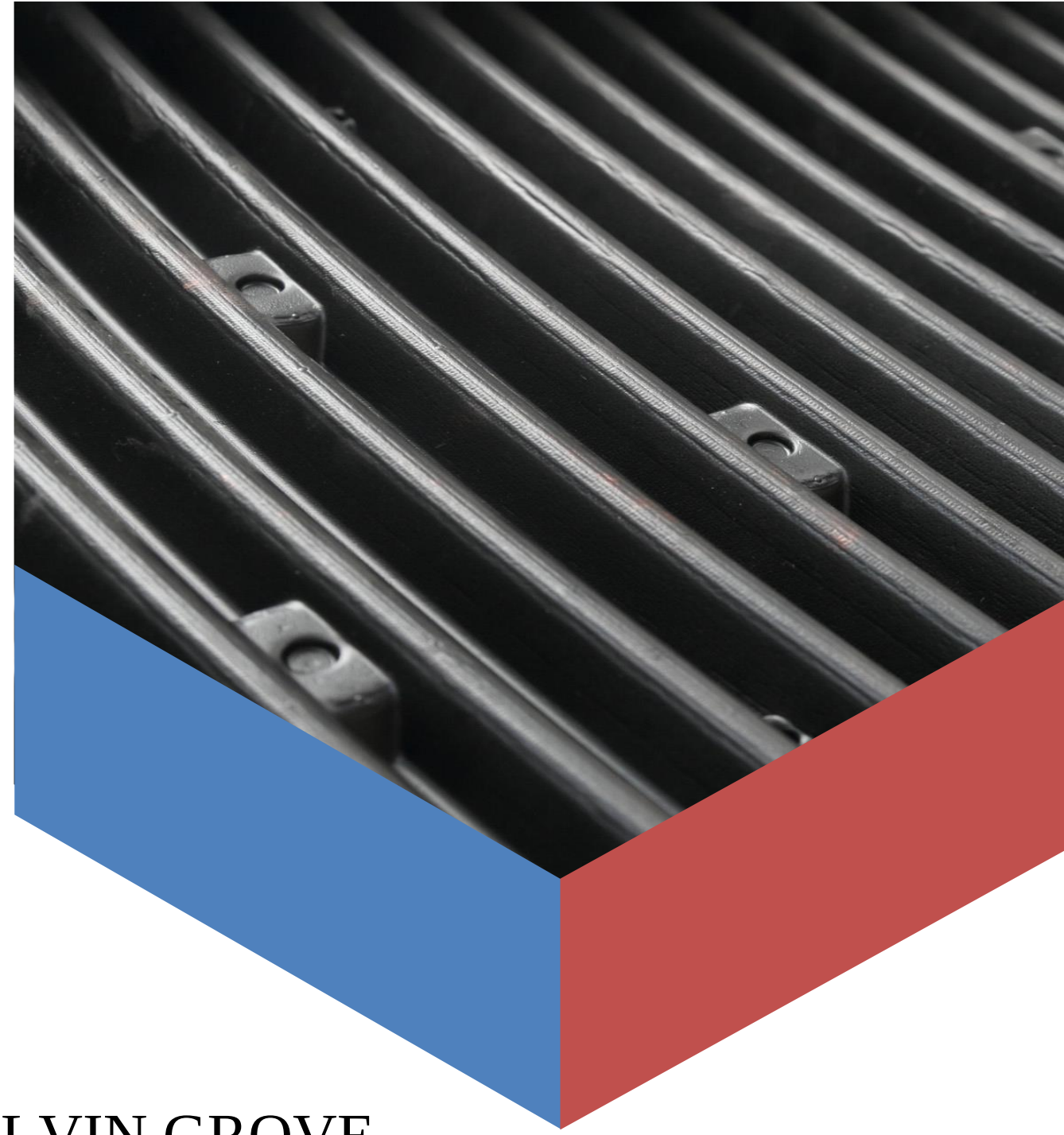
THE VILLAGE OF LIONS BAY



KELVIN GROVE

Wastewater Treatment Plant

2021 ANNUAL REPORT

JAN
2021

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Public Works Manager

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Introduction

The upper and lower Kelvin Grove neighbourhoods in the Village of Lions Bay are serviced by a sanitary sewer network that culminates in a wastewater treatment plant (WWTP) that was constructed in 2019 on the waterfront of Howe Sound, at the Kelvin Grove Beach Park. A total of 94 residential lots are connected to the WWTP through a network of 2,173 meters of 200mm PVC sanitary sewer pipes, manholes, and property connections or service laterals. A map of this sanitary sewer system is shown in Appendix 1.

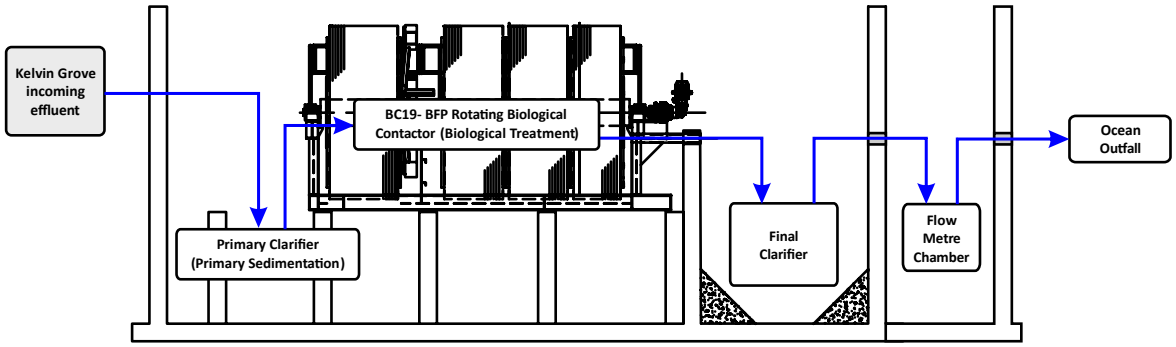
TREATMENT AND MICROBIOLOGY

The new Kelvin Grove WWTP, which was commissioned on January 8, 2021, is a fixed-film treatment process that consists of three distinct process phases:

- Primary Clarification;
- Biological Treatment; and
- Final Clarification.

Upon passing through each of these phases, the treated wastewater then passes through a flow meter and then is released into Howe Sound via an ocean outfall pipe 85 meters beyond the high tide mark and at a depth of 60 metres.

Figure 1 - Treatment Process



The wastewater treatment process is dependent upon the presence and activity of the microorganisms within the wastewater and treatment plant. This microbial ecology is a complex combination of interrelationships among bacteria, protozoa, and metazoa with the organic contents of the wastewater. Microorganisms use this organic content as a carbon source for respiration, energy generation, and biomass production. Once the organic content of wastewater is depleted, microorganisms form floc and settle out of the wastewater stream as sludge.

PRIMARY CLARIFICATION

Wastewater enters the primary clarifier where suspended solids are removed by gravity sedimentation under quiescent conditions. The settled solids form a sludge blanket at the bottom of the clarifier. The primary clarifier also provides for effective removal of grit, debris, and fats,

oils, or grease (dubbed 'FOG') prior to the supernatant's entry into the biological treatment phase.

Continual input of raw wastewater into the primary clarifier and gravity settlement results in a thickening of the sludge blanket over time. Sludge blanket depth is a crucial component to the proper functioning of the treatment system, so much so that at excessive sludge blanket depths (greater than 30 cm) the sludge may turn septic, which depletes oxygen levels that ultimately inhibits healthy biomass growth which thereby decreases treatment efficiency.

BIOLOGICAL TREATMENT

From the primary clarifier, the supernatant with its colloidal and dissolved organic matter is further cleansed by biological treatment which is accomplished by a rotating biological contactor (RBC) treatment system. The Kelvin Grove WWTP utilizes the BC19-BFP™ system which consists of multiple large-diameter corrugated discs constructed of high-density polyethylene (HDPE). These disks are bundled closely together and are mounted in series along a horizontal shaft which is rotated by an electric motor at a rate of 1.5 to 1.6 revolutions per minute. The rotating discs alternately expose the media packs to wastewater and air. Microfauna within the wastewater affix themselves to the discs creating a biofilm over the entire surface area of the media. The corrugations on the media disks are designed to give extra surface area per unit volume to each disc thereby increasing the biofilms' ability to metabolize and treat the organic materials contained in the wastewater. This permits high degrees of treatment to be achieved for relatively short wastewater retention times.

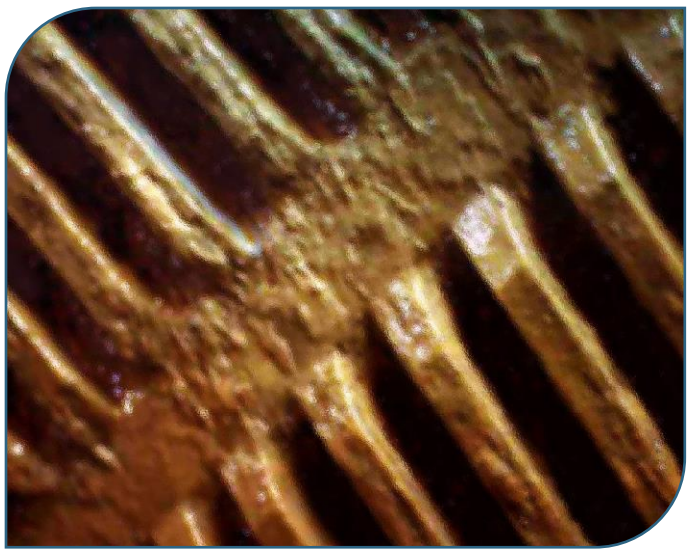


Photo: Initial biofilm growth on RBC media.

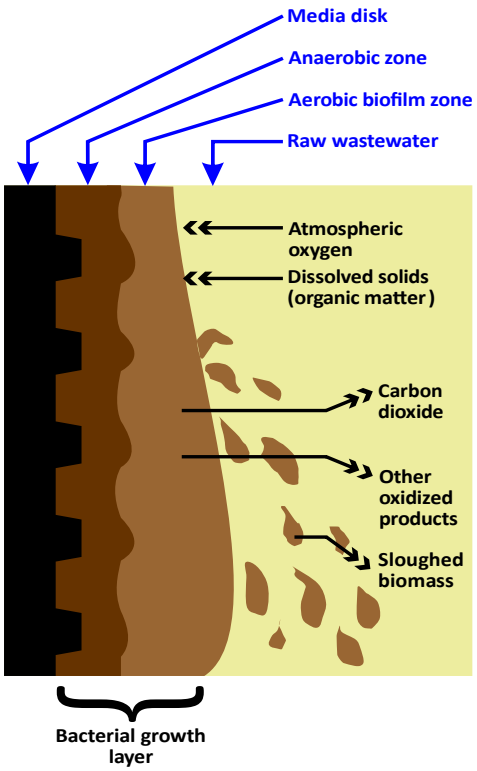
From start to finish, the wastewater flows through the RBC's stages or bioreactors by simple displacement and gravity. As wastewater passes through the system, it undergoes a progressively increasing degree of treatment by specific biological cultures in each stage, which are adapted to the changing wastewater.

When the supernatant from the primary clarifier first enters the RBC module, it encounters the first set of disks. This is the stage where the highest biological activity occurs and where biofilm accumulations are the greatest since the organic loading is highest. As the biofilm thickens, it

develops into two layers: an active (aerobic) and an inactive (anaerobic) layer. By and large organics within the wastewater are transformed into biomass in the aerobic layer.

Biofilm growth increases on the media disks until it reaches a tipping point with the continual drag caused by the media packs rotation generating shearing forces that causes excess biomass to slough off into the supernatant [Figure 2]. Rotation of the media also provides turbulence at the interface between biomass and wastewater so that dissolved oxygen and wastewater nutrients to the biomass through the mechanism of mixing and that of diffusion. This continual rotation also serves to keep the sloughed material in suspension through the progressive stages and into the secondary clarifier.

Figure 2- Cross Section at RBC



Microfauna in the Initial stages are almost entirely constituted by species of ciliates and filamentous and non-filamentous bacteria. As the wastewater passes through subsequent stages, it undergoes a progressively increasing degree of treatment by specific microfauna in each stage. The decreasing concentration of organic matter leads to the appearance of higher life forms including nitrifying bacteria, along with various types of protozoans, rotifers, and other predators.

In a well-functioning unit with the appropriate feed rate, nutrient loading, microfauna, and media rotation rates, the RBC will emit an earthy, humus-like ("musty") smell inside the unit. A substantial sour or "sewage" smell is indicative of suboptimal conditions.

SECONDARY CLARIFICATION

Once through the fourth stage of the RBC, the treated wastewater enters the secondary clarifier. The large aggregates of biomass sloughed off the media packs retain their high density and settle rapidly in the secondary clarifier. At this point in the process the effluent is relatively clear and colourless and free of suspended matter. Sludge from the primary and secondary clarifiers is removed on an annual basis and transferred to the Iona Island wastewater treatment plant in Richmond where it undergoes further treatment.

KELVIN GROVE WWTP OPERATING PERMIT

The authority to discharge wastewater into the waters of Howe Sound is governed by the provincial *Environmental Management Act*. The Kelvin Grove WWTP operates under permit number 5188 (the "Permit") which regulates the quantity and quality of the plant's discharge. The parameters stipulated in the Permit are as follows:

Parameter	Permit Value
Volume (m^3/day)	340
BOD_5 (mg/L)	45
TSS (mg/L)	60

Water Quality

Reporting requirements consist of quarterly sampling of treated wastewater for five-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) as well as the submission of an annual report to the Ministry of the Environment each January.

Discharge Volumes

Though the plant was commissioned in early January of 2021, SCADA functionality was not enabled until March of 2021, therefore, the data results referred to in this report only contain real-time flows for 10 of the 12 months in 2021. Estimated flows during the first two months of the year were anticipated to be between were 65m^3/day to 85m^3/day in accordance with our reporting during the replacement of the old plant. Daily flows can be found in Appendix 2.

What's immediately notable from the daily flow results in 2021 is the abnormal discharge volumes in the fall and early winter of 2021. The following table compares historical flows with those experienced in 2021:

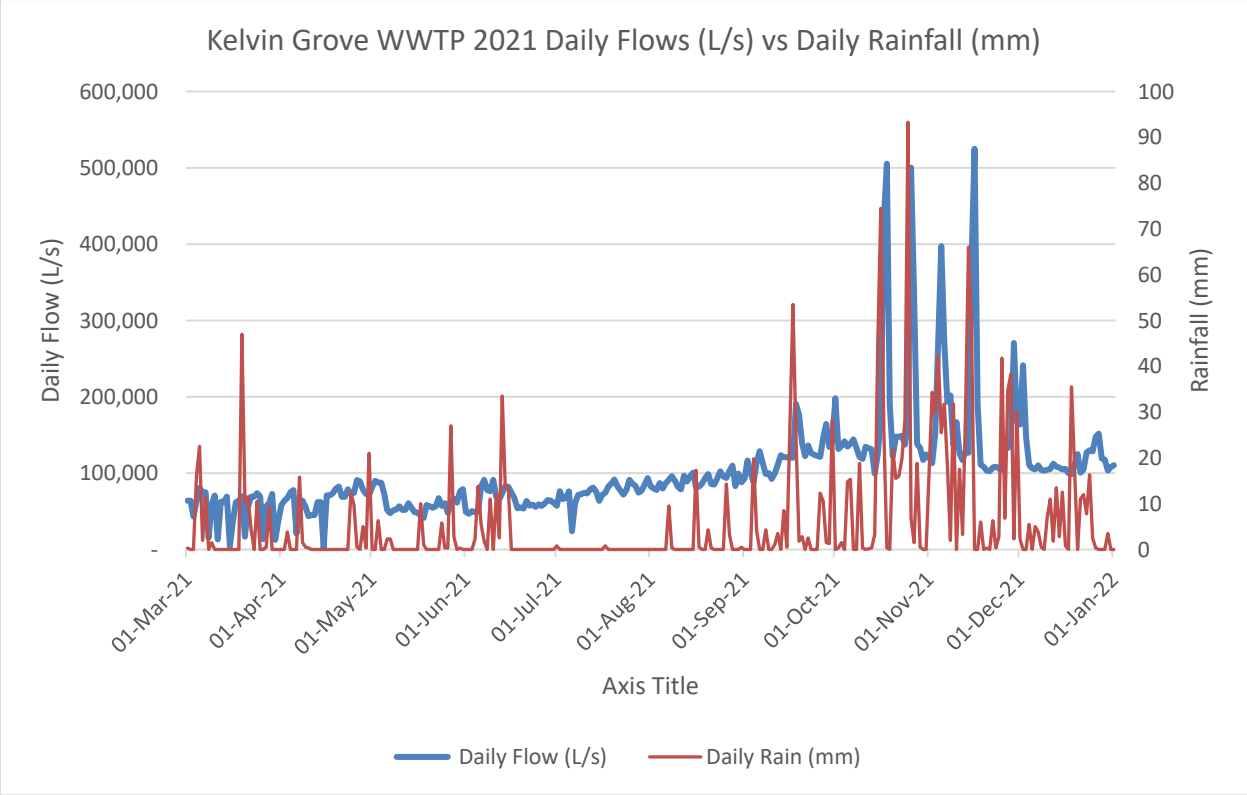
	2016	2017	2018	2019	2020	2021*
Average Daily Flow (L/s)	79,316	93,706	80,494	72,215	81,312	100,529
Total Annual Flow (L)	28,952,320	34,204,557	29,382,508	26,360,580	29,762,090	30,560,696
Max Daily Flow (L/Day)	336,083	269,683	199,790	204,571	202,999	**525,035**
Min Daily Flow (L/Day)	32	99	8,055	5,845	8,158	1,894

* flow results from March to December

While the old plant came close to the permitted discharge volumes in 2016, the balance of the results are well below our permitted discharge volume of 340 m^3/day. In 2021, the maximum daily discharge was 525 m^3/day and as the next table shows, discharge volumes exceeded the permitted values on 6 separate occasions:

Date	Daily Flow (L)
17-Oct-21	432,150.06
18-Oct-21	505,440.13
26-Oct-21	500,395.38
05-Nov-21	397,543.91
15-Nov-21	375,820.06
16-Nov-21	525,035.25

It's clear that the exceedances were caused by the unprecedented storms, including atmospheric rivers which delivered tropical moisture to southwestern BC, during the months of October and November. This extreme rainfall highlighted the inflow and infiltration present within the wastewater collection network and this relationship is captured in the following chart comparing Daily Flows (L/s) and Daily Rainfall totals (mm):



Effluent Parameters

As 2021 was the first year of the new treatment plant, Municipal staff opted to sample effluent on a monthly basis rather than the quarterly (Jan., Apr., Aug., and Dec.) requirement of Permit 5188. This was done to help staff understand the maintenance requirements and frequency of pump-outs necessary to keep the plant within compliance during this initial year. The following table is a summary of the results showing Total Suspended Solids (TSS) and five-day Biological Oxygen Demand (BOD_5) in milligrams per litre:

	30-Dec-2020	29-Jan-2021	26-Feb-2021	26-Mar-2021	23-Apr-2021	21-May-2021	18-Jun-2021	30-Jul-2021	27-Aug-2021	24-Sep-2021	22-Oct-2021	19-Nov-2021	17-Dec-2021
TSS	18.5	21.5	15.3	45.9	13.8	25.8	29.1	46.1	14	12.1	13.8	9	27.2
BOD_5	26.3	25.2	27.8	**50.9**	39.4	33.6	30.6	32.3	7.7	12.8	17.5	10.7	20.7

Full sampling information can be found in Appendix 3.

As indicated with the orange shading, the Municipality experienced one instance of permit exceedance in March of 2021. By sampling monthly as opposed to quarterly, Municipal staff were able to identify an issue immediately as it was occurring. In conjunction with the plant's manufacturer, staff were able to determine an excessive slug of fats, oils, and grease (FOG), was discharged into the collection system and compromised the functionality of the RBC. The RBC process is designed to manage FOG up to concentrations of 200 mg/l while lab analysis indicated incoming effluent FOG levels of 534 mg/l. In response to this uncharacteristic event, Municipal staff introduced an engineered bacteria designed to lower FOG levels. Additionally, a FOG brochure was created and mailed out to each resident connected to the sewer network. The brochure may be viewed at the following URL: https://tinyurl.com/4fakd9tx.

Routine Maintenance

In accordance with the Permit, regular inspection and maintenance activities are conducted to keep the facility in good working order. Biweekly inspections are performed to check for vandalism, damage to the media disks, misalignment or excessive shaft deflection, motor torque loading (excessive heat), and for clogging of weirs or orifice areas. At the time of inspection, greased fittings and bearings are lubricated.

Sludge removal for the new plant occurs regularly and is based upon test results and visual inspection of the sludge level in the primary clarifier. Municipal staff's experience with the new system continues to grow and currently, sludge removal occurs on a quarterly basis. During sludge removal, any fog or other materials present on the surface of the effluent in the primary clarifier is removed via suction truck.

Upcoming Work Program

In 2022, staff have budgeted for the smoke testing of the Municipal Sewer system in order to pinpoint sources of inflow and infiltration as well as any potential cross connections within the collection network. In 2023 staff anticipate completing a video inspection of the sewer system to determine the condition of the pipe network and manholes.

Deficiencies determined during this work will be identified and scheduled for remediation.

Facility Classification and Operator Certification

The Kelvin Grove WWTP has been evaluated as a Small Wastewater System (Lagoon) by the Environmental Operators Certification Program Society (EOCP). The Municipality has one operator certified as a Small Wastewater System Operator and is striving to have more staff obtain certification in the near future.

Appendix 1 – Sanitary Sewer System Diagram

Appendix 2 – Daily Flow Monitoring Logs

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (ºC)	Min Temp (ºC)	Daily Rain (mm)
01-Mar-21	63,946.80	0.00	0.00	0.00	0.00	0.3
02-Mar-21	63,946.80	0.00	0.00	0.00	0.00	0
03-Mar-21	43,163.14	0.76	0.02	11.91	0.00	0
04-Mar-21	62,835.62	1.08	1.00	11.57	11.57	16
05-Mar-21	80,835.96	1.37	1.00	11.78	11.77	22.5
06-Mar-21	74,844.99	1.27	1.00	11.71	11.71	2
07-Mar-21	74,844.99	1.27	1.00	11.71	11.71	11.3
08-Mar-21	15,275.94	1.27	1.00	11.71	11.71	0
09-Mar-21	58,402.58	0.32	0.20	11.91	11.91	1.5
10-Mar-21	70,716.01	0.32	0.20	11.91	11.91	0
11-Mar-21	13,143.77	0.00	0.00	0.00	0.00	0
12-Mar-21	62,407.86	0.52	0.08	12.02	12.01	0
13-Mar-21	62,407.86	0.52	0.08	12.02	12.01	0
14-Mar-21	69,072.37	1.10	1.00	11.71	11.70	0
15-Mar-21	4,148.56	1.10	1.00	11.71	11.70	0
16-Mar-21	35,916.60	1.18	1.00	11.91	11.91	0
17-Mar-21	61,888.03	0.11	0.04	12.11	12.11	0
18-Mar-21	63,973.14	0.00	0.00	0.00	0.00	0
19-Mar-21	69,742.86	1.10	1.00	12.22	12.22	47
20-Mar-21	16,666.82	1.22	1.00	12.48	12.47	10.3
21-Mar-21	55,531.78	0.36	0.22	12.24	12.24	11.5
22-Mar-21	69,264.24	0.97	0.88	11.78	11.77	4.5
23-Mar-21	69,264.24	0.97	0.88	11.78	11.77	0
24-Mar-21	73,705.76	0.97	0.88	11.78	11.77	10.5
25-Mar-21	69,298.88	1.23	1.00	11.96	11.95	0
26-Mar-21	13,451.52	1.27	1.00	12.17	12.17	0
27-Mar-21	56,529.61	1.18	1.00	12.17	12.17	0.5
28-Mar-21	60,775.80	0.29	0.18	12.09	12.09	9.3
29-Mar-21	72,634.14	1.02	0.91	12.36	12.35	0
30-Mar-21	12,615.31	1.28	1.00	12.69	12.69	0
31-Mar-21	36,883.85	0.43	0.10	12.40	12.40	0
01-Apr-21	57,926.82	0.70	0.56	12.40	12.39	0
02-Apr-21	63,894.19	1.00	0.95	12.36	12.35	0
03-Apr-21	67,358.63	1.08	1.00	12.43	12.42	3.8
04-Apr-21	74,868.87	1.19	1.00	12.67	12.66	0
05-Apr-21	77,826.93	1.27	1.00	12.92	12.91	0
06-Apr-21	20,812.00	1.32	1.00	13.07	13.07	0
07-Apr-21	50,158.76	0.40	0.30	12.94	12.94	15.8

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
08-Apr-21	63,875.26	0.88	0.83	12.76	12.76	1.5
09-Apr-21	55,452.63	1.08	1.00	12.94	12.94	0.5
10-Apr-21	43,662.49	0.96	0.91	12.92	12.91	0.3
11-Apr-21	45,032.83	0.73	0.73	12.51	12.51	0
12-Apr-21	45,026.02	0.76	0.76	12.04	12.04	0
13-Apr-21	62,059.90	0.76	0.76	12.04	12.04	0
14-Apr-21	62,059.90	1.10	1.00	12.24	12.24	0
15-Apr-21	1,894.46	1.10	1.00	12.24	12.24	0
16-Apr-21	70,781.01	0.17	0.07	12.63	12.63	0
17-Apr-21	70,781.01	0.17	0.07	12.63	12.63	0
18-Apr-21	73,512.47	1.25	1.22	13.07	13.07	0
19-Apr-21	79,697.11	1.29	1.27	13.39	13.38	0
20-Apr-21	82,302.86	1.43	1.37	13.57	13.56	0
21-Apr-21	69,065.67	0.00	0.00	0.00	0.00	0
22-Apr-21	69,065.67	1.37	0.04	14.09	13.94	0
23-Apr-21	78,817.10	1.37	0.04	14.09	13.94	0
24-Apr-21	73,184.76	1.37	0.04	14.09	13.94	12.3
25-Apr-21	74,215.61	1.45	0.04	14.23	13.90	9.8
26-Apr-21	90,874.87	1.35	0.04	14.23	14.10	0.5
27-Apr-21	89,053.80	1.45	0.04	14.31	13.96	0
28-Apr-21	78,205.54	1.57	0.04	14.41	14.19	5
29-Apr-21	72,447.13	1.54	0.04	14.38	14.13	0.3
30-Apr-21	71,390.55	1.40	0.04	14.51	14.33	21
01-May-21	81,792.98	1.34	0.04	14.85	14.66	0
02-May-21	89,944.86	1.34	0.03	14.98	14.74	0
03-May-21	87,640.62	1.27	0.06	15.06	14.87	6.3
04-May-21	87,414.09	1.26	0.05	15.06	14.66	0
05-May-21	72,312.79	1.35	0.00	14.85	14.66	0
06-May-21	51,504.63	0.91	0.00	15.03	14.71	2.3
07-May-21	47,513.60	0.83	0.00	15.23	15.03	2.3
08-May-21	51,361.18	0.89	0.00	15.14	14.69	0
09-May-21	52,399.30	0.89	0.00	14.80	14.56	0
10-May-21	56,691.42	0.91	0.00	15.06	14.66	0
11-May-21	51,810.64	0.91	0.00	15.23	15.04	0
12-May-21	52,052.22	0.94	0.00	15.41	15.16	0
13-May-21	60,678.52	0.97	0.00	15.57	15.41	0
14-May-21	54,743.79	0.94	0.00	15.75	15.49	0
15-May-21	48,922.97	0.89	0.00	15.91	15.69	0
16-May-21	48,148.66	1.01	0.00	16.01	15.74	0
17-May-21	44,611.41	1.01	0.00	16.35	15.93	10

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
18-May-21	41,210.07	1.11	0.00	16.60	16.34	1
19-May-21	58,207.41	1.01	0.00	16.53	15.43	0
20-May-21	56,679.66	1.14	0.00	15.59	15.29	0
21-May-21	54,690.74	0.92	0.00	15.62	15.41	0
22-May-21	56,327.90	1.02	0.00	15.70	15.49	0
23-May-21	67,315.70	1.11	0.00	15.93	15.69	0
24-May-21	57,176.37	1.10	0.00	16.19	15.88	5.8
25-May-21	60,610.02	1.10	0.00	16.40	16.19	0.3
26-May-21	47,996.74	0.91	0.00	16.65	16.39	0.3
27-May-21	61,430.40	1.20	0.00	16.78	16.39	27
28-May-21	66,393.84	1.07	0.00	16.49	16.21	2.8
29-May-21	61,357.50	1.04	0.00	16.27	15.93	0
30-May-21	75,988.02	1.39	0.00	16.19	15.85	0.3
31-May-21	79,013.77	1.28	0.00	16.40	16.13	0
01-Jun-21	49,017.41	1.02	0.00	16.86	16.37	0
02-Jun-21	46,702.96	0.85	0.00	17.23	16.77	0
03-Jun-21	50,283.13	0.93	0.00	17.41	17.14	0
04-Jun-21	48,602.12	0.93	0.00	17.68	17.34	2.3
05-Jun-21	49,392.53	0.93	0.00	17.71	17.40	13.8
06-Jun-21	82,850.06	1.48	0.00	17.48	16.96	5.5
07-Jun-21	91,206.48	1.45	0.00	16.99	16.59	1.8
08-Jun-21	77,838.52	1.33	0.00	16.83	16.59	0
09-Jun-21	76,301.88	1.39	0.00	16.99	16.75	11
10-Jun-21	91,242.98	1.43	0.01	16.99	16.68	0
11-Jun-21	68,444.20	4.69	0.00	16.91	16.52	12
12-Jun-21	66,005.13	1.28	0.00	16.91	16.70	2.5
13-Jun-21	73,938.79	1.38	0.00	17.17	16.86	33.5
14-Jun-21	83,076.36	1.48	0.00	17.23	17.09	13.5
15-Jun-21	82,169.06	1.39	0.00	17.33	17.14	13.3
16-Jun-21	74,588.68	1.39	0.00	17.30	17.14	0
17-Jun-21	67,241.37	1.30	0.00	17.30	17.14	0
18-Jun-21	53,978.48	1.18	0.00	17.48	17.22	0
19-Jun-21	55,134.05	0.98	0.00	17.56	17.34	0
20-Jun-21	53,596.40	1.02	0.00	17.74	17.49	0
21-Jun-21	63,447.42	1.11	0.00	17.92	17.61	0
22-Jun-21	57,521.09	1.08	0.00	18.31	17.81	0
23-Jun-21	58,624.10	1.09	0.00	18.49	18.30	0
24-Jun-21	55,677.86	1.10	0.00	18.58	18.43	0
25-Jun-21	59,098.60	1.05	0.00	18.77	18.53	0
26-Jun-21	56,990.79	1.06	0.00	19.08	18.71	0

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
27-Jun-21	60,351.16	1.08	0.00	19.44	19.00	0
28-Jun-21	64,826.48	1.17	0.00	19.75	19.36	0
29-Jun-21	64,024.07	1.17	0.00	20.11	19.69	0
30-Jun-21	61,079.10	1.06	0.00	20.24	20.03	0
01-Jul-21	57,271.57	1.16	0.00	20.24	20.05	0.8
02-Jul-21	76,262.06	1.36	0.00	20.19	19.87	0
03-Jul-21	66,088.64	1.33	0.00	20.03	19.85	0
04-Jul-21	67,728.35	1.43	0.00	20.03	19.87	0
05-Jul-21	76,139.22	1.31	0.00	20.03	19.80	0
06-Jul-21	23,835.70	1.29	0.00	20.06	19.87	0
07-Jul-21	60,522.25	1.31	0.00	20.19	20.02	0
08-Jul-21	71,477.41	1.29	0.00	20.24	19.92	0
09-Jul-21	72,229.12	1.39	0.00	20.11	19.76	0
10-Jul-21	74,162.95	1.30	0.00	20.17	19.80	0
11-Jul-21	73,398.90	1.62	0.00	20.24	20.07	0
12-Jul-21	78,641.00	1.50	0.00	20.24	20.01	0
13-Jul-21	81,032.22	1.43	0.00	20.29	20.05	0
14-Jul-21	75,832.55	1.48	0.00	20.37	20.16	0
15-Jul-21	63,652.40	1.42	0.00	20.42	20.10	0
16-Jul-21	71,670.66	1.80	0.00	20.31	20.09	0
17-Jul-21	74,241.40	1.43	0.00	20.29	20.05	0.8
18-Jul-21	82,467.61	1.50	0.00	20.29	20.09	0
19-Jul-21	86,464.40	1.59	0.01	20.37	20.16	0
20-Jul-21	91,545.55	1.51	0.01	20.37	20.10	0
21-Jul-21	83,104.03	1.48	0.01	20.42	20.27	0
22-Jul-21	77,567.01	1.42	0.00	20.44	20.05	0
23-Jul-21	72,002.23	1.38	0.00	20.19	19.92	0
24-Jul-21	77,930.46	1.43	0.00	20.34	20.05	0
25-Jul-21	91,268.49	7.40	0.00	20.46	20.28	0
26-Jul-21	86,142.73	1.52	0.00	20.55	20.31	0
27-Jul-21	83,248.33	1.49	0.00	20.76	20.54	0
28-Jul-21	74,512.62	1.34	0.00	20.83	20.68	0
29-Jul-21	77,216.00	1.59	0.00	20.96	20.74	0
30-Jul-21	85,049.77	1.50	0.00	21.07	20.88	0
31-Jul-21	93,425.03	1.68	0.00	21.20	20.98	0
01-Aug-21	82,648.10	1.49	0.00	21.34	21.13	0
02-Aug-21	79,828.72	1.46	0.00	21.48	21.24	0
03-Aug-21	78,033.29	1.49	0.00	21.52	21.39	0
04-Aug-21	86,953.83	1.54	0.00	21.65	21.49	0
05-Aug-21	79,840.91	1.48	0.01	21.66	21.49	0

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
06-Aug-21	86,926.62	1.64	0.01	21.63	21.44	0
07-Aug-21	91,151.43	1.53	0.00	21.66	21.42	9.5
08-Aug-21	95,943.27	1.73	0.00	21.52	21.13	0.3
09-Aug-21	90,218.17	4.49	0.01	21.24	20.93	0
10-Aug-21	81,983.60	1.54	0.00	21.32	21.03	0
11-Aug-21	78,781.56	1.49	0.00	21.38	21.24	0
12-Aug-21	96,718.11	6.54	0.00	21.52	21.37	0
13-Aug-21	88,989.44	7.81	0.00	21.47	21.31	0
14-Aug-21	95,784.38	1.73	0.01	21.52	21.24	0
15-Aug-21	100,585.01	1.71	0.01	21.45	21.13	0
16-Aug-21	81,249.91	1.49	0.00	21.45	21.26	17.3
17-Aug-21	82,282.31	1.86	0.00	21.52	21.29	0.5
18-Aug-21	86,320.39	1.58	0.00	21.40	21.01	0
19-Aug-21	93,518.69	1.74	0.01	21.19	21.03	0
20-Aug-21	98,654.95	1.64	0.01	21.19	20.93	4.3
21-Aug-21	85,773.27	1.56	0.01	21.14	20.97	0.3
22-Aug-21	85,038.21	1.59	0.00	21.06	20.85	0
23-Aug-21	93,183.17	1.84	0.00	21.11	20.34	0
24-Aug-21	102,308.73	2.13	0.02	20.68	20.41	0
25-Aug-21	95,592.04	2.12	0.01	20.55	20.27	0
26-Aug-21	93,715.27	1.60	0.00	20.59	20.31	14.3
27-Aug-21	102,894.46	2.27	0.00	20.59	20.47	3.3
28-Aug-21	109,806.25	2.00	0.00	20.55	20.27	0
29-Aug-21	83,093.11	1.63	0.00	20.49	20.23	0
30-Aug-21	99,318.49	2.47	0.00	20.49	20.23	0
31-Aug-21	88,071.22	1.58	0.00	20.49	20.27	0.5
01-Sep-21	92,588.12	2.09	0.00	20.34	19.76	0
02-Sep-21	116,517.59	2.15	0.00	20.06	19.71	0
03-Sep-21	100,604.02	1.93	0.00	19.98	19.76	0
04-Sep-21	88,177.66	1.78	0.00	20.03	19.82	19.8
05-Sep-21	113,815.34	2.42	0.00	19.98	19.84	4
06-Sep-21	128,769.77	2.16	0.00	20.11	19.89	0
07-Sep-21	113,284.70	7.59	0.00	20.21	19.95	0
08-Sep-21	98,890.23	9.29	0.00	20.31	20.07	4.3
09-Sep-21	100,080.22	7.83	0.00	20.37	20.23	0
10-Sep-21	92,519.10	6.79	0.00	20.49	20.28	0
11-Sep-21	99,474.75	1.87	0.00	20.59	20.41	1
12-Sep-21	110,790.51	2.03	0.00	20.55	20.23	3.5
13-Sep-21	123,572.63	9.57	0.00	20.34	20.05	0
14-Sep-21	120,950.95	10.25	0.06	20.28	19.89	8.5

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
15-Sep-21	120,795.59	2.06	0.03	20.06	19.87	0.5
17-Sep-21	120,092.80	2.02	0.00	19.59	19.24	53.5
18-Sep-21	190,704.36	4.94	0.00	19.38	18.66	24.5
19-Sep-21	176,223.72	3.14	0.20	18.66	17.96	1.8
20-Sep-21	139,360.19	2.37	0.00	18.51	18.16	2.8
21-Sep-21	122,269.54	2.28	0.05	18.69	18.48	0
22-Sep-21	136,211.56	2.16	0.00	18.79	18.55	2.5
23-Sep-21	126,350.29	2.28	0.00	18.89	18.69	0
24-Sep-21	124,015.47	2.05	0.00	18.98	18.81	0
25-Sep-21	122,716.73	2.03	0.00	19.02	18.81	0
26-Sep-21	121,340.42	2.00	0.00	19.13	18.89	12.3
27-Sep-21	146,250.08	6.10	0.00	19.16	18.94	10.5
28-Sep-21	164,411.44	2.98	0.10	18.96	18.43	1.5
29-Sep-21	134,468.88	7.98	0.00	18.48	18.16	1.3
30-Sep-21	140,798.41	3.28	0.00	18.31	17.99	28.3
01-Oct-21	198,029.00	3.65	0.22	18.06	17.58	0
02-Oct-21	131,564.59	2.37	0.00	17.71	17.47	0.3
03-Oct-21	135,466.52	2.27	0.00	17.79	17.60	1.5
04-Oct-21	141,809.22	3.02	0.00	17.86	17.65	0
05-Oct-21	134,722.61	2.40	0.00	17.92	17.73	14.8
06-Oct-21	138,424.95	6.65	0.00	17.99	17.53	15.3
07-Oct-21	144,242.00	2.70	0.00	17.66	17.31	0
08-Oct-21	132,994.59	3.22	0.00	17.41	17.06	0
09-Oct-21	121,061.80	2.00	0.00	17.32	16.96	18.8
10-Oct-21	118,665.13	2.13	0.00	17.14	16.95	0.3
11-Oct-21	134,582.63	3.81	0.07	17.16	16.82	0
13-Oct-21	130,989.13	2.22	0.07	16.89	16.44	0.3
14-Oct-21	99,418.78	1.96	0.00	16.55	15.88	3.3
15-Oct-21	124,551.36	2.32	0.00	14.64	14.43	44.5
16-Oct-21	170,894.23	4.06	0.06	16.31	16.10	74.5
17-Oct-21	432,150.06	8.56	0.29	16.31	14.33	26
18-Oct-21	505,440.13	7.70	1.13	14.34	13.47	0.3
19-Oct-21	190,969.08	4.16	0.23	14.72	14.15	0
20-Oct-21	121,910.39	2.04	0.05	15.16	14.71	21.8
21-Oct-21	147,476.97	3.82	0.00	15.50	15.11	15.5
22-Oct-21	147,867.00	2.66	0.14	12.54	12.35	16
23-Oct-21	148,971.86	6.18	0.11	15.88	15.67	19.8
24-Oct-21	137,243.69	2.63	0.00	15.80	15.59	28.3
25-Oct-21	171,478.03	3.94	0.07	15.77	15.36	93.3
26-Oct-21	500,395.38	10.36	0.54	15.37	12.99	6.8

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
27-Oct-21	333,500.63	6.00	0.33	13.39	12.91	1.5
28-Oct-21	138,161.45	2.32	0.11	14.21	13.38	18.8
29-Oct-21	133,171.73	2.48	0.00	14.54	14.19	0.5
30-Oct-21	117,183.58	1.95	0.00	14.81	14.51	0
31-Oct-21	124,551.36	2.10	0.00	14.88	14.51	0
01-Nov-21	120,940.03	2.00	0.06	14.77	14.46	17
02-Nov-21	113,070.52	2.32	0.00	14.64	14.43	34.3
03-Nov-21	151,355.34	4.55	0.06	14.80	14.64	29.8
04-Nov-21	273,157.06	5.21	0.51	14.77	13.68	42.3
05-Nov-21	397,543.91	7.28	0.80	13.87	12.91	25.5
06-Nov-21	270,609.53	5.13	0.36	13.05	12.01	31.8
07-Nov-21	193,444.25	3.95	0.26	13.35	12.98	18.5
08-Nov-21	201,960.92	3.94	0.25	13.35	13.04	2
09-Nov-21	136,893.09	2.16	0.00	13.44	13.09	31.8
10-Nov-21	166,903.75	3.59	0.07	13.55	13.11	0
11-Nov-21	125,749.63	2.14	0.05	13.44	13.16	17.5
12-Nov-21	116,932.34	2.20	0.03	13.74	13.41	3.3
13-Nov-21	128,395.13	2.44	0.05	11.50	11.24	29
14-Nov-21	126,582.59	3.40	0.03	14.21	14.05	66
15-Nov-21	375,820.06	7.37	0.51	14.08	12.32	48.5
16-Nov-21	525,035.25	9.40	1.76	12.36	11.14	0
17-Nov-21	190,828.64	7.81	0.20	12.04	11.45	0
18-Nov-21	111,166.65	13.69	0.03	12.43	12.04	6
19-Nov-21	108,449.15	1.82	0.03	12.79	12.39	0
20-Nov-21	103,155.90	1.81	0.03	12.99	12.76	0.3
21-Nov-21	102,414.18	1.89	0.00	13.17	12.89	0
22-Nov-21	107,493.12	1.92	0.04	13.28	13.09	6.3
23-Nov-21	108,369.15	1.82	0.04	13.44	13.27	0.3
24-Nov-21	106,157.19	1.79	0.04	13.53	13.40	2.8
25-Nov-21	104,484.53	1.94	0.00	13.56	13.24	41.8
26-Nov-21	136,512.25	3.58	0.04	13.51	13.16	6.8
27-Nov-21	132,811.06	9.02	0.12	13.17	12.91	34.8
28-Nov-21	138,354.39	3.57	0.00	13.05	12.86	38.3
29-Nov-21	270,609.53	5.13	0.36	13.05	12.01	2.3
30-Nov-21	167,748.02	3.12	0.22	12.61	12.22	30
01-Dec-21	163,630.53	4.12	0.08	13.05	12.60	2.3
02-Dec-21	241,199.53	4.76	0.48	12.99	12.35	0
03-Dec-21	147,067.00	2.66	0.14	12.54	12.35	0
04-Dec-21	110,898.34	1.88	0.03	12.48	12.26	5.5
05-Dec-21	106,267.38	1.82	0.03	12.48	12.26	0

Date	Daily Flow (L/s)	Max Flow (L/s)	Min Flow (L/s)	Max Temp (°C)	Min Temp (°C)	Daily Rain (mm)
06-Dec-21	105,064.09	1.82	0.03	12.48	12.26	5
07-Dec-21	110,171.68	2.02	0.03	12.40	12.19	3.8
08-Dec-21	104,053.31	1.82	0.04	12.48	12.30	0.5
09-Dec-21	103,108.03	1.80	0.04	12.61	12.26	0
10-Dec-21	104,388.91	1.79	0.00	12.48	12.35	7
11-Dec-21	105,371.30	2.02	0.00	12.48	12.21	11
12-Dec-21	112,269.80	1.80	0.01	12.27	11.88	1.8
13-Dec-21	108,616.59	2.03	0.00	12.27	12.01	13.5
14-Dec-21	107,160.45	1.88	0.04	12.36	12.21	2.8
15-Dec-21	104,852.79	1.76	0.00	12.29	12.19	12.5
16-Dec-21	105,596.94	2.66	0.00	12.27	12.14	0.8
17-Dec-21	99,925.83	1.67	0.00	12.22	12.08	0
18-Dec-21	98,612.34	1.69	0.00	12.17	11.68	35.5
20-Dec-21	124,908.27	2.13	0.00	11.43	11.24	0
21-Dec-21	100,623.69	1.76	0.00	0.00	11.00	11
22-Dec-21	104,679.75	2.14	0.00	11.12	10.84	12
23-Dec-21	127,116.05	2.17	0.00	11.39	10.98	7.8
24-Dec-21	129,932.02	2.04	0.07	11.46	11.24	16.3
25-Dec-21	128,395.13	2.44	0.05	11.50	11.24	2.5
26-Dec-21	147,598.42	3.07	0.06	11.50	11.06	0.3
27-Dec-21	151,826.64	3.94	0.13	11.14	10.08	0
28-Dec-21	119,219.43	1.93	0.05	10.09	9.56	0
29-Dec-21	117,516.32	1.94	0.04	9.75	9.43	0
30-Dec-21	103,433.82	1.79	0.03	9.84	9.56	3.5
31-Dec-21	107,850.47	1.91	0.00	9.71	9.56	0
01-Jan-22	110,490.24	3.01	0.03	9.73	9.51	17.1

Appendix 3 – Laboratory Analysis Records

Client Sample ID	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)
Date Sampled	30-Dec-2020	29-Jan-2021	26-Feb-2021
Time Sampled	13:00	11:50	11:50
ALS Sample ID	VA20C4286-001	VA21A1700-001	VA21A3584-001
Analyte	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water
Total suspended solids [TSS] mg/L	18.5	21.5	15.3
Biochemical oxygen demand [BOD] mg/L	26.3	25.2	27.8

Client Sample ID	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)
Date Sampled	26-Mar-2021	23-Apr-2021	21-May-2021
Time Sampled	11:00	11:00	11:00
ALS Sample ID	VA21A5745-001	VA21A7666-001	VA21A9929-001
Analyte	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water
Total suspended solids [TSS] mg/L	45.9	13.8	25.8
Biochemical oxygen demand [BOD] mg/L	50.9	39.4	33.6

Client Sample ID	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)
Date Sampled	18-Jun-2021	30-Jul-2021	27-Aug-2021
Time Sampled	11:15	10:15	11:15
ALS Sample ID	VA21B2324-001	VA21B5798-001	VA21B8381-001
Analyte	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water
Total suspended solids [TSS] mg/L	29.1	46.1	14
Biochemical oxygen demand [BOD] mg/L	30.6	32.3	7.7

Client Sample ID	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)	Sewer Treatment Plant (Treated Sewer)
Date Sampled	24-Sep-2021	22-Oct-2021	19-Nov-2021
Time Sampled	11:15	10:45	11:00
ALS Sample ID	VA21C1116-001	VA21C3553-001	VA21C5908-001
Analyte	Sub-Matrix: Water	Sub-Matrix: Wastewater	Sub-Matrix: Water
Total suspended solids [TSS] mg/L	12.1	13.8	9
Biochemical oxygen demand [BOD] mg/L	12.8	17.5	10.7

Client Sample ID	Sewer Treatment Plant (Treated Sewer)
Date Sampled	17-Dec-2021
Time Sampled	11:00
ALS Sample ID	VA21C8192-001
Analyte	Sub-Matrix: Water
Total suspended solids [TSS] mg/L	27.2
Biochemical oxygen demand [BOD] mg/L	20.7