2015

City of Kamloops Drinking Water Annual Report

Utilities Department

City of Kamloops

09/15/2016

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Introduction

This report was prepared in compliance with the requirements under the British Columbia Drinking Water Protection Act (DWPA) and the City of Kamloops Operating Permit. Included in this document is 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 the Interior Health Authority and posted on the City of Kamloops website.

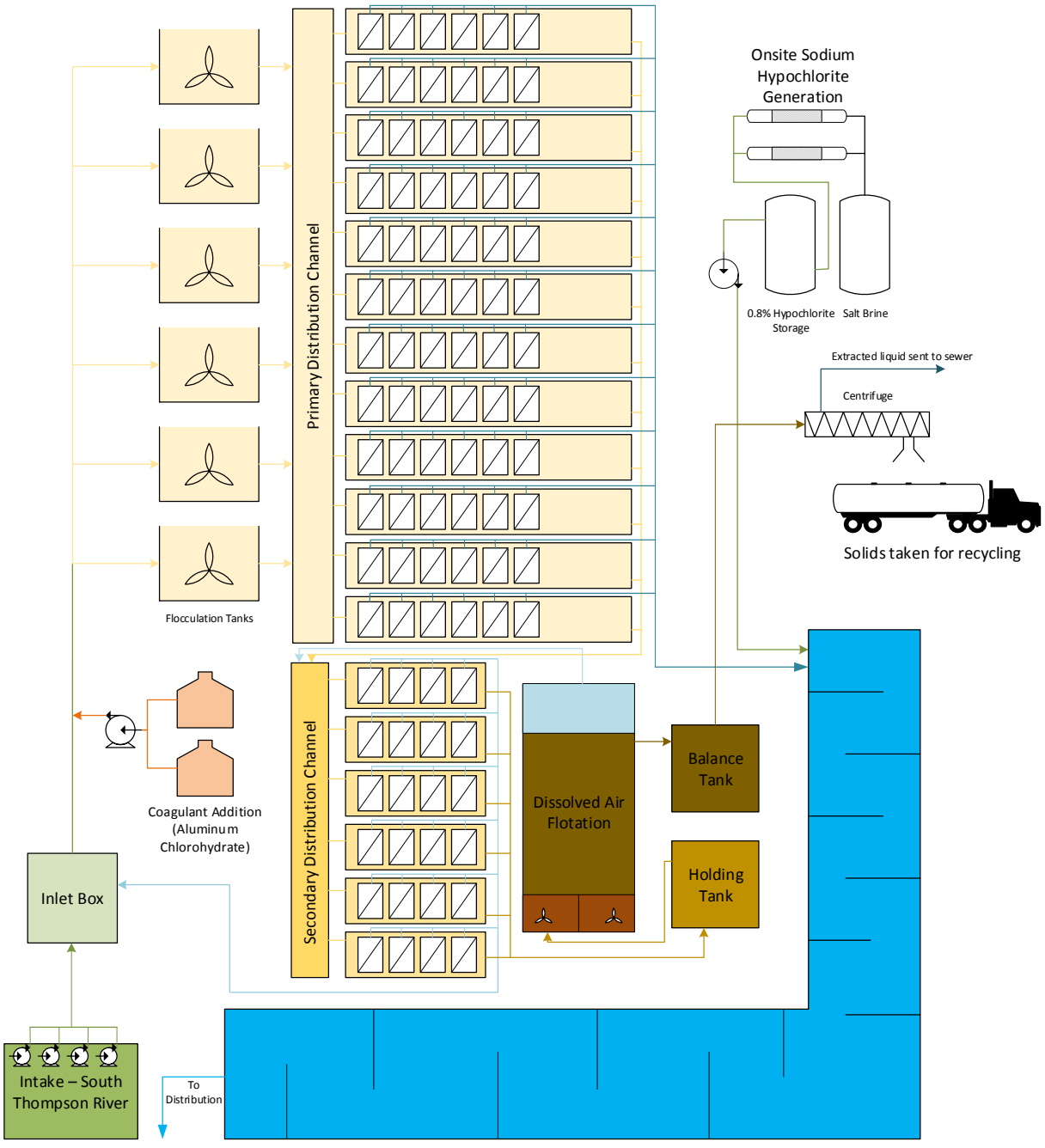
Kamloops Water System

The City of Kamloops 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 two large communities within the city limits that are not fed from the central system are Rayleigh and Heffley Creek. The City's treatment plant, called the Kamloops Centre for Water Quality (KCWQ), is a membrane treatment facility with chlorination of the finished water to ensure safety of the water throughout the distribution system. Both the Water Treatment and Distribution systems are designated Class IV systems and require highly qualified and certified operational staff.

Kamloops Centre for Water Quality (KCWQ)

The KCWQ treats water from the South Thompson River and supplies most of the Kamloops population excluding areas like Rayleigh. The facility is a GE ZeeWeed 500d series ultrafiltration membrane water treatment facility capable of producing 160 MLD. The building is certified by Leaders in Environmental and Energy Design (LEED) as a gold standard green building and the processes within reflect that. Of the water taken into the facility 99.99 % is used to produce drinking water and all of the solids removed are sent to LaFargeHolcim Canada Ltd. for use in manufacturing cement. A Layout of this facility and the accompanying process can be seen in Figure 1.

Figure 1: The Kamloops Centre for Water Quality Plant Processes



KCWQ Production Totals

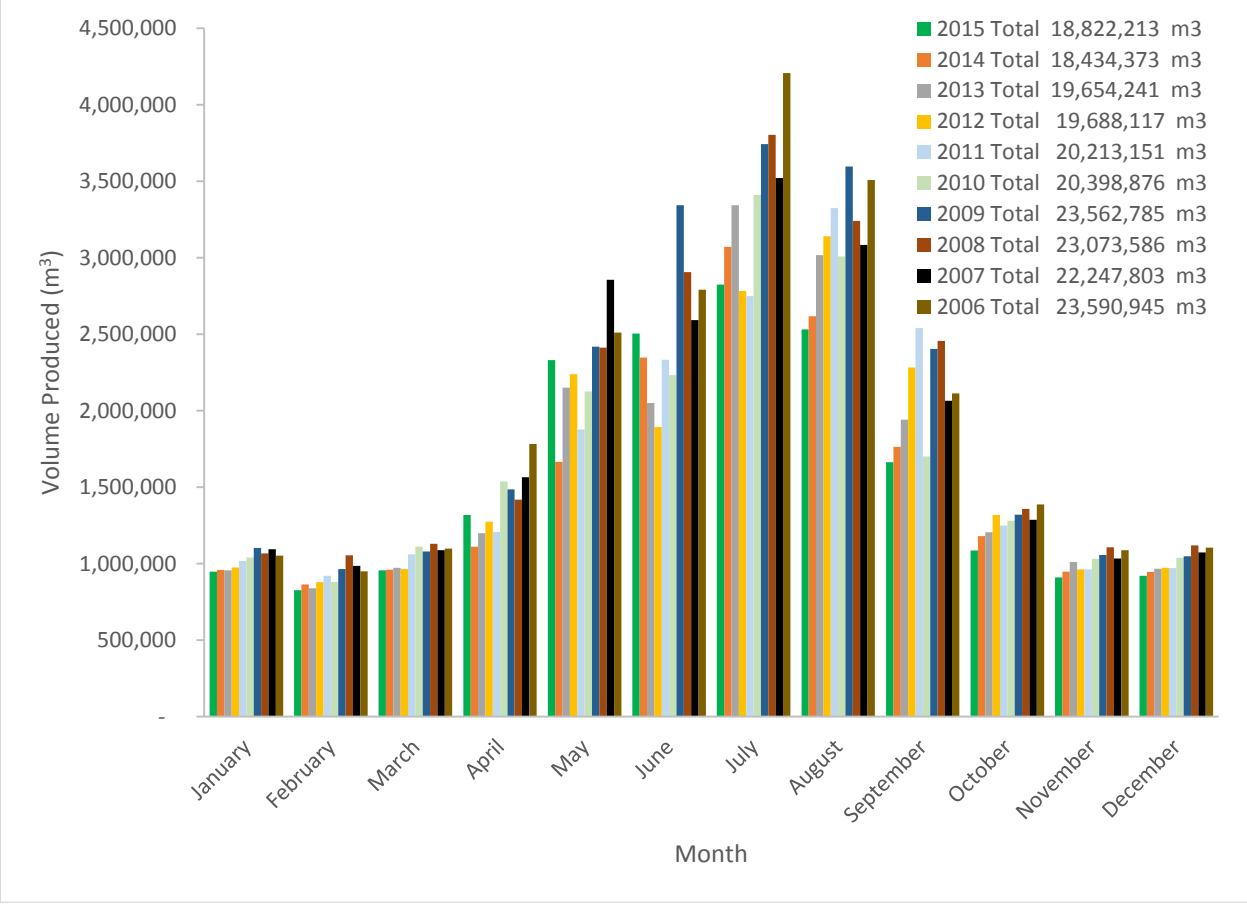
There has been a decrease in water consumption over past 10 years which can be directly linked to public education and the phasing in of water meters within the city. Figure 2, shows the monthly total water consumption over the past 10 years which has come down over a billion liters from 2011 levels.

Figure 2: Monthly Total Production for the Past 10 Years

Month	Total Production (m^3)										Year to Year Comparison		
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average	Minimum	Maximum
January	1,052,675	1,095,540	1,068,079	1,102,050	1,041,252	1,017,583	975,062	956,121	958,639	948,014	971,084	948,014	1,102,050
February	951,166	986,597	1,055,727	965,800	882,146	920,321	880,178	839,540	864,282	827,752	866,415	827,752	1,055,727
March	1,098,228	1,087,778	1,129,479	1,079,800	1,111,459	1,060,221	964,604	973,508	961,301	955,909	983,109	955,909	1,129,479
April	1,781,766	1,565,289	1,418,228	1,484,942	1,537,427	1,207,995	1,275,041	1,199,741	1,111,700	1,318,784	1,222,652	1,111,700	1,781,766
May	2,510,365	2,855,690	2,411,831	2,418,702	2,126,552	1,877,069	2,238,068	2,150,751	1,665,541	2,330,765	2,052,439	1,665,541	2,855,690
June	2,791,568	2,592,920	2,905,390	3,342,126	2,232,802	2,332,211	1,893,865	2,049,643	2,346,313	2,505,237	2,225,454	1,893,865	3,342,126
July	4,205,898	3,520,260	3,803,433	3,742,487	3,408,915	2,749,669	2,782,896	3,342,538	3,071,388	2,823,254	2,953,949	2,749,669	4,205,898
August	3,508,324	3,082,544	3,240,125	3,596,436	3,007,564	3,323,898	3,139,918	3,016,043	2,616,633	2,531,120	2,925,522	2,531,120	3,596,436
September	2,112,270	2,065,431	2,456,995	2,404,774	1,700,291	2,540,271	2,283,234	1,940,697	1,763,875	1,662,936	2,038,203	1,662,936	2,540,271
October	1,386,417	1,287,900	1,357,211	1,320,321	1,281,721	1,249,518	1,319,356	1,206,524	1,180,591	1,085,604	1,208,319	1,085,604	1,386,417
November	1,088,014	1,033,554	1,107,158	1,056,127	1,031,241	963,205	961,951	1,011,491	947,479	910,856	958,997	910,856	1,107,158
December	1,104,254	1,074,300	1,119,930	1,049,221	1,037,506	971,190	973,945	967,644	946,632	921,982	956,278	921,982	1,119,930
Total	23,590,945	22,247,803	23,073,586	23,562,785	20,398,876	20,213,151	19,688,117	19,654,241	18,434,373	18,822,213	20,968,609	18,434,373	23,590,945
Daily Peak	149,148	144,626	140,499	143,509	132,697	126,651	117,522	124,132	121,060	106,235	130,608	106,235	149,148
Peak Date	28-Jul	13-Jul	30-Jun	30-Jul	29-Jul	06-Jul	08-Aug	25-Jul	16-Jul	28-Jun	18-Jul	28-Jun	08-Aug
Daily Low	29,768	29,768	28,682	20,180	20,379	28,034	27,034	24,343	19,449	24,902	25,254	19,449	29,768

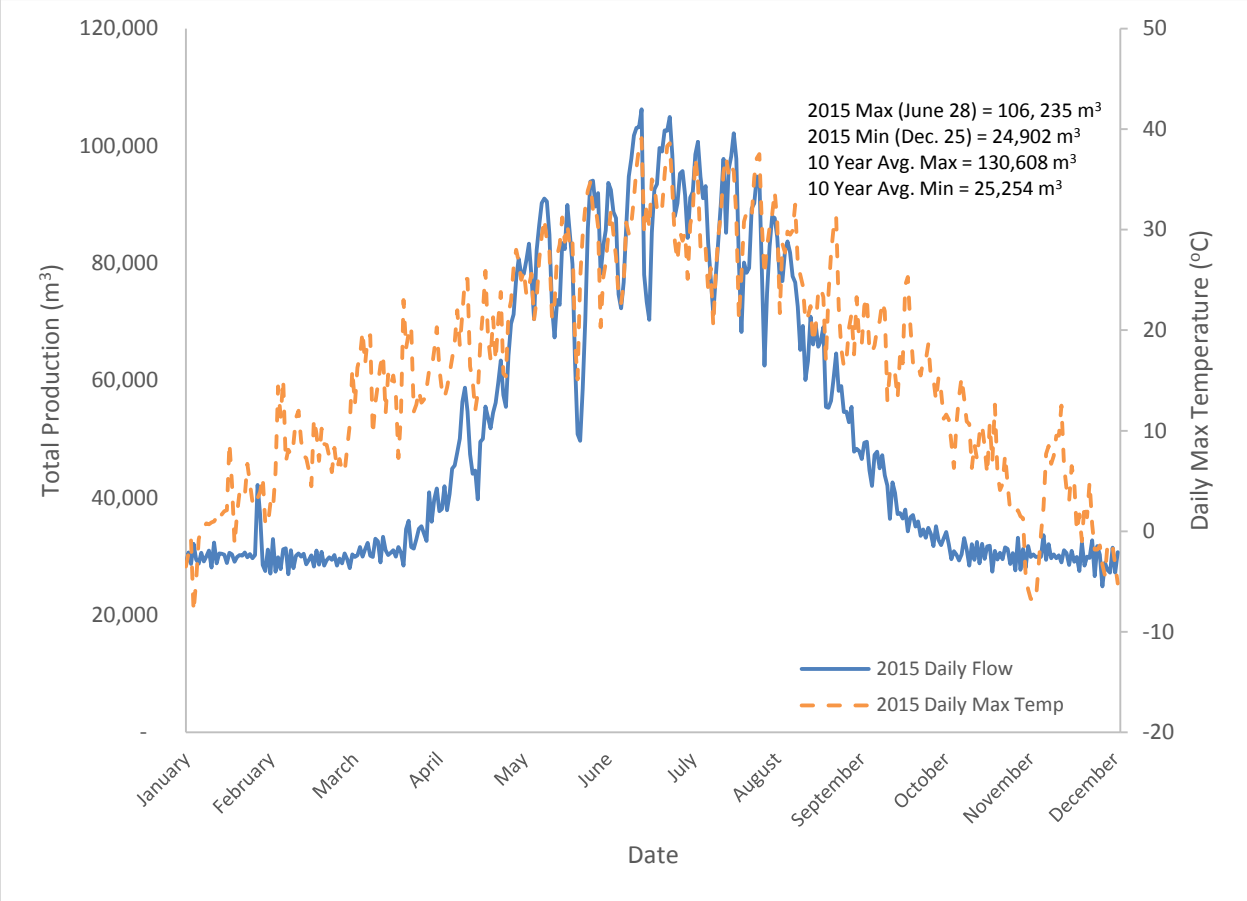
These monthly numbers can be graphically seen in Figure 3. Overall, the peak monthly consumption has decreased in 2015. However it can be seen that there was a marked increase in water consumption in the earlier summer months of May and June which can be attributed to higher than average seasonal weather patterns during those months.

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



For 2015, the peak levels for daily water consumption decreased dramatically from the previous 10-year average. Figure 4 shows the daily water consumption for 2015 with an overlay of the maximum daily temperature. The peak for 2015 was experienced on June 28 with a total water production at the plant reaching just over 106 million liters of water. This is down from a 10-year average maximum of 131 million liters and a peak flow of 149 million liters in 2006. The KCWQ can achieve a maximum daily flow of 160 million liters so these numbers are well below the treatment plants capacity which bodes well for the future.

Figure 4: KCWQ Daily Water Flows for 2015 With Daily Maximum Temperature Overlay



Distribution System Overview

The distribution system consists of over 618 km of water mains, 44 reservoirs, 52 different pressure zones and a total of 24,104 connections. The City also maintains a trucked in water system which feeds potable water to a sports recreation area called the Tournament Capital Ranch (TCR). In the following pages we will give an outline of the distribution system along with summaries of projects and events within the 2015 calendar year.

Booster Stations and Reservoirs

During the 2015 year there were a variety of projects completed in relation to water storage and pumping. The booster stations designated "418" and "509" were given electrical upgrades. The reservoir cleaning program continued and in 2015 three more reservoirs

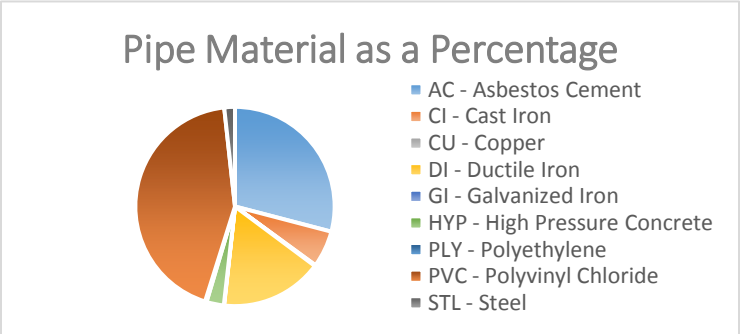
were cleaned including Blackwell, Highridge and Robins Range all of which are located in the Barnhartvale area. Three more reservoirs were inspected in the South East Sector including Blundell, Dallas and Rhonda Lane.

Distribution System

The distribution system is very extensive with the material transporting the water being quite varied as can be seen in Figure 5. The maintenance of this distribution system consists of actively replacing lines that have either 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)	%
AC - Asbestos Cement	180.449	29.07
CI - Cast Iron	37.051	5.97
CU - Copper	0.941	0.15
DI - Ductile Iron	102.794	16.56
GI - Galvanized Iron	0.276	0.04
HYP - High Pressure Concrete	17.492	2.82
PLY - Polyethylene	1.537	0.25
PVC - Polyvinyl Chloride	269.389	43.40
STL - Steel	10.768	1.73
Total	620.698	100



Priorities in the distribution replacement schedule are made on lines that contain ductile iron. These pipes cause the most issues and are scheduled for replacement before any other material type.

Water Conservation

Water conservation is always a primary goal within the City of Kamloops. The 2015 calendar year was the 5th year of the water meter program. Meters have now been installed in all but approximately 200 homes. This has resulted in a reduction of 10% from the total water used yearly and last years peak daily consumption was down by 19% from the 10 year average. In September of 2015, because of the low water levels in the South Thompson River, the City asked the citizens of Kamloops to voluntarily reduce their water usage by

30%. Water usage from September until the end of year decreased by 11% from the 10 year average consumption.

Source Protection

In 2014 a source protection plan for the City of Kamloops was produced. This plan includes recommendations to help mitigate risks to the water source within an area of direct impact to our South Thompson River source and the now approved North Thompson River emergency source (details on the North Thompson Emergency Intake project are provided in another section.) Included in this document were Risk Management Actions which could be taken including the building of a secondary water intake on the North Thompson. Assessments of these actions continue to this date.

Cross Connection Program

The City's Cross Connection Control Plan (CCCP) has focused on premise isolation for industrial, commercial, and institutional (ICI) properties where water meters are installed in pits. A review of the programs in similar sized communities indicates that they have also focused on premise isolation for the same group of customers to begin the program.

To date, the City's CCCP has mainly been focused on new ICI installations when new development and buildings are added to the system. If cross connection control is required, it is made a condition of the building permit or development permit. A testing certificate submitted to Public Works and Utilities indicating that the cross connection control device works satisfactorily is required before occupancy of the property is granted.

Monitoring requirements include annual testing by a certified cross connection control device tester. Should the test fail, repairs and recertification or replacement will be required to maintain the safety of the City's water distribution system. The City currently monitors all inventory of roughly 1,300 cross connection control devices (premise and internal protection). We continue to assess ICI premises for cross connection control risks and if a control devices are required.

2015 Highlights, Future Projects and Service Request Summaries

Distribution Highlights

Each year there are numerous projects that help to upgrade our current system or modify the distribution system in such a way to help in the future. 2015 was no exception with many projects completed including the upgrading sensory control and data acquisition (SCADA) system throughout many areas the distribution system. This is an ongoing project and will be continued into the future through distribution. The upgrades bring new booster stations and reservoirs online which allow them to be remotely monitored and notifying us when problems occur. Along with these upgrades two of the booster stations (designated "418" and "509" booster) were outfitted with all new electrical.

Other upgrades within the distribution system in 2015 included upgrades to the highlift pump station that feeds directly from the water treatment plant. A third generator has been installed at the Highlift pump station on River Street which allows it to power all of the pumps there which feed water to all the major directions in the city. The cathodic

protection inspection survey has been expanded throughout the distribution system and corrosion control has been updated and upgraded where required.

The North Thompson Emergency Intake

The North Thompson Intake project was approved by Council as it was recognized that an emergency water source is required to ensure continuous water supply to the City to fully safeguard its citizens and property in the event of a major spill in the South Thompson River, or a major process failure at the Kamloops Centre for Water Quality.

In 2015, the final design was completed for the emergency water supply from the North Thompson River. The City was working with all the approving authorities for final approvals and permits for tendering in 2016. The project includes a wedge style water intake on the bank of the Thompson River at Yates Road, an adjacent pump house with chlorination facility, and interconnecting pipes from the intake to the pump house and then out to distribution and storage.

Modifications to the primary High Lift Pump Station at River Street would also be required to then back-feed emergency water from the North Shore area and further distribute to the south and southeast sectors of the City. The total project cost is $9,678,000 with $6,064,000 of this funding coming from the New Building Canada Fund. For more details check http://www.kamloops.ca/environment/water-emergencyintake.shtml#.V7Xo96JBk2Y. Project is expected to start late 2016 or early 2017.

Requests for Service

There were a total of 1,883 requests for service filed in the 2015 calendar year with the public works department related to water distribution and treatment. This is down from 2014 year where there were a total of 2,015 requests for service. 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	
	2015	2014
Booster Stations	36	5
Cross Connection Control	15	6
Frozen Services	0	23
General	111	130
Hydrants	81	69
Irrigation On/Off	35	37
No Water	70	75
Reservoirs	8	0
Service Boxes	94	129
Service Location	178	184
Turn Service On/Off	673	739
Water Filling Station	60	72
Water Leak	350	350
Water Pressure	79	100
Water Quality	90	95
Water Restrictions	3	1
Totals	1,883	2,015

Annual Operating Budget for Water Treatment and Distribution

The total budget used for treating water and sending off to each home within the 2015 calendar year was $9,615,955.79.

Water Quality Sampling and Analysis

The water quality from our source water, at the treatment facility and within the distribution system is analyzed extensively. Samples are collected nightly and analyzed at the KCWQ from the raw water, treated water at the plant and from within the distribution system. Bacteriological samples are also analyzed throughout the distribution system on a weekly basis. Also samples of our source water and one from within the distribution system are taken quarterly and sent off to an accredited lab for extensive analysis.

KCWQ Water Quality Testing

The following Figures 8, 9 and 10 are the results of the nightly analysis for the KCWQ. These analysis are done in house by the certified operators at the KCWQ.

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 (^oC)
January	3.2	12	7.55	39	39	38.3	70.8	3.2	1.71	ND	4.0
February	4.3	18.3	7.6	40.9	40.7	41.0	76.1	5.0	2.39	ND	5.4
March	4.1	17.6	7.6	42.3	41.8	41.1	76.8	4.6	2.47	ND	6.8
April	4.2	17.7	7.6	42.0	41.4	42.2	79.9	4.4	2.22	ND	9.1
May	3.7	15.2	7.5	39.6	39.5	39.8	75.3	5.3	2.37	ND	13.2
June	4.0	14.4	7.6	36.9	36.4	38.1	72.3	5.7	2.42	ND	16.9
July	4.4	15.4	7.8	36.8	36.5	39.8	75.7	5.5	2.24	ND	20.9
August	3.1	12.4	7.8	38.0	37.5	41.6	79.0	3.4	1.80	ND	22.1
September	3.1	12.1	7.8	38.7	38.3	41.0	77.9	2.9	1.41	ND	18.1
October	3.1	9.9	7.9	38.6	38.3	40.0	76.2	1.7	1.33	ND	13.9
November	2.5	9.0	7.8	38.6	38.1	39.3	74.9	1.4	1.52	ND	8.4
December	2.7	11.7	7.8	39.3	38.5	39.6	75.4	2.6	1.84	ND	4.5
Min	2.5	9.0	7.53	37	36	38.1	70.8	1.4	1.33	0.0	4.0
Max	4.4	18.3	7.90	42	42	42.2	79.9	5.7	2.47	0.0	22.1
Average	3.5	13.8	7.69	39	39	40.1	75.8	3.8	1.98	0.0	11.9

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 (^oC)	Free Cl (mg/L)	Total Cl (mg/L)
January	0.3	0.3	7.64	39.3	39.2	44.6	84.8	0.013	ND	7.3	1.33	1.42
February	0.2	ND	7.72	41.4	41.3	47.5	90.1	0.013	ND	8.4	1.30	1.35
March	0.1	ND	7.67	42.3	42.0	48.3	91.1	0.012	ND	9.7	1.30	1.35
April	0.1	ND	7.75	42.1	41.8	49.3	93.2	0.013	ND	12.1	1.31	1.35
May	0.2	0.2	7.65	39.5	39.7	45.9	87.0	0.014	ND	14.9	1.27	1.32
June	0.2	ND	7.68	37.0	36.6	44.0	83.3	0.014	ND	18.4	1.20	1.26
July	0.4	0.5	7.85	35.9	36.1	45.5	86.4	0.014	ND	22.3	1.13	1.19
August	ND	ND	7.83	38.0	37.8	48.0	88.9	0.013	ND	23.2	1.10	1.17
September	ND	ND	7.93	38.6	38.8	46.3	87.9	0.013	ND	18.8	1.17	1.24
October	1.0	1.0	7.97	38.3	38.7	45.9	86.7	0.013	0.0	15.5	1.19	1.28
November	ND	ND	7.90	38.3	38.4	46.0	87.4	0.014	0.0	10.2	1.28	1.36
December	ND	ND	7.87	39.4	39.2	45.7	86.6	0.013	ND	5.6	1.30	1.37
Min	0.0	0.0	7.64	36	36	44.0	83.3	0.012	0.0	5.6	1.10	1.17
Max	1.0	1.0	7.97	42	42	49.3	93.2	0.014	0.0	23.2	1.33	1.42
Average	0.2	0.2	7.79	39	39	46.4	87.8	0.013	0.0	13.9	1.24	1.30

*__ND__ refers to Non-Detectable Limit

Figure 9: KCWQ Average Monthly Distribution 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)	Free Cl2 (mg/L)	Total Cl2 (mg/L)	Temp (°C)
January	0.3	0.3	7.7	39.5	39.5	45.7	86.4	0.101	1.0	1.0	7.2
February	0.2	0.2	7.7	41.2	40.9	48.3	91.7	0.084	0.9	1.0	8.3
March	ND	ND	7.7	42.2	41.9	49.1	92.7	0.302	0.9	1.0	10.3
April	ND	ND	7.8	42.0	41.8	50.8	96.0	0.090	0.9	1.0	10.0
May	0.1	0.3	7.7	40.3	40.1	45.6	86.3	0.126	0.9	1.0	12.5
June	0.1	0.1	7.8	37.2	36.8	42.7	80.8	0.086	0.8	0.9	17.0
July	0.1	0.1	7.9	37.2	37.0	44.8	83.2	0.105	0.8	0.8	21.1
August	ND	ND	8.0	38.4	38.3	44.4	84.4	0.080	0.7	0.8	21.4
September	ND	ND	8.0	39.1	39.2	45.0	85.3	0.116	0.8	0.9	18.5
October	1.0	4.0	8.1	38.9	39.1	44.9	85.4	0.110	0.7	0.8	15.4
November	ND	ND	8.0	38.8	39.0	46.2	87.9	0.118	0.7	0.8	12.5
December	ND	0.2	8.0	39.5	39.3	47.0	89.1	0.134	0.9	1.0	10.2
Min	0.0	0.0	7.68	37	37	42.7	80.8	0.080	0.67	0.76	7.2
Max	1.0	4.0	8.07	42	42	50.8	96.0	0.302	0.96	1.05	21.4
Average	0.1	0.4	7.87	40	39	46.2	87.4	0.121	0.83	0.91	13.7

*__ND__ refers to Non-Detectable Limit

Distribution Sampling

The City of Kamloops is committed to providing safe drinking water to each and every connection within its service area. To this end the distribution system is sampled at over 23 different locations weekly and by the end of the year 24 locations as the Tournament Capital Ranch was included. These samples are analyzed for background bacterial counts, total coliforms and E. Coli. If a sample is positive for background bacteria greater than 200 counts then the system is flushed and resampled. Any positive counts of any size for background bacteria are also resampled immediately which is above and beyond the legislative requirements. Positive counts for total coliforms or E. Coli result in an immediate boil water advisory, resampling and cleaning of the affected area.

There were no positive results for total coliforms or E. Coli and background bacteria counts were always lower than 200. While some samples were retaken the follow up analysis showed no bacterial counts. The results for the 2015 distribution system can be seen in Figure 10.

Figure 10: 2015 Distribution System Biological Sampling

Date	Number of Samples Taken	Samples Positive for Background Bacteria	Samples Positive for Coliform and E.Coli	Measures Taken
05/01/2015	23	0	0	
12/01/2015	23	0	0	
19/01/2015	23	0	0	
26/01/2015	23	0	0	
02/02/2015	23	0	0	
09/02/2015	23	0	0	
16/02/2015	23	0	0	
23/02/2015	23	0	0	
02/03/2015	23	0	0	
09/03/2015	23	0	0	
16/03/2015	23	0	0	
18/03/2015	1	0	0	
20/03/2015	1	0	0	
23/03/2015	24	0	0	
30/03/2015	24	0	0	
06/04/2015	24	0	0	
13/04/2015	23	1	0	Plate count of 1, resample taken
20/04/2015	25	0	0	
27/04/2015	23	1	0	Plate count of 2, resample taken
04/05/2015	25	0	0	
11/05/2015	24	0	0	
18/05/2015	24	0	0	
27/05/2015	24	0	0	
01/06/2015	24	2	0	Both had plate counts of 1, resamples taken
08/06/2015	24	0	0	
15/06/2015	24	0	0	
22/06/2015	24	0	0	
29/06/2015	24	0	0	
06/07/2015	24	1	0	Plate count of 2, resample taken
13/07/2015	25	0	0	
20/07/2015	24	2	0	Plate count of 1, resample taken
27/07/2015	26	0	0	
03/08/2015	24	0	0	
10/08/2015	24	0	0	
17/08/2015	24	0	0	
24/08/2015	24	0	0	
31/08/2015	22	2	0	Plate count of 8 and 14, resamples taken
07/09/2015	25	0	0	
14/09/2015	24	0	0	
21/09/2015	24	0	0	
28/09/2015	24	0	0	
05/10/2015	24	0	0	
12/10/2015	24	0	0	
19/10/2015	24	0	0	
26/10/2015	23	1	0	Plate count of 1, resample taken
02/11/2015	24	0	0	
09/11/2015	23	0	0	
16/11/2015	23	0	0	
23/11/2015	23	0	0	
30/11/2015	23	0	0	
07/12/2015	23	0	0	
14/12/2015	23	1	0	Plate count of 1, resample taken
21/12/2015	24	0	0	
28/12/2015	23	0	0	
Totals	1233	11	0	

Quarterly Raw and Distribution Sampling

The following are extensive water quality analysis results as completed by a provincially accredited lab from the source water and within the distribution system. In a typical year there are 4 sampling periods, however in 2015 there were only 3 due to staffing changes. The samples were taken by City staff and sent off to CARO analytical services in Kelowna, BC. The results of these extensive analysis can be seen in Tables 11 through 18. As seen in the tables all of the treated water quality parameters are within the Guidelines for Canadian Drinking Water Quality.

Figure 11: CARO Anions Analysis

Analyte	Units	Method detection limit	Drinking Water Guidline Level	Raw (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Bromide	mg/L	0.1	N/A	<0.1		<0.10		<0.10	
Chloride	mg/L	0.1	AO<=250	0.64	4.39	0.65	0.52	0.6	3.45
Fluoride	mg/L	0.1	MAC=1.5		<0.10		<0.10		<0.10
Nitrate as N	mg/L	0.01	MAC=10	0.078	0.076	0.013	<0.010	<0.010	<0.010
Nitrite as N	mg/L	0.01	MAC=1	<0.010	<0.010	<0.010	<0.010	<0.010	0.012
Phosphate, Ortho as P	mg/L	0.01	N/A		<0.01		<0.01		<0.01
Sulfate	mg/L	1	AO<=500	6.3	6.4	12.9	5.8	6.1	6.1
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective						

Figure 12: CARO General Parameters Analysis

Analyte	Units	Method detection limit	Drinking Water Guidline Level	Raw (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Colour, True	CU	5	AO<=15	6	<5	<5	<5	<5	<5
Alkalinity, Total as CaCO3	mg/L	1	N/A	42	41	38	36	37	39
BOD, 5-day	mg/L	2	N/A	<10		<10		<10	
Carbon, Total Organic	mg/L	0.5	N/A	1.7	1.2	1.9	2	1.8	1.4
Carbon, Dissolved Organic	mg/L	0.5	N/A	1.2		1.9		1.6	
Cyanide, Total	mg/L	0.01	MAC=0.2		<0.010		<0.010		<0.010
Ammonia as N, Total	mg/L	0.02	N/A	0.328		<0.020		<0.020	
Nitrogen, Total Kjeldahl	mg/L	0.05	N/A	0.43	0.1	<0.05	0.06	0.16	0.21
Oil & Grease, Total	mg/L	2	N/A		<2		10		<2
Phenolics, Total	mg/L	0.002	N/A		<0.002		<0.002		<0.002
Solids, Total Dissolved	mg/L	10	AO<=500	53	61	27	25	56	60
Sulfide, total	mg/L	0.05	AO<=0.05		<0.05		<0.05		<0.05
Turbidity	NTU	0.1	OG<0.1	3.2	<0.1	1.3	1	0.7	0.1
Conductivity (EC)	uS/cm	2	N/A	95	110	84	84	90	100
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective						

Figure 13: CARO Calculated Parameters

Analyte	Units	Method detection limit	Drinking Water Guidline Level	Raw (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Hardness, Total (Total as CaCO3)	mg/L	0.5	N/A	46.2	45.2	40.1	38.7	41	41.9
Hardness, Total (Diss. as CaCO3)	mg/L	0.5	N/A	41.7	44.2	36	35.5	37.1	37.1
Nitrate+Nitrite as N	mg/L	0.02	N/A	0.078	0.076	<0.020	<0.020	<0.020	<0.020
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective						

Figure 14: CARO Dissolved Metals Analysis

Analyte	Units	Method detection limit	Drinking Water Guidline Level	Raw (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Aluminum, dissolved	mg/L	0.005	N/A	0.006	0.006	0.009	0.01	0.011	0.009
Antimony, dissolved	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Arsenic, dissolved	mg/L	0.0005	N/A	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Barium, dissolved	mg/L	0.005	N/A	0.01	0.01	0.008	0.008	0.01	0.009
Beryllium, dissolved	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, dissolved	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Boron, dissolved	mg/L	0.004	N/A	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Cadmium, dissolved	mg/L	0.00001	N/A	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Calcium, dissolved	mg/L	0.2	N/A	12.8	13.9	11.5	11.2	12.4	12.5
Chromium, dissolved	mg/L	0.0005	N/A	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt, dissolved	mg/L	0.00005	N/A	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Copper, dissolved	mg/L	0.0002	N/A	0.0017	0.0237	0.0004	0.0137	0.0012	0.0173
Iron, dissolved	mg/L	0.01	N/A	<0.010	<0.010	<0.010	<0.010	0.011	<0.010
Lead, dissolved	mg/L	0.0001	N/A	<0.0001	0.0003	<0.0001	0.0007	<0.0001	0.0007
Lithium, dissolved	mg/L	0.0001	N/A	0.0007	0.0008	0.0006	0.0006	0.0002	0.0002
Magnesium, dissolved	mg/L	0.01	N/A	2.36	2.29	1.79	1.82	1.51	1.45
Manganese, dissolved	mg/L	0.0002	N/A	0.0011	<0.0002	0.0004	0.0003	0.0004	0.0004
Molybdenum, dissolved	mg/L	0.0001	N/A	0.0007	0.0006	0.0006	0.0007	0.0007	0.0007
Nickel, dissolved	mg/L	0.0002	N/A	0.0003	<0.0002	0.0004	<0.0002	<0.0002	<0.0002
Phosphorus, dissolved	mg/L	0.02	N/A	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Potassium, dissolved	mg/L	0.02	N/A	0.85	0.84	0.74	0.75	0.66	0.64
Selenium, dissolved	mg/L	0.0005	N/A	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, dissolved	mg/L	0.5	N/A	3.4	3.2	2.5	2.6	2.6	2.6
Silver, dissolved	mg/L	0.00005	N/A	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium, dissolved	mg/L	0.02	N/A	1.73	4.38	1.56	2.34	1.23	3.19
Strontium, dissolved	mg/L	0.001	N/A	0.087	0.086	0.064	0.065	0.07	0.071
Sulfur, dissolved	mg/L	1	N/A	<1	<1	<1	<1	1	<1
Tellurium, dissolved	mg/L	0.0002	N/A	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, dissolved	mg/L	0.00002	N/A	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium, dissolved	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin, dissolved	mg/L	0.0002	N/A	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium, dissolved	mg/L	0.005	N/A	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Uranium, dissolved	mg/L	0.00002	N/A	0.00031	0.00004	0.00027	0.0002	0.00027	0.00005
Vanadium, dissolved	mg/L	0.001	N/A	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc, dissolved	mg/L	0.004	N/A	<0.004	0.007	<0.004	0.005	<0.004	<0.004
Zirconium, dissolved	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury, dissolved	ug/L	0.005	N/A	<0.005	<0.005	<0.005	<0.005	0.023	0.011
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective						

Figure 15: CARO Total Recoverable Metals Analysis

Analyte	Units	Method detection limit	Drinking Water Guidline Level	Raw (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Aluminum, total	mg/L	0.005	OG<0.1	0.145	0.008	0.087	0.013	<0.0001	<0.0001
Antimony, total	mg/L	0.0001	MAC=0.006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005
Arsenic, total	mg/L	0.0005	MAC=0.01	<0.0005	<0.0005	<0.0005	<0.0005	0.009	0.01
Barium, total	mg/L	0.005	MAC=1	0.012	0.01	0.01	0.009	<0.0001	<0.0001
Beryllium, total	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth, total	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	0.005	0.004
Boron, total	mg/L	0.004	MAC=5	<0.004	<0.004	0.012	0.006	<0.00001	<0.00001
Cadmium, total	mg/L	0.00001	MAC=0.005	<0.00001	<0.00001	<0.00001	<0.00001	12.9	13.4
Calcium, total	mg/L	0.2	N/A	14.4	14.3	12.7	12.3	0.0005	0.0006
Chromium, total	mg/L	0.0005	MAC=0.05	<0.0005	<0.0005	<0.0005	<0.0005	<0.00005	<0.00005
Cobalt, total	mg/L	0.00005	N/A	0.00012	<0.00005	0.00009	<0.00005	0.0012	0.0172
Copper, total	mg/L	0.0002	AO<=1	0.0024	0.0275	0.0008	0.0398	0.04	<0.01
Iron, total	mg/L	0.01	AO<=0.3	0.22	<0.01	0.12	<0.01	<0.0001	0.0007
Lead, total	mg/L	0.0001	MAC=0.01	0.0001	0.0004	<0.0001	0.0022	0.0007	0.0007
Lithium, total	mg/L	0.0001	N/A	0.001	0.0008	0.0008	0.0007	2.1	2.05
Magnesium, total	mg/L	0.01	N/A	2.46	2.32	2.04	1.94	0.0031	0.0004
Manganese, total	mg/L	0.0002	AO<=0.05	0.0067	<0.0002	0.0045	0.0011		<0.00002
Molybdenum, total	mg/L	0.0001	N/A	0.0007	0.0007	0.0007	0.0007	0.0007	0.0008
Nickel, total	mg/L	0.0002	N/A	0.0007	0.0006	0.0002	<0.0002	0.0002	0.0003
Phosphorus, total	mg/L	0.02	N/A	0.032	0.021	<0.02	<0.02	<0.02	<0.02
Potassium, total	mg/L	0.02	N/A	0.91	0.93	0.85	0.82	0.89	0.89
Selenium, total	mg/L	0.0005	MAC=0.05	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon, total	mg/L	0.5	N/A	3.6	3.3	2.9	2.8	2.9	2.9
Silver, total	mg/L	0.00005	N/A	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Sodium, total	mg/L	0.02	AO<=200	1.88	4.54	1.68	3.95	1.75	3.76
Strontium, total	mg/L	0.001	N/A	0.088	0.087	0.071	0.07	0.073	0.075
Sulfur, total	mg/L	1	N/A	<1	1	1	<1	<1	<1
Tellurium, total	mg/L	0.0002	N/A	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thallium, total	mg/L	0.00002	N/A	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thorium, total	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Tin, total	mg/L	0.0002	N/A	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Titanium, total	mg/L	0.005	N/A	0.007	<0.005	<0.005	<0.005	<0.005	<0.005
Uranium, total	mg/L	0.00002	MAC=0.02	0.00036	0.00004	0.00029	0.00009	0.00027	0.00004
Vanadium, total	mg/L	0.001	N/A	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc, total	mg/L	0.004	AO<=5	0.006	0.009	<0.004	0.007	<0.004	0.005
Zirconium, total	mg/L	0.0001	N/A	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury, total	ug/L	0.005	MAC=1	<0.005	<0.005	<0.005	<0.005	<0.005	
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 (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Alachlor	ug/L	0.1	N/A		<0.10				<0.10
Aldrin	ug/L	0.04	N/A		<0.04				<0.04
alpha-BHC	ug/L	0.05	N/A		<0.05				<0.05
alpha-Chlordane	ug/L	0.05	N/A		<0.05				<0.05
Atrazine	ug/L	0.1	MAC=5		<0.10				<0.10
Azinphos-methyl	ug/L	0.2	N/A		<0.20				<0.20
beta-BHC	ug/L	0.05	N/A		<0.05				<0.05
Bromacil	ug/L	0.1	N/A		<0.10				<0.10
Captan	ug/L	0.1	N/A		<0.10				<0.10
Chlorothalonil	ug/L	0.05	N/A		<0.05				<0.05
Chlorpyrifos	ug/L	0.2	MAC=90		<0.20				<0.20
Cyanazine	ug/L	0.2	N/A		<0.20				<0.20
delta-BHC	ug/L	0.05	N/A		<0.05				<0.05
Diazinon	ug/L	0.03	MAC=20		<0.03				<0.03
Dichlorvos	ug/L	0.1	N/A		<0.10				<0.10
Dieldrin	ug/L	0.04	N/A		<0.04				<0.04
Dimethoate	ug/L	0.2	MAC=20		<0.20				<0.20
Disulfoton	ug/L	0.1	N/A		<0.10				<0.10
Endosulfan I	ug/L	0.05	N/A		<0.05				<0.05
Endosulfan II	ug/L	0.05	N/A		<0.05				<0.05
Endosulfan sulfate	ug/L	0.05	N/A		<0.05				<0.05
Endrin	ug/L	0.032	N/A		<0.03				<0.03
Endrin aldehyde	ug/L	0.05	N/A		<0.05				<0.05
Endrin ketone	ug/L	0.05	N/A		<0.05				<0.05
gamma-BHC (Lindane)	ug/L	0.05	N/A		<0.05				<0.05
gamma-Chlordane	ug/L	0.05	N/A		<0.05				<0.05
Heptachlor	ug/L	0.05	N/A		<0.05				<0.05
Heptachlor epoxide	ug/L	0.05	N/A		<0.05				<0.05
Malathion	ug/L	0.1	MAC=190		<0.10				<0.10
Methyl parathion	ug/L	0.1	N/A		<0.10				<0.10
Metolachlor	ug/L	0.1	MAC=50		<0.10				<0.10
Metribuzin	ug/L	0.2	MAC=80		<0.20				<0.20
p,p-DDD	ug/L	0.04	N/A		<0.04				<0.04
p,p-DDE	ug/L	0.04	N/A		<0.04				<0.04
p,p-DDT	ug/L	0.04	N/A		<0.04				<0.04
Parathion	ug/L	0.1	N/A		<0.10				<0.10
Pentachloronitrobenzene	ug/L	0.1	N/A		<0.10				<0.10
Phorate	ug/L	0.1	MAC=2		<0.10				<0.10
Fenchlorphos (Ronnel)	ug/L	0.1	N/A		<0.10				<0.10
Simazine	ug/L	0.2	MAC=10		<0.20				<0.20
Sulfotep	ug/L	0.1	N/A		<0.10				<0.10
Terbufos	ug/L	0.1	MAC=1		<0.10				<0.10
Triallate	ug/L	0.1	N/A		<0.10				<0.10
Trifluralin	ug/L	0.2	MAC=45		<0.20				<0.20
cis-Permethrin	ug/L	0.1	N/A		<0.10				<0.10
trans-Permethrin	ug/L	0.1	N/A		<0.10				<0.10
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 (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Acenaphthene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Acenaphthylene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Acridine	ug/L	0.1	N/A	<0.10	<0.10		<0.10		<0.10
Anthracene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Benz (a) anthracene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Benzo (a) pyrene	ug/L	0.01	MAC=0.01	<0.01	<0.01		<0.01		<0.01
Benzo (b) fluoranthene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Benzo (g,h,i) perylene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Benzo (k) fluoranthene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Chrysene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Dibenz (a,h) anthracene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Fluoranthene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Fluorene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Indeno (1,2,3-cd) pyrene	ug/L	0.05	N/A	<0.05	<0.05		<0.05		<0.05
Naphthalene	ug/L	0.3	N/A	<0.30	<0.30		<0.30		<0.30
Phenanthrene	ug/L	0.1	N/A	<0.10	<0.10		<0.10		<0.10
Pyrene	ug/L	0.1	N/A	<0.10	<0.10		<0.10		<0.10
Quinoline	ug/L	0.1	N/A	<0.10	<0.10		<0.10		<0.10
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 (April 1, 2015)	Campbell Creek Booster Station (April 1, 2015)	Raw (July 20, 2015)	Soutwest #3 Booster Station (July 20, 2015)	Raw (Sep 17, 2015)	Batchelor North Booster Station (Sep 17, 2015)
Benzene	ug/L	0.5	MAC=5	<0.5	<0.5		<0.5		<0.5
Bromodichloromethane	ug/L	1	N/A		1.3		<1.0		1.4
Bromoform	ug/L	1	N/A		<1.0		<1.0		<1.0
Carbon tetrachloride	ug/L	1	MAC=2		<1.0		<1.0		<1.0
Chlorobenzene	ug/L	1	AO<=30		<1.0		<1.0		<1.0
Chloroethane	ug/L	2	N/A		<2.0		<2.0		<2.0
Chloroform	ug/L	1	N/A		33.1		29.2		39.9
Dibromochloromethane	ug/L	1	N/A		<1.0		<1.0		<1.0
1,2-Dibromoethane	ug/L	0.3	N/A		<0.3		<0.3		<0.3
Dibromomethane	ug/L	1	N/A		<1.0		<1.0		<1.0
1,2-Dichlorobenzene	ug/L	0.5	AO<=3		<0.5		<0.5		<0.5
1,3-Dichlorobenzene	ug/L	1	N/A		<1.0		<1.0		<1.0
1,4-Dichlorobenzene	ug/L	1	AO<=1		<1.0		<1.0		<1.0
1,1-Dichloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0
1,2-Dichloroethane	ug/L	1	MAC=5		<1.0		<1.0		<1.0
1,1-Dichloroethene	ug/L	1	MAC=14		<1.0		<1.0		<1.0
cis-1,2-Dichloroethene	ug/L	1	N/A		<1.0		<1.0		<1.0
trans-1,2-Dichloroethene	ug/L	1	N/A		<1.0		<1.0		<1.0
1,2-Dichloropropane	ug/L	1	N/A		<1.0		<1.0		<1.0
cis-1,3-Dichloropropene	ug/L	1	N/A		<1.0		<1.0		<1.0
trans-1,3-Dichloropropene	ug/L	1	N/A		<1.0		<1.0		<1.0
Ethylbenzene	ug/L	1	AO<=1.6	<1.0	<1.0		<1.0		<1.0
Methyl tert-butyl ether	ug/L	1	AO<=15	<1.0	<1.0		<1.0		<1.0
Methylene chloride	ug/L	3	MAC=50		<3.0		<3.0		<3.0
Styrene	ug/L		N/A	<1.0	<1.0		<1.0		<1.0
1,1,2,2-Tetrachloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0
Tetrachloroethene	ug/L	1	MAC=30		<1.0		<1.0		<1.0
Toluene	ug/L	1	AO<=24	<1.0	<1.0		<1.0		<1.0
1,1,1-Trichloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0
1,1,2-Trichloroethane	ug/L	1	N/A		<1.0		<1.0		<1.0
Trichloroethene	ug/L	1	MAC=5		<1.0		<1.0		<1.0
Trichlorofluoromethane	ug/L	1	N/A		<1.0		<1.0		<1.0
Vinyl chloride	ug/L	2	MAC=2		<2.0		<2.0		<2.0
Xylenes (total)	ug/L	2	AO<=20	<2.0	<2.0		<2.0		<2.0
MAC = Maximum Acceptable Concentration			AO = Aesthetic objective						