watershed-wide Wastewater Optimization Program (WWOP). A key program activity is the preparation of an annual report of effluent quality and plant loading for treatment facilities discharging in the Grand River watershed. The first annual report was produced for data collected in 2012.

Year-to-year variations are used to evaluate the success of the program and track WWTP impacts on the Grand River. Available performance and loading data for 26 of 30 municipal wastewater treatment plants were voluntarily reported in 2020. These results were summarized in terms of treatment performance, data integrity, impacts on the Grand River, plant loading and bypasses and overflows and compared to results from previous years.

Treatment Performance

Table 1 shows the total average day flow for all the reporting plants from 2012 to 2020 and includes the reported service population for each year. From 2012-2020 the reported population increased by 8.1% (or 1% per year). Total plant flow shows greater year-to-year variations reflecting the impact of variations in precipitation.

Table 1: Total reported WWTP average daily flow and population from 2012-2020

Year	Average Daily Flow	Service Population
2012	265,861	819,782
2013	294,226	819,119
2014	303,426	825,198
2015	271,612	830,244
2016	278,426	835,137
2017	292,378	837,708
2018	283,005	859,568
2019	283,275	883,739
2020	271,162	885,854

Despite the increase in population, flow-weighted concentrations and loadings of TP and TAN have steadily decreased over the years. Table 2 and Table 3 shows the final

effluent TP and TAN flow-weighted average concentrations and the total loading from 2012 to 2020. Although it appears that the flow-weighted average is meeting the TP target, there are still many individual plants that are not meeting the target month by month. The watershed-wide flow-weighted concentration target in Table 2 for TP is calculated based on each plant's ADF multiplied by the corresponding TP target and the sum of these values is divided by the total ADF. This target can change year over year as the annual average daily flow changes. The TAN targets in Table 3 are calculated using the same method.

Table 2: TP Flow-weighted concentrations, total loading and targets

Year	TP flow-weighted concentration (mg/L)	Total Loading (tonnes per year)	TP flow-weighted concentration target (mg/L)
2012	0.37	35.9	0.24
2013	0.35	37.6	0.24
2014	0.33	36.8	0.24
2015	0.37	36.5	0.24
2016	0.33	33.8	0.24
2017	0.30	32.5	0.24
2018	0.30	30.6	0.24
2019	0.26	27.1	0.24
2020	0.21	21.1	0.24

With respect to the TP concentrations and loads in Table 2, the following observations can be made:

- From 2019 to 2020, the TP flow-weighted concentration decreased by 19% and the TP load decreased by 21% (from 27.1 to 21.1 tonnes); and
- From 2012 to 2020, the TP flow-weighted concentration decreased by 43% and the TP load by 40% (from 35.9 to 21.1 tonnes).

Table 3: Flow-weighted summer and winter TAN concentrations, total loading and targets

Year	Winter TAN flow-weighted concentration (mg/L)	Summer TAN flow-weighted concentration (mg/L)	Summer Target (mg/L)	Winter Target (mg/L)	Total Loading (tonnes per year)
2012	5.5	4.3	1	2	951
2013	3.9	3.2	1	2	773
2014	4.6	3.1	1	2	855
2015	3.6	2.1	1	2	560
2016	2.2	1.3	1	2	347
2017	1.7	0.7	1	2	259
2018	0.9	0.5	1	2	146
2019	1.1	0.4	1	2	149
2020	0.5	0.2	1	2	69.5

With respect to Table 3 showing the TAN loads and concentrations, the following comments are applicable:

- From 2019 to 2020 the summer TAN decreased by 50% and winter TAN decreased by 54%. TAN total loading decreased 54% (149 to 70 tonnes) compared to the previous year.
- From 2012 to 2020, the overall total TAN flow-weighted concentration decreased by 93% and the total loading by 93% (951 to 70 tonnes).

Data Integrity Checks

A sludge accountability analysis compares the annual amount of sludge reported by a mechanical plant to the amount of sludge projected based on plant loadings and removal. Conducting this analysis can help to determine if monitoring is truly representative. In 2019, sludge accountabilities were reported for 19 plants in the watershed. For eleven of the plants, the accountability “closed” within ± 15%. In 2020, 19 plants reported sludge accountability and 11 plants “closed” within ± 15%.

A water balance analysis compares the annual amount of measured net precipitation on the surface area of a lagoon system to the annual amount of projected net precipitation using lagoon level measurements, total influent and total effluent flows of a lagoon system. This analysis can help to determine if the flow measurement devices at a

lagoon are accurate. In 2020, water balances were reported for 3 lagoon systems in the watershed. Two of these analyses closed within ±15%.

Grand River Impacts

Table 4 summarizes the impact of total annual average discharge of effluent from wastewater treatment plants to the total flow in the Grand River.

Table 4: WWTP Effluent flow as a percentage of Grand River total flow

Parameter	2012	2013	2014	2015	2016	2017	2018	2019	2020
% Annual Average Flow	6.8%	3.1%	2.6%	5.0%	4.7%	3.5%	3.6%	3.7%	4.7%
% August Average Flow	13.9%	5.4%	9.5%	11.5%	9.0%	7.3%	8.7%	10.3%	11.7%

The year to year variations in Table 4 are largely a function of precipitation and weather in the watershed in any given year. The percent of flows in August is also shown, as August is typically the month when flows in the river are the lowest and treated wastewater makes up a larger portion of river flow. In 2017 and 2019, precipitation was above average. In 2014, 2018 and 2020, precipitation was close to the long-term average. In 2012, 2015 and 2016, precipitation was near the lower end of typical. In 2013, the watershed generally experienced higher than normal precipitation across its central and northern portions.

Some improvements in the water quality of the Grand River have been noted due to recent WWTP upgrades and optimization efforts. For example, optimization activities at the Hespeler WWTP resulted in lower concentrations of TAN in the lower Speed River in the summer and winter of 2018 (LGL Limited, 2019). Additionally, upgrades at the Kitchener and Waterloo WWTPs have allowed the plants to nitrify, resulting in lower concentrations of TAN, UIA and nitrite in the Grand River. Data from 2018 demonstrated a statistically significant reduction in these parameters compared to previous years. Data also demonstrated a statistically significant reduction in TP downstream of both plants in the fall of 2020 compared to previous years (LGL Limited , 2021).

Plant Loading

Table 5 summarizes key process loading metrics for 2020 as well as typical values and the range of median reported values from 2012 to 2019. The results in the table enable municipalities to compare loadings at their facilities to those at other plants in the watershed, which can be used to determine the impact of industrial discharges and may highlight concerns with unrepresentative sampling of raw influent. For plants that do not measure TBOD in the raw influent it was assumed to be 20% higher than the cBOD measurement.

Table 5: Summary of 2012 to 2020 watershed WWTP loading measures

Loading Measure	Watershed Median 2012-2019 (min-max)	Watershed Median 2020	Typical Value
Per capita flow (L/person/day)	294 - 351	302	350 - 500
ADF as % of Nominal Design	51% - 66%	63%	N/A
Peak day: Annual average flow	2.25 – 3.06	3.54	2.5 – 4.0
Per capita TBOD loading (g/person/day)	63 - 77	65	80
Per capita TSS loading (g/person/day)	69 - 93	74	90
Per capita TKN loading (g/person/day)	13 - 14	13	13
Per Capita TP loading (g/person/day)	1.6 – 2.0	1.8	2.1
Raw TSS:TBOD ratio	1.01 - 1.25	1.18	0.8 - 1.2
Raw TKN:TBOD ratio	0.17 - 0.23	0.22	0.1 - 0.2

Year-to-year variations in per capita flow, the average day flow as a percentage of the design flow and the ratio of the average day to peak day flow from Table 5 are largely due to differences in inflow and infiltration (I&I) related to precipitation.

Bypasses and Overflows

Bypasses and overflows are terms used to describe events that result in untreated or partially treated sewage reaching natural water bodies (Grand River Municipal Water Managers Working Group, 2009). Bypasses occur when parts of a treatment process are bypassed and wastewater flows discharge to the environment via the WWTP

effluent outfall. Overflows occur when sewage enters the environment at a location other than the effluent outfall. Bypasses/overflows can be classified as low, medium or high according to the level of risk to downstream users. Overall the total number of bypasses decreased by 58% from 66 in 2013 to 28 in 2020. The total volume of bypasses has increased 103% from 1,156,707 m^3 in 2013 to 2,344,771 m^3 in 2020. The large increase in bypass volume was due to the upgrade work on the Galt WWTP filters, which required a planned bypass of the filters. In general, many of the bypasses are due to wet weather conditions.

Contact

Further information on the Grand River Watershed-wide Optimization Program can be obtained from the Grand River wastewater optimization web page, or by contacting Kelly Hagan, Optimization Extension Specialist at 519-621-2761 Ext. 2295 or Mark Anderson, Water Quality Engineer at 519-621-2761 Ext. 2226.