2019

City of Kamloops
Drinking Water Annual Report

Canada's Tournament Capital

Kamloops Centre for Water Quality

1315 River Street, Kamloops BC

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1.0 INTRODUCTION

This report was prepared in compliance with the requirements under the British Columbia *Drinking Water Protection Act* (DWPA) and the City of Kamloops' (the City's) Operating Permit. This document includes an overview of the treatment and distribution system within the city, a summary of the total water consumption and water quality analysis within the system, and a recap of projects and related operations. This report has been provided to Interior Health and posted on the City's website for public reading.

2.0 KAMLOOPS WATER SYSTEM

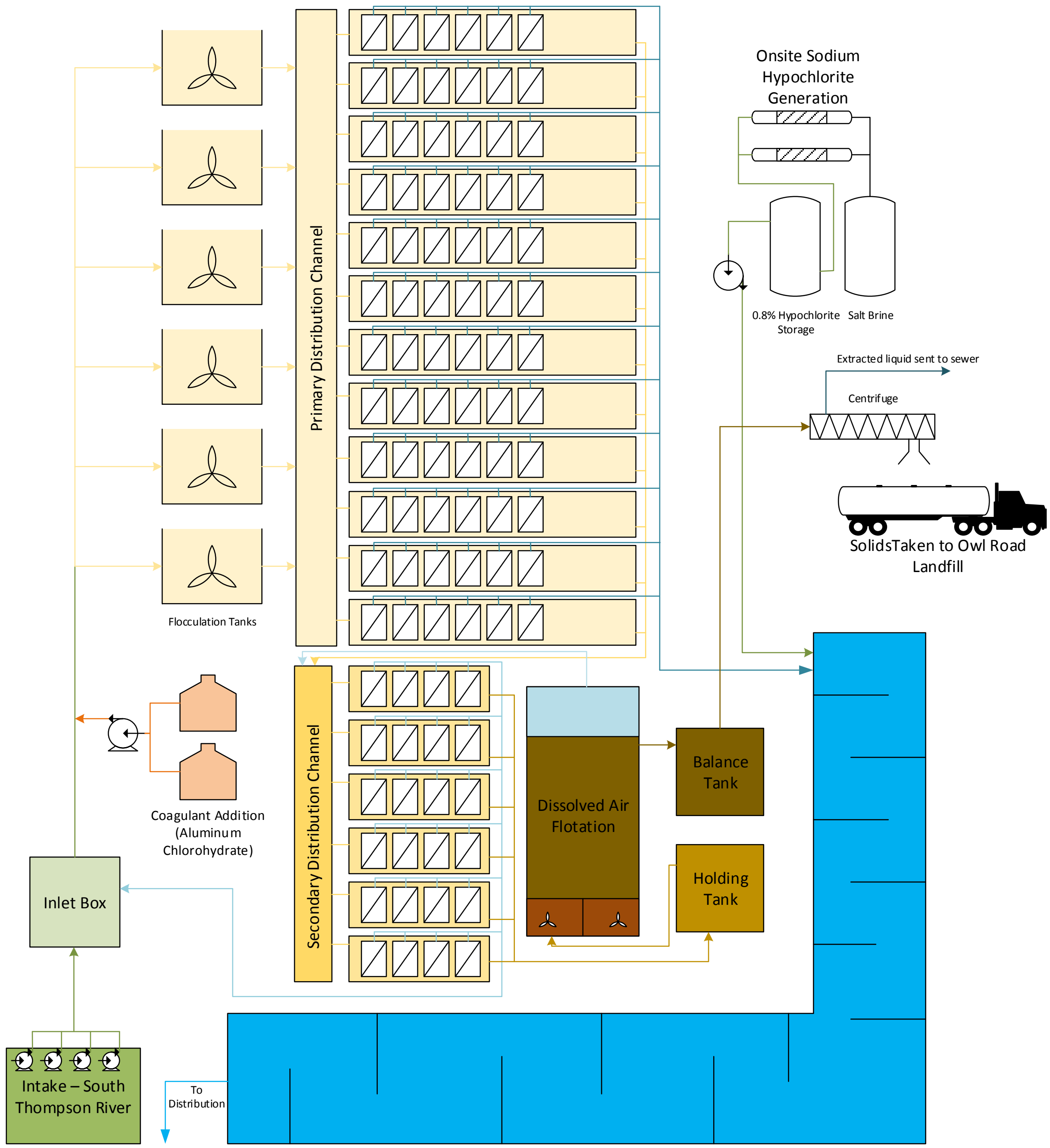
The City's drinking water system consists of a single treatment plant, which feeds an extensive distribution system that supplies water throughout all areas of the community. The only large community that is not fed from the central system is the Rayleigh Waterworks District, which has its own system supplied from the North Thompson River. The City's treatment plant, the Kamloops Centre for Water Quality (KCWQ), is an ultra-filtration membrane treatment facility that chlorinates the finished water to ensure the water's safety throughout the distribution system. The water treatment and distribution/storage systems are assessed and classified as Level IV systems through the Environmental Operators Certification Program (EOCP) and require highly qualified and certified operational staff.

2.1 Kamloops Centre for Water Quality

The KCWQ treats water from the South Thompson River and supplies most of the city's population. KCWQ is a Suez ZeeWeed 500D ultra-filtration membrane water treatment facility that is capable of producing 160 MLD (million litres per day). Leaders in Environmental and Energy Design (LEED) certify the building as a gold-standard green, which is reflected by the KCWQ's processes. Of the water taken into the facility, 99.99 % is processed and delivered as drinking water. The solids recovered through the filtering process are taken the City's Owl Road Resource Recovery Centre, where they are used as clean cover.

A layout of the KCWQ and the accompanying process can be seen in Figure 1.

Figure 1: The Kamloops Centre for Water Quality Plant Processes



2.1.1 *KCWQ Production Totals*

Overall water use in Kamloops seems to be stabilizing after the installation of water meters finished in 2017. The 2019 single-day peak production was still down over 10% from the 10-year average, and the total production was the second lowest in the KCWQ's history. Figure 2 shows the monthly total water consumption over the past 10 years.

Figure 2: Monthly Total Production for the Past 10 Years

Month	Total Production (m^3)										Year to Year Comparison		
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average	Minimum	Maximum
January	1,041,252	1,028,342	1,004,683	997,845	998,516	998,859	999,352	936,100	916,086	899,134	982,017	899,134	1,041,252
February	882,146	920,659	912,473	870,821	903,897	875,057	876,222	823,798	809,346	853,167	872,759	809,346	920,659
March	1,111,459	1,112,117	1,000,423	1,013,585	1,001,555	1,001,061	991,862	893,219	912,847	955,490	999,362	893,219	1,112,117
April	1,537,427	1,254,472	1,338,717	1,256,169	1,155,441	1,377,097	1,519,266	982,158	1,029,452	1,062,333	1,251,253	982,158	1,537,427
May	2,126,552	1,970,344	2,338,361	2,228,929	1,736,305	2,405,924	2,089,764	1,576,441	2,226,009	2,069,861	2,076,849	1,576,441	2,405,924
June	2,232,802	2,446,945	2,008,220	2,128,609	2,435,774	2,633,979	2,317,143	2,596,685	2,318,204	2,510,126	2,362,849	2,008,220	2,633,979
July	3,408,915	2,902,192	2,895,880	3,424,556	3,187,312	2,922,031	2,421,451	3,322,818	2,675,200	2,445,471	2,960,582	2,421,451	3,424,556
August	3,007,564	3,430,008	3,257,773	3,133,474	2,746,427	2,659,919	2,740,741	2,869,866	2,445,042	2,629,652	2,892,047	2,445,042	3,430,008
September	1,700,291	2,629,657	2,366,983	2,036,171	1,836,736	1,737,829	1,618,868	2,046,575	1,470,836	1,636,242	1,908,019	1,470,836	2,629,657
October	1,281,721	1,301,444	1,383,194	1,254,593	1,237,151	1,147,270	1,096,279	1,128,010	1,026,683	1,082,077	1,193,842	1,026,683	1,383,194
November	1,031,241	991,751	999,703	1,114,296	996,238	976,284	958,048	899,987	905,669	953,635	982,685	899,987	1,114,296
December	1,037,506	1,003,279	1,011,471	1,005,151	1,006,889	989,458	978,535	919,666	920,749	971,695	984,440	919,666	1,037,506
Total	20,398,876	20,991,210	20,517,881	20,464,199	19,242,241	19,724,769	18,607,531	18,993,324	17,656,123	18,068,883	19,466,504	17,656,123	20,991,210
Daily Peak	132,697	127,032	117,905	124,608	121,608	106,999	99,564	117,078	106,218	102,470	115,618	99,564	132,697
Peak Date	29-Jul	06-Jul	08-Aug	25-Jul	16-Jul	28-Jun	19-Aug	03-Jul	18-Jul	08-Aug			
Daily Low	20,379	29,180	29,794	29,094	28,771	28,603	29,330	15,394	29,330	27,073	26,695	15,394	29,794
Daily Average	55,887	57,510	56,060	56,066	52,718	54,040	50,840	52,037	48,373	49,504	53,304	48,373	57,510

These monthly numbers are shown in Figure 3. Total consumption for 2019 was over one billion L less than the 10-year average. The overall production was up slightly from 2018, but this could be representative of a new baseline production level.

Figure 3: Graphical Representation of the KCWQ 10-Year Monthly Water Consumption

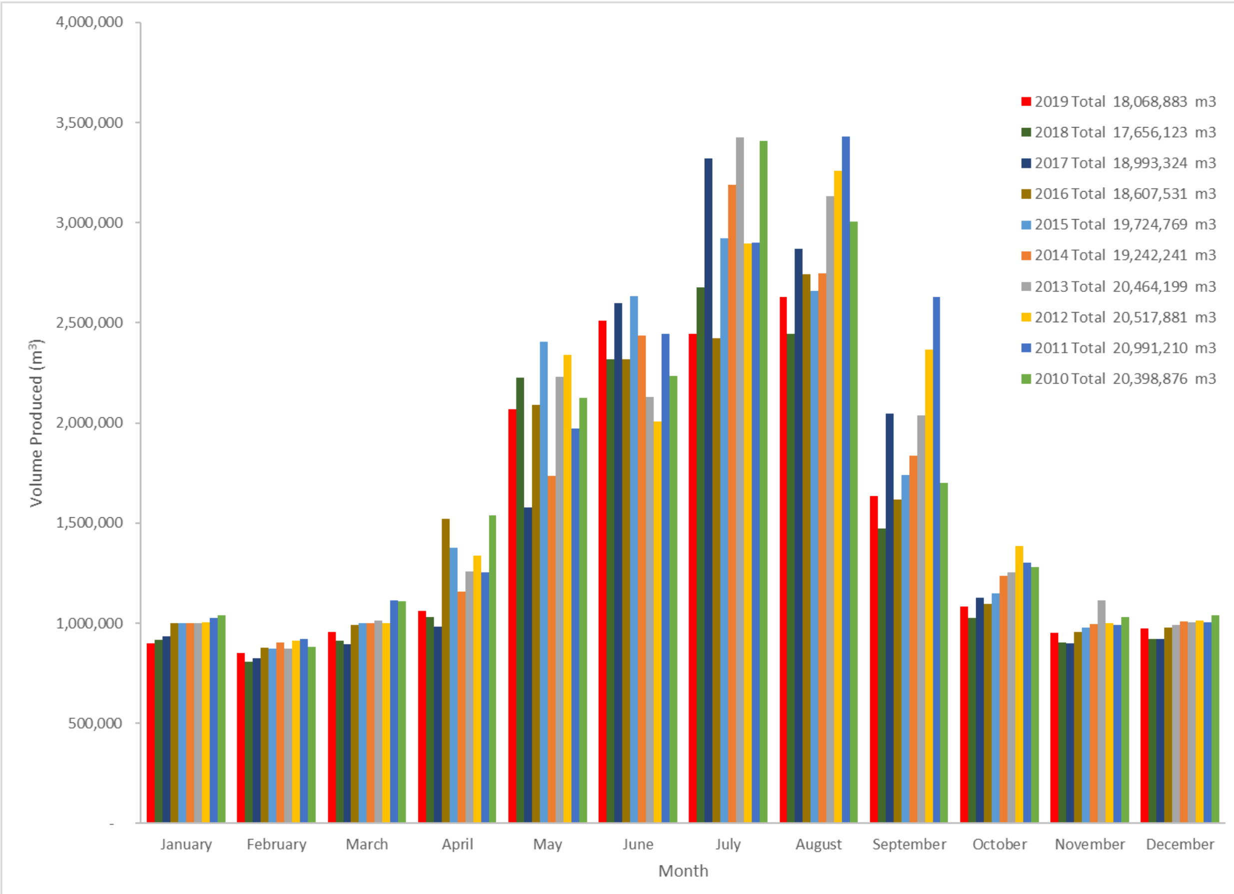
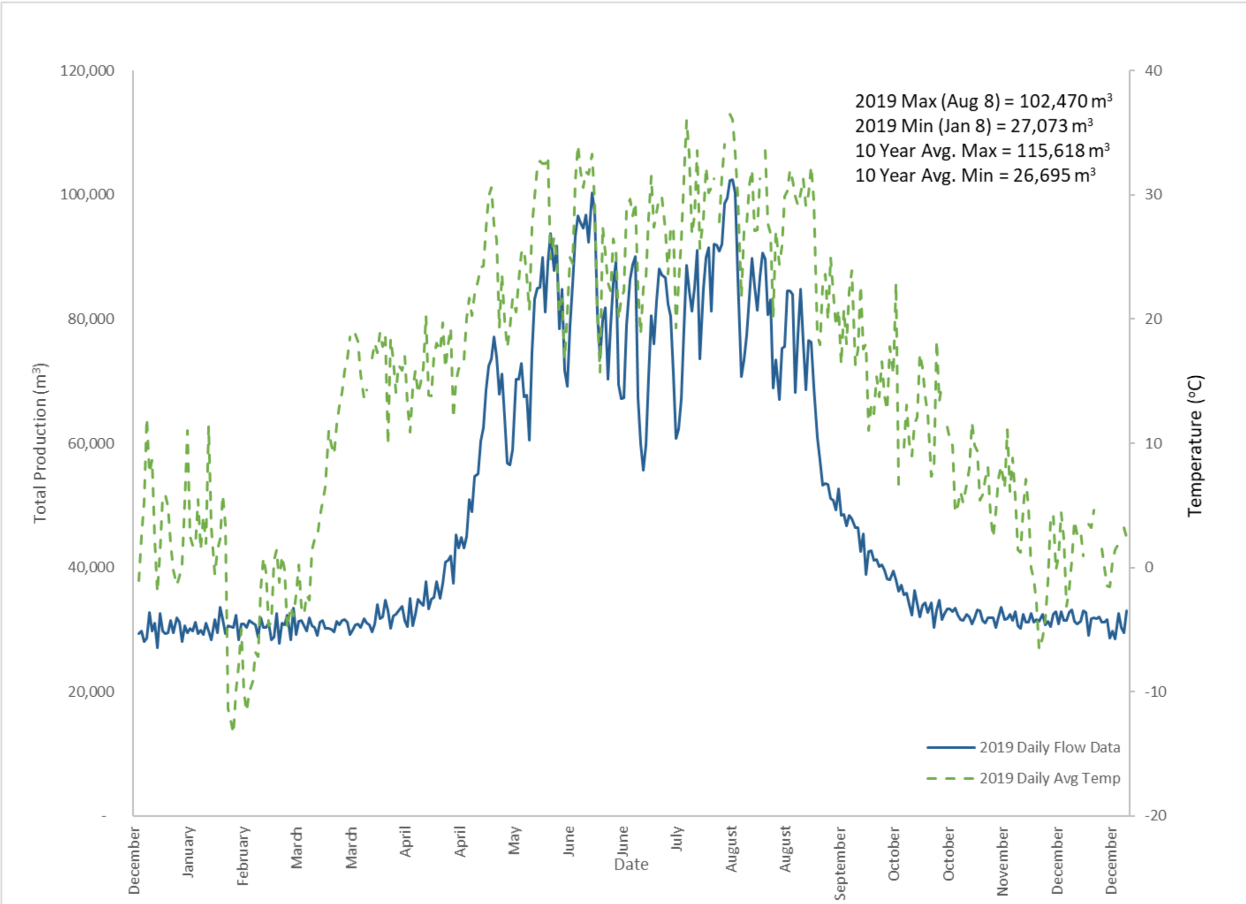


Figure 4 shows the daily water consumption for 2019 with an overlay of the maximum daily temperature. The daily peak for 2019 was 102.5 million L on August 8, which is the second lowest summer maximum peak since the plant was built. The KCWQ can achieve a maximum daily flow of 160 million L, which allows room for population growth well into the future.

Figure 4: KCWQ Daily Water Flows for 2019 With Daily Average Temperature Overlay



2.2 Water Conservation

In 2019, the total water used and and the daily peak water use were both the second lowest in the KCWQ's history. The total usage was nearly 1.5 billion liters below the 10-year average. Irrigation demands continue to be the largest factor in our water demands, and methods to address this challenge are be considered as the next phase of water conservation.

2.3 Distribution System Overview

The distribution system consists of 630.6 km of water mains, 45 booster stations, 44 reservoirs, 2,350 fire hydrants, and a total of 24,983 connections. The City also maintains a trucked-in water system, which supplies potable water to the Tournament Capital Ranch, a sports recreation area. The following sections of this report provide an outline of the distribution system along with summaries of projects and events within the 2019 calendar year.

2.4 Booster Stations and Reservoirs

In 2019, Utility Services Division staff contracted a company that specializes in underwater utilities work to clean the Southwest #2 Booster Station reservoir. A new technique was used where water was filtered and dispersed on site through filtering bags, which eliminated the need for truck hauling and improved cost efficiencies. A major benefit to this technique is the ability to maintain the use of the reservoir throughout the cleaning process.

A vegetation management plan was initiated to clear vegetation from high-voltage compounds to conform with BC Hydro regulations. This process will continue into the future in order to keep the weeds from reoccurring within the compounds.

In 2019, much effort was put towards upgrading the communications system throughout the distribution network. Many water stations throughout the system were upgraded to radio communications, which has improved the speed and the reliability of information exchanged with the control systems at the High Lift and resulted in financial savings.

2.4.1 *Distribution System*

The distribution system is the most complex water distribution system in Canada, due to our area’s unique topography. The material used in the water mains in our distribution system is quite varied, as illustrated in Figure 5. Maintaining this distribution system consists of actively replacing lines that have reached the end of their functional life, need upgrading due to inadequate sizing for development, or are in poor condition and cause issues.

Figure 5: Water Main Material Summary

Material	Length (km)	% of Total Pipe	% Change from Last Year
AC - Asbestos Cement	178.148	28.25	-0.48
CI - Cast Iron	36.582	5.80	-1.13
CU - Copper	0.905	0.14	-2.21
DI - Ductile Iron	103.74	16.45	1.19
GI - Galvanized Iron	0.276	0.04	0.00
HYP - High-Pressure Concrete	17.321	2.75	-0.99
PLY - Polyethylene	1.662	0.26	7.52
PVC - Polyvinyl Chloride	281.12	44.58	2.96
STL - Steel	10.898	1.73	1.36
Total	630.6 km	100%	

The City uses asset management practices to identify and strategically plan the replacement of water infrastructure. Water mains are replaced based on their life expectancy, condition, and risk. Typically, new mains are constructed of PVC. Any increases in water main material besides PVC in Figure 5 are due to updates in the GIS system on previously unidentified or improperly identified mains; these increases may not reflect the addition of newly installed lines of that type.

2.5 Source Protection

In 2014, a source protection plan for Kamloops was developed. This plan included recommendations to help mitigate risks to the water source within an area of direct impact to the South Thompson River intake and the now-approved North Thompson River emergency intake (details on the North Thompson Emergency Intake project are provided in another section of this report). Included in this document were risk management actions, including the building of a secondary water intake on the North Thompson River. Assessments of the recommendations continue.

2.6 Cross-Connection Program

The City is developing an enhanced Cross-Connection Control Program, in compliance with the Interior Health's permit to operate a water system (*Drinking Water Protection Act*). The purpose of this program is to protect public health by ensuring that the safe, clean drinking water the City provides is not contaminated due to backflow. At present, the City is working on revisions for a newly created, stand-alone Cross-Connection Control Bylaw and Cross-Connection Control Program Guide.

The Cross-Connection Control Program will use the premise isolation method and will address cross-connection threats by establishing policies and procedures as well as backflow preventer; selection, installation, testing and maintenance practices and procedures. The program will track all premise isolation backflow preventers directly connected to the City's water distribution system to ensure that they remain in proper working order. The program currently monitors an inventory of roughly 1,300 testable devices (premise isolation and internal protection) and maintains a list of certified backflow preventer testers to help ensure qualified persons are testing the backflow preventers. Written procedures will be provided to ensure City staff can interpret and enforce the Cross-Connection Control Program and Bylaw in a consistent manner.

The Cross-Connection Control Program will be implemented in a manner that will address the severe hazard water use processes first. The initial action will be a public and industry education campaign designed to highlight the importance of the Cross-Connection Control Program and explain its components. A cross-connection inspection and hazard assessment shall be conducted for all industrial, commercial, institutional, and agricultural consumers. Following the survey, a summary report and letter will be sent to the property owner explaining the result of the survey, including any recommendations or requirements, and indicating a timeline for compliance. The consumer is required to respond in writing to indicate what their intentions or plans are to rectify potential hazards and requirements identified on the survey report. If response is not received from the consumer or property owner, a second notice will be sent explaining the importance of the compliance. Ultimately, if a response is not received within the allotted time frame, a final notice will be sent preceding bylaw enforcement action. The program will then address the moderate and minor hazard uses.

Public education programs will be delivered as required to inform residential consumers of the dangers of backflow. A survey of a residence will only be undertaken if there is a real or perceived higher than normal risk to the water utility from the residents.

The City will maintain and assess its program in an ongoing manner, and in conjunction with Interior Health periodically to review its effectiveness to ensuring that clean safe water is delivered to the people of the City.

3.0 2019 HIGHLIGHTS, FUTURE PROJECTS, AND SERVICE REQUEST SUMMARIES

As within any year, 2019 had many projects, upgrades, and challenges to overcome. The following sections will highlight some of the major projects and challenges that arose.

3.1 KCWQ Highlights, Projects, and Challenges

The following is a list of some of the major projects completed at KCWQ in 2019:

- PLC and SCADA upgrades to allow more seamless operation of control interface
- programming changes to upgrade the operation of the sodium hypochlorite pumps
- planning for the primary channel separation, which will include the physical construction completed at the beginning of 2020

One of the greatest challenges at the KCWQ in 2019 was the disruption of salt supply for the on-site generation of sodium hypochlorite. Suppliers of salt appropriate for water treatment were unable to produce the quantity of salt required to supply the industry. Staff worked hard to find alternative solutions, including purchasing and using liquid sodium hypochlorite. By the end of 2019, our supplier’s salt production returned to normal and supply lines were re-established.

3.2 Distribution Highlights

In 2019, much effort was put toward upgrading the communications system throughout the distribution network. This included improvements to the control system for the High and Low Lift pumping systems. The upgrades also included projects to improve redundancy in case of failures in critical systems. Many water stations throughout the system were also upgraded to radio communications, which has improved the speed and reliability of information exchanged with the control systems at the High Lift and resulted in financial savings.

The in-house construction crews completed water infrastructure replacement projects, including:

- Riverview Road - new water main and services
- Gleneagles Drive (from Glenesk Place to Glen Nevis Place) - new water services
- Glenesk Place - new water services
- Wedgewood Crescent - new water services

The City also advanced major capital projects, including upgrades to the water system in the following areas:

- Victoria Street West - replacement/upgrades to water mains
- Todd Road - replacement/upgrades to water mains
- replacement of the Caribou PRV Station

3.2.1 *The North Thompson Emergency Intake*

Construction of the North Thompson Emergency Water Intake was completed in 2018. City staff are now operating this station and performing regular maintenance activities to ensure it is functioning as intended in the event it is needed.

3.2.2 *Requests for Service*

In 2019, there were a total of 3,106 requests for service filed with the Civic Operations Department related to water distribution and treatment. Figure 6 is a breakdown of the categories to which each of the requests is related.

Figure 6: Service Requests in Water Treatment and Distribution

Request Categories Related to Utilities/ Water	Number of Requests	
	2018	2019
Booster Stations	7	6
Cross Connection Control	42	16
Frozen Services	0	2
General	65	131
Hydrants	68	65
Irrigation On/Off	24	18
No Water	47	91
Reservoirs	3	3
Service Boxes	100	79
Service Location	138	130
Turn Service On/Off	675	630
Water Filling Station	33	23
Water Leak	293	274
Water Meters	1586	1498
Water Pressure	58	81
Water Quality	59	58
Water Restrictions	1	1
Totals	3,199	3,106

4.0 WATER QUALITY MONITORING PROGRAM

The City's Water Quality Monitoring Program (WQMP) incorporates principles from the Guidelines for Canadian Drinking Water Quality (GCDWQ) and BC's *Drinking Water Protection Act* (DWPA) and *Drinking Water Projection Regulation* (DWPR). The program is designed to monitor weekly, monthly, quarterly, and annual water quality for immediate and long-term water quality trends.

The WQMP uses the multi-barrier approach. The City has one primary surface water source—the South Thompson River—for all domestic purposes. A second surface water source—the North Thompson River—is an emergency backup.

The City's treatment, distribution, and storage system water quality monitoring program is performed by EOCP-certified staff who take samples at designated sites.

4.1 Quality Assurance and Quality Control Program

The City's Utility Services Division staff are committed to ensuring accurate information is gathered from the WQMP. As directed in the DWPA and DWPR, a water supplier is required to have its bacteriological analysis completed by a certified laboratory that is approved by the Provincial Health Officer. The City utilizes a certified third-party laboratory to analyze weekly bacteriological samples and the more comprehensive annual full spectrum analysis.

Staff taking samples are trained on the proper sampling methods to ensure accuracy of our results and to protect the quality of our water. Field instruments for chlorine residual, turbidity, and pH are scheduled for monthly cleaning and calibration.

The WQMP program also includes quality control inspections and calibrations of sampling and analyzing equipment. Online chlorine analyzers are checked nightly at the KCWQ and weekly within the distribution system.

All samples are collected and shipped in accordance with the 2005 21st Edition Standard Methods for the Examination of Water and Wastewater. A sample confirmation or requisition and chain of custody form accompany all samples sent to the certified lab. City staff have developed procedures for sampling and shipping.

4.2 KCWQ Water Quality Testing

A variety of parameters are measured and monitored at the plant in order to check the treatment process. These parameters are listed below. Figures 7, 8, and 9 summarize the results of the nightly analysis for the KCWQ. These analyses are done in-house by the certified operators at the KCWQ.

4.2.1 *True and Apparent Colour*

Colour in water can be imparted in two ways—through dissolved material or suspended material. The suspended material could be clays, silts, algae, or any other material that can be remain undissolved in water. The dissolved materials are typically organics such as tannins that are leached from plants, trees, or roots and impart a yellowish/brown colour. They may also be from dissolved metals like iron. Suspended material in water is much easier to treat through filtration; dissolved material may be more difficult to treat. Apparent colour is a measure of all colour in water, including suspended material, and true colour measures only the dissolved colour. Colour in itself is not a health issue, but it is unwanted as aesthetically it does not make for good drinking water.

4.2.2 *pH*

pH is a measure of the activity of the hydrogen ion in water. It represents the acidity or basicity of water. The pH scale goes from 0 to 14, with anything smaller than 7 being acidic, anything greater than 7 being basic, and 7 being neutral. Drinking water is regulated to fall between a pH of 6.5 and 8.5. In Kamloops, we want to be slightly on the higher side of that range in order to protect our pipes against corrosion.

4.2.3 *Hardness*

Hardness is primarily made up of dissolved calcium and magnesium in water. These compounds are not harmful to health, and people actually need them in their diet. However, when they are at high levels, they may cause "soap scum" when reacting with soaps, require more soap or detergent when cleaning things, and clog pipes and hot water tanks. Hardness is broken down into the following general categories—0 to 60 mg/L as $CaCO_3$ is considered soft, 61 to 120 mg/L is considered moderate, 121 to 180 mg/L is considered hard, and anything over 180 mg/L is considered very hard.

4.2.4 *Alkalinity*

Alkalinity is a measure of the water's buffering capacity. The alkalinity will keep the pH stable if something acidic or basic is introduced to the water. The higher the alkalinity, the more stable your pH will remain. In general, this parameter has no health implications, it is strictly used as a guideline in treatment processes.

4.2.5 *Conductivity and Total Dissolved Solids (TDS)*

Conductivity and total dissolved solids (TDS) go hand in hand as the probe that measures conductivity in water will give an estimate of the TDS. Conductivity is a measure of how well a water sample conducts electricity. Water is actually an insulator, and in order to conduct electricity, water needs dissolved ions. So water's ability to conduct electricity is directly related to the amount of dissolved solids within the water. In water treatment, this measurement is used to monitor any changes in water quality, as it is a fairly quick test.

4.2.6 *Total Suspended Solids*

Total suspended solids (TSS) is a measure of all the colloidal material in water. Measuring this in our raw water gives an indication of the amount of solids that will be removed in our process. The higher the TSS, the "dirtier" the water is. There is no guideline limit on this as there is another related test called turbidity, which is a quicker test in which a guideline is applied.

4.2.7 *Turbidity*

Turbidity is a measure of the clarity of the water. It is also directly related to the colloidal material in the water. Turbidity is measured by passing a beam of light through the sample and measuring the amount of water that is refracted at a 90° angle. The units applied are called nephelometric turbidity units (NTU). The GCDWQ state that drinking water should have a turbidity of less than 1 NTU. Our membrane water treatment plant should not have a turbidity of greater than 0.1 NTU leaving the plant.

4.2.8 *Aluminum*

Aluminum in our water is of interest as we use an aluminum-based coagulant to help in the treatment process. By monitoring the amount of aluminum in our raw and treated water, we ensure that our coagulant is not being overdosed and is not entering our drinking water at elevated levels. The GCDWQ sets the operational guideline for water treatment plants at 0.1 mg/L.

4.2.9 *Free and Total Chlorine (Cl_2)*

Chlorine levels are important in water treatment to ensure that water is safe all the way through the distribution system to each home. The primary form of chlorine used in our treatment system is sodium hypochlorite. Free chlorine measures the amount of hypochlorite in our water, while total chlorine measures the free chlorine plus any combined chlorine disinfectants such as chloramines. In our system, we strive to maintain a residual free chlorine level of greater than 0.2 mg/L at the end of the distribution system.

Figure 7: KCWQ Average Monthly Raw Water Analysis

Month	True Colour (PtCo Units)	Apparent Colour (PtCo Units	pH	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	TDS (mg/L)	Conductivity (µs/cm)	TSS (mg/L)	Turbidity (NTU)	Aluminium (mg/L)	Temp (°C)
January	3	17	7.53	43	41	41.8	79.7	3.3	2.7	ND	4.0
February	2	10	7.87	44	42	42.4	81.1	1.6	1.9	ND	1.8
March	3	19	7.82	45	43	46.8	88.6	3.3	2.8	ND	4.6
April	5	22	7.89	46	45	44.6	84.6	3.0	3.0	ND	8.2
May	3	18	7.89	43	42	43.3	82.1	2.7	2.9	ND	12.1
June	3	17	7.81	39	39	39.4	75.0	5.7	2.8	ND	13.9
July	2	13	7.91	38	38	49.5	81.5	2.6	2.1	ND	19.4
August	3	12	7.91	38	37	41.6	74.8	1.1	1.5	ND	21.3
September	2	9	7.86	39	38	38.1	72.5	0.9	1.2	ND	19.3
October	2	10	7.83	39	38	38.6	70.5	1.5	1.4	ND	11.8
November	2	11	7.79	40	39	36.9	68.5	1.2	1.5	ND	7.6
December	2	11	7.81	41	39	38.1	72.6	2.2	1.9	ND	4.3
Min	2	9	7.53	38	37	36.9	68.5	0.9	1.21	ND	1.8
Max	5	22	7.91	46	45	49.5	88.6	5.7	3.04	ND	21.3
Average	3	14	7.83	41	40	41.8	77.6	2.4	2.13	ND	10.7

*ND refers to Non-Detectable Limit

Figure 8: KCWQ Average Monthly Treated Water Analysis

Month	True Colour (PtCo Units)	Apparent Colour (PtCo Units	pH	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	TDS (mg/L)	Conductivity (µs/cm)	Turbidity (NTU)	Aluminium (mg/L)	Temp (°C)	Free Cl (mg/L)	Total Cl (mg/L)
January	ND	ND	7.90	43	41	49.5	93.8	0.011	ND	5.7	1.35	1.43
February	ND	ND	8.00	44	42	50.0	94.2	0.011	ND	3.7	1.38	1.47
March	ND	ND	7.93	45	44	53.3	101.0	0.012	ND	5.9	1.29	1.42
April	ND	ND	8.01	46	45	54.2	102.6	0.012	ND	9.3	1.33	1.42
May	ND	ND	7.99	43	42	49.2	93.2	0.017	ND	13.0	1.35	1.44
June	ND	ND	7.91	39	39	44.7	84.9	0.016	ND	14.8	1.36	1.45
July	ND	ND	8.05	38	38	54.9	93.1	0.011	ND	19.9	1.33	1.40
August	ND	ND	8.03	38	37	47.2	84.4	0.009	ND	21.7	1.35	1.45
September	ND	ND	7.96	39	38	43.1	81.9	0.012	ND	19.7	1.32	1.40
October	ND	ND	7.93	39	38	42.8	81.1	0.012	ND	12.4	1.35	1.46
November	ND	ND	7.91	40	39	43.3	82.3	0.013	ND	8.6	1.39	1.51
December	ND	ND	7.92	40	39	43.6	81.8	0.012	ND	6.6	1.40	1.49
Min	ND	ND	7.90	37.81	37.48	42.80	81.14	0.01	0.00	3.67	1.29	1.40
Max	ND	ND	8.05	46.40	45.43	54.94	102.62	0.02	0.00	21.75	1.40	1.51
Average	ND	ND	7.96	41.20	40.40	47.99	89.52	0.01	ND	11.78	1.35	1.45

*ND refers to Non-Detectable Limit

Figure 9: KCWQ Average Monthly Distribution Water Analysis

Month	Resevoir Sampled	True Colour (PtCo Units)	Apparent Colour (PtCo Units)	pH	Hardness (mg/L as $CaCO_3$)	Alkalinity (mg/L as $CaCO_3$)	TDS (mg/L)	Conductivity (µs/cm)	Turbidity (NTU)	Free Cl2 (mg/L)	Total Cl2 (mg/L)	Temp (°C)
January	418	ND	ND	7.85	42	42	50.8	96.0	0.08	0.91	1.01	6.1
	Cinnamon Ridge	ND	ND	7.98	43	41	53.4	101.1	0.10	0.50	0.59	7.2
	Juniper #3	ND	ND	7.89	42	41	52.1	98.6	0.09	0.53	0.60	13.2
	Knutsford	ND	ND	8.17	43	42	54.8	103.7	0.12	0.48	0.57	8.4
	Memorial	ND	ND	7.94	42	42	49.6	94.0	0.13	1.08	1.17	6.0
	Noble Creek	ND	ND	7.97	43	42	52.4	99.2	0.08	0.92	0.99	9.3
	Southwest #4	ND	ND	7.94	43	42	49.2	93.2	0.08	0.93	1.03	5.4
February	418	ND	ND	8.21	44	42	55.0	104.1	0.08	0.96	1.04	4.3
	Cinnamon Ridge	ND	ND	8.15	44	42	51.0	96.6	0.08	0.53	0.62	4.9
	Juniper #3	ND	ND	8.12	43	42	54.1	102.4	0.10	0.66	0.79	8.3
	Knutsford	ND	ND	8.11	44	42	51.9	98.7	0.13	0.69	0.77	5.8
	Memorial	ND	ND	8.10	44	42	55.1	104.9	0.11	0.97	1.05	3.4
	Noble Creek	ND	ND	8.36	43	42	56.2	108.0	0.12	1.03	1.13	12.5
	Southwest #4	ND	ND	8.06	44	42	51.3	97.2	0.14	0.89	0.99	3.9
March	418	ND	ND	8.02	44	43	54.6	103.4	0.10	1.04	1.15	3.4
	Cinnamon Ridge	ND	ND	7.89	44	42	54.0	102.5	0.10	0.63	0.70	5.0
	Juniper #3	ND	ND	7.96	43	42	53.1	100.7	0.10	0.72	0.82	7.6
	Knutsford	ND	ND	8.01	45	43	54.5	103.2	0.09	0.84	0.94	7.1
	Memorial	ND	ND	7.98	45	43	54.7	103.6	0.11	0.96	1.07	3.2
	Noble Creek	ND	ND	8.11	45	43	54.4	103.0	0.14	0.97	1.08	10.1
	Southwest #4	ND	ND	8.09	45	43	54.1	102.5	0.24	0.87	0.96	5.3
April	418	ND	ND	8.09	47	46	54.1	102.5	0.13	0.79	0.91	8.5
	Cinnamon Ridge	ND	ND	8.10	46	45	54.3	102.8	0.10	0.49	0.58	7.7
	Juniper #3	ND	ND	8.05	47	45	55.3	104.7	0.10	0.63	0.74	10.3
	Knutsford	ND	ND	8.03	48	46	57.5	108.8	0.10	0.64	0.74	7.6
	Memorial	ND	ND	8.03	47	46	54.9	103.6	0.24	0.98	1.07	8.3
	Noble Creek	ND	ND	8.26	48	47	59.1	111.8	0.08	0.79	0.90	2.0
	Southwest #4	ND	ND	8.13	47	46	52.8	102.2	0.14	0.74	0.83	9.4
	Simms	ND	ND	8.13	47	45	56.3	106.1	0.05	0.66	0.71	4.1
May	418	ND	ND	8.02	43	42	47.8	90.6	0.11	0.93	1.04	10.2
	Cinnamon Ridge	ND	ND	8.00	44	44	49.4	93.6	0.08	0.47	0.57	3.1
	Juniper #3	ND	ND	7.95	43	42	48.3	90.6	0.09	0.80	0.91	13.4
	Knutsford	ND	ND	8.08	45	44	52.7	99.8	0.17	0.56	0.66	6.3
	Memorial	ND	ND	8.08	43	43	48.1	89.4	0.29	0.88	1.00	13.0
	Noble Creek	ND	ND	8.11	43	43	50.7	96.1	0.08	0.81	0.89	14.8
	Southwest #4	ND	ND	8.07	43	42	47.8	90.6	0.20	0.87	0.96	13.6
	SImms	ND	ND	8.07	47	45	53.1	100.6	0.20	0.82	0.92	9.9
June	418	ND	ND	7.92	39	40	43.7	82.9	0.10	1.09	1.22	14.4
	Cinnamon Ridge	ND	ND	7.98	40	39	44.2	84.0	0.11	0.44	0.52	15.3
	Juniper #3	ND	ND	7.96	40	40	43.7	83.0	0.09	1.06	1.15	15.1
	Knutsford	ND	ND	7.96	40	40	45.8	86.9	0.10	0.81	0.91	7.3
	Memorial	ND	ND	8.01	40	39	43.5	82.7	0.12	0.89	0.99	16.3
	Noble Creek	ND	ND	8.03	40	40	45.4	86.2	0.13	0.81	0.91	18.2
	Southwest #4	ND	ND	7.92	40	38	44.3	84.1	0.11	0.91	1.03	15.6
July	418	ND	ND	8.06	39	38	52.3	86.7	0.08	1.11	1.24	19.1
	Cinnamon Ridge	ND	ND	7.99	39	39	57.9	94.2	0.09	0.23	0.29	9.2
	Juniper #3	ND	ND	8.04	39	39	52.4	86.8	0.10	0.72	0.81	15.2
	Knutsford	ND	ND	8.11	39	39	58.0	94.4	0.09	0.64	0.74	15.4
	Memorial	ND	ND	8.11	38	38	60.6	94.5	0.13	0.96	1.14	20.0
	Noble Creek	ND	ND	8.11	39	39	46.6	75.4	0.09	0.77	0.87	16.1
	Southwest #4	ND	ND	8.08	38	39	50.5	84.0	0.13	0.80	0.91	18.3
August	418	ND	ND	8.13	38	38	48.3	84.6	0.07	1.09	1.20	18.0
	Cinnamon Ridge	ND	ND	8.00	39	38	45.8	79.8	0.09	0.28	0.34	17.7
	Juniper #3	ND	ND	8.12	38	38	45.6	81.6	0.09	0.93	1.00	21.4
	Knutsford	ND	ND	8.09	39	38	46.6	81.1	0.09	0.51	0.59	17.4
	Memorial	ND	ND	8.01	39	38	43.7	81.5	0.09	0.99	1.09	21.7
	Noble Creek	ND	ND	8.21	38	37	47.9	83.2	0.08	0.74	0.84	18.2
	Southwest #4	ND	ND	8.09	38	38	39.3	74.8	0.07	0.94	1.03	13.9
September	418	ND	ND	8.04	40	39	42.3	80.6	0.09	0.76	0.85	20.1
	Cinnamon Ridge	ND	ND	7.97	40	38	40.9	78.5	0.09	0.15	0.22	13.6
	Juniper #3	ND	ND	8.03	39	38	40.9	77.5	0.10	0.68	0.80	18.8
	Knutsford	ND	ND	8.09	40	38	41.6	79.1	0.07	0.43	0.54	11.5
	Memorial	ND	ND	8.10	40	38	41.1	78.5	0.13	0.92	1.04	20.2
	Noble Creek	ND	ND	8.30	39	38	42.8	81.0	0.08	0.41	0.45	11.3
	Southwest #4	ND	ND	8.09	40	39	42.0	79.2	0.36	0.63	0.72	19.6
October	418	ND	ND	8.00	39	38	42.0	79.6	0.08	0.93	1.02	13.3
	Cinnamon Ridge	ND	ND	7.97	39	39	42.1	80.0	0.07	0.15	0.25	12.5
	Juniper #3	ND	ND	8.01	40	38	42.4	80.4	0.09	0.41	0.50	14.1
	Knutsford	ND	ND	8.10	39	39	43.0	82.3	0.08	0.36	0.47	10.3
	Memorial	ND	ND	7.95	39	38	41.2	78.2	0.13	1.10	1.20	13.6
	Noble Creek	ND	ND	8.24	39	38	43.9	84.0	0.08	0.63	0.72	15.9
	Southwest #4	ND	ND	7.99	39	38	42.1	79.7	0.19	0.93	1.02	13.8
November	418	ND	ND	7.95	41	40	44.3	84.0	0.08	1.02	1.13	11.5
	Cinnamon Ridge	ND	ND	7.88	40	39	43.7	79.3	0.08	0.08	0.15	6.8
	Juniper #3	ND	ND	7.89	41	39	43.8	83.3	0.09	0.33	0.39	15.7
	Knutsford	ND	ND	8.09	41	40	44.0	84.2	0.09	0.38	0.47	11.8
	Memorial	ND	ND	7.97	41	39	43.9	84.0	0.08	1.14	1.24	9.9
	Noble Creek	ND	ND	8.24	41	40	44.9	85.7	0.06	0.64	0.69	15.6
	Southwest #4	ND	ND	8.04	40	39	43.6	82.7	0.22	0.94	1.03	10.6
December	418	ND	ND	7.94	41	40	45.0	85.5	0.08	0.96	1.05	6.2
	Cinnamon Ridge	ND	ND	7.92	40	39	44.0	83.5	0.07	0.40	0.50	8.6
	Juniper #3	ND	ND	7.97	41	39	44.0	83.5	0.10	0.68	0.78	10.2
	Knutsford	ND	ND	8.01	41	40	45.1	87.0	0.08	0.76	0.85	9.0
	Memorial	ND	ND	7.93	41	40	43.6	82.8	0.10	1.16	1.27	7.0
	Noble Creek	ND	ND	8.17	41	40	45.9	87.1	0.09	0.91	1.02	9.5
	Southwest #4	ND	ND	7.90	40	40	42.8	81.2	0.07	1.10	1.21	5.8
Min		ND	ND	7.85	37.80	37.20	39.33	74.83	0.05	0.08	0.15	2.03
Max		ND	ND	8.36	47.67	46.67	60.60	111.77	0.36	1.16	1.27	21.74
Average		ND	ND	8.04	41.56	40.61	48.49	90.40	0.11	0.75	0.85	11.31

*ND refers to Non-Detectable Limit

4.3 Distribution Sampling

The City is committed to providing safe drinking water to to its customers. The distribution system is sampled at 24 different locations. These samples are analyzed for background bacterial counts, total coliforms, and E. coli.

4.3.1 *Background Bacterial Monitoring*

Background bacteria monitoring is done through a heterotrophic plate count (HPC). Heterotrophic bacteria are a group of bacteria that use carbon as a food source and can be found in a variety of water sources. Most bacteria found in water are actually heterotrophic. In general, these bacteria are not pathogenic, and the HPC test in itself will not tell you whether the water is safe to drink. Because of this, there is no maximum acceptable concentration, as stated in the GCDWQ. This test tells us if there are conditions within the system that bacteria can regrow or thrive in.

The City uses this test to monitor integrity and overall "health" of the distribution system. If a sample is positive for background bacteria greater than 200 counts, the system is flushed and resampled. Any positive counts of any size for background bacteria are also resampled, which is above and beyond any legislative requirements.

4.3.2 *Coliform Bacterial Monitoring*

Coliform bacteria is a group of bacteria that is a little more of a narrow focus from the HPC test. These bacteria represent a large group of bacteria found in water and soil, on vegetation, and in the feces of mammals. Most of these bacteria are not harmful to humans, but because of the ease of testing of this bacteria, it makes for a great indicator of contamination.

In water treatment systems, there is a zero threshold allowance for coliforms within water samples. If a sample shows up positive for coliforms, the site is immediately resampled, and if coliforms are found again, a boil water advisory is put in place. The distribution area is then pulled offline and cleaned before being put back into action and resampled.

4.3.3 *E. Coli Bacterial Monitoring*

E. coli bacteria are a subsection of coliform bacteria. These bacteria may not be harmful to human health, but specific strains can cause serious health issues and even death in some instances. These bacteria are also found almost exclusively in the feces of mammals; therefore, they are a definite sign of contamination. Any positive counts for coliforms or E. coli result in an immediate boil water advisory, resampling, and cleaning of the affected area. The results for the 2019 distribution system can be seen in Figure 10.

Figure 10: 2019 Distribution System Biological Sampling

Date	Number of Samples Taken	Samples Positive for Background Bacteria	Samples Positive for Coliforms	Samples Positive for E. Coli	Notes/ Measures Taken
2019-01-02	23	0			
2019-01-07	23	0			
2019-01-14	23	0			
2019-01-21	23	0			
2019-01-28	23	0			
2019-02-04	23	1			Background count of 1 - resampled, negative
2019-02-11	24	1			Background count of 1 - resampled, negative
2019-02-18	24	1			Background count of 1 - resampled, negative
2019-02-25	24	0			
2019-03-04	23	0			
2019-03-11	23	0			
2019-03-18	23	5			Background count of 1 for 4 samples, 1 sample background of 3 - resamled, negative
2019-03-25	26	6			Background count of 1 for all 6 samples - resampled, negative
2019-04-01	28	0			
2019-04-08	23	0			
2019-04-15	24	0			
2019-04-22	24	0			
2019-04-29	24	1			Background count of 1 - resampled, negative
2019-05-06	25	0			
2019-05-13	24	3	1		Background count of 1 for 3 samples, coliform count of 1 - resampled, negative
2019-05-20	27	0			
2019-05-27	24	0			
2019-06-03	24	0			
2019-06-10	24	0			
2019-06-17	24	0			
2019-06-24	24	0			
2019-07-01	24	0			
2019-07-08	24	0			
2019-07-15	24	3			Background count of 2 for 2 samples, background count of 11 for the other - resampled, negative
2019-07-22	26	1			Background count of 1
2019-07-29	24	1			Background count of 1 - resampled, negative
2019-08-05	25	0			
2019-08-12	24	0			
2019-08-19	24	0			
2019-08-26	24	2			Background count of 1 for both samples
2019-09-02	24	3			Background count of 1 for 2 samples, background count of 4 for the other - resampled, negative
2019-09-09	26	0			
2019-09-16	24	0			
2019-09-23	24	1			Background count of 2
2019-09-30	24	1			Background count of 120 - resampled, negative
2019-10-07	25	1			Background count of 1
2019-10-14	23	1			Background count of 1
2019-10-21	23	0			
2019-10-28	23	0			
2019-11-04	23	0			
2019-11-11	23	0			
2019-11-18	23	0			
2019-11-25	23	0			
2019-12-02	23	1			Background count of 1
2019-12-09	23	0			
Totals	1197	33	1	0	

There were a total of 33 positive results for background bacteria and one positive sample for coliform bacteria. After resampling, all results came back negative.

4.4 Yearly Raw and Distribution Sampling

The following extensive water quality analysis results were completed by a provincially accredited lab from the source water and within the distribution system. The single sampling event was completed in compliance with the KCWQ operational certificate. The samples were taken by City staff and sent to CARO Analytical Services (CARO) in Kelowna, BC. The results of these extensive analysis can be seen in Figures 11 through 19. As seen in the tables, all of the treated water quality parameters are within the GCDWQ.

Figure 11: CARO Anions Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Bromide	mg/L	0.1	N/A	<0.10	
Chloride	mg/L	0.1	AO<=250	1.1	5.52
Fluoride	mg/L	0.1	MAC=1.5		<0.10
Nitrate as N	mg/L	0.01	MAC=10	0.054	0.054
Nitrite as N	mg/L	0.01	MAC=1	<0.010	<0.010
Phosphate, Ortho as P	mg/L	0.01	N/A		<0.0050
Sulfate	mg/L	1	AO<=500	8.3	7.7

MAC = Maximum Acceptable Concentration   AO = Aesthetic objective

Figure 12: CARO General Parameters Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Colour, True	CU	5	AO<=15	<5.0	<5.0
Alkalinity, Total (as CaCO3)	mg/L	2	N/A	42.9	42.7
Alkalinity, Phenolphthalein (as CaCO3)	mg/L	2	N/A	<1.0	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	2	N/A	42.9	42.7
Alkalinity, Carbonate (as CaCO3)	mg/L	2	N/A	<1.0	<1.0
Alkalinity, Hydroxide (as CaCO3)	mg/L	2	N/A	<1.0	<1.0
Ammonia, Total (as N)	mg/L	0.02	N/A	0.026	
BOD, 5-day	mg/L	2	N/A	<6.5	
Carbon, Total Organic	mg/L	0.5	N/A	1.86	1.59
Carbon, Dissolved Organic	mg/L	0.5	N/A	1.5	
Cyanide, Total	mg/L	0.002	MAC=0.2		<0.0020
Nitrogen, Total Kjeldahl	mg/L	0.05	N/A	<0.050	<0.050
Oil & Grease, Total	mg/L	2	N/A		<2.0
Phenolics, Total	mg/L	0.002	N/A		<0.10
Solids, Total Dissolved	mg/L	10	AO<=500	58	72
Sulfide, Total	mg/L	0.05	AO<=0.05		<0.020
Turbidity	NTU	0.1	OG<0.1	0.47	<0.10
Conductivity (EC)	uS/cm	2	N/A	99.8	115

MAC = Maximum Acceptable Concentration   AO = Aesthetic objective

Figure 13: CARO Calculated Parameters

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Hardness, Total (Total as CaCO3)	mg/L	0.5	N/A	41.3	40.8
Nitrate+Nitrite as N	mg/L	0.02	N/A	0.0545	0.0544
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 14: CARO Dissolved Metals Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Aluminum, dissolved	mg/L	0.005	N/A	<0.0050	<0.0050
Antimony, dissolved	mg/L	0.0001	N/A	<0.00020	<0.00020
Arsenic, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050
Barium, dissolved	mg/L	0.005	N/A	0.0108	0.0101
Beryllium, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010
Bismuth, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010
Boron, dissolved	mg/L	0.004	N/A	<0.0050	<0.0050
Cadmium, dissolved	mg/L	0.00001	N/A	<0.000010	<0.000010
Calcium, dissolved	mg/L	0.2	N/A	12.2	12.5
Chromium, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050
Cobalt, dissolved	mg/L	0.00005	N/A	<0.00010	<0.00010
Copper, dissolved	mg/L	0.0002	N/A	0.00093	0.00177
Iron, dissolved	mg/L	0.01	N/A	<0.010	<0.010
Lead, dissolved	mg/L	0.0001	N/A	<0.00020	<0.00020
Lithium, dissolved	mg/L	0.0001	N/A	0.00076	0.00076
Magnesium, dissolved	mg/L	0.01	N/A	2.63	2.35
Manganese, dissolved	mg/L	0.0002	N/A	0.002	0.00029
Mercury, dissolved	mg/L	0.00001	N/A	<0.000010	<0.000010
Molybdenum, dissolved	mg/L	0.0001	N/A	0.00076	0.00069
Nickel, dissolved	mg/L	0.0002	N/A	<0.00040	<0.00040
Phosphorus, dissolved	mg/L	0.02	N/A	<0.050	<0.050
Potassium, dissolved	mg/L	0.02	N/A	0.96	0.9
Selenium, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050
Silicon, dissolved	mg/L	0.5	N/A	3.1	3
Silver, dissolved	mg/L	0.00005	N/A	<0.000050	<0.000050
Sodium, dissolved	mg/L	0.02	N/A	2.39	5.51
Strontium, dissolved	mg/L	0.001	N/A	0.085	0.0812
Sulfur, dissolved	mg/L	1	N/A	4.4	3.8
Tellurium, dissolved	mg/L	0.0002	N/A	<0.00050	<0.00050
Thallium, dissolved	mg/L	0.00002	N/A	<0.000020	<0.000020
Thorium, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010
Tin, dissolved	mg/L	0.0002	N/A	<0.00020	<0.00020
Titanium, dissolved	mg/L	0.005	N/A	<0.0050	<0.0050
Tungsten, dissolved	mg/L	0.001	N/A	<0.0010	<0.0010
Uranium, dissolved	mg/L	0.00002	N/A	0.000181	0.000068
Vanadium, dissolved	mg/L	0.001	N/A	<0.0010	<0.0010
Zinc, dissolved	mg/L	0.004	N/A	<0.0040	<0.0040
Zirconium, dissolved	mg/L	0.0001	N/A	<0.00010	<0.00010
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 15: CARO Total Recoverable Metals Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Aluminum, total	mg/L	0.005	OG<0.1	0.0118	<0.0050
Antimony, total	mg/L	0.0002	MAC=0.006	<0.00020	<0.00020
Arsenic, total	mg/L	0.0005	MAC=0.01	<0.00050	<0.00050
Barium, total	mg/L	0.005	MAC=1	0.0115	0.0099
Beryllium, total	mg/L	0.0001	N/A	<0.00010	<0.00010
Bismuth, total	mg/L	0.0001	N/A	<0.00010	<0.00010
Boron, total	mg/L	0.005	MAC=5	<0.0050	<0.0050
Cadmium, total	mg/L	0.00001	MAC=0.005	<0.000010	<0.000010
Calcium, total	mg/L	0.2	None Required	12.7	12.7
Chromium, total	mg/L	0.0005	MAC=0.05	<0.00050	<0.00050
Cobalt, total	mg/L	0.0001	N/A	<0.00010	<0.00010
Copper, total	mg/L	0.0004	AO<=1	0.00109	0.00181
Iron, total	mg/L	0.01	AO<=0.3	0.02	<0.010
Lead, total	mg/L	0.0002	MAC=0.01	<0.00020	<0.00020
Lithium, total	mg/L	0.0001	N/A	0.00076	0.00075
Magnesium, total	mg/L	0.01	None Required	2.75	2.48
Manganese, total	mg/L	0.0002	AO<=0.05	0.0028	0.00031
Mercury, total	mg/L	0.00001	MAC=0.001	<0.000010	<0.000010
Molybdenum, total	mg/L	0.0001	N/A	0.00075	0.00072
Nickel, total	mg/L	0.0004	N/A	<0.00040	<0.00040
Phosphorus, total	mg/L	0.05	N/A	<0.050	<0.050
Potassium, total	mg/L	0.1	N/A	0.95	0.9
Selenium, total	mg/L	0.0005	MAC=0.05	<0.00050	<0.00050
Silicon, total	mg/L	1	N/A	3.2	3.1
Silver, total	mg/L	0.00005	None Required	<0.000050	<0.000050
Sodium, total	mg/L	0.1	AO<=200	2.4	5.62
Strontium, total	mg/L	0.001	N/A	0.0864	0.0825
Sulfur, total	mg/L	3	N/A	4.1	3.9
Tellurium, total	mg/L	0.0005	N/A	<0.00050	<0.00050
Thallium, total	mg/L	0.00002	N/A	<0.000020	<0.000020
Thorium, total	mg/L	0.0001	N/A	<0.00010	<0.00010
Tin, total	mg/L	0.0002	N/A	<0.00020	<0.00020
Titanium, total	mg/L	0.005	N/A	<0.0050	<0.0050
Tungsten, total	mg/L	0.001	N/A	<0.0010	<0.0010
Uranium, total	mg/L	0.00002	MAC=0.02	0.000193	0.000073
Vanadium, total	mg/L	0.001	N/A	<0.0010	<0.0010
Zinc, total	mg/L	0.004	AO<=5	<0.0040	<0.0040
Zirconium, total	mg/L	0.0001	N/A	<0.00010	<0.00010

MAC = Maximum Acceptable Concentration AO = Aesthetic objective

Figure 16: CARO Pesticides, Herbicides, and Fungicides Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Glyphosate	mg/L	0.05	MAC=0.28	<0.050	<0.050
Alachlor	ug/L	0.1	N/A		<0.100
Aldrin	ug/L	0.006	N/A		<0.006
Azinphos-methyl	ug/L	0.2	MAC=20		<0.200
alpha-BHC	ug/L	0.01	N/A		<0.010
beta-BHC	ug/L	0.05	N/A		<0.050
delta-BHC	ug/L	0.05	N/A		<0.050
gamma-BHC (Lindane)	ug/L	0.05	N/A		<0.050
Bromacil	ug/L	0.1	N/A		<0.100
Captan	ug/L	0.1	N/A		<0.100
alpha-Chlordane	ug/L	0.05	N/A		<0.050
gamma-Chlordane	ug/L	0.05	N/A		<0.050
Chlordane (cis + trans)	ug/L	0.05	N/A		<0.050
Chlorothalonil	ug/L	0.05	N/A		<0.050
Chlorpyrifos	ug/L	0.01	MAC=90		<0.010
Cyanazine	ug/L	0.1	N/A		<0.100
p,p-DDD	ug/L	0.01	N/A		<0.010
p,p'-DDE	ug/L	0.01	N/A		<0.010
p,p'-DDT	ug/L	0.01	N/A		<0.010
Diazinon	ug/L	0.02	MAC=20		<0.020
Dichlorvos	ug/L	0.1	N/A		<0.100
Dieldrin	ug/L	0.01	N/A		<0.010
Dimethoate	ug/L	0.2	MAC=20		<0.200
Disulfoton	ug/L	0.1	N/A		<0.100
Endosulfan I	ug/L	0.01	N/A		<0.010
Endosulfan II	ug/L	0.01	N/A		<0.010
Endosulfan sulfate	ug/L	0.05	N/A		<0.050
Endrin	ug/L	0.02	N/A		<0.020
Endrin aldehyde	ug/L	0.02	N/A		<0.020
Endrin ketone	ug/L	0.02	N/A		<0.020
Fenchlorphos (Ronnel)	ug/L	0.1	N/A		<0.100
Heptachlor	ug/L	0.01	N/A		<0.010
Heptachlor epoxide	ug/L	0.01	N/A		<0.010
Malathion	ug/L	0.1	MAC=190		<0.100
Methyl parathion	ug/L	0.1	N/A		<0.100
Metolachlor	ug/L	0.1	MAC=50		<0.100
Metribuzin	ug/L	0.2	MAC=80		<0.200
Parathion	ug/L	0.1	N/A		<0.100
Pentachloronitrobenzene	ug/L	0.1	N/A		<0.100
cis-Permethrin	ug/L	0.01	N/A		<0.010
trans-Permethrin	ug/L	0.01	N/A		<0.010
Phorate	ug/L	0.1	MAC=2		<0.100
Sulfotep	ug/L	0.1	N/A		<0.100
Terbufos	ug/L	0.1	MAC=1		<0.100
Triallate	ug/L	0.1	N/A		<0.100
Trifluralin	ug/L	0.2	MAC=45		<0.200

MAC = Maximum Acceptable Concentration   AO = Aesthetic objective

Figure 17: CARO Polycyclic Aromatic Hydrocarbon (PAH) Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Acenaphthene	ug/L	0.05	N/A		<0.050
Acenaphthylene	ug/L	0.2	N/A		<0.200
Acridine	ug/L	0.05	N/A		<0.050
Anthracene	ug/L	0.01	N/A		<0.010
Benz(a)anthracene	ug/L	0.01	N/A		<0.010
Benzo(a)pyrene	ug/L	0.01	MAC=0.04		<0.010
Benzo(b+j)fluoranthene	ug/L	0.05	N/A		<0.050
Benzo(g,h,i)perylene	ug/L	0.05	N/A		<0.050
Benzo(k)fluoranthene	ug/L	0.05	N/A		<0.050
2-Chloronaphthalene	ug/L	0.1	N/A		<0.100
Chrysene	ug/L	0.05	N/A		<0.050
Dibenz(a,h)anthracene	ug/L	0.01	N/A		<0.010
Fluoranthene	ug/L	0.03	N/A		<0.030
Fluorene	ug/L	0.05	N/A		<0.050
Indeno(1,2,3-cd)pyrene	ug/L	0.05	N/A		<0.050
1-Methylnaphthalene	ug/L	0.1	N/A		<0.100
2-Methylnaphthalene	ug/L	0.1	N/A		<0.100
Naphthalene	ug/L	0.2	N/A		<0.200
Phenanthrene	ug/L	0.1	N/A		<0.100
Pyrene	ug/L	0.02	N/A		<0.020
Quinoline	ug/L	0.05	N/A		<0.050
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 18: CARO Volatile Organic Compounds (VOC) Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (March 4, 2019)	Harrington Booster (March 4, 2019)
Benzene	ug/L	0.5	MAC=5		<0.5
Bromodichloromethane	ug/L	1	N/A		4.6
Bromoform	ug/L	1	N/A		9.2
Carbon tetrachloride	ug/L	0.5	MAC=2		<0.5
Chlorobenzene	ug/L	1	AO<=30		<1.0
Chloroethane	ug/L	2	N/A		<2.0
Chloroform	ug/L	1	N/A		33.9
Dibromochloromethane	ug/L	1	N/A		3.7
1,2-Dibromoethane	ug/L	0.3	N/A		<0.3
Dibromomethane	ug/L	1	N/A		<1.0
1,2-Dichlorobenzene	ug/L	0.5	AO<=3		<0.5
1,3-Dichlorobenzene	ug/L	1	N/A		<1.0
1,4-Dichlorobenzene	ug/L	1	AO<=1		<1.0
1,1-Dichloroethane	ug/L	1	N/A		<1.0
1,2-Dichloroethane	ug/L	1	MAC=5		<1.0
1,1-Dichloroethylene	ug/L	1	MAC=14		<1.0
cis-1,2-Dichloroethylene	ug/L	1	N/A		<1.0
trans-1,2-Dichloroethylene	ug/L	1	N/A		<1.0
Dichloromethane	ug/L	3	MAC=50		<3.0
1,2-Dichloropropane	ug/L	1	N/A		<1.0
3-Dichloropropene (cis + trar	ug/L	1	N/A		<1.0
Ethylbenzene	ug/L	1	AO<=1.6		<1.0
Methyl tert-butyl ether	ug/L	1	AO<=15		<1.0
Styrene	ug/L	1	N/A		<1.0
1,1,2,2-Tetrachloroethane	ug/L	0.5	N/A		<0.5
Tetrachloroethylene	ug/L	1	MAC=10		<1.0
Toluene	ug/L	1	AO<=24		<1.0
1,1,1-Trichloroethane	ug/L	1	N/A		<1.0
1,1,2-Trichloroethane	ug/L	1	N/A		<1.0
Trichloroethylene	ug/L	1	MAC=5		<1.0
Trichlorofluoromethane	ug/L	1	N/A		<1.0
Vinyl chloride	ug/L	1	MAC=2		<1.0
Xylenes (total)	ug/L	2	AO<=20		<2.0
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 19: CARO Haloacetic Acid (HAA) Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Feb-19			
Sampling Sites				Site 1	Site 2	Site 3	Site 4
Monochloroacetic Acid	mg/L	0.002	N/A	0.0071	< 0.0020	< 0.0020	< 0.0020
Monobromoacetic Acid	mg/L	0.002	N/A	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Dichloroacetic Acid	mg/L	0.002	N/A	0.0135	0.0106	0.0097	0.0184
Trichloroacetic Acid	mg/L	0.002	N/A	0.0198	0.0148	0.0124	0.0243
Dibromoacetic Acid	mg/L	0.002	N/A	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Total Haloacetic Acids (HAA5)	mg/L	0.020	MAC = 0.08	0.0404	0.0254	0.0221	0.0427

MAC = Maximum Acceptable Concentration AO = Aesthetic objective