2022 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, first constructed in 1913, services approximately 130,000 residents and is located at 951 Raymer Ave., Kelowna BC. It currently utilizes modified Bardenpho technology to biologically reduce and remove nutrients from the sewage stream and has a rated capacity of 70,000 m^3/day (70 MLD). The treatment facility discharges into Lake Okanagan and is operated under Certificate Approval 12211 in accordance with BC Environmental Management Act.

The total influent flow to the plant in 2022 was 13,241,710 m^3 or an average of 36,280 m^3/day, which represents a 2.7% increase relative to 2021. The equivalent daily rate of discharge was below the estimated rate of effluent discharge listed in the operational certificate of 42,747 m^3/day and used to calculate the permit fee.

The WWTF monitored all effluent quality standards as regulated under the plant's Operational Certificate of Approval. Wastewater treatment produced the following effluent quality in 2022:

	Operational Certificate Limit	**2022 Treated Effluent**
Total Suspended Solids (TSS) - Monthly Maximum	≤ 10 mg/L	All monthly results <10 mg/L
Biochemical Oxygen Demand (BOD) - Monthly Maximum	≤ 10 mg/L	1 Exceedance >10 mg/L
Total Phosphorus (TP) - Annual Average	≤ 0.25 mg/L	Annual Average 0.24 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	Annual Average 5.36 mg/L
Total Nitrogen (TN) - Daily Max. Concentration	< 10.0 mg/L	8 Exceedances >10 mg/L
Fecal Coliforms – Monthly Max. Geometric Mean	≤ 50 CFU/100ml	All monthly results <50 CFU/100ml

Table 1. Effluent quality standards relative to permit

Analytical results for grab samples and 24-hour composite 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, Chemical Oxygen Demand (COD), Total Kjeldahl Nitrogen (TKN), Organic Nitrogen (ON), BOD, TSS, pH, E.coli. and Fecal Coliform.

The wasted activated sludge produced at the WWTF was removed from the facility and utilized at the Commonage composting facility in the production of Ogogrow. A total of 20,334 metric tonnes of activated sludge was removed in 2022, which was a decrease of 1.7% from the previous year.

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.

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.

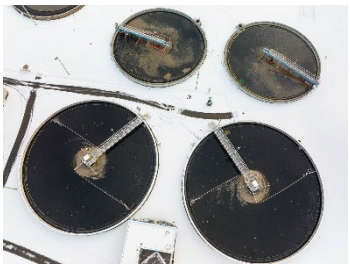
Primary Treatment

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 equalization basins.

Advanced Nutrient Removal

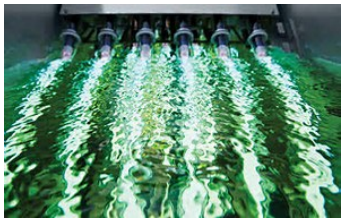
The Biological Nutrient Removal (BNR) system is a modified Bardenpho design consisting of various size bioreactors and cells that consist of three zones: anoxic, anaerobic, and aerobic which reduce ammonia and nitrate to nitrogen gas. Fermenter effluent, rich in Volatile Fatty Acids (VFA's) aids in phosphorus removal, flows into the beginning of each reactor 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).

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 all of the settled solids return 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 treatment system prior to final discharge.

Sludge Conditioning and Composting

Sludge from the primary clarifiers is thickened in fermenters and the resulting waste activated sludge from the bioreactor is further 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 590 km of gravity sewer mains collect and convey sewage to more than 43 pump stations throughout Kelowna where wastewater is directed through a series of gravity and forcemains 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 in the collection system as well as within the treatment facility. 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.

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.

2022 Discharge Permit Compliance Monitoring:

- 13 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.
    - 60 permit compliance monitoring events in 2022.

Key Manhole Sampling

- System wide monitoring program continued in 2022 to measure and track wastewater strength; measure the concentration and loading of regulated parameters; measure the concentration of toxic substances; monitor pH and H_2S.
- Three (3) consecutive 24-hour composite samples 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)
- 5 additional sites were monitored in 2022 for the Influent High Strength Study (AECOM). Four (4) consecutive 24-hour composite samples collected during the month of July. The objective of the study and the sampling undertaken was to characterize wastewater strength within the City of Kelowna collection system and assess potential locations of high strength point sources.

Sewer Data Logging

City expanded the use of remote, cellular based sensors for sewer monitoring of flows, rain gauges and H_2S in 2022.

These included:

- 8 H_2S sensors to detect elevated sewer gas and nuisance odors
- 5 flow sensors to determine sewer flow and pipe capacity
- 3 rain gauges to determine contribution of storm water to sewer flow

These provided instant, up to date information on sewer conditions and play a vital role in staff safety and reduction in GHG emissions by reducing the number of vehicle trips required.

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.

FOG enforcement focused on the Food Service Establishments (FSEs) sector to ensure proper management of Fats, Oil, and Grease (FOG):

- 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.
- 55 FSEs inspected in 2022
- Work is being done to develop a software and for ease of data management and and app for FSEs to self-report on their grease trap maintenance to streamline inspections.

As per Medical Marihuana Producer Business Licence and Regulation Bylaw, all new businesses are inspected prior to issuing a Business Licence to see if the wastewater generated could have a potential impact to the collection system.

FOG Public Education

The 'FOG cup' initiative continued in 2022 using rebranded logo:

- Educational boots set-up at the Kelowna Home Show, City Hall, Downtown Library, Okanagan College.
- Cups and educational material distributed to households within the Guy St and Cedar Aver Lift Station collection area (single family 600 households)
- Social marketing campaigns through social media, mail-outs, PSAs, etc. continued in 2022, focusing on educating the public on issues of improper disposal of FOG, hazardous waste, 'flushable' wipes, etc.

Vehicle Wash Operations

Vehicle wash operations were inspected and samples collected to test for TSS, BOD, COD, FOG, Phenolics, pH, and Metals. Actions carried out through 2022 included:

- Best Management Practice (BMP) document was provided to assist in complying with Bylaw requirements
- 13 vehicle wash operations inspected
- Requirement to keep Oil and Grease separator maintenance log
- Signage was provided for operations with self-serve wash bays in hope to deter illegal dumping

Storm-Sanitary Interconnects

Wastewater Operations is responsible for infrastructure repair and replacement and 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.

Elevated E.coli. counts in the storm system triggered an investigation into two potential interconnections in 2022. Physical examination of the connection revealed this to be the case and was corrected.

Operations

Water Quality and Treatment Performance

Wastewater quality and flow are monitored through a series of 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. Total Phosphorus, Total Nitrogen, and Metals analysis is sublet to a third party accredited laboratory as per permit requirements.

Year End Report - Water and Wastewater Division Kelowna Wastewater Treatment Facility - ME #12211 - 2022																				
Date	Influent Flow		Final Effluent Composite														Effluent Grab			
			24 hour composite														pH		Bacteria	
			Ortho P			Total P			NO3	NH3	TKN	Org N	Total N	BOD	Solids	COD				
	Total	Avg	Avg		Total	Avg		Total											Faecal	e.Coli
	ML	MLD	mg/L	kg/day	kg	mg/L	kg/day	kg	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	min	max		
Jan	1146	36.95	0.24	8.87	275	0.43	13.90	431	1.20	5.18	7.56	2.38	8.47	14.4	8.2	51.0	6.35	6.50	ND	2.0
Feb	1003	35.83	0.04	1.43	40	0.23	8.13	228	2.84	3.07	5.09	2.02	7.68	6.7	3.7	46.5	6.35	6.47	ND	7.5
Mar	1118	36.06	0.18	6.49	201	0.34	12.30	381	2.79	0.47	2.09	1.62	4.88	3.8	2.0	39.9	6.36	6.50	ND	7.5
Apr	1064	35.48	0.13	4.61	138	0.29	10.40	312	3.52	0.47	2.13	1.66	5.40	5.1	2.3	41.3	6.36	6.49	ND	1.0
May	1102	35.55	0.02	0.71	22	0.14	5.08	157	3.83	0.16	1.65	1.49	4.66	2.3	1.6	36.3	6.37	6.54	ND	ND
Jun	1165	38.85	0.02	0.78	23	0.11	4.43	133	3.53	0.06	1.36	1.29	3.91	2.0	1.3	35.1	6.40	6.61	ND	ND
Jul	1204	38.85	0.04	1.55	48	0.14	5.26	163	3.08	0.07	1.55	1.48	4.28	2.3	1.6	35.4	6.43	6.65	ND	1.0
Aug	1130	36.46	0.03	1.09	34	0.13	4.55	141	3.00	0.06	1.42	1.36	4.21	4.6	1.3	37.2	6.53	6.73	ND	ND
Sep	1072	35.72	0.04	1.43	43	0.17	5.95	179	2.49	0.19	1.65	1.47	3.98	2.1	1.5	40.0	6.45	6.69	ND	ND
Oct	1104	35.60	0.11	3.92	121	0.22	7.73	240	3.53	0.40	1.86	1.46	5.32	2.3	1.3	36.4	6.41	6.66	ND	ND
Nov	1051	35.02	0.15	5.25	158	0.28	9.69	291	4.31	0.47	2.02	1.55	5.81	2.5	1.6	39.3	6.40	6.61	ND	1.0
Dec	1083	34.93	0.03	1.05	32	0.16	5.66	175	3.78	1.05	2.61	1.56	5.90	2.4	1.6	37.3	6.39	6.54	ND	1.0
2022	**13,242**	**36.28**	**0.09**	**3.10**	**1136**	**0.24**	**7.76**	**2831**	**3.16**	**0.97**	**2.58**	**1.61**	**5.36**	**4.6**	**2.3**	**39.6**	**6.40**	**6.58**	**ND**	***2.0**
*indicates geometric mean																				

Table 2. Summary of monthly flow and Effluent water quality

Influent Quantity and Quality

The WWTF 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 36,280 m^3 of influent was received on a daily basis in 2022.

Flow has remained relatively consistent on a year over year (YOY) basis since 2013 and well below the permited flows issued in 2010 and listed in the Operational Certificate (Figure 1).

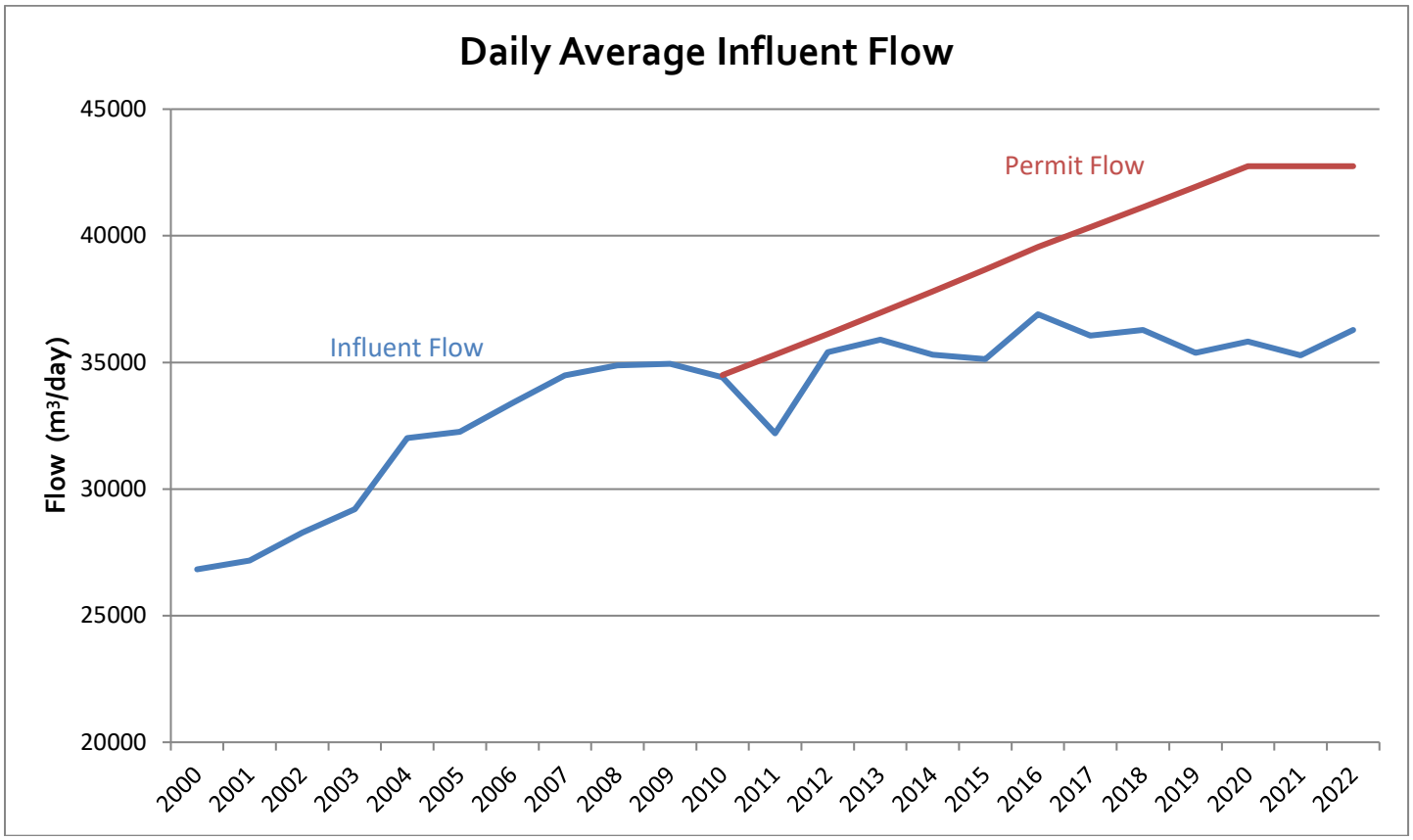


Figure 1 – Historical Influent flow relative to permit

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 2022 monthly averages are listed in Table 3. All nutrient parameters showed an average increase in concentration over 2021.

Raw Influent Monthly Averages - 2022								
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	6.52	7.26	2.15	41.3	53.4	3.72	6.65	301
Feb	6.53	7.29	1.99	44.2	52.7	4.18	6.14	219
Mar	6.88	7.94	2.80	43.7	58.2	3.82	7.40	315
Apr	6.75	7.88	2.90	45.4	53.7	4.26	6.31	461
May	6.77	7.88	6.60	40.5	53.5	4.41	6.62	263
Jun	6.73	7.77	1.70	42.2	56.0	4.03	7.73	345
Jul	6.75	7.66	1.40	41.7	58.0	3.95	6.26	420
Aug	6.81	7.71	1.77	36.9	52.6	3.97	6.83	466
Sep	6.84	7.75	2.73	41.1	57.8	4.00	7.82	392
Oct	6.80	7.70	1.08	44.4	58.8	3.82	6.81	310
Nov	7.10	8.00	2.40	44.1	60.4	4.01	7.38	347
Dec	7.04	7.95	2.67	43.9	55.6	4.00	6.48	386
2022 Avg.	**6.79**	**7.73**	**2.52**	**42.45**	**55.90**	**4.01**	**6.89**	**352**
Increase over 2021			33%	6%	17%	3%	4%	1%

Table 3 – Monthly average Influent water quality concentrations

Effluent Quality and Nutrient Removal

The final effluent is treated to meet condition 1.1.2 (Table 1) of the operating permit that stipulates maximum discharge concentrations for Total Phosphorus, Total Nitrogen, Suspended Solids, BOD, and Fecal Coliform. In addition to the operational conditions, the plant must also meet 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 algae on drinking water (Microcystin).

Municipal wastewater influent typically contains between 5 to 20 mg/L of Total Phosphorus (TP), 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 daily composite discharge of TP peaked at 1.78 mg/L, below the daily discharge permit limit of 2.0 mg/L while the yearly average TP concentration was calculated to be 0.24 mg/L, also below the annual average permit level set at 0.25 mg/L (Figure 2). The annual average TP concentrations have been noted to be generally increasing over the past 25 years (Figure 3).

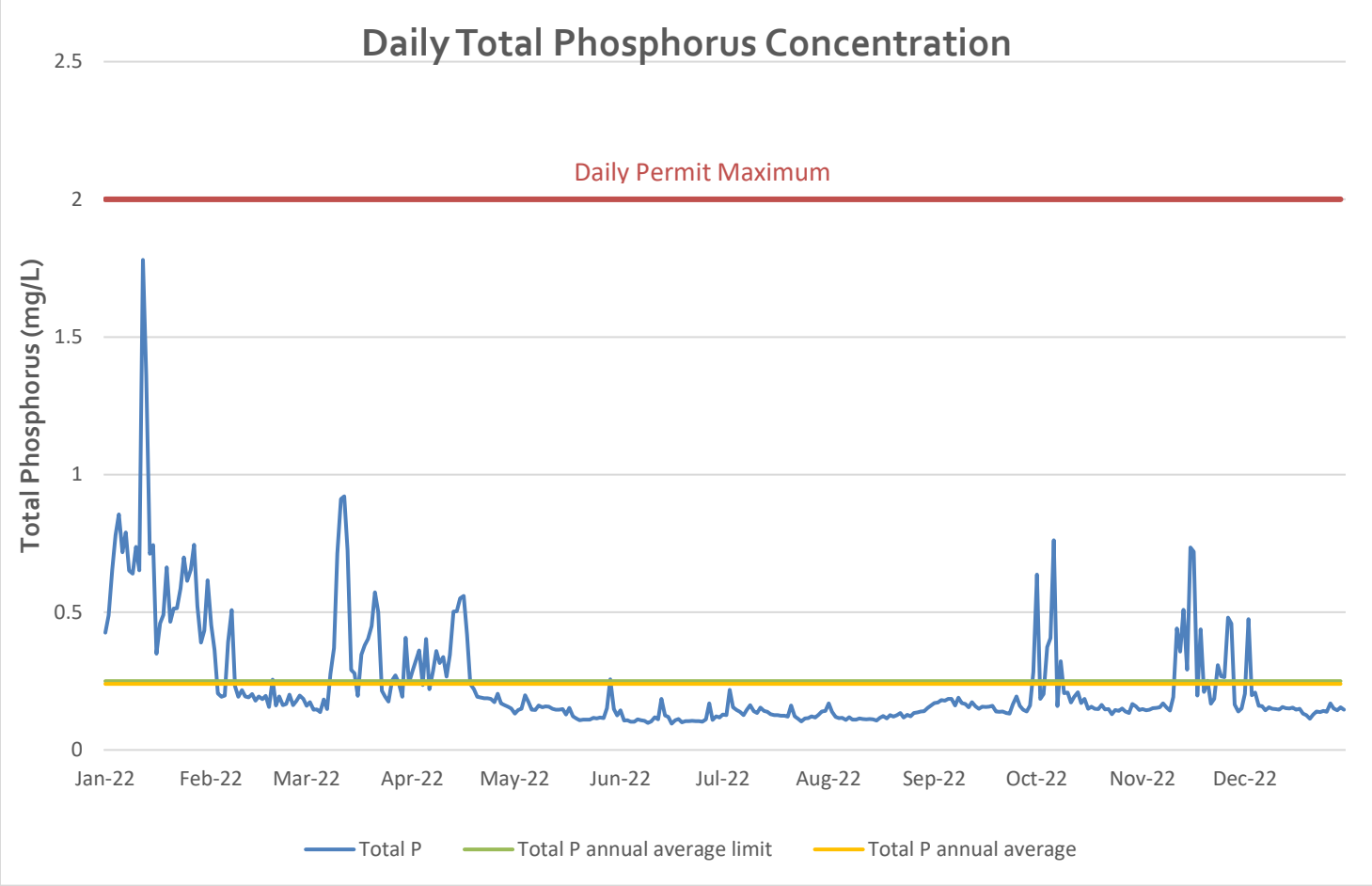


Figure 2. Daily Total Phosphorus concentration relative to permit levels

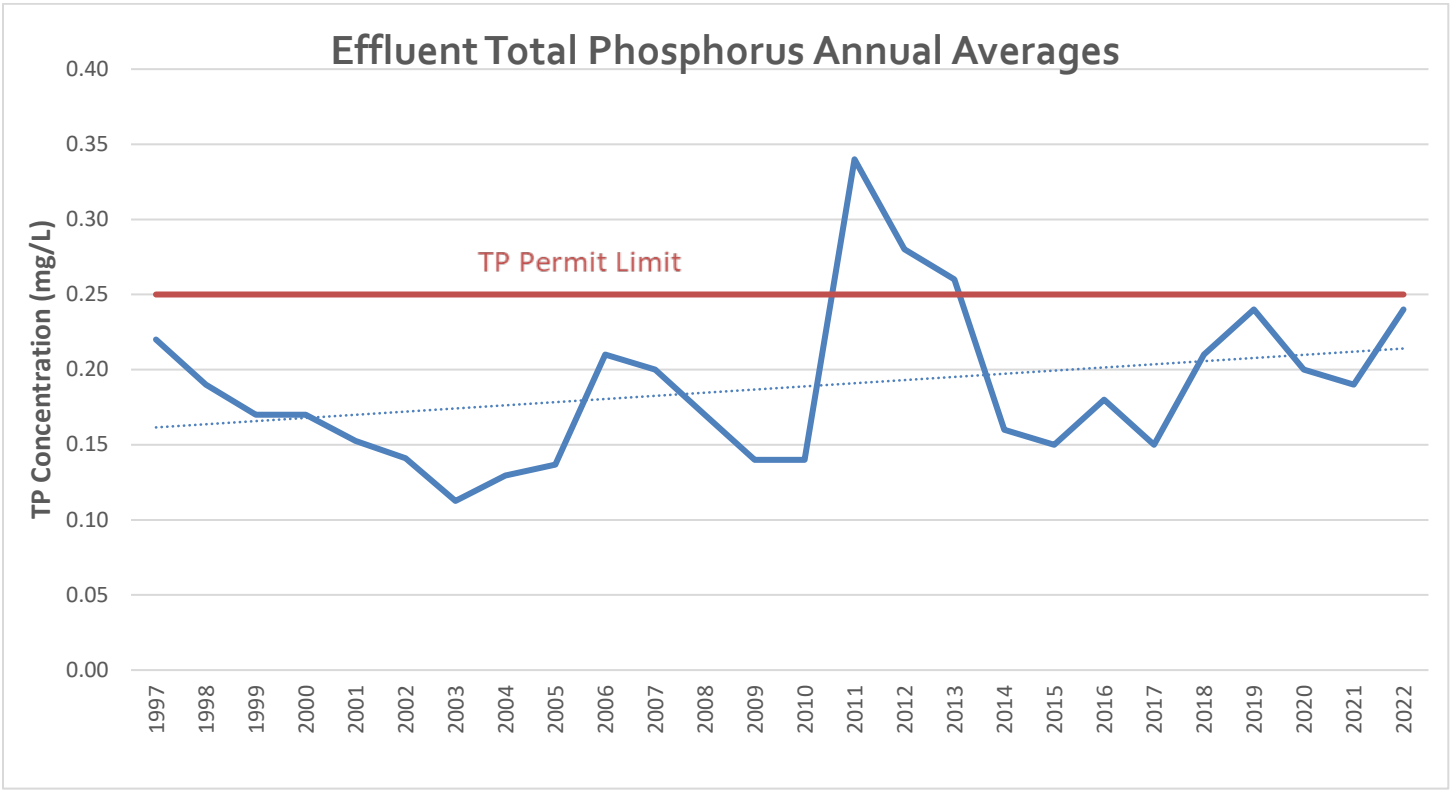


Figure 3. Total Phosphate annual average concentrations

The efficiency of the BNR process to remove Total Phosphorus from the waste stream averaged 96.5% in 2022, which represents a 0.7% decrease over 2021 and just below the historical 20-year average of 96.9% (Figure 4).

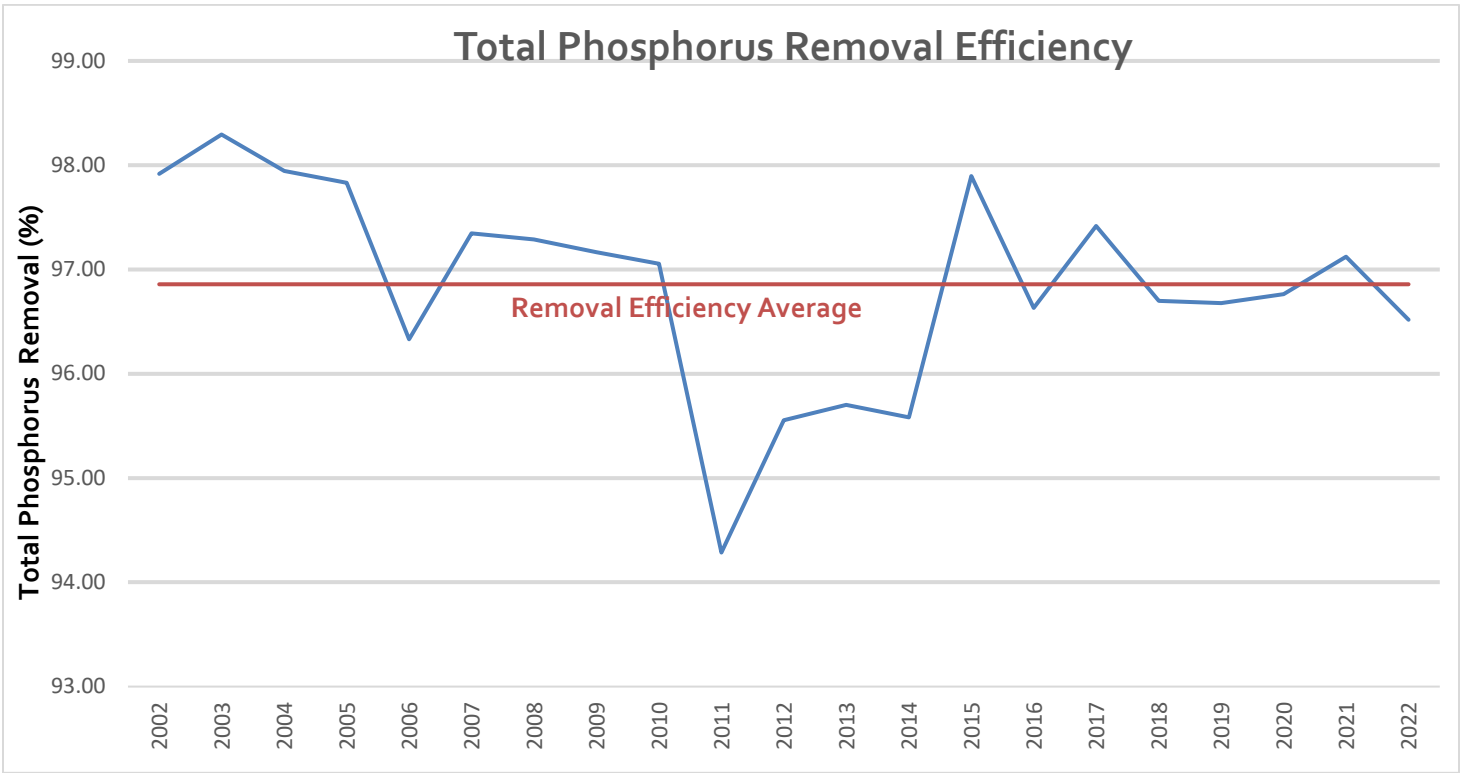


Figure 4. BNR Total Phosphorus removal efficiency from Influent

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, measured from composite samples, had a total of 8 exceedances over 10 mg/L, but annual average was below the allowable annual average of 6.0 mg/L (Figure 5).

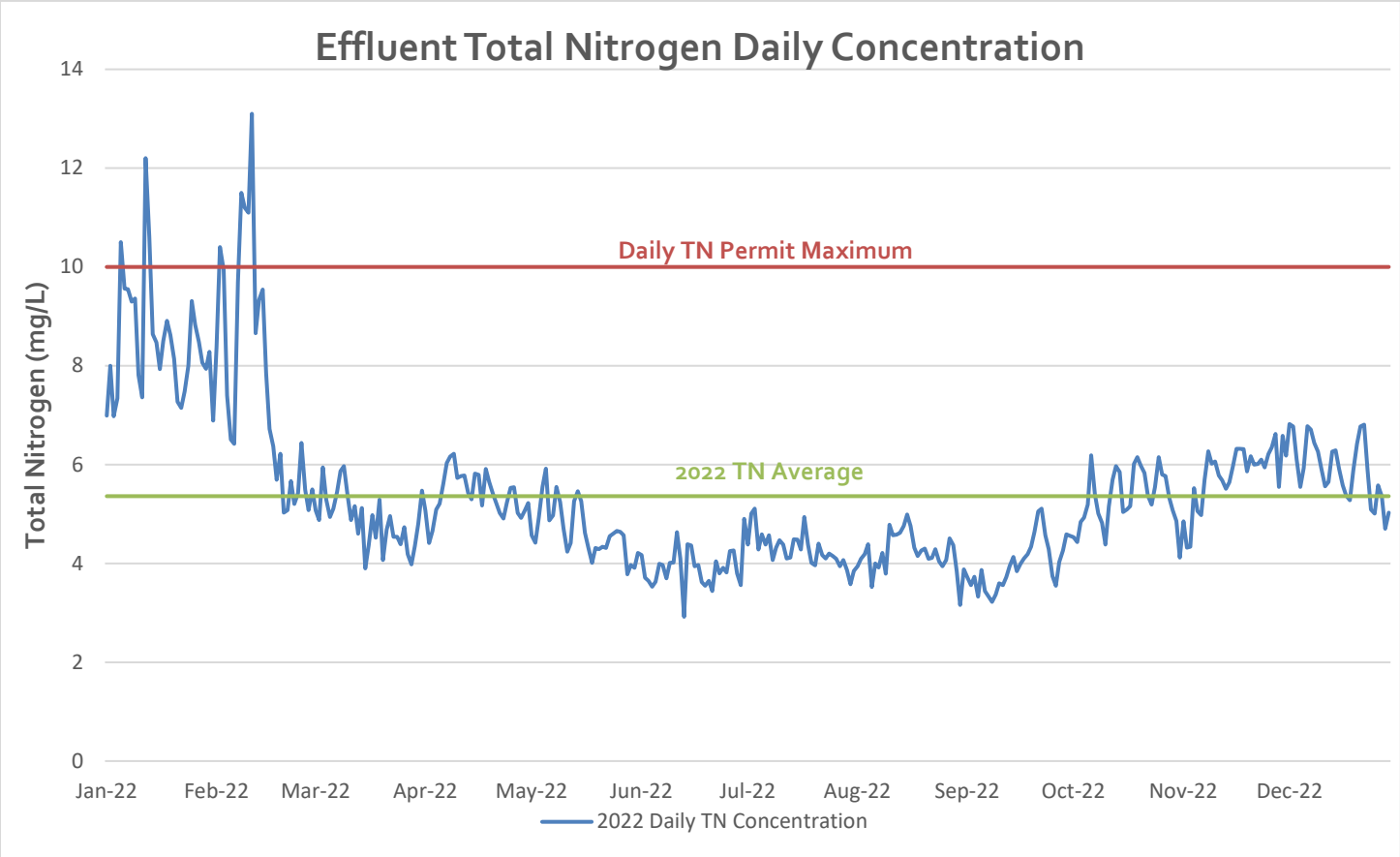


Figure 5. Average daily Total Nitrogen concentration in discharge

The average daily TN concentration discharged was 5.36 mg/L in 2022, which represents a 1% increase from 2021, below the permit maximum and slightly above the historical 20-year average (Figure 6). Consultants are working with the City to assess flow and nutrient loading to the facility to assist in reversing the longer term increasing trend.

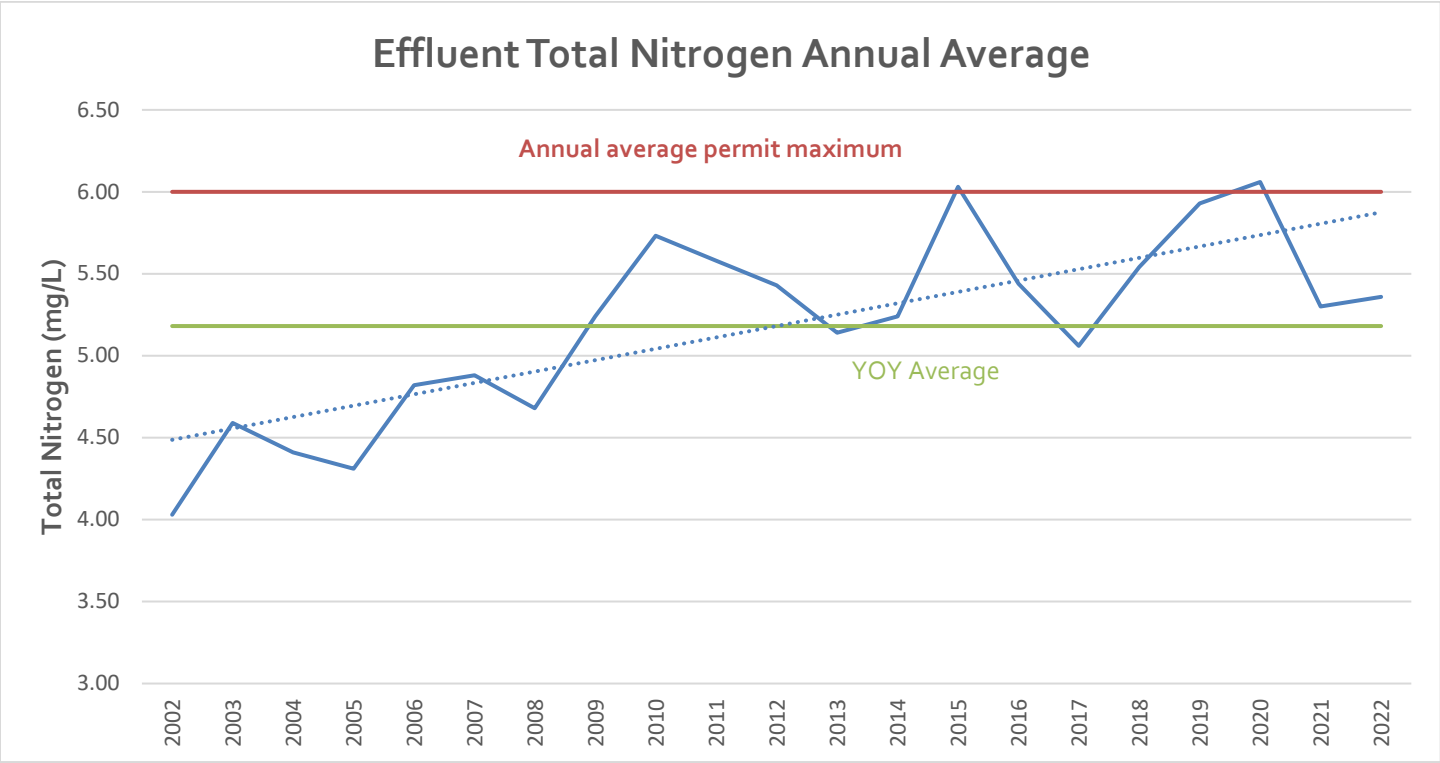


Figure 6. Historical annual average Total Nitrogen concentration in Effluent

Plant performance saw a 1.8% improvement in the removal efficiency of Total Nitrogen from the influent (Figure 8).

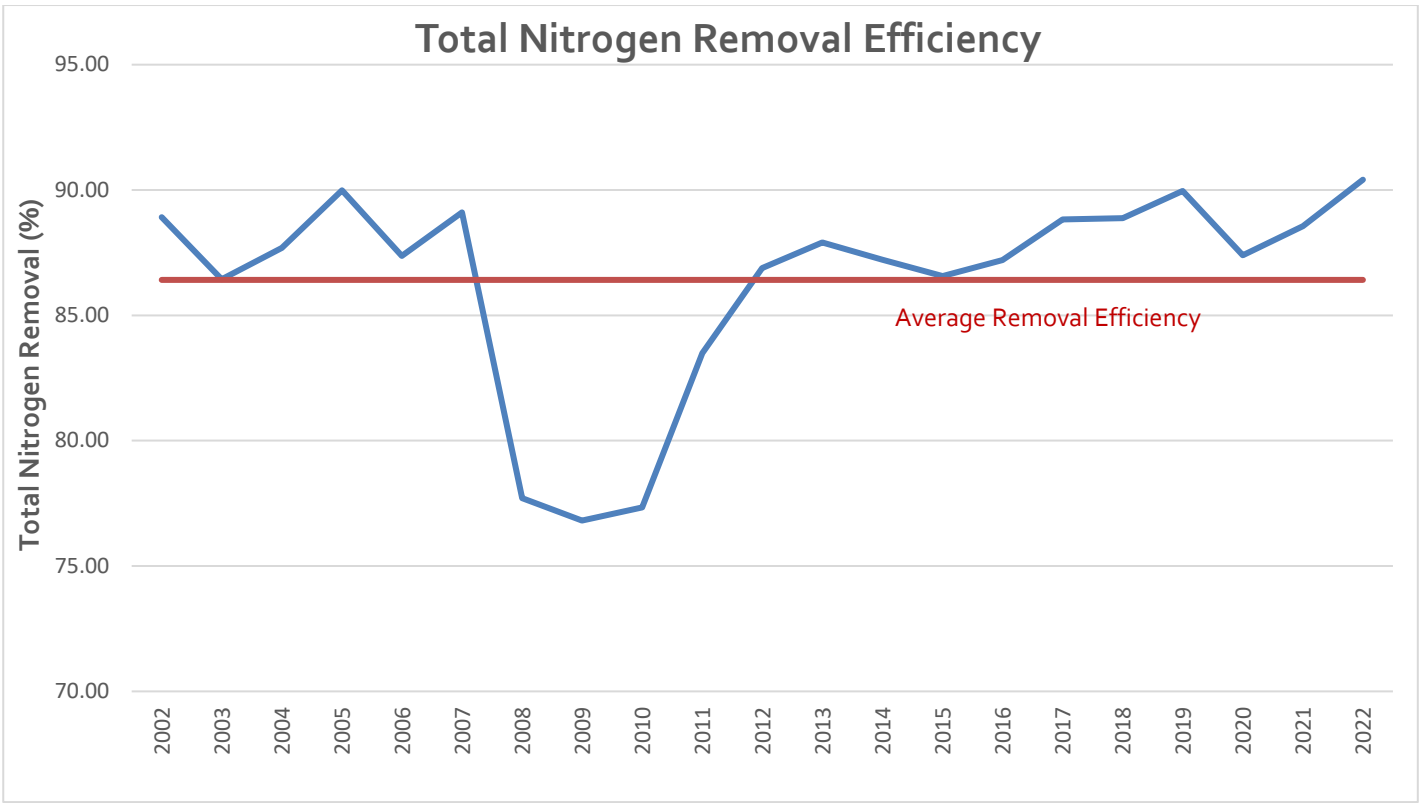


Figure 7. Total Nitrogen removal efficiency

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 bacteria 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 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. There were 6 daily TSS values above 10 mg/L, but the average monthy value still met the permit requirement of <10 mg/L (Figure 8).

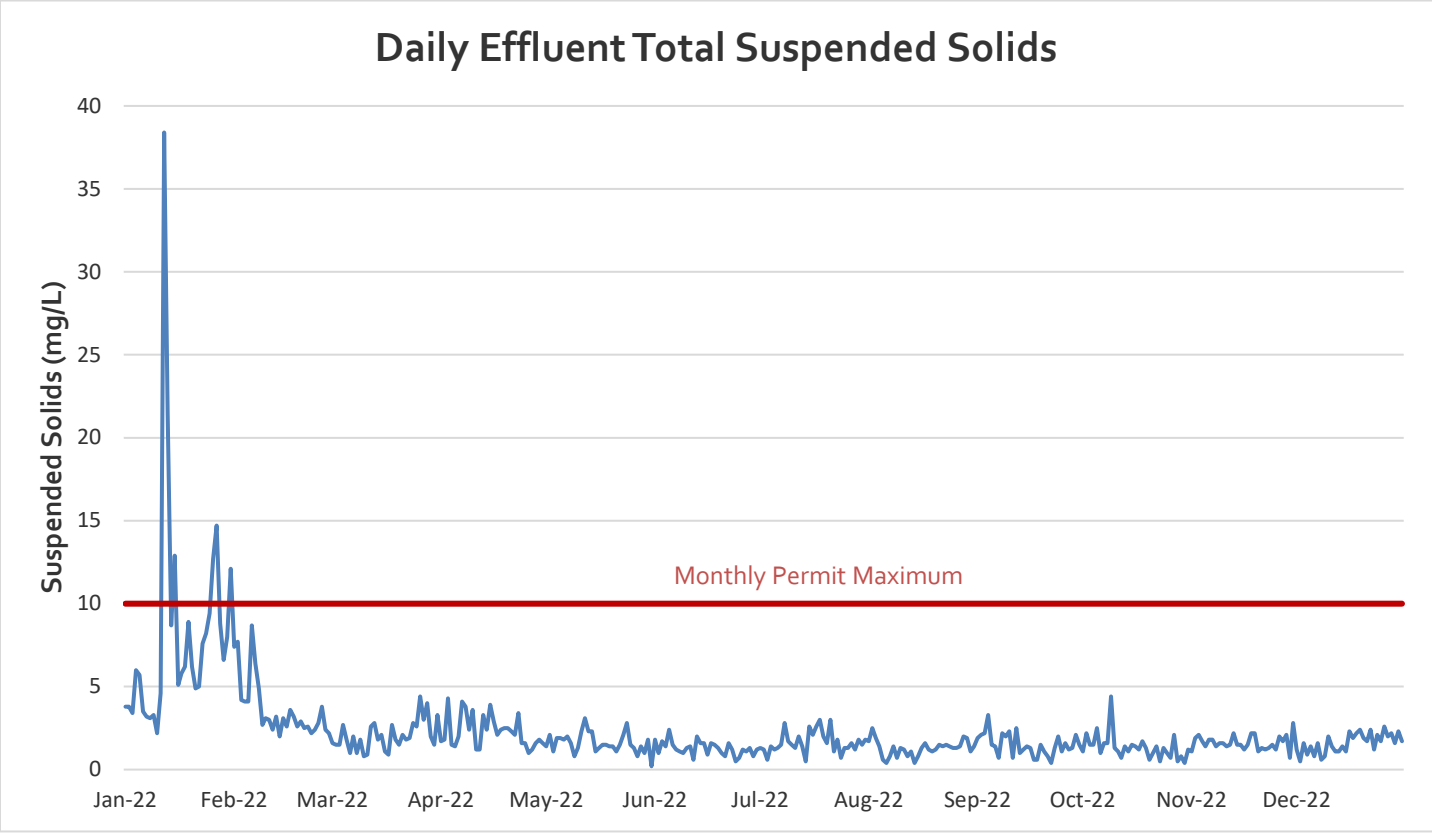


Figure 8. Total Daily Suspended Solid concentration

The 2022 average annual effluent TSS value was 2.3 mg/L and consistent with the historical average over the past 20 years (Figure 9).

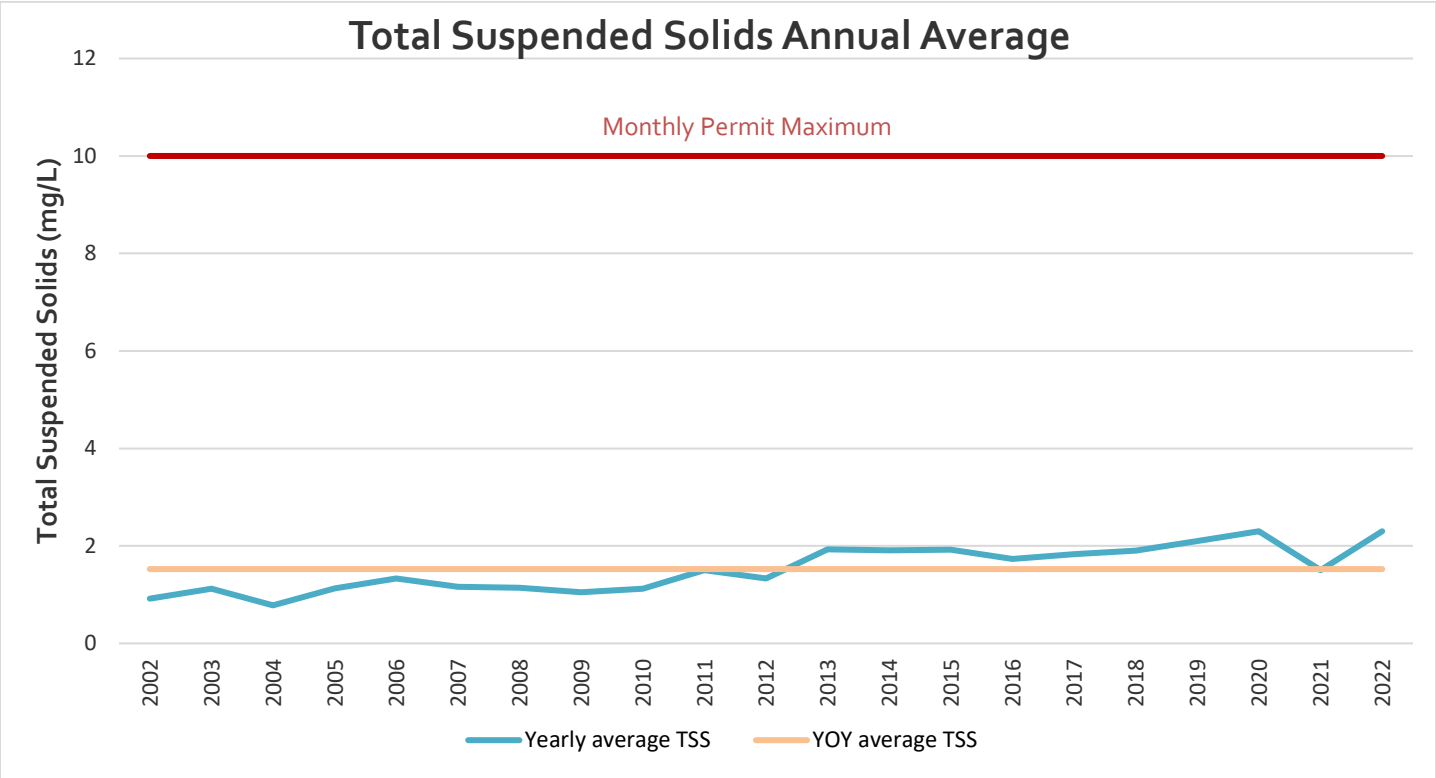


Figure 9. Annual average Total Suspended Solid concentration in effluent

The TSS removal efficiency of the treatment process declined 0.16% and indicative of an overall declining trend over the the past 20 years. Notable that the efficiency has remained within 0.5% over that time period (Figure 10).

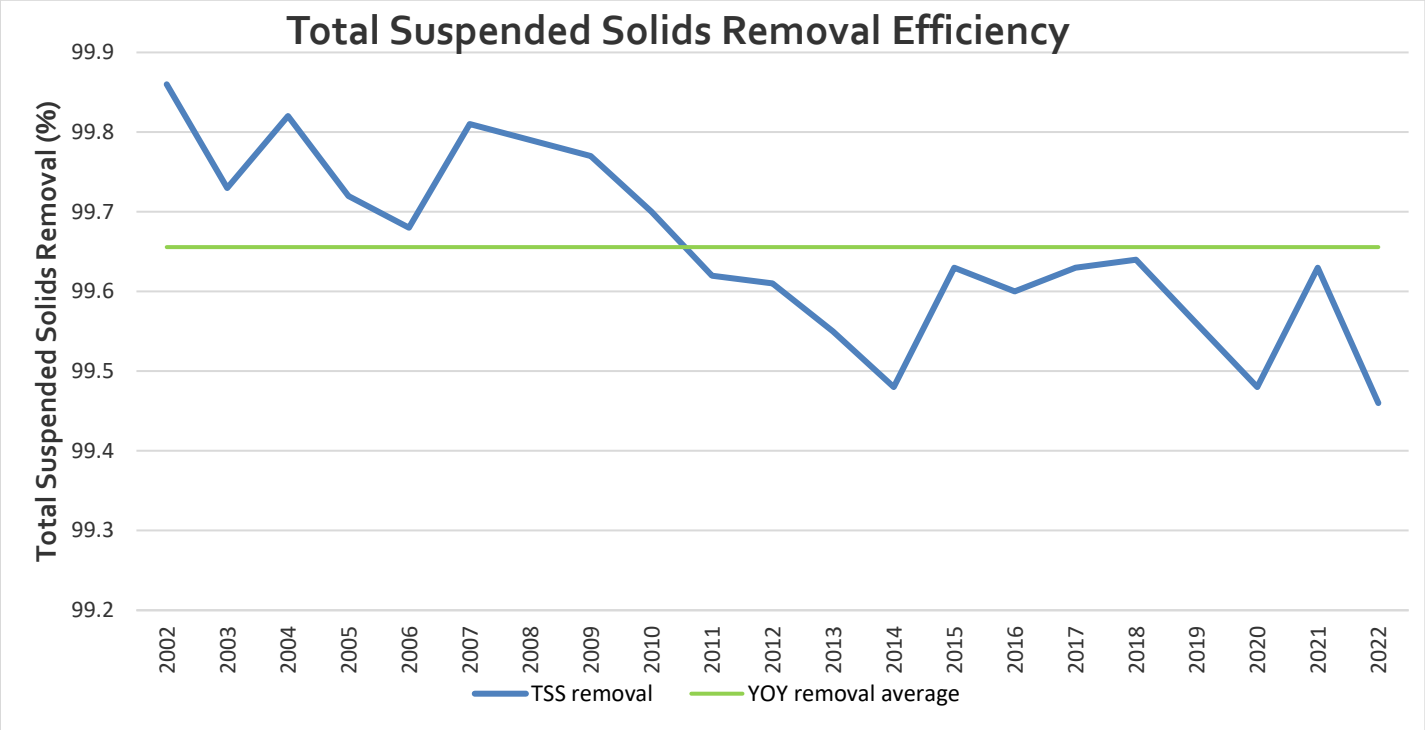


Figure 10. Total Suspended Solid process removal efficiency from Influent flow

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 stress and ecosystem changes.

Wastewater is made up of a variety of inorganic and organic substances from 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 into carbon dioxide and water is the biochemical oxygen demand (BOD). The 5-day BOD, or commonly referred to as BOD_5, 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 as necessary to support the growth of the beneficial bacteria.

Effluent BOD is typically measured on a bi-weekly basis with one measurement excursion above the monthly permit level of 10 mg/L (Figure 11).

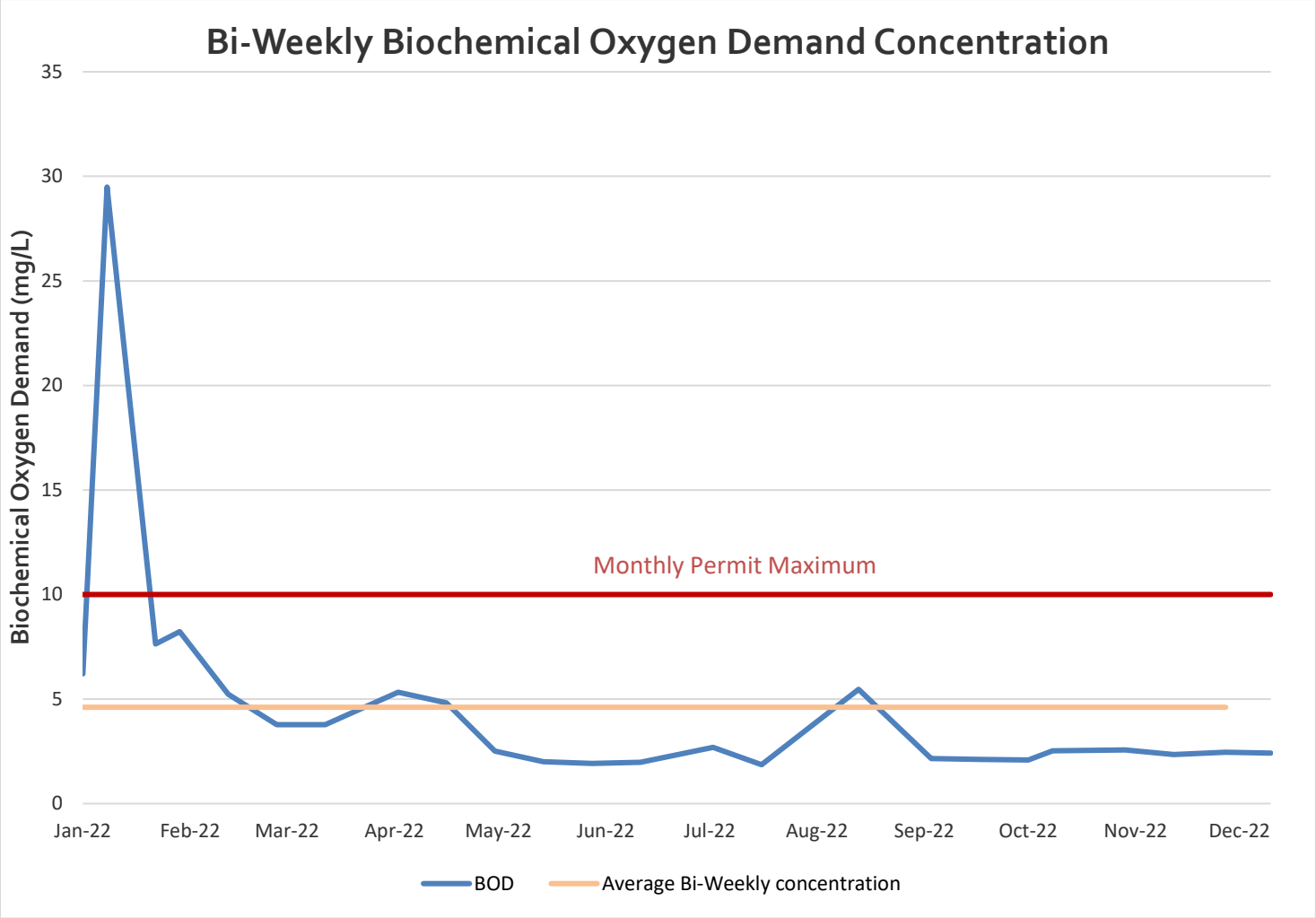


Figure 12. Weekly BOD Effluent concentration relative to permit

The 2022 annual average BOD discharge was 4.61 mg/L. higher than the 20-year historical BOD annual concentration average (Figure 12).

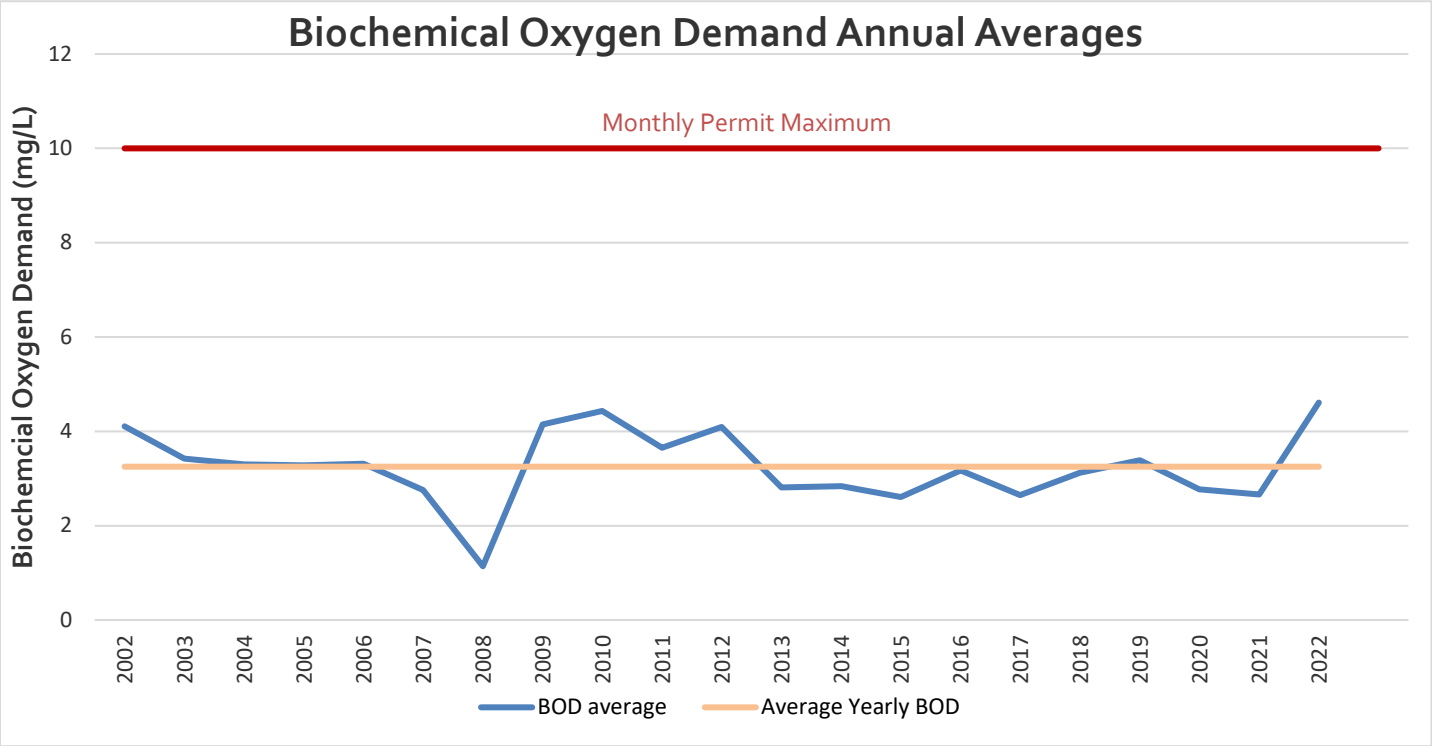


Figure 12. Annual average BOD concentration in discharge relative to permit

The BOD removal efficiency for 2022 was 98.7% which represents a 0.6% decrease form 2021 (Figure 13). The overall BOD removal efficiency trend has generally improved since 2012.

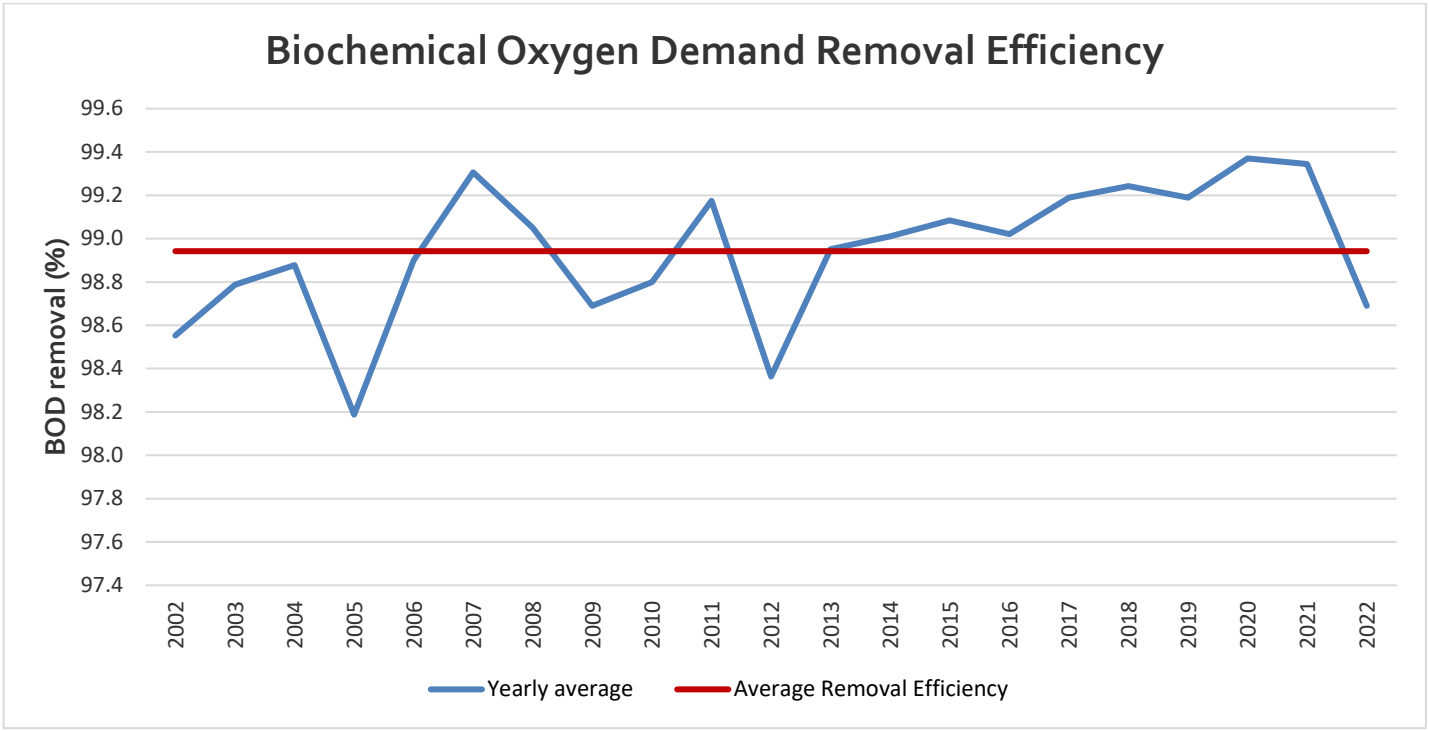


Figure 13 - BOD removal efficiency from Influent

Fecal Coliform

The effectiveness of the effluent UV disinfection is measured weekly through the monitoring of Fecal Coliform bacteria in the UV channels. All values throughout 2022 were well below the monthly permit level of 50 counts/100ml.

There has been a consistent, high level of effective disinfection over the past 22 years and at no time has the annual average Fecal concentration exceeded 1.1 count/100mL.

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 in 2021.

Acute Lethality	Date	LC50 (%v/v)
WWTF Final Effluent Grab	12-Aug-22	>100

Table 4. Effluent Acute Lethality

Metal Concentrations

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 metal parameter, the effluent water quality met all the requirements of the Canadian Drinking Water Guidelines for 2022.

Total Metals (Effluent)	Units	Canadian Drinking Water Guidelines	Influent Composite Jul 11, 2022	Effluent Composite Jul 11, 2022	Influent Composite Dec 20, 2022	Effluent Composite Dec 20, 2022
Aluminum (Al)-Total	mg/L	AO=0.1	0.478	0.0202	0.0966	*0.253
Antimony (Sb)-Total	mg/L	MAC=0.006	0.00098	0.00043	0.00061	0.00059
Arsenic (As)-Total	mg/L	MAC=0.01	0.00132	0.00056	0.0011	0.00052
Barium (Ba)-Total	mg/L	MAC=1	0.0456	0.0194	0.0266	0.0128
Boron (B)-Total	mg/L	MAC=5	0.198	0.195	0.137	0.175
Cadmium (Cd)-Total	mg/L	MAC=0.005	0.00033	0.000036	0.000103	0.000061
Calcium (Ca)-Total	mg/L		50	45.1	51.2	48.4
Chromium (Cr)-Total	mg/L	MAC=0.05	0.00331	0.00058	0.00118	<.000050
Copper (Cu)-Total	mg/L	AO=15	0.00077	0.0146	0.00051	0.0133
Iron (Fe)-Total	mg/L	AO=0.3	1.15	0.053	0.31	0.046
Lead (Pb)-Total	mg/L	MAC=0.01	0.0157	0.00075	0.001	0.00037
Magnesium (Mg)-Total	mg/L		18.1	15.6	15.2	14
Manganese (Mn)-Total	mg/L	AO=0.05	0.0952	0.0438	0.0503	0.0462
Mercury (Hg)-Total	mg/L	MAC=0.001	<.000040	<.000010	0.000061	<.000010
Potassium (K)-Total	mg/L		19.1	16.6	17.9	16.7
Selenium (Se)-Total	mg/L	MAC=0.05	0.00107	<.00050	0.00082	0.0005
Sodium (Na)-Total	mg/L	AO=200	90.8	82.9	83.1	81.5
Uranium (U)-Total	mg/L	MAC=0.02	0.00325	0.00126	0.00255	0.000806
Zinc (Zn)-Total	mg/L	AO=5	0.181	0.0542	0.0734	0.0491

MAC= Maximum Acceptable Concentration related to Health Concerns

AO = Aesthetic Objective related toTaste, Odor, Appearance

*Indicates the usage of alum for settling on Secondary Clarifiers

Table 5. Metal concentrations in Influent and Effluent Composite samples

Quality Control

To ensure quality control, the WWTF lab participates in a biannual Canadian Association of Laboratory Accreditation (CALA) proficiency testing program as well as an in-house developed quality control program that has standards for acceptable precision and accuracy of test results . All results of the Quality Control program were classified as being acceptable in 2022.

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 on behalf of various municipalities and districts that discharge into Okanagan Lake. This report is submitted to the Ministry of Environment as part of the condition on permit for wastewater operations. The report examines 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 fell within water quality objectives published (Nordin, 2005) with increasing trends noted in Phosphorus, Nitrogen, and Algae biovolume concentrations.

Biosolids Management

1215 loads of waste activated sludge, each averaging 16,736 kg, were removed from the Kelowna WWTF in 2022 for a total of 20,334 metric tonnes, which represents a 1.7 % descrease over 2021 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 6.

Dewatered Sludge for Composting - 2022															
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
192	80.8	163	0.0	5249	1.6	0.5	10.6	1.2	411	1.6	5.4	8.8	8.0	2.6	278

Table 6. Average monthly Biosolids composite concerntrations

Reclaimed Wastewater

The City is committed to water conservation, the WWTF is situated on 21.27 acres of landscaped property. To help, the WWTF irrigation system was converted to use reclaimed wastewater effluent to water landscaping around the treatment plant grounds.The effluent is treated with chlorine and routinely tested to meet Ministry water quality guidelines. In 2022 the WWTF used a total of 815ML of reclaimed treated wastewater effluent for general outdoor operations of the facility and in onsite irrigation March to October.

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 Manager, one EOCP Level IV Supervisor, one EOCP Level III Operations Foreman, three EOCP Level III Operators, eleven EOCP Level II Operators, one Maintenace Foreman, three Millwrights, one Instrumentation/Electrical Foreman, three Instrumentation/Electrical Technicians, two Laboratory staff, and one Source Control Technician (Figure 14).

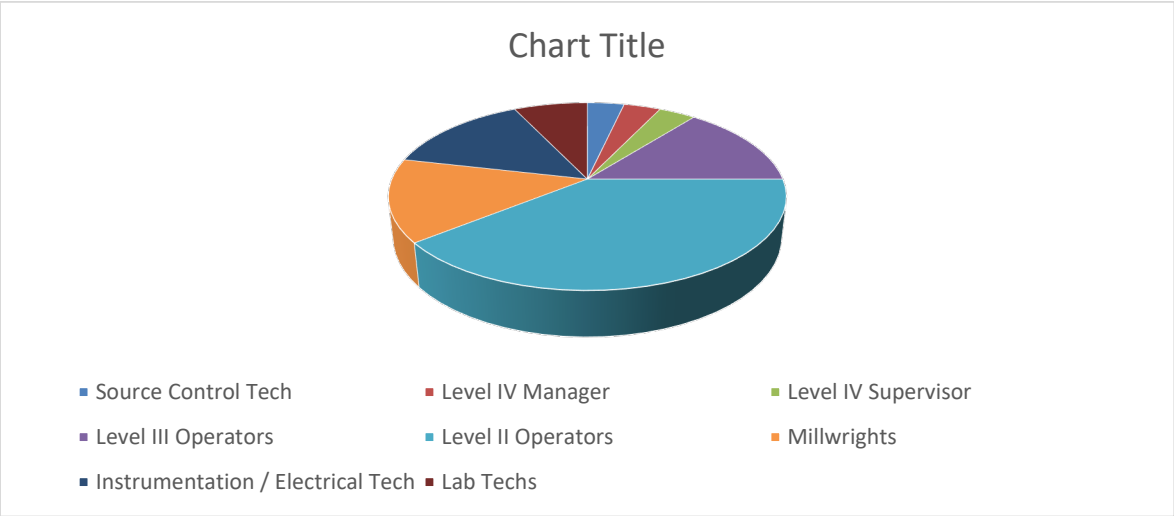


Figure 14. Overview of WWTF Operators certification level and support staff

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 concern. 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 an asset management and scheduling system 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 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. There were no reported odor complaint registered from residents or businesses in the area throughout 2022.

Emergency Response Plan

A thorough review of the WWTF Emergency Response Plan was conducted in 2022 by staff and updated to reflect current practices and policies and aligns with the permit requirements of the COK treatment plant. 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. Three energy reductions were explored and implemented in 2019 through 2022, further reducing the facility energy consumption and overall green house emmissions.

The WWTF continues to participate in the annual National Water and Wastewater Benchmarking Initiative (NWWBI) 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

There was an overall upward trend in wastewater nutrient discharge concentrations year over year (Table 7). However, treatment objectives in all major parameters in 2022 primarily met conditions on permit.

Total P	Total N	TSS	BOD	Fecal
Up 0.05 mg/L	Up 0.06 mg/L	Up 0.08 mg/L	Up 1.95 mg/L	No Change

Table 7. Nutrient treatment trends

Despite a population increase over 13% since 2017, overall influent flow has remained consistent (+/-5%). Nutirent concentrations have marginally increased over that time period (Table 8), but still within annual permit guidelines.

Total P	Total N	TSS	BOD	Fecal	Flow	Population
Up 1%	Up 9%	Up 8%	Up 15%	No Change	No Change	Up 13%

Table 8. Effluent nutrient discharge concentration trends since 2017

The City 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:

"Kelowna, a City of the Future"

City of Kelowna is pleased to present the 2022 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 utility at 250-469-8502 or email at ask@kelowna.ca.