CITY OF Thunder Bay
Superior by Nature

2023

# WASTEWATER TREATMENT

ANNUAL REPORT

# Table of Contents



**List of Figures**



**List of Data Tables**

# Introduction

The City of Thunder Bay (City) owns and operates the Water Pollution Control Plant (WPCP) located at 901 Atlantic Ave., on the shore of Lake Superior. 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 Oct. 15. The treatment facility has a rated capacity of 84.5 million litres per day (MLD).

The Atlantic Avenue WPCP is classified as a Class IV wastewater treatment facility under Ontario Regulation 129/04. This WPCP is operated under **Environmental Compliance Approval (ECA) #6927-9QDM2P**.

This report summarizes the monitoring results for the Atlantic Avenue WPCP required by the ECA and describes the operational performance to ensure production of quality effluent. In 2023, the annual average daily flow to the WPCP was **60 million litres**, which is **71%** of the rated capacity specified in the ECA. The Report 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 feed 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.

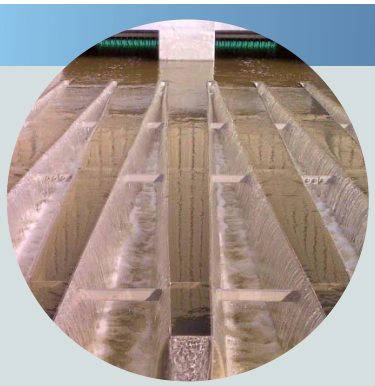
## 4. SECONDARY TREATMENT

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 Oct. 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

Ontario's Ministry of the Environment, Conservation and Parks (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 ($CBOD_5$), 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 Oct. 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

Throughout 2023, the Atlantic Avenue WPCP met the effluent concentration limits for Total Suspended Solids (TSS), Total Phosphorus (TP), E. coli, and maintained pH within the range of 6.0 to 9.5, as prescribed in the ECA. The WPCP experienced operational challenges related to the planned secondary plant maintenance outage and meeting the limits for Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) in November and December.

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.

Despite running the WPCP in Chemically Enhanced Primary Treatment during the planned secondary treatment plant maintenance outage, the WPCP encountered difficulties in meeting the effluent limits for $CBOD_5$. The effluent exceeded $CBOD_5$ monthly average limit of 25.0 mg/L, with an average of 42.8 mg/L in October, and 26.1 mg/L in November.

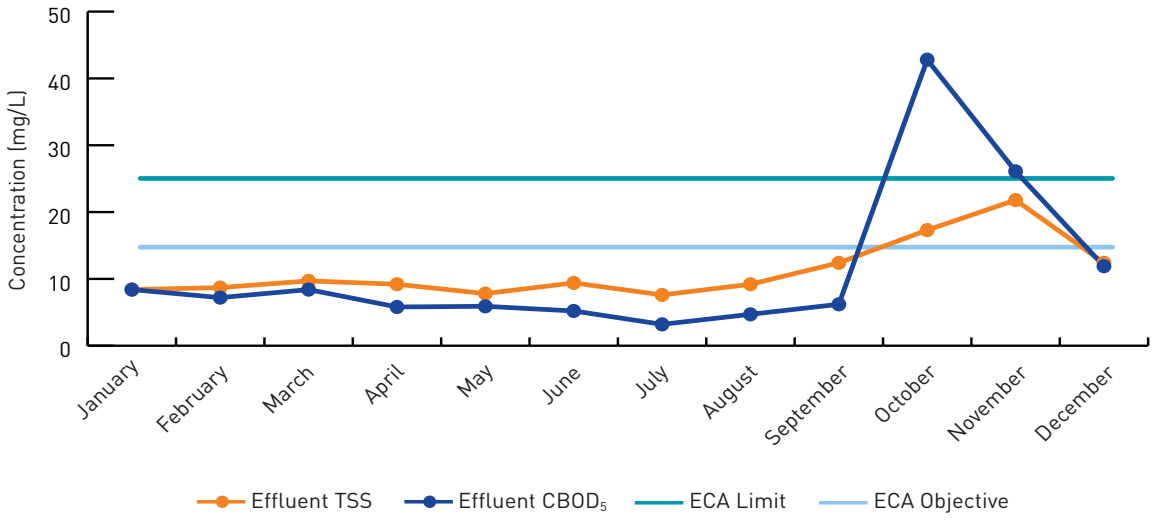



**Figure 1**: Monthly Effluent Results - TSS and $CBOD_5$

The effluent total phosphorus concentrations remained below the ECA limits during the year. While the WPCP was operating in Chemically Enhanced Primary Treatment, which occurred during the planned secondary treatment maintenance outage, the total phosphorus objectives were not met. Refer to Table 1 – Summary of Operating Issues and Actions Taken for more details.

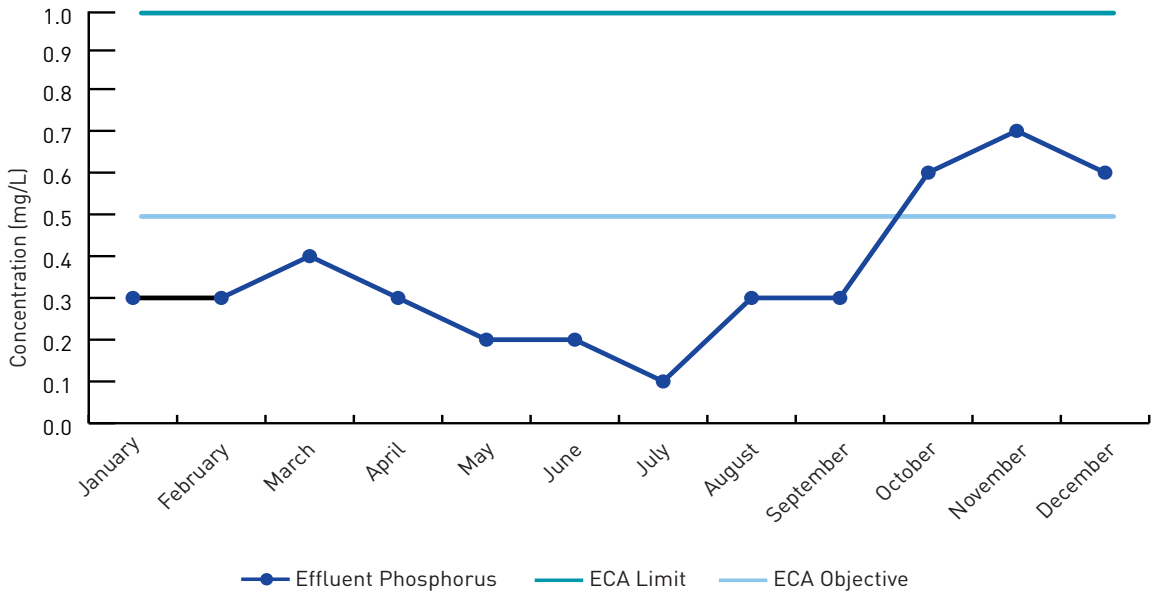



**Figure 2**: Monthly Effluent Results - Total Phosphorus

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

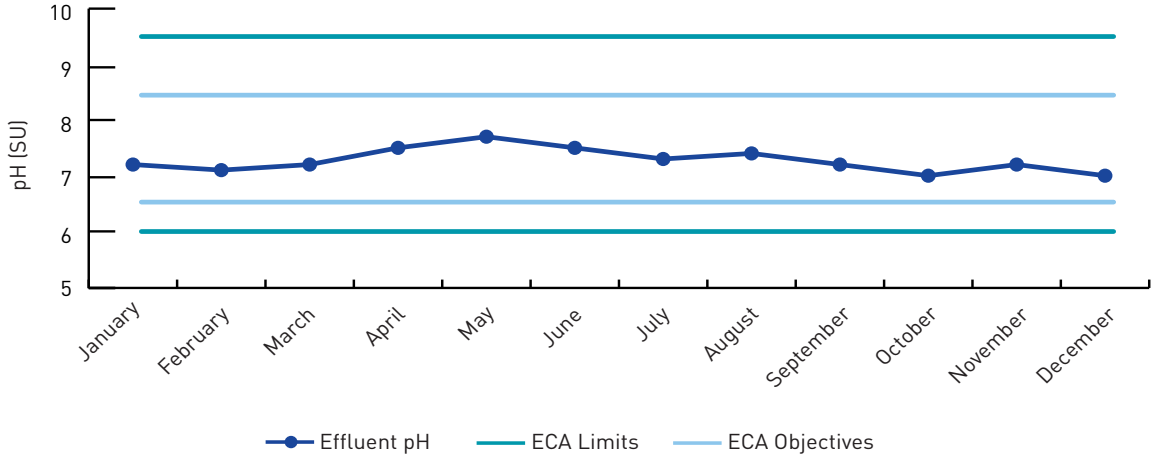



**Figure 3**: Monthly Effluent Results - pH

The effluent exceeded total ammonia nitrogen monthly average objectives for roughly half of the year. This occurred during the colder months due to a combination of the limited nitrifying capacity in the secondary treatment process during periods of colder wastewater temperatures and the secondary treatment plant returning to service after maintenance outages. Refer to Figure 4: Monthly Effluent Results - Ammonia Nitrogen.

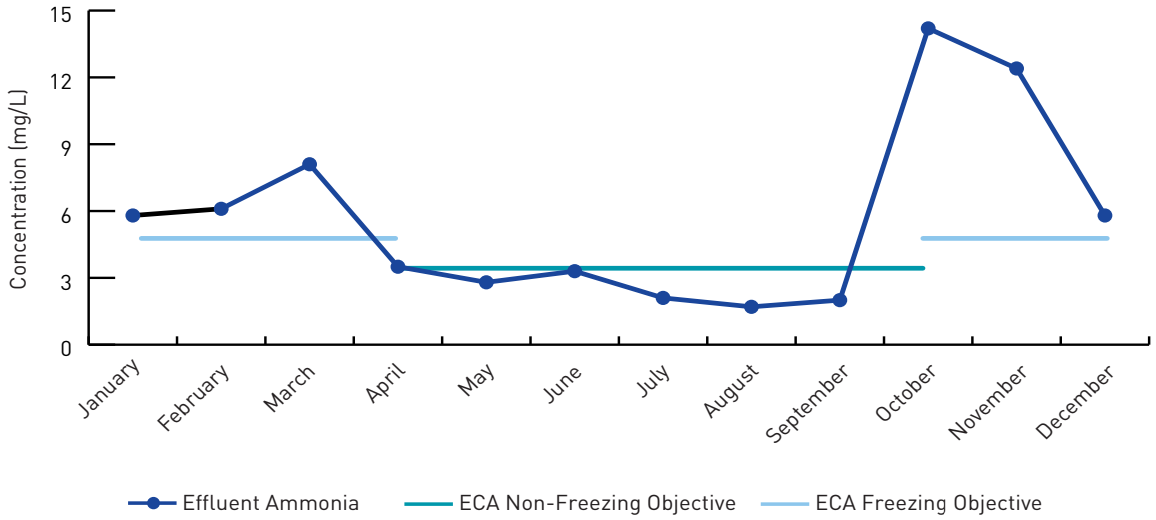



**Figure 4**: Monthly Effluent Results - Ammonia Nitrogen

## BIOSOLIDS SUMMARY

The dewatered sludge generated in 2023 is presented in Figure 5. In 2023, 7,907 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 buried at the City's SWRF in 2024. The WPCP expects to generate approximately 8,000 tonnes of biosolids in 2024, assuming a similar wastewater flow.

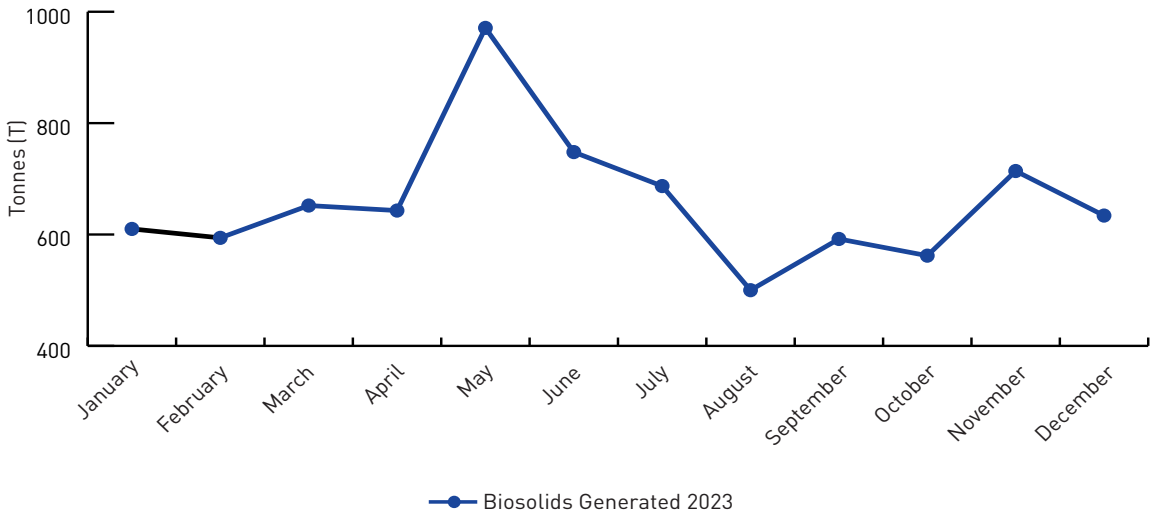



**Figure 5**: Biosolids Transferred to City of Thunder Bay's Solid Waste & Recycling Facility

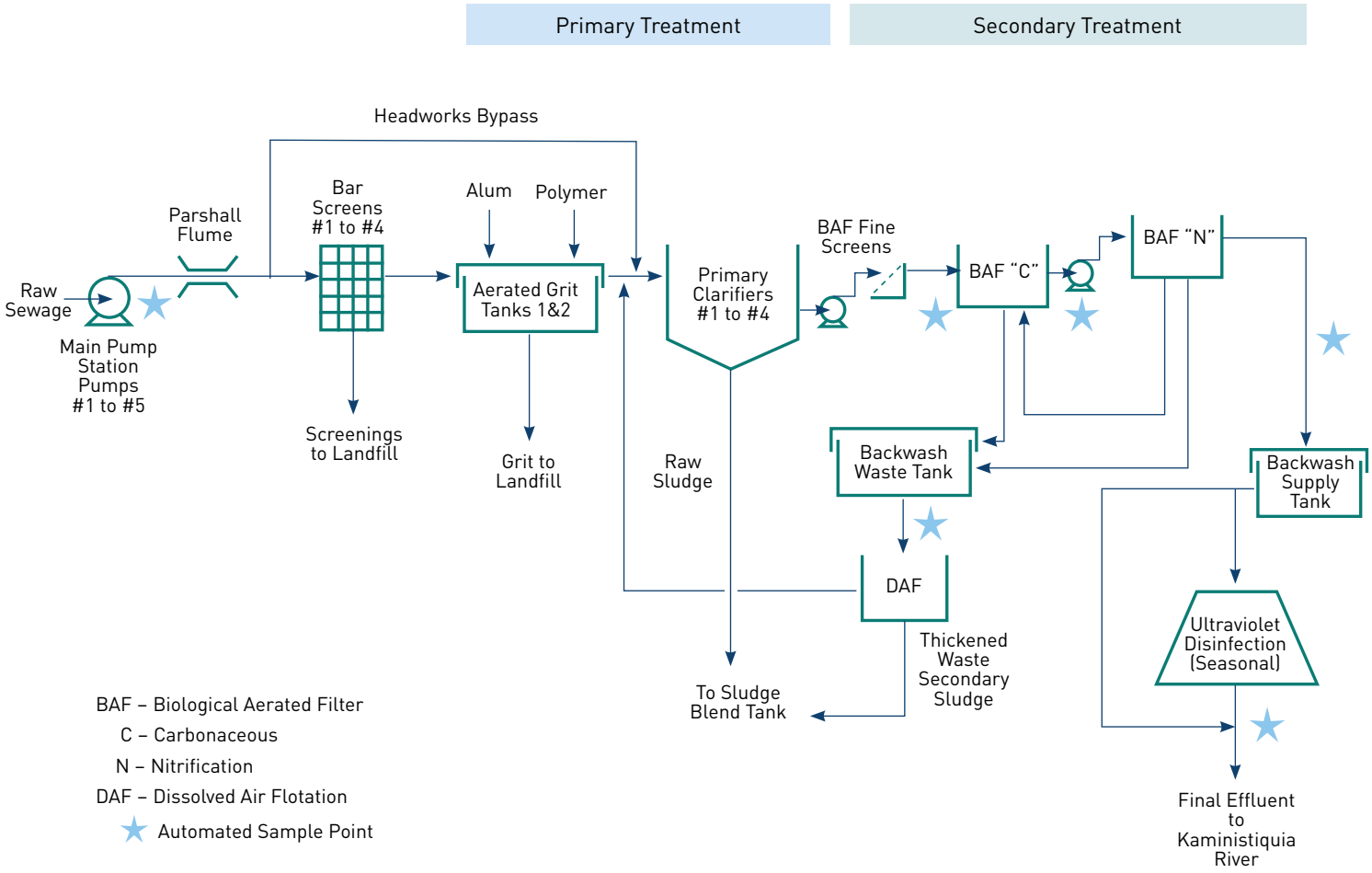
# Operating Issues and Corrective Actions

The Atlantic Avenue WPCP operates year-round, 24 hours a day. Occasional operating issues are encountered. Table 1 summarizes operating issues in the reporting period that temporarily affected the process or effluent quality, and lists the corrective actions taken.

**Table 1 - Summary of Operating Issues and Actions Taken**

| Issue | Date | Causes | Corrective Actions |
|---|---|---|---|
| Effluent TAN objective exceeded | January<br>February<br>March<br>April<br>June<br>November<br>December | 1. Low wastewater temperature, which inhibits nitrification<br>2. Secondary treatment plant outage for planned maintenance shutdown | 1. Reduce nitrification side filtration times for more frequent backwashing<br>2. Reduce backwash filtration to waste times<br>3. Ran secondary treatment in 'Winter Mode' to allow for nitrification treatment with increased recycle flow |
| Daily plant flow exceeded rated capacity | April 13-30<br>May 1-16<br>May 19-23 | Seasonal snow melt and heavy precipitation | 1. Monitored plant processes<br>2. Processes were bypassed during the high plant flows |
| Effluent E. coli higher than usual | May 17<br>July 5<br>Sept. 21<br>Oct. 4 | E. coli test results were higher than usual but in compliance with the monthly geometric mean | 1. UV Disinfection process was adjusted to manual operation and full power<br>2. High flows on May 17 resulted in low UV dose, with UV Disinfection running at full power |
| Effluent $CBOD_5$, TSS, and TP objectives or limits exceeded | October<br>November | Secondary treatment plant outage for planned maintenance shutdown | 1. Plant ran in Chemically Enhanced Primary Treatment - with increased coagulant and polymer dosages<br>2. Coagulant feed changed to Main Pump Station to allow for more contact time<br>3. Closely monitored primary treatment process |

## PLANT TREATMENT PROCESS SCHEMATIC



## INFRASTRUCTURE PROJECTS

As part of the Environment Division's Asset Management Plan, many projects were carried out during 2023 to protect and improve the equipment and infrastructure.

### 2023 WPCP PROJECTS

**Influent Pump Station (IPS)**

- Wet well cleaning and scum removal
- Parshall Flume transmitter verification and calibration

**Primary Treatment**

- Annual maintenance on primary clarifiers
- Replacement of Primary Clarifier #3 Raw Sludge Pump intake pipe
- Grit classifier replacement
- New scum tipper actuators on Primary Clarifiers #3 and #4

**Sludge and Dewatering System**

- Digester #4 cleaning and service
- Centrifuge #1 sent out for overhaul
- Sludge mixer replacement
- Sludge dewatering control room ventilation improvement design

**Biological Aeration Filtration (BAF)**

- BAF filter aeration system service
- Interstage Pump #3 repair and overhaul
- Interstage flap gate repairs
- Backwash pumps discharge valve replacement
- BAF filter #7, #8, #9 and #11, #13, #15 drain valve replacements
- BAF mud valve actuator replacement
- Thickened waste secondary solids flow meter replacement

**Heating and Ventilation**

- BAF glycol supply line and valving upgrades
- Boiler repairs

**Buildings & Grounds**

- Exterior lighting improvements
- Exterior security camera installation

**Cogeneration and Gas System**

- Repair, upgrade and insulate Cogen hot water distribution lines
- Gas skid overhaul
- Flare programmable logic controller repair

**Electrical & Instrumentation Systems**

- 5kV distribution breaker control upgrades
- Plant wide motor control centre infrared scans
- IT/OT information and operational technology service
- Spare 800 Hp frequency drive
- Emergency power upgrade preliminary design

**Disinfection System**

- UV system maintenance and lamp replacement
- Replace quartz sleeves

**Remote Stations**

- Replace one lift pump at Montreal Station
- Preliminary design started for improvements at Montreal, Current and Adelaide Stations

**Wastewater Collection – Pollution Prevention Control Plan**

- Separation of 109 m of combined sewers occurred on Argyle St.

## WASTEWATER SYSTEM SUMMARY
## 2023 ATLANTIC AVENUE WATER POLLUTION CONTROL PLANT

### INFRASTRUCTURE

**520 km** of sanitary sewer

900 metres of combined sewer

Four remote lift stations

Serving over **108,000** people

### WASTEWATER TREATED

**Over 21 billion**

litres of wastewater treated in 2023

Equivalent to over 8,700 Olympic sized swimming pools

Average flow of 60 MLD

### RESOURCES

**2,000 MWh** of electricity generated on-site

Over **80%** of gas generated in digesters was used to generate electricity or to 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 **7,900** 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, weekly sampling for COVID in the influent wastewater began in February 2021. Sampling and analysis since has increased to five 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, chemical oxygen demand (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 822 loads of processed water and septic tank wastes, which accounted for 12 million litres received and processed at the WPCP in 2023. 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.

## 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 2023 related to the WPCP.

## BYPASS EVENTS

A **bypass** is a diversion of wastewater around one or more wastewater treatment processes. The bypassed portion of wastewater undergoes part of the treatment process prior to release into the Kaministiquia River at the approved discharge location and sampling point. Final effluent is sampled and tested during bypass events to assess its quality.

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.

When a planned bypass is required to repair a part of the treatment process, a request is submitted to the federal and provincial governments to perform the bypass, including a plan to minimize its impact.

Two types of bypasses account for the majority of the bypasses during 2023. 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 3,600 ML of parallel bypasses and 1,300 ML of secondary bypasses. During the disinfection season, from April to October, the bypasses received UV disinfection prior to discharge.

Of the bypasses that occurred in 2023, 75% of the volume bypassed was due to weather events where the influent flows were higher than those for which the plant was designed. The remaining bypassed volume was the result of the secondary treatment plant outage.

All bypass events were reported to the MECP, Environment and Climate Change Canada 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*

## Table 2: Plant Effluent Quality

| Month | Daily Flow (MLD) | $CBOD_5$ (mg/L) | $CBOD_5$ Loading (kg/day) | TSS (mg/L) | TSS Loading (kg/day) | TP (mg/L) | TP Loading (kg/day) | E Coli (#/100 mL) | TAN (mg/L) | pH (SU) |
|---|---|---|---|---|---|---|---|---|---|---|
| Objective | N/A | 15.0 | N/A | 15 | N/A | 0.5 | N/A | 150 | Apr 1 to Oct 31: 3.0<br>Nov 1 to Mar 31: 5.0 | 6.5 to 8.5 |
| Limit | 84.5 | 25.0 | 2,112.5 | 25.0 | 2,112.5 | 1.0 | 84.5 | 200 | N/A | 6.0 to 9.5 |
| Compliance Assessment Basis | Daily Average | Monthly Average | Annual Average | Monthly Average | Annual Average | Monthly Average | Annual Average | Monthly Geometric Mean Density | Monthly Average | At all times |
| January | 50.3 | 8.4 | 393.2 | 8.4 | 420.3 | 0.3 | 16.6 | | 5.8 | 7.2 |
| February | 49.7 | 7.2 | 324.5 | 8.7 | 423.9 | 0.3 | 15.7 | | 6.1 | 7.0 |
| March | 49.7 | 8.4 | 387.9 | 9.7 | 480.5 | 0.4 | 18.0 | | 8.1 | 7.2 |
| April | 102.5 | 5.8 | 595.1 | 9.2 | 1,083.5 | 0.3 | 30.1 | 90 | 3.5 | 7.5 |
| May | 94.7 | 5.9 | 518.3 | 7.8 | 720.7 | 0.2 | 20.2 | 80 | 2.8 | 7.7 |
| June | 60.3 | 5.2 | 319.4 | 9.4 | 574.8 | 0.2 | 13.0 | 10 | 3.3 | 7.5 |
| July | 52.2 | 3.2 | 164.3 | 7.6 | 393.0 | 0.1 | 7.5 | 25 | 2.0 | 7.3 |
| August | 50.4 | 4.7 | 228.9 | 9.2 | 461.8 | 0.3 | 14.1 | 22 | 1.7 | 7.4 |
| September | 52.8 | 6.2 | 309.0 | 12.4 | 669.1 | 0.3 | 18.3 | 77 | 2.0 | 7.2 |
| October | 50.3 | 42.8 | 1,932.2 | 17.3 | 866.8 | 0.6 | 28.7 | 74 | 14.2 | 7.0 |
| November | 53.5 | 26.1 | 1,294.6 | 21.8 | 1,187.9 | 0.7 | 40.1 | | 12.4 | 7.2 |
| December | 50.7 | 11.9 | 547.8 | 12.4 | 627.9 | 0.6 | 28.0 | | 5.8 | 7.0 |
| **Annual Average** | **59.7** | **11.2** | **668.6** | **11.8** | **704.5** | **0.4** | **23.9** | **N/A** | **5.6** | **7.3** |

### Table 3: Flows Received

| Month | Influent Volume (ML) | Total Precipitation (mm) | Maximum Daily Flow (MLD) | Average Daily Flow (MLD) |
|---|---|---|---|---|
| January | 1,559 | 12 | 121 | 50.3 |
| February | 1,390 | 25 | 121 | 49.7 |
| March | 1,539 | 21 | 130 | 49.7 |
| April | 3,074 | 82 | 262 | 102.5 |
| May | 2,935 | 42 | 179 | 94.7 |
| June | 1,808 | 52 | 121 | 60.3 |
| July | 1,617 | 35 | 123 | 52.2 |
| August | 1,561 | 59 | 115 | 50.4 |
| September | 1,584 | 34 | 112 | 52.8 |
| October | 1,559 | 25 | 124 | 50.3 |
| November | 1,606 | 32 | 114 | 53.5 |
| December | 1,573 | 26 | 113 | 50.7 |
| **Total** | **21,805** | **444** | | |
| **Average** | **1,817** | | | **59.7** |

### Table 4: Sludge Dewatering Results

| Month | Sludge to Dewatering ($m^3$/day) | Total Sludge Dewatered ($m^3$) | Biosolids Generated (tonnes) |
|---|---|---|---|
| January | 356 | 7,485 | 610 |
| February | 342 | 6,164 | 594 |
| March | 326 | 7,826 | 652 |
| April | 352 | 7,747 | 643 |
| May | 404 | 10,100 | 971 |
| June | 337 | 8,077 | 748 |
| July | 261 | 7,295 | 687 |
| August | 204 | 6,134 | 500 |
| September | 230 | 6,907 | 592 |
| October | 190 | 5,904 | 562 |
| November | 240 | 7,194 | 714 |
| December | 236 | 7,302 | 634 |
| **Average** | **290** | | |
| **Total** | | **88,134** | **7,907** |

# Staff Organization

## Infrastructure, Development 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 Officer –** 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.

**Manager – Compliance & Quality Control –** 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 Superintendents –** Bob Bates, P. Eng. Lindsay Menard, P. Eng., PMP

**Supervisor, Maintenance –** Mike Brown

**Supervisor, Operations –** Mark Wilson

**Accounting & Administration Clerk –** Kristie Fisher

**Chief of Electrical –** Andreas Makrides

**Chief of Maintenance –** Sal Piccolo

**Chief Operator –** Rick Sutton

**Environmental Inspector –** Patrick McGuire

**Janitor/Handyworker –** Darrin White

**Laboratory Technicians –** Julie Carlin, Brett Rizzuto

**Millwrights –** Thane Gagnon, John Hrycyk, Mike Noga, Warren Perry

**Operators –** Shane Bureau, Keenan Colosimo, Phillip Kennedy, Cody Lane, Patrick Melanson, Marcus Uliana, Chris Unick, Jayden McEachern

**Plant Electrician –** Brian Dobson

**Relief Operators** – Daniella N de Lima, Reid Stajkowski

Thunder Bay WATER POLLUTION CONTROL PLANT

**WATER POLLUTION CONTROL PLANT**

**TEL:** (807) 625-3370
**WEB:** thunderbay.ca

CITY OF THUNDER BAY
ENVIRONMENT DIVISION
901 ATLANTIC AVE
THUNDER BAY ON P7C 2T3

CITY OF Thunder Bay
*Superior by Nature*