Ministry of Municipal Affairs and Housing

University Endowment Lands

2019 Drinking Water Quality Monitoring Report

Prepared July 2020

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 2019.

The implementation of the Drinking Water Quality Monitoring program was a significant commitment made 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 2019, one (1) sample of the 202 samples taken did not meet the bacteriological standards set out in the *Drinking Water Protection Act* through the *Drinking Water Protection Regulation.* All samples met the health standards specified in the *Guidelines for Canadian Drinking Water Quality*.

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

TABLE OF CONTENTS

LIST OF TABLES

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).

During 2019, the provision of drinking water was 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 ten sampling stations in operation throughout 2019. Eight (8) 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 test results for 2019.

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 2019 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, 552 service connections, 501 water meters, 87 hydrants, and 216 valves. 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 2019, the UEL replaced 620 m of aging steel and cast iron watermain with polyvinyl chloride (PVC) watermain. The 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 is conducted annually and was conducted between May and June in 2019. The UEL intends to continue the watermain UDF program on an annual basis going forward.

There are 400 total cross connection control backflow devices registered in the UEL with 311 from single family dwellings and 89 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 proving the devices have been tested and meet the required standards. In 2019, there was a total compliance rate of 86% as shown in Table 1. Compared to 2018, there was a 34% improvement in overall compliance. The UEL relies on voluntary compliance with their cross connection control bylaw with letters of non-compliance being issued to addresses delinquent in submitting inspection reports. In addition, the UEL followed-up with several non-compliant properties in an effort to enforce the bylaw.

Table 1. Cross Connection Control Backflow Devices

AREA	INSTALLED	TESTED	OUTSTANDING	COMPLIANCE (%)
Single Family	311	272	39	87
Multi-Family/ Commercial	89	72	17	81
Total	**400**	**344**	**56**	**86**

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 2.

Table 2. 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:
https://www.canada.ca/en/health-canada/services/environmental-workplace-health/water-quality/drinking-water/canadian-drinking-water-guidelines.html
or by contacting Health Canada at **(613) 957-2991**.

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. The ten (10) locations were strategically selected based on land use and system configuration.

The locations include:

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

These locations are illustrated in Appendix A.

Table 3. 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[3]	Acadia Rd. & Toronto Rd.	Source	Water Source / High-Density Residential
S-E	Western Pkwy. South of Chancellor Blvd.	Medium Flow	Residential
S-F[4]	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-I[5]	North Side of Newton Wynd	Low Flow	Residential
S-J[5]	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] Station was temporarily taken out of service as of August 2018 due to construction activities near the sampling station. It was reinstated March 2019.
[4] Station was moved as a part of system reconfiguration on Oct 23rd, 2019.
[5] Temporary sampling locations. Station S-I was removed in September 2019.

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 4 samples per month as outlined in *Schedule B* of the BCDWPR During 2019, the UEL tested more than 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 4.

Table 4. Sampling Frequency

Frequency:	**FOUR SAMPLES PER WEEK**	**FOUR SAMPLES PER YEAR**	**TWO SAMPLES PER YEAR**
Parameters:	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-I, S-J	S-B, S-E	S-A, S-C, S-H
Station Category:	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 four 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 202 samples were taken from the UEL water distribution system during 2019. The sample analysis results are summarized in Table 5 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 5. Summary of Analysis Results

Sample Station	No. of Samples	HPC (CFU/mL)[1]			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	4	24	0.43	0.57	0.63	0.11	0.27	2.30	none	none
S-B	25	<2	3	24	0.41	0.56	0.68	0.10	0.25	2.30	none	none
S-D	20	<2	28	460	0.48	0.64	0.70	0.10	0.17	0.37	none	none
S-E	26	<2	2	4	0.41	0.60	1.06	0.10	0.21	0.99	none	none
S-F	33	<2	160	1700	0.00	0.15	0.44	0.16	0.66	5.60	1	none
S-G	27	<2	2	4	0.12	0.37	0.58	0.13	0.28	0.82	none	none
S-I	19	<2	15	170	0.39	0.52	0.67	0.11	0.32	1.20	1	none
S-J	26	<2	4	36	0.23	0.52	0.84	0.12	0.30	1.80	none	none
Total	202										2	none
Avg of all Samples[2]			32			0.47			0.32			

[1]Metro Vancouver: HPC tests were not completed on samples taken on December 23 and 30, 2019.
[2]Average values calculated using all samples collected in 2019 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 202 samples tested for total coliforms, two (2) samples tested positive for total coliforms but more than 90% of samples taken in every 30-day period had 0 total coliform per 100mL.

The dates and locations of the two samples that tested positive were on April 23rd from station S-F and on July 9th from station S-I. The sample results were 1 CFU/100mL and 71 CFU/100mL respectively. 71 CFU/100mLs exceeds the BCDWPR requirement of no sample having more than 10 total coliform bacteria. Following the positive results, the system was immediately flushed and resampled with the result of no total coliforms being detected.

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 202 samples analysed for microbiological criteria in 2019.

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 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. Out of the 202 samples tested for HPC, three (3) samples, all taken from station S-F, indicated levels above 500 CFU/mL. Two of the sampling results returned to acceptable levels following flushing and subsequent testing. The readings may be attributed to water with high residence time.

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 202 samples tested, eight (8) measured greater than 1.0 NTU. In response to a high turbidity reading, the procedure is to flush the applicable water main and re-sample as appropriate.

Free Chlorine Residual

Three (3) sampling stations (S-F, S-G, and S-I) within the UEL had readings below the free chlorine residual target of 0.2 mg/L. Station S-F is located at the furthest end of the water distribution system, which has low flows due to a low number of residential connections. These conditions increase the likelihood of stagnant water and the deterioration of chlorine residual.

From 2018 to 2019, samples containing less than 0.2 mg/L of chlorine were reduced from 74% to 64% at station S-F and from 15% to 11% at station S-G. Table 6 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. As shown in the detailed information for station S-F, free chlorine levels were maintained above the 0.2 mg/L threshold during the summer months when water usage in the UEL was at its peak. Conversely, low chlorine residuals at station S-G are thought to be reflective of the periodic water usage at the UEL Works Yard.

Table 6. 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	64%
S-G	11%
S-I	0%
S-J	0%

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. Two (2) new temporary sampling stations (S-I and S-J) were installed to monitor chlorine residuals in other locations of Area B. 2019 results indicate that chronic low chlorine residuals are a localized issue at station S-F.

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 150m west (November sampling was not conducted) and the discharge line was temporarily decommissioned. In 2020, the discharge line will be reinstated, and site S-F will continue to be monitored. It is expected that these changes will improve chlorine residual and HPC results at station S-F.

Water quality parameters at S-F remain within GCDWQ limits. As with HPC, low chlorine residual is a warning sign and not an indication of water quality problems.

Disinfection By-products and pH

Two (2) sample stations, S-B and S-E, were tested for disinfection by-products and pH. Table 7 displays the analysis results.

Table 7. Disinfection By-products and pH Analysis Results

		THM (ppb)						HAA (ppb)							
Sample Location	**Sample Date**	**Bromodichloromethane**	**Bromoform**	**Chlorodibromomethane**	**Chloroform**	**Total Trihalomethanes**	**Total THM Quarterly Running Annual Average**	**Dibromoacetic Acid**	**Dichloroacetic Acid**	**Monobromoacetic Acid**	**Monochloroacetic Acid**	**Trichloroacetic Acid**	**Total Haloacetic Acid**	**Total HAA Quarterly Running Annual Average**	**pH**
S-B	20/02/2019	<1	<1	<1	20	22	**27**	<0.5	8	<1	<2	11.2	20.8	**26**	7.4
S-B	14/05/2019	1	<1	<1	30	31	**28**	<0.5	16	<1	<2	18.9	36.9	**29**	7.5
S-B	20/08/2019	1	<1	<1	24	26	**28**	<0.5	8	<1	<2	7.4	16.3	**28**	7.5
S-B	03/12/2019	<1	<1	<1	27	29	**27**	<0.5	11	<1	<2	13.9	26	**25**	7.3
S-E	20/02/2019	<1	<1	<1	19	21	**25**	<0.5	8	<1	<2	9.2	18.6	**25**	7.3
S-E	14/05/2019	<1	<1	<1	26	27	**26**	<0.5	14	<1	<2	12.2	28.2	**25**	7.4
S-E	20/08/2019	1	<1	<1	24	26	**27**	<0.5	7	<1	<2	4.7	12.8	**24**	7.5
S-E	03/12/2019	<1	<1	<1	28	29	**26**	<0.5	12	<1	<2	12.8	25.1	**21**	7.2

Both stations S-B and S-E meet the GCDWQ requirement 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 31.0 ppb (0.031 mg/L) and 29.0 ppb (0.029 mg/L) for stations S-B and S-E, respectively. The maximum HAA concentration sampled was 36.9 ppb (0.0369 mg/L) for station S-B and 28.2 ppb (0.0282 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 2019 with the samples taken from stations S-A and S-C on April 30th and December 10th. During sample testing, the vinyl chloride concentration was below 1 ppb (0.001 mg/L), which meets the requirement from GCDWQ of less than 2 ppb (0.002 mg/L).

Metals

Two (2) sample locations, stations S-C and S-H, were tested for total concentration of various metals in 2019. Analysis results are presented below in Table 8, measured in µg/L (ppb or 0.001 mg/L). All metal levels fall below the recommended limits outlined in the GCDWQ.

Table 8. Metals Analysis Results

Sample Station		S-C		S-H		GCDWQ	
Sampled date		30/04/2019	10/12/2019	30/04/2019	10/12/2019	Health Guideline	Aesthetic Objective
Total Concentration (µg/L)	Aluminum	26	23	51	43	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	2.9	3.1	1.3	1.7	1000	n/a
	Boron	<10	<10	<10	<10	5000	n/a
	Cadmium	<0.2	<0.2	<0.2	<0.2	5	n/a
	Calcium	4800	3190	4920	6080	n/a	n/a
	Chromium	<0.05	<0.05	0.11	0.11	50	n/a
	Cobalt	<0.5	<0.5	<0.5	<0.5	n/a	n/a
	Copper	32.5	95.1	1	1.3	≤2000	≤1000
	Iron	13	52	45	27	n/a	≤300
	Lead	<0.5	<0.5	<0.5	<0.5	5	n/a
	Magnesium	158	178	86	115	n/a	n/a
	Manganese	1	1.2	0.6	0.9	≤120	≤50
	Mercury	<0.05	<0.05	<0.05	<0.05	1	n/a
	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	161	186	181	176	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	1480	1690	1700	1590	n/a	≤200,000
	Zinc	3	<3.0	<3.0	<3.0	n/a	≤5000

5.0 SUMMARY

The UEL implemented a Drinking Water Quality Monitoring Program in 2002 based on the standard program adopted by Metro Vancouver member municipalities, the Guidelines for Canadian Drinking Water Quality (GCDWQ), 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 2019, the UEL replaced 620 m of aging steel watermain with polyvinyl chloride (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 grows but does not address the underlying reasons for the bacterial growth or loss of disinfectant residual. In 2015, VCH recommended that a long-term strategy be developed to address these issues. Working with VCH, a strategy was developed to improve the loss of chlorine residual at station S-F. The strategy limits the stagnation of water near station S-F which is caused by limited water usage. In 2019, deteriorating and redundant infrastructure was decommissioned near station S-F to decrease the volume of water that needs to be turned-over. As a result, the discharge line was temporarily decommissioned. In 2020, the discharge line will be reinstated, and the chlorine residual levels will continue to be monitored.

The UEL cross connection control program relies on voluntary compliance. In 2019, 86% of all the registered devices were tested and proven to be functioning as intended to protect the public water system from contamination. The UEL relies on voluntary compliance with their cross connection control bylaw and letters of non-compliance have been issued to address those delinquent in submitting inspection reports.

The sampling analysis demonstrates that during 2019, one (1) sample of the 202 samples taken did not meet the bacteriological standards set out in the *Drinking Water Protection Act* through the *Drinking Water Protection Regulation.* All samples met the health standards set out in the *Guidelines for Canadian Drinking Water Quality*. The UEL is committed to delivering water of the highest quality and will continue to make the necessary effort to ensure its continued success.

REFERENCES

British Columbia Drinking Water Protection Regulation. *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>

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

S-F - Before Oct. 23

S-F - After Oct. 23

S-I

S-H

Kingston Road

NW Marine Drive

Newton Wynd

S-G

S-E

S-J

Chancellor Blvd

Acadia Road

Westbrook Crescent

College Highroad

S-D

Supply Connection to the University of British Columbia

S-B

S-A

Connection to City of Vancouver System

Blanca Street

University Boulevard

S-C

Connection to Metro Vancouver System

Supply Connection to the University of British Columbia

Legend

UEL Water Supply

Connection to UBC

Material

- Asbestos Cement
- Cast Iron
- Galvanized Iron
- HDPE
- PVC
- Steel
- MV Water Main
- Decommissioned in 2019

UEL Areas

- Area A
- Area B
- Area C
- Area D
- Island

Overview Map

N

W E

S

0 230 460

Metres

1:10,000

NAD 1983 UTM Zone 10N

2019 Water Quality Report
Location: University Endowment Lands

BRITISH COLUMBIA

Existing UEL Water System Sample Locations

July 2020
Project: 60222155

AECOM

Appendix A

File Location: C:\Workspace\60222155 - UEL\402.12 - Water Quality Report\Uploaded\Appendix A - ExistingUELWaterSystem 10-4.mxd Date Revised: April 09, 2020 Prepared by: ian.rennie Project: 60222155

APPENDIX B

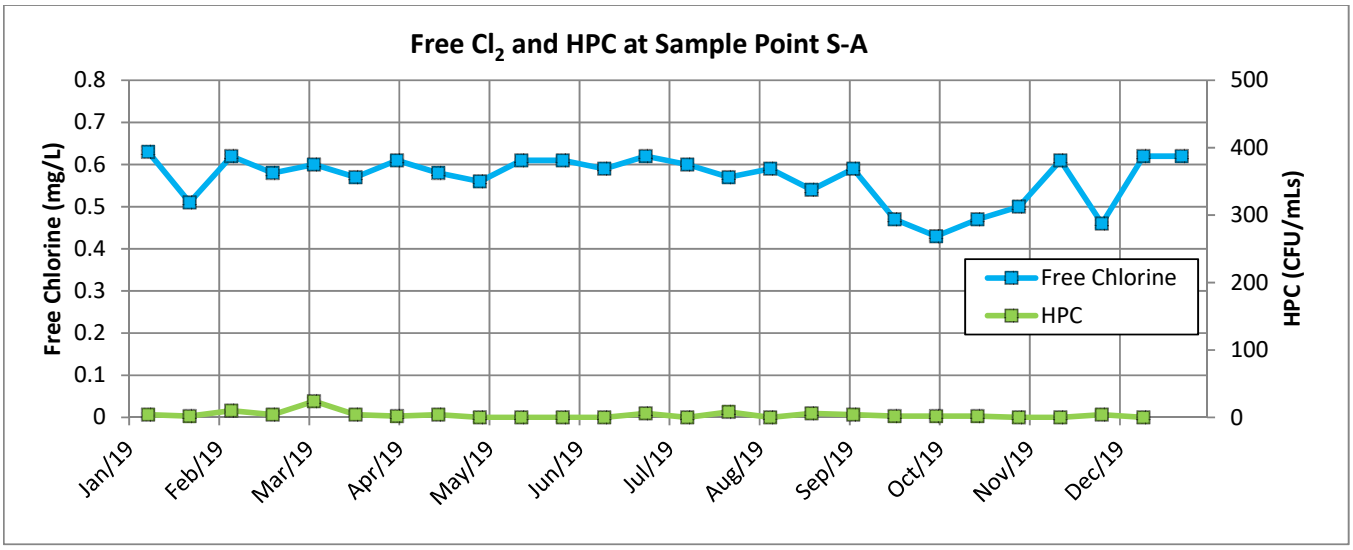
Sample Analysis Results

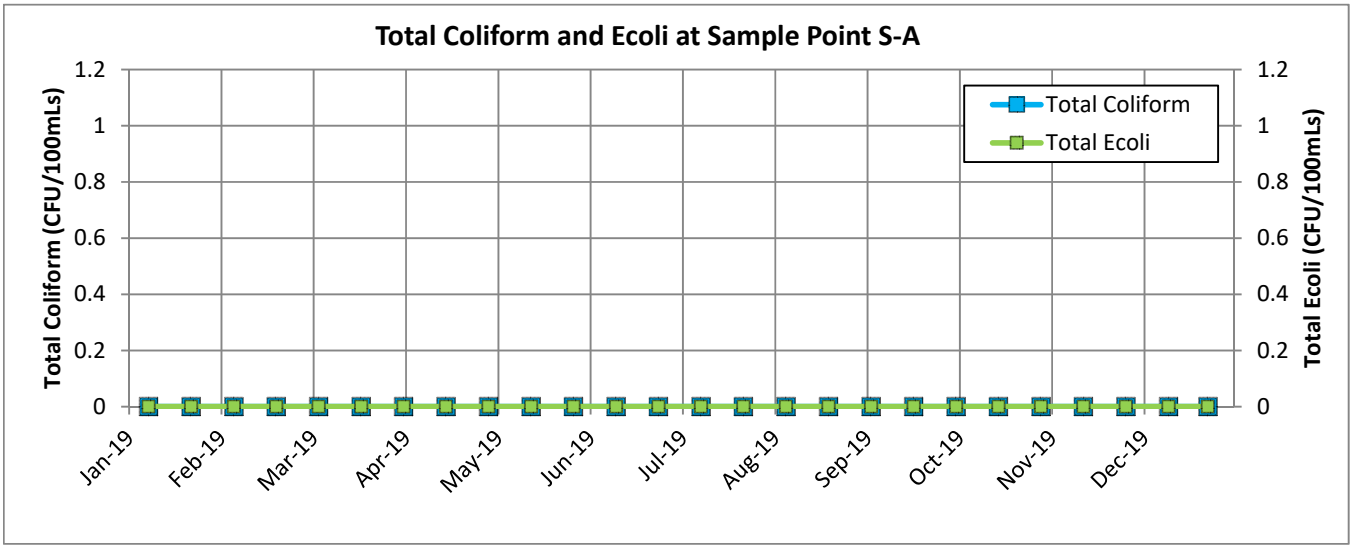
Sample Point S-A
Location: Drummond Dr. & W. 6th Ave.

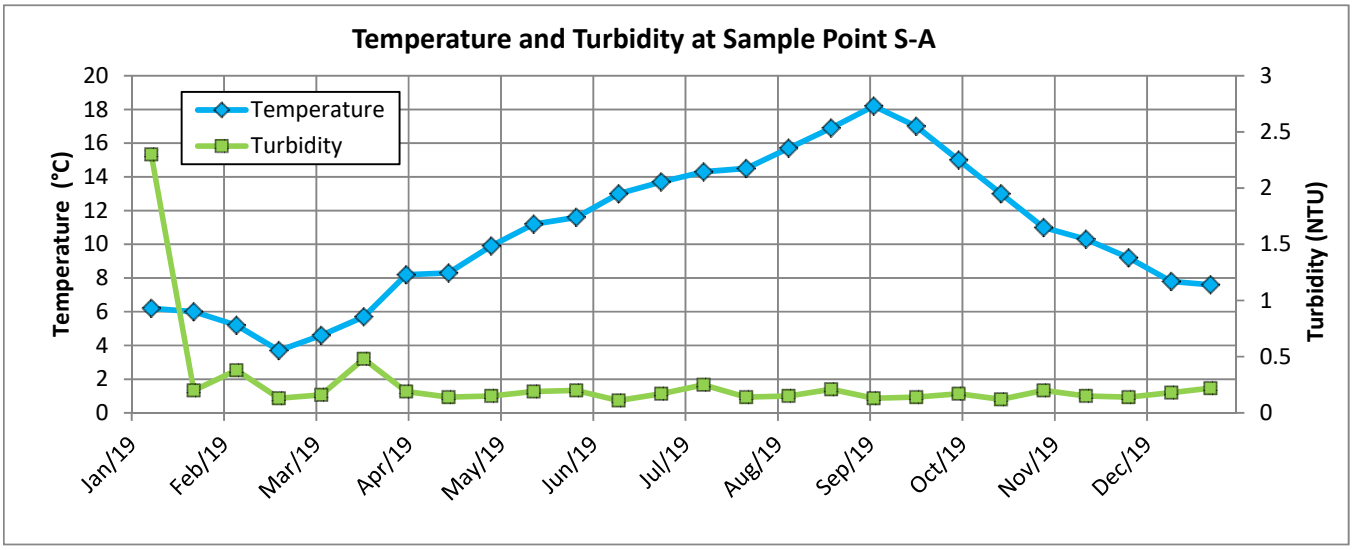
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
8-Jan-19	0.63	<1	4	6.2	<1	2.30
22-Jan-19	0.51	<1	2	6.0	<1	0.20
5-Feb-19	0.62	<1	10	5.2	<1	0.38
19-Feb-19	0.58	<1	4	3.7	<1	0.13
5-Mar-19	0.60	<1	24	4.6	<1	0.16
19-Mar-19	0.57	<1	4	5.7	<1	0.48
2-Apr-19	0.61	<1	2	8.2	<1	0.19
16-Apr-19	0.58	<1	4	8.3	<1	0.14
30-Apr-19	0.56	<1	<2	9.9	<1	0.15
14-May-19	0.61	<1	<2	11.2	<1	0.19
28-May-19	0.61	<1	<2	11.6	<1	0.20
11-Jun-19	0.59	<1	<2	13.0	<1	0.11
25-Jun-19	0.62	<1	6	13.7	<1	0.17
9-Jul-19	0.60	<1	<2	14.3	<1	0.25
23-Jul-19	0.57	<1	8	14.5	<1	0.14
6-Aug-19	0.59	<1	<2	15.7	<1	0.15
20-Aug-19	0.54	<1	6	16.9	<1	0.21
3-Sep-19	0.59	<1	4	18.2	<1	0.13
17-Sep-19	0.47	<1	2	17.0	<1	0.14
1-Oct-19	0.43	<1	2	15.0	<1	0.17
15-Oct-19	0.47	<1	2	13.0	<1	0.12
29-Oct-19	0.50	<1	<2	11.0	<1	0.20
12-Nov-19	0.61	<1	<2	10.3	<1	0.15
26-Nov-19	0.46	<1	4	9.2	<1	0.14
10-Dec-19	0.62	<1	<2	7.8	<1	0.18
23-Dec-19	0.62	<1	NA*	7.6	<1	0.22

Min	0.43	<1	<2	3.7	<1	0.11
Average	0.57	<1	4	10.7	<1	0.27
Max	0.63	<1	24	18.2	<1	2.30
Count	26	26	25	26	26	26

*Results not provided by Metro Vancouver lab.


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/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


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-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

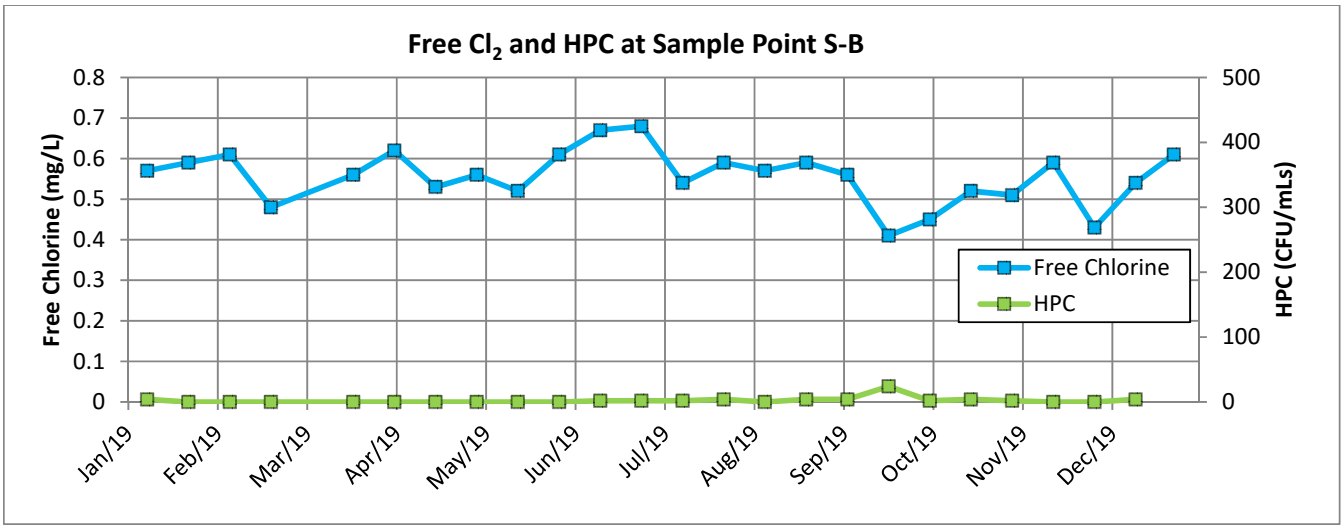

Temperature and Turbidity at Sample Point S-A
Temperature (°C)
Turbidity (NTU)
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Temperature
Turbidity
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

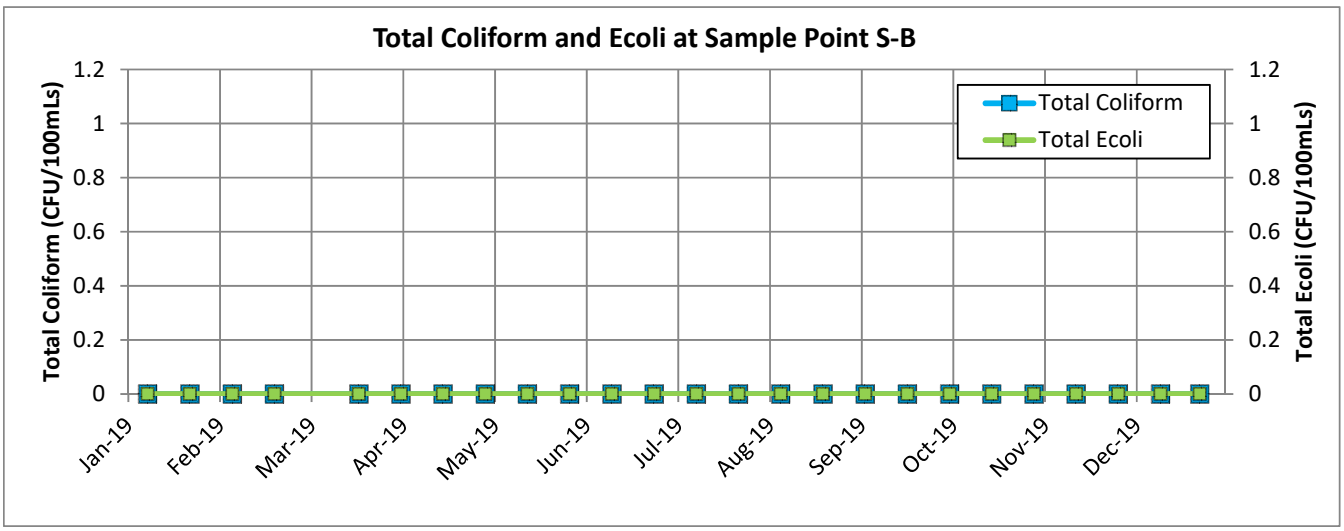
Sample Point S-B
Location Wycliff Road & Tasmania Crescent

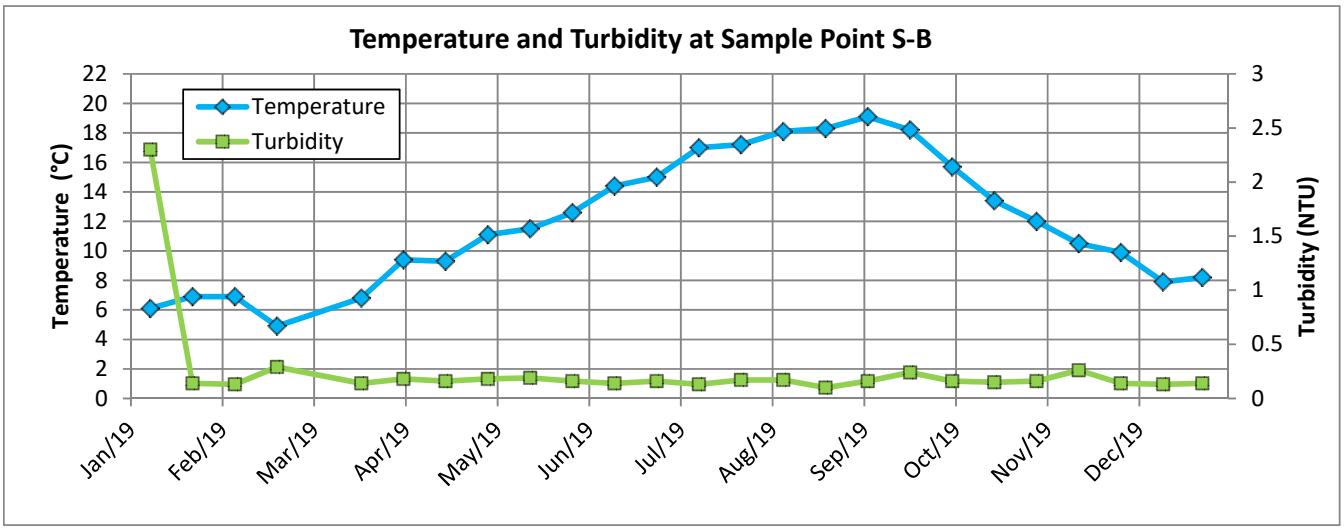
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
8-Jan-19	0.57	<1	4	6.1	<1	2.30
22-Jan-19	0.59	<1	<2	6.9	<1	0.14
5-Feb-19	0.61	<1	<2	6.9	<1	0.13
19-Feb-19	0.48	<1	<2	4.9	<1	0.29
19-Mar-19	0.56	<1	<2	6.8	<1	0.14
2-Apr-19	0.62	<1	<2	9.4	<1	0.18
16-Apr-19	0.53	<1	<2	9.3	<1	0.16
30-Apr-19	0.56	<1	<2	11.1	<1	0.18
14-May-19	0.52	<1	<2	11.5	<1	0.19
28-May-19	0.61	<1	<2	12.6	<1	0.16
11-Jun-19	0.67	<1	2	14.4	<1	0.14
25-Jun-19	0.68	<1	2	15.0	<1	0.16
9-Jul-19	0.54	<1	2	17.0	<1	0.13
23-Jul-19	0.59	<1	4	17.2	<1	0.17
6-Aug-19	0.57	<1	<2	18.1	<1	0.17
20-Aug-19	0.59	<1	4	18.3	<1	0.10
3-Sep-19	0.56	<1	4	19.1	<1	0.16
17-Sep-19	0.41	<1	24	18.2	<1	0.24
1-Oct-19	0.45	<1	2	15.7	<1	0.16
15-Oct-19	0.52	<1	4	13.4	<1	0.15
29-Oct-19	0.51	<1	2	12.0	<1	0.16
12-Nov-19	0.59	<1	<2	10.5	<1	0.26
26-Nov-19	0.43	<1	<2	9.9	<1	0.14
10-Dec-19	0.54	<1	4	7.9	<1	0.13
23-Dec-19	0.61	<1	NA*	8.2	<1	0.14

Min	0.41	<1	<2	4.9	<1	0.10
Average	0.56	<1	3	12.0	<1	0.25
Max	0.68	<1	24	19.1	<1	2.30
Count	25	25	24	25	25	25

*Results not provided by Metro Vancouver lab.


Free Cl2 and HPC at Sample Point S-B
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/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

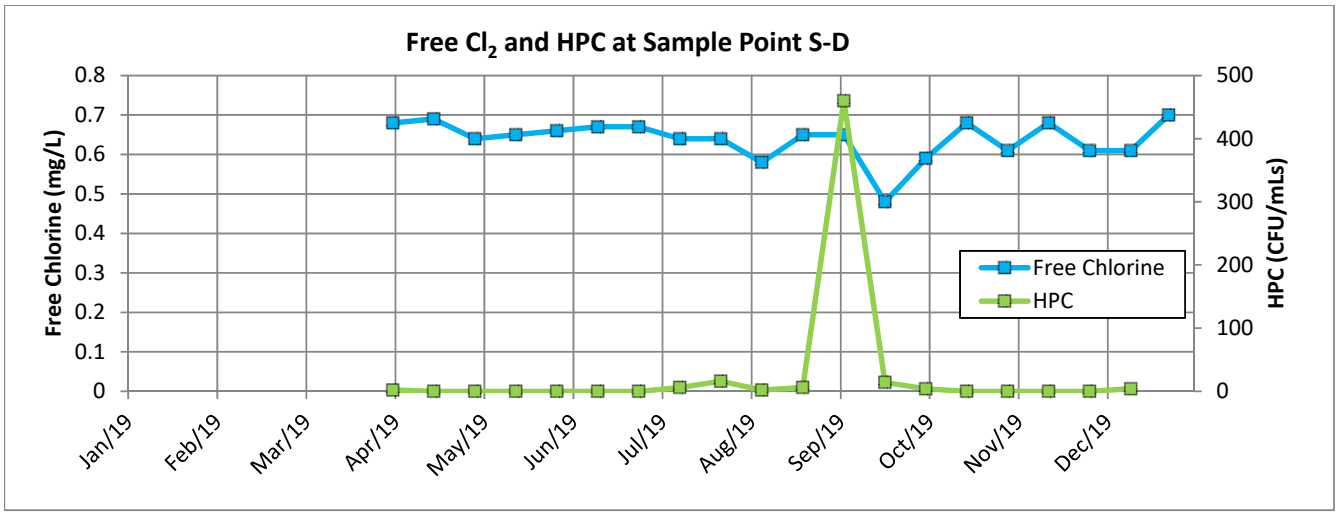

Total Coliform and Ecoli at Sample Point S-B
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
1.2
1
0.8
0.6
0.4
0.2
0
Total Coliform
Total Ecoli
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

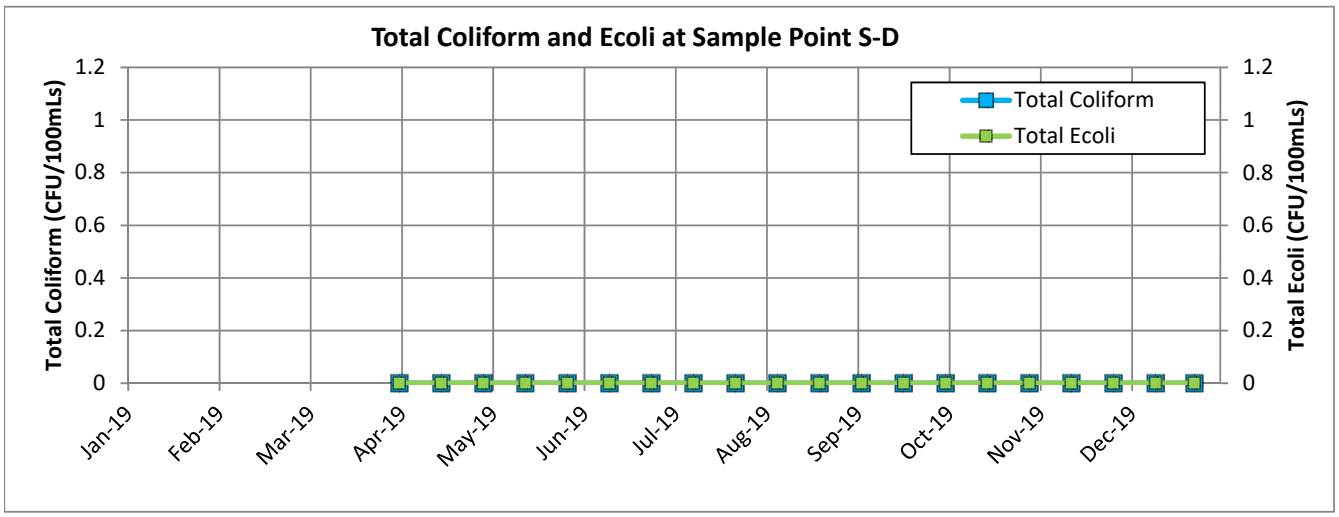

Temperature and Turbidity at Sample Point S-B
Temperature (°C)
Turbidity (NTU)
22
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Temperature
Turbidity
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

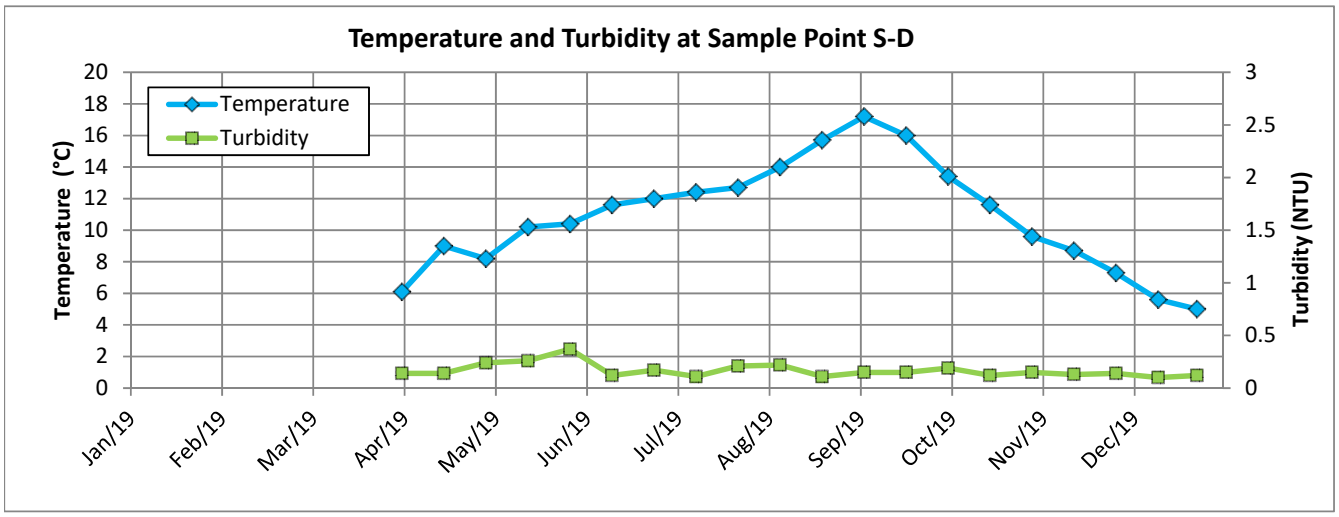
Sample Point S-D
Location: Acadia Rd. & Toronto Rd.

Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
2-Apr-19	0.68	<1	2	6.1	<1	0.14
16-Apr-19	0.69	<1	<2	9.0	<1	0.14
30-Apr-19	0.64	<1	<2	8.2	<1	0.24
14-May-19	0.65	<1	<2	10.2	<1	0.26
28-May-19	0.66	<1	<2	10.4	<1	0.37
11-Jun-19	0.67	<1	<2	11.6	<1	0.12
25-Jun-19	0.67	<1	<2	12.0	<1	0.17
9-Jul-19	0.64	<1	6	12.4	<1	0.11
23-Jul-19	0.64	<1	16	12.7	<1	0.21
6-Aug-19	0.58	<1	2	14.0	<1	0.22
20-Aug-19	0.65	<1	6	15.7	<1	0.11
3-Sep-19	0.65	<1	460	17.2	<1	0.15
17-Sep-19	0.48	<1	14	16.0	<1	0.15
1-Oct-19	0.59	<1	4	13.4	<1	0.19
15-Oct-19	0.68	<1	<2	11.6	<1	0.12
29-Oct-19	0.61	<1	<2	9.6	<1	0.15
12-Nov-19	0.68	<1	<2	8.7	<1	0.13
26-Nov-19	0.61	<1	<2	7.3	<1	0.14
10-Dec-19	0.61	<1	4	5.6	<1	0.10
23-Dec-19	0.70	<1	NA*	5.0	<1	0.12

Min	0.48	<1	<2	5.0	<1	0.10
Average	0.64	<1	28	10.8	<1	0.17
Max	0.70	<1	460	17.2	<1	0.37
Count	20	20	19	20	20	20


Free Cl2 and HPC at Sample Point S-D
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/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


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-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

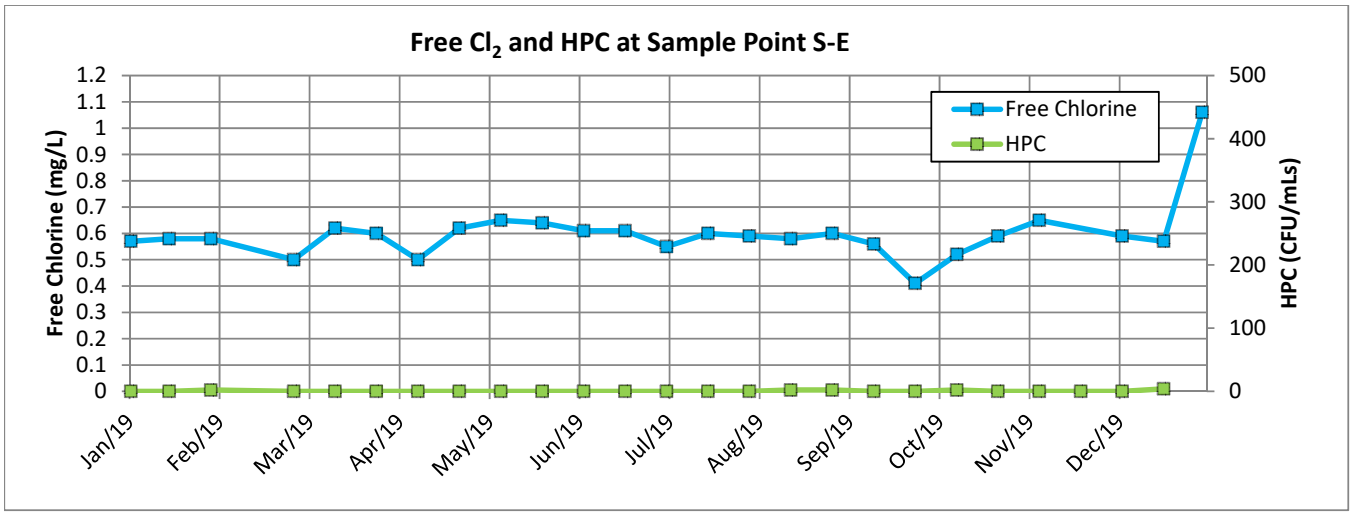

Temperature and Turbidity at Sample Point S-D
Temperature (°C)
Turbidity (NTU)
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Temperature
Turbidity
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

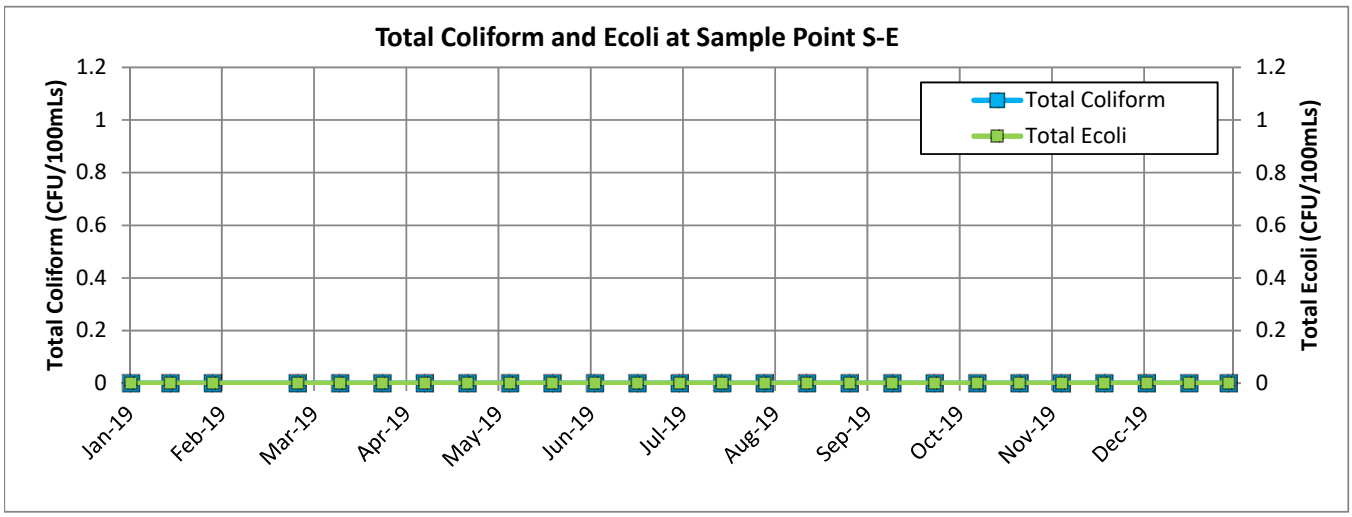
Sample Point S-E
Location: Western Pkwy. S. of Chancellor Blvd.

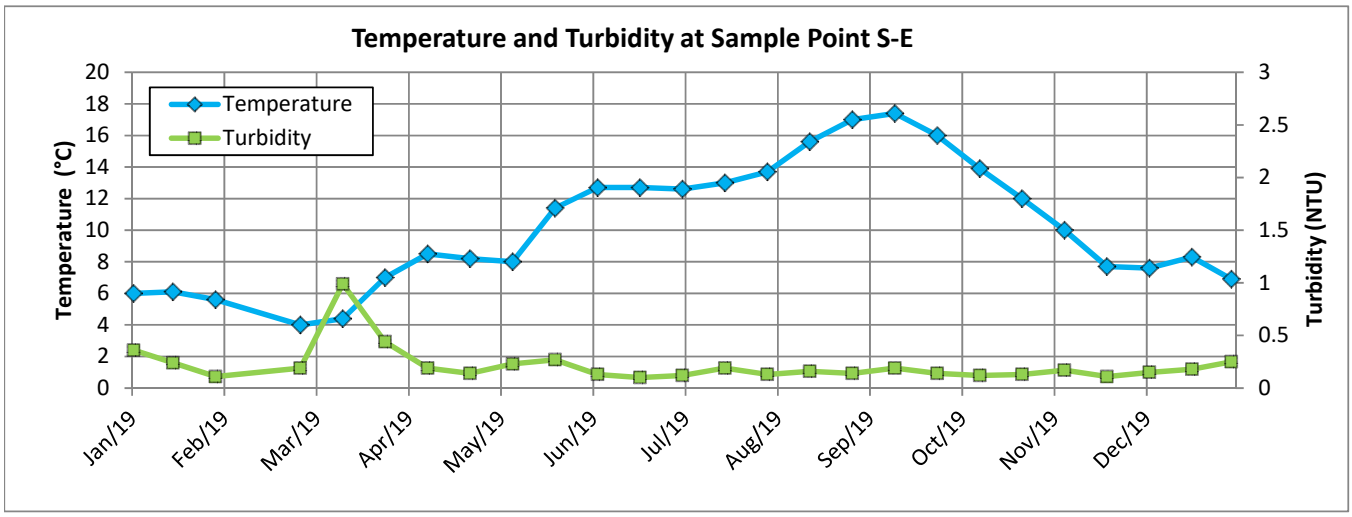
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
2-Jan-19	0.57	<1	<2	6.0	<1	0.36
15-Jan-19	0.58	<1	<2	6.1	<1	0.24
29-Jan-19	0.58	<1	2	5.6	<1	0.11
26-Feb-19	0.50	<1	<2	4.0	<1	0.19
12-Mar-19	0.62	<1	<2	4.4	<1	0.99
26-Mar-19	0.60	<1	<2	7.0	<1	0.44
9-Apr-19	0.50	<1	<2	8.5	<1	0.19
23-Apr-19	0.62	<1	<2	8.2	<1	0.14
7-May-19	0.65	<1	<2	8.0	<1	0.23
21-May-19	0.64	<1	<2	11.4	<1	0.27
4-Jun-19	0.61	<1	<2	12.7	<1	0.13
18-Jun-19	0.61	<1	<2	12.7	<1	0.10
2-Jul-19	0.55	<1	<2	12.6	<1	0.12
16-Jul-19	0.60	<1	<2	13.0	<1	0.19
30-Jul-19	0.59	<1	<2	13.7	<1	0.13
13-Aug-19	0.58	<1	2	15.6	<1	0.16
27-Aug-19	0.60	<1	2	17.0	<1	0.14
10-Sep-19	0.56	<1	<2	17.4	<1	0.19
24-Sep-19	0.41	<1	<2	16.0	<1	0.14
8-Oct-19	0.52	<1	2	13.9	<1	0.12
22-Oct-19	0.59	<1	<2	12.0	<1	0.13
5-Nov-19	0.65	<1	<2	10.0	<1	0.17
19-Nov-19	NA*	<1	<2	7.7	<1	0.11
3-Dec-19	0.59	<1	<2	7.6	<1	0.15
17-Dec-19	0.57	<1	4	8.3	<1	0.18
30-Dec-19	1.06	<1	NA*	6.9	<1	0.25

Min	0.41	<1	<2	4.0	<1	0.10
Average	0.60	<1	2	10.2	<1	0.21
Max	1.06	<1	4	17.4	<1	0.99
Count	25	26	25	26	26	26

*Results not provided by Metro Vancouver lab.


Free Cl2 and HPC at Sample Point S-E
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
500
400
300
200
100
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


Total Coliform and Ecoli at Sample Point S-E
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-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

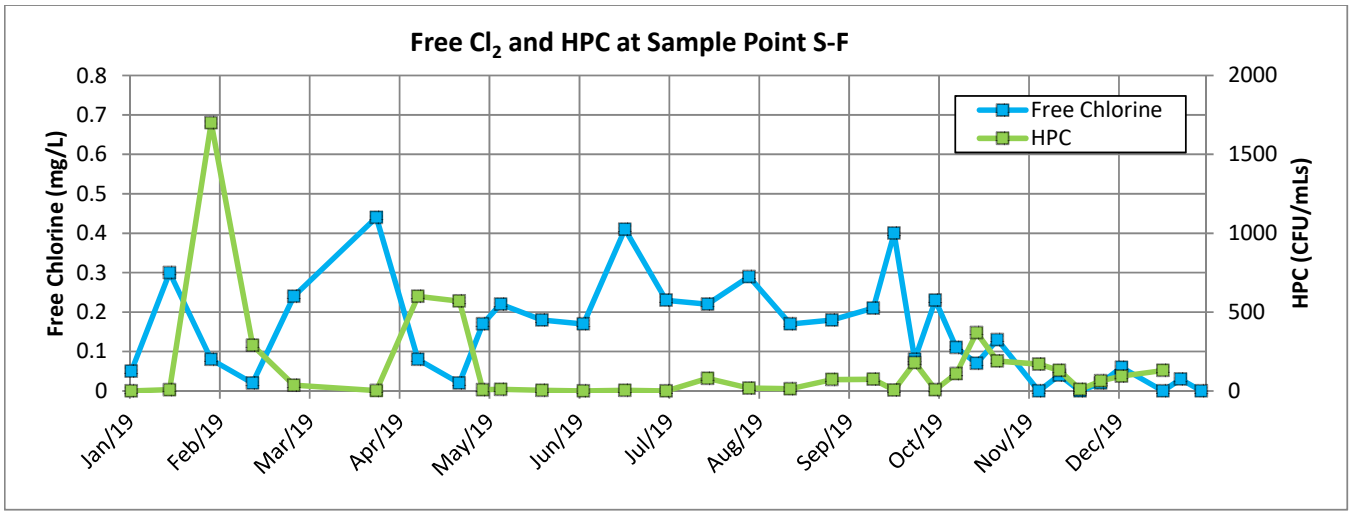

Temperature and Turbidity at Sample Point S-E
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

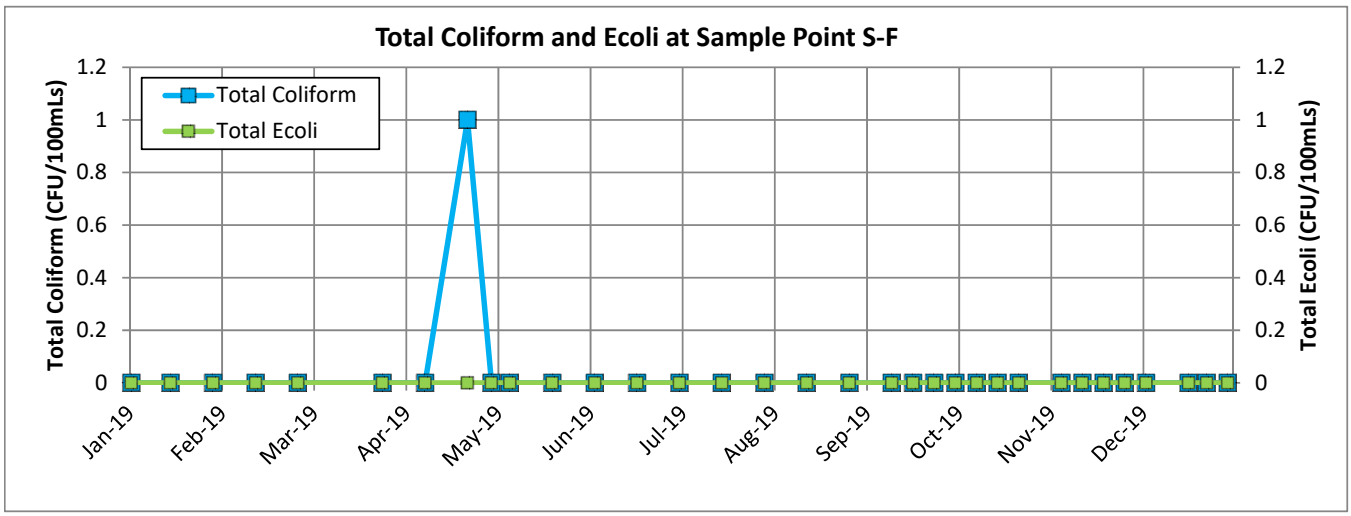
Sample Point S-F
Location: Marine Drive at UEL Boundary

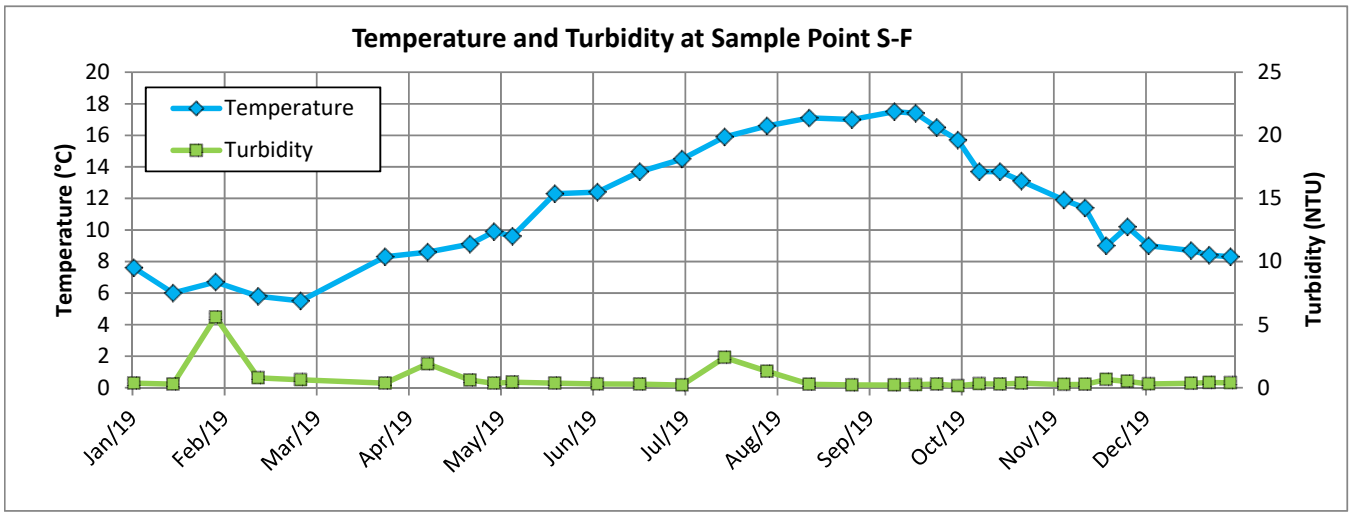
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
2-Jan-19	0.05	<1	<2	7.6	<1	0.37
15-Jan-19	0.30	<1	8	6.0	<1	0.29
29-Jan-19	0.08	<1	1700	6.7	<1	5.60
12-Feb-19	0.02	<1	290	5.8	<1	0.79
26-Feb-19	0.24	<1	36	5.5	<1	0.64
26-Mar-19	0.44	<1	2	8.3	<1	0.37
9-Apr-19	0.08	<1	600	8.6	<1	1.90
23-Apr-19	0.02	<1	570	9.1	1	0.61
1-May-19	0.17	<1	8	9.9	<1	0.36
7-May-19	0.22	<1	10	9.6	<1	0.45
21-May-19	0.18	<1	4	12.3	<1	0.37
4-Jun-19	0.17	<1	<2	12.4	<1	0.30
18-Jun-19	0.41	<1	4	13.7	<1	0.29
2-Jul-19	0.23	<1	<2	14.5	<1	0.22
16-Jul-19	0.22	<1	80	15.9	<1	2.40
30-Jul-19	0.29	<1	18	16.6	<1	1.30
13-Aug-19	0.17	<1	14	17.1	<1	0.28
27-Aug-19	0.18	<1	72	17.0	<1	0.23
10-Sep-19	0.21	<1	74	17.5	<1	0.22
17-Sep-19	0.40	<1	6	17.4	<1	0.25
24-Sep-19	0.08	<1	180	16.5	<1	0.29
1-Oct-19	0.23	<1	8	15.7	<1	0.16
8-Oct-19	0.11	<1	110	13.7	<1	0.32
15-Oct-19	0.07	<1	370	13.7	<1	0.29
22-Oct-19	0.13	<1	190	13.1	<1	0.37
5-Nov-19	0.00	<1	170	11.9	<1	0.26
12-Nov-19	0.04	<1	130	11.4	<1	0.27
19-Nov-19	NA*	<1	10	9.0	<1	0.65
26-Nov-19	0.02	<1	64	10.2	<1	0.51
3-Dec-19	0.06	<1	94	9.0	<1	0.31
17-Dec-19	0.00	<1	130	8.7	<1	0.35
23-Dec-19	0.03	<1	NA*	8.4	<1	0.42
30-Dec-19	0.00	<1	NA*	8.3	<1	0.40

Min	0.00	<1	<2	5.5	<1	0.16
Average	0.15	<1	160	11.5	<1	0.66
Max	0.44	<1	1700	17.5	1	5.60
Count	32	33	31	33	33	33

*Results not provided by Metro Vancouver lab.


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
2000
1500
1000
500
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


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-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

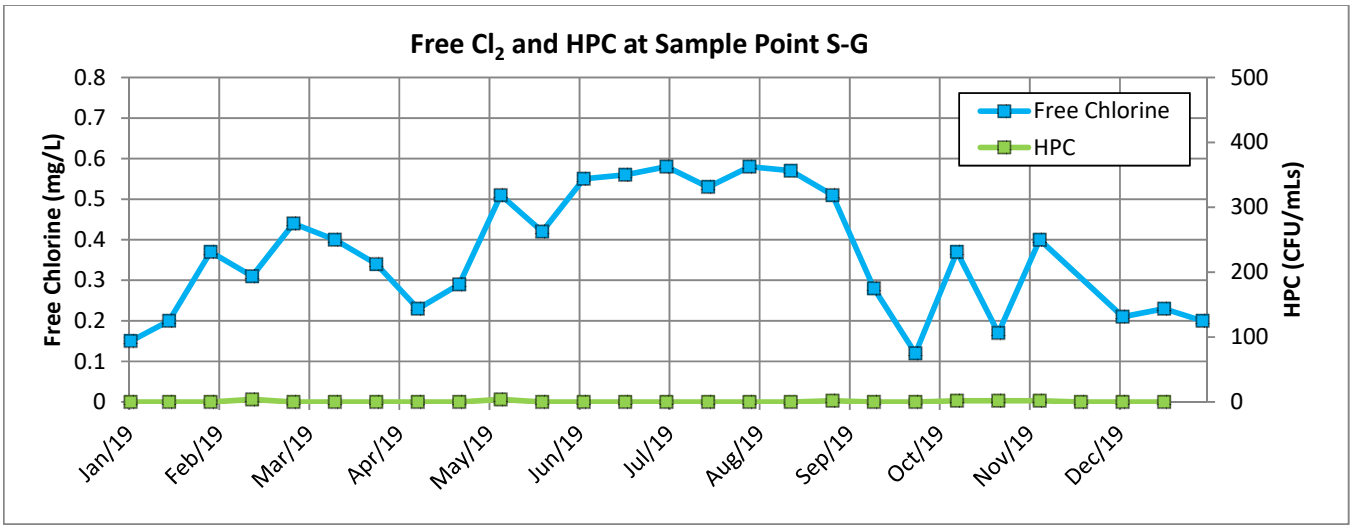

Temperature and Turbidity at Sample Point S-F
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
20
18
16
14
12
10
8
6
4
2
0
25
20
15
10
5
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

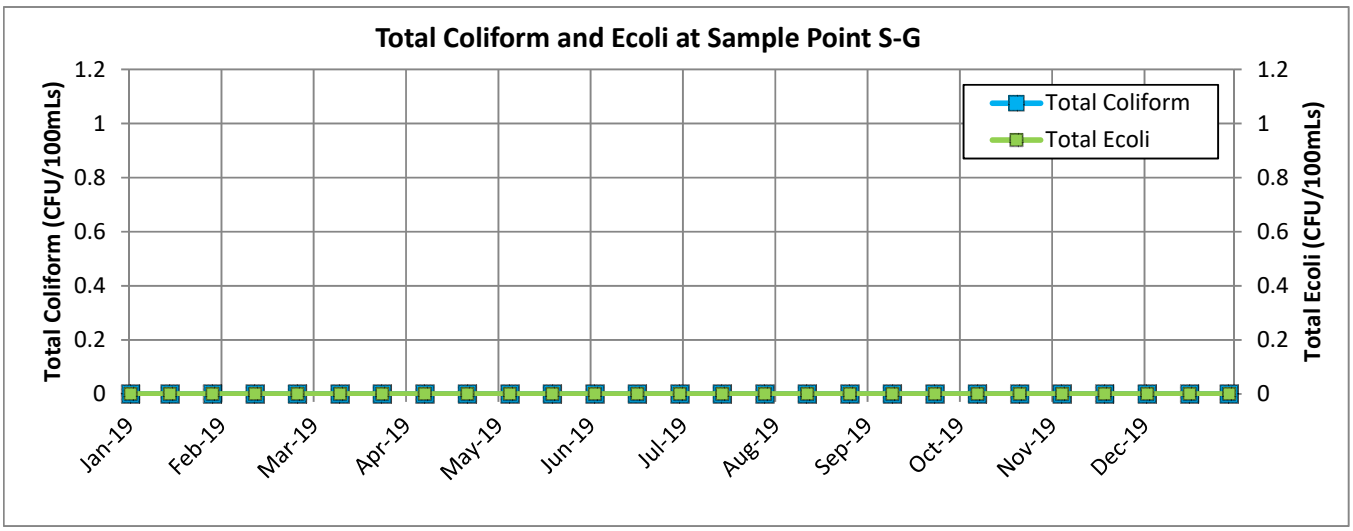
Sample Point S-G
Location: Chancellor Blvd. East of Acadia

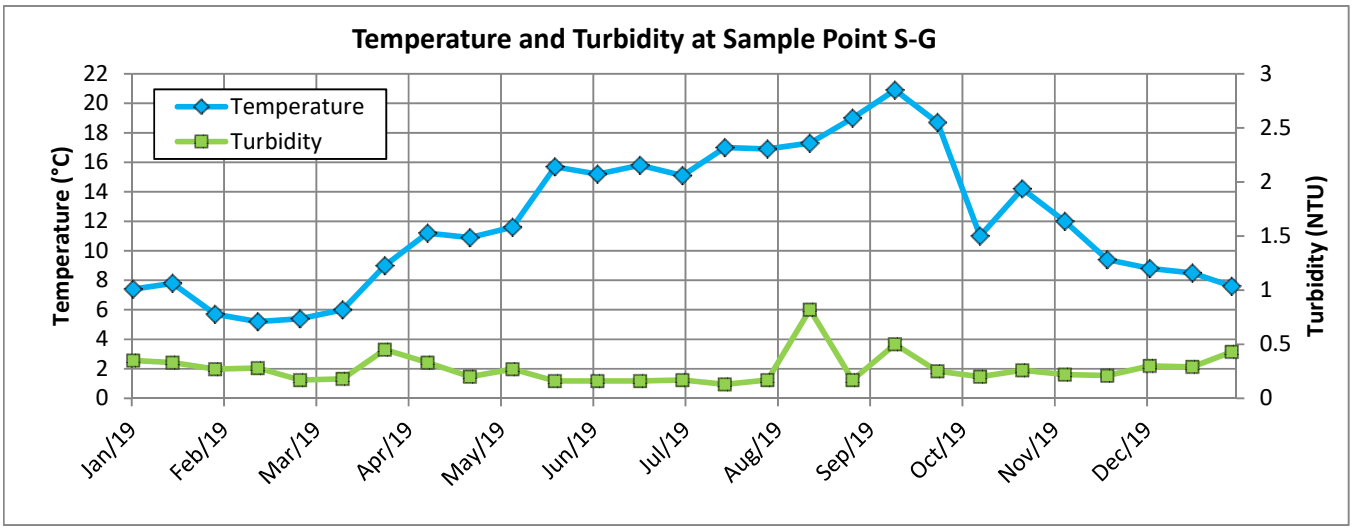
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
2-Jan-19	0.15	<1	<2	7.4	<1	0.35
15-Jan-19	0.20	<1	<2	7.8	<1	0.33
29-Jan-19	0.37	<1	<2	5.7	<1	0.27
12-Feb-19	0.31	<1	4	5.2	<1	0.28
26-Feb-19	0.44	<1	<2	5.4	<1	0.17
12-Mar-19	0.40	<1	<2	6.0	<1	0.18
26-Mar-19	0.34	<1	<2	9.0	<1	0.45
9-Apr-19	0.23	<1	<2	11.2	<1	0.33
23-Apr-19	0.29	<1	<2	10.9	<1	0.20
7-May-19	0.51	<1	4	11.6	<1	0.27
21-May-19	0.42	<1	<2	15.7	<1	0.16
4-Jun-19	0.55	<1	<2	15.2	<1	0.16
18-Jun-19	0.56	<1	<2	15.8	<1	0.16
2-Jul-19	0.58	<1	<2	15.1	<1	0.17
16-Jul-19	0.53	<1	<2	17.0	<1	0.13
30-Jul-19	0.58	<1	<2	16.9	<1	0.17
13-Aug-19	0.57	<1	<2	17.3	<1	0.82
27-Aug-19	0.51	<1	2	19.0	<1	0.17
10-Sep-19	0.28	<1	<2	20.9	<1	0.50
24-Sep-19	0.12	<1	<2	18.7	<1	0.25
8-Oct-19	0.37	<1	2	11.0	<1	0.20
22-Oct-19	0.17	<1	2	14.2	<1	0.26
5-Nov-19	0.40	<1	2	12.0	<1	0.22
19-Nov-19	NA*	<1	<2	9.4	<1	0.21
3-Dec-19	0.21	<1	<2	8.8	<1	0.30
17-Dec-19	0.23	<1	<2	8.5	<1	0.29
30-Dec-19	0.20	<1	NA*	7.6	<1	0.43

Min	0.12	<1	<2	5.2	<1	0.13
Average	0.37	<1	2	12.0	<1	0.28
Max	0.58	<1	4	20.9	<1	0.82
Count	26	27	26	27	27	27

*Results not provided by Metro Vancouver lab.


Free Cl2 and HPC at Sample Point S-G
Free Chlorine (mg/L)
HPC (CFU/mLs)
Free Chlorine
HPC
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
100
200
300
400
500
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


Total Coliform and Ecoli at Sample Point S-G
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
0
0.2
0.4
0.6
0.8
1
1.2
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

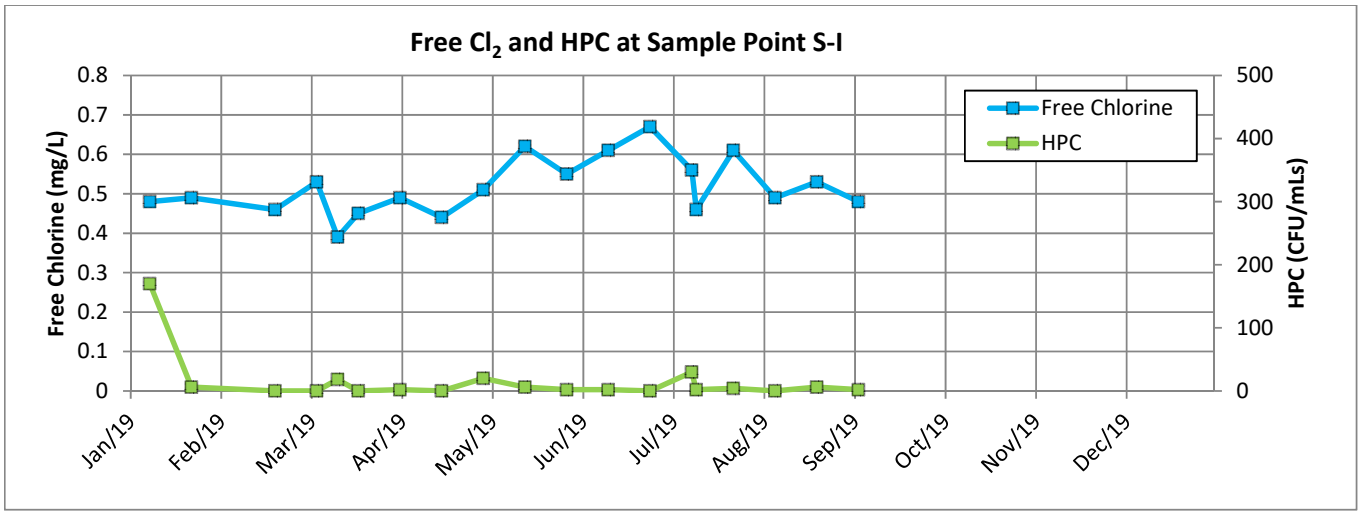

Temperature and Turbidity at Sample Point S-G
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
0
2
4
6
8
10
12
14
16
18
20
22
0
0.5
1
1.5
2
2.5
3
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

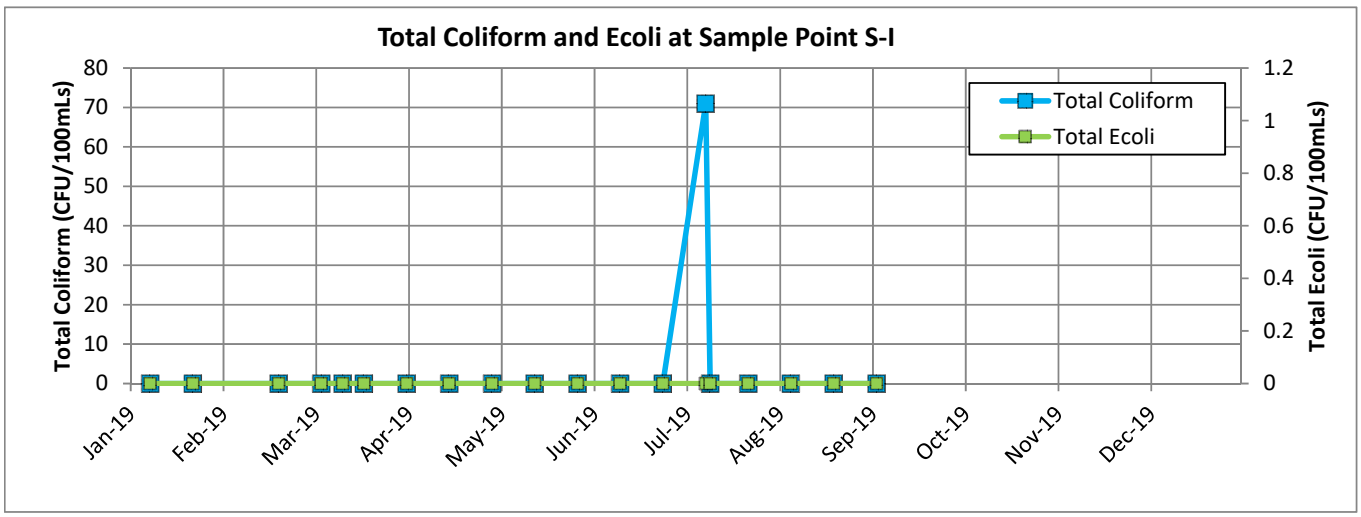
Sample Point S-I
Location: North side of Newton Wynd

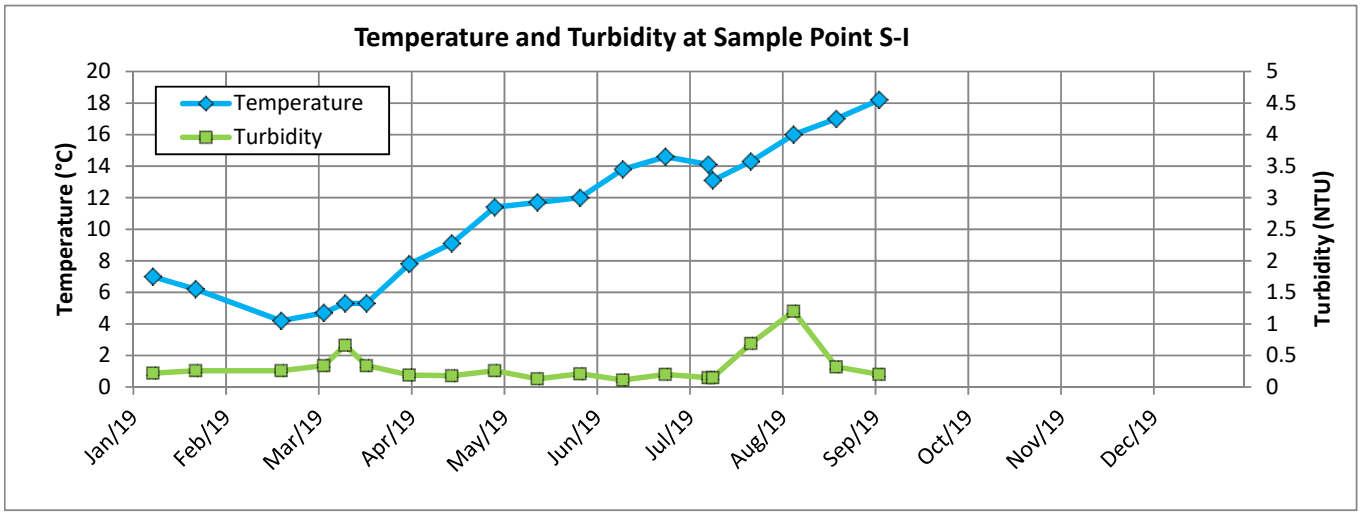
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
8-Jan-19	0.48	<1	170	7.0	<1	0.22
22-Jan-19	0.49	<1	6	6.2	<1	0.26
19-Feb-19	0.46	<1	<2	4.2	<1	0.26
5-Mar-19	0.53	<1	<2	4.7	<1	0.34
12-Mar-19	0.39	<1	18	5.3	<1	0.66
19-Mar-19	0.45	<1	<2	5.3	<1	0.34
2-Apr-19	0.49	<1	2	7.8	<1	0.19
16-Apr-19	0.44	<1	<2	9.1	<1	0.18
30-Apr-19	0.51	<1	20	11.4	<1	0.26
14-May-19	0.62	<1	6	11.7	<1	0.13
28-May-19	0.55	<1	2	12.0	<1	0.21
11-Jun-19	0.61	<1	2	13.8	<1	0.11
25-Jun-19	0.67	<1	<2	14.6	<1	0.20
9-Jul-19	0.56	<1	30	14.1	71	0.15
11-Jul-19	0.46	<1	2	13.1	<1	0.15
23-Jul-19	0.61	<1	4	14.3	<1	0.69
6-Aug-19	0.49	<1	<2	16.0	<1	1.20
20-Aug-19	0.53	<1	6	17.0	<1	0.32
3-Sep-19	0.48	<1	2	18.2	<1	0.20

Min	0.39	<1	<2	4.2	<1	0.11
Average	0.52	<1	15	10.8	4	0.32
Max	0.67	<1	170	18.2	71	1.20
Count	19	19	19	19	19	19

*Results not provided by Metro Vancouver lab.


Free Cl2 and HPC at Sample Point S-I
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/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


Total Coliform and Ecoli at Sample Point S-I
Total Coliform (CFU/100mLs)
Total Ecoli (CFU/100mLs)
Total Coliform
Total Ecoli
80
70
60
50
40
30
20
10
0
1.2
1
0.8
0.6
0.4
0.2
0
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19

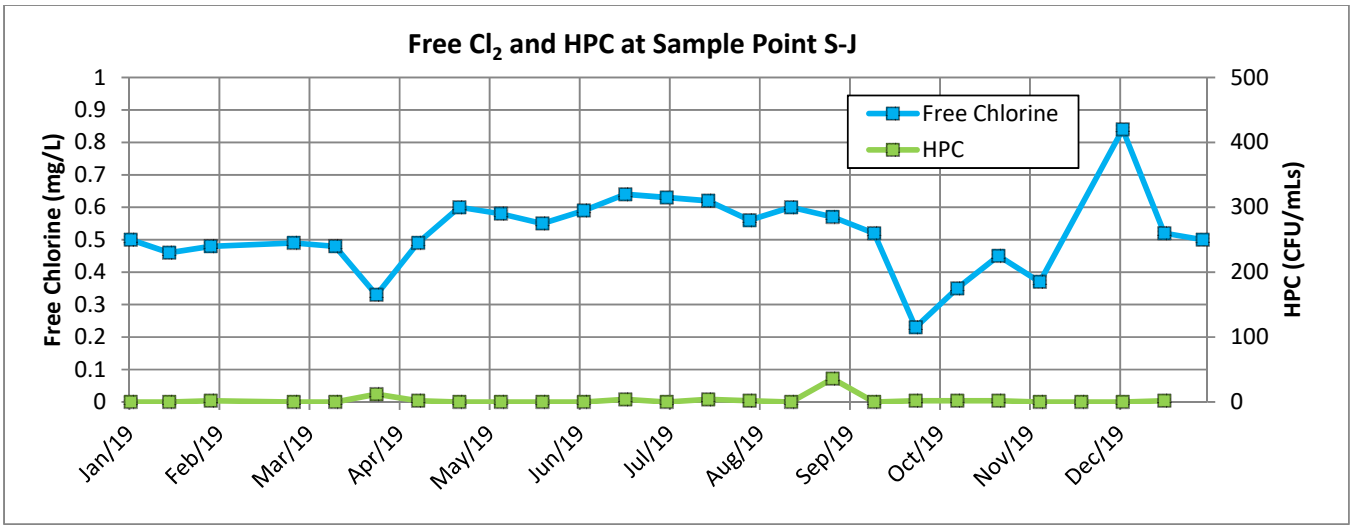

Temperature and Turbidity at Sample Point S-I
Temperature (°C)
Turbidity (NTU)
Temperature
Turbidity
20
18
16
14
12
10
8
6
4
2
0
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19

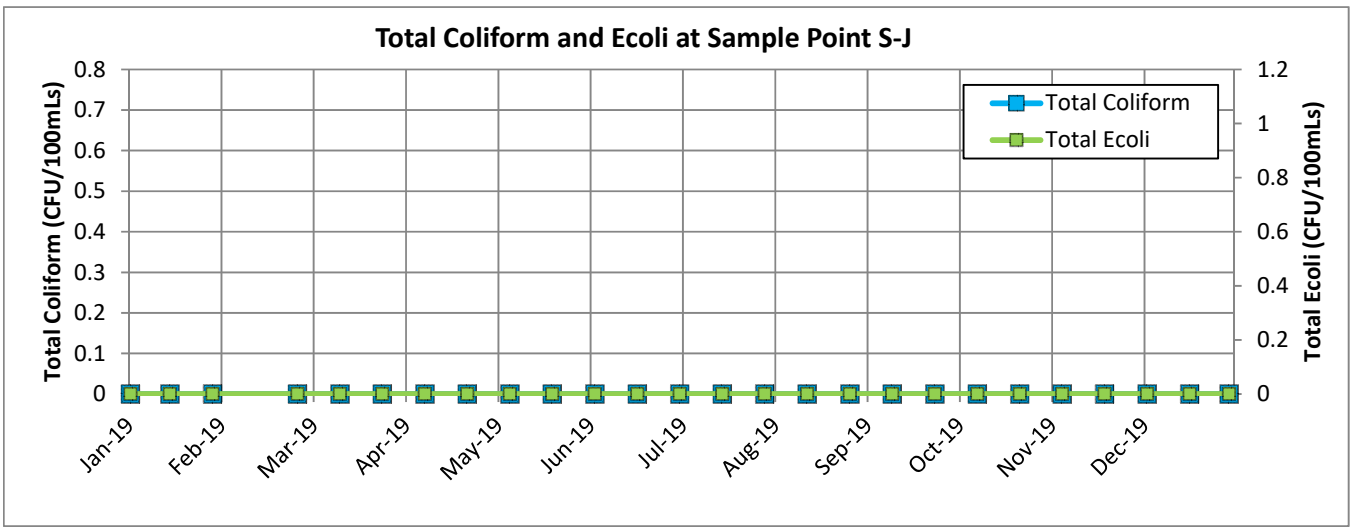
Sample Point S-J
Location: East side of NW Marine Dr

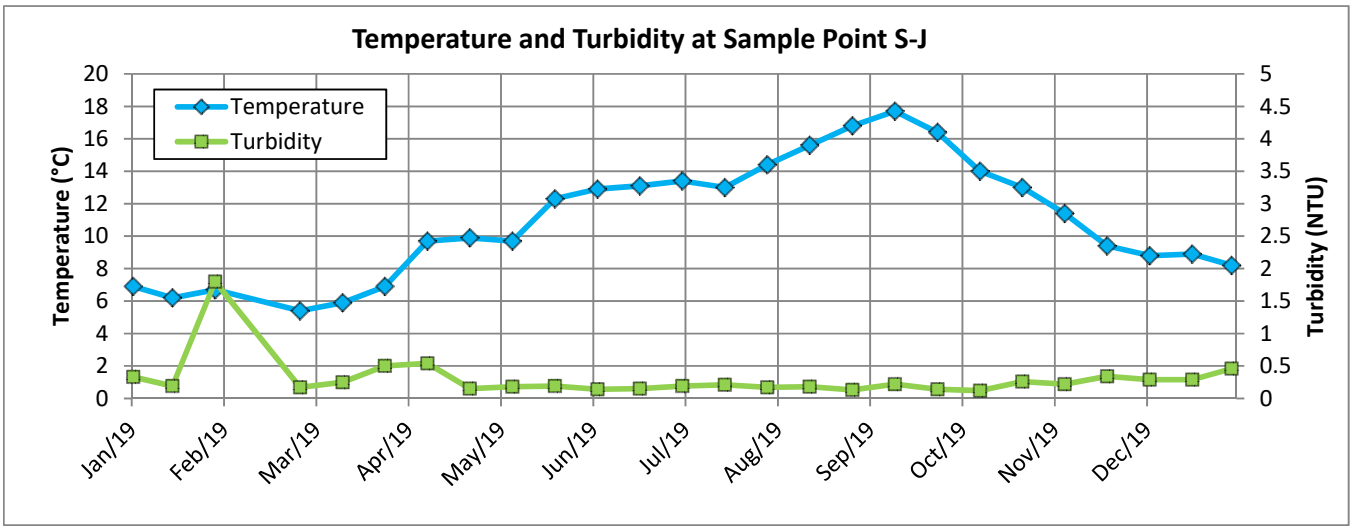
Sampled Date	Chlorine Free (mg/L)	E. Coli (CFU/100mLs)	HPC (CFU/mLs)	Temperature (°C)	Total Coliform (CFU/100mLs)	Turbidity (NTU)
2-Jan-19	0.50	<1	<2	6.9	<1	0.33
15-Jan-19	0.46	<1	<2	6.2	<1	0.19
29-Jan-19	0.48	<1	2	6.7	<1	1.80
26-Feb-19	0.49	<1	<2	5.4	<1	0.17
12-Mar-19	0.48	<1	<2	5.9	<1	0.25
26-Mar-19	0.33	<1	12	6.9	<1	0.50
9-Apr-19	0.49	<1	2	9.7	<1	0.54
23-Apr-19	0.60	<1	<2	9.9	<1	0.15
7-May-19	0.58	<1	<2	9.7	<1	0.18
21-May-19	0.55	<1	<2	12.3	<1	0.19
4-Jun-19	0.59	<1	<2	12.9	<1	0.14
18-Jun-19	0.64	<1	4	13.1	<1	0.15
2-Jul-19	0.63	<1	<2	13.4	<1	0.19
16-Jul-19	0.62	<1	4	13.0	<1	0.21
30-Jul-19	0.56	<1	2	14.4	<1	0.17
13-Aug-19	0.60	<1	<2	15.6	<1	0.18
27-Aug-19	0.57	<1	36	16.8	<1	0.13
10-Sep-19	0.52	<1	<2	17.7	<1	0.22
24-Sep-19	0.23	<1	2	16.4	<1	0.14
8-Oct-19	0.35	<1	2	14.0	<1	0.12
22-Oct-19	0.45	<1	2	13.0	<1	0.26
5-Nov-19	0.37	<1	<2	11.4	<1	0.22
19-Nov-19	NA*	<1	<2	9.4	<1	0.34
3-Dec-19	0.84	<1	<2	8.8	<1	0.29
17-Dec-19	0.52	<1	2	8.9	<1	0.29
30-Dec-19	0.50	<1	NA*	8.2	<1	0.46

Min	0.23	<1	<2	5.4	<1	0.12
Average	0.52	<1	4	11.0	<1	0.30
Max	0.84	<1	36	17.7	<1	1.80
Count	25	26	25	26	26	26

*Results not provided by Metro Vancouver lab.


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
500
400
300
200
100
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19


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-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19


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
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan/19
Feb/19
Mar/19
Apr/19
May/19
Jun/19
Jul/19
Aug/19
Sep/19
Oct/19
Nov/19
Dec/19