July 6, 2022

DISTRICT OF MACKENZIE
WATER SYSTEM ANNUAL REPORT - 2021

Client: District of Mackenzie

L&M Project No.: 1044-62

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1 INTRODUCTION

The District of Mackenzie (District) operates three closed-loop water distribution systems (Town, Airport, & Gantahaz) which are permitted by the Northern Health Authority (NHA). This 2021 Water System Annual Report has been prepared on behalf of the District as part of the District's Water System Operating Permit conditions. This report summarizes the following for each of the systems:

- Water System Infrastructure;
- Operation and maintenance activities;
- Water quality monitoring; and
- Recently completed and upcoming capital initiatives.

In order to maintain compliance with the Drinking Water Protection Act, this annual report must be made available to the water system users within 6 months of the end of the calendar year.

Please refer to Appendix E for the operating permits for each water system and for questions please contact Ken Gawryluk, Interim Director of Operations for the District at 250-997-3761 or at ken@districtofmackenzie.ca.

2 COMMUNITY PROFILE

2.1 Community

Mackenzie sits in the Rocky Mountain Trench with the Omineca Mountain Range and Williston Lake to the west and the Rocky Mountains to the east. It is approximately 180km, by road, northwest of Prince George at 55N 18' north latitude and 123N 8' west longitude. Mackenzie is within the traditional territory of the Sekani People and the Town was established in 1966 after the completion of the W.A.C. Bennet Dam and the creation of the Williston Reservoir. Mackenzie is located on glacial soil mostly composed of sand and gravel that is relatively infertile and therefore has no commercial farming using the town's water.

2.2 Population

Mackenzie is a town dependent on resource industries and as such the population fluctuates based on commodity market conditions. The District of Mackenzie is working hard to diversify its economy to ensure it can weather downturns in the resource industries. As shown in Table 1: Mackenzie Population Summary the population of Mackenzie has stabilized since the dramatic downturn of the local economy that happened in 2009 and the resulting population decrease. Based on information from the District the population has remained unchanged since the last census in 2016. Currently, the population of the community is projected to remain relatively constant with a net population increase of four percent between 2011 and 2036.

Table 1: Mackenzie Population Summary

Year	Total Population	Total Connections	Townsite Population	Townsite Connections	Gantahaz Population	Gantahaz Connections
2001	5206	1850	4835	1747	371	103
2002	5206	1850	4835	1747	371	103
2003	5039	1828	4680	1726	359	101
2004	4873	1806	4525	1705	347	100
2005	4706	1783	4370	1684	335	99
2006	4539	1761	4215	1663	324	98
2007	4333	1711	4024	1616	309	95
2008	4126	1505	3832	1421	294	84
2009	3920	1299	3640	1227	279	72
2010	3713	1092	3449	1032	265	61
2011	3507	1513	3257	1429	250	84
2012	3548	1532	3295	1447	253	85
2013	3590	1552	3334	1466	256	86
2014	3631	1571	3372	1484	259	87
2015	3673	1591	3411	1502	262	88
2016	3714	1610	3449	1521	265	89
2017	3714	1610	3449	1521	265	89
2018	3714	1610	3449	1521	265	89
2019	3714	1610	3449	1521	265	89
2020	3714	1610	3449	1521	265	89
2021	3714	1610	3449	1521	265	89

Notes:

Census Data

2.3 Climate

Mackenzie has cold winters and warm summers with a substantial significant number of days without rain as shown in Table 2: Mackenzie Climate Summary below. In the winter there is generally snow cover from November until April each year. There is consistent precipitation throughout the whole year, however, in the summer the rainfall often comes in short heavy rains.

Table 2: Mackenzie Climate Summary

	Average Maximum Temperature (°C)		Precipitation (mm)		Maximum Summer Temperature (°C)	Summer Days Without Rain
	May - Oct	Nov - Apr	May - Oct	Nov - Apr		
2011	16.1	-1.1	368	187	28.4	42
2012	17.0	-0.5	227	141	30.6	54
2013	18.8	-0.2	277	194	31.8	56
2014	18.8	-1.6	279	202	34.2	64
2015[1]	18.2	1.0	101	148	31.5	78
2016[1]	17.4	1.7	186	78	28.5	73
2017	18.1	-2.1	288	135	32	70
2018[1]	17.8	-1.0	141	51	33.4	70
2019	16.5	-0.3	305	180	27.8	48
2020[1]	16.5	0.0	393	143	29.7	40
2021	18.0	-1.1	257	335	38.7	58

Notes:

Source: Environment Canada Historical Climate Data

(https://climate.weather.gc.ca/climate_data/daily_data_e.html?StationID=48370)

[1] Missing Precipitation Data

3 MACKENZIE WATER SYSTEM OVERVIEW

3.1 Town Water System

The District of Mackenzie currently obtains its drinking water from three relatively shallow wells west of the townsite adjacent to Morfee Lake.

- Well # 1 & # 5 are located in Pumphouse # 1, at First Beach.
- Well # 4 located in Pumphouse #2, at Second Beach

Table: Town Water System Well Identification Numbers.

Well #	WIN	Pumphouse
1	28314	1
5	20900	1
4	28315	2

Note, due to age and underperformance, Well #2, referenced in past reports was replaced in July 2018 with a new drilled well (well #5). Well #5 that has a capacity of 70 L/s.

Figure 1: Town Reservoir & Booster Station

Water is pumped from pumphouses 1 & 2 into a 500,000 Igal above grade concrete reservoir. A booster station then pumps the water throughout the distribution system. The Town booster station has three electric booster pumps and an emergency diesel fire pump. Booster pumps turn on and off as necessary to maintain pressure in the distribution system. Boosting the pressure is required as the reservoir is too low to provide sufficient pressure to the network. The fire pump operates when there is insufficient system pressure to fight a fire and can be started with a cell phone or manually by the Fire Department or by Public Works.

The Town distribution system is approximately divided between asbestos cement (AC) pipe in the older, eastern portion of the network, and newer polyvinyl chloride (PVC) pipe in the western, newer portion of the network. There are five pressure-reducing valve (PRV) stations that divide the Town distribution system into six pressure zones which ensure that pressures are within acceptable ranges throughout the distribution system. For reference, a copy of the water system map for the townsite is attached in Appendix D.

The significant conclusions of the study were as follows:

- The District is deficient in fire water storage capacity. Utilizing guidelines developed by the Insurance Bureau of Canada, the District requires an additional 2,660,000 Igal (12,103,000 L) of storage;
- With the future addition of a new reservoir north and west of the Valleyview Apartments, the District's distribution system can supply all the firefighting demands in accordance with the Insurance Bureau of Canada guidelines with the sole exception of a fire at the Pinedale Apartments;
- The existing system can supply only 57.5% of the Insurance Bureau of Canada recommended firefighting demand to the Pinedale Apartments;
- The existing booster station is capable of meeting existing and projected future demands without upgrading the capacity of the pumps; and
- The pipe roughness coefficient calculated from the test data was quite low indicating a rough pipe interior.

The recommendations of the study were as follows:

- The District should construct a new reservoir located north and west of the Valleyview Apartments. The minimum size of the reservoir should be 1,000,000 gal (4,540,000 L) although as stated in the conclusions a larger size of 2,660,000 Igal is desirable;

- The District should develop a new well water supply with a capacity of approximately 110 L/s (1500 Igpm) to provide safety and redundancy of supply;
- The District should replace the existing well pump in well #3 with a unit capable of supplying 110 L/s (1500 Igpm); and
- The District should initiate a pipe cleaning program of all distribution pipes to increase pipe smoothness.

3.2 Gantahaz Water System

Water for Gantahaz residents is supplied from two deep low capacity wells positioned in a confined aquifer with pitless adapter connections.

- Well #1 is located on Columbia Drive next to the storage reservoir
- Well #4 is located on Alberta Drive

Table: Gantahaz Water System ,Well Identification Numbers.

Well #	WIN
1	21376
4	21356

Well #4 is positioned in a manhole that requires heating to prevent freezing during the winter. Both wells pump water to a 1,350 m^3 (300,000 Igal) storage reservoir next to Well #1 on Columbia Drive. This reservoir is an above-ground, insulated, metal structure.

The Gantahaz water distribution network is pressurized by a booster station located on Columbia Drive next to the storage reservoir and Well #1. The booster station has an electric booster pump with a spare pump and motor located in the building for maintenance purposes. The booster pump increases the water pressure level to approximately 55 psi and services all 90 residences (approximately 265 people).

An emergency natural gas fire pump is available to supplement system pressures during a fire flow event. The fire pump can be started with a cell phone or manually by the Fire Department or by Public Works. The booster station is also equipped with a portable,

manually operated gas-powered generator that can be used to power the station in a power outage.

Booster station controls, VFDs, and other building envelope improvements were completed in 2019 and there is expected improved electrical efficiency because of these upgrades.

Figure 2: Gantahaz Booster Station and Reservoir

The Gantahaz distribution system is composed of primarily PVC pipes. For reference, we have enclosed a copy of the water system map for the Gantahaz subdivision in Appendix D.

Improvements are planned for the Gantahaz water system in summer 2022 as follows:

- Piping replacement within pump house.
- Well 4 chamber, flow meter, and test point upgrades.

3.3 Airport Water System

The Airport system consists of one well, an open water reservoir, and a fire pump. The primary purpose of the airport system is to provide water for fire fighting purposes for several industrial sites in the area, however, the airport system also supplies six structures.

In the summer of 2021 a new well and well pump along with associated equipment and controls were installed to service the fire lagoon. The new well is located near the pump house and the pump house has a wet well that is interconnected to the reservoir so they are both at the same water level. The fire water reservoir is located adjacent to the pump house and is surrounded by a fence.

The fire suppression reservoir now fills automatically based on the water level of the wet well. Inside the pump house there is an electric jockey pump and in the event of a fire a diesel fire pump operates automatically.

4 TREATMENT & DISINFECTION

4.1 Town Water System

The Town water system supply wells are positioned within Aquifer 431 which is categorized as an unconfined sand and gravel aquifer. Source protection plans completed by Kala Geoscience Ltd. in 2015 found that Town Wells #1 and #4 are not under the direct influence of surface water (non-GWUDI). Furthermore, the Well # 5 Drilling and Completion report completed by Western Water Associates Ltd. in 2018 found that Well # 5 was not under the direct influence of surface water (non-GWUDI) nor groundwater at risk of containing pathogens (non-GARP) Seasonal water level fluctuations are not expected to impact the well yields unless there is a very prolonged drought in the region.

The water quality of the Town water supply wells meets all Northern Health health-based objectives and therefore does not require treatment or disinfection but does require long-term water quality monitoring, the results of which are shown in Section 7.

4.2 Gantahaz Water System

The Gantahaz water system supply wells are positioned in a deep confined aquifer and are considered non-GWUDI and non-GARP. Historically, aquifer water quality results have complied with all Northern Health's health-based objectives. However, in 2019 a new maximum allowable concentration of manganese was implemented by Northern Health.

However, over the past several years the levels of iron and manganese in the source water have fluctuated, with the total metal analysis showing the presence of iron ranging from 0.030 to 1.47 mg/L (aesthetic objective: 0.3 mg/L) and manganese ranging from 0.005 to 0.145 mg/L (maximum allowable concentration: 0.12 mg/L and aesthetic objective: 0.02 mg/L).

Testing completed in 2021 throughout the distribution network has indicated the accumulation of manganese in the network is causing significant but inconsistent exceedances of the MAC for manganese.

Based on the monitoring performed in 2021 and the new MAC for manganese, treatment of this water supply will be necessary in the future to reduce source levels and mitigate accumulation in the water network.

The District should monitor the concentrations and develop a plan to decrease concentrations. These plans could be as simple as more frequent flushing or implementing some of the recommendations from the study that the District of Mackenzie engaged L&M Engineering and Conestoga Rover Associates to undertake in 2008. The study researched the following concerns:

- Mitigate the residents' request for improved quality of water;
- Provide a water treatment system that is simple to operate by the householder;
- Provide a water treatment system that is "eco-friendly" and does not introduce chemicals into the environment; and
- Minimize the potential for future maintenance cost expenditures by the District of Mackenzie.

The conclusion of the study was that a new water treatment plant is required to reduce the levels of iron and manganese at that time to acceptable levels. The District did not have funding available to complete this project.

Subsequent to the 2008 study another option was considered which involved the abandonment of the existing poor water quality wells and connecting the Gantahaz water system with the Townsite water system. This option would require a new 6km water transmission pipe to be installed between the Townsite and Gantahaz along the existing highway. The added advantage to this option is that it services the land between the Townsite and Gantahaz with municipal water which provides the potential for cost-sharing, increased fire flows, and infrastructure for community growth.

5 WATER SYSTEM OPERATION & MAINTENANCE

The District's water system was upgraded from a Class II to a Class III distribution system in April 2018. The District employs one Class II distribution system operator, Jim Fast, Class 2 ECOP number 8864, and Mark Turnbull, trainee operator. Jim Fast is in the process of obtaining a sufficient number of direct responsible charge (DRC) credits to take the Environmental Operators Certification Program (EOCP) Class III Distribution course.

Regular inspections, maintenance, and water quality testing are performed by the system operators to ensure optimal operation of the District's water system. Operation and maintenance of the water system involve several daily, weekly, periodic, and/or 'as-needed tasks.

Daily tasks performed in 2021 include:

- Record well pump run times at each well;
- Record flow meter totalizer and flow; and
- Inspect the well and booster station pumps to ensure normal operation.

Weekly tasks performed in 2021 include:

- Inspect pressure-reducing valves; and
- Clean water system buildings.

Monthly tasks performed in 2021 include:

- Check static water levels in wells; and
- Inspect backup motors and run motors for 60 minutes.

Periodic, or "as-needed" tasks include:

- Troubleshoot minor electrical and mechanical equipment problems;

- Check propane heaters and propane tanks (winter);
- Record the time and nature of any alarms received on the water system and take appropriate action;
- Flush and clean the water mains (twice annually); and
- Exercise control valves, isolation valves, hydrants, and related appurtenances (annually).
- Water quality is discussed in Section 7.

6 WATER CONSUMPTION - 2021

6.1 Town Water System

The total water distributed to the Town distribution system in 2021 was 38,487 m^3. Table 3: Town Water System Consumption shows the monthly water consumption for the Town Water system. The average daily flow and average daily per/capita flow for 2021 was 1,513 m^3/day and 439 L/day/person respectively. The average daily flow in 2021 was slightly higher than 2020 and 2019 which were 1,432 m^3/day and 1,483 m^3/day respectively but slightly lower than 2018 which was 1,580 m^3/day.

Table 3: Town Water System Consumption

Month	Total Monthly Flow (m^3)	Average Daily Flow (L/s)
January	2713.5	14.52
February	3079.1	18.24
March	3616.0	19.34
April	3255.7	18.00
May	3321.6	17.77
June	3672.7	20.30
July	3677.7	19.67
August	3597.8	19.25
September	3269.5	18.07
October	2806.5	15.01
November	2557.5	14.14
December	2969.8	15.89

6.2 Gantahaz Water System

In 2021 reliable flow data was only available for January to August. The total water distributed to the Gantahaz distribution system from January to August 2021 was 29,197 m^3. Table 4: Gantahaz Water System Consumption shows the monthly water consumption for the Gantahaz system. The average daily flow and average daily per/capita flow for 2021 from January to August was 119 m^3/day and 451 L/day/person respectively. The average daily flow in 2021 was significantly higher than 2020, 2019, and 2018 which were 71 m^3/day, 87 m^3/day, and 90 m^3/day respectively this is likely due to the lack of flow data from September to December. If the available 2018 – 2020 data is used in place of the missing 2021 information the 2021 yearly daily average would be 97.8 m3/day which is slightly higher than the last few years.

Table 4: Gantahaz Water System Consumption

Month	Total Monthly Flow (m^3)	Average Daily Flow (L/s)
January	1561.4	0.65
February	1594.6	0.66
March	1591.1	0.59
April	2098.2	0.76
May	3342.6	1.33
June	5196.2	1.94
July	8029.4	2.90
August	5783.6	2.31
September*	1415.2 (1903.6)	0.55 (0.73)
October*	436.4 (1682.9)	0.16 (0.63)
November*	162.4 (1474.4)	0.06 (0.57)
December*	- (1456.3)	- (0.54)

*Flow meter issues starting in the middle of September. 2018 – 2022 average in brackets.

6.3 Airport Water System

There are no flow records available for the Airport system. Since this system is mainly providing fire fighting water, with only six service connections, the water consumption is expected to be low.

7 WATER QUALITY MONITORING

In order to ensure continued high standards of drinking water quality and delivery for the District of Mackenzie, the District sends water samples to ALS Analytical Services for bacteriological and chemical testing. The District's sampling program has been designed to meet the requirements of the Water System Operation permits and the Drinking Water Protection Regulation.

7.1 Chemical Testing Requirements:

The District's Operating Permits require the submittal of water chemistry data annually to Northern health for the Town system, every three years for the Gantahaz system, and every five years for the Airport system. Annual chemical water quality results are assessed to ensure compliance with the Guidelines for Canadian Drinking Water Quality (GCDWQ) published by Health Canada. Additional Testing has been performed to determine where elevated metals are occurring.

7.2 Bacteriological Testing Requirements:

The District's Operating Permits require the submittal of a minimum of five water bacteriological samples per month for the Town system, two bacteriological samples per month for the Gantahaz system, and one bacteriological sample per month for the Airport System. The Drinking Water Protection Regulation (DWPR) requires that water suppliers monitor for total coliform bacteria and Escherichia coli at a certified lab. This testing is used to monitor the distribution system, and not notify users of potential issues.

The standards for water quality are set out in Schedule A of the DWPR as follows:

Table 5: DWPR Water Quality Standards

Parameter	Standard
Fecal coliform bacteria	No detectable fecal coliform bacteria per 100ml
Escherichia coli	No detectable Escherichia coli per 100ml
Total coliform bacteria	
(a) 1 sample in a 30 day period	No detectable total coliform bacteria per 100ml
(b) more than 1 sample in a 30 day period	At least 90% of samples have no detectable total coliform bacteria per 100ml and no sample has more than 10 total coliform bacterial per 100ml

The water sampling parameters, locations, and frequency for the District's water system are shown in Table 6: Water Sampling Parameters, Locations, and Frequency. All samples are sent to an accredited laboratory (ALS Analytical Services). This sampling program meets the requirements outlined in the District's Water System Operating Permits.

Table 6: Water Sampling Parameters, Locations, and Frequency

Parameter	Frequency	Locations	Comments
Town System			
Escherichia coli, Total Coliforms	Weekly	Mackenzie Hospital	
Escherichia coli, Total Coliforms	Weekly	• Pumphouse #1 (Well #1 & #5) • Pumphouse #2 (Well #4) • Public works office • Town Booster Station • Northwest Quadrant (Munro Crescent, Blackwater Crescent, Crooked Creek Crescent) • Southeast Quadrant (Pine Crescent, Parsnip Crescent)	Sample locations are rotated on a weekly basis with one of the listed locations sampled per week.
Comprehensive Drinking Water Test	Annually	Hospital, Town booster station, and various locations throughout the town system.	Including total and dissolved metals.
Gantahaz System			
Escherichia coli, Total Coliforms	Bi-weekly	• Gantahaz booster station • Gantahaz Well #4 • Gantahaz Well # 1. • Distribution System (including Columbia Drive, Manitoba Drive, Yukon Drive, and Saskatchewan Drive)	Sample locations are rotated on a bi-weekly basis, with one of the listed locations sampled bi-weekly.
Comprehensive Drinking Water Test	Annually	Gantahaz booster station, Well #1, Well #4, and various locations throughout the Gantahaz subdivision.	Including total and dissolved metals.
Airport System			
Escherichia coli, Total Coliforms	Monthly	Airport	
Comprehensive Drinking Water Test	Once every five years	Airport	Including total and dissolved metals.

8 WATER QUALITY RESULTS

Water samples were sent to ALS Analytical Services for bacteriological and water chemistry laboratory testing. A complete set of lab results can be found on Northern Health's website: https://www.healthspace.ca/Clients/NHA/NHA_Website.nsf.

Based on the chemistry sampling that was completed, the majority of water samples conformed to the GCDWQ, and overall the groundwater quality is very good which is why the systems are being operated without treatment/disinfection. Please note that Northern Health recommends the following caveat for all water systems:

No water supply is 100 percent safe, and sudden water quality failures can take hours or even days to identify and communicate to the entire community. People who have HIV/AIDs, are undergoing chemotherapy, or have compromised immune systems are advised to consider boiling their water or installing an in-home drinking water treatment device capable of reducing their risk of illness. For additional info, please refer to the following:https://www.healthlinkbc.ca/healthlinkbc-files/preventing-water-borne-infection.

With regards to the 2021 water quality testing summarized below, there are a few parameters that exceed the guidelines. The parameters that were above the guidelines are the following:

Table 7: Parameters Exceeding Guidelines

Location	Parameter	Guideline	Number of Samples	Number of Samples Over Guideline	Minimum	Average	Maximum
Town (Source)	Total Coliforms	MAC < 1 MPN/100 mL	2	Above MAC = 1	<1	<1	1
Town (Source)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	4	Above AO = 3	0.00052	0.0694	0.12
Town (Source)	Turbidity	OG ≤ 1 NTU	4	Above OG = 2	<0.10	<0.683	1.39
Town (Distribution)	Iron (Fe) - Total	AO ≤ 0.3 mg/L	10	Above AO = 1	0.028	0.121	0.351
Town (Distribution)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	10	Above AO = 8	0.0007	0.0377	0.0886

Location	Parameter	Guideline	Number of Samples	Number of Samples Over Guideline	Minimum	Average	Maximum
Town (Distribution)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	10	Above AO = 8	0.0007	0.0377	0.0886
Town (Distribution)	Turbidity	OG ≤ 1 NTU	10	Above OG = 2	0.26	0.886	2.89
Gantahaz (Source)	Total Coliforms	MAC < 1 MPN/100 mL	28	Above MAC = 1	<1	<1	1
Gantahaz (Source)	Iron (Fe) - Total	AO ≤ 0.3 mg/L	2	Above AO = 2	0.353	0.912	1.47
Gantahaz (Source)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	2	Above MAC = 2 Above AO = 2	0.129	0.137	0.145
Gantahaz (Source)	Turbidity	OG ≤ 1 NTU	1	Above OG = 1	3.66	3.66	3.66
Gantahaz (Distribution)	Arsenic (As) - Total	MAC ≤ 0.01 mg/L	5	Above MAC = 1	0.0046	0.0077	0.0143
Gantahaz (Distribution)	Iron (Fe) - Total	AO ≤ 0.3 mg/L	5	Above AO = 3	0.227	0.688	1.84
Gantahaz (Distribution)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	5	Above MAC = 3 Above AO = 5	0.047	0.313	0.998

MAC = Guidelines for Canadian Drinking Water Quality Maximum Acceptable Concentration
AO = Guidelines for Canadian Drinking Water Quality Maximum Aesthetic Objective
OG = Guidelines for Canadian Drinking Water Quality recommend that turbidity should generally be below 1.0 NTU for groundwater systems. In some cases, a less stringent value for turbidity may be acceptable if it is demonstrated that the system has a history of acceptable microbiological quality and that a higher turbidity value will not compromise disinfection.

8.1 Bacteriological Testing Results

In 2021, there were 101 Bacteriological Samples taken throughout the district's three systems with each sample tested for E.Coli and Total Coliforms. The Town System had 68 samples taken, Gantahaz System has 31 samples and the Airport System has 2 samples taken. A summary of the results of the bacteriological water quality sampling is provided in Table 8: Bacteriological Sampling Results.

Table 8: Bacteriological Sampling Results Summary

Parameter	Location	Number of Samples	Minimum	Maximum	Average	Guideline
E. Coli (MPN/100 mL)	Town System	68	<1	<1	<1	MAC < 1 MPN/100 mL
	Gantahaz System	31	<1	<1	<1	
	Airport System	2	<1	<1	<1	
Total Coliforms (MPN/100 mL)	Town System	68	<1	1	<1	MAC < 1 MPN/100 mL
	Gantahaz System	31	<1	1	<1	
	Airport System	2	<1	<1	<1	

8.1.1 Total Coliforms

Two samples found total coliforms present with each of the two samples having 1 MPN/100 mL. One sample was taken from Well #4 at Morfee Lake on October 26th. The other sample was taken from Well #1 in the Gantahaz Water System on June 15th. Given both of these results were single occurrences with only 1 MPN/100 mL and with no further positive results it is most likely that these were caused by contamination or sampling errors.

8.2 Water Chemistry Testing Results

Summaries of the chemical laboratory testing results are provided in Table 9 to Table 12. For clarity, only chemical testing parameters with a Maximum Allowable Concentration (MAC) or Aesthetic Objective (AO) in the Guidelines for Canadian Drinking Water Quality (GCDWQ) or parameters that indicate the overall water quality are shown. The full water chemistry summaries can be found in Appendix A – 2021 Water Chemistry Results Summaries.

Table 9: Town System - Source Water Chemistry

	GCDWQ			Source				
Parameter	**MAC**	**AO**	**OG**	**Samples**	**Below Detection Limit**	**Minimum**	**Average**	**Maximum**
Physical Tests (Water)								
Hardness (as CaCO3)				4	0	124	158.25	221
Total Metals (Water)								
Aluminum (Al)			<0.1	4	3	<0.0050	<0.00525	0.006
Antimony (Sb)	0.006			4	4	<0.00020	<0.00020	<0.00020
Arsenic (As)	0.01			4	1	<0.00050	<0.0025175	0.00504
Barium (Ba)	1			4	0	0.0361	0.237025	0.752
Boron (B)	5			4	4	<0.050	<0.050	<0.050
Cadmium (Cd)	0.005			4	4	<0.000010	<0.000010	<0.000010
Chromium (Cr)	0.05			4	4	<0.00050	<0.00050	<0.00050
Copper (Cu)	2	≤1		4	1	<0.00040	<0.00157	0.0031
Iron (Fe)		≤0.3		4	1	<0.010	<0.13225	0.292
Lead (Pb)	0.005			4	1	<0.00020	<0.001755	0.00333
Manganese (Mn)	0.12	≤0.02		4	0	0.00052	0.069405	0.12
Mercury (Hg)	0.001			4	4	<0.00001	<0.00001	<0.00001
Selenium (Se)	0.05			4	4	<0.00050	<0.00050	<0.00050
Sodium (Na)		≤200		4	0	2.01	4.71	11.3
Uranium (U)	0.02			4	0	0.000787	0.00152525	0.00237
Zinc (Zn)		≤5		4	2	<0.0040	<0.011125	0.0325
General Parameters								
Chloride		≤250		4	0	0.83	12.18	42
Fluoride	1.5			4	4	<0.10	<0.10	<0.10
Nitrate (as N)	10			4	2	<0.010	<0.036	0.107
Nitrite (as N)	1			4	4	<0.010	<0.010	<0.010
Sulfate		≤500		4	0	5.3	7.6	9.2
Langelier Index				3	0	-0.1	0.2	0.4
Solids, Total Dissolved (calc)		≤500		4	0	125	178.5	264
Colour, True		≤15		3	2	<5.0	<5.55	7.2
Alkalinity, Total (as CaCO3)				4	0	114	156	201
Cyanide, Total	0.2			4	4	<0.0020	<0.0020	<0.0020
Turbidity			≤1	4	1	<0.10	<0.6825	1.39
pH		7.0-10.5		4	0	7.69	7.77	7.88

Table 10: Town System - Distribution Water Chemistry

	GCDWQ			Distribution System				
Parameter	**MAC**	**AO**	**OG**	**Samples**	**Below Detection Limit**	**Minimum**	**Average**	**Maximum**
Physical Tests (Water)								
Hardness (as CaCO3)				10	1	128	142	157
Total Metals (Water)								
Aluminum (Al)			<0.1	10	9	<0.0050	<0.0055	0.01
Antimony (Sb)	0.006			10	10	<0.00020	<0.00020	<0.00020
Arsenic (As)	0.01			10	0	0.00279	0.00374	0.00544
Barium (Ba)	1			10	1	<0.0050	<0.12382	0.691
Boron (B)	5			10	10	<0.050	<0.050	<0.050
Cadmium (Cd)	0.005			10	10	<0.000010	<0.000010	<0.000010
Chromium (Cr)	0.05			10	10	<0.00050	<0.00050	<0.00050
Copper (Cu)	2	≤1		10	0	0.00804	0.056424	0.128
Iron (Fe)		≤0.3		10	0	0.028	0.1208	0.351
Lead (Pb)	0.005			10	4	<0.00020	<0.000301	0.00057
Manganese (Mn)	0.12	≤0.02		10	0	0.00071	0.037661	0.0886
Mercury (Hg)	0.001			10	10	<0.00001	<0.00001	<0.00001
Selenium (Se)	0.05			10	10	<0.00050	<0.00050	<0.00050
Sodium (Na)		≤200		10	0	2.47	9.754	73.7
Uranium (U)	0.02			10	0	0.00199	0.018849	0.169
Zinc (Zn)		≤5		10	6	<0.0040	<0.004818	0.0083
General Parameters								
Chloride		≤250		10	0	0.1	2.516	3.06
Fluoride	1.5			10	9	<0.10	<0.1	0.1
Nitrate (as N)	10			10	9	<0.010	<0.01	0.01
Nitrite (as N)	1			10	9	0.01	<0.01	0.01
Sulfate		≤500		10	0	8.8	9.01	9.4
Langelier Index				9	0	-2.2	-0.067	0.3
Solids, Total Dissolved (calc)		≤500		10	0	154	162.5	179
Colour, True		≤15		9	9	<5.0	<5.0	<5.0
Alkalinity, Total (as CaCO3)				10	0	150	153.2	155
Cyanide, Total	0.2			10	9	<0.002	<0.002	0.002
Turbidity			≤1	10	0	0.26	0.886	2.89
pH		7.0-10.5		10	0	7.79	7.843	7.91

Table 11: Gantahaz System - Source Water Chemistry

				Date Sampled	23-Sep-2021	23-Sep-2021
				Lab Sample ID	L2232028	21I3735-03
		GCDWQ			Gantahaz Source	Gantahaz Source
Parameter	Units	MAC	AO	OG	Booster Station	Columbia Well #4
Physical Tests (Water)						
Hardness (as CaCO3)	mg/L				173	173
Total Metals (Water)						
Aluminum (Al)-Total	mg/L			>0.1	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.006			<0.00020	<0.00020
Arsenic (As)-Total	mg/L	0.01			0.00551	0.00668
Barium (Ba)-Total	mg/L	2			0.113	0.114
Boron (B)-Total	mg/L	5			<0.0500	<0.0500
Cadmium (Cd)-Total	mg/L	0.005			<0.000010	0.000102
Chromium (Cr)-Total	mg/L	0.05			<0.00050	<0.00050
Copper (Cu)-Total	mg/L	2	≤1		0.00118	0.00086
Iron (Fe)-Total	mg/L		≤0.3		0.353	1.47
Lead (Pb)-Total	mg/L	0.005			0.00059	0.00168
Manganese (Mn)-Total	mg/L	0.12	≤0.02		0.129	0.145
Mercury (Hg)-Total	mg/L	0.001			<0.000010	<0.000010
Selenium (Se)-Total	mg/L	0.05			<0.00050	<0.00050
Sodium (Na)-Total	mg/L		≤200		2.81	3.53
Uranium (U)-Total	mg/L	0.02			0.00273	0.00275
Zinc (Zn)-Total	mg/L		≤5		0.0118	0.527
General Parameters						
Chloride	mg/L		≤250		0.55	
Fluoride	mg/L	1.5			<0.10	
Nitrate (as N)	mg/L	10			<0.010	
Nitrite (as N)	mg/L	1			<0.010	
Sulfate	mg/L		≤500		16	
Langelier Index	-				0.6	
Solids, Total Dissolved (calc)	mg/L		≤500		187	
Colour, True	CU		≤15		<5.0	
Alkalinity, Total (as CaCO3)	mg/L				171	
Alkalinity, Hydroxide (as CaCO3)	mg/L				<1.0	
Cyanide, Total	mg/L	0.2			<0.0020	
Turbidity	NTU			≤1	3.66	
pH	pH units		7.0-10.5		8.11	

Table 12: Gantahaz System - Distribution Water Chemistry

		GCDWQ			Distribution System				
Parameter	Units	MAC	AO	OG	Samples	Below Detection Limit	Minimum	Average	Maximum
Physical Tests (Water)									
Hardness (as CaCO3)	mg/L				5	0	167	171	181
Total Metals (Water)									
Aluminum (Al)-Total	mg/L			>0.1	5	5	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.006			5	5	<0.00020	<0.00020	<0.00020
Arsenic (As)-Total	mg/L	0.01			5	0	0.00462	0.00775	0.0143
Barium (Ba)-Total	mg/L	2			5	0	0.108	0.1142	0.127
Boron (B)-Total	mg/L	5			5	5	<0.0500	<0.0500	<0.0500
Cadmium (Cd)-Total	mg/L	0.005			5	4	<0.000010	<0.000012	0.000018
Chromium (Cr)-Total	mg/L	0.05			5	5	<0.00050	<0.00050	<0.00050
Copper (Cu)-Total	mg/L	2	≤1		5	0	0.00337	0.02028	0.0392
Iron (Fe)-Total	mg/L		≤0.3		5	0	0.227	0.6876	1.84
Lead (Pb)-Total	mg/L	0.005			5	2	<0.00020	<0.001284	0.0039
Manganese (Mn)-Total	mg/L	0.12	≤0.02		5	0	0.0474	0.3128	0.998
Mercury (Hg)-Total	mg/L	0.001			5	5	<0.000010	<0.000010	<0.000010
Selenium (Se)-Total	mg/L	0.05			5	5	<0.00050	<0.00050	<0.00050
Sodium (Na)-Total	mg/L		≤200		5	0	2.73	2.79	2.93
Uranium (U)-Total	mg/L	0.02			5	0	0.00267	0.002748	0.00294
Zinc (Zn)-Total	mg/L		≤5		5	0	0.0048	0.0102	0.0167

8.2.1 Turbidity

The GCDWQ recommends that turbidity typically be below 1.0 NTU for groundwater sources. In some cases, a less stringent value may be actable if it is demonstrated that the system has a history of acceptable microbiological quality and that a higher value for turbidity will not compromise disinfection (which is not applicable in this case).

In the Town System, turbidity results exceeded 1.0 NTU in 2 of 4 source water samples and in 2 of 10 distribution water samples. The average of the samples for both the source and distribution water were all below 1.0 NTU. In the Gantahaz System, there was only one turbidity sample exceedance at 3.66 NTU which was taken from one of the booster stations.

Future analysis including field testing of the turbidity in the raw water is recommended to determine whether the turbidity exceedances observed in both the Town and Gantahaz are a cause for concern.

8.2.2 Iron

The GCDWQ has an aesthetic objective of 0.3 mg/L for iron. Iron is objectionable in water supplies for several reasons unrelated to health. Iron can precipitate as rust-colored silt which can result in an unpalatable taste as well as stain laundry and plumbing fixtures. In addition, iron can promote the growth of "iron bacteria" which can cause a slimy coating in water distribution pipes.

Five iron exceedances occurred in seven samples from the Gantahaz subdivision, with two occurring in the source water and three in the distribution network. The results ranged from 0.353 to 1.47 mg/L with an average of 0.912 mg/L from two samples of the source water. In the distribution network results ranged from 0.227 to 1.84 mg/L with an average of 0.688 mg/L from 5 samples.

In the Town System, iron exceedances were only observed in the distribution network with only one of the ten samples having an iron concentration above the aesthetic objective. This one result had an iron concentration of 0.351 mg/L which is slightly above the AO.

Given that the primary concern for iron concentrations above the AO is colour and taste the system should be monitored and any complaints about the aesthetic should be recorded for future consideration.

Appendix B and C contains graphs showing all the iron concentrations from sampling taken between 2018 and February 2022 for the Town and Gantahaz Water Systems.

8.2.3 Manganese

Similar to iron, manganese can form a precipitate that can cause maintenance issues in distribution systems, resulting in laundry/plumbing staining in households, and cause objectionable taste issues. In the past, the GCDWQ had only an aesthetic objective of 0.05 mg/L for manganese. However, as of May 10, 2019, the guideline was updated to include a new Maximum Acceptable Concentration (MAC) of 0.12 mg/L and a reduced Aesthetic Objective (AO) of 0.02 mg/L.

The MAC was added because new research has shown that at higher concentrations it can pose adverse neurological effects in infants and children, primarily to the central nervous system, followed by the reproductive system. Infants who consume powdered baby formula reconstituted from water that is high in manganese are that the greatest risk. Although the MAC was established based on infants, this value is intended to protect all Canadians. The AO was reduced to minimize the occurrence of discolored water due to manganese and to improve consumer confidence in drinking water quality.

As noted in Table 7: Parameters Exceeding Guidelines the manganese results are somewhat variable for both the Town and Gantahaz water systems. The results vary depending on the location and are sometimes below the AO, and some of the results exceed the new MAC. Appendix B and C contains graphs showing all the manganese concentrations from sampling taken between 2018 and February 2022 for the Town and Gantahaz Systems.

In the Town System, manganese AO exceedances were observed in 11 of the 14 samples but no sample exceeded the MAC. In the distribution network, the results ranged from 0.0007 to 0.0886 mg/L with an average of 0.0377 mg/L from ten samples. The source water was sampled four times with results ranging from 0.00052 to 0.12 mg/L with an average of 0.0694 mg/L.

All seven samples from the Gantahaz subdivision exceeded the aesthetic objective with five samples also exceeding the maximum acceptable concentration. Both source samples and two of the five distribution network samples were above the MAC. The results ranged from 0.129 to 0.145 mg/L with an average of 0.137 mg/L from two samples of the source water. The distribution network results ranged from 0.047 to 0.998 mg/L with an average of 0.313 mg/L from 5 samples.

The District flushes each distribution system twice annually to control the iron and manganese concentrations due to accumulation in the network. The highest concentrations of the iron and manganese exceedances occurred at multiple points throughout the distribution system. This indicates that those exceedances are primarily due to the accumulation and release of the minerals.

8.2.4 Arsenic

Arsenic is naturally occurring from weathering of soils and minerals and is classified as a human carcinogen. The GCDWQ has a Maximum Acceptable Concentration (MAC) of 0.01

mg/L with a recommendation to achieve an arsenic concentration As Low As Reasonable Achievable (ALARA).

No exceedances were found in the Town Water System but there was one sample from the Gantahaz distribution network that exceeded the maximum allowable concentration. The Gantahaz system had one sample from the distribution system with a concentration of 0.0143 mg/L with all five samples throughout the network averaging 0.0077 mg/L. The maximum concentration detected in the source water was 0.00668 mg/L indicating this is a potential accumulation and release issue. Appendix B contains a graph showing all the arsenic concentrations from sampling taken between 2018 and February 2022 for the Gantahaz Systems.

As with all of the metal concentrations, the arsenic level should be closely monitored and it is recommended that additional system flushing should occur.

9 CONCLUSION & RECOMMENDATIONS

The water quality of the three water systems in the District of Mackenzie are of good water chemistry with some exceedances of the manganese MAC and one occurrence of the arsenic MAC in the distribution system. The microbiological quality of the water is excellent with no E. Coli found in the water system and only two of the 101 samples containing total coliforms with the two positive samples containing only 1 MPN/100 mL.

The District of Mackenzie is committed to ensuring that the community has safe and secure drinking water. In 2022, the District will be undertaking additional water sampling and analysis to determine the extent and impact that manganese and other metals are having on the water system while exploring options to improve water quality for the end-users.

If you have any questions or comments regarding the content of this report please contact Ken Gawryluk, Interim Director of Operations for the District at 250-997-3761 or at ken@districtofmackenzie.ca.

APPENDIX A – 2021 WATER CHEMISTRY RESULTS SUMMARY

Table 13: Town System - Source Water Chemistry

	GCDWQ			Source				
Parameter	**MAC**	**AO**	**OG**	**Samples**	**Below Detection Limit**	**Minimum**	**Average**	**Maximum**
Physical Tests (Water)								
Hardness (as CaCO3)				4	0	124	158.25	221
Total Metals (Water)								
Aluminum (Al)			<0.1	4	3	<0.0050	<0.00525	0.006
Antimony (Sb)	0.006			4	4	<0.00020	<0.00020	<0.00020
Arsenic (As)	0.01			4	1	<0.00050	<0.0025175	0.00504
Barium (Ba)	1			4	0	0.0361	0.237025	0.752
Boron (B)	5			4	4	<0.050	<0.050	<0.050
Cadmium (Cd)	0.005			4	4	<0.000010	<0.000010	<0.000010
Calcium (Ca)				4	0	42.1	50	68
Chromium (Cr)	0.05			4	4	<0.00050	<0.00050	<0.00050
Cobalt (Co)				4	4	<0.00010	<0.00010	<0.00010
Copper (Cu)	2	≤1		4	1	<0.00040	<0.00157	0.0031
Iron (Fe)		≤0.3		4	1	<0.010	<0.13225	0.292
Lead (Pb)	0.005			4	1	<0.00020	<0.001755	0.00333
Magnesium (Mg)				4	0	4.54	8.05	12.3
Manganese (Mn)	0.12	≤0.02		4	0	0.00052	0.069405	0.12
Mercury (Hg)	0.001			4	4	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)				4	0	0.00031	0.0004575	0.00058
Nickel (Ni)				4	3	<0.00040	<0.0005925	0.00117
Potassium (K)				4	0	0.5	0.6325	0.77
Selenium (Se)	0.05			4	4	<0.00050	<0.00050	<0.00050
Sodium (Na)		≤200		4	0	2.01	4.71	11.3
Uranium (U)	0.02			4	0	0.000787	0.00152525	0.00237
Zinc (Zn)		≤5		4	2	<0.0040	<0.011125	0.0325
General Parameters								
Chloride		≤250		4	0	0.83	12.18	42
Fluoride	1.5			4	4	<0.10	<0.10	<0.10
Nitrate (as N)	10			4	2	<0.010	<0.036	0.107
Nitrite (as N)	1			4	4	<0.010	<0.010	<0.010
Sulfate		≤500		4	0	5.3	7.6	9.2
Langelier Index				3	0	-0.1	0.2	0.4
Solids, Total Dissolved (calc)		≤500		4	0	125	178.5	264
Colour, True		≤15		3	2	<5.0	<5.55	7.2
Alkalinity, Total (as CaCO3)				4	0	114	156	201
Cyanide, Total	0.2			4	4	<0.0020	<0.0020	<0.0020
Turbidity			≤1	4	1	<0.10	<0.6825	1.39
pH		7.0-10.5		4	0	7.69	7.77	7.88
Conductivity (EC)				4	0	251	333.25	504

Table 14: Town System - Distribution Water Chemistry

	GCDWQ			Distribution System				
Parameter	**MAC**	**AO**	**OG**	**Samples**	**Below Detection Limit**	**Minimum**	**Average**	**Maximum**
Physical Tests (Water)								
Hardness (as CaCO3)				10	1	128	142	157
Total Metals (Water)								
Aluminum (Al)			<0.1	10	9	<0.0050	<0.0055	0.01
Antimony (Sb)	0.006			10	10	<0.00020	<0.00020	<0.00020
Arsenic (As)	0.01			10	0	0.00279	0.00374	0.00544
Barium (Ba)	1			10	1	<0.0050	<0.12382	0.691
Boron (B)	5			10	10	<0.050	<0.050	<0.050
Cadmium (Cd)	0.005			10	10	<0.000010	<0.000010	<0.000010
Calcium (Ca)				10	1	<0.20	<40.63	50.8
Chromium (Cr)	0.05			10	10	<0.00050	<0.00050	<0.00050
Cobalt (Co)				10	10	<0.00010	<0.00010	<0.00010
Copper (Cu)	2	≤1		10	0	0.00804	0.056424	0.128
Iron (Fe)		≤0.3		10	0	0.028	0.1208	0.351
Lead (Pb)	0.005			10	4	<0.00020	<0.000301	0.00057
Magnesium (Mg)				10	0	0.033	6.4693	7.45
Manganese (Mn)	0.12	≤0.02		10	0	0.00071	0.037661	0.0886
Mercury (Hg)	0.001			10	10	<0.00001	<0.00001	<0.00001
Molybdenum (Mo)				10	0	0.0005	0.000556	0.00062
Nickel (Ni)				10	10	<0.00040	<0.00040	<0.00040
Potassium (K)				10	0	0.14	0.569	0.64
Selenium (Se)	0.05			10	10	<0.00050	<0.00050	<0.00050
Sodium (Na)		≤200		10	0	2.47	9.754	73.7
Uranium (U)	0.02			10	0	0.00199	0.018849	0.169
Zinc (Zn)		≤5		10	6	<0.0040	<0.004818	0.0083
General Parameters								
Chloride		≤250		10	0	0.1	2.516	3.06
Fluoride	1.5			10	9	<0.10	<0.1	0.1
Nitrate (as N)	10			10	9	<0.010	<0.01	0.01
Nitrite (as N)	1			10	9	0.01	<0.01	0.01
Sulfate		≤500		10	0	8.8	9.01	9.4
Langelier Index				9	0	-2.2	-0.067	0.3
Solids, Total Dissolved (calc)		≤500		10	0	154	162.5	179
Colour, True		≤15		9	9	<5.0	<5.0	<5.0
Alkalinity, Total (as CaCO3)				10	0	150	153.2	155
Cyanide, Total	0.2			10	9	<0.002	<0.002	0.002
Turbidity			≤1	10	0	0.26	0.886	2.89
pH		7.0-10.5		10	0	7.79	7.843	7.91
Conductivity (EC)				10	0	154	276.3	294

Table 15: Gantahaz System - Source Water Chemistry

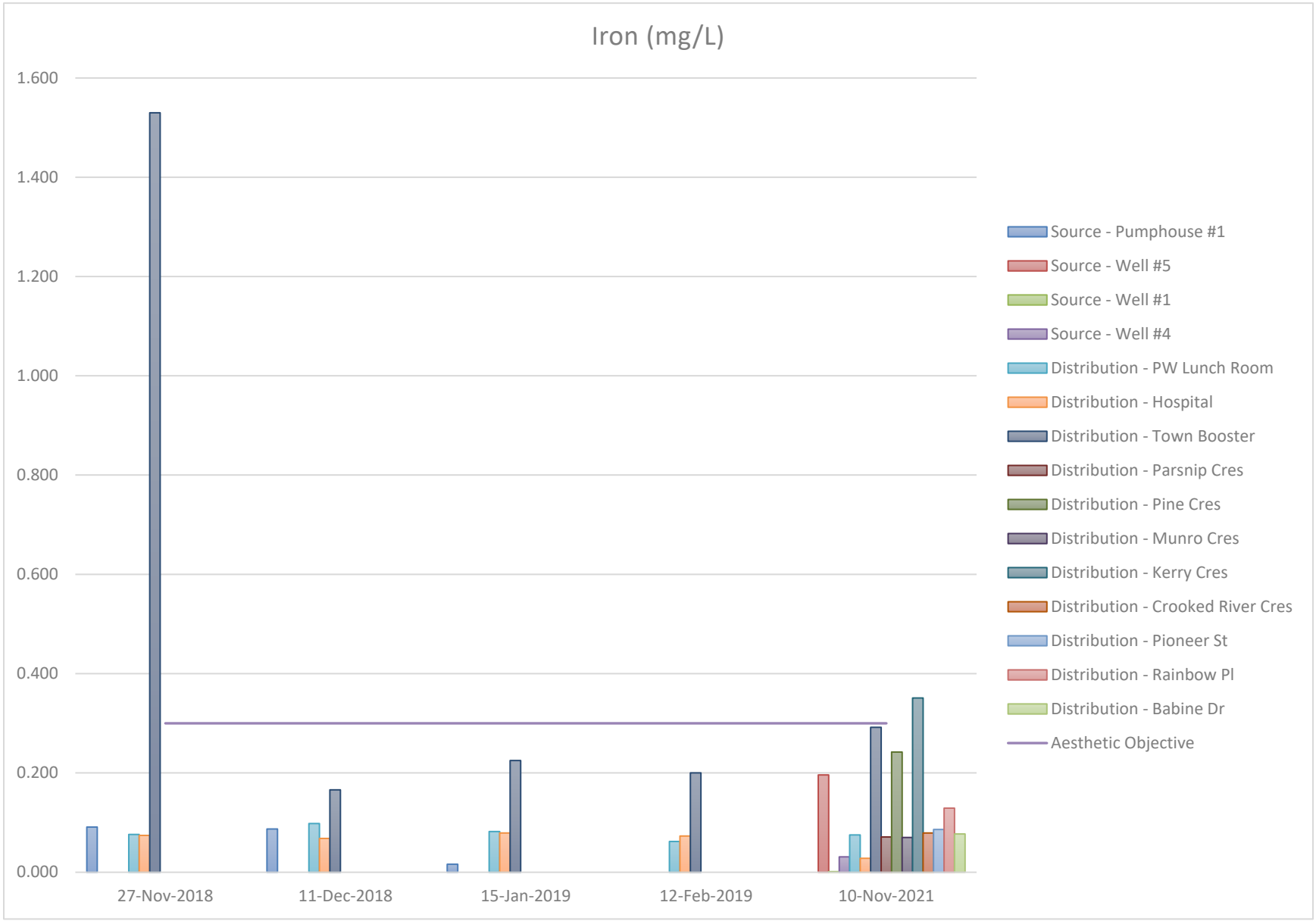
					Date Sampled	23-Sep-2021	23-Sep-2021
					Lab Sample ID	L2232028	21I3735-03
		GCDWQ				Gantahaz Source	Gantahaz Source
Parameter	Units	MAC	AO	OG		Booster Station	Columbia Well #4
Physical Tests (Water)							
Hardness (as CaCO3)	mg/L					173	173
Total Metals (Water)							
Aluminum (Al)-Total	mg/L			>0.1		<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.006				<0.00020	<0.00020
Arsenic (As)-Total	mg/L	0.01				0.00551	0.00668
Barium (Ba)-Total	mg/L	2				0.113	0.114
Beryllium (Be)-Total	mg/L					--	<0.00010
Boron (B)-Total	mg/L	5				<0.0500	<0.0500
Cadmium (Cd)-Total	mg/L	0.005				<0.000010	0.000102
Calcium (Ca)-Total	mg/L					52.3	52.9
Chromium (Cr)-Total	mg/L	0.05				<0.00050	<0.00050
Cobalt (Co)-Total	mg/L					<0.00010	0.00016
Copper (Cu)-Total	mg/L	2	≤1			0.00118	0.00086
Iron (Fe)-Total	mg/L		≤0.3			0.353	1.47
Lead (Pb)-Total	mg/L	0.005				0.00059	0.00168
Lithium (Li)-Total	mg/L					--	0.00354
Magnesium (Mg)-Total	mg/L					10.2	9.95
Manganese (Mn)-Total	mg/L	0.12	≤0.02			0.129	0.145
Mercury (Hg)-Total	mg/L	0.001				<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L					0.00156	0.00129
Nickel (Ni)-Total	mg/L					<0.00040	0.001
Potassium (K)-Total	mg/L					0.75	0.72
Selenium (Se)-Total	mg/L	0.05				<0.00050	<0.00050
Silver (Ag)-Total	mg/L					--	<0.000050
Sodium (Na)-Total	mg/L		≤200			2.81	3.53
Thallium (Tl)-Total	mg/L					--	<0.000020
Tin (Sn)-Total	mg/L					--	<0.00020
Titanium (Ti)-Total	mg/L					--	<0.0050
Uranium (U)-Total	mg/L	0.02				0.00273	0.00275
Vanadium (V)-Total	mg/L					--	<0.0010
Zinc (Zn)-Total	mg/L		≤5			0.0118	0.527

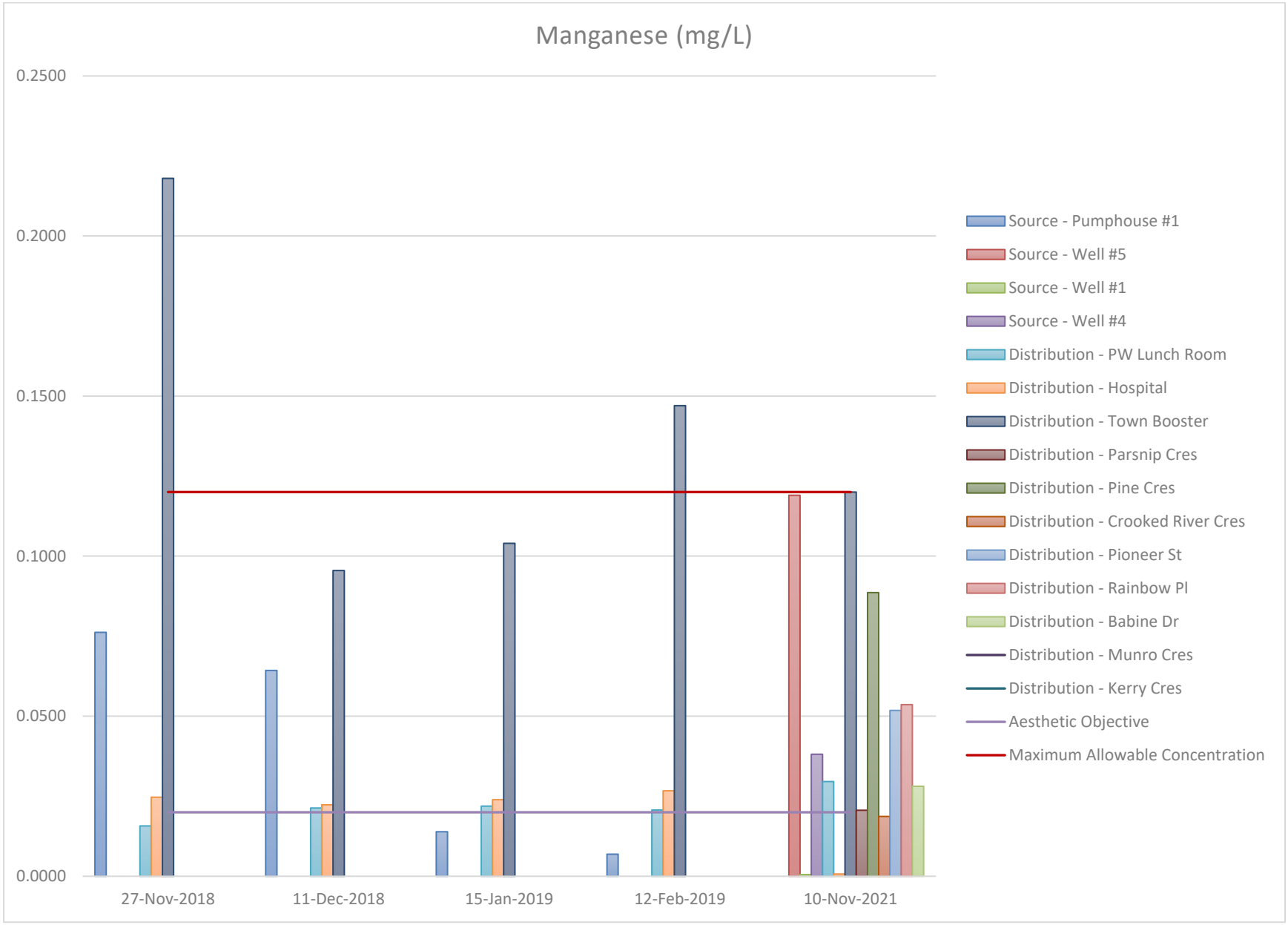
		GCDWQ			Gantahaz Source	Gantahaz Source
Parameter	Units	MAC	AO	OG	Booster Station	Columbia Well #4
General Parameters						
Chloride	mg/L		≤250		0.55	
Fluoride	mg/L	1.5			<0.10	
Nitrate (as N)	mg/L	10			<0.010	
Nitrite (as N)	mg/L	1			<0.010	
Sulfate	mg/L		≤500		16	
Langelier Index	-				0.6	
Solids, Total Dissolved (calc)	mg/L		≤500		187	
Temperature, at pH	°C				21.1	
Colour, True	CU		≤15		<5.0	
Alkalinity, Total (as CaCO3)	mg/L				171	
Alkalinity, Phenolphthalein (as CaCO3)	mg/L				<1.0	
Alkalinity, Bicarbonate (as CaCO3)	mg/L				171	
Alkalinity, Carbonate (as CaCO3)	mg/L				<1.0	
Alkalinity, Hydroxide (as CaCO3)	mg/L				<1.0	
Cyanide, Total	mg/L	0.2			<0.0020	
Turbidity	NTU			≤1	3.66	
pH	pH units		7.0-10.5		8.11	
Conductivity (EC)	uS/cm				311	

Table 16: Gantahaz System - Distribution Water Chemistry

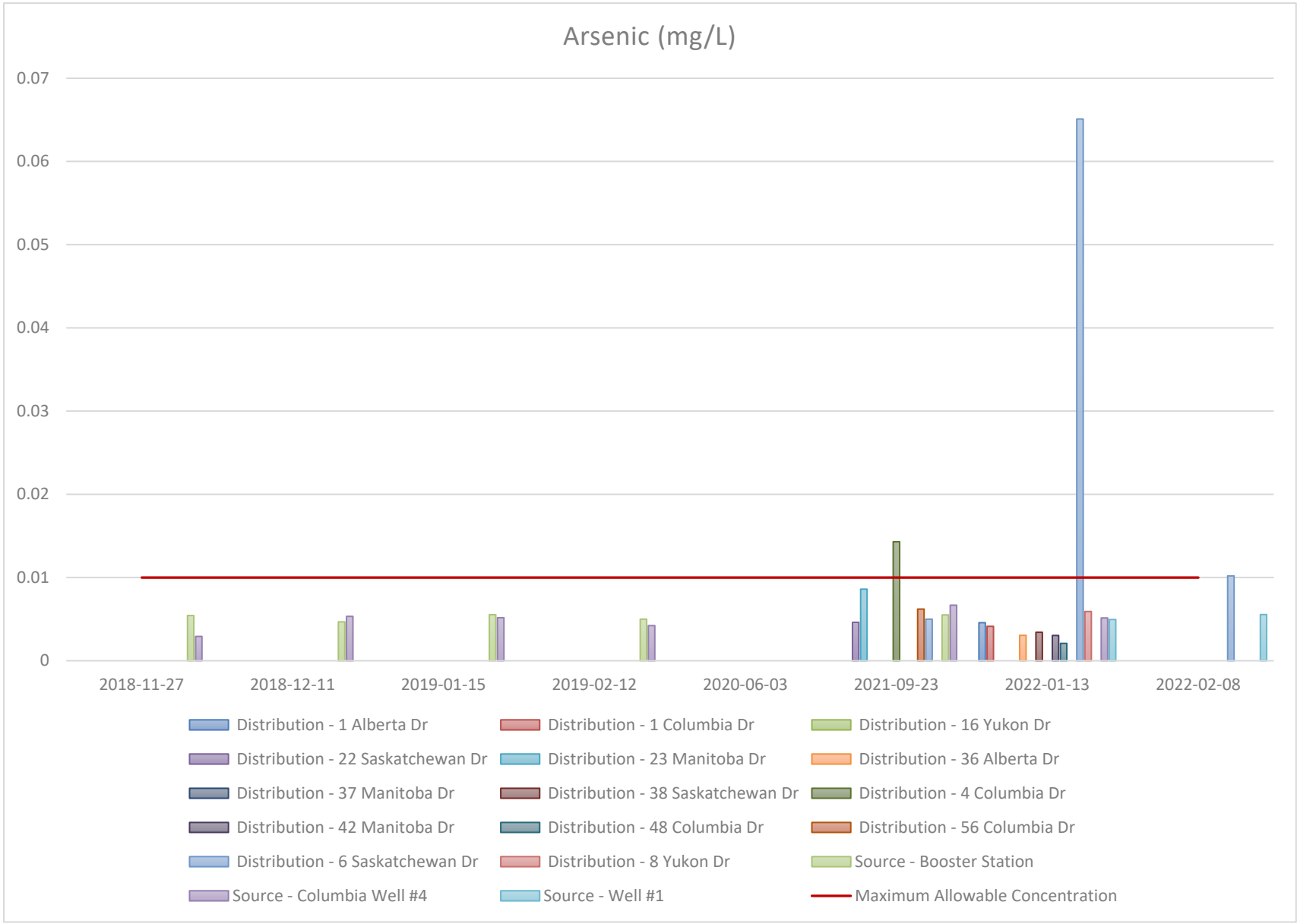
		GCDWQ			Distribution System				
Parameter	Units	MAC	AO	OG	Samples	Below Detection Limit	Minimum	Average	Maximum
Physical Tests (Water)									
Hardness (as CaCO3)	mg/L				5	0	167	171	181
Total Metals (Water)									
Aluminum (Al)-Total	mg/L			>0.1	5	5	<0.0050	<0.0050	<0.0050
Antimony (Sb)-Total	mg/L	0.006			5	5	<0.00020	<0.00020	<0.00020
Arsenic (As)-Total	mg/L	0.01			5	0	0.00462	0.00775	0.0143
Barium (Ba)-Total	mg/L	2			5	0	0.108	0.1142	0.127
Beryllium (Be)-Total	mg/L				5	5	<0.00010	<0.00010	<0.00010
Boron (B)-Total	mg/L	5			5	5	<0.0500	<0.0500	<0.0500
Cadmium (Cd)-Total	mg/L	0.005			5	4	<0.000010	<0.000012	0.000018
Calcium (Ca)-Total	mg/L				5	0	50.7	51.76	54.9
Chromium (Cr)-Total	mg/L	0.05			5	5	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total	mg/L				5	4	<0.00010	0.00012	0.00012
Copper (Cu)-Total	mg/L	2	≤1		5	0	0.00337	0.02028	0.0392
Iron (Fe)-Total	mg/L		≤0.3		5	0	0.227	0.6876	1.84
Lead (Pb)-Total	mg/L	0.005			5	2	<0.00020	<0.001284	0.0039
Lithium (Li)-Total	mg/L				5	0	0.00344	0.003516	0.00368
Magnesium (Mg)-Total	mg/L				5	0	9.87	10.094	10.6
Manganese (Mn)-Total	mg/L	0.12	≤0.02		5	0	0.0474	0.3128	0.998
Mercury (Hg)-Total	mg/L	0.001			5	5	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	mg/L				5	0	0.00104	0.00138	0.00174
Nickel (Ni)-Total	mg/L				5	5	<0.00040	<0.00040	<0.00040
Potassium (K)-Total	mg/L				5	0	0.72	0.734	0.78
Selenium (Se)-Total	mg/L	0.05			5	5	<0.00050	<0.00050	<0.00050
Silver (Ag)-Total	mg/L				5	5	<0.000050	<0.000050	<0.000050
Sodium (Na)-Total	mg/L		≤200		5	0	2.73	2.79	2.93
Thallium (Tl)-Total	mg/L				5	5	<0.000020	<0.000020	<0.000020
Tin (Sn)-Total	mg/L				5	5	<0.00020	<0.00020	<0.00020
Titanium (Ti)-Total	mg/L				5	5	<0.0050	<0.0050	<0.0050
Uranium (U)-Total	mg/L	0.02			5	0	0.00267	0.002748	0.00294
Vanadium (V)-Total	mg/L				5	5	<0.0010	<0.0010	<0.0010
Zinc (Zn)-Total	mg/L		≤5		5	0	0.0048	0.0102	0.0167

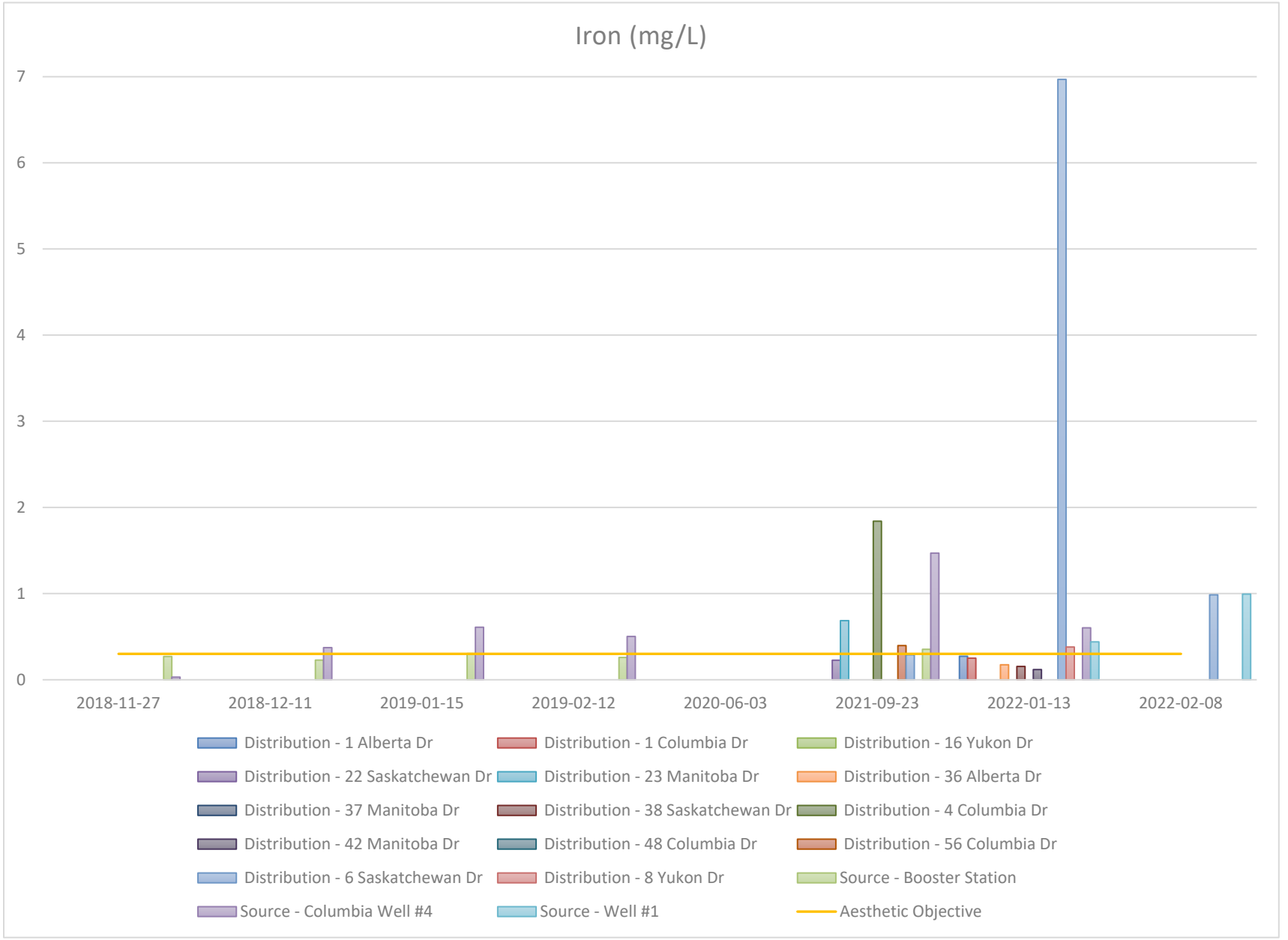
APPENDIX B – TOWN SYSTEM EXCEEDANCES (2018-2022)

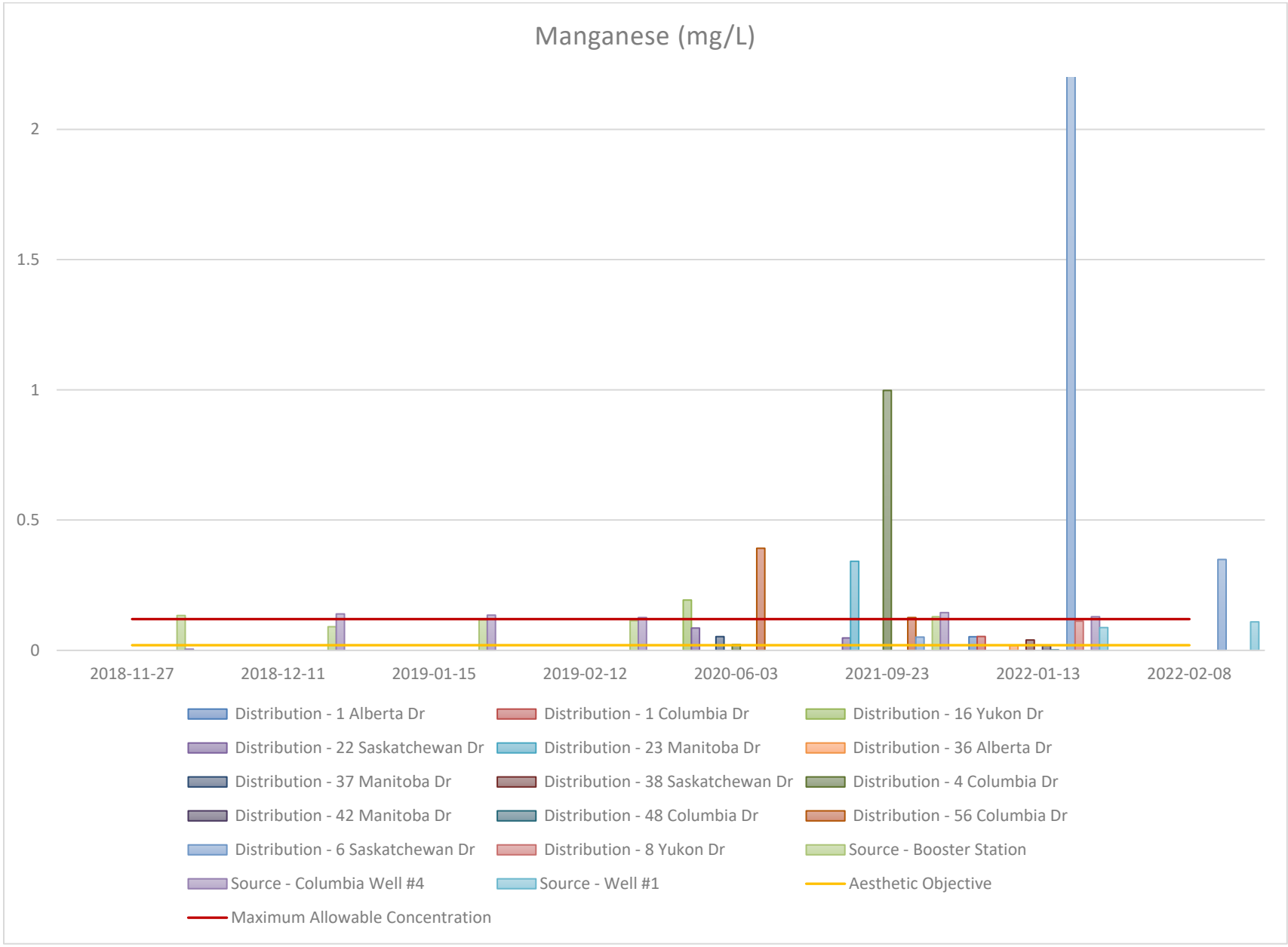



Manganese (mg/L)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
27-Nov-2018
11-Dec-2018
15-Jan-2019
12-Feb-2019
10-Nov-2021
Source - Pumphouse #1
Source - Well #5
Source - Well #1
Source - Well #4
Distribution - PW Lunch Room
Distribution - Hospital
Distribution - Town Booster
Distribution - Parsnip Cres
Distribution - Pine Cres
Distribution - Crooked River Cres
Distribution - Pioneer St
Distribution - Rainbow Pl
Distribution - Babine Dr
Distribution - Munro Cres
Distribution - Kerry Cres
Aesthetic Objective
Maximum Allowable Concentration

APPENDIX C – GANTAHAZ SYSTEM EXCEEDANCES (2018-2022)



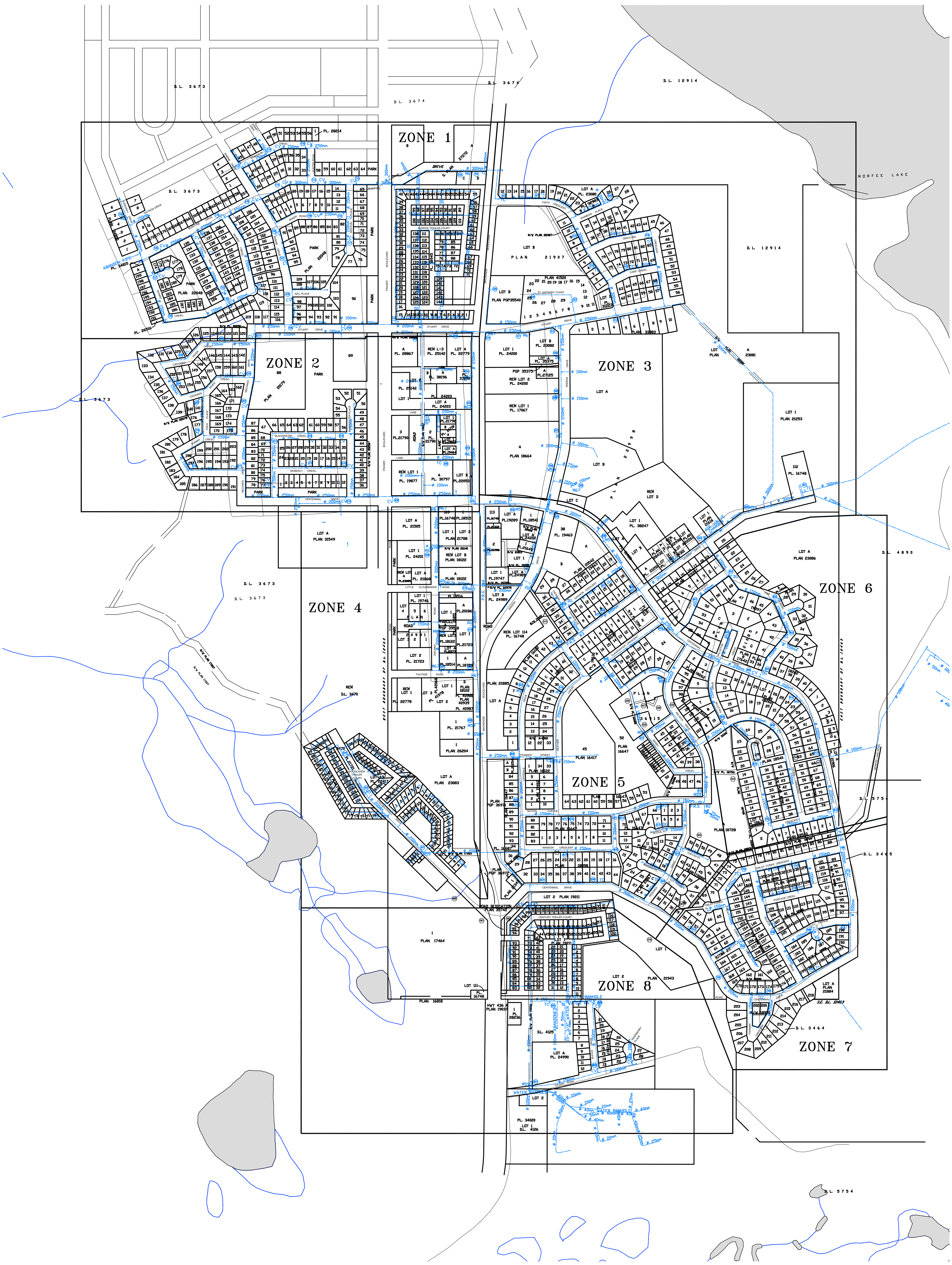

Iron (mg/L)
7
6
5
4
3
2
1
0
2018-11-27
2018-12-11
2019-01-15
2019-02-12
2020-06-03
2021-09-23
2022-01-13
2022-02-08
Distribution - 1 Alberta Dr
Distribution - 1 Columbia Dr
Distribution - 16 Yukon Dr
Distribution - 22 Saskatchewan Dr
Distribution - 23 Manitoba Dr
Distribution - 36 Alberta Dr
Distribution - 37 Manitoba Dr
Distribution - 38 Saskatchewan Dr
Distribution - 4 Columbia Dr
Distribution - 42 Manitoba Dr
Distribution - 48 Columbia Dr
Distribution - 56 Columbia Dr
Distribution - 6 Saskatchewan Dr
Distribution - 8 Yukon Dr
Source - Booster Station
Source - Columbia Well #4
Source - Well #1
Aesthetic Objective


Manganese (mg/L)
2
1.5
1
0.5
0
2018-11-27
2018-12-11
2019-01-15
2019-02-12
2020-06-03
2021-09-23
2022-01-13
2022-02-08
Distribution - 1 Alberta Dr
Distribution - 1 Columbia Dr
Distribution - 16 Yukon Dr
Distribution - 22 Saskatchewan Dr
Distribution - 23 Manitoba Dr
Distribution - 36 Alberta Dr
Distribution - 37 Manitoba Dr
Distribution - 38 Saskatchewan Dr
Distribution - 4 Columbia Dr
Distribution - 42 Manitoba Dr
Distribution - 48 Columbia Dr
Distribution - 56 Columbia Dr
Distribution - 6 Saskatchewan Dr
Distribution - 8 Yukon Dr
Source - Booster Station
Source - Columbia Well #4
Source - Well #1
Aesthetic Objective
Maximum Allowable Concentration

APPENDIX D – TOWN AND GANTAHAZ WATER SYSTEM MAPS

DISTRICT OF MACKENZIE

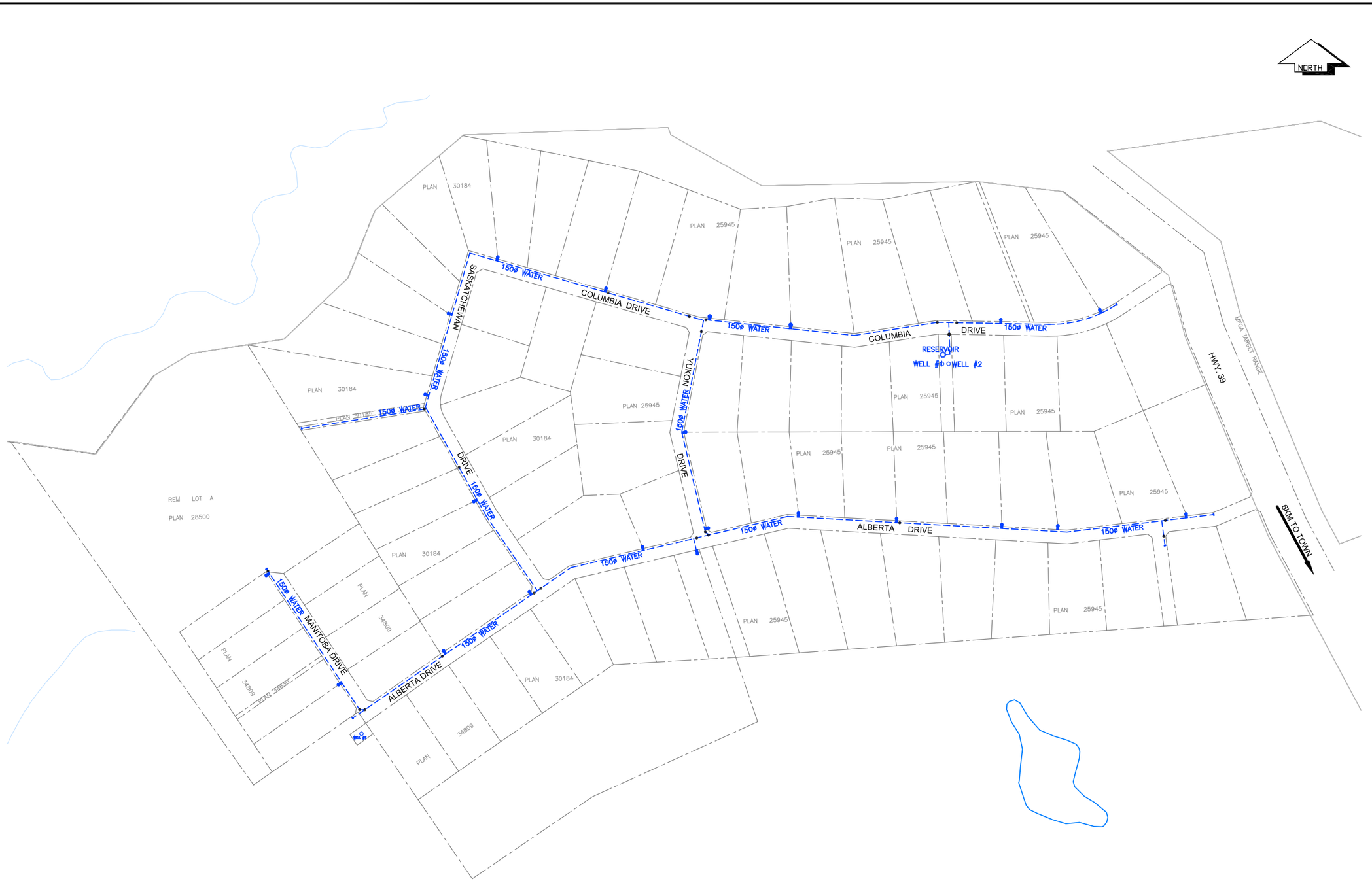
WATER SYSTEM SERVICING LAYOUT



0 500

SCALE 1:5000

ENGINEERING LIMITED



LEGEND

- FIRE HYDRANT
- VALVE
- WELL
- PUMP HOUSE
- RESERVOIR
- WATER LINE
- EXISTING LEGAL

DISTRICT OF MACKENZIE

NO.	DATE	REVISION	DR.

L&M ENGINEERING LIMITED

1210 FOURTH AVENUE
PRINCE GEORGE, B.C.
V2L 3J4
TEL. (250) 562-1977
FAX (250) 562-1967

DRAWN:	NP
CHECKED:	
ENGINEER:	LR
SURVEY FILE:	
DRAWING FILE:	Gantahaz_water_system.dwg
CORRESPONDENCE:	CPG
GRID:	
DATE:	12/02/08
SCALES:	1:3000

MACKENZIE DISTRICT
GANTAHAZ RURAL SUBDIVISION
WATER SYSTEM

CONSULTANTS PROJECT No.
1044-00-00

DRAWING No.
MAP 01

SHEET No.	REV. No.
1 OF 1	0

ISSUED FOR INFORMATION ONLY

G:\Job Files\1000\1044 - District of Mackenzie\19 GANTAHAZ LAKE\Gantahaz_water_system.dwg

APPENDIX E – WATER SYSTEM OPERATING PERMITS

PERMIT
TO OPERATE

A Drinking Water System with
301-10000 Connections

System Name: Mackenzie CWS Morfee Lake

Physical Location: Mackenzie CWS
1 Mackenzie Boulevard
Mackenzie BC

Owner Name: District Of Mackenzie

Conditions of Permit

> Maintain a minimum of 5 water bacteriology samples per month unless the Enviro
Health Officer requests a greater frequency.
> Maintain an up-to-date Emergency Response Plan.
> Operator must be trained and certified at the level specified by the Environmental Op
Certification Program.
> Submit water chemistry data every 1 years, unless the Environmental Health Officer
requests a greater frequency

northern health
Expires March 2021
0542

northern health
Expires March 2020
0605

northern health
Expires March 2019
1904

northern health
Expires March 2023
0248

PERMIT
TO OPERATE

A Drinking Water System with
15-300 Connections

System Name: Mackenzie CWS Gantahaz Subdivision

Physical Location: Mackenzie CWS
1 Mackenzie Boulevard
Mackenzie BC

Owner Name: District Of Mackenzie

Conditions of Permit

intain a minimum of 2 water bacteriology samples per month unless the Environmental
th Officer requests a greater frequency.
intain an up-to-date Emergency Response Plan.
erator must be trained and certified at the level specified by the Environmental Operators
ication Program.
mit water chemistry data every 3 years, unless the Environmental Health Officer
ets a greater frequency.

-Mar-2001
ctive Permit Date

Environmental Health Officer

ul-2019
rmit Revised Date