April 30, 2025

DISTRICT OF MACKENZIE
WATER SYSTEM ANNUAL REPORT - 2024

Client: District of Mackenzie
L&M Project No.: 1044-67

L&M ENGINEERING LIMITED
1210 Fourth Avenue, Prince George, BC V2L 3J4
Phone: (250) 562-1977

TABLE OF CONTENTS

1 INTRODUCTION

The District of Mackenzie ("The District") operates three separate water distribution systems (Town, Airport, & Gantahaz) which are permitted by the Northern Health Authority (NHA). This 2024 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.

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 Jim Fast, Lead Operator, for the District at 250-997-3761 or at utilities@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 180 km, by road, northwest of Prince George at 55 N 18' north latitude and 123 N 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 2021. 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
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	3281	1610	3048	1521	233	89
2022	3281	1610	3048	1521	233	89
2023	3281	1610	3048	1521	233	89
2024	3281	1610	3048	1521	233	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. On the Environment Canada website, the Precipitation Data from March to June 2022 looks to be missing but not flagged. After a number of years of low precipitation, 2024 returned to an above average amount of precipitation.

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	-1.1	257	335	38.7	58
2022[1]	19.0	-2.0	74.4	77.9	28.4	91
2023	20.2	1.6	30.1	56.1	32.7	69
2024	17.9	0.3	327	202	26.5	61

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 3: 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.

In 1998 a Water System Study was performed by L&M Engineering Limited that examined water system flows and pressure throughout the distribution network. The study also reviewed the recommended and available fire flows. The conclusions and recommendations are based on the Insurance Bureau of Canada Guidelines, however, there are no government regulations requiring any given volume of storage and the District can decide based on financial and other considerations.

The significant conclusions of the study were as follows:

- The existing booster station is capable of meeting existing and projected future demands without upgrading the capacity of the pumps.
- Like many towns the District's fire water storage capacity was identified by previous reporting as being 2,660,000 Igal (12,103,000 L) below the amount recommended by the Insurance Bureau of Canada ("IBC"); and
- With the future addition of a new reservoir, 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 recommendations of the study were as follows:

- The District should construct a new reservoir to provide additional storage volume. The final location will be confirmed during the design process based on current needs and anticipated future demands. The minimum size of the reservoir should be 1,000,000 Igal (4,540,000 L) although as stated in the conclusions a larger size of 2,660,000 Igal is desirable;

- The District should consider a pipe cleaning program of all distribution pipes to increase pipe smoothness areas of reduced flow

Improvements are planned for the Town water system in summer 2025 as follows:

- Five Hydrants are to be rebuilt. #527,309,103,507 and 610
- One Hydrant (704) to be replaced.
- Continued cross connection awareness and remediation.
- Reservoir Inspection.
- Reservoir cleaning unable to be scheduled for 2024.
- Ongoing training.

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

Both wells pump water to a 380 m^3 (85,580 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, variable frequency drives, and other building envelope improvements were completed in 2019.

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 2025 as follows:

- New Water Treatment Plant completion and operation
- Hydrant rebuild and maintenance.
- Continued cross connection awareness and remediation.
- Ongoing training.

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 firefighting 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 not groundwater under direct influence (GWUDI) and not groundwater at risk of pathogens (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 has selected a

Design-Build Contractor to design and construct a new water treatment plant with an anticipated operational date of Summer 2025.

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, Class I distribution system operator. Jim Fast is in the process of obtaining enough 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 2024 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 2024 include:

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

Monthly tasks performed in 2024 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 - 2024

6.1 Town Water System

The total water distributed to the Town distribution system in 2024 was 563,904 m^3. Table 4: 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 2024 was 1,545 m^3/day and 507 L/day/person respectively. The average daily flow in 2024 was lower than the last 5 year average which was 1,553 m^3/day and last year was 1719 m^3/day.

Table 4: Town Water System Consumption

Month	Total Monthly Flow (m^3)	Average Daily Flow (L/s)
January	44,150	16.48
February	38,114	14.70
March	43,460	16.23
April	50,598	19.52
May	45,439	16.97
June	54,604	20.39
July	45,834	17.68
August	51,120	19.09
September	48,485	18.71
October	53,398	19.94
November	41,869	17.31
December	46,833	17.49

6.2 Gantahaz Water System

The total water distributed to the Gantahaz distribution system 2024 was 41,912 m^3. Table 5: Gantahaz Water System Consumption shows the monthly water consumption for the Gantahaz system. The average daily flow and average daily per/capita flow for 2024 was 115 m^3/day and 493 L/day/person respectively. The average daily flow in 2024 was higher than the last 5 years average which was 101 m^3/day but lower than 2023 average which was 125 m^3/day.

Table 5: Gantahaz Water System Consumption

Month	Total Monthly Flow (m^3)	Average Daily Flow (L/s)
January	2,505	0.94
February	1,728	0.67
March	2,085	0.78
April	2,638	1.02
May	5,615	2.10
June	10,085	3.77
July	4,077	1.57
August	4,067	1.52
September	2,044	0.79
October	2,176	0.81
November	2,628	1.09
December	2,265	0.85

6.3 Airport Water System

There are no flow records available for the Airport system. Since this system is mainly providing firefighting 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 6: DWPR Water Quality Standards

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

The water sampling parameters, locations, and frequency for the District's water system are shown in Table 7: 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 7: Water Sampling Parameters, Locations, and Frequency

Parameter	Frequency	Locations	Comments
Town System			
Escherichia coli, Total Coliforms	Minimum five per month	• Recreation Centre • Emergency Heath Services • Pumphouse #1 (Well #1 & #5) • Pumphouse #2 (Well #4) • Public works office • Town Booster Station • Northwest Quadrant (Summit Crescent, Gataiga Drive, and McIntyre Drive) • Southeast Quadrant (Cicada Road and Centennial Drive)	Sample locations are rotated

Comprehensive Drinking Water Test	Minimum Annually	Town booster station, and various locations throughout the town system.	Including total and dissolved metals.
Gantahaz System			
Escherichia coli, Total Coliforms	Minimum twice per month	• 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
Comprehensive Drinking Water Test	Minimum Once every three years	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 2024 water quality testing summarized below, there are a few parameters that exceed the guidelines or exceeded the guidelines in previous years. The parameters that were above the guidelines or were above the guidelines in previous years are the following:

Table 8: Parameters Exceeding Guidelines

Location	Parameter	Guideline	Number of Samples	Number of Samples Over Guideline	Minimum	Average	Maximum
Town (Source)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	1	Above AO = 1	0.065	0.065	0.065
Town (Source)	Iron (Fe) - Total	AO ≤ 0.3 mg/L	1	Above AO = 0	0.097	0.097	0.097
Gantahaz (Source)	Iron (Fe) - Total	AO ≤ 0.3 mg/L	1	Above AO = 0	0.138	0.138	0.138
Gantahaz (Source)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	1	Above AO = 1	0.117	0.117	0.117
Airport (Source)	Manganese (Mn) - Total	MAC ≤ 0.12 mg/L AO ≤ 0.02 mg/L	1	Above AO = 1	0.114	0.114	0.114

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 2024, there were 200 Bacteriological Samples taken throughout the District's three systems with each sample tested for E. Coli and Total Coliforms. The Town System had 149 samples taken with 1 rejected due to the sample freezing during transport, Gantahaz System had 39 samples with 1 rejected due to a delay in the lab receiving the sample and 1 rejected due to the sample freezing during transport, and the Airport System had 13 samples taken. A summary of the results of the bacteriological water quality sampling is provided in Table 9: Bacteriological Sampling Results. There were no samples in the last year that detected the presence of E. Coli. Total Coliforms were found in 1 sample in the Town System and 3 samples in the Gantahaz system. The Total Coliforms results were

satisfactory since at least 90% of samples had no detectable total coliform bacteria per 100 ml and no samples has more than 10 total coliform bacterial per 100 ml.

Table 9: Bacteriological Sampling Results Summary

Parameter	Location	Number of Samples	Minimum	Maximum	Exceedance	Criteria
E. Coli (MPN/100 mL)	Town System	147	<1	<1	<1	MAC < 1 MPN/100 mL
	Gantahaz System	38	<1	<1	<1	
	Airport System	13	<1	<1	<1	
Total Coliforms (MPN/100 mL)	Town System	147	<1	1	1	MAC < 1 MPN/100 mL
	Gantahaz System	38	<1	4.2	3	
	Airport System	13	<1	<1	<1	

8.2 Water Chemistry Testing Results

Summaries of the chemical laboratory testing results are provided in Table 10 to Table 11. 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 – Water Chemistry Results Summaries.

Table 10: Town System - Source Water Chemistry

Date Sampled					**5-Feb-2024**
Lab Sample ID					KS2400367-001
Parameter	Units	GCDWQ			Town Water
		MAC	AO	OG	**Laurier Booster**
Physical Tests (Water)					
Hardness (as CaCO3)	mg/L				147
Total Metals (Water)					
Aluminum (Al)-Total	mg/L			>0.1	<0.0030
Antimony (Sb)-Total	mg/L	0.006			<0.00010
Arsenic (As)-Total	mg/L	0.01			0.00258
Barium (Ba)-Total	mg/L	2			0.0629
Boron (B)-Total	mg/L	5			<0.010
Cadmium (Cd)-Total	mg/L	0.005			<0.0000050
Calcium (Ca)-Total	mg/L				47

Chromium (Cr)-Total	mg/L	0.05			<0.00050
Cobalt (Co)-Total	mg/L				<0.00010
Copper (Cu)-Total	mg/L	2	≥1		0.0008
Iron (Fe)-Total	mg/L		≥0.3		0.097
Lead (Pb)-Total	mg/L	0.005			0.000259
Magnesium (Mg)-Total	mg/L				7.22
Manganese (Mn)-Total	mg/L	0.12	≥0.02		0.065
Mercury (Hg)-Total	mg/L	0.001			<0.0000050
Molybdenum (Mo)-Total	mg/L				0.000508
Nickel (Ni)-Total	mg/L				<0.00050
Potassium (K)-Total	mg/L				0.589
Selenium (Se)-Total	mg/L	0.05			<0.000050
Sodium (Na)-Total	mg/L		≥200		2.94
Uranium (U)-Total	mg/L	0.02			0.00159
Zinc (Zn)-Total	mg/L		≥5		0.0219

Table 11: Gantahaz System - Source Water Chemistry

				Date Sampled	5-Feb-2024
		GCDWQ			Gantahaz Source
Parameter	Units	MAC	AO	OG	Booster Station
Physical Tests (Water)					
Hardness (as CaCO3)	mg/L				167
Total Metals (Water)					
Antimony (Sb)-Total	mg/L	0.006			<0.0030
Arsenic (As)-Total	mg/L	0.01			<0.00010
Barium (Ba)-Total	mg/L	2			0.00347
Boron (B)-Total	mg/L	5			0.1010
Cadmium (Cd)-Total	mg/L	0.005			<0.010
Chromium (Cr)-Total	mg/L	0.05			<0.0000050
Copper (Cu)-Total	mg/L	2	≥1		0.00080
Iron (Fe)-Total	mg/L		≥0.3		<0.00010
Lead (Pb)-Total	mg/L	0.005			<0.00010
Magnesium (Mg)-Total	mg/L				0.00080
Manganese (Mn)-Total	mg/L	0.12	≥0.02		0.138
Mercury (Hg)-Total	mg/L	0.001			0.000073
Selenium (Se)-Total	mg/L	0.05			8.87
Sodium (Na)-Total	mg/L		≥200		0.117
Uranium (U)-Total	mg/L	0.02			<0.0000050
Zinc (Zn)-Total	mg/L		≥5		0.0013

Table 12: Airport System - Source Water Chemistry

				Date Sampled	5-Feb-2024
		GCDWQ			Airport Source
Parameter	Units	MAC	AO	OG	Pump House
Physical Tests (Water)					
Hardness (as CaCO3)	mg/L				154
Total Metals (Water)					
Antimony (Sb)-Total	mg/L	0.006			<0.0030
Arsenic (As)-Total	mg/L	0.01			0.0054
Barium (Ba)-Total	mg/L	2			0.0866
Boron (B)-Total	mg/L	5			0.012
Cadmium (Cd)-Total	mg/L	0.005			<0.010
Chromium (Cr)-Total	mg/L	0.05			<0.0000050
Copper (Cu)-Total	mg/L	2	≥1		0.00170
Iron (Fe)-Total	mg/L		≥0.3		0.053
Lead (Pb)-Total	mg/L	0.005			0.000208
Magnesium (Mg)-Total	mg/L				15
Manganese (Mn)-Total	mg/L	0.12	≥0.02		0.114
Mercury (Hg)-Total	mg/L	0.001			<0.0000050
Selenium (Se)-Total	mg/L	0.05			<0.0000050
Sodium (Na)-Total	mg/L		≥200		12.2
Uranium (U)-Total	mg/L	0.02			0.00126
Zinc (Zn)-Total	mg/L		≥5		0.0859

8.2.1 Turbidity

The GCDWQ recommends that turbidity is typically below 1.0 NTU for groundwater sources. In some cases, a less stringent value may be acceptable 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).

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.

In past years exceedances occurred in the Gantahaz subdivision but results this year for all water systems are below 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 2024 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 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 8: 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 in previous years. Appendix B and C contains graphs showing all the manganese concentrations from sampling taken between 2018 and February 2024 for the Town and Gantahaz Systems.

In 2024 the manganese concentration was found to be 0.065 mg/L in the Town System, 0.117 mg/L in the Gantahaz subdivision and 0.114 mg/L in the airport system. All these samples exceeded the aesthetic objective but no sample exceeded the MAC.

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 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 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 Reasonably Achievable (ALARA).

No exceedances were found in the Town Water System and the Gantahaz Water System in 2024. In previous years the Gantahaz distribution network has exceeded the maximum allowable concentration. In the Gantahaz system past samples having concentrations above the maximum concentration were detected in the distribution system 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 2024 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 no exceedances of any MAC. The concentration of the Manganese have exceeded the AO in the Town, Gantahaz and Airport Systems. The microbiological quality of the water is excellent with no E. Coli and only four samples with Total Coliforms found in the water system. The Total Coliforms results were satisfactory since at least 90% of samples had no detectable total coliform bacteria per 100 ml and no samples has more than 10 total coliform bacterial per 100 ml.

The District of Mackenzie is committed to ensuring that the community has safe and secure drinking water. In 2024, the District has contracted a new Gantahaz Water Treatment Plant to be designed and under construction which will improve water quality for the end-users.

If you have any questions or comments regarding the content of this report please contact Jim Fast, Lead Operator, for the District at 250-997-3761 or at utilities@districtofmackenzie.ca.

APPENDIX A – 2024 WATER CHEMISTRY RESULTS SUMMARY

Table 13: Town System - Water Chemistry

Date Sampled					**5-Feb-2024**
Lab Sample ID					KS2400367-001
Parameter	Units	GCDWQ			Town Water
					Town Booster
		MAC	AO	OG	
Physical Tests (Water)					
Hardness (as CaCO3)	mg/L				147
Total Metals (Water)					
Aluminum (Al)-Total	mg/L			<0.1	<0.0030
Antimony (Sb)-Total	mg/L	0.006			<0.00010
Arsenic (As)-Total	mg/L	0.01			0.00258
Barium (Ba)-Total	mg/L	2			0.0629
Beryllium (Be)-Total	mg/L				<0.000100
Boron (B)-Total	mg/L	5			<0.010
Cadmium (Cd)-Total	mg/L	0.005			<0.0000050
Calcium (Ca)-Total	mg/L				47
Chromium (Cr)-Total	mg/L	0.05			<0.00050
Cobalt (Co)-Total	mg/L				<0.00010
Copper (Cu)-Total	mg/L	2	≤1		0.0008
Iron (Fe)-Total	mg/L		≤0.3		0.097
Lead (Pb)-Total	mg/L	0.005			0.000259
Lithium (Li)-Total	mg/L				0.0041
Magnesium (Mg)-Total	mg/L				7.22
Manganese (Mn)-Total	mg/L	0.12	≤0.02		0.065
Mercury (Hg)-Total	mg/L	0.001			<0.0000050
Molybdenum (Mo)-Total	mg/L				0.000508
Nickel (Ni)-Total	mg/L				<0.00050
Potassium (K)-Total	mg/L				0.589
Selenium (Se)-Total	mg/L	0.05			<0.000050
Silver (Ag)-Total	mg/L				<0.000010
Sodium (Na)-Total	mg/L		≤200		2.94
Thallium (Tl)-Total	mg/L				<0.000010
Tin (Sn)-Total	mg/L				<0.00010
Titanium (Ti)-Total	mg/L				<0.00030
Uranium (U)-Total	mg/L	0.02			0.00159
Vanadium (V)-Total	mg/L				<0.00050
Zinc (Zn)-Total	mg/L		≤5		0.0219
General Parameters					
Chloride	mg/L		≤250		4.05
Fluoride	mg/L	1.5			0.049
Nitrate (as N)	mg/L	10			0.032

Nitrite (as N)	mg/L	1			<0.0010
Sulfate	mg/L		≤500		9.23
Langelier Index	-				
Solids, Total Dissolved (calc)	mg/L		≤500		173
Colour, True	CU		≤15		
Alkalinity, Total (as CaCO3)	mg/L				154
Cyanide, Total	mg/L	0.2			
Turbidity	NTU			≤1	
pH	pH units		7.0-10.5		
Conductivity (EC)	uS/cm				

Table 14: Gantahaz System - Water Chemistry

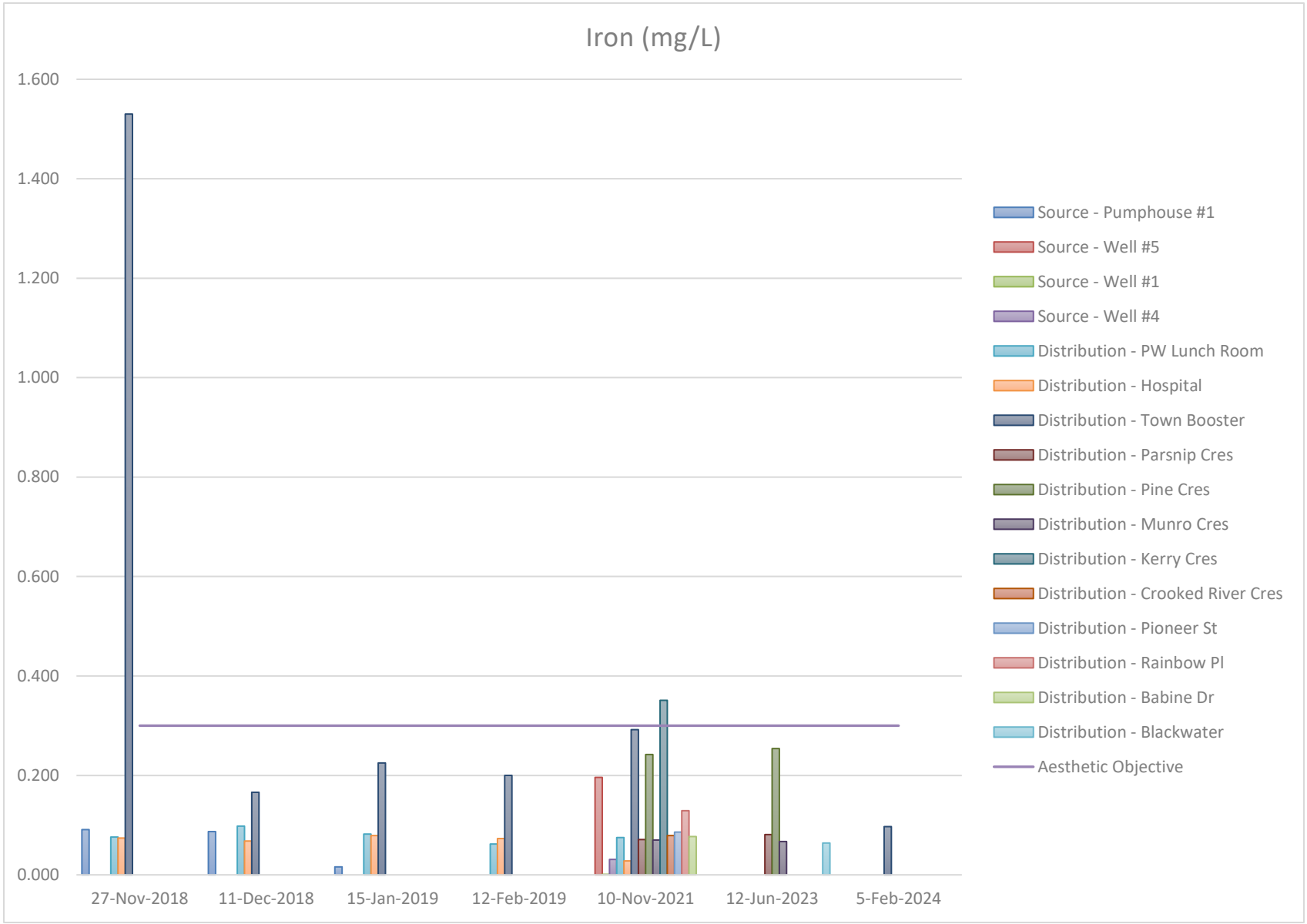
Date Sampled					5-Feb-2024
Lab Sample ID					KS2400366-001
Parameter	Units	GCDWQ			Gantahaz Water
		MAC	AO	OG	Booster Station
Physical Tests (Water)					
Hardness (as CaCO3)	mg/L				167
Total Metals (Water)					
Aluminum (Al)-Total	mg/L			>0.1	<0.0030
Antimony (Sb)-Total	mg/L	0.006			<0.00010
Arsenic (As)-Total	mg/L	0.01			0.00347
Barium (Ba)-Total	mg/L	2			0.1010
Beryllium (Be)-Total	mg/L				<0.000100
Boron (B)-Total	mg/L	5			<0.010
Cadmium (Cd)-Total	mg/L	0.005			<0.0000050
Calcium (Ca)-Total	mg/L				52.4
Chromium (Cr)-Total	mg/L	0.05			<0.00010
Cobalt (Co)-Total	mg/L				<0.00010
Copper (Cu)-Total	mg/L	2	≥1		0.00080
Iron (Fe)-Total	mg/L		≥0.3		0.138
Lead (Pb)-Total	mg/L	0.005			0.000073
Lithium (Li)-Total	mg/L				0.0035
Magnesium (Mg)-Total	mg/L				8.87
Manganese (Mn)-Total	mg/L	0.12	≥0.02		0.117
Mercury (Hg)-Total	mg/L	0.001			<0.0000050
Molybdenum (Mo)-Total	mg/L				0.0013
Nickel (Ni)-Total	mg/L				<0.00050
Potassium (K)-Total	mg/L				0.711
Selenium (Se)-Total	mg/L	0.05			<0.000050
Silver (Ag)-Total	mg/L				<0.000010
Sodium (Na)-Total	mg/L		≥200		2.52
Thallium (Tl)-Total	mg/L				<0.000010
Tin (Sn)-Total	mg/L				<0.00010
Titanium (Ti)-Total	mg/L				<0.00030
Uranium (U)-Total	mg/L	0.02			0.00314
Vanadium (V)-Total	mg/L				<0.00050
Zinc (Zn)-Total	mg/L		≥5		0.0128

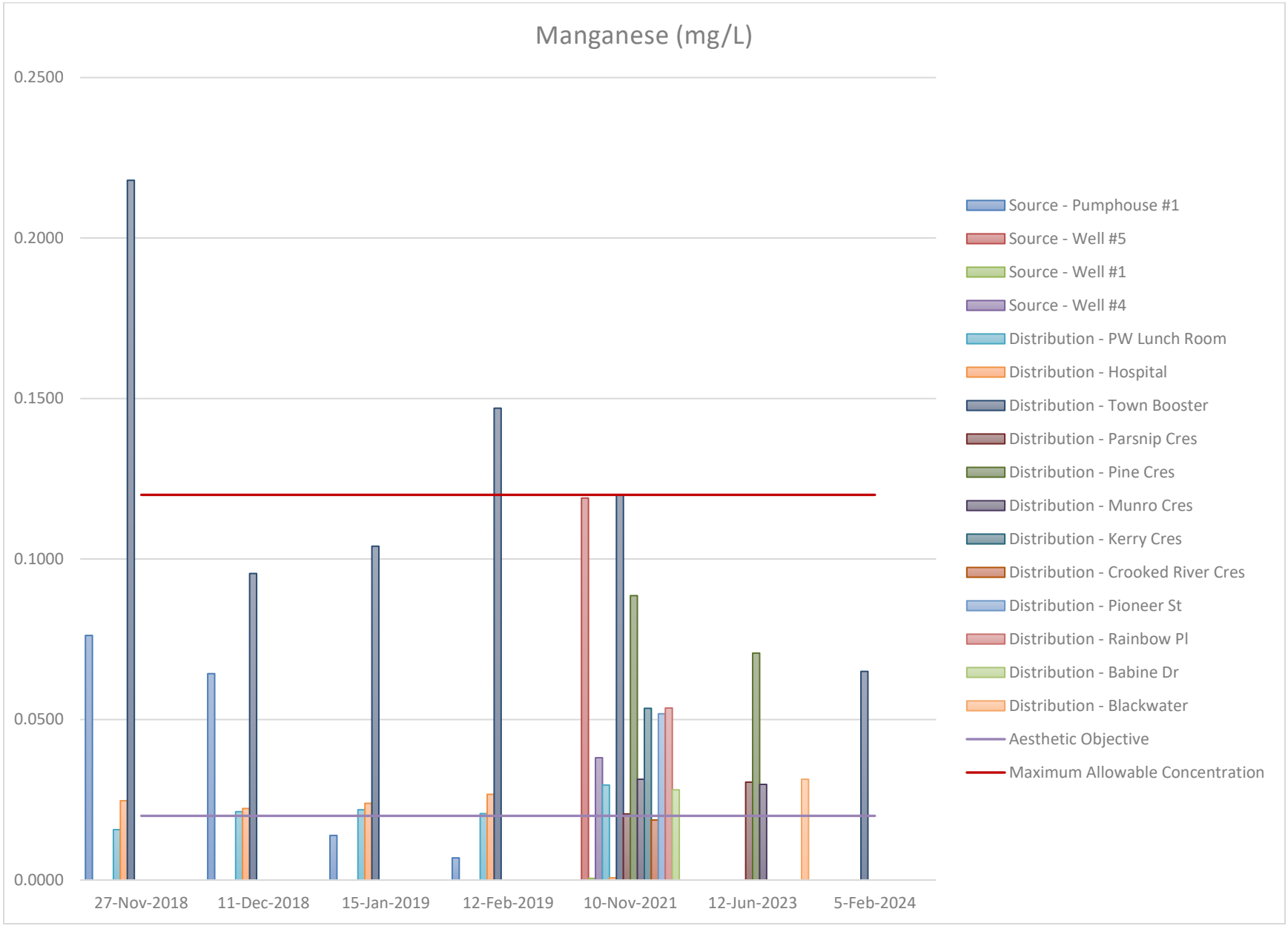
Table 15: Airport System - Water Chemistry

Date Sampled					05-Feb-24
Lab Sample ID					KS2400364-001
Parameter	Units	GCDWQ			Airport
					Pump House
		MAC	AO	OG	
Physical Tests (Water)					
Hardness (as CaCO3)	mg/L				147
Total Metals (Water)					
Aluminum (Al)-Total	mg/L			<0.1	<0.0030
Antimony (Sb)-Total	mg/L	0.006			<0.00010
Arsenic (As)-Total	mg/L	0.01			0.0054
Barium (Ba)-Total	mg/L	2			0.0866
Beryllium (Be)-Total	mg/L				<0.000100
Boron (B)-Total	mg/L	5			0.012
Cadmium (Cd)-Total	mg/L	0.005			<0.0000050
Calcium (Ca)-Total	mg/L				36.9
Chromium (Cr)-Total	mg/L	0.05			<0.00050
Cobalt (Co)-Total	mg/L				<0.00010
Copper (Cu)-Total	mg/L	2	≤1		0.0017
Iron (Fe)-Total	mg/L		≤0.3		0.053
Lead (Pb)-Total	mg/L	0.005			0.000208
Lithium (Li)-Total	mg/L				0.0015
Magnesium (Mg)-Total	mg/L				15
Manganese (Mn)-Total	mg/L	0.12	≤0.02		0.114
Mercury (Hg)-Total	mg/L	0.001			<0.0000050
Molybdenum (Mo)-Total	mg/L				0.0126
Nickel (Ni)-Total	mg/L				<0.00050
Potassium (K)-Total	mg/L				1.35
Selenium (Se)-Total	mg/L	0.05			<0.000050
Silver (Ag)-Total	mg/L				<0.000010
Sodium (Na)-Total	mg/L		≤200		12.2
Thallium (Tl)-Total	mg/L				<0.000010
Tin (Sn)-Total	mg/L				<0.00010
Titanium (Ti)-Total	mg/L				<0.01
Uranium (U)-Total	mg/L	0.02			0.00126
Vanadium (V)-Total	mg/L				<0.00050

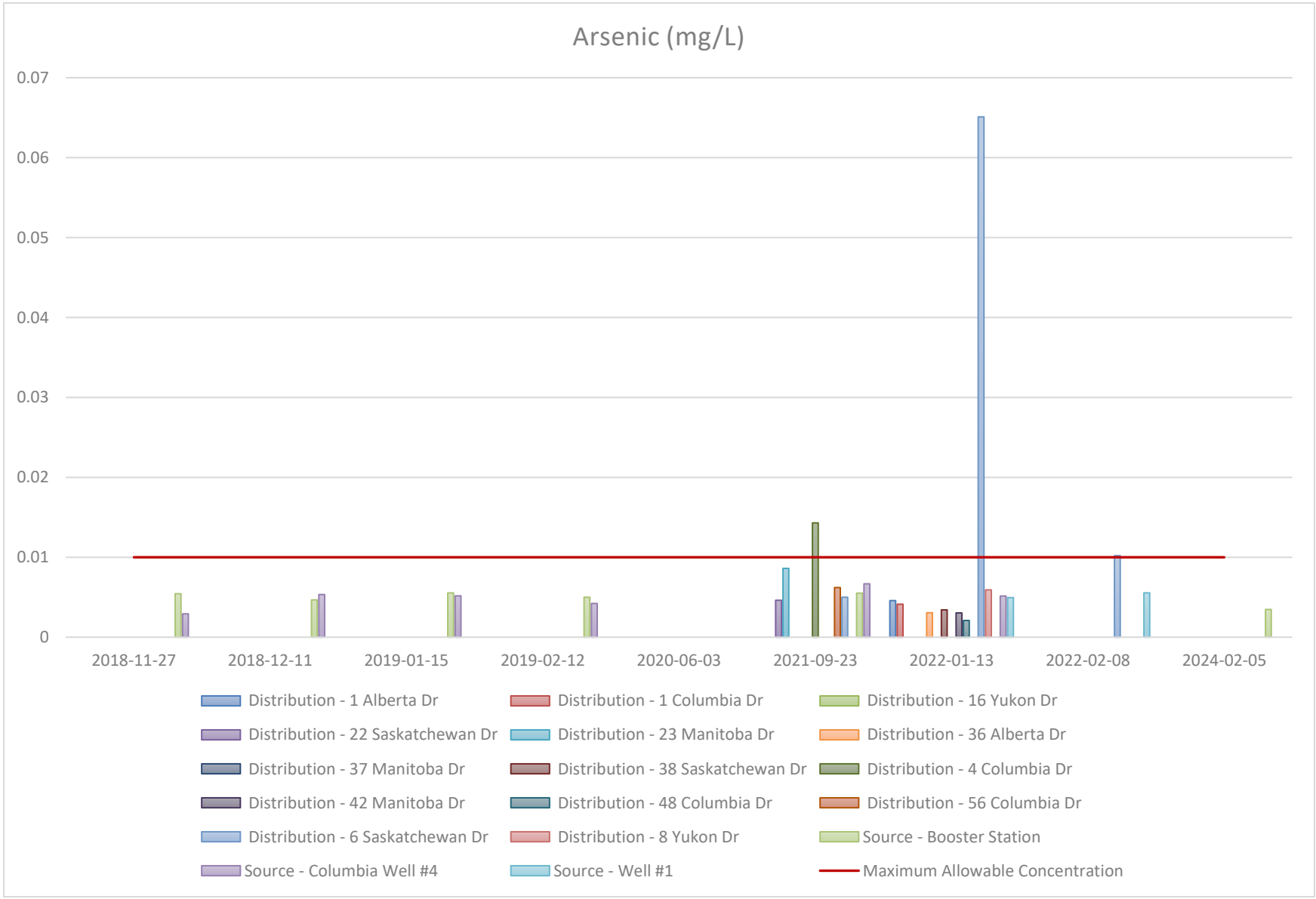
Zinc (Zn)-Total	mg/L		≤5		0.0859
General Parameters					
Chloride	mg/L		≤250		<0.50
Fluoride	mg/L	1.5			0.182
Nitrate (as N)	mg/L	10			0.0105
Nitrite (as N)	mg/L	1			<0.0010
Sulfate	mg/L		≤500		10.7
Solids, Total Dissolved (calc)	mg/L		≤500		190
Alkalinity, Total (as CaCO3)	mg/L				177

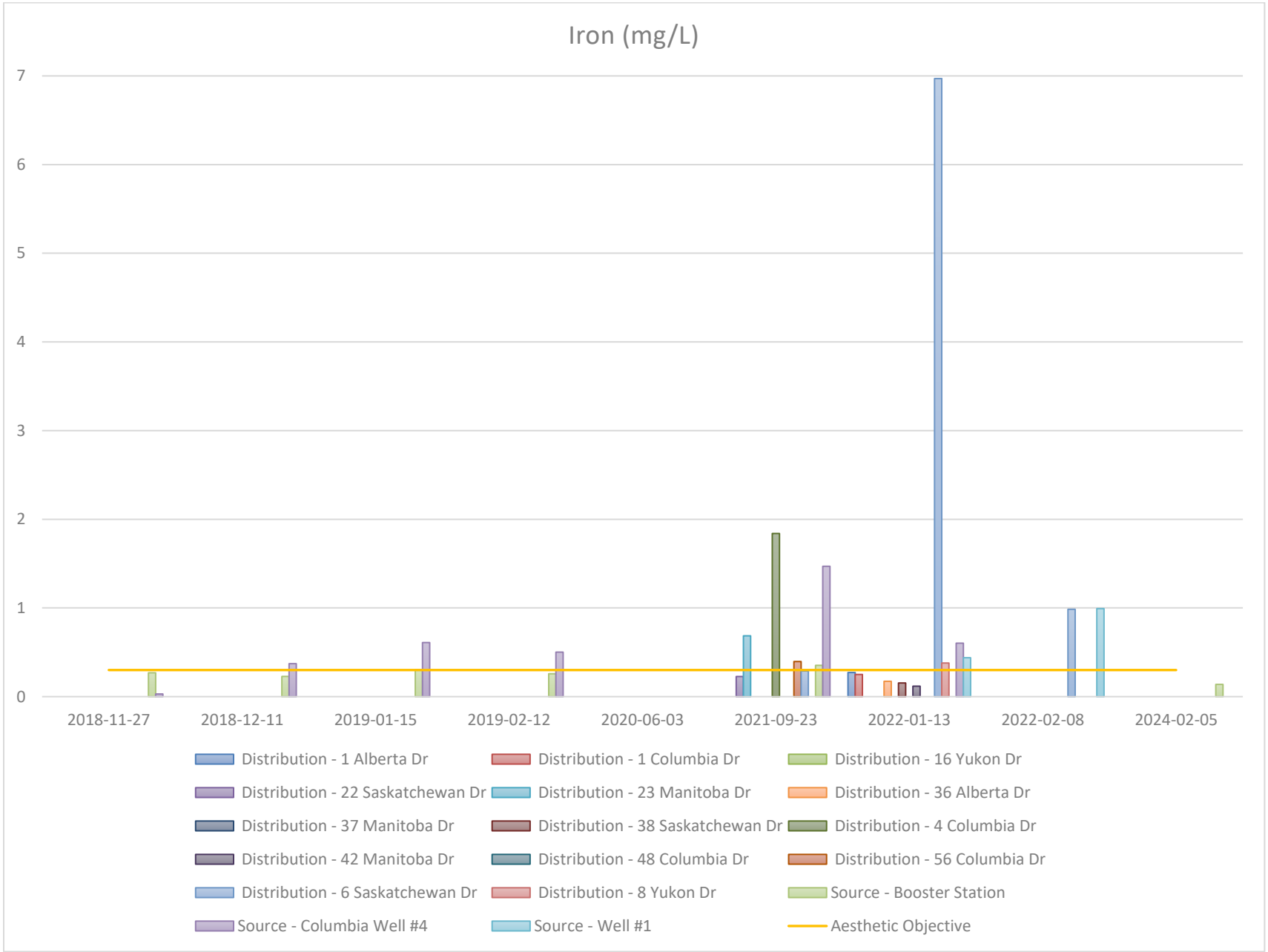
APPENDIX B – TOWN SYSTEM EXCEEDANCES (2018-2024)

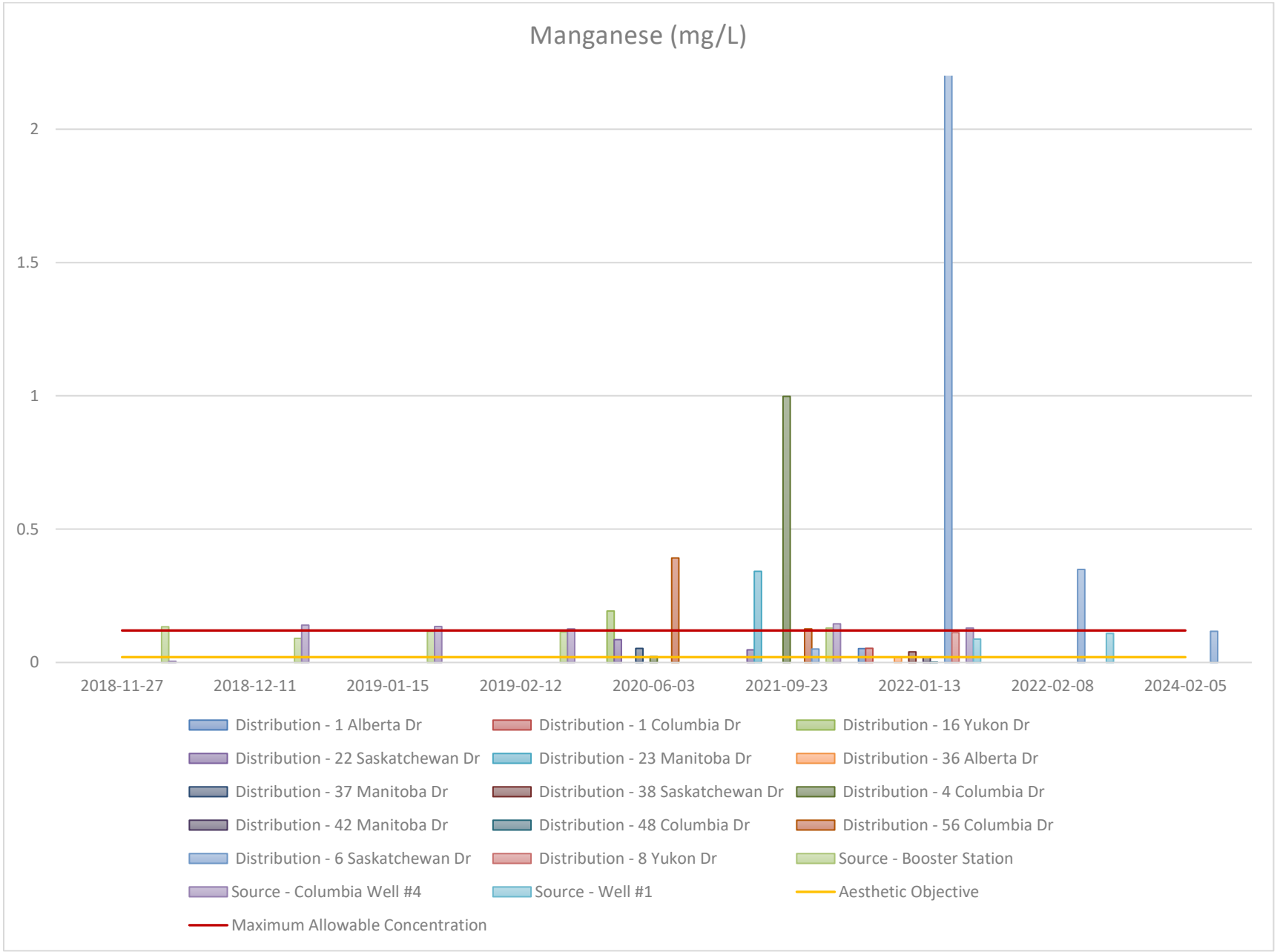



Manganese (mg/L)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
27-Nov-2018
11-Dec-2018
15-Jan-2019
12-Feb-2019
10-Nov-2021
12-Jun-2023
5-Feb-2024
Source - Pumphouse #1
Source - Well #5
Source - Well #1
Source - Well #4
Distribution - PW Lunch Room
Distribution - Hospital
Distribution - Town Booster
Distribution - Parsnip Cres
Distribution - Pine Cres
Distribution - Munro Cres
Distribution - Kerry Cres
Distribution - Crooked River Cres
Distribution - Pioneer St
Distribution - Rainbow Pl
Distribution - Babine Dr
Distribution - Blackwater
Aesthetic Objective
Maximum Allowable Concentration

APPENDIX C – GANTAHAZ SYSTEM EXCEEDANCES (2018-2024)



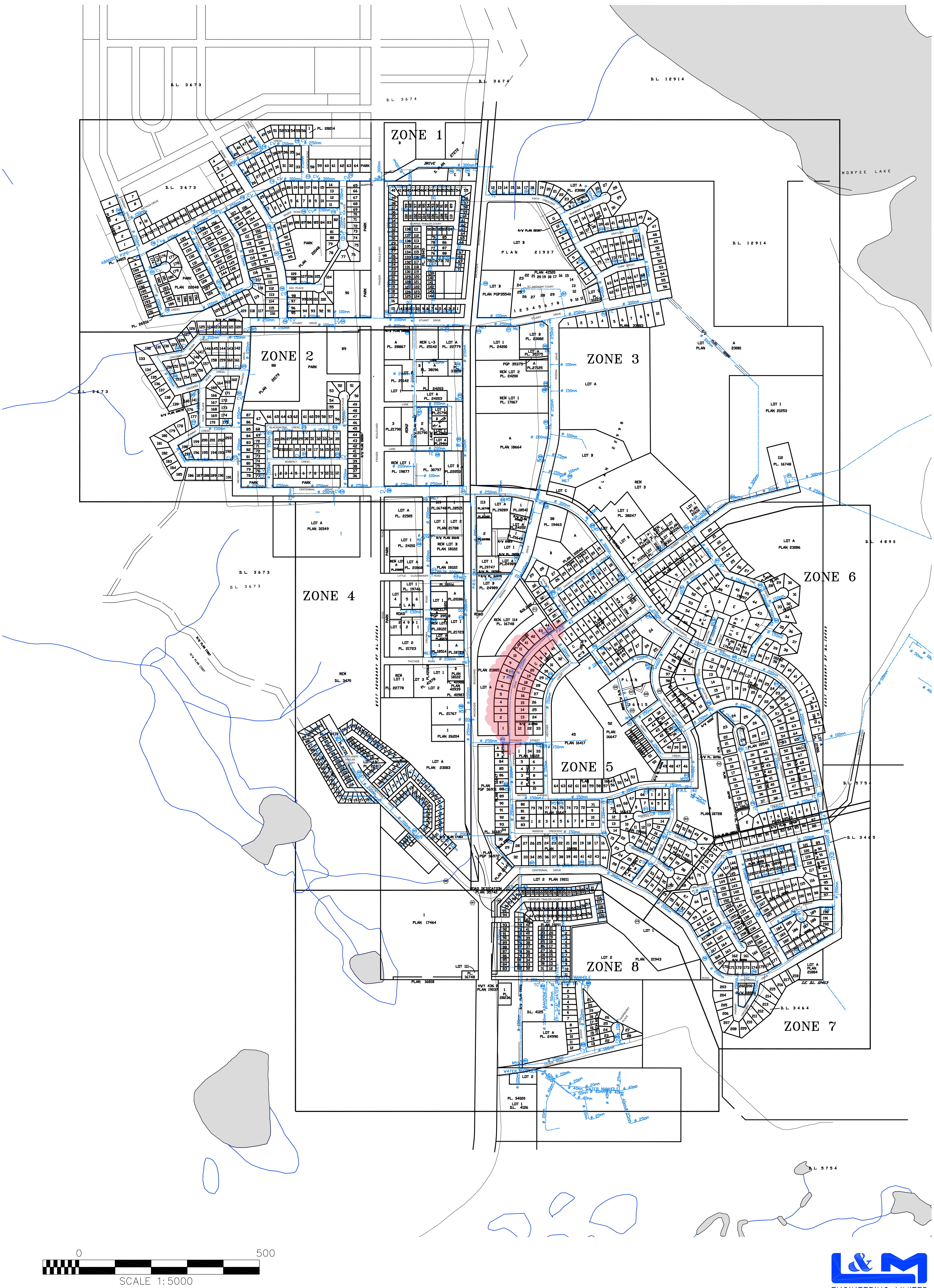

Iron (mg/L)
7
6
5
4
3
2
1
0
2018-11-27
2018-12-11
2019-01-15
2019-02-12
2020-06-03
2021-09-23
2022-01-13
2022-02-08
2024-02-05
Distribution - 1 Alberta Dr
Distribution - 1 Columbia Dr
Distribution - 16 Yukon Dr
Distribution - 22 Saskatchewan Dr
Distribution - 23 Manitoba Dr
Distribution - 36 Alberta 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
2024-02-05
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

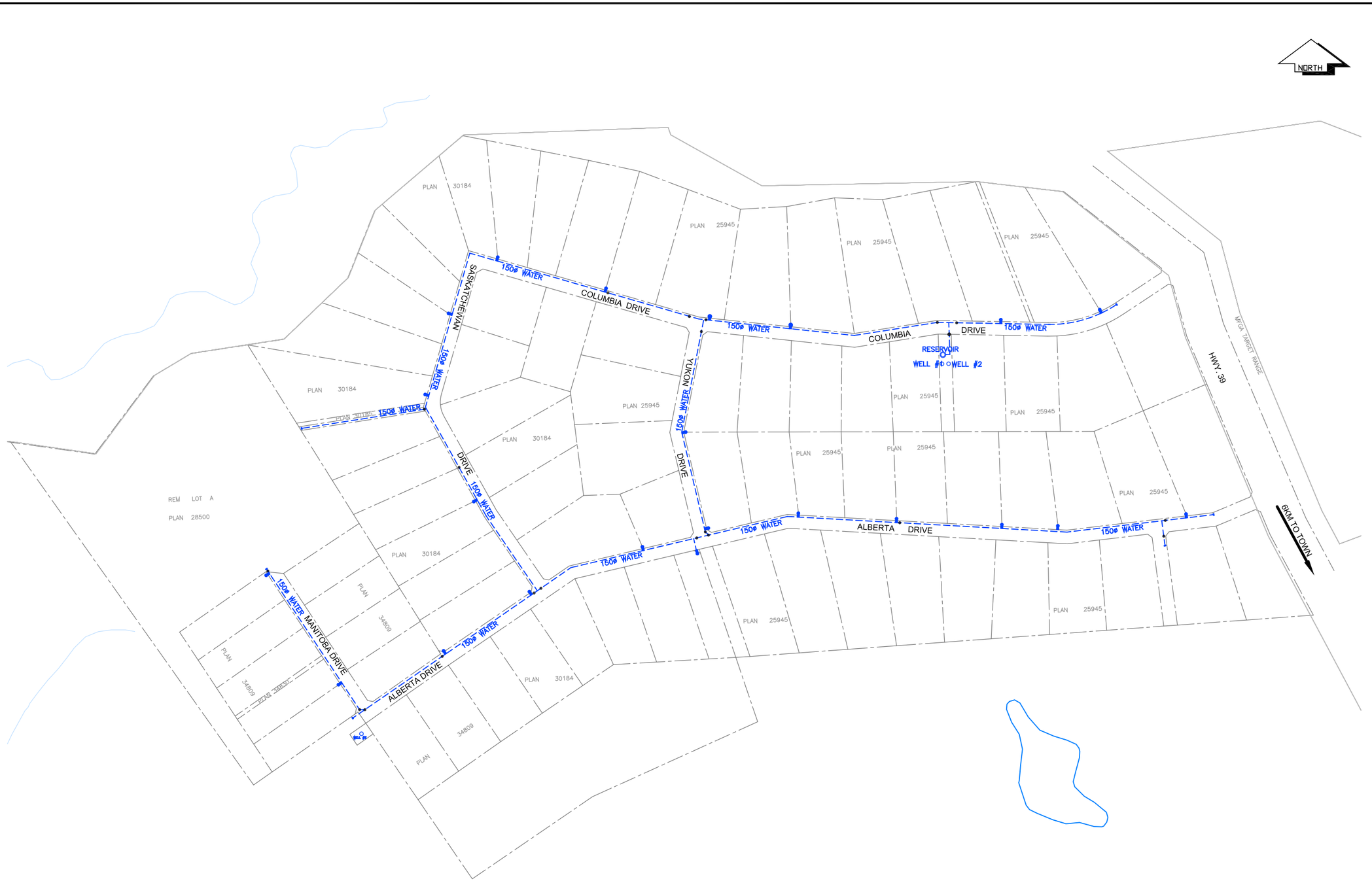
APPENDIX D – TOWN AND GANTAHAZ WATER SYSTEM MAPS

DISTRICT OF MACKENZIE

WATER SYSTEM SERVICING LAYOUT



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 Environmental 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 Operators Certification Program.
> Submit water chemistry data every 1 years, unless the Environmental Health Officer requests a greater frequency.

30-Mar-1996
Effective Permit Date

A Snell
Environmental Health Officer

2-Jul-2019
Permit Revised Date

northern health
Expires March 2024
02204

northern health
the northern way of caring

-411-7011 (LC - Appr. - 06/11pc)

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

> Maintain a minimum of 2 water bacteriology samples per month unless the Environmental 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 Environmen
Certification Program.
> Submit water chemistry data every 3 years, unless the Environmental Health
requests a greater frequency.

northern health
Expires March 2023
02203

30-Mar-2001
Effective Permit Date

Environmental Health Officer

2-Jul-2019
Permit Revised Date

northern heal
the northern way of c

411-7011 (LC - Appr. - 06/11pc)

PERMIT
TO OPERATE

A Drinking Water System with
1 Public Connection

System Name: **Mackenzie CWS Airport**

Physical Location: **Mackenzie CWS**
1 Mackenzie Boulevard
Mackenzie BC

Owner Name: **District Of Mackenzie**

Conditions of Permit

> Maintain a minimum of one water bacteriology sample per month unless the Environmental Health Officer requests a greater frequency.
> Maintain an up-to-date Emergency Response Plan.
> Submit water chemistry data every 5 years, unless the Environmental Health Officer requests a greater frequency.

25-May-2005
Effective Permit Date

Environmental Health Officer

3-July-2019
Permit Revised Date

DECAL
NOT REQUIRED

northern health
the northern way of caring

-7011 (LC - Appr. - 06/11pc)