CITY OF Thunder Bay
Superior by Nature

WASTEWATER TREATMENT

Annual Report 2022

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Introduction

The City of Thunder Bay (City) owns and operates the Water Pollution Control Plant (WPCP) located at 901 Atlantic Avenue. The Plant provides primary and secondary treatment, phosphorus and ammonia removal and anaerobic sludge digestion for the entire serviced area of Thunder Bay. Disinfection of the effluent occurs on a seasonal basis, from April 15 to October 15. The treatment facility has a rated capacity of 84.5 million litres per day.

This report is prepared on an annual basis to meet the requirements of the Government of Ontario's Ministry of the Environment, Conservation and Parks (MECP) amended **Environmental Compliance Approval (ECA) #6927-9QDM2P** for the design and operation of the Atlantic Avenue WPCP. It also serves to explain the operation of a vital part of the City of Thunder Bay's infrastructure.

Wastewater Treatment Process

1. INFLUENT PUMP STATION

Wastewater from the serviced area in Thunder Bay enters the WPCP at the Influent Pump Station (IPS) where five pumps are available to deliver the wastewater to the preliminary treatment process. The wastewater then flows by gravity to the end of the primary treatment process.

2. PRELIMINARY TREATMENT

The Preliminary Treatment Process removes larger objects such as rags, paper, and wood debris. The wastewater enters two aerated grit tanks, where the flow is slowed to allow solids to settle out. Suspended heavier material such as sand and gravel settles to the bottom of the grit tanks, where it is collected and dewatered by grit classifiers. This material is collected and hauled to the City's Solid Waste and Recycling Facility (SWRF). Polymer is added to the grit tanks to increase the settlement of suspended solids. Aluminum sulphate is also added to help remove phosphorus and suspended solids.

3. PRIMARY TREATMENT

The Primary Treatment Process settles the organic material and dissolved contaminants by gravity in four large rectangular settling tanks (clarifiers). The wastewater flows very slowly through the clarifiers, where the wastewater, now called primary effluent, overflows the outlet weirs. A surface skimmer pushes fats, oils and greases (FOG) to the scum troughs, which then feeds the FOG into the scum treatment system. Settled sludge is moved by a skimmer along the bottom of the clarifier to a sludge hopper where the sludge is collected and then treated in the anaerobic digesters to allow decomposition by micro-organisms.

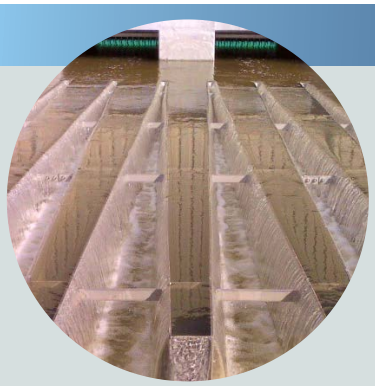
4. SECONDARY TREATMENT

Secondary Treatment is a biological process that uses aerobic bacteria to consume suspended solids and dissolved organic materials in wastewater. The WPCP uses the Biological Aerated Filter (BAF) process. The BAF process removes biochemical oxygen demand, suspended solids and ammonia. In the filters, the primary effluent flows upward through a bed of media. The filters are aerated to satisfy the requirements of the micro-organism population and to maintain biological activity and growth.

Sludge generated in the Secondary Treatment Process is thickened in the Dissolved Air Flotation (DAF) plant before being treated in the anaerobic digesters.

5. DISINFECTION

Treated wastewater is disinfected with ultraviolet (UV) light to destroy pathogenic bacteria. The process utilizes UV light, and therefore has no impact on the chemical composition of the water. UV disinfection is required from April 15 to October 15.



6. DISCHARGE

The final step in the wastewater treatment process is the return of clear treated water to Lake Superior. The effluent from the WPCP is discharged into the Kaministiquia River, approximately 400 metres upstream of Lake Superior.

7. SOLIDS TREATMENT AND COGENERATION

Sludge is produced as a by-product of the wastewater treatment process. Two types of sludge, primary and secondary, are processed in the anaerobic digesters.

Biogas contains approximately 60% methane (the combustible component of natural gas). The cogeneration system converts the biogas to electricity and captures the heat generated from the engine. The biogas can also be used in the plant boilers to generate heat.

Digested sludge is mechanically dewatered using centrifuges to separate the solids from the liquid to create a sludge cake. The centrifuges increase the solids content of the digested sludge from approximately 2% to 25%. The sludge cake is collected in bins and transported to the City's SWRF for final disposal.

The residual liquid (centrate) is returned to the Influent Pump Station for processing.

FINAL EFFLUENT MONITORING AND COMPLIANCE

The MECP sets effluent discharge limits and objectives for all wastewater plants across the province. The limits are set out in the Environmental Compliance Approval (ECA) for each plant. The limits define the maximum concentrations or ranges of parameters such as:

- Total Suspended Solids (TSS), a measure of the amount of particulate matter in the water
- Acidic or alkaline (pH) levels
- Carbonaceous Biochemical Oxygen Demand (CBOD), a measure of the amount of material in water that will consume oxygen as it decomposes
- E. coli bacteria associated with the wastewater during the disinfection season (April 15 to October 15)
- Total Phosphorus (TP), where high levels can cause increase growth of algae and large aquatic plants
- Ammonia, as the total ammonia expressed as nitrogen. Ammonia has seasonal objectives set under the ECA

Compliance Summary

During 2022, the final effluent met all the ECA limits for $CBOD_5$, TSS, TP, pH. Due to extreme wet weather events in April and May 2022, the E. coli limits were not achieved. The WPCP was operating above its rated capacity during this time, with flows bypassing the second stage of the secondary treatment process. The UV disinfection system was operating at 100% capacity and supplemental disinfection treatment was provided using calcium hypochlorite pucks.

The TSS effluent concentrations remained below the ECA objective and limits for the entire year. See Figure 1 below for the monthly total suspended solids and carbonaceous biochemical oxygen demand.

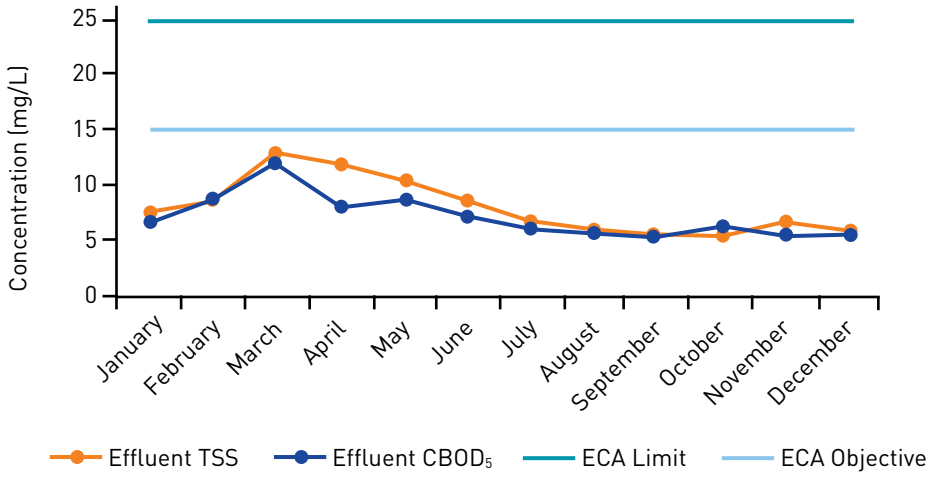


Figure 1: Monthly Effluent Results - TSS and $CBOD_5$

The effluent total phosphorus concentrations were below the ECA limits for the year and at or below the ECA objectives for the year. The primary coagulant dosage was increased to lower the total phosphorus concentration below the objective during the periods of low wastewater flow. Refer to Figure 2 for the monthly effluent total phosphorus concentrations for 2022.

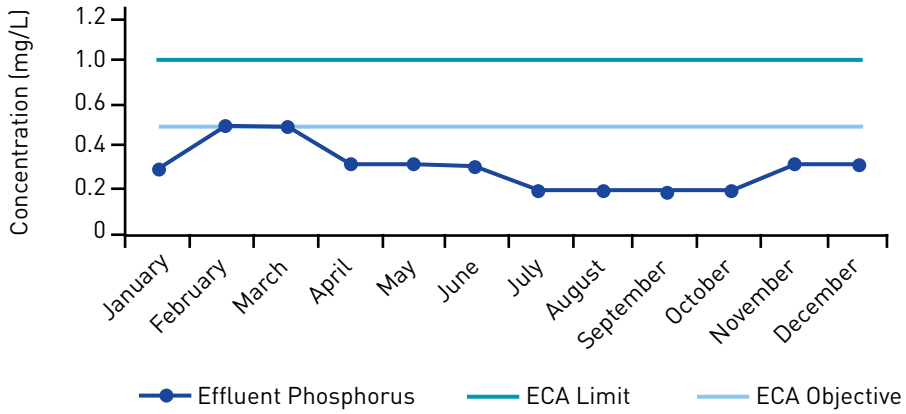


Figure 2: Monthly Effluent Results - Total Phosphorus

The effluent pH for the WPCP remained within the range outlined in the ECA as shown in Figure 3.

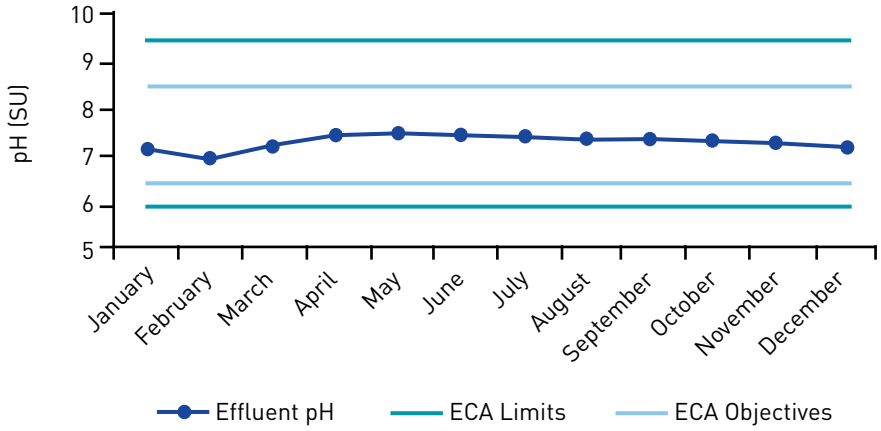


Figure 3: Monthly Effluent Results - pH

The monthly effluent results for total ammonia nitrogen remained below the ECA objectives for the majority of the year. The effluent ammonia concentrations were over the objective in March. This was due to the limited nitrifying capacity in the secondary treatment process during periods of colder wastewater temperatures.

The effluent ammonia concentrations were also above the ECA objectives in June and July. This was due to the limited nitrifying capacity in the secondary treatment process during and after the wet weather events where the WPCP was operating above the rated capacity.

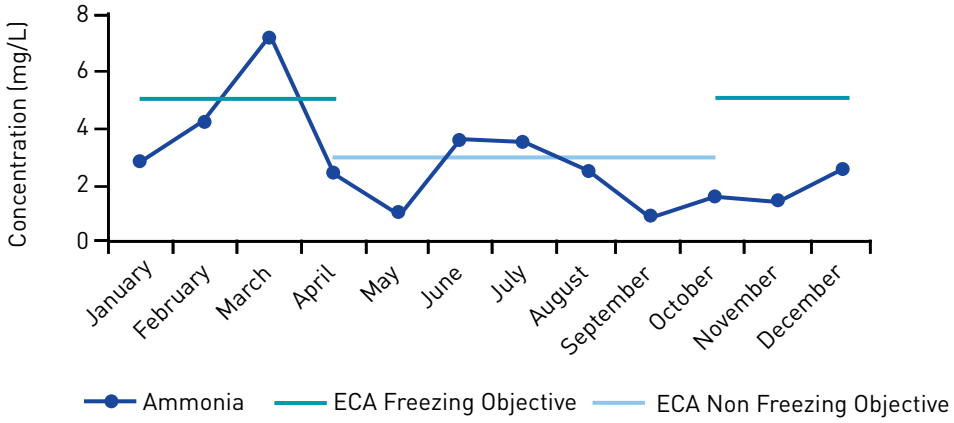


Figure 4: Monthly Effluent Results - Ammonia Nitrogen

BIOSOLIDS SUMMARY

The dewatered sludge generated in 2022 is presented in Figure 5. In 2022, 7,777 tonnes of biosolids (dewatered sludge) were hauled to the City's SWRF by a contracted waste hauler. The biosolids are weighed before being buried with incoming solid non-hazardous waste. Dewatered sludge will continue to be direct buried at the City's SWRF in 2023. The WPCP expects to generate approximately 8,000 tonnes of biosolids in 2023, assuming a similar wastewater flow.

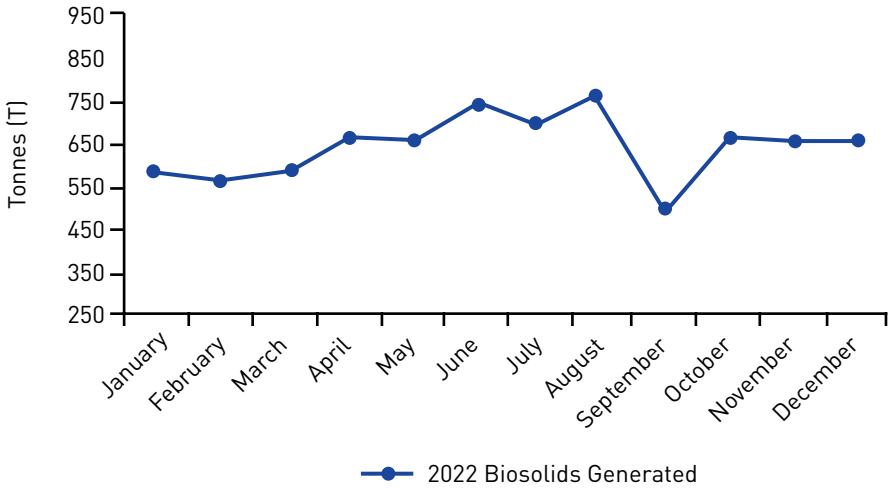
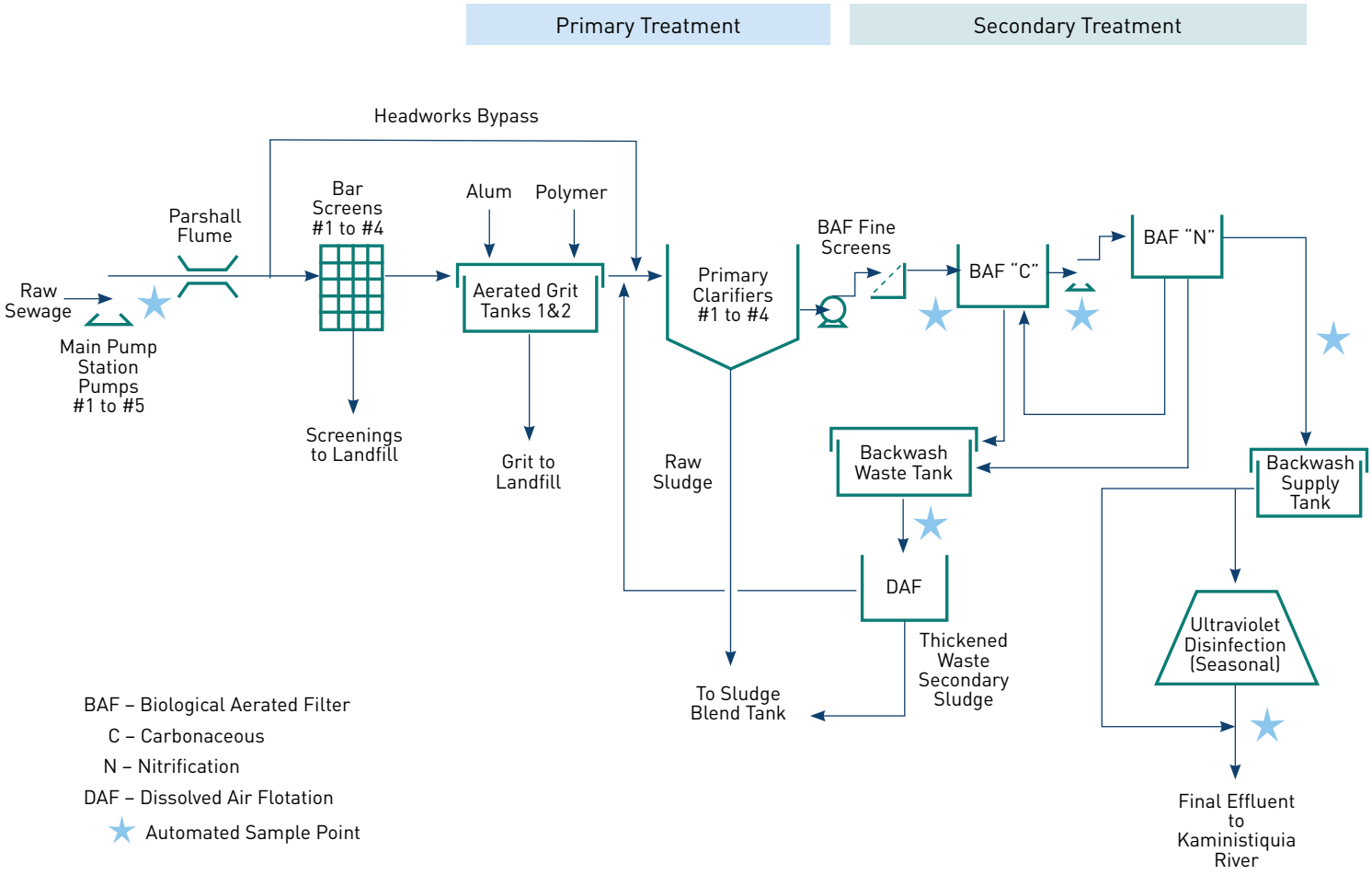


Figure 5: Biosolids Shipped to Solid Waste & Recycling Facility (SWRF)

PLANT TREATMENT PROCESS SCHEMATIC



INFRASTRUCTURE PROJECTS

As part of the Environment Division's Asset Management Plan, many projects were carried out during 2022 to protect and improve the equipment and infrastructure.

2022 WPCP PROJECTS

Influent Pump Station (IPS)

- Wet well cleaning and scum removal
- Parshall Flume access stairs installed
- VFD replaced on 400 Hp main sewage pump
- Replacement of autosamplers (6)
- Parshall Flume transmitter verification and calibration

Primary Treatment

- Annual maintenance on primary clarifiers
- Bar screen and influent channel cleaning
- Bar screen #2 refurbishment
- Replacement of Primary Clarifier #4 Raw Sludge Pump intake pipe
- Screen and Grit odour control unit media replacement
- New scum tipper actuators on Primary Clarifiers #1 and #2

Sludge and Dewatering System

- Digester #2 cleaning and service
- Alfa Laval on site for centrifuge assessment and optimization
- Replace Dewatering long conveyor #1 and bearings
- Centrifuge #2 main motor replacement
- Dewatering loading bay apron extension

Biological Aeration Filtration (BAF)

- BAF filter aeration system service
- New BAF interstage pump #1
- BAF interstage pump #2 rebuild
- BAF filter #1, #3 and #5 drain valve replacements
- BAF fire alarm panel upgrade
- Fine screen long conveyor and gearbox replacement
- BAF water supply line upgrade
- DAF tank area overhead rail extension
- DAF alum dosing pump replacement
- DAF polymer feed delivery system improvements

Heating and Ventilation

- IPS HVAC maintenance
- BAF HVAC upgrades
- DAF glycol supply line and valving upgrades
- Boiler repairs

Buildings & Grounds

- Primary clarifier weir levelling
- Alum off-loading header replacement
- Site wide Matterport survey

Cogeneration

- Major overhaul of top end of cogen
- Gas skid overhaul of media and filter replacement

Electrical & Instrumentation Systems

- Infrared scan arc flash window installations and survey
- Load bank testing and annual service of generators and remote station
- 5 kV vacuum breaker testing and inspection
- Optimization of incoming 4160 kV breaker trip settings
- New fibre optic communication line brought into the plant
- Assessment and updates for cybersecurity resiliency
- Third party cybersecurity vulnerability scan and assessment
- IT/OT information and operational technology service agreement in place

Disinfection System

- UV system maintenance and lamp replacement
- UV wiper PLC integrated with the UV Main PLC
- Trojan Technologies on site for assessment and optimization

Wastewater Collection – Pollution Prevention Control Plan

- Separation of 445 m of sanitary sewers
- Majority of the sewer separation work occurred in the area of Legion Track Dr. , Miles St. W, Alloy St. W, Franklin St. and Moodie St. E

WASTEWATER SYSTEM SUMMARY
2022 ATLANTIC AVENUE WATER POLLUTION CONTROL PLANT

INFRASTRUCTURE

520 km of sanitary sewer

2.7 km of combined sewer

Four remote lift stations

Serving over **108,000** people

WASTEWATER TREATED

Over 28 billion

litres of wastewater treated in 2022

Equivalent to over 11,200 Olympic sized swimming pools

Average flow of 77 MLD

RESOURCES

1,640 MWh of electricity generated on-site

Over **80%** of gas generated in digesters was used to generate electricity or heat on-site buildings

OPERATIONS

5,000+ samples analyzed by in-house lab

17 licensed operators

Operated **365** days/year

24 hours/day

ENVIRONMENTAL PROTECTION

100% of effluent limits were achieved*

Over 90% removal efficiency for:

- Ammonia
- Suspended Solids
- Phosphorus
- Carbonaceous biochemical demand

Over **7,700** Tonnes of solids removed from effluent stream

Equivalent to the weight of **47** adult moose a day

*with secondary treatment

WASTEWATER SURVEILLANCE

The Wastewater Surveillance Initiative was created in late 2020 by the MECP to coordinate and fund university-led efforts in sewage analysis for COVID-19. Wastewater surveillance provides a non-invasive, anonymous and scalable method of obtaining pooled samples from a population within a geographic area at a point in time, completely independent of clinical testing. In collaboration with the MECP and the University of Windsor, weekly sampling for COVID in the influent wastewater began in February 2021. Sampling and analysis since has increased to three-times weekly and expanded to include surveillance for Influenza A and RSV.

COMPLIANCE & QUALITY CONTROL LABORATORY

The Compliance & Quality Control (C&QC) laboratory supports the process control testing for the WPCP. The testing includes, but is not limited to the following parameters: carbonaceous biochemical oxygen demand ($CBOD_5$), total suspended solids (TSS), total and soluble phosphorous (TP and SP), total solids (TS), volatile solids (VS), volatile acids, ammonia, alkalinity and ultraviolet transmittance (UVT). The laboratory has a quality control and assurance program in place. Additionally, the calibration and verification of the analytical equipment used in the laboratory is confirmed annually.

An external accredited laboratory conducts tests for metals, COD, ammonia, E. coli and total Kjeldahl nitrogen (TKN). Also, the C&QC laboratory provides analytical support for the SWRF and the Sewer Use Control Program.

CALIBRATION & MAINTENANCE OF MONITORING EQUIPMENT

Calibration and maintenance of the effluent monitoring equipment and automatic samplers was carried out by the Environmental Inspector and Laboratory Technicians. The influent flow measuring device is verified for accuracy by Plant Electricians on a routine basis and calibrated by a third party on an annual basis.

SEWER USE CONTROL PROGRAM

The Hauled Sewage Monitoring Program recorded a total of 944 loads of processed water and septic tank wastes, which accounted for 13.8 million litres received and processed at the WPCP in 2022. The WPCP provided sewage disposal services for cruise ships docked at the Pool 6 Cruise Terminal at the Prince Arthur's Landing and Marina.

The Over-Strength Discharge Program, provided through the City's Sewer Use By-law, allows participating industrial users to discharge effluent which contains excess phosphorous, $CBOD_5$, and total suspended solids higher than the limits outlined in the By-law. An additional fee, based on these parameters, and on the actual treatment cost of the loading above the By-law limits, is then applied to these industries. Industries approved to discharge are issued agreements, as required.

The City's Environmental Inspector responded to 12 reports of possible spills or pollution complaint calls in 2022. Each of these issues were addressed and remediated as required.

SUMMARY OF COMPLAINTS

The ECA requires that all complaints received by the WPCP are logged, investigated and resolved. The City makes every effort to contact residents and address their concerns. There were no complaints received in 2022 related to the WPCP.

BYPASS EVENTS

Occasional weather events such as heavy rainfall and spring snow melt can result in flow rates that exceed the WPCP design capacity and burden the treatment process. Challenges such as these and the requirement for planned, preventative maintenance, may result in a discharge to the environment that has not undergone all treatment processes at the WPCP.

During 2022, there was a 44% increase in precipitation compared to 2021. Almost all wastewater bypasses in 2022 were caused by wet weather events.

Two types of bypasses account for the majority of the bypasses during 2022. The first type is parallel bypasses, where wastewater received screening, grit removal, primary treatment and the first stage of secondary treatment (carbonaceous removal), prior to discharge. The second type is secondary bypasses, where wastewater received screening, grit removal and primary treatment prior to discharge. Total bypassed flows were estimated to be 5,800 ML of parallel bypasses and 1,000 ML of secondary bypasses. During the disinfection season, from April to October, the bypasses received UV disinfection prior to discharge.

All bypass events were reported to the MECP, ECCC and the Thunder Bay District Health Unit following established reporting protocol.

There were no combined sewer overflows at the discharge located in the McVicar Creek.

"Island Drive Bridge"
by Sean Randall

DATA TABLES

Table 1: Flows Received

Month	Influent Volume (ML)	Total Precipitation (mm)	Maximum Daily Flow (MLD)	Average Daily Flow (MLD)
January	1,690	19	125	54.5
February	1,428	36	136	51.0
March	1,796	67	118	57.9
April	4,066	183	525	135.5
May	4,601	107	425	148.4
June	2,731	43	290	91.0
July	2,127	66	98	68.6
August	1,995	45	139	64.4
September	2,196	108	216	73.2
October	1,926	25	120	62.1
November	1,790	58	110	59.7
December	1,679	41	117	54.2
Total	**28,026**	**798**		
Average	**2,335**	**66**		**76.7**

Table 2: Plant Effluent Quality – Monthly Average Concentration

Month	$CBOD_5$ (mg/L)	TSS (mg/L)	TP (mg/L)	E. coli (#/100 mL)	TAN (mg/L)	pH (SU)	Temperature (°C)
Limit	25.0	25.0	1.0	200 [1]	No Limit	6.0 to 9.5	No Limit
Objective	15.0	15.0	0.5	150 [1]	Apr 1 - Oct 31: 3.0 Nov 1 to Mar 31: 5.0	6.5 to 8.5	No Objective
January	6.4	7.4	0.3		2.9	7.2	11.4
February	9.2	9.1	0.5		4.4	6.9	10.9
March	12.4	13.2	0.5		7.5	7.3	10.9
April	8.4	12.9	0.3	741	2.6	7.6	10.8
May	9.2	11.8	0.3	7,124	1.7	7.7	11.5
June	7.0	9.2	0.3	88	3.7	7.8	14.6
July	6.7	7.0	0.2	122	3.6	7.7	17.4
August	5.5	6.0	0.2	39	2.7	7.5	18.3
September	5.2	5.8	0.2	25	1.0	7.5	17.7
October	5.7	5.7	0.2	17	1.4	7.4	16.3
November	6.6	7.2	0.3		1.2	7.3	14.1
December	6.9	6.9	0.3		2.8	7.2	12.2
Average	**7.4**	**8.5**	**0.3**	**138**	**3.0**	**7.4**	**13.8**

1 Monthly geometeric mean density

Table 3: Plant Effluent Quality – Monthly Average Loading

Month	$CBOD_5$ (kg/d)	TSS (kg/d)	TP (kg/d)
Limit	2112.5	2112.5	84.5
January	346.0	404.8	18.7
February	467.2	462.5	24.6
March	707.5	759.1	28.9
April	998.0	1956.4	44.0
May	1360.1	1894.2	54.1
June	647.2	882.5	28.0
July	469.9	483.8	15.8
August	360.8	381.9	13.8
September	353.4	416.6	13.8
October	350.3	352.8	13.2
November	377.4	430.8	15.9
December	350.1	376.1	16.1
Average	**565.7**	**733.5**	**23.9**

Table 4: Sludge Dewatering Results

Month	Sludge to Dewatering (m^3/day)	Total Sludge Dewatered (m^3)	Biosolids Generated (Tonnes)
January	246	7,614	568
February	253	7,071	533
March	256	7,937	589
April	283	8,484	688
May	229	7,099	636
June	263	7,894	756
July	222	6,888	708
August	254	7,885	775
September	187	5,623	516
October	251	7,794	687
November	271	7,587	663
December	256	7,949	658
Average	**248**	**7,485**	**648**
Total		**89,825**	**7,777**

Staff Organization

Infrastructure and Operations

General Manager - Kerri Marshall, P. Eng., MBA, FEC

Policy & Research Analyst – Julie Wiejak

Project Manager - Amy Coomes

Sustainability Coordinator - Summer Stevenson

Climate Adaptation Coordinator Jacob Porter

Communications Officers – Amanda Nason, Stephanie Reid (Acting)

Technology Management Specialist - Henry Connor, B. Eng.

Environment Division

Director Michelle Warywoda, P. Eng.

Administrative Assistant - Lynae Grace

Chief Chemist – Ian Morgan, Ph.D., P. Chem., C. Chem.

Managers – Compliance & Quality Control – Tony Santos, Gary Person

Planning & Research Analyst Dan Currie, C.E.T.

Process Engineers - Lindsay Menard, P. Eng., PMP, Walter Turek, P. Eng.

Training & Quality Assurance Coordinators – Shelby Jaspers, Marc Leschuk, P. Eng.

Water and Wastewater Engineer – Joshua Daniels, M. Eng., P. Eng.

Water Pollution Control Plant

Plant Superintendent – Bob Bates, P. Eng.

Supervisor, Maintenance – Mike Brown

Supervisor, Operations – Mark Wilson

Accounting & Administration Clerk – Kristie Fisher

Chief Operator, Electrical – Andreas Makrides

Chief Operator, Maintenance – Sal Piccolo

Chief Operator, Operations – Rick Sutton

Environmental Inspector – Patrick McGuire

Janitor/Handyworker – Darrin White

Laboratory Technicians – Julie Carlin, Brett Rizzuto

Millwrights – Gord Belanger, Thane Gagnon, John Hrycyk, Mike Noga, Warren Perry

Operators – Shane Bureau, Keenan Colosimo, Jeff Coull, Phillip Kennedy, Cody Lane, Patrick Melanson, Marcus Uliana, Chris Unick

Plant Electrician – Brian Dobson

Relief Operators Daniella N de Lima, Reid Stajkowski

WATER POLLUTION CONTROL PLANT
CITY OF THUNDER BAY
ENVIRONMENT DIVISION
901 ATLANTIC AVE
THUNDER BAY ON P7C 2T3

TEL: (807) 625-3370

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