2017 City of Kelowna
Wastewater Treatment Annual Report

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Executive Summary

The Kelowna Wastewater Treatment Facility (WWTF) is a Level IV Environmental Operators Certification program (EOCP) designated treatment facility - owned and operated by the City of Kelowna (COK). The facility is located at 951 Raymer Ave., Kelowna BC and has been in operation at this site since 1913. It currently utilizes modified Bardenpho technology to biologically reduce and remove nutrients from the sewage stream. It has a rated capacity of 70,000 m^3/day (70 MLD) and serves an equivalent population of approximately 97,000. The treatment facility discharges into Lake Okanagan and is operated under Certificate Approval 12211 (Appendix H) in accordance with BC Environmental Management Act.

Inflow and Discharge Volumes

The total influent flow to the plant in 2017 was 13,163,000 m^3 or averaged at 36,063 m^3/day which is below the daily rate of discharge listed in the operational certificate (Table 1).

	Certificate of Approval	2017 Treated Effluent
Discharge Flow Value - Daily Average	40,333 m^3/day	36,060 m^3/day

Table 1. Daily influent flow relative to certificate

Effluent Quality Standards

The WWTF monitored all effluent quality standards in 2017 as regulated under the plants Operational Certificate of Approval. Wastewater treatment produced the following effluent quality in 2017:

	Certificate of Approval	2017 Treated Effluent
Total Suspended Solids (TSS) - Daily Maximum	10 mg/L	All daily max. <10 mg/L
Biochemical Oxygen Demand (BOD) - Daily Maximum	10 mg/L	All daily max. <10 mg/L
Total Phosphorus (TP) - Annual Average	0.25 mg/L	0.15 mg/L
Total Phosphorus (TP) - Daily Max. Concentration	2.0 mg/L	All daily max. <2.0 mg/L
Total Nitrogen (TN) - Annual Average	6.0 mg/L	4.97 mg/L
Total Nitrogen (TN) - Daily Max. Concentration	10.0 mg/L	2 excursions of >10 mg/L
Fecal Coliforms – Daily Max. Geometric Mean	50 CFU/100ml	All daily max. < 50 CFU/100ml

Table 2. Effluent quality standards relative to permit

Year End Effluent Composite Results

Analytical results for one-time grab samples, 24-hour composite, and 7-day composite effluent results are reported to the Ministry of Environment on a monthly basis and assessed for compliance and trending purposes. Monitored parameters include TP, Ortho-Phosphorus, TN, Nitrates, Ammonia, Total Kjeldahl Nitrogen, Organic Nitrogen, BOD, TSS, pH, and Total and Fecal Coliform. Effluent results measured in 2017 were consistent with historical and expected seasonal values (Table 3).

Year End Report - Water and Wastewater Division * Kelowna Wastewater Treatment Facility - ME #12211 - 2017																					
Date	Influent Flow		Final Effluent Composite															Effluent Grab			
			7 day comp Total P			Total N daily est.	24 hour composite											pH		Coliform	
							Ortho P			Total P	NO3	NH3	TKN	Org N	Total N	BOD	Solids				
	Total	Avg	Average		Total		Avg		Total											Total	Faecal
	ML	MLD	mg/L	kg/day	kg	mg/L	mg/L	kg/day	kg	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	min	max	cfu/100 mL	
Jan	1039	33.53	0.162	5.43	168.4	7.49	0.04	1.34	41.6	0.17	2.59	3.26	4.95	1.69	7.19	2.7	1.8	6.77	6.88	1*	1*
Feb	950	33.92	0.136	4.61	129.2	7.69	0.01	0.34	9.5	0.13	1.46	4.70	5.97	1.27	7.10	3.4	1.8	6.78	6.89	1*	0*
Mar	1075	34.67	0.177	6.14	190.2	5.83	0.01	0.35	10.7	0.19	2.15	2.33	3.83	1.50	5.77	3.5	2.4	6.83	6.92	3*	1*
Apr	1078	35.92	0.187	6.72	201.5	4.14	0.03	1.08	32.3	0.21	2.14	0.58	2.00	1.42	4.11	2.9	2.3	6.84	6.95	8*	2*
May	1257	40.54	0.170	6.89	213.6	3.58	0.04	1.62	50.3	0.17	1.63	0.55	2.12	1.57	3.79	2.4	2.7	6.86	6.98	4*	1*
Jun	1279	42.64	0.130	5.54	166.3	3.52	0.05	2.13	64.0	0.13	1.94	0.20	1.54	1.34	3.55	2.1	1.8	6.92	7.07	2*	1*
Jul	1193	38.48	0.140	5.39	167.0	3.82	0.03	1.15	35.8	0.13	2.22	0.27	1.68	1.41	4.10	2.1	1.6	6.93	7.09	4*	1*
Aug	1095	35.33	0.140	4.95	153.3	3.56	0.04	1.41	43.8	0.15	1.57	0.50	2.00	1.50	3.47	3.2	1.6	6.92	7.08	2*	1*
Sep	1055	35.18	0.147	5.17	155.1	4.88	0.04	1.41	42.2	0.15	2.85	0.52	1.98	1.46	4.78	2.4	1.6	6.95	7.10	25*	1*
Oct	1072	34.59	0.136	4.70	145.8	5.32	0.03	1.04	32.2	0.14	3.48	0.35	1.81	1.46	5.28	2.6	1.3	6.94	7.09	21*	1*
Nov	1029	34.29	0.136	4.66	139.9	5.97	0.02	0.69	20.6	0.14	3.86	0.48	2.08	1.60	5.53	2.8	1.5	6.93	7.05	1*	1*
Dec	1041	33.57	0.142	4.77	147.8	4.95	0.03	1.01	31.2	0.15	2.44	0.90	2.59	1.69	5.01	2.3	1.6	6.92	7.02	1*	1*
2017	**13,163**	**36.06**	**0.15**	**5.41**	**1978.23**	**5.06**	**0.03**	**1.13**	**414**	**0.15**	**2.36**	**0.88**	**2.71**	**1.49**	**4.97**	**2.70**	**1.8**	**6.88**	**7.01**	**3***	**1***

*indicates geometric mean

Table 3. Summary of monthly flow and Effluent water quality

Residual Management

1059 loads of waste activated sludge, each averaging 19,078 kg, were removed from the Kelowna WWTF in 2017 for a total of 20,204 metric tonnes. The residual was transferred directly to the Commonage composting facility for the production of Ogogrow compost product in accordance with the Organic Matter Recycling Regulation (OMRR). A separate compliance report for the composting facility is issued to the Ministry of Environment under authorization permit #108537. A breakdown of composite moisture, solids, and metal concentrations analyzed on a monthly basis are included in Table 4.

Dewatered Sludge for Composting - 2017															
Total Solids	Moisture Content	Volatile Solids	PCB's	Potassium	Arsenic	Cadmium	Chromium	Cobalt	Copper	Mercury	Molybdenum	Nickel	Lead	Selenium	Zinc
g/L	%	g/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
172	81.9	146	0.0	5437	1.6	0.6	9.8	1.3	441	0.4	4.6	7.7	8.2	2.3	277.0

Table 4. Average monthly analytical Biosolids composite results

Introduction

As required by the *Ministry of Environment – Operational Certificate 12211*, the COK provides the following annual report in accordance with our conditions on permit.

This report provides an overview of our service area, processing volumes, disinfection procedures, maintenance of works, staff certification program, sampling and analytical testing procedures, authorized discharges, emergency procedures, and collaborative lake monitoring as part of the Ministry Memorandum of Understanding (MOU).

The City of Kelowna's WWTF primary focus is to ensure that sanitary services are held to high standards, meets all permitting requirements and to ensure that our natural water resources are protected. For further details on the content of this report or to request additional information, please contact the City of Kelowna at 250-469-8502 or email ask@kelowna.ca.

Wastewater System Overview

Initially constructed at the City outskirts in 1913 to service a population of 10,000, the treatment plant has continually been upgraded and expanded to meet the needs of the community. The treatment facility underwent a significant, pioneering wastewater treatment conversion in 1982 to a Bardenpho process – a chemical free, biological nutrient removal process. In 2011, the City completed a large infrastructure project to increase the capacity to treat water from 40,000 to 70,000 m^3/day , which should accommodate the City's sewer servicing needs beyond 2030 (Appendix A).

Treatment Process

On average, it takes 18-20 hours for sanitary sewage to pass through the complete treatment stages from initial screening through to final discharge. Each of the treatment steps are designed to be exclusively independent from the use of chemicals and to effectively reduce the nutrient and biological loading into receiving waters.

Preliminary Treatment

Raw sewage that enters the treatment facility is initially screened through a climbing bar screen and passed through a vortex grit removal system and the resulting grit and debris is collected, washed, dewatered, and transported to the landfill for disposal.

Primary Treatment

There are 7 rectangular primary clarifiers designed to separate the larger organic solids from the waste stream by gravity sedimentation. Sludge is removed from the bottom of the tanks by scrappers and pumped to Fermenter tanks. During peak flows, a steady flow is maintained by diverting excess flow into one of the 5 equalization basins.

Reactor

Advanced Nutrient Removal

The Biological Nutrient Removal (BNR) system is a modified Bardenpho design consisting of 2 large reactors with 14 cells and 2 smaller reactors with 7 cells. The wastewater flows through three zones: anoxic, anaerobic, and aerobic which reduce ammonia and nitrate to harmless nitrogen gas. Fermenter effluent, rich in Volatile Fatty Acids (VFA's) that aid in phosphorus removal, flows into the beginning of each train along with the internal recycle. Each liter that enters the reactor is recycled 4 to 6 times and eventually wasted at a rate of 2,000 m^3/day to the Dissolved Air Floatation (DAF).

Fermenters

Secondary Treatment

The effluent from the bioreactor then proceeds to the secondary clarifiers where the remaining larger solids settle to the bottom of the tank. The clarifiers are fitted with a return system where the settled solids to the bioreactor to feed the incoming flow with bacteria while the effluent proceeds to the final tertiary treatment process.

Tertiary Treatment

Effluent is processed through a series of 10-micron disk filters to reduce remaining suspended material to below discharge limits. Filtration is followed by bacterial inactivation by effluent exposure to low pressure, medium intensity UV radiation system prior to final discharge.

Sludge Conditioning and Composting

Sludge from the primary clarifiers is thickened in one of the three circular fermenters and the resulting waste activated sludge from the bioreactor is thickened in the four DAF units. The thickened sludge is then pumped separately to the dewatering building where they are blended with polymer and centrifuged into a ~15-20 % solids cake. The resulting cake is trucked to the biosolids composting site where it is mixed with wood waste and composted to create Class A soil conditioner called Ogogrow and sold to businesses, agricultural farmers, and public from the commonage and landfill sites.

Pre-Treatment

Collection System

More than 480 km of gravity sewer mains collect and convey sewage to more than 30 pump stations throughout Kelowna where wastewater is forcibly redirected through a series of gravity and pressured systems to the WWTF for treatment. The Utility has an on-going asset management program designed to replace and repair damaged and leaking pipes in the sewer system - both proactively and on-demand. The City uses an internationally accepted condition rating system to evaluate the condition of existing pipes, facilitated by the use of a CCTV video imaging system which, in conjunction with age considerations, establishes a replacement schedule. In 2017, the City completed $300,000 of sewer replacement and repair.

Source Control

Under the authority of the Sanitary Sewer/Storm Drain Regulation Bylaw 6618-90 and the Sewerage System User Bylaw 3480, the City sets out the requirements for wastewater discharge monitoring, permitting, and enforcement. In order to minimize excessive nutrient and chemical loading from entering the treatment process, the City has a dedicated Source Control Technician who oversees a monitoring program that samples known high strength industrial and commercial business discharges. The measured concentrations are compared to bylaw discharge limits and offending industries are both educated on reduction options as well as surcharged relative to the volume of over-permitted high strength flow discharged.

<u>Discharge Permits</u>:

- 19 temporary discharge permits issued
- 8 active continuous discharge permits maintained
    - Monitoring done semi-annually to ensure compliance with permit limits and confirm the effectiveness and efficiency of required treatment works and waste reduction measures.
    - 52 permit audit sampling events

Key Manhole Monitoring:

- Monitoring program continued in order to measure and track wastewater strength; measure the concentration and loading of regulated parameters; measure the concentration of toxic substances; monitor pH and H2S.
- Three (3) consecutive 24-hour composite samples were collected bi-annually from nine (9) sampling sites:
    - North-East Trunk (mixed use)
    - Gyro Trunk (mixed use)
    - Water St Lift Station (mixed use)
    - Guy St Lift Station (mixed use)
    - Edwards Lift Station (Commercial/Industrial)
    - Jim Bailey Lift Station (Commercial/Industrial)
    - Loyd Lift Station (Commercial/Industrial)
    - Morrison Lift Station (Residential)
    - Birch Lift Station (Residential)

FOG Management:

The Source Control program has a similar mandate to monitor and enforce restrictions on the discharge of Fats, Oils, and Grease (FOG) into the drainage systems. This primarily includes the inspection of Food Service Establishments (FSE) for use and maintenance records on mandatory Grease Trap devices as per bylaw stipulation (Appendix G). Buildup of grease results in pipe blockages which costs the City over $60,00 in annual maintenance costs in 2017.

FOG Enforcement:

- 95 FSEs visited in 2017
- Current FOG management program reviewed at each FSE inspected.
- Best Management Practice (BMP) document was provided to assist FSEs in complying with FOG control requirements.
- FOG Hot-Spots were also identified and FSE which contribute to Hot-Spots were put an annual inspection program.
- Letter and educational material was mailed out to residential areas that contribute to FOG Hot-Spots.

FOG Public Education:

In addition to general social marketing campaigns, such as mail-outs, focusing on residential grease, hazardous waste, and 'flushable' wipes, the outreach program was enhanced with targeted social media campaign designed to raise awareness of FOG at a particular time of the year. 'Cease the grease this Thanksgiving weekend' public service announcement was released just before Thanksgiving to reiterate the importance of proper FOG management to our residents.

Sewer Data Logging:

- Continued flow, pH and H_2S logging and CCTV inspection enable the City to address sewer collection system concerns such as, increased hydraulic loading, odour, grease build-up and structural deficiencies.
- No fines issued or spills to the sanitary collection system reported in 2017

Water Management

The City of Kelowna continually promotes the concept of water conservation related to irrigation and consumption. Although primarily designed to conserve water, this also helps limit the flow that requires treatment at the WWTF. Promotion is done through social media, website content, public events, and educational material throughout the year. Low-flow devices and recycling options are listed on our website and include toilet retro-fits, water efficient washing machines and dishwashers, low-flow showerheads, and grey water recycling.

Storm-Sanitary Interconnects

The City Utility Network Maintenance division is responsible for infrastructure repair and replacement and rigorously follow-up on reports of possible storm to sanitary interconnection and infiltration issues in conjunction with the City storm drainage technician. This may involve the use of CCTV footage, smoke tests, dye tests, and sample analysis to detect the presence of high bacteria counts related to sewage. There were 4 possible interconnects investigated in 2017 of which 3 had repairs completed and one in progress.

Kelowna area experienced significant flooding events during the spring of 2017, but there appeared to be minimal water infiltration into the sanitary system as indicated by the overall decrease treatment flow. This indicates that the majority of the sanitary system is in good repair and interconnection issues are minimal.

Operations

Water Quality and Treatment Performance

Wastewater quality and flow are monitored through a series on in-line sensors, composite samplers, and grab samples taken by operators and laboratory staff. Majority of the sample analysis is conducted in the dedicated laboratory facility on site, but a portion is sublet to a third party accredited laboratory as per permit requirements (Appendix E). To ensure quality control, the WWTF lab participates in a biannual Canadian Association of Laboratory Accreditation (CALA) proficiency testing program and has an in-house developed quality control program that has stringent standards for acceptable precision and accuracy.

Influent Quantity and Quality

The WWFT treats wastewater converging from three primary sewage collection networks throughout the City that include the Gyro trunk, Northeast trunk and Ethel Street trunk. An average of 36,063 m^3 of influent were received daily in 2017, which was below the certificate limit of 40,333 m^3/day. Flow has generally increased on a year over year (YOY) basis and at a rate consistent with the permitted flows listed in the Operational Certificate (Figure 1).

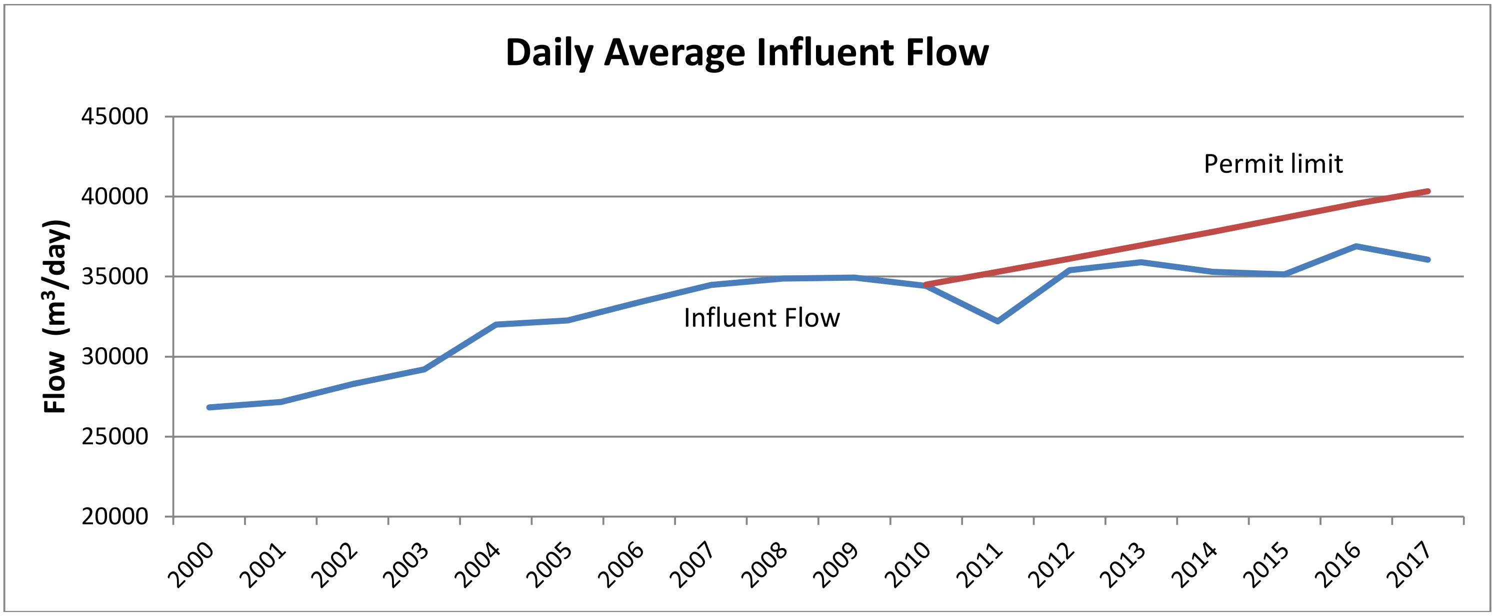


Figure 1 – Historical Influent flow relative to permit

The nutrient and physical properties of the influent are monitored throughout the month to ensure that the biological removal process is balanced with loading demand. A summary of the 2017 monthly averages are listed in Table 5 and supporting in Appendix B.

Raw Influent Monthly Averages - 2017									
Date	Raw Influent Grab			Raw Influent Composite					
	pH		NO3	NH3	Total N	Ortho P	Total P	BOD
	min	max	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Jan	7.50	8.50	0.32	40.3	49.5	3.90	5.69	371
Feb	7.36	8.57	1.40	38.6	47.9	4.36	4.83	334
Mar	7.30	8.55	2.04	34.4	44.9	3.56	5.86	344
Apr	7.41	8.66	1.76	35.9	46.9	3.47	6.51	276
May	7.36	8.60	1.41	31.0	38.3	3.35	5.16	298
Jun	7.54	8.62	1.84	29.5	37.6	3.10	4.84	224
Jul	7.32	8.49	1.44	33.8	50.3	3.64	6.06	240
Aug	7.51	8.64	1.59	36.9	44.1	3.59	5.88	324
Sep	7.62	8.83	0.54	37.6	47.0	3.66	5.93	372
Oct	7.49	8.77	1.14	36.6	43.3	3.66	6.06	392
Nov	7.14	8.27	1.80	35.4	45.6	3.62	6.27	355
Dec	7.22	8.30	0.69	37.2	51.0	4.23	6.61	403
2017	**7.40**	**8.57**	**1.33**	**35.60**	**45.3**	**3.68**	**5.81**	**327**

Table 5 – Monthly Influent water quality parameter averages

Effluent Quality and Nutrient Removal

The final effluent is treated to meet condition 1.1.2 of the operating permit (Appendix G). In 2017, the Kelowna WWTF encountered no abnormal operating problems and continued to produce a high quality effluent which met or exceeded the requirements of the treatment objectives. In addition to the operational conditions, the plant is also met all the Federal Government Wastewater System Effluent Regulation (WSER) monitoring and reporting requirements.

Total Phosphorus

Managing Phosphorus discharge from municipal and industrial wastewater treatment is a key factor in preventing eutrophication of surface waters (excessive algae growth and oxygen depletion). Its presence in higher concentrations may cause a variety of water quality problems including increased purification costs, affecting growth of micro-organisms, and possible toxic effect of algae on drinking water (Microcystin).

Municipal wastewater influent typically contains between 5 to 20 mg/L of Total Phosphorus, of which 1-5 mg/L is organic and the remainder inorganic. Ortho-Phosphate, a subset of TP, is the main phosphorus chemical form measured, which is in direct proportion to the total phosphorus concentration. The average daily discharge of TP from the Kelowna WWTF was calculated to be 0.15 mg/L; below both the daily discharge permit limit of 2.0 mg/L as well as the annual average permit level set at 0.25 mg/L (Figure 2).

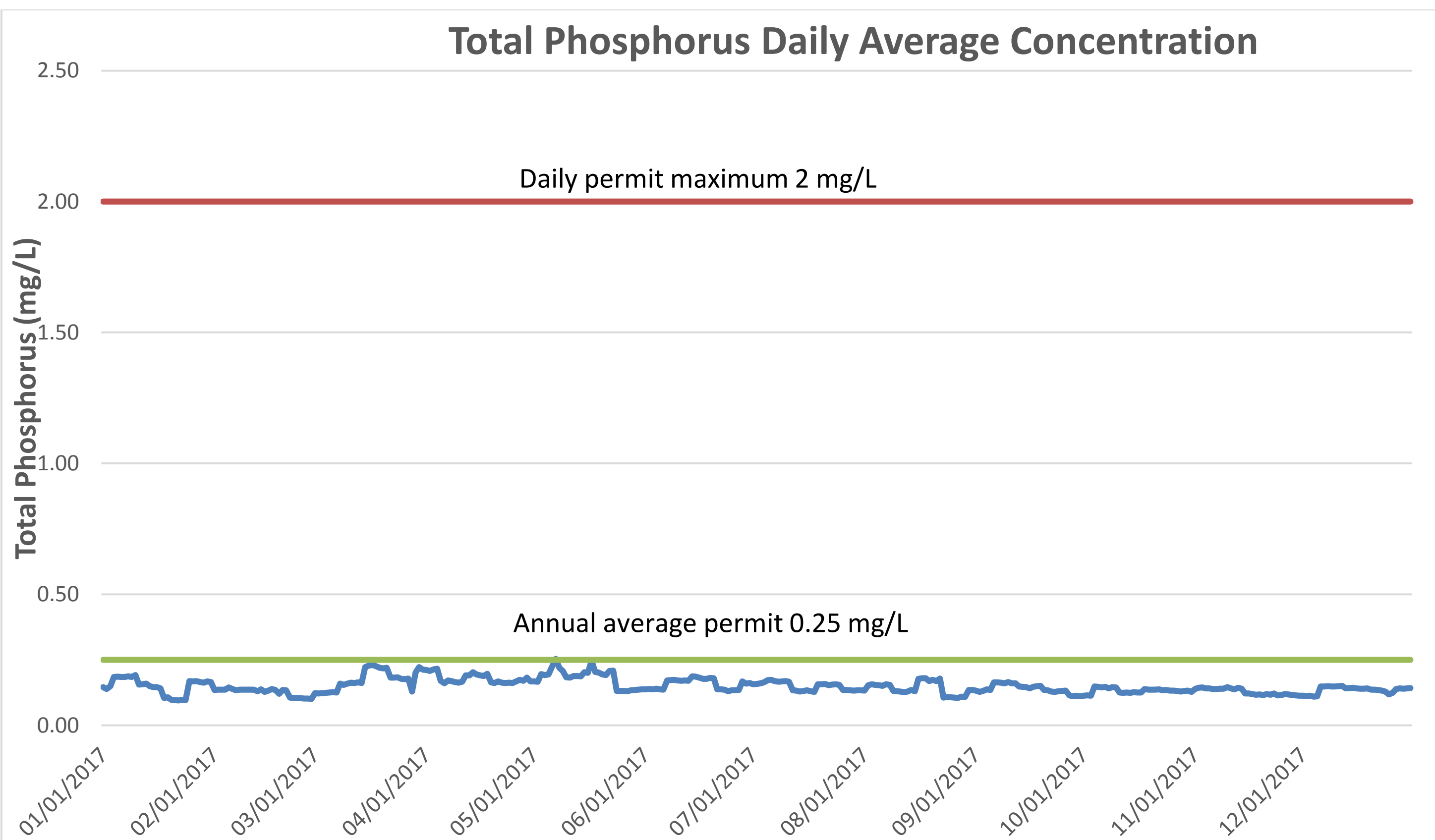


Figure 2. Daily Total Phosphorus concentration estimates relative to permit levels

The total amount of Phosphorus load discharged for the 2017 calendar year was 1974 kg, a 19% decrease from 2016 and 16% below the 17-year historical average despite an increasing overall plant flow (Figure 3).

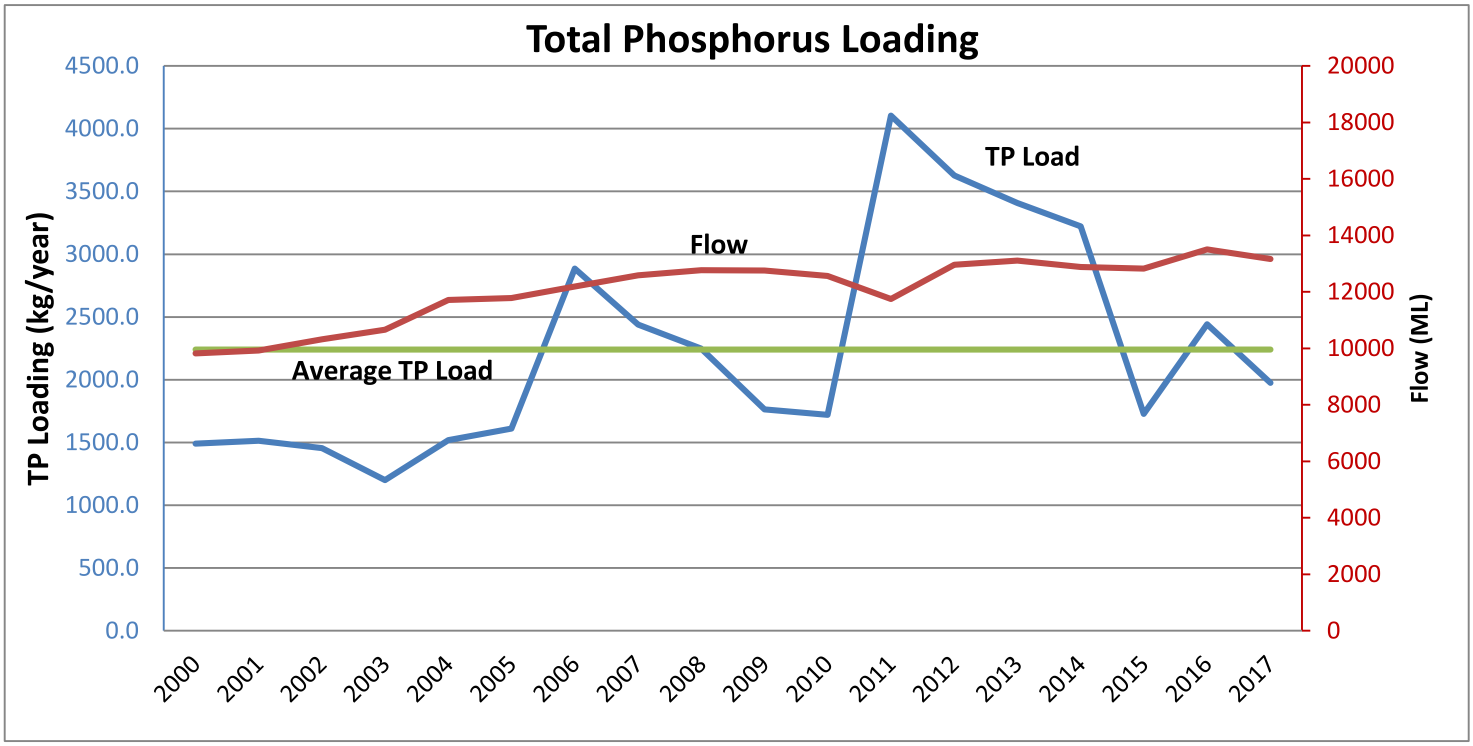


Figure 3. Historical Total Phosphate annual load relative to Influent Flow

Conversely, the Total Phosphorus removal efficiency continues to improved 0.80% above 2016 and 0.40% above the historical 17-year average (Figure 4).

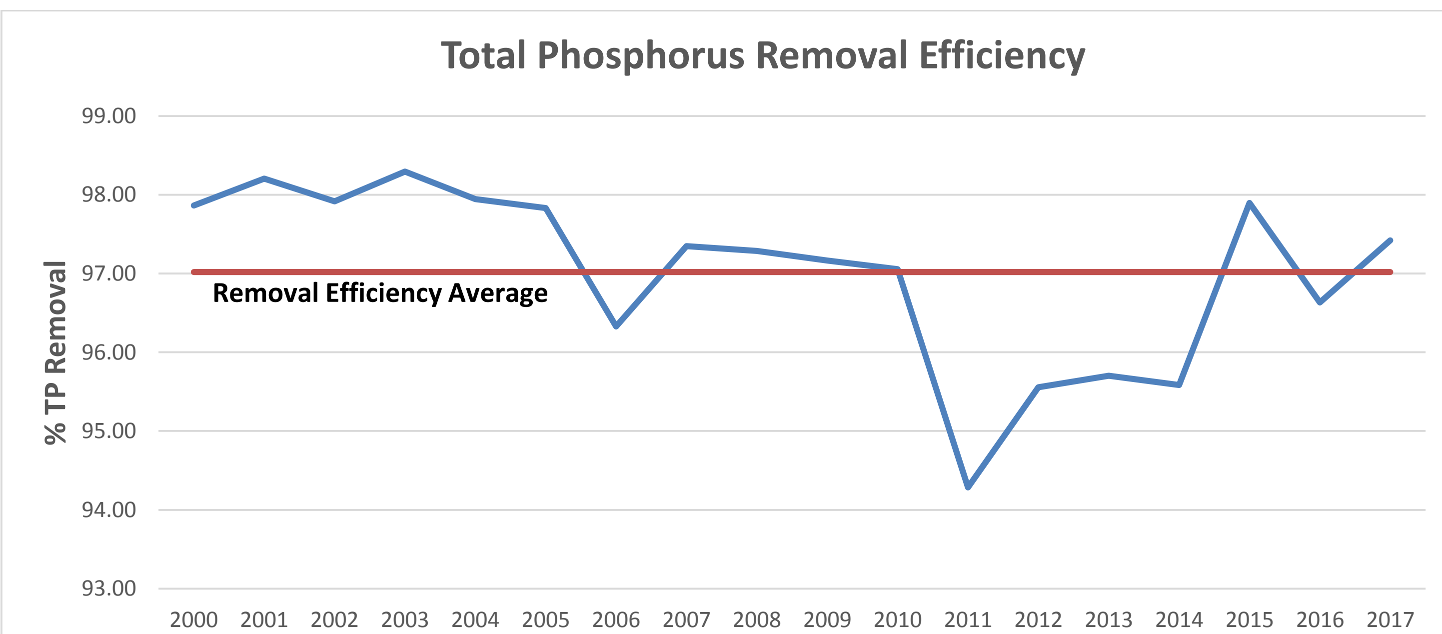


Figure 4. Historical Total Phosphorus removal efficiency from Influent

Total Nitrogen

Excessive Nitrogen release into waterways can have eutrophication affects similar to Total Phosphorus as well as having direct impacts to human health. The Canadian Drinking Water Quality guidelines have stipulated upper concentration limits for both Nitrite and Nitrate in drinking water sources. Considering that the effluent discharge to a drinking water source (Okanagan Lake), limiting the contribution of nitrogen loading discharged to this source is of upmost importance to the treatment process.

The BNR process consists of an aerobic nitrification process that converts Ammonium (NH_4) to Nitrite (NO_2) and subsequent Nitrate (NO_3). This process is followed by an anoxic denitrification process that takes the Nitrate Nitrogen form and coverts it to Nitrogen gas (N_2) and Oxygen (O_2) that is released into the atmosphere. Each of these steps are facilitated by use of specific bacteria that are cycled and maintained in the biological process.

The TN concentration in the effluent is a calculated addition of the various nitrogen forms in the Nitrogen cycle and reported relative to a daily and annual average maximum concentration. The TN daily concentration discharged was below the permitted maximum of 10 mg/L with only 2 exceedances experienced during prolonged cold weather temperatures in February (Figure 5). Each of these exceedances were reported to the Ministry along with cause analysis at the time of discharge.

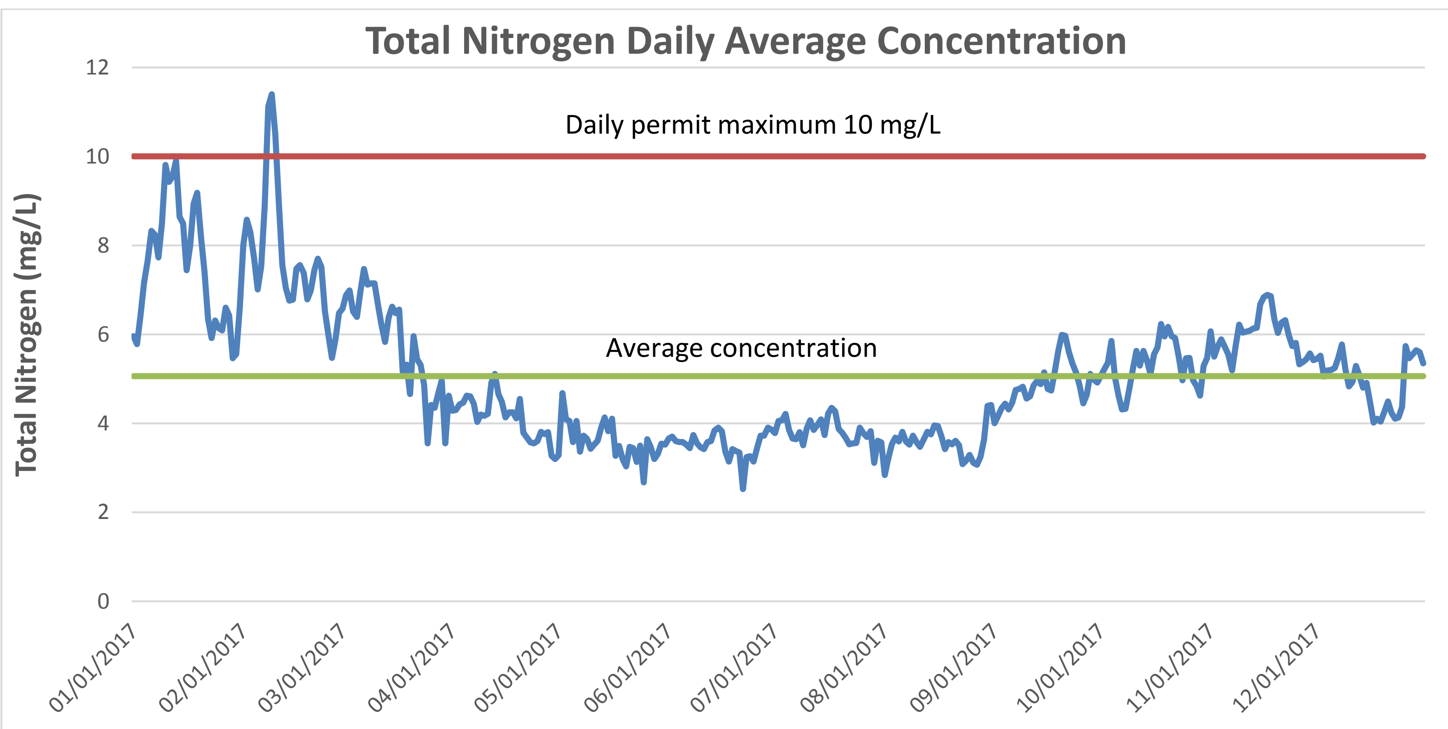


Figure 5. Average daily Total Nitrogen concentration in discharge

The average daily TN concentration discharged was 5.06 mg/L and below the annual allowable permit average of 6.0 mg/L (Figure 6). Over the past 2 years, the average effluent TN concentration has trended 10% and 7.4% lower respectively as a result of process optimization and waste recycling and balancing.

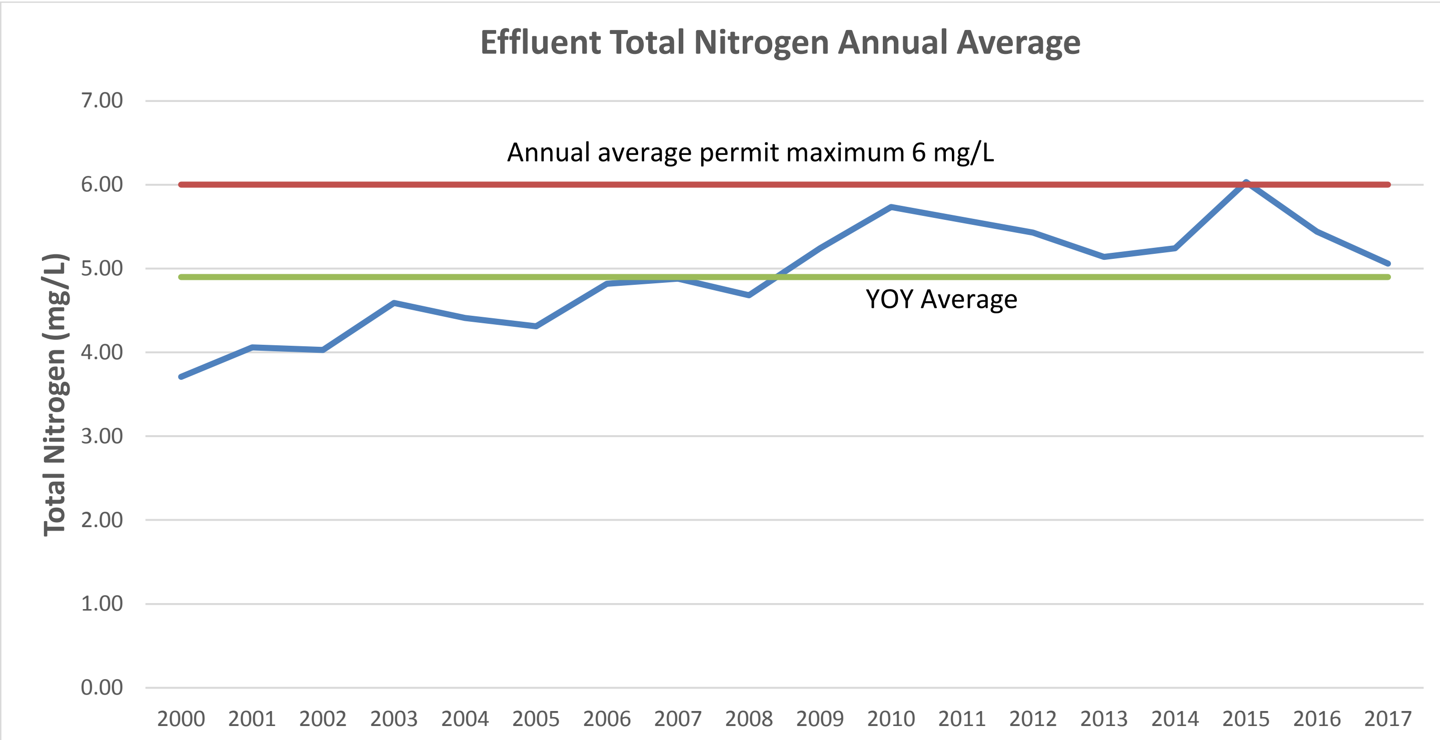


Figure 6. Historical annual average Total Nitrogen concentration in Effluent

The total average TN load leaving the plant has been observed to be consistent with the wastewater influent flow over the past 17 years (Figure 7). The aligned TN concentration with flow may be partially attributed to the 1-2 mg/L of organic nitrogen that is generally not amenable to biological treatment.

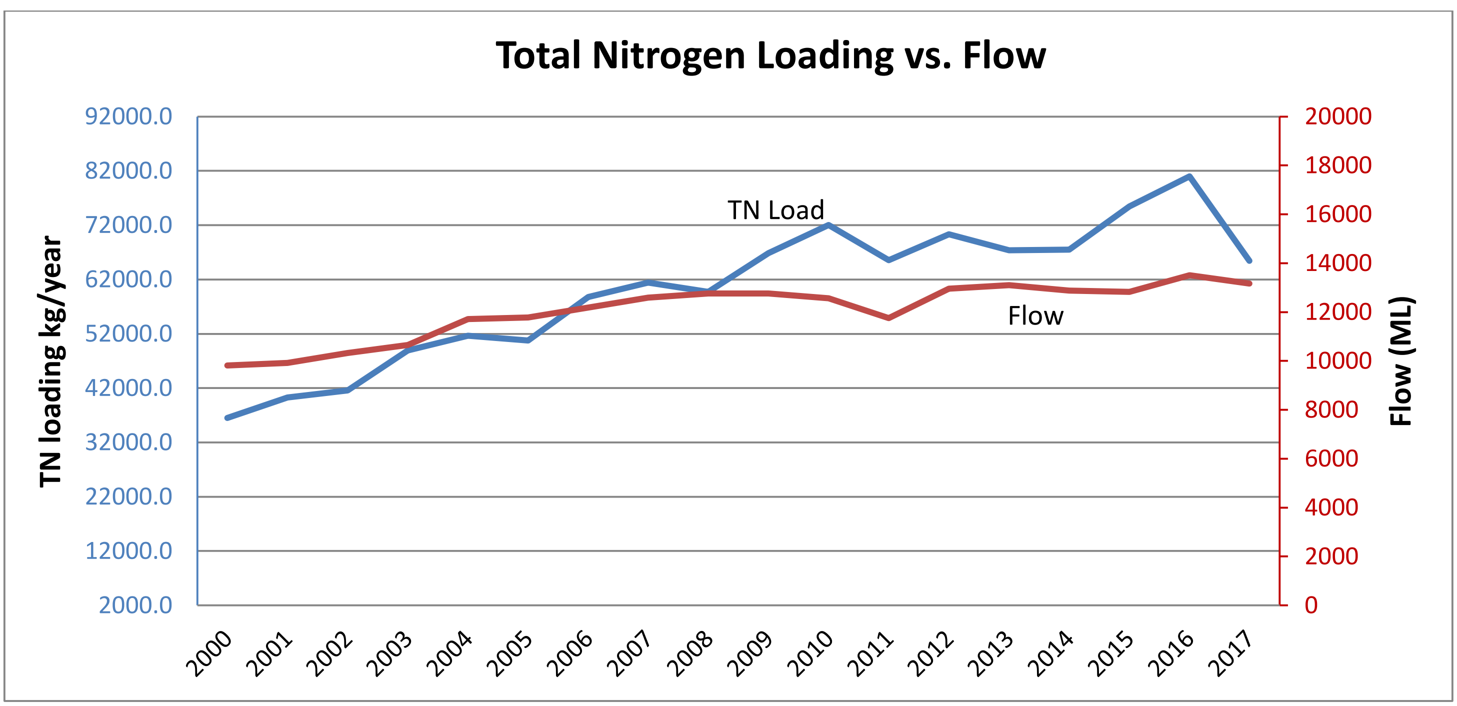


Figure 7. Historical Total Nitrogen Loaded relative to Influent Flow

The TN removal efficiency, much like the TP removal efficiency, has improved significantly since the 2011 plant expansion and is 0.17% higher than the 17-year average (Figure 8).

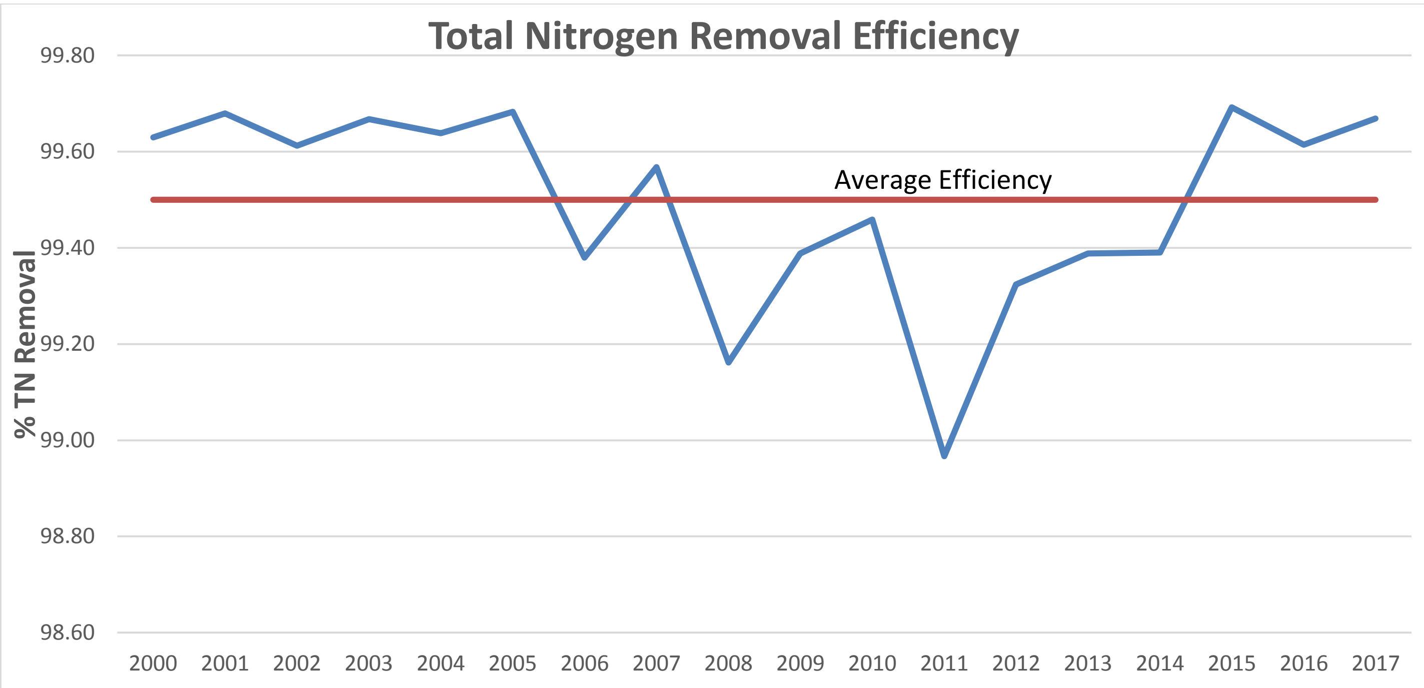


Figure 8. Historical Total Nitrogen concentration removal efficiency from Influent

Total Suspended Solids

The TSS data is critical in determining the operational behavior of the wastewater treatment system. They are generally indicative of the amount of nutrients available for the bacterial in the nitrifying and denitrifying process. Although critical to the biological treatment, excessive suspended solids must be removed through successive settling processes followed by filtration before being discharged from the plant.

High TSS values in effluent are often related to the excessive solids generation due to an increase in Biochemical Oxygen Demand (BOD) loading or can indicate problems with the bacteria like nutrient deficiency. High TSS values can also be attributed to high flows, insufficient settling times, or may indicate aeration adjustments are needed.

In addition to operational optimization, suspended solids are also a measure used to assess risks associated with bacterial discharge into natural waters. Particles have the ability to harbor various forms of protozoa, bacteria, and viruses on the surface and can impede effective UV disinfection by shielding the organisms from radiated light exposure and subsequent inactivation.

Suspended solids are sampled from the various points in the treatment process as well as daily from the effluent discharged. The measured TSS values were all well below daily effluent discharge limit of 10 mg/L with no exceedances of the at any point throughout 2017 (Figure 9).

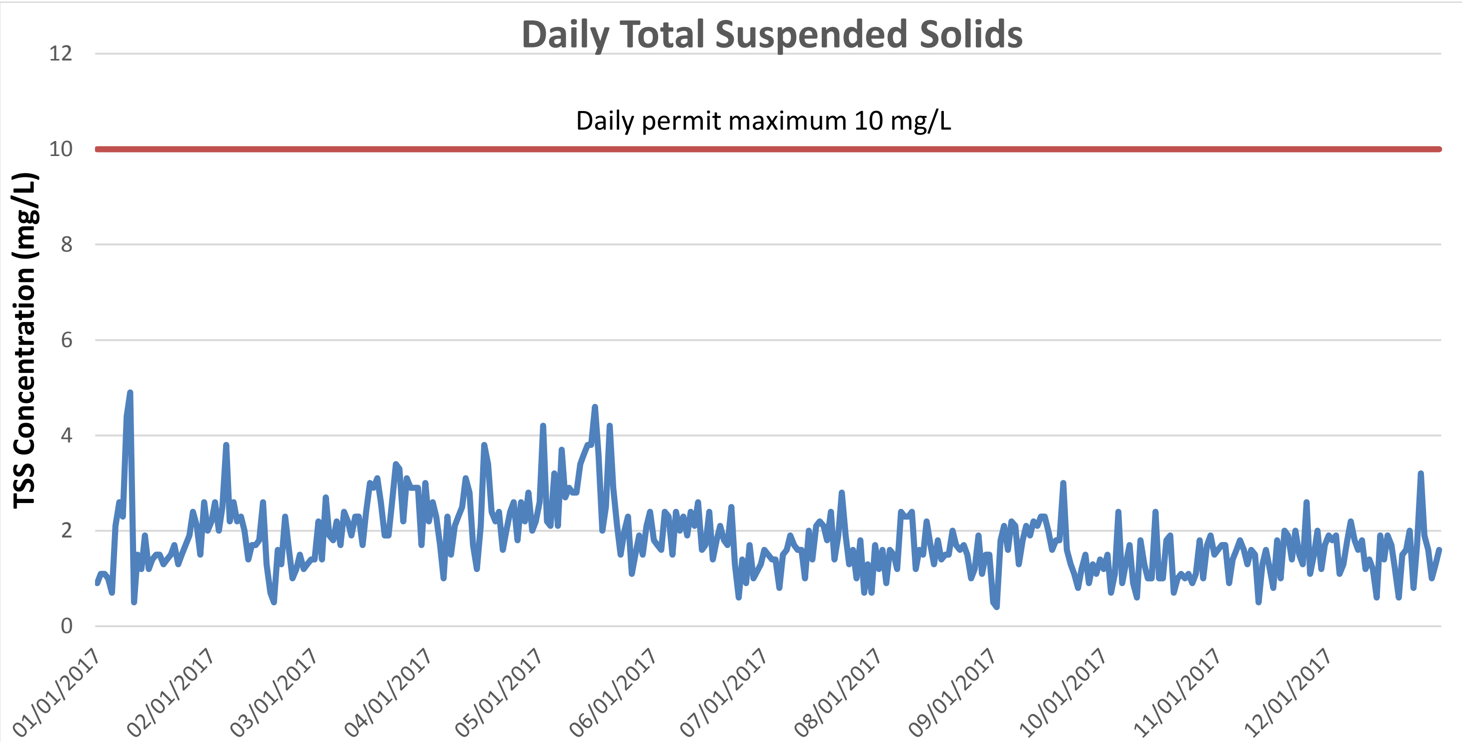


Figure 9. Daily average Total Suspended Solid concentration in discharge

The 2017 average annual effluent TSS value was 1.8 mg/L and consistent with the historical average over the past 17 years (Figure 10).

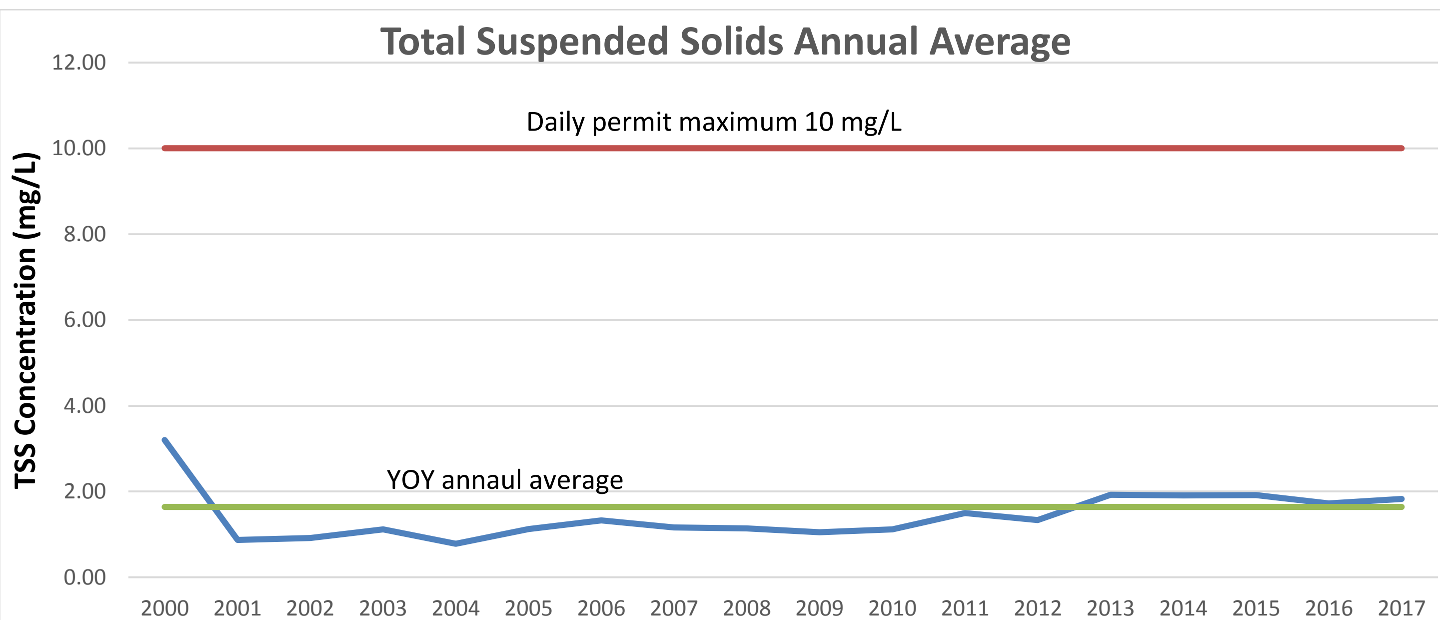


Figure 10. Annual average Total Suspended Solid concentration in discharge relative to permit

The TSS removal efficiency of the treatment process improved by 0.03% over 2016 and consistently within 0.5% relative to the past 17-year historical average (Figure 11). No significant statistical trends were detected.

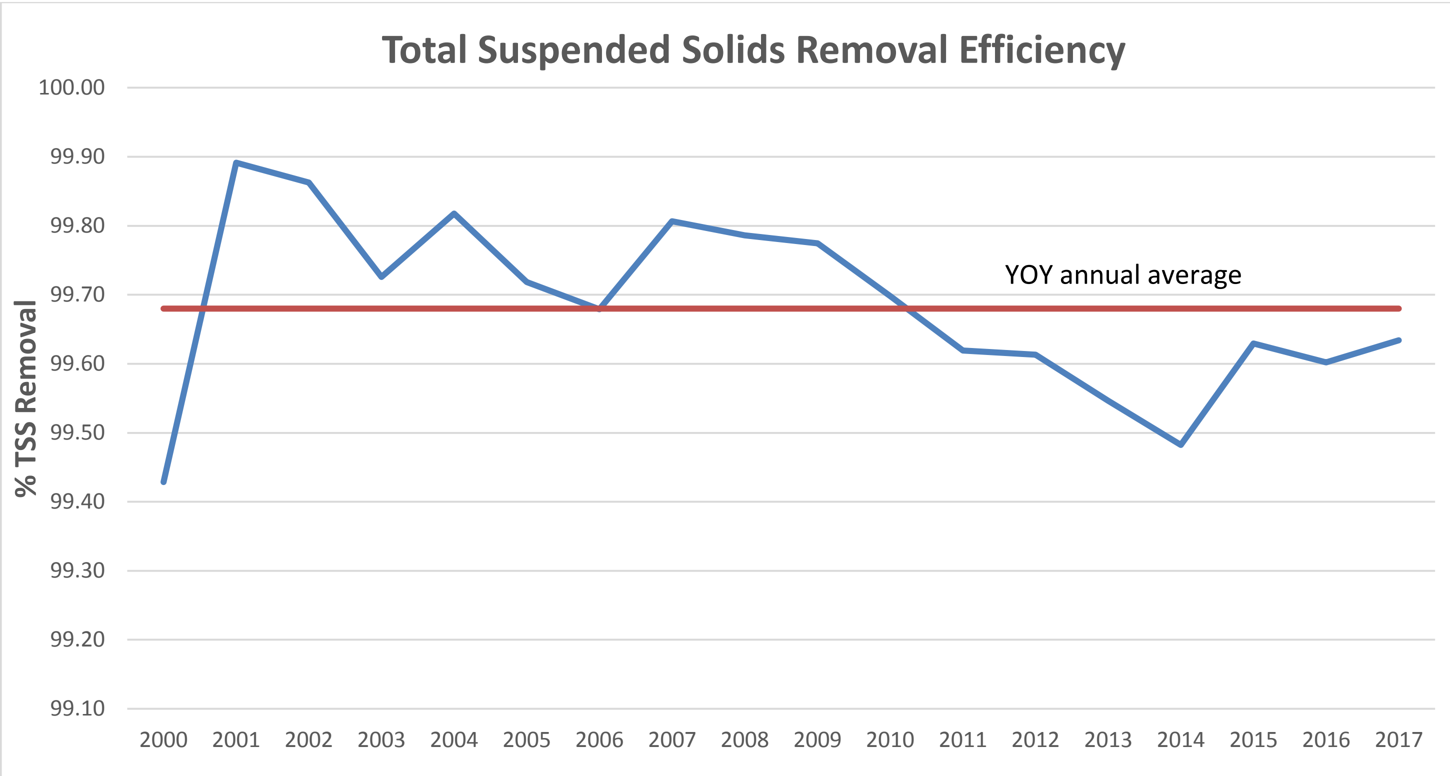


Figure 11. Historical Total Suspended Solid plant removal efficiency from Influent

Biochemical Oxygen Demand

BOD has traditionally been used to measure the strength of effluent released in natural receiving waters due to the fact that sewage high in BOD can deplete oxygen and can result in fish kills and ecosystem changes.

Wastewater is made up of a variety of inorganic and organic substances made up of carbon compounds such as fecal matter, detergents, soaps, fats, greases, and food particles. These large organic molecules are easily decomposed by bacteria, but the process requires the consumption of oxygen. The amount of oxygen required to convert these compounds in carbon dioxide and water is the biochemical oxygen demand (BOD). The 5-day BOD, or BOD_5 commonly referred to as, is measured by the quantity of oxygen depleted over 5 days and is the benchmark for measuring sewage strength.

It is also important to note that BOD serves as the food source for the denitrifying bacteria during the secondary stage of the nitrogen removal process. In these situations, BOD is desired ad necessary to support the growth of the beneficial bacteria.

Effluent BOD was typically measured on a weekly basis and consistently fell well below the permit level of 10 mg/L at all times throughout the past year (Figure 12).

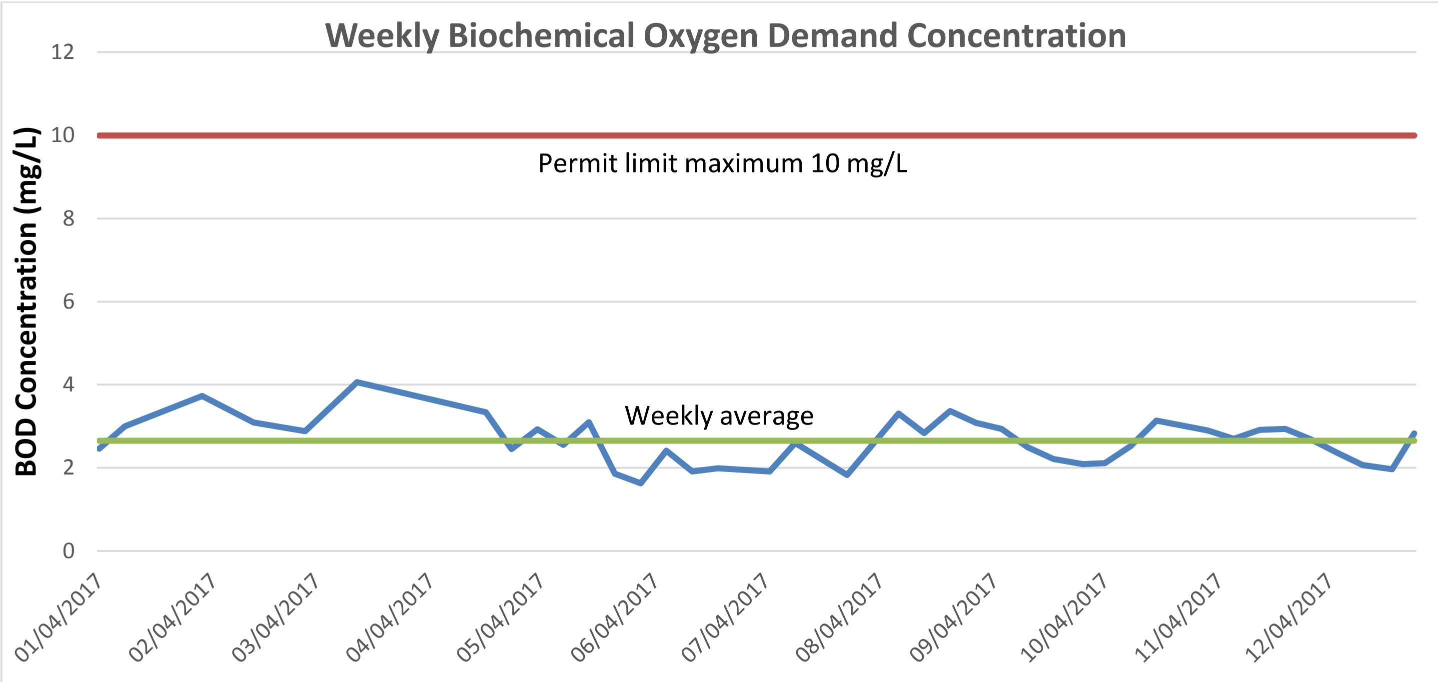


Figure 12. Weekly BOD concentration of discharge relative to permit

The 2017 annual average BOD discharge was 2.65 mg/L, below the 17-year historical BOD annual concentration average by 0.50 mg/L (Figure 13). No statistical significant trends were detected.

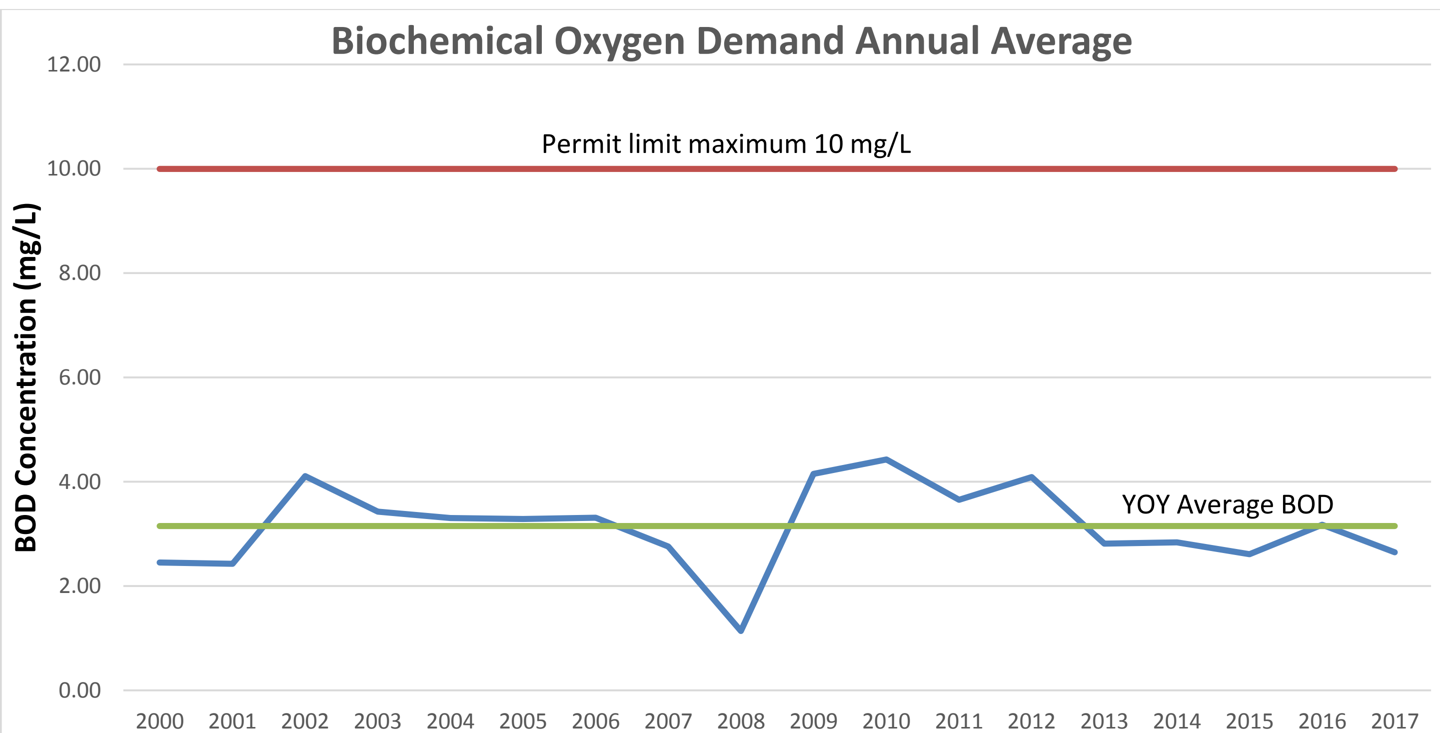


Figure 13. Historical annual average BOD concentration in discharge relative to permit

The BOD removal efficiency of the treatment process improved by 0.17% over 2016 and was 0.34% higher than the past 17-year historical average (Figure 14). All removal efficiencies over this period have been within +/- 1.1%.

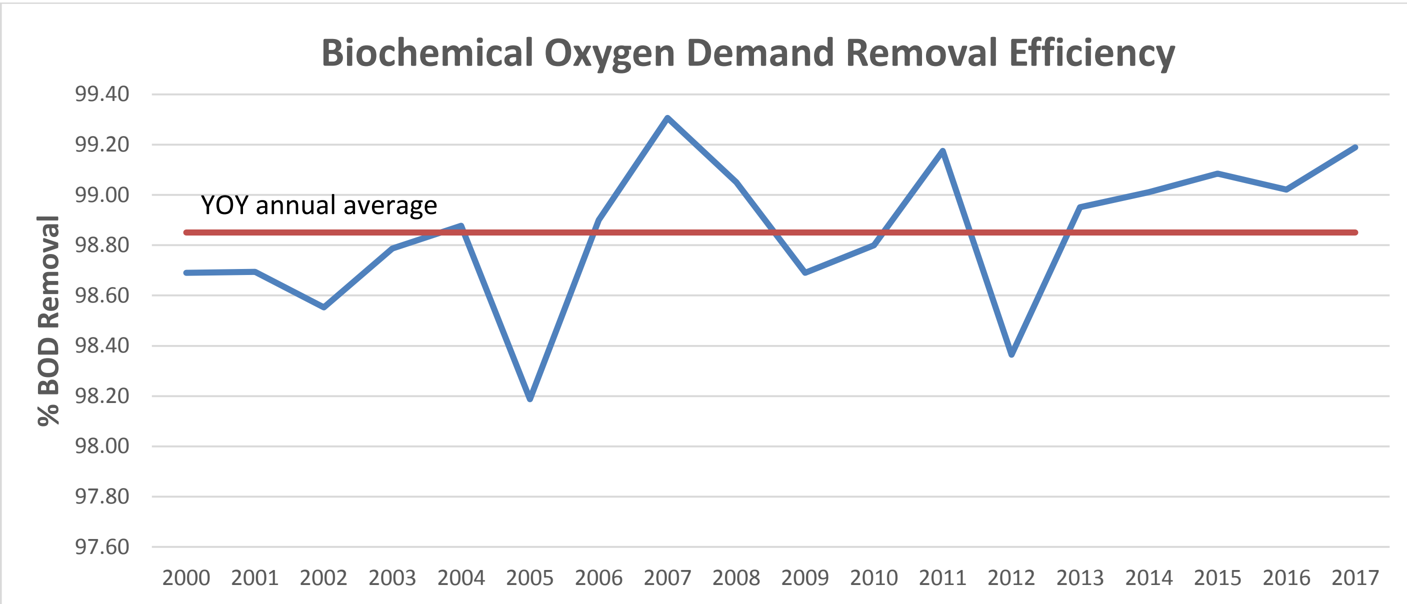


Figure 14 - Historical BOD plant removal efficiency from Influent

Fecal Coliform

The effectiveness of the effluent UV disinfection is measured weekly through the monitoring of Fecal Coliform bacteria in the UV channels. No values exceeded 4 counts/100ml at any point throughout 2017 and were well below the permit level of 50 counts/100ml (Figure 15).

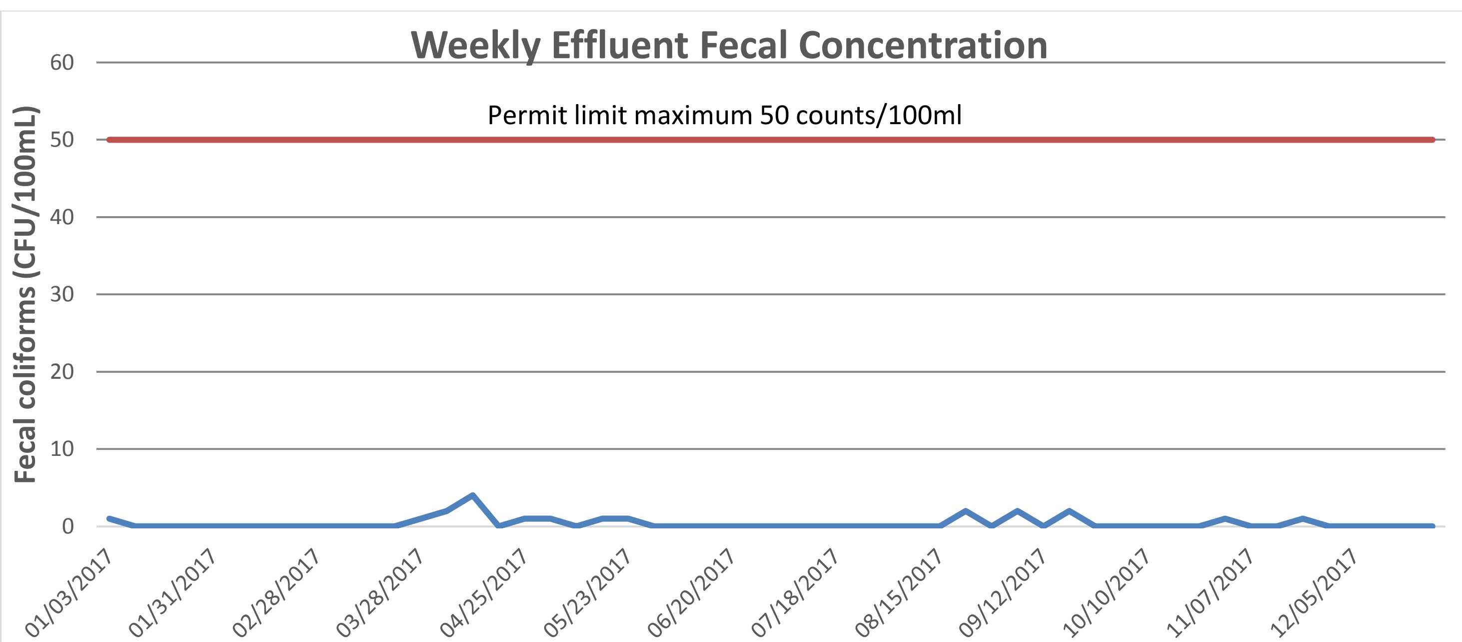


Figure 15. Weekly Fecal concentration in Effluent

There has been consistent, high level of effective disinfection over the past 17 years and at no time has the annual average Fecal concentration exceeded 1 count/100mL (Figure 16).

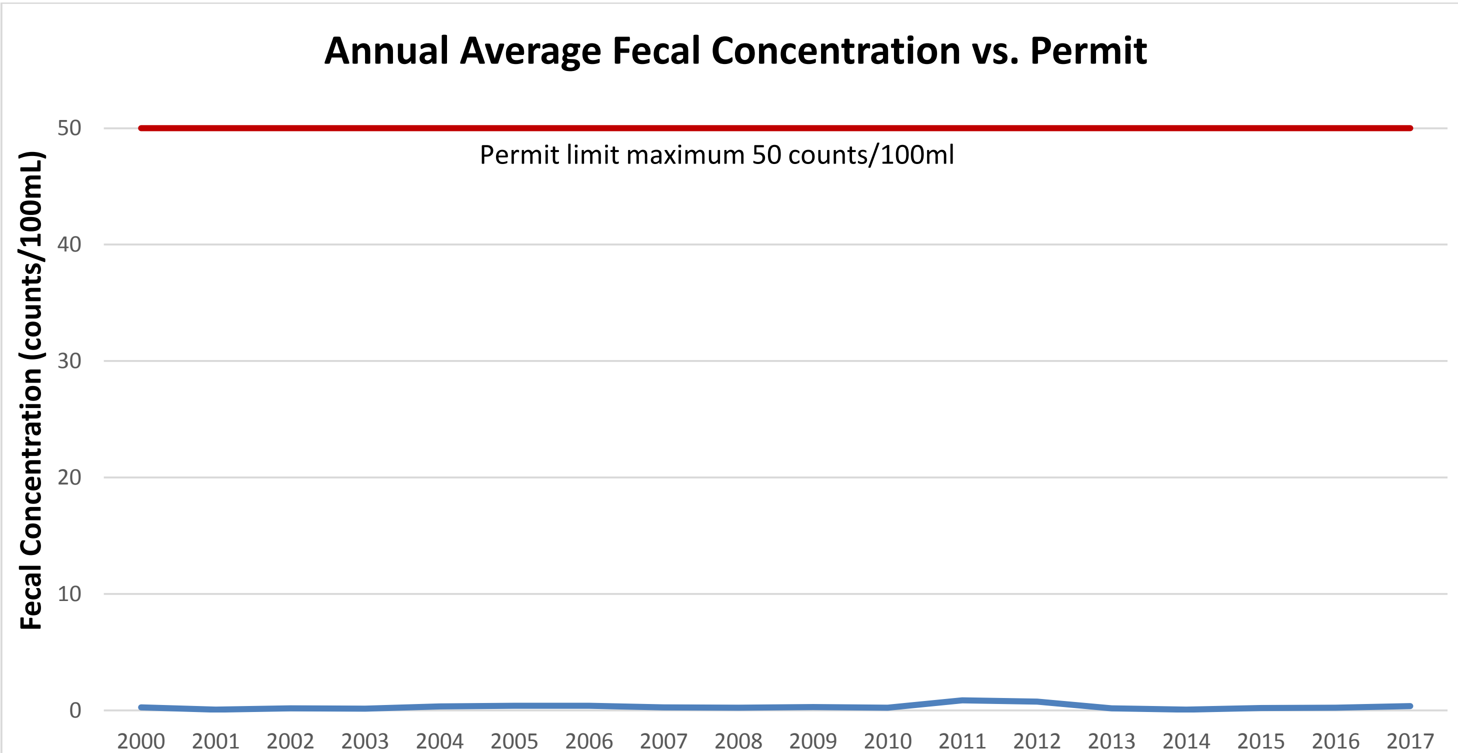


Figure 16 – Historical annual average Effluent Fecal concentration

Acute Toxicity

In order to gauge the influence of WWTF discharge on fish in natural receiving waters, acute toxicity is measured and reported on an annual basis to the Federal Government. This analysis effectively measures the cumulative impact of all chemical and biological stresses on trout fish stock by directly exposing the fry to the effluent dilutions over a 96-hour period. Effluent samples were sent to an accredited aquatic laboratory facility and results submitted to the WSER database (Table 6). Results indicate that there was no mortality or stress reported for any of the fish exposed and met all health and regulatory guidelines.

Acute Lethality	Date	LC50 (%v/v)
WWTF Final Effluent Grab	25-Jul-17	>100

Table 6. Effluent Acute Lethality

Metal Concentrations

Although not a stipulated as an operational monitoring requirement, metal concentrations are measured in the influent flow and effluent discharge twice a year and results contained in this report (Table 7). Comparative results between the influent and effluent composite measurements indicate that the biological treatment process is effectively removing a wide range of heavy metals from the influent. For each listed parameter, the effluent water quality exceeded the Canadian Drinking Water Guidelines for maximum allowable concentrations related to health as well as all aesthetic parameters.

Total Metals (Water)		Canadian Drinking Water Guidelines	Influent Composite Jan 17, 2017	Effluent Composite Jan 17, 2017	Influent Composite July 24, 2017	Effluent Composite July 24, 2017
Aluminum (Al)-Total	mg/L	AO=0.1	0.477	0.079	0.614	0.032
Antimony (Sb)-Total	mg/L	MAC=0.006	0.00096	<0.00050	0.00101	<0.00050
Arsenic (As)-Total	mg/L	MAC=0.01	0.0011	<0.001	0.00130	<0.001
Barium (Ba)-Total	mg/L	MAC=1	0.044	<0.020	0.06	0.020
Boron (B)-Total	mg/L	MAC=5	0.012	0.13	0.18	0.16
Cadmium (Cd)-Total	mg/L	MAC=0.005	0.000275	0.000156	0.000299	<0.00005
Calcium (Ca)-Total	mg/L		47.6	43.4	54.1	45.0
Chromium (Cr)-Total	mg/L	MAC=0.05	0.00283	<0.005	0.00363	0.00065
Copper (Cu)-Total	mg/L	AO=15	0.139	0.0140	0.1870	0.0109
Iron (Fe)-Total	mg/L	AO=0.3	0.902	0.084	1.25	0.094
Lead (Pb)-Total	mg/L	MAC=0.01	0.0035	<0.001	0.0047	<0.001
Magnesium (Mg)-Total	mg/L		17.1	13.9	18.3	14.6
Manganese (Mn)-Total	mg/L	AO=0.05	0.065	0.044	0.11	0.063
Mercury (Hg)-Total	mg/L	MAC=0.001	<0.00020	<0.00020	0.0002	<0.00020
Potassium (K)-Total	mg/L		20.2	17.6	22.0	17.4
Selenium (Se)-Total	mg/L	MAC=0.05	<0.0010	<0.0010	0.0011	<0.0010
Sodium (Na)-Total	mg/L	AO=200	91.2	79.7	86.7	75.4
Uranium (U)-Total	mg/L	MAC=0.02	0.00276	0.00107	0.00292	0.00121
Zinc (Zn)-Total	mg/L	AO=5	0.147	0.0547	0.254	0.0357

MAC= Maximum Acceptable Concentration related to Health Concerns

AO = Aesthetic Objective related to Taste, Odor, Appearance

Table 7. Metal concentrations in Influent and Effluent Composite samples

Lake Monitoring Program

In addition to internal testing program, the COK is part of an annual *Collaborative Okanagan Lake Water Quality Study* that is generated annually by Larratt Aquatic Consultants and submitted to the Ministry of Environment as part of the condition on permit for wastewater operations. This report indicates the general physical, chemical, and biological health of Lake Okanagan and water quality trends that may be influenced by tributaries as well as outfalls from treatment plants. Parameters generally all fell within water quality objectives published (Nordin, 2005) and accepted by the Ministry of Environment.

Trends of concern were related to decreasing dissolved oxygen content throughout the Lake and unusually high concentrations of heterocystic cyanobacteria relative to historical concentrations. None of these were directly linked to impacts of the COK wastewater discharge or tributary water quality contributions. Recommendations included continual, annual monitoring to determine on-going water quality trends of concerns throughout Lake Okanagan.

Staffing

The WWTF operates with a skilled staff that have been certified to a level that meets Ministry of Environment regulations. This includes; one EOCP Level IV Supervisor, four EOCP Level III Operators, nine EOCP Level II Operators, three Millwrights, three Instrumentation/Electrical Technicians, two Laboratory staff, and one Source Control Technician (Figure 17).

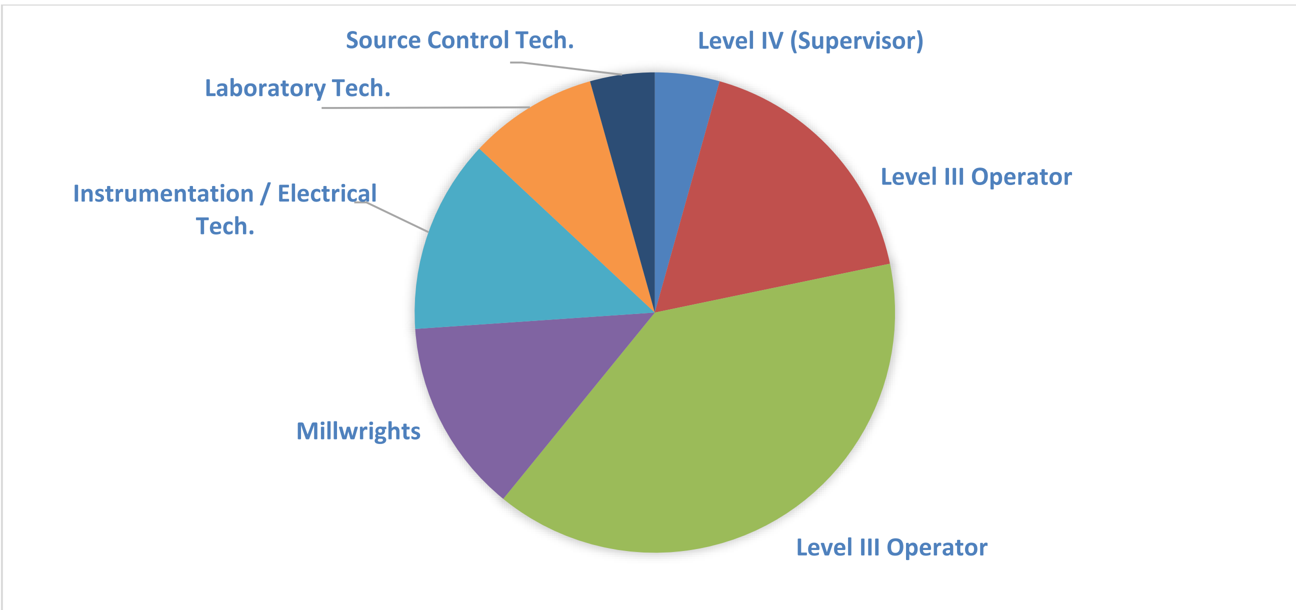
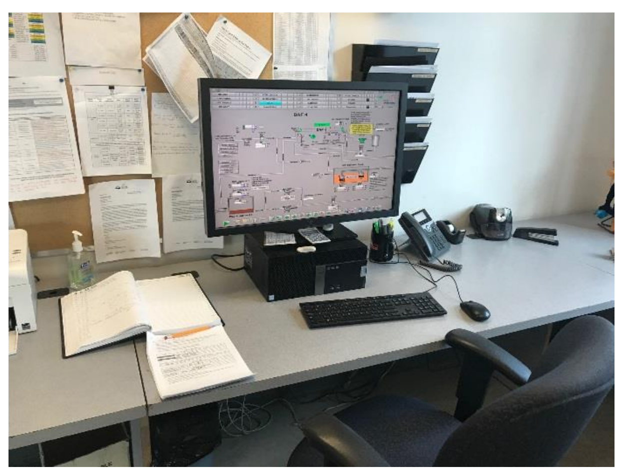


Figure 17. Overview of WWTF Operators certification level and support staff

System Control

The operational monitoring of the wastewater facility is conducted through the use of a Supervisory Control and Data Acquisition Software (SCADA) program. Connected by wireless links, the SCADA software remotely collects information from monitors and sensors at strategic points in the wastewater processing plant. The software interprets the receiving data and automatically adjusts pumps and system settings to maintain pre-defined operating requirements. When an issue is detected within the system, the SCADA system issues alerts and alarms to wastewater system operators who then respond to the concerns. This software platform also allows the COK to collect and track historical performance of our system for auditing and future optimization of the wastewater system.



Operational Maintenance

Valued at more than $100 million, the WWTF infrastructure requires thorough condition assessment, preventative maintenance and scheduled replacement of aging components. To support this, the City has developed and continues to re-assess a comprehensive asset management plan that ensures the WWTF is maintained in good condition. For day to day maintenance, the WWTF utilizes a maintenance data and scheduling software program (PM Expert) that highlights facility and equipment work that needs to be maintained. The maintenance is delegated by wastewater foreman and is reviewed by the supervisor for compliance.

Odour Management

The COK WWTF employs a centralized odor control system that consists of a mechanical bio-filter lined with a patented, engineered media. This biological process eliminates the need for additional chemical treatment and has proven to be highly effective. Foul air is extracted from designated buildings and tanks throughout the plant and cycled through the bio-filter and discharged via a 14-meter stack on-site.

The WWTF has a dedicated service request program whereby the public can provide feedback or register complaints regarding our wastewater treatment process, but as of Dec 31, 2017, there were no reported odor complaints from residents or businesses in the area through 2017.

Emergency Response Plan

A thorough review of the WWTF Emergency Response Plan was conducted in 2017 by staff and updated to reflect current practices and policies and aligns with the permit requirements of the COK treatment plant (Appendix F). Operators and technicians are informed of and carry out mock exercises of the Emergency Response Plan that contains information on course of actions, list of appropriate contacts, and procedures necessary to assist operators and staff to make timely and informed decisions.

Technology and Efficiency Improvements

Energy efficiencies and process efficiencies continue to be drivers at the treatment facility. The COK brought on-staff an Energy Program Manager in 2017 that assisted the plant with evaluating equipment and processes and making recommendation for improvements. The on-site air compression system was fully replaced in 2017 with a single, energy efficient unit that has effectively reduced power demand and lowered maintenance requirements and replacement costs. Assessment of potentially using reclaimed water for irrigation is also underway which should effectively reduce the discharge volume and lower water demand.

The WWTF continues to participate in the annual National Water Benchmarking Initiative (NWBI) that highlights performance relative to other wastewater treatment facilities across the country. Particular strengths referenced include below average Operational and Maintenance costs per volume treated, zero accidents with lost time on site, below average reactive maintenance, and very minimal regulated tests out of compliance.

Conclusion

The COK is committed to continually improving wastewater services to all of its residents, industrial, and commercial stakeholders. Protecting our water source is not an option – it is a priority, for our current generation and those to come. This requires extensive planning, funding, collaboration, vision and leadership from City Council all the way through to the wastewater utility staff and operators working diligently to support the Kelowna vision statement:

"To be the best mid-sized city in North America"

City of Kelowna is pleased to present the 2017 Annual Wastewater Report, detailing the health and direction of our wastewater system. If you have any questions about this report or wish to have additional information provided, please contact the COK Water Utility at 250-469-8475 or email at ask@kelowna.ca/.