Ministry of Municipal Affairs and Housing

University Endowment Lands

2022 Drinking Water Quality Monitoring Report

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EXECUTIVE SUMMARY

The University Endowment Lands (UEL) implemented a Drinking Water Quality Monitoring Program in 2002. The UEL adopted the Water Quality Monitoring and Reporting Plan developed by the Greater Vancouver Regional District (GVRD), its member municipalities and the region's Medical Health Officers. With this approved monitoring program in place, the UEL has collected and analyzed water quality data since 2002. This report provides an outline of the program and its water quality testing results for the year 2022.

The implementation of the Drinking Water Quality Monitoring program continues to be a significant commitment by the UEL to monitor the delivery of safe and high-quality water. It generates valuable data for gaining an understanding of the UEL's water distribution system and for evaluating the historic performance of the system in a reliable and systematic way. Most importantly, it allows for potential health hazards to be identified and consumers' water concerns to be addressed.

The sampling analysis demonstrates that during 2022, all except two (2) samples of the 186 samples taken met the bacteriological standards set out in the *British Columbia Drinking Water Protection Act* (BCDWPA) and the *British Columbia Drinking Water Protection Regulation* (BCDWPR). Additionally, all but one (1) sample of the 186 samples taken met the health standards specified in the *Guidelines for Canadian Drinking Water Quality*. Re-tests were conducted following the two (2) samples which did not meet the BCDWPR, the re-tests came back with no exceedances. The UEL plans to monitor the situation at the sampling station which had reported total coliform counts and will react should future sampling flag a potential issue in the system.

The UEL is committed to delivering water of the highest quality and will continue to make the necessary effort to ensure its continued success.

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1.0 INTRODUCTION

In 2002, the University Endowment Lands (UEL) implemented a Drinking Water Quality Monitoring Program to monitor the delivery of safe and high-quality water. This annual Water Quality Monitoring Report is required under the program and as a requirement of the *British Columbia Drinking Water Protection Act* (BCDWPA).

The provision of drinking water is governed by the *British Columbia Drinking Water Protection Regulation* (BCDWPR), pursuant to the BCDWPA. This regulation requires drinking water suppliers in BC to:

- Develop a protocol to notify the Drinking Water Officer (DWO) of situations or conditions that render or could render the water unsuitable to drink.
- Implement a plan for collecting, shipping, and analyzing water samples in compliance with the standards set by the DWO.
- Implement a plan for reporting monitoring results to the DWO and to water users, including the preparation of an annual report.

The UEL monitors the water quality in the UEL distribution system on a weekly basis in accordance with their Drinking Water Quality Monitoring Program. There was a total of nine sampling stations in operation throughout 2022. Seven (7) of the stations were sampled in two (2) groups alternating weekly. The remaining two (2) stations are sampled biannually. Appendix A shows the locations of the sampling stations. Appendix B includes a tabular and graphic summary of the weekly test results for 2022.

This document includes a brief introduction to the UEL's water distribution system and its drinking water monitoring and testing program. The remaining parts of this document summarize the results and analyses of water samples collected in 2022 and evaluate the distribution system's performance in delivering safe drinking water.

2.0 WATER DISTRIBUTION SYSTEM

The UEL is responsible for the installation, operation, and maintenance of its water distribution system which includes: 24 km of watermains, 568 service connections, 523 water meters, 97 hydrants, 287 line valves, and two pressure reducing valve stations. The UEL receives water from Metro Vancouver through two (2) supply points; one (1) located at Blanca Street and West 16th Avenue and the other at Drummond Drive and West 6th Avenue. Water is then supplied to the UEL's customers through its distribution system. The UEL also supplies water to the University of British Columbia (UBC) through two (2) connection points; one (1) located at Wesbrook Mall and University Boulevard, and the other, located at West 16th Avenue between Blanca Street and Wesbrook Mall. The UEL has adopted a comprehensive watermain replacement program and an operations and maintenance (O&M) program for the water distribution system to ensure the highest quality water is delivered in ample quantity and pressure to its customers.

The watermain replacement program systematically replaces aging infrastructure in the water distribution system to ensure the system continues to meet the needs of the UEL. In 2022, the UEL replaced 380 m of aging steel watermain with polyvinyl chloride (PVC) watermain and replaced 60 m of aging asbestos cement (AC) watermain with PVC watermain. Looking forward to 2023 the following projects have been identified as potential 'shovel-ready' projects for opportunistic water main replacement as budget allows.

Table 1. 2023 Watermain Replacement Program

DESCRIPTION	STATUS
300 mm AC on Western Parkway from North of College Highroad to Chancellor Boulevard	Design Complete
100 mm ST on Wesbrook Crescent from North of Chancellor Boulevard to Newton Wynd	Design Complete
150 mm CI on West 7th Avenue midblock to Drummond Drive	Design in Progress
150 mm CI on Chancellor Boulevard from East of Drummond Drive to West of Blanca Street	Design Not Started

The UEL's O&M program includes an annual watermain unidirectional flushing (UDF) program, a hydrant inspection and maintenance program, a comprehensive cross connection control program, and the Drinking Water Quality Monitoring Program. The watermain UDF program was conducted between May 16th and June 14th in 2022. The UEL intends to continue the watermain UDF program on an annual basis.

There are 436 total cross connection control backflow devices registered in the UEL with 322 from single family dwellings and 114 from multi-family or commercial land uses (note that several commercial users have multiple registered units within their building). Test

reports are required to be submitted annually proving the devices have been tested and meet the required standards. The UEL insists on compliance with their cross-connection control bylaw with letters of non-compliance being issued to addresses delinquent in submitting inspection reports.

In 2022, there was a total compliance rate of 56% as shown in Table 2. Cross Connection Control Backflow Devices Table 2. Compared to 2021, there was a 30% decrease in overall compliance. This decrease has been associated with staffing issues and not being able to follow up with non-compliant properties to enforce the bylaw. To increase compliance in 2023, the UEL will be sending out reminder letters and subsequently following up with delinquent accounts during the summer.

Table 2. Cross Connection Control Backflow Devices

AREA	INSTALLED	TESTED	OUTSTANDING	COMPLIANCE (%)
Single Family	322	189	133	59
Multi-Family/ Commercial	114	56	58	49
Total	**436**	**245**	**191**	**56**

3.0 TESTING AND MONITORING PROGRAM

Drinking water quality is a function of source water quality, water treatment, and water quality changes after treatment. As a result, monitoring of drinking water quality consists of three (3) components: source water monitoring, monitoring after treatment, and monitoring in the distribution system. While Metro Vancouver carries out testing of water at the source and after treatment, the UEL's Drinking Water Quality Monitoring Program is focused on monitoring the water quality within its own water distribution system.

The monitoring and testing program consists of routine monitoring (for obtaining an accurate overview of water quality within the distribution system), and non-routine monitoring (for handling complaint and emergency situations). Monitoring involves three (3) components: the collection of samples, the laboratory analyses of those samples, and the review and analysis of the results by the UEL, Metro Vancouver, and Vancouver Coastal Health (VCH).

3.1 Routine Monitoring

The collection of water samples was completed as part of an annual contract with Caro Analytical Services. Samples were collected from sampling stations within the UEL on a regular basis and then forwarded to laboratories for various analyses. The collection, transportation, and analysis of the samples were performed in accordance with the *Standard Methods for the Examination of Water and Wastewater 23rd Edition*, 2017, published by the American Public Health Association, the American Water Works Association, and the Water Environment Federation. All analyses were conducted by laboratories that are accredited by the Canadian Association of Environmental Analytical Laboratories or an equivalent certification program for the other tests performed, as approved by the Provincial Health Officer.

All testing parameters except vinyl chloride were analyzed by the laboratories of Metro Vancouver. Analysis of vinyl chloride, a volatile organic compound, was tested by the laboratory of Caro Analytical Services.

3.1.1 Sampling Parameters

The parameters that were analyzed are summarized in Table 3.

Table 3. Sampling Parameters

PARAMETERS	
Microbiological	Total Coliforms, Escherichia Coli, Heterotrophic Plate Count (HPC)
Chemical and Physical	Turbidity, Temperature, Free Chlorine Residual, pH, Aluminum, Antimony, Arsenic, Barium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Zinc, Haloacetic Acids (HAAs), Trihalomethanes (THMs), Vinyl Chloride

The most relevant parameters are briefly discussed below. Further details regarding the parameters listed in the above table can be found by accessing the supporting documents of the *Guidelines for Canadian Drinking Water Quality* (GCDWQ) through the following web site or by contacting Health Canada at **(613) 957-2991.**
https://www.canada.ca/en/health-canada/services/environmental-workplace-health/water-quality/drinking-water/canadian-drinking-water-guidelines.html

Total Coliforms

One of the primary concerns in water quality is the growth of coliform bacteria. The presence of coliforms indicates a possibility of regrowth of the bacteria in biofilms or the intrusion of untreated water.

Escherichia Coli (E. coli)

E. coli is used as an indicator of microbiological safety of drinking water; if detected, enteric pathogens may also be present. *E. coli* monitoring is used, in conjunction with other indicators, as part of a multi-barrier approach to producing drinking water at an acceptable quality.

Heterotrophic Plate Counts

Heterotrophic Plate Counts (HPC) are a useful operational tool for monitoring general bacteriological water quality through the treatment process and in the distribution system. HPC results are not an indicator of water safety and should not be used as an indicator of potential adverse human health effects. Increases in HPC concentrations above baseline levels are considered undesirable.

Free Chlorine Residual

Free chlorine residual provides a good indication of water quality within the distribution system. Low chlorine residual may indicate deteriorating water quality as a result of bacterial regrowth or stagnant water. The operational target is 0.5 mg/L in Metro Vancouver's transmission system which allows municipalities to meet a target of 0.2 mg/L at the end points of their distribution system.

Turbidity

Turbidity in distribution systems is caused by naturally occurring particles consisting of inorganic and organic matter. Controlling turbidity is important for both health and aesthetic reasons. Bacteria, viruses, and protozoa can adhere to suspended particles in turbid water and interfere with disinfection. Excessive turbidity detracts from the appearance of treated water and has often been associated with unacceptable tastes and odours.

Disinfection By-products

Haloacetic acids (HAAs) and Trihalomethanes (THMs) are disinfection by-products (DBPs) and are formed in drinking water when chlorine reacts with organic matter that is naturally present in raw water supplies. Research suggests that HAAs have an adverse impact on human health and may possibly be carcinogenic. The most common THM is chloroform

which is classified as being possibly carcinogenic. DBPs are maintained as low as possible without compromising the effectiveness of disinfection.

pH

pH is used as a measure of the acidity and basicity of water. pH is monitored in a distribution system because at low values water becomes corrosive while at high levels chlorine disinfection is less effective and efficient. Health Canada guidelines state an optimal pH between 7.0 and 10.5.

Copper

Copper is used extensively in plumbing for domestic water systems. Although copper is frequently found in surface water, distributed water contains considerably more copper than the original water supply because of the dissolution of copper from copper piping. Copper can stain laundry and plumbing fixtures and cause an undesirable bitter taste in water. Copper intake at extremely high doses can result in adverse health effects.

Iron

Iron is naturally present in food and drinking water. However, there is no evidence to indicate that concentrations of iron commonly found in food or water constitute any hazard to human health. Iron can stain laundry and plumbing fixtures and cause undesirable tastes in beverages. The precipitation of excessive iron imparts an objectionable reddish-brown color to the water. Iron may also promote the growth of certain microorganisms, which can lead to the deposition of a slimy coat in piping.

Lead

Lead was used in drinking water plumbing and as solder in distribution systems. Older distribution systems may also be made from lead pipe or appurtenances. Lead is present in tap water as a result of dissolution from natural sources or from household plumbing systems. Lead is a cumulative general poison and has been classified as being potentially carcinogenic to humans. Fetuses, infants, young children, and pregnant women are most susceptible to adverse health effects caused by lead. In order to minimize exposure to lead introduced into drinking water from plumbing systems, it is recommended that only cold water be used, after an appropriate period of flushing to rid the system of standing water, for sampling, drinking, beverage preparation, and cooking.

Vinyl Chloride

The presence of vinyl chloride in potable water is associated mainly with the use of polyvinyl chloride (PVC) water pipes manufactured with incompletely polymerized vinyl chloride monomer. Acute exposure or chronic inhalation results in a variety of adverse effects in humans. Sufficient evidence has accumulated to implicate vinyl chloride as a human and animal carcinogen.

Zinc

Although zinc is present in surface waters at low concentrations, levels in domestic water systems can be considerably higher because of the use of zinc in plumbing materials. Water containing zinc in excessive concentrations has an undesirable astringent taste and

may develop a greasy film upon boiling. Long-term ingestion of zinc in excess of the daily requirement has not shown to result in adverse effects.

3.1.2 Sampling Locations

Sampling locations are distributed in different areas within the UEL to obtain an accurate overview of water quality in the distribution system. Nine (9) locations were strategically selected based on land use and system configuration.

The sampling station supply types include:

- residential area supply;
- high-density residential area supply;
- institutional area supply; and,
- water source supply.

Sampling stations are summarized in Table 4 below and locations are illustrated in Appendix A.

Table 4. Drinking Water Sampling Stations

STATION	LOCATION	FLOW CATEGORY	SUPPLY TYPE
S-A	Drummond Dr. & W. 6th Ave.	Source	Water Source / Residential
S-B	Wycliffe Rd. & Tasmania Cres.	Low Flow	Residential
S-C[1,2]	Norma Rose Elementary	Service Connection	Institutional
S-D	Acadia Rd. & Toronto Rd.	Source	Water Source / High-Density Residential
S-E	Western Pkwy. South of Chancellor Blvd.	Medium Flow	Residential
S-F	NW Marine Dr. at the UEL boundary	Low Flow	Residential
S-G	Chancellor Blvd. East of Acadia	Medium Flow	Institutional
S-H[1]	University Hill Elementary	Service Connection	Institutional
S-J	East Side of NW Marine Dr.	Low Flow	Residential

[1] Stations are taps located within schools. These stations are not used for weekly sampling.
[2] Norma Rose Elementary School is serviced through the UBC water distribution system.

3.1.3 Sampling Frequency

The UEL, as a purveyor of drinking water to a population of less than 5000, is required to test at least four (4) samples per month as outlined in *Schedule B* of the BCDWPR. During 2022, the UEL tested nearly four (4) times the minimum required number of samples. Parameters that have greater effects on health were sampled and analyzed more often than those that only affect the aesthetic quality. The sampling frequency of different parameters from different sampling locations is summarized in Table 5.

Table 5. Sampling Frequency

FREQUENCY	FOUR SAMPLES PER WEEK	FOUR SAMPLES PER YEAR	TWO SAMPLES PER YEAR
PPARAMETERS	Total coliforms *E. Coli* HPC Free chlorine residual Turbidity Temperature	Haloacetic Acids pH Trihalomethanes	Aluminum Antimony Arsenic Barium Boron Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Mercury Molybdenum Nickel Potassium Selenium Silver Sodium Zinc Vinyl Chloride
STATION NAMES	S-A, S-B, S-D, S-E, S-F, S-G, S-J	S-B, S-E	S-A, S-C, S-H
STATION CATEGORIES	Residential Areas	Residential Areas	Residential Areas & Taps in Building

Notes: Weekly sampling stations are sampled on a biweekly rotating schedule with four stations sampled in week one and the other three stations sampled in week two.
S-A and S-C were sampled for vinyl chlorides while S-C and S-H were sampled for metals.

3.2 Non-routine Monitoring

A laboratory was on-call for monitoring for complaint and emergency situations. Consumer complaints were recorded so that water quality concerns could be tracked and responded to efficiently. In any emergency, the procedures outlined in the UEL Emergency Response Plan would be followed.

4.0 SAMPLE ANALYSIS RESULTS

A total of 186 samples were taken from the UEL water distribution system during 2022. The sample analysis results are summarized in Table 6 below and some of the parameters worth noting are discussed in this section. Refer to Appendix B for detailed sample analysis results. It should be noted that the limits contained within the GCDWQ are recommendations only and representative of best practices. These can become requirements if the DWO places a condition on the Operating Permit for the UEL. At present, there are no such DWO conditions placed on the UEL.

Table 6. Summary of Analysis Results

Sample Station	No. of Samples	HPC (CFU/mL)			Free Chlorine Residual (mg/L)			Turbidity (NTU)			Positive Coliform Tests	Positive *E. coli* Tests
		Low	Avg	High	Low	Avg	High	Low	Avg	High		
S-A	26	<2	3	6	0.40	0.49	0.60	0.09	0.16	0.51	none	none
S-B	26	<2	4	20	0.29	0.45	0.55	0.09	0.13	0.21	none	none
S-D	26	<2	2	6	0.42	0.54	0.63	0.09	0.16	0.31	none	none
S-E	27	<2	13	220	0.40	0.51	0.73	0.09	0.25	3.10	2	none
S-F	27	<2	6	26	0.24	0.35	0.46	0.08	0.14	0.21	none	none
S-G	27	<2	40	150	0.31	0.41	0.54	0.08	0.13	0.40	none	none
S-J	27	<2	6	44	0.33	0.48	0.59	0.09	0.13	0.19	none	none
Total	**186**		11			0.46			0.16		2	none

Total average values calculated using all samples collected in 2022 from all stations.

Total Coliforms

For total coliforms, the BCDWPR requires that 1) when there is one (1) sample in a 30-day period, the sample contains no total coliform bacteria per 100 mL and that 2) when there is more than one (1) sample in a 30-day period, at least 90% of samples have no detectable total coliform bacteria per 100 mL and no sample has more than 10 total coliform bacteria per 100 ml.

Of the 186 samples taken, two (2) samples taken at station S-E, tested positive for total coliforms on July 12th and October 4th. Due to these positive coliform tests, the sampling station was flushed, and a re-test was performed. In both cases the re-test came back with no positive coliforms. Due to the occurrence of the positive coliform tests, the UEL plans to monitor the station and will react should future sampling flag a potential issue in the system. The location with the positive coliform tests has consistent water flow and is not expected to have future positive coliform tests.

E. coli

For *E. coli*, the BCDWPR requires that the samples contain no detectable colonies per 100 mL. No *E. coli* colonies were detected in the 186 samples analysed for microbiological criteria in 2022.

Heterotrophic Plate Count, HPC

The GCDWQ does not indicate a maximum acceptable concentration of HPC and instead states that unexpected increase outside the baseline range could indicate a change in the treatment process, a disruption or contamination in the distribution system, or a change in the general bacteriological quality of the water. However, the National Primary Drinking Water Regulations (established by the United States Environmental Protection Agency), note that concentration in drinking water should be maintained below 500 CFU/mL to aid in the better maintenance of the treatment and distribution systems. All 186 samples tested for HPC indicated levels below 500 CFU/mL.

Turbidity

The GCDWQ recommends that turbidity levels of no more than 1.0 Nephelometric Turbidity Units (NTU) be present for water entering the distribution system. Maintaining an NTU below 1.0 minimizes the potential for interference with disinfection and allows for adequate operation of the distribution system. Of the 186 samples tested, one (1) sample measured greater than 1.0 NTU. In the event of a high turbidity reading, the procedure is to flush the applicable water main and re-sample as appropriate.

Free Chlorine Residual

In previous years, sampling stations (S-F and S-G) had readings below the free chlorine residual target of 0.2 mg/L. These stations are located at the furthest ends of the water distribution system, which has low flows due to a low number of connections. These conditions increase the likelihood of stagnant water and the deterioration of chlorine residual.

In 2017, a strategy was implemented to improve chlorine residual and HPC results at station S-F. Circulation of water at station S-F was increased by releasing water through a discharge line at a controlled rate of 2 L/min. The intent was to decrease the water age in the area by removing 'old' water from the system and promoting the flow of 'fresh' water to the area. In 2018, the water discharge line continued to operate and samples from station S-F were closely monitored as additional strategies were implemented to improve free chlorine residuals in the area.

On Oct 23, 2019, the UEL removed deteriorating and redundant infrastructure in the vicinity of station S-F in an effort to minimize the volume of water that needed to be introduced as 'fresh' water. As a result, station S-F was moved 150 m to the west and the discharge line was temporarily decommissioned until it was reinstated in 2020. In addition, the UEL completed the replacement of aging cast iron water main on Acadia Road from Chancellor Boulevard to NW Marine Drive in 2020. With those two interventions, chlorine residual and HPC sampling results have seen significant improvements since then.

In 2021 and 2022, the improvements at site S-F continued with all samples returning a detectable chlorine residual. The UEL will continue to monitor chlorine residuals at S-F and adjust the bleed rate as necessary to maintain chlorine residuals, but no further interventions are planned.

Table 7 displays the percentage of samples for each station with a free chlorine residual less than 0.2 mg/L while Appendix B shows individual results in tabular and graphical form. From 2021 to 2022, samples containing less than 0.2 mg/L of chlorine were decreased from 16% to 0% at station S-F and from 20% to 0% at station SG. The decrease seen at station SG is the result of abandoning of a section of aged steel watermain with servicing now being from a newer parallel AC watermain.

Table 7. Summary of Free Chlorine Residual Results

Sample Station	Free Chlorine Residual
	% Of Samples <0.2 mg/L
S-A	0%
S-B	0%
S-D	0%
S-E	0%
S-F	0%
S-G	0%
S-J	0%

Disinfection By-products and pH

Two (2) sample stations, S-B and S-E, were tested for disinfection by-products and pH. Table 8 displays the analysis results.

Table 8. Disinfection By-products and pH Analysis Results

		THM (ppb)						HAA (ppb)							
Sample Location	Sample Date	Bromodichloromethane	Bromoform	Chlorodibromomethane	Chloroform	Total Trihalomethanes	[1]Total THM Quarterly Running Annual Average	Dibromoacetic Acid	Dichloroacetic Acid	Monobromoacetic Acid	Monochloroacetic Acid	Trichloroacetic Acid	Total Haloacetic Acid	[1]Total HAA Quarterly Running Annual Average	pH
S-B	16-Feb-22	<1	<1	<1	24	26	28	<0.5	8.9	<5.0	<5.0	8	17	18	8.0
S-B	10-May-22	1	<1	<1	32	34	30	<0.5	10	<0.5	0.6	8	19	16	8.0
S-B	23-Aug-22	<1	<1	<1	23	23	29	<0.5	6.8	<0.5	<5.0	5.2	12	17	8.1
S-B	15-Nov-22	2	<1	<1	37	39	31	<0.5	2.0	<0.5	<0.5	8.2	10	15	8.2
S-E	16-Feb-22	<1	<1	<1	22	23	27	<0.5	9.3	<5.0	<5.0	8.3	18	17	7.8
S-E	10-May-2022	<1	<1	<1	26	27	28	<0.5	11	<0.5	0.9	6.3	18	17	7.9
S-E	23-Aug-22	<1	<1	<1	22	22	26	<0.5	8.1	<0.5	<0.5	4.7	13	17	7.9
S-E	15-Nov-22	1	<1	<1	25	27	25	<0.5	9.4	<0.5	1	8.0	18	17	8.0

Average values for each station calculated by taking the average of the current and three previous quarters.

Both stations S-B and S-E meet the GCDWQ recommendation for the running annual average of quarterly samples for THM of 100 ppb (0.1 mg/L) and for HAA of 80 ppb (0.080 mg/L). The maximum THM concentration sampled was 39.0 ppb (0.0390 mg/L) and 27.0 ppb (0.0270 mg/L) for stations S-B and S-E, respectively. The maximum HAA concentration sampled was 19 ppb (0.019 mg/L) for station S-B and 18 ppb (0.018 mg/L) for station S-E.

The pH concentrations for both stations S-B and S-E were within the GCDWQ recommended range of 7.0 to 10.5 for water treatment related objectives.

Vinyl Chloride

Vinyl chloride concentration was tested twice in 2022 with the samples taken from stations S-A and S-C on May 3rd and November 9th. During sample testing, the vinyl chloride concentration was below 1 ppb (0.001 mg/L), which meets the recommendation from GCDWQ of less than 2 ppb (0.002 mg/L).

Metals

Two (2) sample locations, stations S-C and S-H, were tested twice for total concentration of various metals in 2022. Analysis results are presented below in Table 9, measured in µg/L (ppb or 0.001 mg/L). All metals with recommended limits, fall below the limits outlined in the GCDWQ.

Table 9. Metals Analysis Results

Sample Station		S-C		S-H		GCDWQ	
Sampled date		03/05/2022	9/11/2022	03/05/2022	9/11/2022	Health Guideline	Aesthetic Objective
Total Concentration (µg/L)	Aluminum	29	29	46	68	n/a	200
	Antimony	<0.5	<0.5	<0.5	<0.5	6	n/a
	Arsenic	<0.5	<0.5	<0.5	<0.5	10	n/a
	Barium	2.4	3.0	1.7	1.5	2000	n/a
	Boron	<10	<10	<10	<10	5000	n/a
	Cadmium	<0.2	<0.2	<0.2	<0.2	7	n/a
	Calcium	8270	8030	9790	9990	n/a	n/a
	Chromium	<0.05	0.08	0.16	0.26	50	n/a
	Cobalt	<0.5	<0.5	<0.5	<0.5	n/a	n/a
	Copper	8.2	14.9	1.0	1.1	≤2000	≤1000
	Iron	10	9	13	21	n/a	≤300
	Lead	<0.5	<0.5	<0.5	<0.5	5	n/a
	Magnesium	200	208	137	109	n/a	n/a
	Manganese	2.6	9.2	1.9	8.4	≤120	≤50
	Mercury	<0.05	<0.05	<0.05	<0.05	1	n/a

Sample Station		S-C		S-H		GCDWQ	
Sampled date		03/05/2022	9/11/2022	03/05/2022	9/11/2022	Health Guideline	Aesthetic Objective
	Molybdenum	<0.5	<0.5	<0.5	<0.5	n/a	n/a
	Nickel	<0.5	<0.5	<0.5	<0.5	n/a	n/a
	Potassium	151	228	171	205	n/a	n/a
	Selenium	<0.5	<0.5	<0.5	<0.5	50	n/a
	Silver	<0.5	<0.5	<0.5	<0.5	n/a	n/a
	Sodium	1490	1720	1560	1830	n/a	≤200,000
	Zinc	<3.0	<3.0	<3.0	<3.0	n/a	≤5000

5.0 EMERGENCY WATER SUPPLY

In 2019, the UEL started working on the commissioning and permitting process of the emergency water supply well located at the UEL Works Yard, as part of their commitment to emergency preparedness and planning. This work was based on recommendations from the UEL and was informed by the *Regional Temporary Provision of Drinking Water Guideline*, developed by the Metro Vancouver Regional Engineers Advisory Committee (REAC).

Metro Vancouver Regional Engineers Advisory Committee Temporary Provision of Drinking Water Guideline and the UEL's commitment to emergency preparedness and planning.

The purpose of the well is to supply water to residents in the event that the distribution system is inoperable. As part of the UEL's Water Provision Emergency Plan, the UEL plans to supply a minimum of 4 L of potable water per person per day in the immediate aftermath of a disaster, increasing to 10 L per day in the weeks following a disaster until the regular water supply is restored. The water would be supplied to residents through filling of individual containers at the UEL Work's Yard or if needed through community distribution points.

The well was initially constructed in March/April 2019 with compliance testing, as directed by DWO completed in November 2021. The well is part of the UEL's Water Utility Emergency Plan and Water Provision Emergency Plan which have been approved by the DWO. An application has also been made to register the well under the Water Sustainability Act.

Until 2022, the UEL tested monthly for bacteriological contamination in the same manner as the piped distribution system. In consultation with the DWO and starting in June 2022, bacteriological testing of the well was reduced to once a year. One (1) of the samples (collected on June 7th) returned with positive for bacteriological contamination. A re-test was conducted on June 14th due to the positive coliform test. The re-test sample came back with no bacteriological contamination. Results of the testing are presented in Appendix C.

6.0 SUMMARY

The UEL implemented a Drinking Water Quality Monitoring Program in 2002 per requirements of BCDWA and BCDWR and based on the standard program adopted by Metro Vancouver member municipalities, and input from Vancouver Coastal Health (VCH). With this approved monitoring program in place, the UEL has collected and analyzed water quality data since 2002.

The implementation of the Drinking Water Quality Monitoring program is a significant commitment made by the UEL to deliver safe water to its consumers. It generates valuable data for gaining an understanding of the UEL's water distribution system and for evaluating the past performance of the system in a reliable and systematic way. Most importantly, it allows for potential health hazards to be identified and consumers' water concerns to be addressed.

The watermain replacement program systematically replaces aging infrastructure in the water distribution system to ensure the system continues to meet the needs of UEL residents. In 2022, the UEL replaced 380m of aging steel watermain with polyvinyl chloride (PVC) watermain and 60m of aging asbestos cement (AC) watermain with PVC watermain.

A unidirectional flushing (UDF) program is conducted annually. This helps reduce the risk of sediment and corrosion by-products that build up in the watermains producing turbidity. Unidirectional flushing can help reduce the habitats where bacteria grow but does not address the underlying reasons for the bacterial growth or loss of disinfectant residual.

The UEL cross connection control program relies on user compliance. In 2022, 56% of all the registered devices were tested and proven to be functioning as intended to protect the public water system from contamination. The UEL requests compliance through their cross-connection control bylaw. In 2023 the UEL plans to increase their enforcement efforts through proactive issuance of notices and warning letters of non-compliance to properties that do not submit inspection reports.

The sampling analysis demonstrates that during 2022, all except two (2) samples of the 186 samples taken met the bacteriological standards set out in the BCDWP pursuant to the BCDWPA. Additionally, all but two (2) samples of the 186 samples taken met the health recommendations specified in the *Guidelines for Canadian Drinking Water Quality*. Re-tests were conducted following the two (2) samples which did not meet the BCDWPR. The re-tests came back with no exceedances. The UEL will monitor the samples during 2023 and will react if results flag a potential issue in the system. The UEL is committed to delivering water of the highest quality and will continue to make the necessary effort to ensure its continued success.

As part of the UEL's Water Utility Emergency Plan and Water Provision Emergency Plan the UEL has constructed an emergency potable water supply well to be used following a disaster that renders the piped water distribution system inoperable. The well is maintained and kept active throughout the year through different uses at the UEL Public Works Yards. Water quality samples are taken monthly.

REFERENCES

British Columbia Drinking Water Protection Regulation. *British Columbia Drinking Water Protection Act* Reg. 200/2003, 2003

Guidelines for Canadian Drinking Water Quality – Health Canada, February 2017 <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html>

National Primary Drinking Water Regulations – US Environmental Protection Agency, January 9, 2023 <https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations>

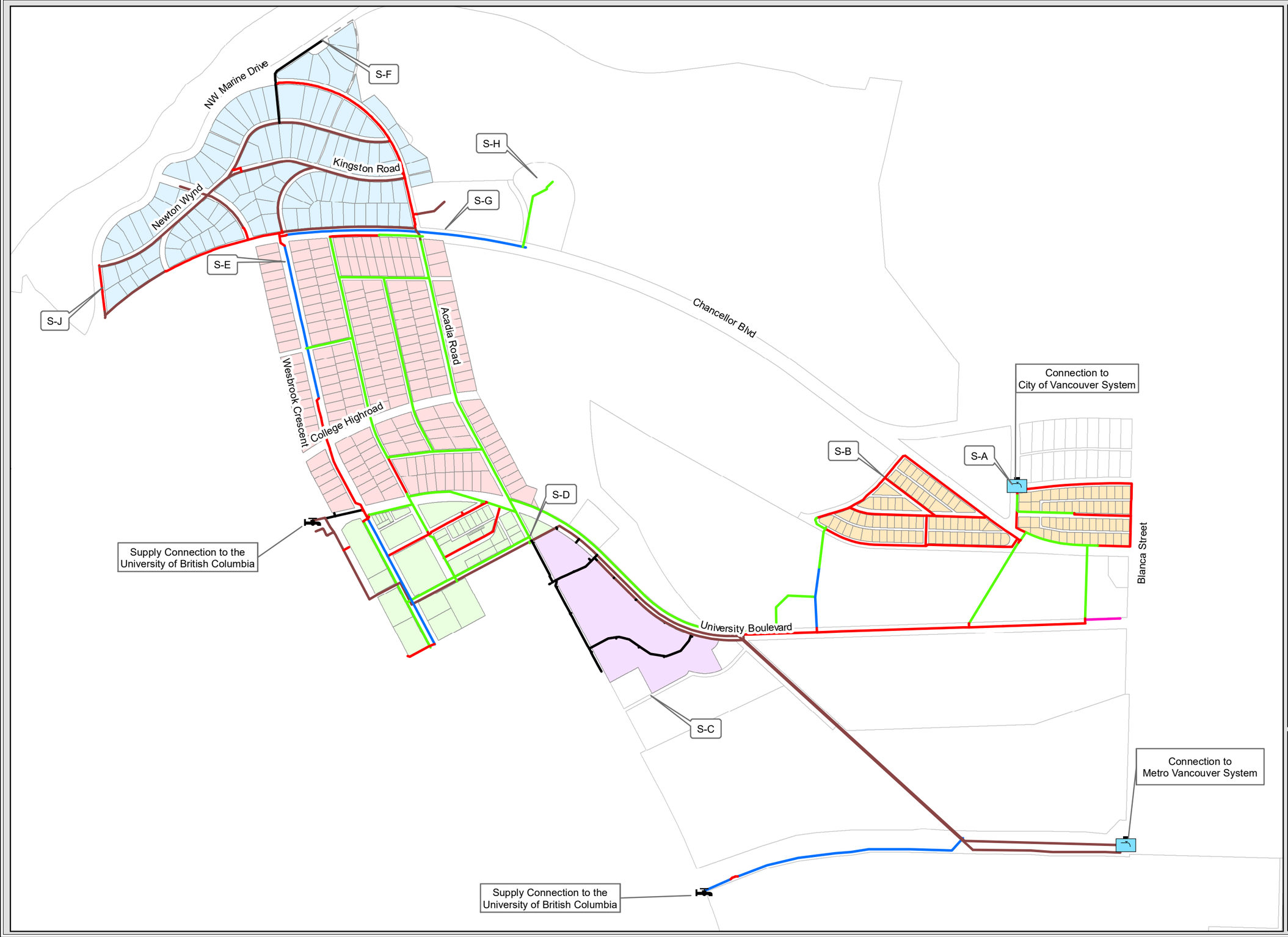
Regional Temporary Provision of Drinking Water Guideline - Metro Vancouver Regional Engineers Advisory Committee (2018).

Standard Methods for the Examination of Water and Wastewater, 23rd Edition. APHA, AWWA, WEF, 2017

Water Quality Monitoring and Reporting Plan for the GVRD and Member Municipalities. Regional Engineers Advisory Committee (REAC), May 2000

APPENDIX A

Water Sampling Stations Map



Legend

UEL Water Supply

Connection to UBC

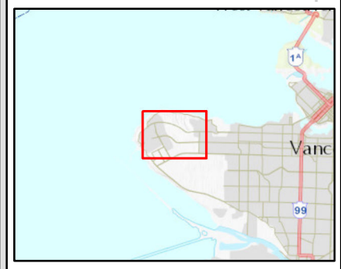
Material

- Asbestos Cement
- Cast Iron
- Ductile Iron
- Polyvinyl Chloride
- Steel
- High Density Polyethylene

UEL Areas

- Area A
- Area B
- Area C
- Area D
- Ieləm'

Overview Map



N
W E
S

0 230 460

Metres

1:10,000

NAD 1983 UTM Zone 10N

2022 Water Quality Report
Location: University Endowment Lands

BRITISH COLUMBIA

Existing UEL Water System Sample Locations

April 2023
Project: 60639142 - 303

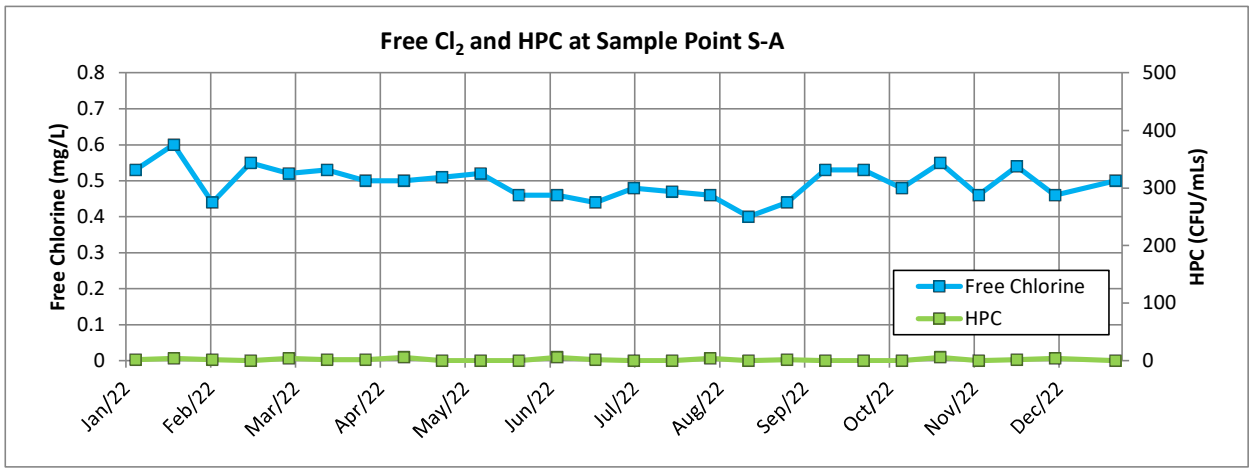
AECOM

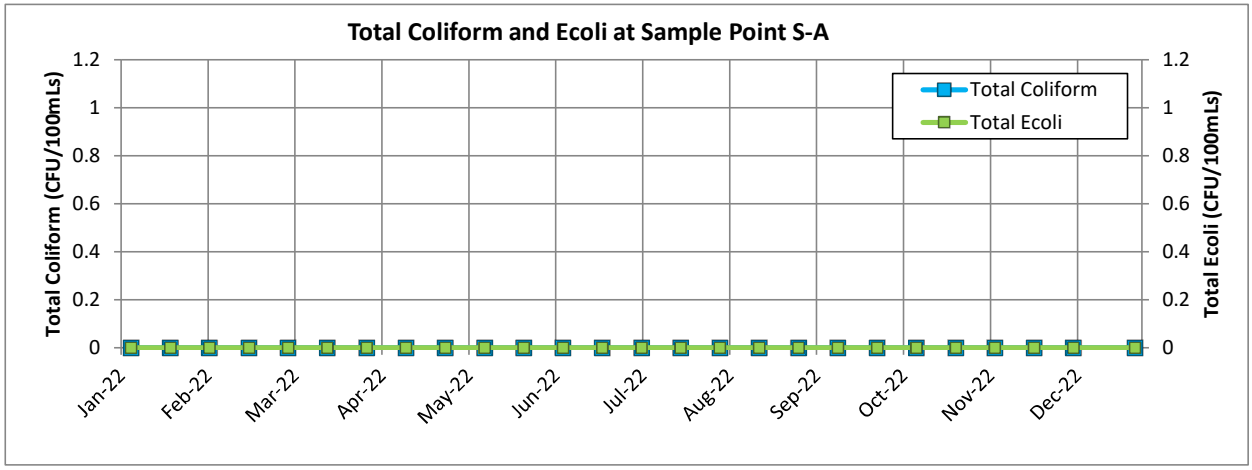
Appendix A

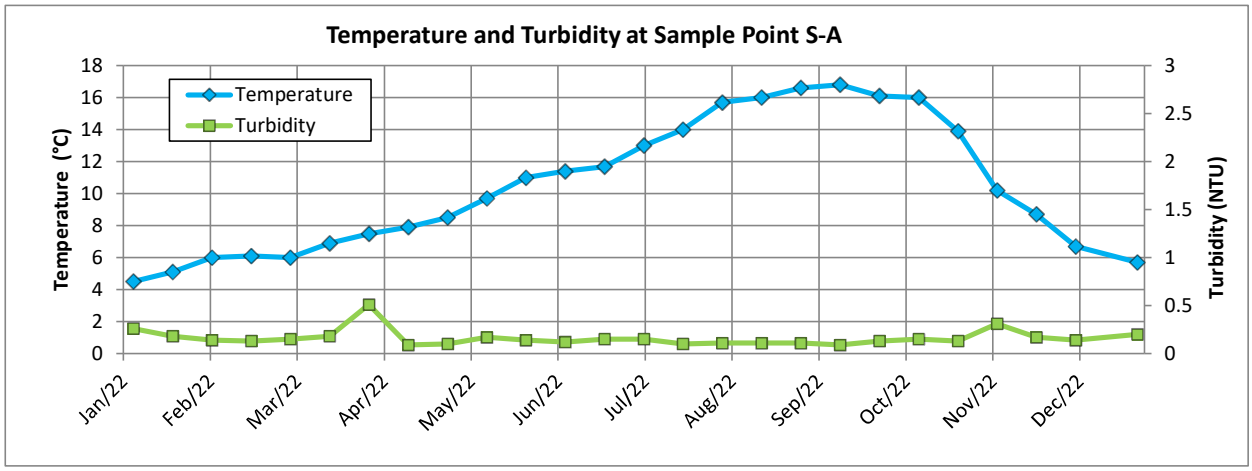
File Location: L:\Legacy\cabny1fp001\prod\Projects\60639142\900-CAD_GIS\920-GIS\02_Maps\303 - Water Quality Report\2022 Appendix A - ExistingUELWaterSystem 10-6.mxd Date Revised: April 19, 2023 Prepared by: witchardm Project: 60639142 - 303

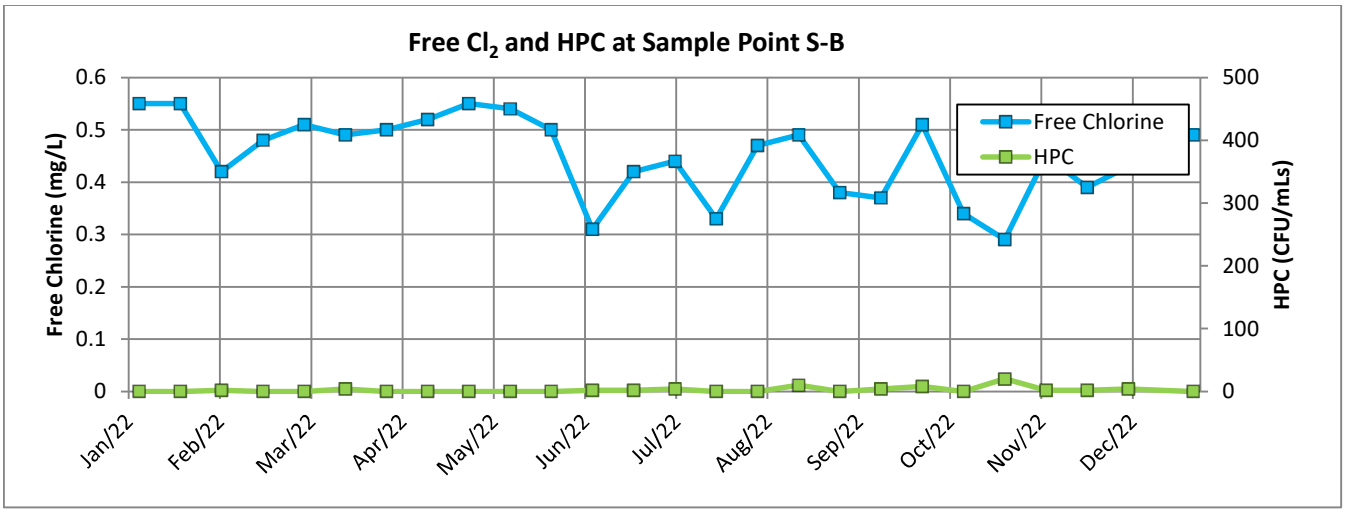
APPENDIX B

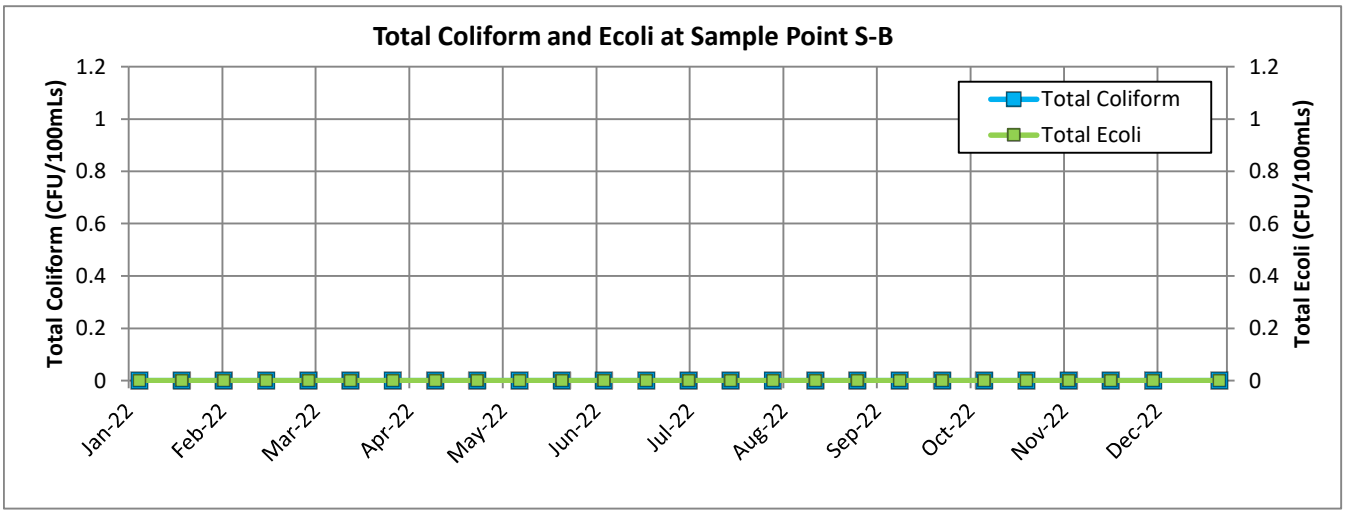
Sample Analysis Results

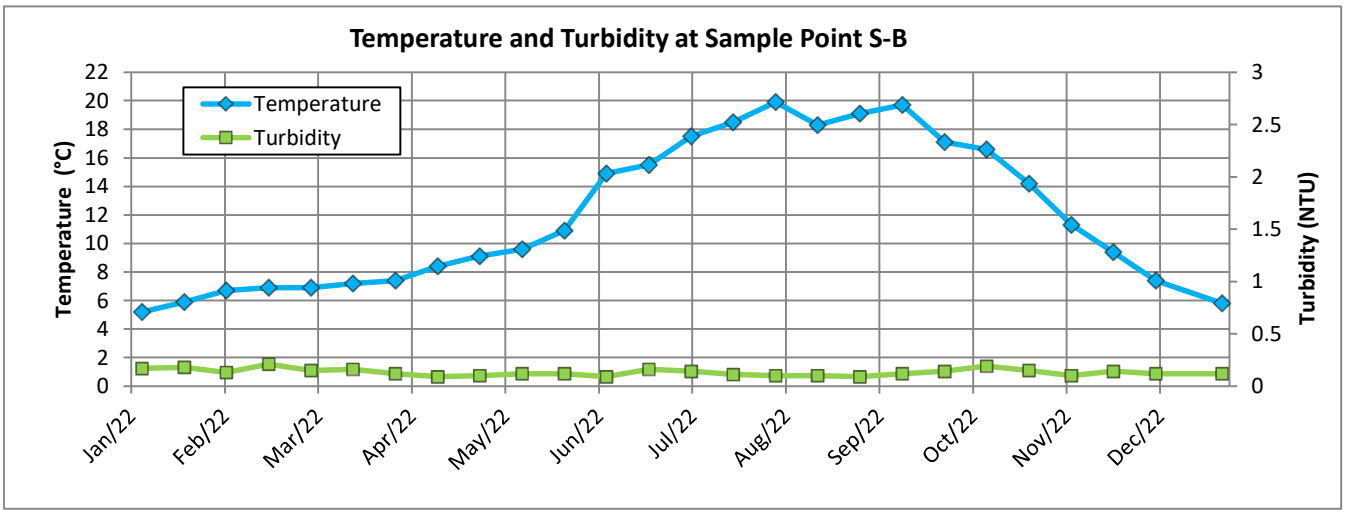

Free Cl2 and HPC at Sample Point S-A
Free Chlorine (mg/L)
HPC (CFU/mLs)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Free Chlorine
HPC
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

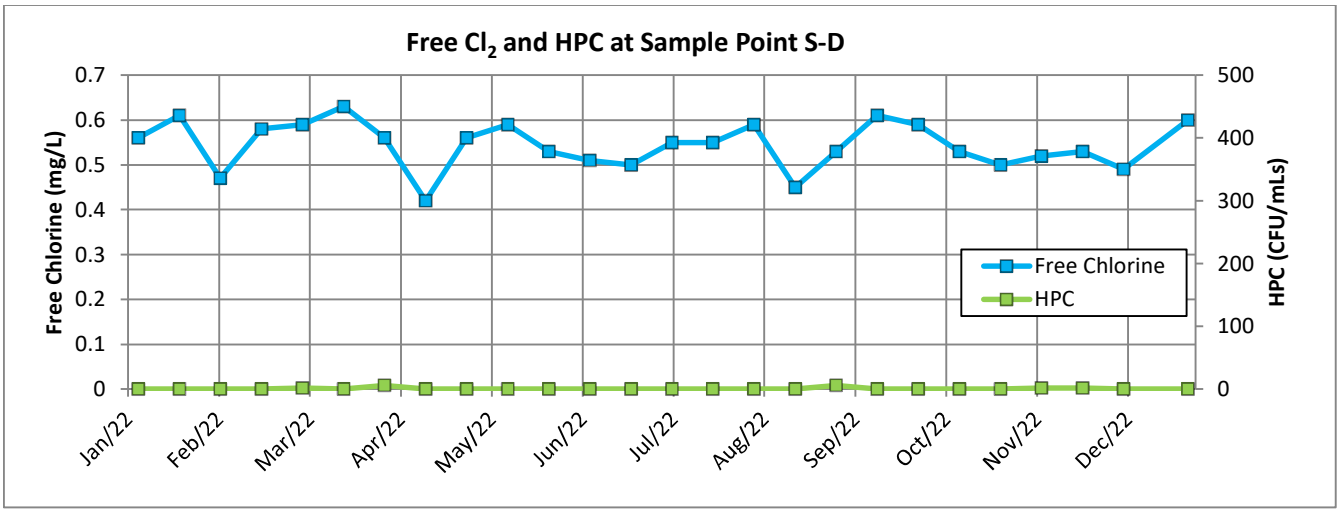

Total Coliform and Ecoli at Sample Point S-A
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
1.2
1
0.8
0.6
0.4
0.2
0
Total Coliform
Total Ecoli
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22

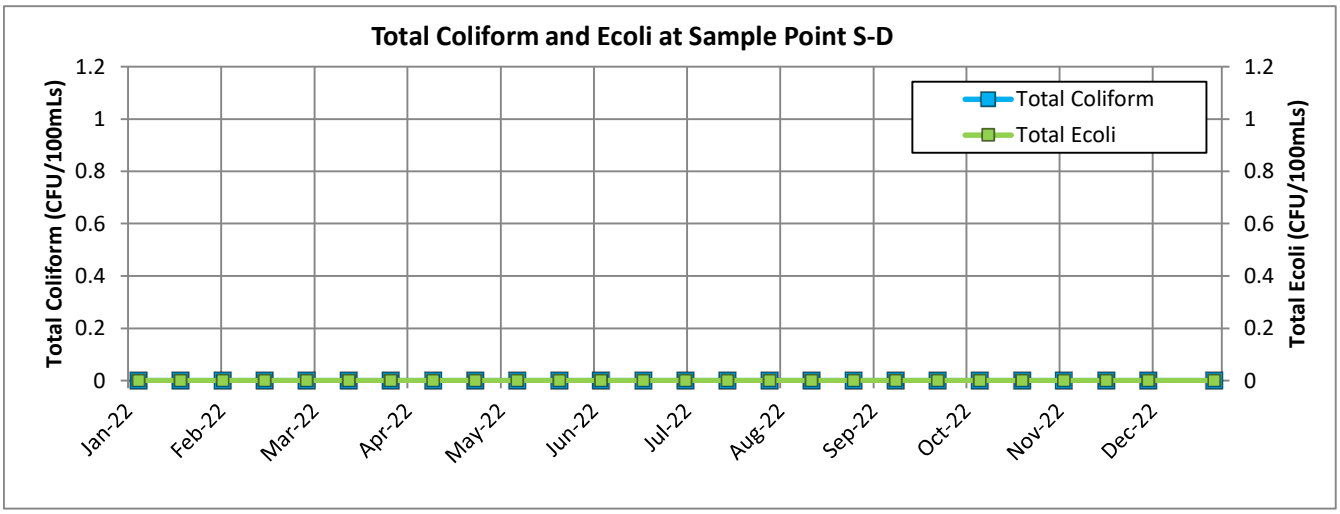

Temperature and Turbidity at Sample Point S-A
Temperature (°C)
Turbidity (NTU)
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Temperature
Turbidity
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

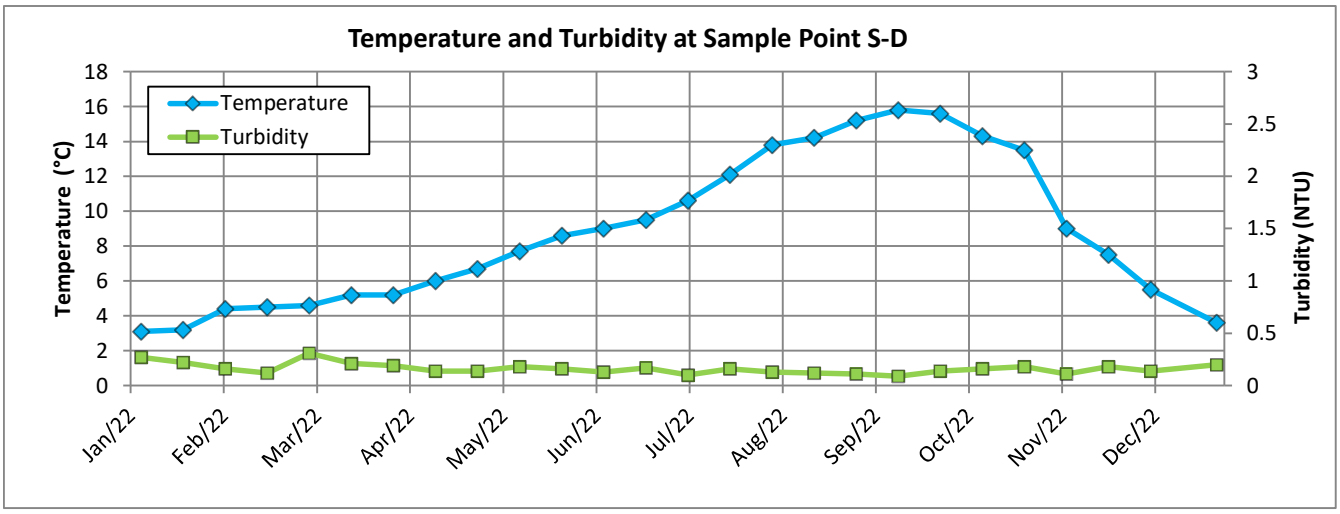

Free Cl2 and HPC at Sample Point S-B
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

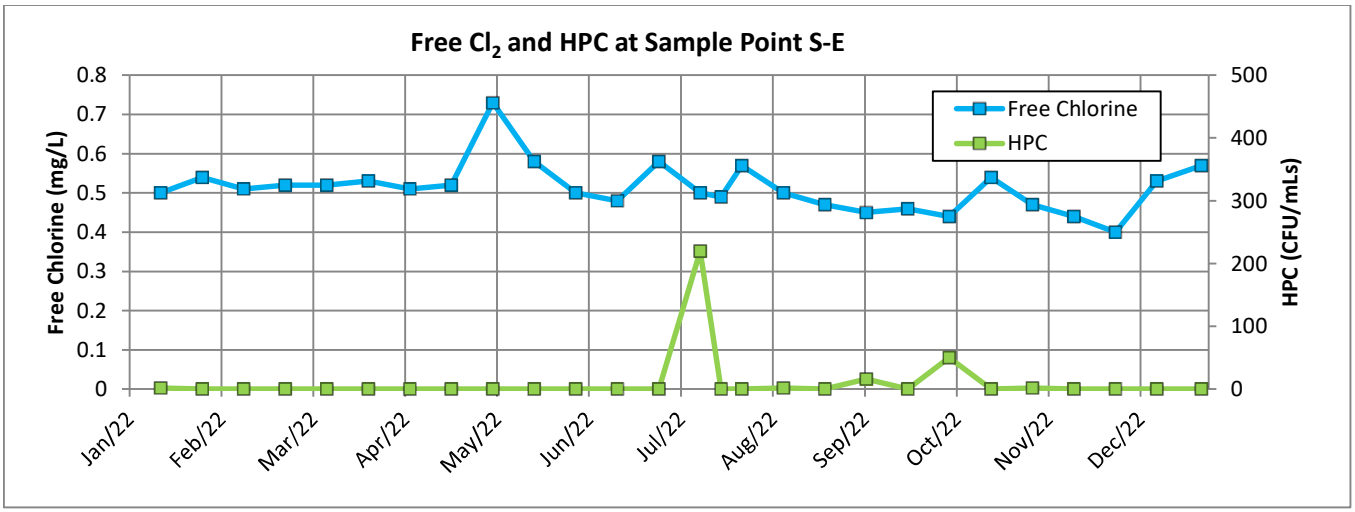

Total Coliform and Ecoli at Sample Point S-B
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
1.2
1
0.8
0.6
0.4
0.2
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22

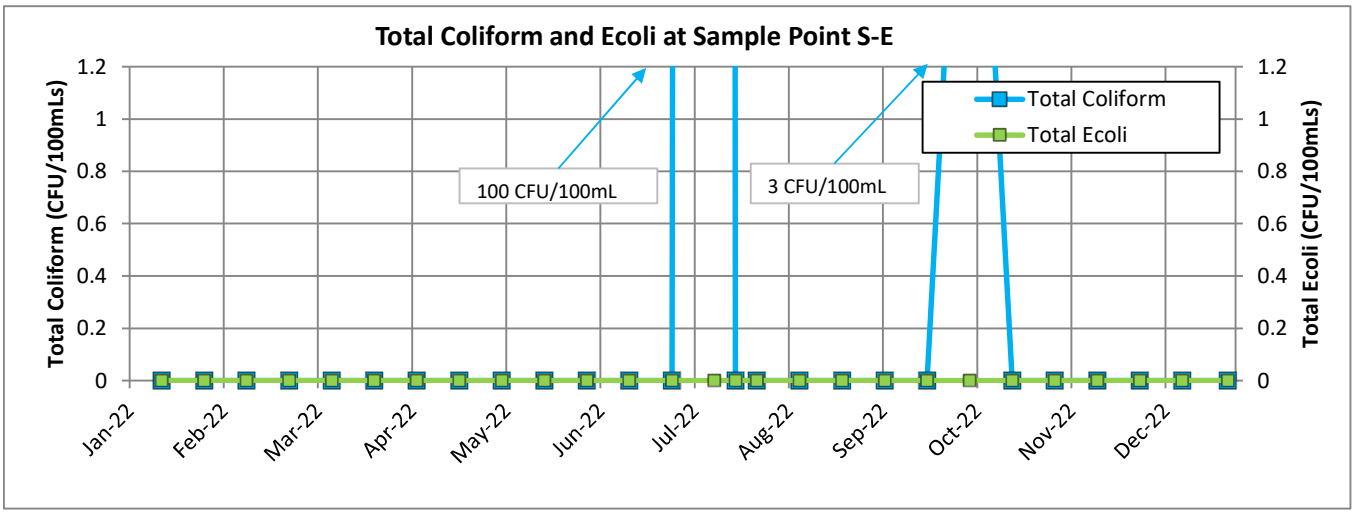

Temperature and Turbidity at Sample Point S-B
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
22
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

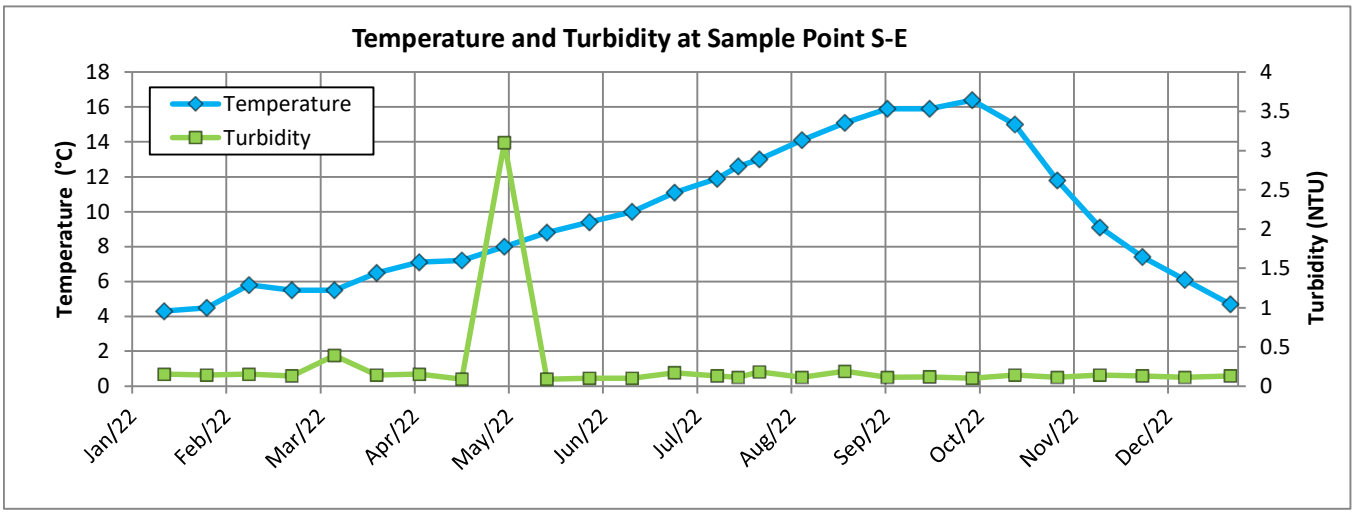

Free Cl2 and HPC at Sample Point S-D
Free Chlorine (mg/L)
HPC (CFU/mLs)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Free Chlorine
HPC
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

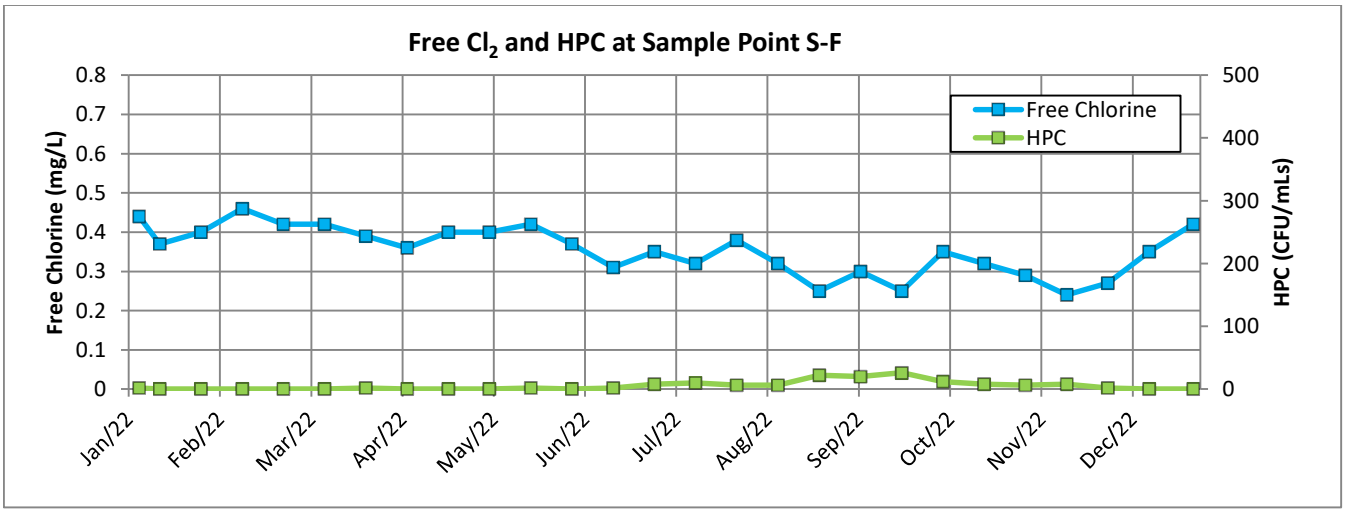

Total Coliform and Ecoli at Sample Point S-D
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
1.2
1
0.8
0.6
0.4
0.2
0
Total Coliform
Total Ecoli
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22

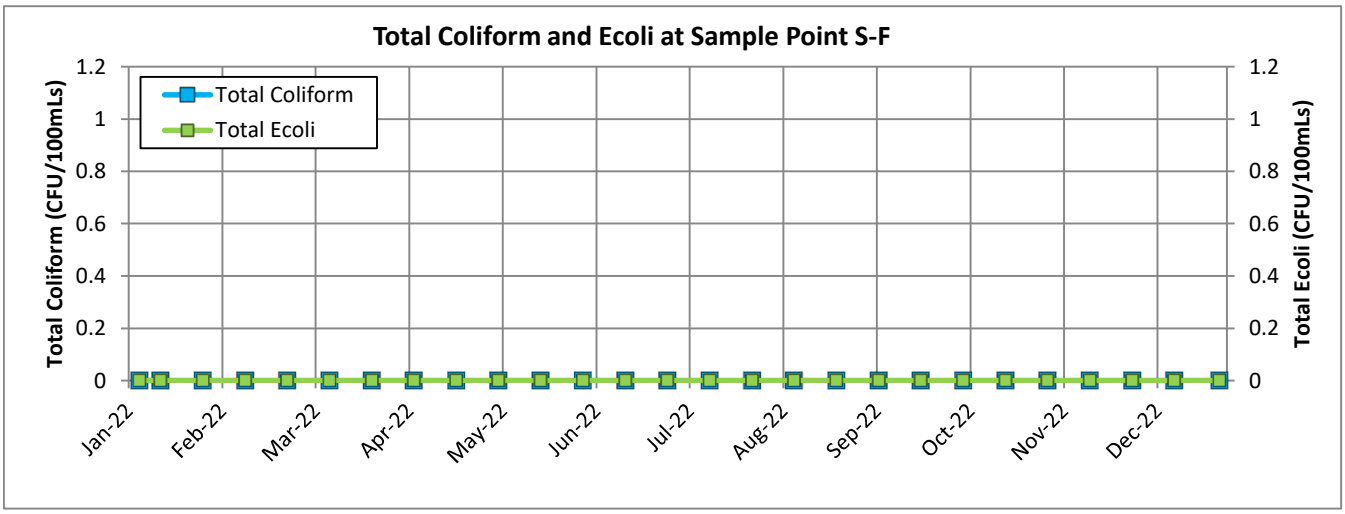

Temperature and Turbidity at Sample Point S-D
Temperature (°C)
Turbidity (NTU)
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Temperature
Turbidity
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

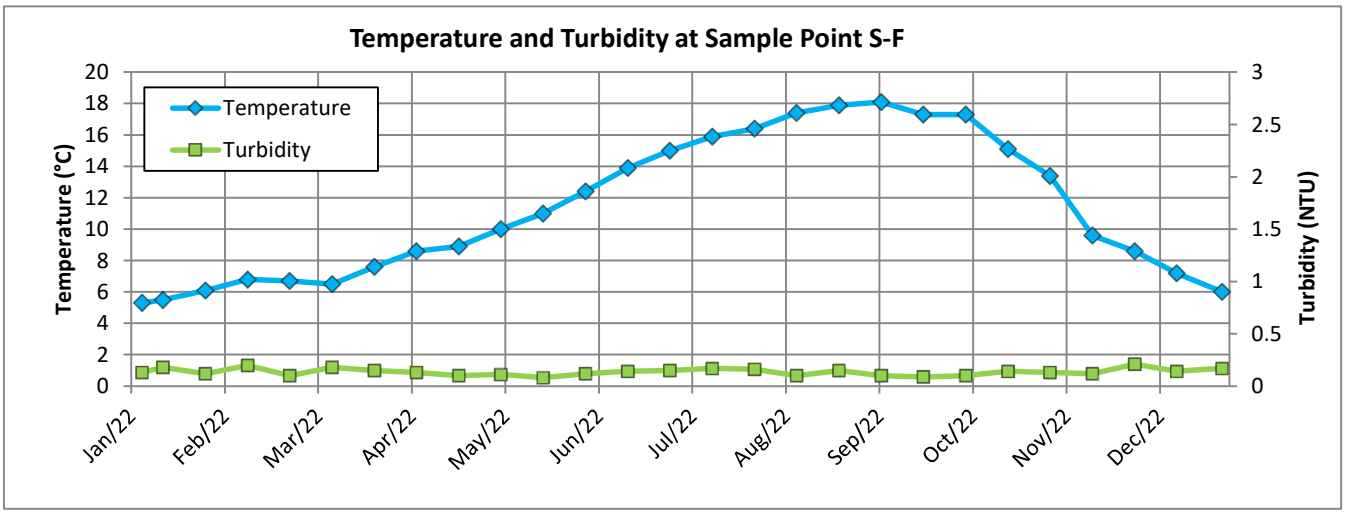

Free Cl_2 and HPC at Sample Point S-E
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

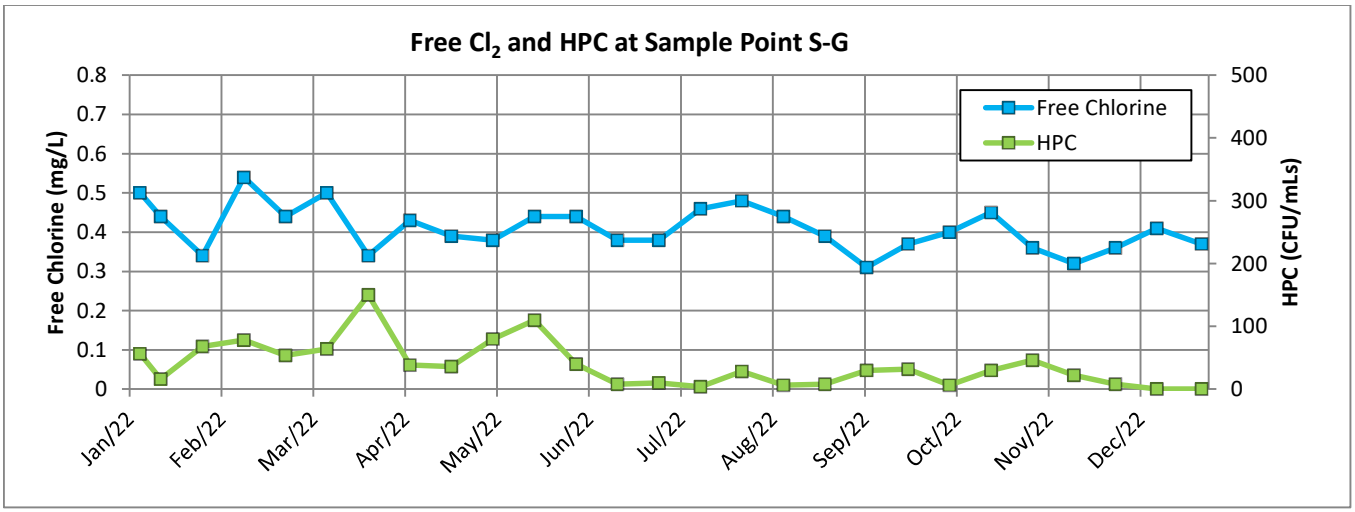

Total Coliform and Ecoli at Sample Point S-E
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
100 CFU/100mL
3 CFU/100mL
1.2
1
0.8
0.6
0.4
0.2
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22

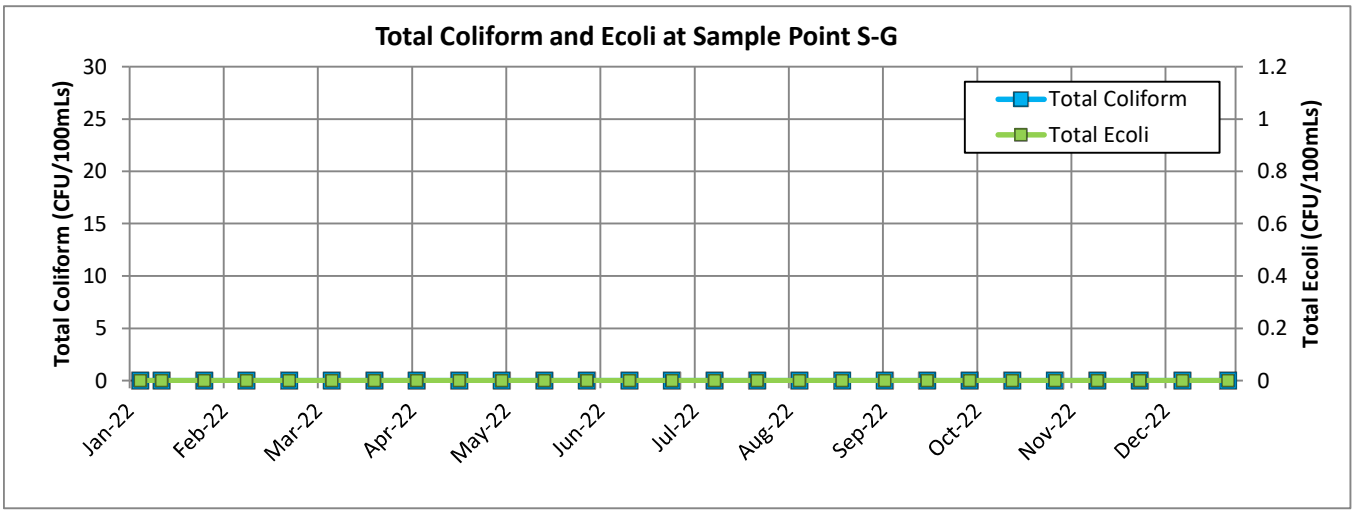

Temperature and Turbidity at Sample Point S-E
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
18
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

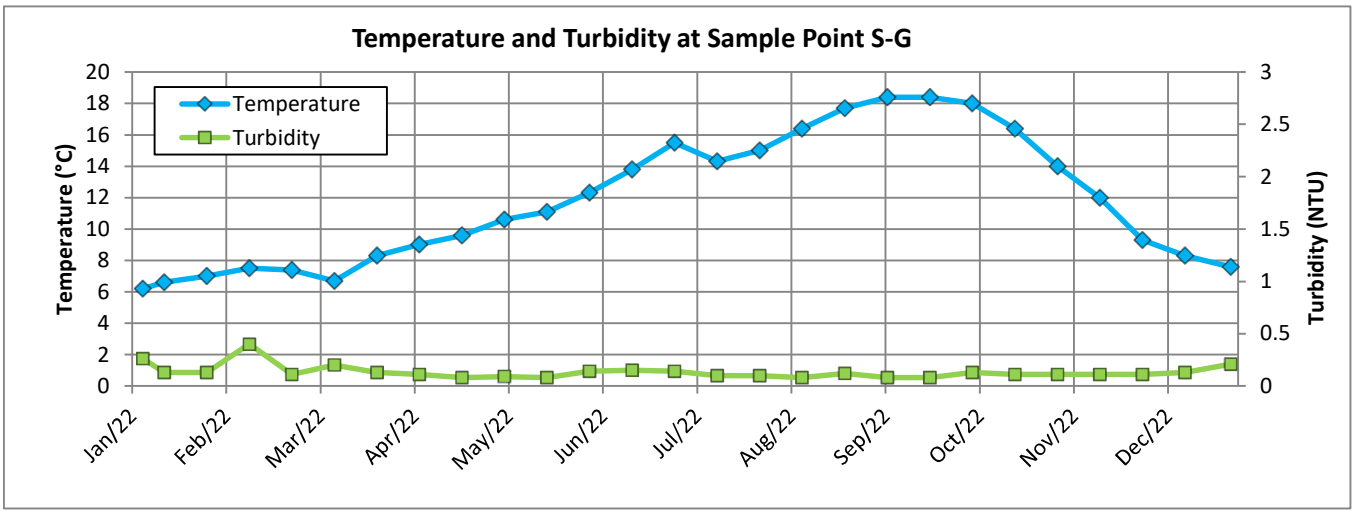

Free Cl2 and HPC at Sample Point S-F
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

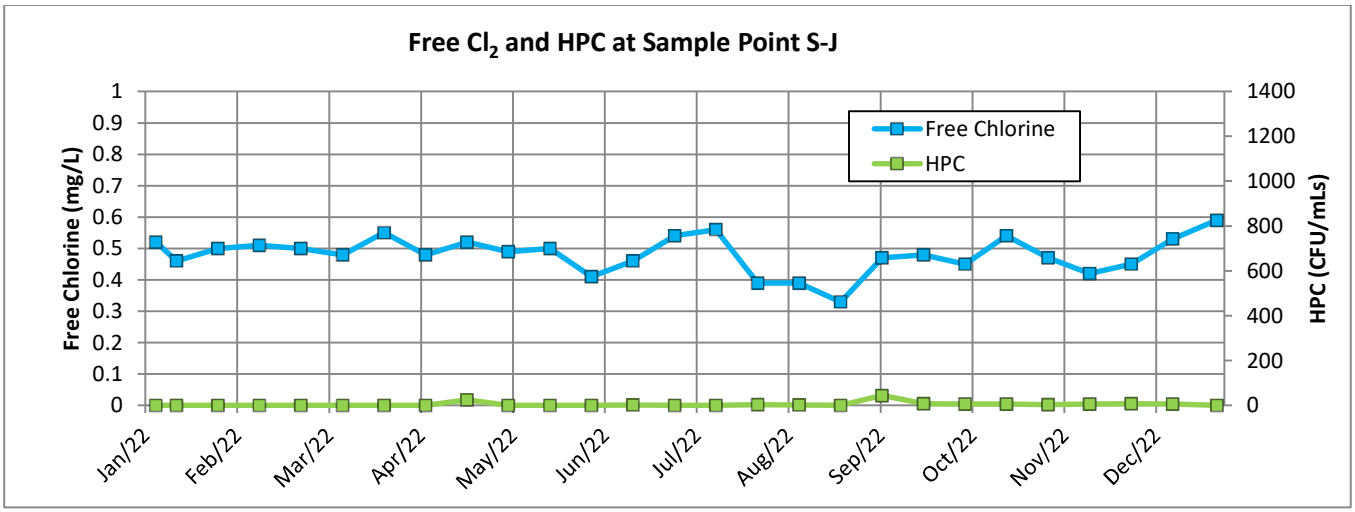

Total Coliform and Ecoli at Sample Point S-F
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
1.2
1
0.8
0.6
0.4
0.2
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22


Temperature and Turbidity at Sample Point S-F
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22


Free Cl_2 and HPC at Sample Point S-G
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22


Total Coliform and Ecoli at Sample Point S-G
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
30
25
20
15
10
5
0
1.2
1
0.8
0.6
0.4
0.2
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22


Temperature and Turbidity at Sample Point S-G
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22


Free Cl2 and HPC at Sample Point S-J
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1400
1200
1000
800
600
400
200
0
Jan/22
Feb/22
Mar/22
Apr/22
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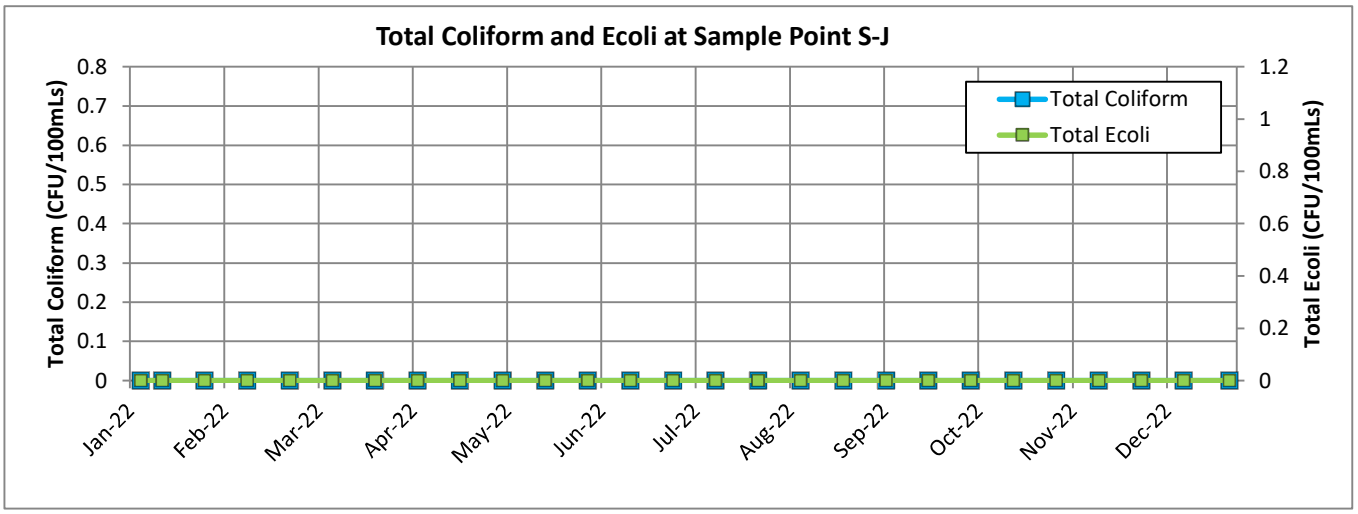
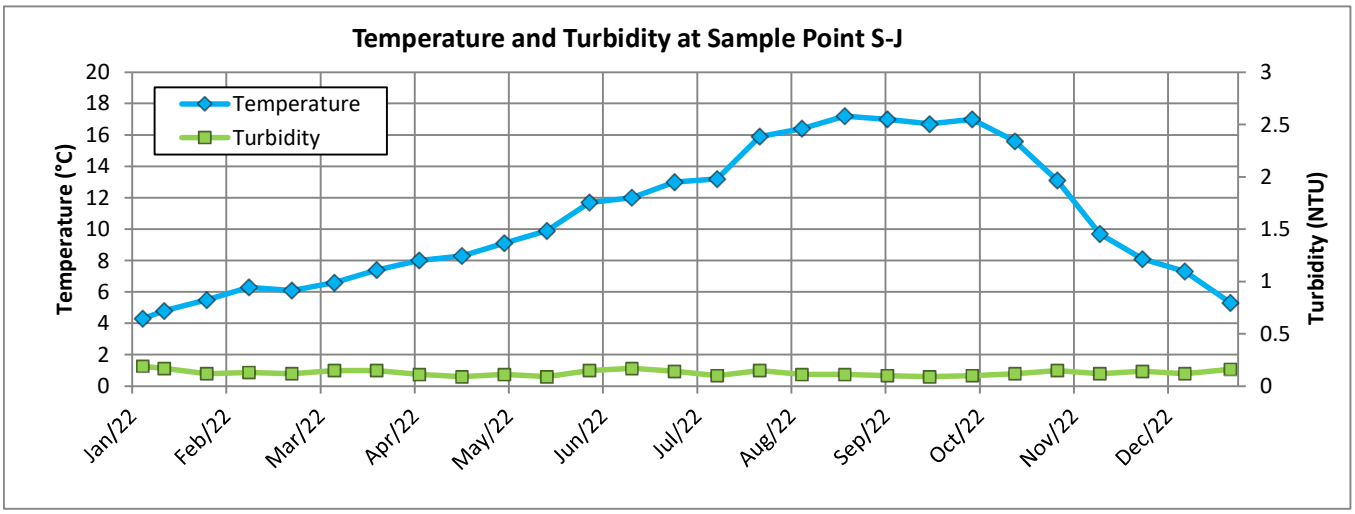
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22


Total Coliform and Ecoli at Sample Point S-J
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1.2
1
0.8
0.6
0.4
0.2
0
Jan-22
Feb-22
Mar-22
Apr-22
May-22
Jun-22
Jul-22
Aug-22
Sep-22
Oct-22
Nov-22
Dec-22


Temperature and Turbidity at Sample Point S-J
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Jan/22
Feb/22
Mar/22
Apr/22
May/22
Jun/22
Jul/22
Aug/22
Sep/22
Oct/22
Nov/22
Dec/22

APPENDIX C

Well Water Quality Results

Emergency Water Supply Well Water Quality Results
Location: UEL Public Works Yard

Date Sampled	Field Parameters				Microbiological Parameters	
	Free Chlorine (mg/L)	Conductivity (µS/cm)	pH (pH units)	Field Temp. (°C)	Total Coliforms (MPN/100 mL)	E. coli (MPN/100 mL)
2022/01/11	<0.02	172	7.6	9.8	-	-
2022/02/01	<0.02	170	7.7	10.8	-	-
2022/03/01	0.02	171	7.6	10.3	-	-
2022/04/05	0.02	149	7.1	10.0	-	-
2022/05/10	<0.02	161	7.5	12.2	-	-
2022/06/07	<0.02	170	7.6	11.1	1	<1
2022/06/14[1]	<0.02	-	-	10.2	<1	<1
2022/07/05	<0.02	171	6.9	11.0	-	-
2022/08/02	<0.02	164	6.6	11.1	-	-
2022/09/06	<0.02	170	7.5	11.5	-	-
2022/10/04	<0.02	167	7.4	12.5	-	-
2022/11/08	<0.02	153	7.6	10.2	-	-
2022/12/06	<0.02	170	7.4	11.1	-	-

Microbiology to be completed annually. Turbidity can no longer be done due to issues with equipment.

[1]Re-test due to positive coliform test.