2020

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

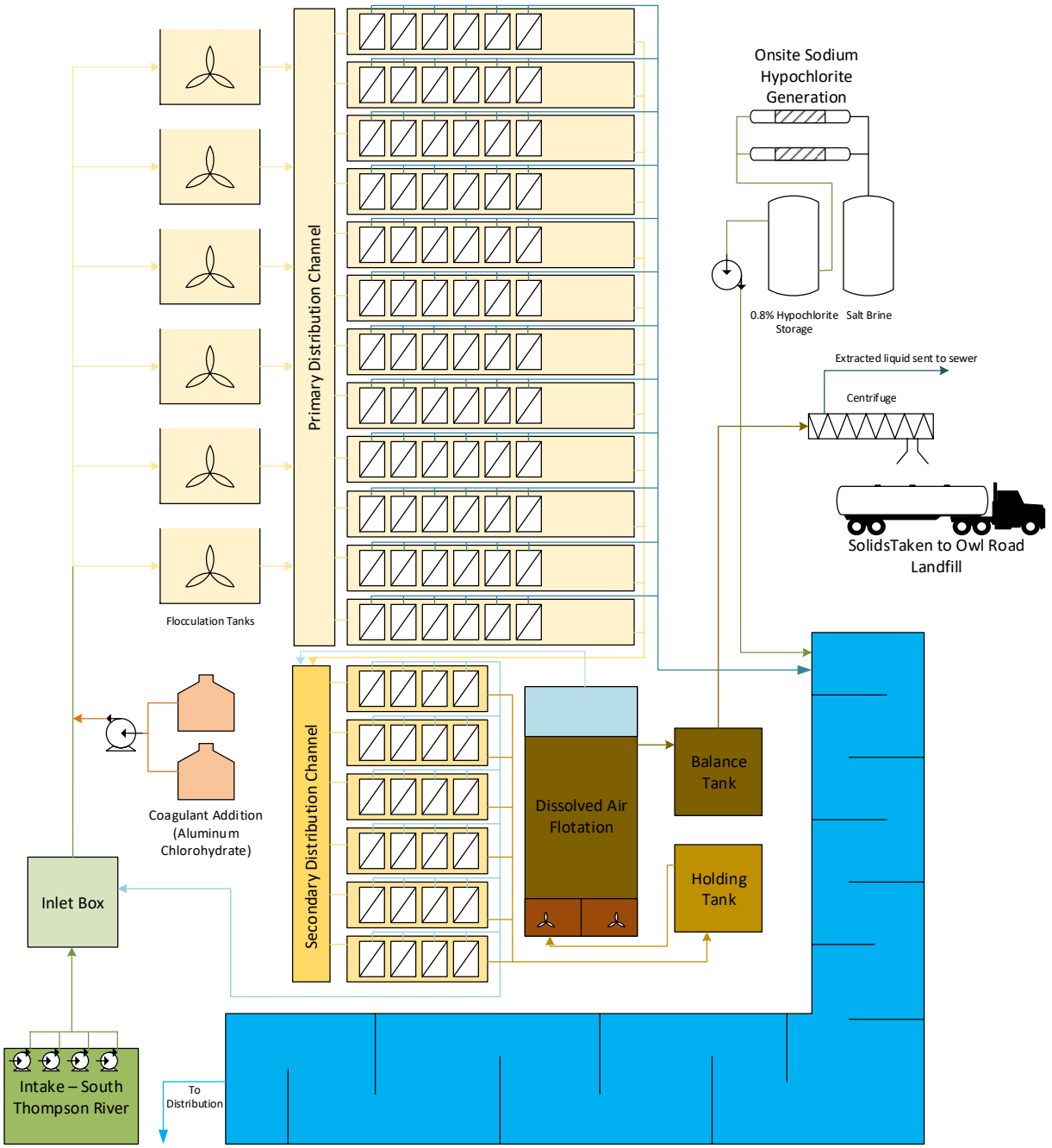
The City's drinking water system consists of a single treatment plant, which feeds an extensive distribution system that supplies water throughout the community. The only large community that is not fed from the central system is the Rayleigh Waterworks District, which has its own system supplied from 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


Onsite Sodium Hypochlorite Generation
0.8% Hypochlorite Storage
Salt Brine
Extracted liquid sent to sewer
Centrifuge
SolidsTaken to Owl Road Landfill
Primary Distribution Channel
Flocculation Tanks
Secondary Distribution Channel
Coagulant Addition (Aluminum Chlorohydrate)
Dissolved Air Flotation
Balance Tank
Holding Tank
Inlet Box
Intake – South Thompson River
To Distribution

2.1.1 *KCWQ Production Totals*

Overall water use in Kamloops seems to be stabilizing after the installation of water meters finished in 2017. In 2020, the single-day peak production was still down over 10% from the 10-year average while the total production was the **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		
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average	Minimum	Maximum
January	1,028,342	1,004,683	997,845	998,516	998,859	999,352	936,100	916,086	899,134	950,250	972,917	899,134	1,028,342
February	920,659	912,473	870,821	903,897	875,057	876,222	823,798	809,346	853,167	894,331	873,977	809,346	920,659
March	1,112,117	1,000,423	1,013,585	1,001,555	1,001,061	991,862	893,219	912,847	955,490	931,501	981,366	893,219	1,112,117
April	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	1,153,929	1,212,903	982,158	1,519,266
May	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	1,854,085	2,049,602	1,576,441	2,405,924
June	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	1,664,238	2,305,992	1,664,238	2,633,979
July	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	2,216,536	2,841,345	2,216,536	3,424,556
August	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	2,623,550	2,853,645	2,445,042	3,430,008
September	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	2,046,294	1,942,619	1,470,836	2,629,657
October	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	1,121,312	1,177,801	1,026,683	1,383,194
November	991,751	999,703	1,114,296	996,238	976,284	958,048	899,987	905,669	953,635	917,608	971,322	899,987	1,114,296
December	1,003,279	1,011,471	1,005,151	1,006,889	989,458	978,535	919,666	920,749	971,695	935,748	974,264	919,666	1,011,471
Total	20,991,210	20,517,881	20,464,199	19,242,241	19,724,768	18,607,531	18,995,323	17,656,123	18,068,883	17,309,382	19,157,754	17,309,382	20,991,210
Daily Peak	127,032	117,905	124,608	121,608	106,999	99,564	117,078	106,218	102,470	97,460	112,094	97,460	127,032
Peak Date	06-Jul	08-Aug	25-Jul	16-Jul	28-Jun	19-Aug	03-Jul	18-Jul	08-Aug	04-Aug			
Daily Low	29,180	29,794	29,094	28,771	28,603	29,330	15,394	29,330	27,073	14,659	26,123	14,659	29,794
Daily Average	57,510	56,060	56,066	52,718	54,040	50,840	52,037	48,373	49,504	45,913	52,306	45,913	57,510

These monthly numbers are shown in Figure 3. Total consumption for 2020 was close to two billion L less than the 10-year average. The overall production was the lowest we have recorded, which could be representative of a new baseline production level.

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

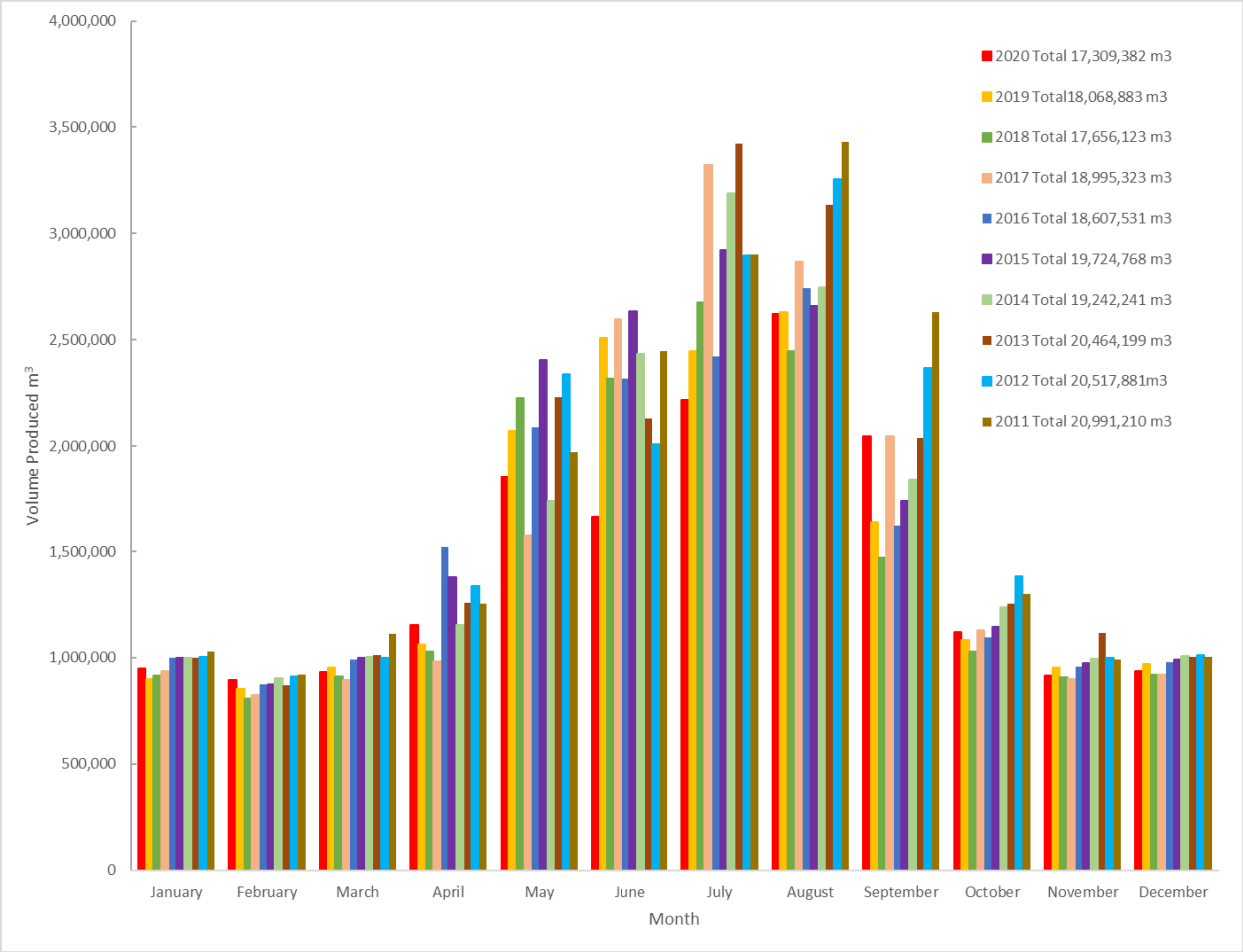
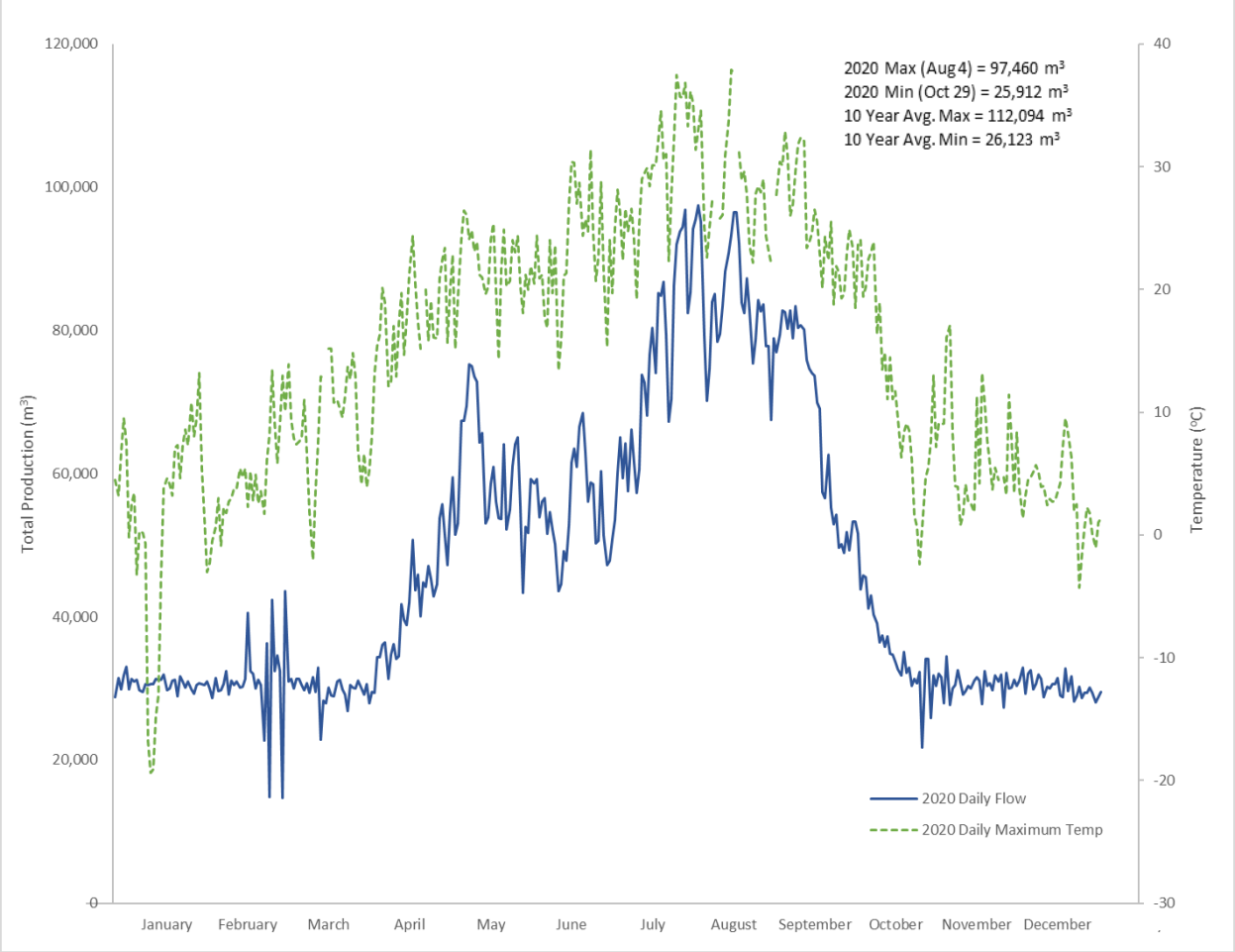


Figure 4 shows the daily water consumption for 2020 with an overlay of the maximum daily temperature. The daily peak for 2020 was 97.46 million L, which happened on August 4 and was the lowest summer maximum peak since the plant was built. The KCWQ can achieve a maximum daily flow of 160 million L, which allows room for population growth well into the future. The highest single-day production at KCWQ happened on August 28, 2006, when the KCWQ treated 149.14 million L.

Figure 4: KCWQ Daily Water Flows for 2020 With Daily Average Temperature Overlay



2.2 Water Conservation

The total usage was nearly two billion L below the 10-year average. Overall monthly water consumption was below the 10-year average recorded, with September being the only exception. This led to the overall lowest annual water usage. 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 over 632.4 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 2020 calendar year.

2.3.1 *Booster Stations and Reservoirs*

In 2020, 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.

Many water pumping stations throughout the system were upgraded to radio communications (highlighted in section 3.2), which resulted in savings and a more reliable form of communication.

2.3.2 *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	176.432	27.90	-0.71
CI - Cast Iron	36.3	5.74	-0.38
CU - Copper	0.854	0.14	-1.76
DI - Ductile Iron	103.225	16.32	-0.47
GI - Galvanized Iron	0.276	0.04	0.00
HYP - High Pressure Concrete	17.321	2.74	0.00
PLY - Polyethylene	1.988	0.31	21.88
PVC - Polyvinyl Chloride	285.322	45.11	0.75
STL - Steel	10.726	1.70	-1.26
Total	632.444	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.

In 2020, the City continued work to improve asset management for the water system. Staff are working to identify future needs based on criticality, life expectancy, condition, and capacity.

2.4 Cross-Connection Program

The City is developing an enhanced Cross-Connection Control Program, in compliance with 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 developing a bylaw and accompanying program to protect our drinking water.

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.

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.

2.5 EOCP Certified Operators

The City has a full complement of staff to assure the safe treatment and distribution of potable water throughout the City of Kamloops.

Staffing levels for EOCP-certified water/treatment/distribution operators are as follows:

Certification	Level	Number of Certified Operators
Water Treatment	I	0
Water Treatment	II	1
Water Treatment	III	2
Water Treatment	IV	2
Water Distribution	I	12
Water Distribution	II	14
Water Distribution	III	3
Water Distribution	IV	2

3.0 2020 HIGHLIGHTS, FUTURE PROJECTS, AND SERVICE REQUEST SUMMARIES

The following sections will highlight some of the major projects and challenges that arose throughout the 2020 operating year.

3.1 KCWQ Highlights, Projects, and Challenges

The following is a list of some of the major projects completed at KCWQ in 2020:

- major overhaul of intake facility and new drives with SCADA interface for optimal pump speed control and redundancy
- primary channel separation project completed
- new drives and ethernet replaced devicenet control for all motors and pumps as equipment ages out for more reliable communication and operation; project ongoing

One of the greatest challenges faced at KCWQ was adapting to the COVID-19 pandemic. The City took extreme measures to protect its operators and limit access to one of the City's most critical buildings. Access to the facility was restricted to essential workers only as a means of protecting staff and the water supply.

3.2 Distribution Highlights

In 2020, 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.

As part of our asset management efforts, the City's in-house utility construction crew installed new water services on Gleneagles Drive from Glenesk Place to Glenshee Place. The construction crew was shut down for most of the season as capital projects were halted due to the pandemic.

- Greystone Crescent (from Garymede Drive to Van Horne Drive) – new water services
- Gleneagles Drive (from Glenesk Place to Glenshee Place) – new water services

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

- Dallas Drive - new main
- Valleyview - new water reservoir
- Tranquille Road sewer main project - water infrastructure renewals

3.2.1 *Requests for Service*

In 2020, there were a total of 2,765 requests for service filed with the Civic Operations Department related to water distribution and treatment. Figure 7 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 2019	2020
Booster Stations	6	8
Cross Connection Control	16	17
Frozen Services	2	4
General	131	89
Hydrants	65	44
Irrigation On/Off	18	15
No Water	91	63
Reservoirs	3	9
Service Boxes	79	76
Service Location	130	102
Turn Service On/Off	630	533
Water Filling Station	23	20
Water Leak	274	175
Water Meters	1498	1469
Water Pressure	81	65
Water Quality	58	61
Water Restrictions	1	15
Totals	3,106	2,765

Service Leaks and Main Breaks

Service Leaks	51
Main Breaks	9

4.0 WATER QUALITY SAMPLING AND ANALYSIS

The City's Water Quality Monitoring Program (WQMP) incorporates principles from the Guidelines for Canadian Drinking Water Quality (GCDWQ) and BC's 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 8, 9, and 10 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 CaCO3 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 (Pt Co Units)	Apparent Colour (Pt Co 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 (^{O}C)
January	4	12	7.81	42	40	40.2	76.2	5.0	2.57	ND	2.3
February	4	17	7.81	44	41	44.7	84.8	4.0	3.53	ND	3.0
March	4	17	7.85	45	43	46.3	87.3	3.8	2.59	ND	4.8
April	6	32	8.03	49	47	51.4	97.4	6.4	3.55	ND	8.2
May	7	52	7.92	45	43	46.3	87.9	11.1	7.21	ND	10.9
June	4	23	7.81	41	39	42.7	81.1	5.1	3.14	ND	12.5
July	6	18	7.72	39	39	42.4	80.4	3.2	2.45	ND	15.9
August	6	22	7.81	39	38	41.7	79.3	3.3	2.68	ND	19.0
September	5	15	7.87	41	41	43.0	81.7	2.1	1.97	ND	18.7
October	4	13	7.86	42	41	42.9	81.5	1.6	1.68	ND	13.5
November	5	11	7.82	42	41	41.5	78.7	1.8	1.44	ND	7.5
December	4	13	7.78	42	41	41.4	78.8	2.0	1.68	ND	5.3
Min	4	11	7.72	39	38	40.2	76.2	1.6	1.44	ND	2.3
Max	7	52	8.03	49	47	51.4	97.4	11.1	7.21	ND	19.0
Average	5	20	7.84	42	41	43.7	82.9	4.1	2.87	ND	10.1

*ND refers to Non-Detectable Limit

Figure 8: KCWQ Average Monthly Treated Water Analysis

Month	True Colour (Pt Co Units)	Apparent Colour (Pt Co 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 (^{O}C)	Free Chlorine (mg/L)	Total Chlorine (mg/L)
January	ND	ND	7.90	42	40	45.2	87.5	0.013	ND	5.1	1.35	1.45
February	ND	ND	7.90	44	41	51.0	96.7	0.014	0.013	4.9	1.33	1.41
March	ND	ND	7.94	45	44	53.1	100.5	0.014	0.015	6.3	1.33	1.42
April	2	3	8.08	49	47	57.7	109.2	0.015	ND	9.2	1.34	1.44
May	2	2	8.03	44	43	53.3	100.9	0.014	ND	11.8	1.35	1.48
June	2	2	7.92	41	40	49.6	93.9	0.013	ND	13.0	1.33	1.42
July	2	2	7.86	39	39	49.4	94.0	0.014	ND	16.2	1.34	1.42
August	2	2	7.98	39	38	48.5	91.9	0.014	0.006	19.3	1.33	1.45
September	2	2	8.05	41	40	50.4	95.6	0.012	0.007	18.8	1.87	1.52
October	2	2	8.02	42	42	50.5	95.7	0.015	ND	14.2	1.38	1.48
November	2	2	7.98	42	41	49.9	94.7	0.014	ND	8.3	1.46	1.51
December	2	2	7.95	42	41	50.5	95.8	0.016	ND	6.0	1.33	1.44
Min	ND	ND	7.86	39	38	45.2	87.5	0.012	ND	4.9	1.33	1.41
Max	2	3	8.08	49	47	57.7	109.2	0.016	0.015	19.3	1.87	1.52
Average	2	2	7.97	42	41	50.8	96.4	0.014	0.010	11.1	1.39	1.45

*ND refers to Non-Detectable Limit

Figure 9: KCWQ Average Monthly Distribution Water Analysis

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)	Temp (°C)	Free Cl2 (mg/L)	Total Cl2 (mg/L)
January	418 Booster	ND	ND	7.96	43	41	47.4	89.9	0.06	5.67	1.07	1.2
	Booster #4 SW	ND	ND	8.04	42	40	48.3	91.6	0.11	6.40	1.00	1.1
	Cinnamon Ridge	ND	ND	7.92	43	41	46.6	86.0	0.08	8.45	0.57	0.7
	Knutsford	ND	ND	7.90	42	41	46.5	88.2	0.11	8.93	0.82	0.9
	Juniper #3	ND	ND	8.12	42	40	49.2	93.1	0.10	7.38	0.79	0.9
	Memorial	ND	ND	7.93	42	41	46.2	87.6	0.13	6.30	1.11	1.2
	Noble Creek	ND	ND	8.21	42	41	49.7	94.2	0.06	11.23	1.03	1.1
February	418 Booster	ND	ND	7.91	44	41	52.9	100.1	0.30	4.50	1.03	1.1
	Booster #4 SW	ND	ND	7.94	44	42	51.7	97.9	0.22	3.53	1.02	1.1
	Cinnamon Ridge	ND	ND	7.85	43	41	51.7	98.0	0.14	7.30	0.65	0.8
	Knutsford	ND	ND	7.91	44	41	52.8	99.9	0.10	14.28	0.64	0.8
	Juniper #3	ND	ND	8.03	44	41	51.6	97.7	0.12	6.70	0.92	1.0
	Memorial	ND	ND	7.97	44	42	50.8	96.2	0.13	3.77	1.06	1.2
	Noble Creek	ND	ND	8.08	44	43	52.7	99.8	0.10	9.55	0.86	1.0
March	418 Booster	ND	ND	8.05	45	44	54.3	102.9	0.08	5.60	1.03	1.1
	Booster #4 SW	ND	ND	7.97	45	43	53.6	101.5	0.26	6.23	0.90	1.0
	Cinnamon Ridge	ND	ND	7.89	45	43	52.7	99.9	0.12	6.28	0.63	0.7
	Knutsford	ND	ND	7.98	45	44	54.0	102.3	0.12	9.42	0.75	0.9
	Juniper #3	ND	ND	7.98	45	43	53.5	101.4	0.14	6.13	0.82	0.9
	Memorial	ND	ND	7.92	44	42	53.6	102.2	0.14	5.91	1.01	1.1
	Noble Creek	ND	ND	8.19	45	43	56.3	106.5	0.09	6.00	0.95	1.0
April	418 Booster	ND	4.0	8.08	49	48	57.4	108.6	0.09	8.88	0.96	1.1
	Booster #4 SW	ND	2	8.06	48	47	56.5	106.9	0.26	6.08	0.76	0.8
	Cinnamon Ridge	ND	ND	8.00	48	47	55.5	105.2	0.08	12.10	0.51	0.6
	Knutsford	1	1	8.00	49	48	57.5	106.4	0.10	7.28	0.60	0.7
	Juniper #3	1.0	1.0	8.11	48	47	56.0	105.9	0.08	7.63	0.87	1.0
	Memorial	ND	3	8.05	49	48	56.6	107.1	0.36	8.42	0.87	1.0
	Noble Creek	ND	ND	8.18	40	47	56.9	107.7	0.12	8.72	0.87	1.0
May	418 Booster	ND	ND	8.06	46	44	54.0	102.3	0.10	8.45	0.99	1.1
	Booster #4 SW	ND	ND	8.08	45	44	53.2	102.2	0.13	10.16	0.74	0.8
	Cinnamon Ridge	ND	ND	8.01	45	44	54.2	102.7	0.07	6.08	0.18	0.3
	Knutsford	ND	ND	8.06	46	45	53.1	100.7	0.10	5.50	0.65	0.8
	Juniper #3	ND	ND	8.09	46	44	54.3	102.9	0.12	8.52	0.69	0.8
	Memorial	1	1	8.04	45	44	51.9	98.4	0.15	7.88	0.92	1.0
	Noble Creek	1	1	8.21	46	44	56.0	106.3	0.10	9.70	0.63	0.7
June	418 Booster	ND	ND	7.99	41	40	50.5	95.8	0.10	10.77	0.87	1.0
	Booster #4 SW	1	1	8.01	41	40	47.4	90.1	0.14	10.75	0.86	0.9
	Cinnamon Ridge	ND	ND	7.88	41	40	48.4	93.3	0.10	11.95	0.38	0.4
	Knutsford	2	2	7.92	40	39	48.2	91.5	0.09	12.08	0.65	0.7
	Juniper #3	1	1	7.96	41	40	49.6	94.0	0.11	10.30	0.71	0.8
	Memorial	1	2	7.94	41	40	48.6	92.2	0.12	11.88	0.89	1.0
	Noble Creek	ND	ND	8.08	42	40	50.5	95.8	0.09	14.40	0.72	0.8
July	418 Booster	ND	ND	7.91	40	39	47.6	90.3	0.12	14.75	0.96	1.1
	Booster #4 SW	3	4	7.89	40	39	48.1	91.3	0.34	15.76	0.67	0.8
	Cinnamon Ridge	ND	ND	7.88	40	39	48.7	92.3	0.12	13.93	0.11	0.2
	Knutsford	ND	ND	7.88	40	39	49.7	94.2	0.14	17.13	0.40	0.5
	Juniper #3	ND	ND	7.94	40	39	49.2	93.2	0.12	13.05	0.47	0.6
	Memorial	ND	4	7.92	39	39	46.9	88.9	0.14	14.94	0.95	1.0
	Noble Creek	ND	ND	8.11	40	40	50.5	95.5	0.09	19.13	0.55	0.6
August	418 Booster	ND	ND	7.95	39	38	46.1	87.5	0.12	18.25	1.07	1.2
	Booster #4 SW	1	10	8.06	39	38	45.5	86.3	0.72	18.75	0.70	0.8
	Cinnamon Ridge	1	1	7.87	39	39	44.3	84.1	0.26	15.98	0.17	0.2
	Knutsford	1	1	7.96	39	39	43.8	83.2	0.09	18.53	0.76	0.9
	Juniper #3	ND	ND	7.99	39	38	46.3	87.9	0.09	15.83	0.53	0.6
	Memorial	ND	ND	8.02	39	38	46.3	87.8	0.34	18.03	0.73	0.8
	Noble Creek	ND	ND	8.06	39	39	48.8	92.6	0.12	19.98	0.45	0.5
September	418 Booster	ND	ND	8.02	41	41	48.7	92.3	0.13	17.68	0.77	0.9
	Booster #4 SW	3	3	8.06	41	41	48.7	92.3	0.09	18.43	0.89	1.0
	Cinnamon Ridge	ND	ND	7.96	40	40	48.1	91.2	0.13	15.35	0.14	0.2
	Knutsford	ND	ND	8.06	41	41	49.9	94.6	0.11	18.03	0.85	1.0
	Juniper #3	ND	ND	8.05	41	41	49.6	94.1	0.11	15.13	0.48	0.6
	Memorial	ND	ND	8.05	41	41	47.6	90.3	0.10	18.48	1.05	1.1
	Noble Creek	2	3	8.18	41	41	49.5	93.9	0.08	19.74	0.47	0.5
October	418 Booster	ND	ND	8.07	42	42	50.3	95.4	0.10	15.15	0.76	0.8
	Booster #4 SW	ND	ND	8.13	43	42	49.3	93.5	0.11	14.22	0.69	0.8
	Cinnamon Ridge	ND	ND	8.01	43	42	49.3	93.6	0.08	14.27	0.17	0.3
	Knutsford	ND	ND	7.93	42	41	50.0	94.8	0.15	15.15	0.60	0.7
	Juniper #3	ND	ND	8.09	42	41	49.1	93.2	0.25	14.10	0.43	0.5
	Memorial	ND	ND	7.99	42	42	49.7	94.2	0.11	14.12	0.97	1.1
	Noble Creek	1	2	8.30	43	43	52.4	99.2	0.10	16.90	0.35	0.4
November	418 Booster	ND	ND	7.97	42	42	52.7	97.5	0.14	9.28	0.93	1.0
	Booster #4 SW	ND	ND	8.08	42	42	52.9	94.2	0.08	8.98	0.86	1.0
	Cinnamon Ridge	ND	ND	7.85	42	42	51.7	97.9	0.20	11.43	0.01	0.0
	Knutsford	ND	ND	7.95	43	41	51.0	96.7	0.09	13.14	0.44	0.5
	Juniper #3	ND	ND	8.13	43	42	51.8	100.1	0.35	11.00	0.24	0.3
	Memorial	ND	ND	8.00	42	42	50.2	95.6	0.24	7.38	1.16	1.3
	Noble Creek	ND	ND	8.32	42	42	50.7	100.7	0.10	11.90	0.59	0.7
December	418 Booster	ND	ND	7.99	42	41	53.2	100.6	0.14	7.08	1.03	1.1
	Booster #4 SW	ND	ND	8.00	43	41	51.1	96.9	0.21	7.13	0.94	1.0
	Cinnamon Ridge	ND	ND	7.95	42	41	50.8	96.3	0.09	9.18	0.03	0.1
	Knutsford	ND	ND	7.99	42	41	51.9	98.3	0.10	10.00	0.88	1.0
	Juniper #3	ND	ND	8.09	43	41	52.4	322.2	0.20	8.40	0.51	0.6
	Memorial	ND	ND	7.96	42	41	53.4	101.1	0.30	6.88	1.06	1.2
	Noble Creek	ND	ND	8.25	42	42	54.2	102.7	0.11	9.76	0.73	0.8
Min		ND	ND	7.85	38.50	38.20	43.80	83.20	0.06	3.53	0.01	0.05
Max		3	10	8.32	49.33	48.00	57.45	322.23	0.72	19.98	1.16	1.26
Average		ND	ND	8.02	42.57	41.59	50.88	99.06	0.14	11.18	0.72	0.81

*ND refers to Non-Detectable Limit

4.3 Distribution Sampling

The City is committed to providing safe drinking water 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 (MAC), 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 2020 distribution system can be seen in Figure 10.

Figure 10: 2020 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
02/01/2020					
06/01/2020	23	1			Background count of 1
13/01/2020	23	0			
20/01/2020	23	0			
27/01/2020	23	0			
03/02/2020	23	0			
10/02/2020	23	0			
17/02/2020	23	0			
24/02/2020	23	0			
02/03/2020	23	0			
09/03/2020	23	0			
16/03/2020	23	0			
23/03/2020	23	0			
30/03/2020	23	0			
06/04/2020	23	0			
13/04/2020	23	0			
20/04/2020	23	0			
27/04/2020	23	0			
04/05/2020	23	0			
11/05/2020	23	0			
18/05/2020	23	1			Background count of 1
25/05/2020	24	0			
01/06/2020	23	0			
08/06/2020	23	0			
15/06/2020	23	1			Background count of 1
22/06/2020	23	0			
29/06/2020	24	1			Background count of 1
06/07/2020	25	1			Background count of 1
13/07/2020	24	2			Background count of 2
20/07/2020	24	1			Background count of 1
27/07/2020	24	13			Background count of 13
03/08/2020	24	0			
10/08/2020	24	1			Background count of 1
17/08/2020	24	1			Background count of 1
24/08/2020	24	0			
31/08/2020	24	0			
07/09/2020	24	2			Background count of 2
14/09/2020	24	0			
21/09/2020	24	2			Background count of 2
28/09/2020	24	0			
05/10/2020	24	0			
12/10/2020	24	0			
19/10/2020	23	0			
26/10/2020	23	0			
02/11/2020	23	1			Background count of 1
09/11/2020	23	1			Background count of 1
16/11/2020	23	0			
23/11/2020	23	0			
30/11/2020	23	1			Background count of 1
07/12/2020	23	0			
Totals	1145	30	0	0	

There were a total of 30 positive results for background 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 12 through 20. 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 (May 12, 2020)	Memorial (May 12, 2020)
Bromide	mg/L	0.1	N/A	<0.10	
Chloride	mg/L	0.1	AO<=250	1.22	5.43
Fluoride	mg/L	0.1	MAC=1.5		<0.10
Nitrate as N	mg/L	0.01	MAC=10	0.03	0.016
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	7.9	8
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 12: CARO General Parameters Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 12, 2020)	Memorial (May 12, 2020)
Colour, True	CU	5	AO<=15	12	5.1
Alkalinity, Total (as CaCO3)	mg/L	2	N/A	55.9	53.6
Alkalinity, Phenolphthalein (as CaCO3)	mg/L	2	N/A	<1.0	<1.0
Alkalinity, Bicarbonate (as CaCO3)	mg/L	2	N/A	55.9	53.6
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	<0.050	
BOD, 5-day	mg/L	2	N/A	<6.2	
Carbon, Total Organic	mg/L	0.5	N/A	3.4	2.19
Carbon, Dissolved Organic	mg/L	0.5	N/A	3.38	
Cyanide, Total	mg/L	0.002	MAC=0.2		<0.0020
Nitrogen, Total Kjeldahl	mg/L	0.05	N/A	0.233	0.097
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	109	109
Sulfide, Total	mg/L	0.05	AO<=0.05		<0.020
Turbidity	NTU	0.1	OG<0.1	2.27	<0.10
Conductivity (EC)	uS/cm	2	N/A	113	127
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 13: CARO Calculated Parameters

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 12, 2020)	Memorial (May 12, 2020)
Hardness, Total (Total as CaCO3)	mg/L	0.5	N/A	49.3	49.9
Nitrate+Nitrite as N	mg/L	0.02	N/A	<0.020	0.0297
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective		

Figure 14: CARO Dissolved Metals Analysis

Analyte	Units	Method Detection Limit	Drinking Water Guidline Level	Raw (May 12, 2020)	Memorial (May 12, 2020)
Aluminum, dissolved	mg/L	0.005	N/A	0.00569	0.0056
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	0.0111	0.0115
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	0.021	0.0157
Cadmium, dissolved	mg/L	0.00001	N/A	<0.000010	<0.000010
Calcium, dissolved	mg/L	0.2	N/A	14.7	14.2
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	0.00234	0.00139
Iron, dissolved	mg/L	0.01	N/A	0.018	<0.010
Lead, dissolved	mg/L	0.0001	N/A	<0.00020	<0.00020
Lithium, dissolved	mg/L	0.0001	N/A	0.0009	0.00095
Magnesium, dissolved	mg/L	0.01	N/A	3.03	3.47
Manganese, dissolved	mg/L	0.0002	MAC=0.12 mg/L	0.00056	0.00087
Mercury, dissolved	mg/L	0.00001	N/A	<0.000010	<0.000010
Molybdenum, dissolved	mg/L	0.0001	N/A	0.00085	0.00078
Nickel, dissolved	mg/L	0.0002	N/A	0.00241	0.00041
Phosphorus, dissolved	mg/L	0.02	N/A	<0.050	<0.050
Potassium, dissolved	mg/L	0.02	N/A	1.06	1.11
Selenium, dissolved	mg/L	0.0005	N/A	<0.00050	<0.00050
Silicon, dissolved	mg/L	0.5	N/A	3.6	4
Silver, dissolved	mg/L	0.00005	N/A	<0.000050	<0.000050
Sodium, dissolved	mg/L	0.02	N/A	5.94	3.01
Strontium, dissolved	mg/L	0.001	N/A	0.11	0.116
Sulfur, dissolved	mg/L	1	N/A	<3.0	<3.0
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	0.000213	0.000382
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 (May 12, 2020)	Memorial (May 12, 2020)
Aluminum, total	mg/L	0.005	OG<0.1	0.074	0.0068
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	0.0129	0.0113
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	0.0312	0.0381
Cadmium, total	mg/L	0.00001	MAC=0.005	<0.000010	<0.000010
Calcium, total	mg/L	0.2	None Required	15	15.1
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	0.011	0.00219
Iron, total	mg/L	0.01	AO<=0.3	0.11	<0.010
Lead, total	mg/L	0.0002	MAC=0.01	0.00067	<0.00020
Lithium, total	mg/L	0.0001	N/A	0.00116	0.00099
Magnesium, total	mg/L	0.01	None Required	3.62	3.09
Manganese, total	mg/L	0.0002	AO<=0.02	0.00866	0.00098
Mercury, total	mg/L	0.00001	MAC=0.001	<0.000010	<0.000010
Molybdenum, total	mg/L	0.0001	N/A	0.00074	0.00078
Nickel, total	mg/L	0.0004	N/A	0.00061	<0.00040
Phosphorus, total	mg/L	0.05	N/A	<0.050	<0.050
Potassium, total	mg/L	0.1	N/A	1.23	1.15
Selenium, total	mg/L	0.0005	MAC=0.05	<0.00050	<0.00050
Silicon, total	mg/L	1	N/A	4.3	3.9
Silver, total	mg/L	0.00005	None Required	<0.000050	<0.000050
Sodium, total	mg/L	0.1	AO<=200	3.22	6.08
Strontium, total	mg/L	0.001	N/A	0.119	0.11
Sulfur, total	mg/L	3	N/A	<3.0	<3.0
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	0.00041	0.000213
Vanadium, total	mg/L	0.001	N/A	<0.0010	<0.0010
Zinc, total	mg/L	0.004	AO<=5	<0.0040	0.0041
Zirconium, total	mg/L	0.0001	N/A	0.00019	<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 (May 12, 2020)	Memorial (May 12, 2020)
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 (May 12, 2020)	Memorial (May 12, 2020)
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 (May 12, 2020)	Memorial (May 12, 2020)
Benzene	ug/L	0.5	MAC=5		<0.5
Bromodichloromethane	ug/L	1	N/A		4.3
Bromoform	ug/L	1	N/A		8.8
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		55.3
Dibromochloromethane	ug/L	1	N/A		2.7
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	May-20			
Sampling Sites				Site 1	Site 2	Site 3	Site 4
Monochloroacetic Acid	mg/L	0.002	N/A	< 0.0020	< 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	0.016	0.0235	0.0137	0.0221
Trichloroacetic Acid	mg/L	0.002	N/A	0.0291	0.0324	0.0201	0.0304
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	0.0451	0.0559	0.0338	0.0525
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective				

5.0 SMALL WATER SYSTEMS

The City owns and operates two small water systems in areas that the distribution system does not reach. One of those systems is at the Tournament Capital Ranch in Rayleigh, and the other is a reverse osmosis system for the KSTC administration building.

5.1 Tournament Capital Ranch Water System

In this water system's current configuration, treated, chlorinated drinking water is trucked to the Tournament Capital Ranch potable water system and stored in a cistern. The cistern supplies the washroom/concession building and the outdoor fountains/taps with potable water. The drinking water storage cistern has a capacity of approximately 38,000 L and is maintained and consistently monitored when in use. During the winter months, there is a risk of freezing; therefore, the system is drained and winterized every fall. Due to the start of the pandemic in 2020, the Tournament Capital Ranch was not in use until later in the year than usual and only required potable water from late June until mid-October.

Microbial water sampling occurs weekly, and the 2020 results are listed below. Chlorine residual sampling occurs regularly when the system is in use.

5.1.1 *Microbial Water Sampling Results*

400-24 Tournament Capital Ranch (0062941-24) | Matrix: Water | Sampled: 2020-06-29 10:30

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-06-30

Background Colonies < 1 N/A 1 CFU/100 mL 2020-06-30

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-06-30

100-24 Tournament Capital Ranch (0070404-24) | Matrix: Water | Sampled: 2020-07-06 08:15

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-07-07

Background Colonies **5** N/A 1 CFU/100 mL 2020-07-07

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-07-07

200-24 Tournament Capital Ranch (0071157-24) | Matrix: Water | Sampled: 2020-07-13 10:30

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-07-14

Background Colonies < 1 N/A 1 CFU/100 mL 2020-07-14

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-07-14

300-24 Tournament Capital Ranch (0071921-24) | Matrix: Water | Sampled: 2020-07-20 10:40

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-07-21

Background Colonies < 1 N/A 1 CFU/100 mL 2020-07-21

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-07-21

400-24 Tournament Capital Ranch (0072644-24) | Matrix: Water | Sampled: 2020-07-27 11:15

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-07-28

Background Colonies < 1 N/A 1 CFU/100 mL 2020-07-28

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-07-28

100-24 Tournament Capital Ranch (0080188-24) | Matrix: Water | Sampled: 2020-08-04 12:30

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-08-05

Background Colonies < 1 N/A 1 CFU/100 mL 2020-08-05

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-08-05

200-24 Tournament Capital Ranch (0080831-24) | Matrix: Water | Sampled: 2020-08-10 10:20

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-08-11

Background Colonies < 1 N/A 1 CFU/100 mL 2020-08-11

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-08-11

300-24 Tournament Capital Ranch (0081610-24) | Matrix: Water | Sampled: 2020-08-17 09:40

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-08-18

Background Colonies < 1 N/A 1 CFU/100 mL 2020-08-18

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-08-18

400-24 Tournament Capital Ranch (0082335-24) | Matrix: Water | Sampled: 2020-08-24 10:40

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-08-25

Background Colonies < 1 N/A 1 CFU/100 mL 2020-08-25

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-08-25

100-24 Tournament Capital Ranch (0090107-24) | Matrix: Water | Sampled: 2020-08-31 11:30

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-09-01

Background Colonies < 1 N/A 1 CFU/100 mL 2020-09-01

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-09-01

200-24 Tournament Capital Ranch (0090813-24) | Matrix: Water | Sampled: 2020-09-08 10:35

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-09-09

Background Colonies < 1 N/A 1 CFU/100 mL 2020-09-09

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-09-09

300-24 Tournament Capital Ranch (0091434-24) | Matrix: Water | Sampled: 2020-09-14 10:30

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-09-15

Background Colonies < 1 N/A 1 CFU/100 mL 2020-09-15

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-09-15

400-24 Tournament Capital Ranch (0092202-24) | Matrix: Water | Sampled: 2020-09-21 12:05

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-09-22

Background Colonies < 1 N/A 1 CFU/100 mL 2020-09-22

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-09-22

100-24 Tournament Capital Ranch (0109151-24) | Matrix: Water | Sampled: 2020-09-30 09:20

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-10-01

Background Colonies < 1 N/A 1 CFU/100 mL 2020-10-01

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-10-01

200-24 Tournament Capital Ranch (20J0162-24) | Matrix: Water | Sampled: 2020-10-05 09:55

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-10-06

Background Colonies < 1 N/A 1 CFU/100 mL 2020-10-06

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-10-06

300-24 Tournament Capital Ranch (20J1075-24) | Matrix: Water | Sampled: 2020-10-13 10:05

Microbiological Parameters

Coliforms, Total < 1 MAC = 0 1 CFU/100 mL 2020-10-14

Background Colonies < 1 N/A 1 CFU/100 mL 2020-10-14

E. coli < 1 MAC = 0 1 CFU/100 mL 2020-10-14

5.2 Kamloops Sewage Treatment Center Water System

The City municipal water system does not extend to KSTC. In 2014, a local water supply and treatment system was installed to provide potable water to the KSTC administration building only.

A 250 mm diameter bedrock well was constructed to a depth of 168 m and completed with a 150 mm diameter Sched 80 PVC liner slotted over the interval 87 – 147 m. The well is located north of the KSTC access road and immediately to the east of the administration building parking lot. The water treatment system is installed in the administration building mechanical room.

Water is pumped from the well through pre-treatment and softening stages before it flows through a UV and RO system. After the treatment, it is stored in a 1,590 L storage tank.

5.2.1 *In-House Testing*

Water use in 2020 was measured at 334 m^3 from January to December. This works out to a usage rate of 914 L per day, which is lower than the design level of 1,352 L per day.

The results of the 2020 in-house testing are shown in Figure 20.

Figure 20: 2020 In-House Testing of Raw and Finished Water

	No. of Samples	Temperature (°C)	pH	Conductivity (µS/cm)
RO Treated Water	38	20.6	8.7	193

The 2020 in-house testing indicated that the RO system is functioning well

5.2.2 *External Testing*

In 2020, samples of treated water were taken twice and sent to a commercial laboratory for a full analysis. The results are shown in Figure 21.

Figure 21: 2020 Average RO Treated Water Chemical and Physical Parameters

	RO Treated Water May 7, 2020	RO Treated Water October 21, 2020	Government of Canada Drinking Water Quality Guidelines
General Parameters			
pH	8.1	7.9	7.0–10.5
TSS (mg/L)	<2	<2	No guideline for drinking water
TDS (mg/L)	57	79	Aesthetic Objective: ≤ 500 mg/L
Conductivity (µS/cm)	105	121	No drinking water quality guideline
Total Hardness	9.9	9.4	No drinking water quality guideline
Turbidity	0.18	0.18	Operational Guideline: < 0.1 NTU
True Colour	<5	<5	Aesthetic Objective: ≤ 15 mg/L
Chloride	7.5	8.2	Aesthetic Objective: ≤ 250 mg/L
Fluoride	<0.10	<0.10	1.5 mg/L (max)
Sulphate	3.2	3.9	Aesthetic Objective: ≤ 500 mg/L
Sulphide	0.02	<0.02	Aesthetic Objective: ≤ 0.05 mg/L

	RO Treated Water May 7, 2020	RO Treated Water October 21, 2020	Government of Canada Drinking Water Quality Guidelines
Nutrients (ppm)			
Total Ammonia-N	<0.050	<0.050	No drinking water quality guideline
Nitrate-N	<0.010	<0.010	10 mg/L (max)
Nitrite-N	<0.010	<0.010	1 mg/L (max)
Total Phosphorus-P	0.025	0.039	No drinking water quality guideline
Bacteriological Parameters (CFU/100 mL)			
Faecal Coliforms	<1	<1	0 CFU
Total Coliforms	<1	<1	0 CFU
E. coli	<1	<1	0 CFU
Total Metals (ppm)			
Aluminum	0.0095	<0.0050	Operational Guideline: < 0.1 mg/L
Antimony	<0.00020	<0.00020	0.006 mg/L (max)
Arsenic	0.0016	0.0024	0.01 mg/L (max)
Barium	<0.0050	<0.0050	1.0 mg/L (max)
Beryllium	<0.00010	<0.00010	No drinking water quality guideline
Bismuth	<0.00010	<0.00010	No drinking water quality guideline
Boron	1.06	0.92	5 mg/L (max)
Cadmium	0.00003	0.00002	0.005 mg/L (max)
Calcium	3.78	4.13	No drinking water quality guideline
Chromium	<0.00050	<0.00050	0.05 mg/L (max)
Cobalt	<0.00010	<0.00010	No drinking water quality guideline
Copper	0.0321	0.0093	Aesthetic Objective: ≤ 1 mg/L

	RO Treated Water May 7, 2020	RO Treated Water October 21, 2020	Government of Canada Drinking Water Quality Guidelines
Iron	0.115	<0.010	Aesthetic Objective: ≤ 0.3 mg/L
Lead	<0.00020	<0.00020	0.01 mg/L (max)
Lithium	0.0009	0.00010	No drinking water quality guideline
Magnesium	0.104	0.117	No drinking water quality guideline
Manganese	0.00091	0.00135	Aesthetic Objective: ≤ 0.02 mg/L
Mercury	<0.000010	<0.000010	0.001 mg/L(max)
Molybdenum	0.0091	0.0115	No drinking water quality guideline
Nickel	<0.00040	<0.00040	No drinking water quality guideline
Potassium	0.17	<0.10	No drinking water quality guideline
Selenium	<0.00050	<0.00050	0.05 mg/L (max)
Silicon	2.9	N/A	No drinking water quality guideline
Silver	<0.000050	<0.000050	No drinking water quality guideline
Sodium	19.4	22.7	Aesthetic Objective: ≤ 200 mg/L
Strontium	0.0116	0.012	No drinking water quality guideline
Sulphur	<3.0	<3.0	No drinking water quality guideline
Tellurium	<0.00050	<0.00050	No drinking water quality guideline
Thallium	<0.000020	<0.000020	No drinking water quality guideline
Thorium	<0.00010	<0.00010	No drinking water quality guideline

	RO Treated Water May 7, 2020	RO Treated Water October 21, 2020	Government of Canada Drinking Water Quality Guidelines
Tin	<0.00020	<0.00020	No drinking water quality guideline
Titanium	<0.0050	<0.0050	No drinking water quality guideline
Uranium	<0.000020	<0.000020	0.02 mg/L (max)
Vanadium	0.0013	0.0010	No drinking water quality guideline
Zinc	<0.0040	<0.0040	Aesthetic Objective: ≤ 5 mg/L
Zirconium	<0.00010	<0.00010	No drinking water quality guideline

The RO treated water at KSTC met all drinking water quality guidelines for nitrogen, phosphorus and total metals.