

2023 ANNUAL REPORT

VERNON WATER RECLAMATION CENTRE



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List of Acronyms and Measurement Units

BOD ₅	5-day Biochemical Oxygen Demand (mg/L)
FC	Fecal Coliform (MPN/100ml)
L	liters
mg	milligrams
m ³	cubic meters
MPN	most probable number
OC	Operating Certificate
OP	Ortho Phosphate (mg/L)
TN	Total Nitrogen (mg/L)
TP	Total Phosphorus (mg/L)
TSS	Total Suspended Solids (mg/L)
VWRC	Vernon Water Reclamation Centre
Fasl	Feet above sea level
EMS	Environmental Monitoring System
HRAD	High Rate Anaerobic Digestion

Introduction

This report is submitted as per Section 9.3.1 of the Ministry of Environment and Climate Change Strategy Operational Certificate ME 12215 (OC) for the City of Vernon Water Reclamation Centre (VWRC).

The Vernon Water Reclamation Centre (VWRC) is designated as a Class IV Wastewater Treatment Center. The current plant was commissioned in 2004 as a Modified Johannesburg Biological Nutrient Removal (BNR) process.

There are four major treatment stages that complete the VWRC process. First, pretreatment of the influent at the fine screen and grit removal. Second, primary settling where solids are further settled out and removed. Third, nutrients and BOD are removed by the organisms in the bioreactors and settled out in the secondary clarifiers. Lastly, sand filters and ultraviolet lights are utilized for disinfection and the fully treated reclaimed water is ready for discharge.

Under the provisions of the Operational Certificate, the Corporation of the City of Vernon is authorized to discharge reclaimed wastewater from the VWRC located at 2100 43rd Street, Vernon, B.C., to a water storage reservoir (MacKay Reservoir) and then to the ground by irrigation. The discharge of treated reclaimed water to Okanagan Lake via the deep lake outfall is only authorized when:

- a) Unforeseen conditions or circumstances beyond the City's control prevent the City from pumping treated reclaimed water from the Vernon Water Reclamation Centre to MacKay Reservoir. Such conditions would include but not be limited to power outages, pump station or pipeline failures,
- Or;
- b) The elevation in MacKay Reservoir exceeds 1935 feet above mean sea level and it is projected that the level of MacKay Reservoir will exceed 1939 feet above mean sea level prior to the start of the next irrigation season.

VWRC is further authorized to discharge biosolids. Biosolids from the VWRC are processed by the Regional Compost Facility located at 551 Commonage Road, Vernon, B.C., into a Class A soil compost.

Reclaimed Water Quality Requirements

Reclaimed water discharged from the VWRC to MacKay Reservoir to be used for irrigation may not exceed the following limits:

- 26 mg/L 5-day Biochemical Oxygen Demand (BOD₅) and
- 25 mg/L Total Suspended Solids (TSS)

Reclaimed water may be discharged from the VWRC to Okanagan Lake via the deep lake outfall if the quality is better than or equivalent to the following parameters:

- 10 mg/L 5-day Biochemical Oxygen Demand (BOD₅)
- 10 mg/L Total Suspended Solids (TSS)
- Not to exceed 2.0 mg/L of Total Phosphorus (TP) (as P)
- Annual average of 0.25 mg/L of Total Phosphorus (TP) (as P)
- 6.0 mg/L Total Nitrogen (TN) (as N)
- 50 MPN /100ml Fecal Coliform (FC)

The analytical requirements stipulated by the OC and reported in this annual report were conducted by Caro Analytical Services in Kelowna, BC, and Nautilus Environmental in Burnaby, BC. The lab reports are attached in the appendices. Analysis data stipulated by the OC is downloaded annually to the Ministry of Environment and Climate Change Strategy Environmental Monitoring System (EMS) site.

VWRC Influent

The VWRC continuously monitors influent flow at the headworks parshall flume. Table 1 shows the average daily flow of 12,018m³/day with a maximum daily flow of 13,297 m³/day occurring in May. The VWRC influent flow is below the maximum authorized daily volume to discharge at 28,100 m³/day, as per section 2.1 of the OC. Figure 1 shows the total influent flows from 1992 to 2023.

Table. 1 Summary of Influent Flows

2023	Average Daily flow (m³/day)	Min (m³/day)	Max (m³/day)	Monthly (m³)
January	12,560	11,523	13,275	389,375
February	12,168	11,653	12,734	340,707
March	11,751	11,505	12,029	364,270
April	11,813	11,495	12,553	354,381
May	12,392	11,844	13,297	384,157
June	12,188	11,346	12,666	365,632
July	12,335	11,553	12,904	382,384
August	12,132	11,494	12,670	376,091
September	11,796	11,065	12,874	353,889
October	11,627	11,178	12,120	360,428
November	11,609	10,928	12,476	348,264
December	11,844	10,644	12,509	367,161
	12,018	10,644	13,297	4,386,739

Figure 1. Annual Influent flow 1992 – 2023

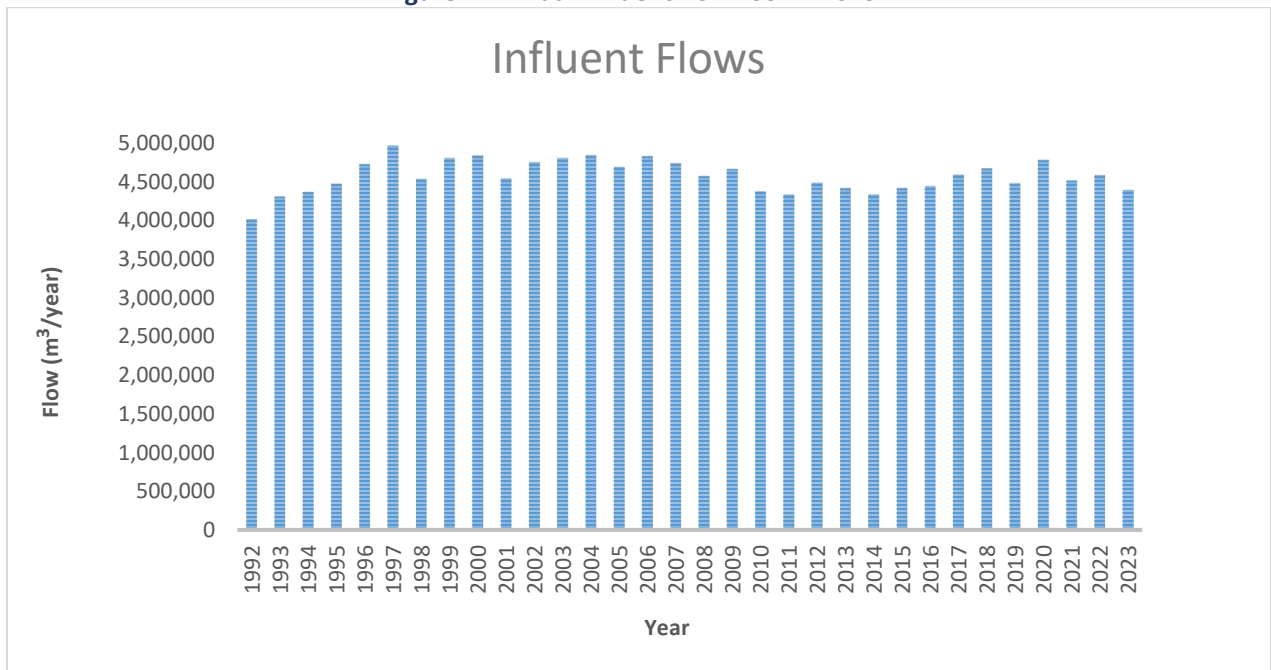


Figure 2 shows the flow changes each year from 2018 to 2023. Table 2 summarizes the influent quality treated at the VWRC. A monthly 24-hour composite sample is sent to CARO Analytical services for analysis (Appendix A – Influent Results).

Figure 2. Daily Influent Flows 2017 - 2023

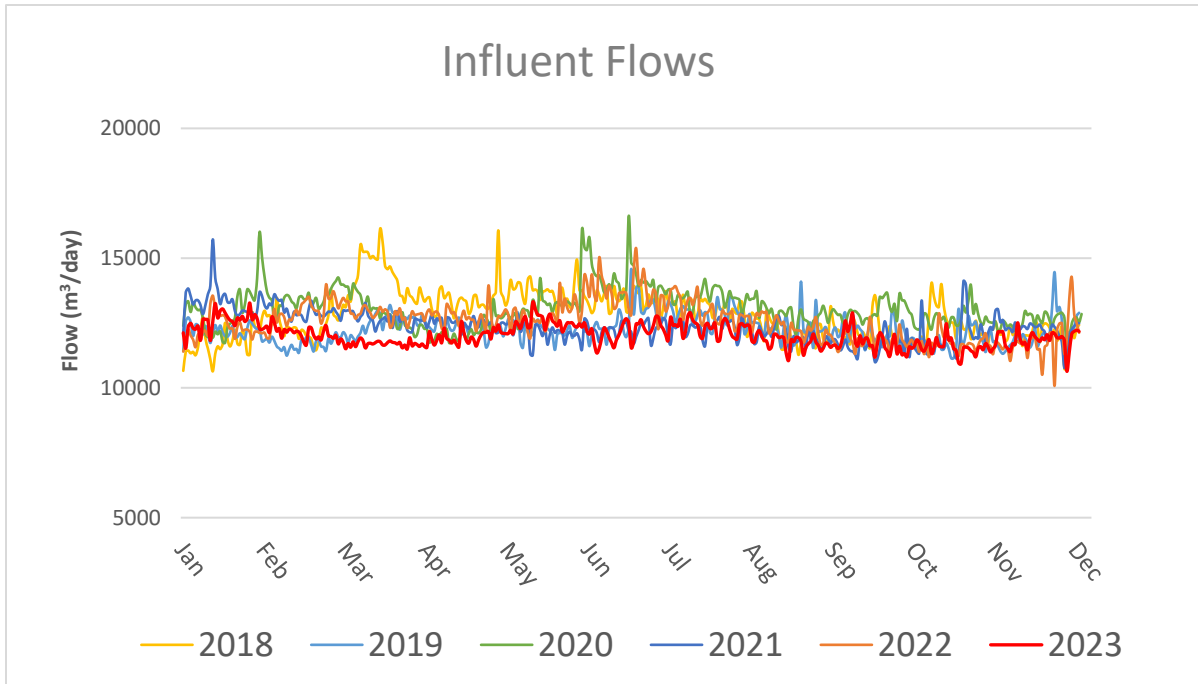


Table 2. 2023 Monthly Sampling of Influent Quality - EMS site # E228537

	BOD5 (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	pH (pH units)
January	454	290	10.20	56.4	7.2
February	459	263	8.02	55.0	7.3
March	236	170	6.66	57.4	7.8
April	283	316	6.83	63.4	7.4
May	377	296	7.79	64.6	7.6
June	370	248	7.09	47.8	7.0
July	319	290	9.03	49.6	7.6
August	475	440	10.50	66.4	7.4
September	355	284	8.03	59.3	7.2
October	313	268	7.05	59.9	7.5
November	313	344	8.60	58.4	7.6
December	328	376	9.72	61.6	7.7
Average	357	299	8.29	58.3	7.4

VWRC Reclaimed Water

Summary

The VWRC has three distribution options for reclaimed water. One option, the VWRC delivers reclaimed water to MacKay Reservoir through the year. Second option, under certain conditions the VWRC can discharge to the Okanagan lake following tertiary treatment. Lastly, during irrigation season the sand filters, Ultra-Violet (UV) lights, and chlorination are utilized for disinfection of reclaimed water used for direct irrigation. Table 3 summarizes the monthly distribution of the VWRC reclaimed water in 2023.

The quantity of reclaimed water discharged to MacKay Reservoir and Okanagan Lake is measured at the VWRC headworks parshall flume as per section 2 and 3 of the OC at EMS site #E229537. Table 4 summarizes the reclaimed water quality to MacKay Reservoir (Appendix C – Reclaimed Water Quality Results). Monthly, 24hr composite samples are submitted to CARO Analytical Services. The VWRC reclaimed water met the permit requirements in 2023 as per section 2.2 for discharge to MacKay Reservoir.

Table 3. 2023 Reclaimed Water Distribution

2023	Plant Influent (m ³)	Lake Discharge (m ³)	Spray Irrigation		
			MacKay Reservoir		Direct to Irrigation (m ³)
			Inflow (m ³)	Outflow (m ³)	
January	389,375		389,375		
February	340,707		340,707		
March	364,270	209,017	155,253		
April	354,381	354,381			
May	384,157	330,555	53,602		
June	365,632	161,065	180,296	895,932	24,272
July	382,384		325,751	1,343,898	56,634
August	376,091		343,310	1,746,420	32,781
September	353,889		341,899	497,820	11,990
October	360,428		360,428		
November	348,264		348,264		
December	367,161		367,161		
Total (m3/day)	4,386,739	1,055,018	3,206,045	4,484,070	125,676
Daily Average (m³/day)	12,018	11,105	9,570	37,367	1,047

Table 4. Quality of Reclaimed Water to MacKay Reservoir in 2023 - EMS site # E105004

VWRC Treated Effluent to MacKay Reservoir														
	OC		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	Units	Limit												
BOD ₅	(mg/L)	26	18.1	13.8	6.2			18.4	7.5	3.5	3.6	5.3	7.4	9.9
TSS	(mg/L)	25	18.4	3.4	2.4			6.4	9.7	<2.9	6.4	3.8	8.2	10.6
pH	pH units		7.6	7.5	7.8			8.0	7.8	8.1	8.0	7.8	7.7	7.5
Total Phosphorus	(mg/L)		0.643	0.197	0.126			0.254	0.753	0.433	2.160	2.400	0.292	0.375
Total Dissolved Phosphorus	(mg/L)		0.1	0.1	0.1			0.1	0.2	0.1	1.9	2.3	0.1	0.1
Orthophosphorus	(mg/L)		0.010	0.007	0.006			0.013	0.047	<0.005	1.620	1.780	0.025	0.059
Total Nitrogen	(mg/L)		7.4	5.8	4.5			7.2	8.2	8.1	7.8	10.5	8.4	8.5
Organic Nitrogen	(mg/L)		3.780	1.810	1.800			1.700	2.170	2.120	1.850	1.620	1.760	2.190
Ammonia Nitrogen	(mg/L)		0.4	0.5	0.2			0.5	0.3	0.2	0.1	<0.050	0.100	1.4
Nitrate Nitrogen	(mg/L)		2.9	3.4	2.4			4.9	5.7	5.8	5.7	8.8	6.5	4.7
Nitrite Nitrogen	(mg/L)		0.262	0.177	0.086			0.092	0.029	0.0300	0.078	0.084	0.044	0.180
Sodium	(mg/L)		79.30	83.40	88.00			99.50	97.80	98.30	98.50	78.30	88.60	102.0
Chloride	(mg/L)		84.4	89.1	90.8			84.7	78.5	84.9	103.0	83.8	78.4	81.2
Specific Conductivity	(µS/cm)		840.0	829.0	856.0			873.0	818.0	870.0	844.0	793.0	791.0	844.0

*Due to an oversight, effluent results discharging to MacKay Reservoir for May were reported under EMS site #E228121. The water quality results reported met all OC permit requirements. Please see Table 5 for results.

Reclaimed Water Quantity to Okanagan Lake

The Vernon Water Reclamation Centre commenced a lake discharge March 14, 2023. Figure 3 shows the elevation of MacKay Reservoir exceeding 1935 feet above sea level and was projected to reach 1939 feet prior to the irrigation season in 2023. The total volume of reclaimed water discharged to Okanagan lake via the deep lake outfall in 2023 was 1,055,018m³ (Table 3). In 2023, VWRC discharged to the Okanagan Lake for a total of 95 days. Figure 4 shows the daily flow discharged to Okanagan Lake. The daily flow was reduced intermittently for maintenance on the tertiary treatment process and a portion of reclaimed water was directed to MacKay Reservoir. The VWRC sampled reclaimed water at EMS site #E228121 30 days prior to Lake Discharge (Appendix B – 30-day Reclaimed Water Quality Results). Composite samples were sent to Caro Analytical Services for analysis as per section 8.5.2 of the OC.

Figure 3. MacKay Reservoir Minimum and Maximum Elevations 2003 - 2023

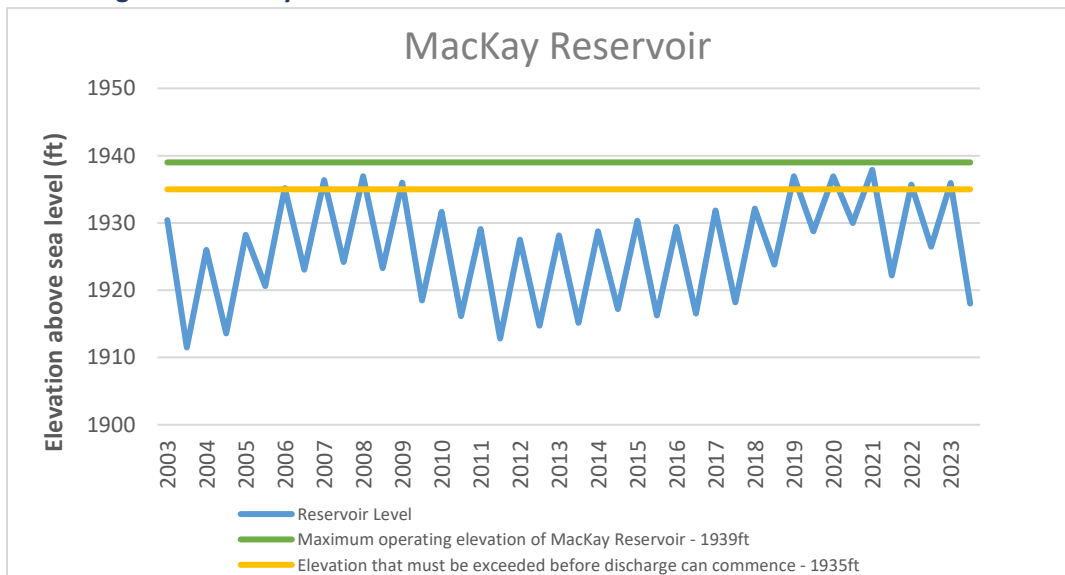
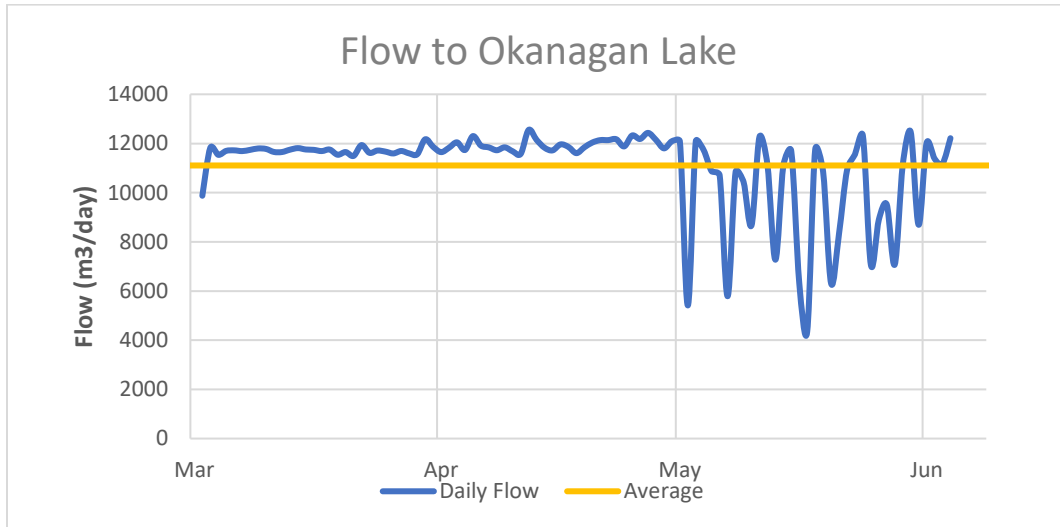


Figure 4. Daily Flow Discharged to Okanagan Lake March 14th 2023 – June 16th 2023



Reclaimed Water Quality to Okanagan Lake

As per section 8.5 of the OC, monthly, weekly, and daily analysis are required while discharging. Table 5 summarizes the monthly average reclaimed water quality results from CARO Analytical Services during discharge to Okanagan Lake. Samples were taken from a flow proportional 24-hour composite sample of the reclaimed water (Appendix C – Reclaimed Water Quality Results). In addition, Table 5 shows the monthly average of the daily sampling required for pH and orthophosphorus during the discharge.

As per item 5 in the agreement between the Okanagan Indian Band and the City of Vernon the reclaimed water was below 1.2 tonnes of total phosphorus discharged to Okanagan Lake per annum requirement. The calculated nutrient loading to Okanagan Lake during the discharge period was 0.420 tonnes of total phosphorus and 5.107 tonnes of total nitrogen in 2023. The calculation was based on the total volume discharged and the monthly average for total nitrogen and total phosphorus shown in Table 5.

The VWRC completed trout toxicity tests on the treated effluent. The two tests were completed at Nautilus Environmental during the lake release. Both tests concluded that over the 96-hour period there were zero rainbow trout fatalities (Appendix D – LT50 Trout Results).

Table 5. Quality of Reclaimed Water During Lake Discharge in 2023 – EMS site #E228121

2023		OC Limit	AVG	Mar	Apr	May	June
BOD5	(mg/L)	10	6.4	6.2	<6.9	4.7	8.2
TSS	(mg/L)	10	2.65	2.4	2.0	4.0	2.200
Total Phosphorus	(mg/L)	0.25	0.568	0.122	0.141	0.127	1.88
Total Dissolved Phosphorus	(mg/L)		0.50	0.072	0.047	0.076	1.798
Orthophosphorus	(mg/L)		0.327	0.006	0.010	0.028	1.265
Total Nitrogen	(mg/L)	6	4.98	3.44	4.98	4.56	6.93
Organic Nitrogen	(mg/L)		1.60	1.60	1.61	1.59	1.59
Ammonia Nitrogen	(mg/L)		0.31	0.199	0.706	0.232	0.112
Nitrate Nitrogen	(mg/L)		2.55	1.53	2.61	2.41	3.65
Nitrite Nitrogen	(mg/L)		0.578	0.108	0.266	0.352	1.585
Total Kjeldahl Nitrogen	(mg/L)		1.91	1.80	2.34	1.81	1.70
Sodium	(mg/L)		86.10	88.0	85.5	80.0	90.9
Chloride	(mg/L)		86.73	90.8	81.7	97.3	77.1
Specific Conductivity	(µS/cm)		811	856	779	847	760
Fecal Bacteria	(MPN/100mL)	50	2.3	<1	1	6	<1
Total Coliform Bacteria	(MPN/100mL)		34.75	86	4	44	5
Daily Testing	pH	pH Units		7.6	7.5	7.3	7.5

***Effluent water quality in May pertains to discharge to both MacKay Reservoir and Okanagan Lake.**

Effluent was discharged to Okanagan lake over a period of 95 days. A total of 14 samples were collected for total phosphorus analysis between Mar 15 and June 15, 2023 (i.e., weekly during the discharge). The average, maximum, 90th percentile, and 99th percentile total phosphorus concentrations of those samples were as follows in table 6:

Table 6. Description of Total Phosphorus Results Average

Total-P	Result
Number of samples (Mar 15 – June 15)	14
Average concentration (mg/L)	0.506
Minimum concentration (mg/L)	0.099
Maximum concentration (mg/L)	2.96
90th percentile concentration (mg/L)	1.78
99th percentile concentration (mg/L)	2.90
Total Loading (Tonnes)	0.4203

The average concentration of total phosphorus over the first 12 weeks or at least 80 days of lake discharge (Mar 15 to June 2, 2023) was 0.140 mg/L, with 90th and 99th percentile concentrations of 0.176 and 0.238 mg/L, respectively. The total phosphorus loading in tonnes during the 95 days discharge was 0.4203 tonnes which is below the OC permit annual loading requirement of 1.2 tonnes.

The elevated values are attributed to issues experienced at the VWRC in early June; specifically, the primary clarifier was offline due to mechanical failure and the facility was in the process of commissioning the new HRAD system. As a result, the total phosphorus concentrations on June 7 and 15 (2 samples total; 2.96 mg/L and 2.44 mg/L, respectively) exceeded the OC maximum limit. The exceeding concentrations were reported to the Ministry, and the lake discharge ceased on June 15th, 2023 (see appendix P).

Figure 5. Total Phosphorus Concentration During Lake Discharge in 2023

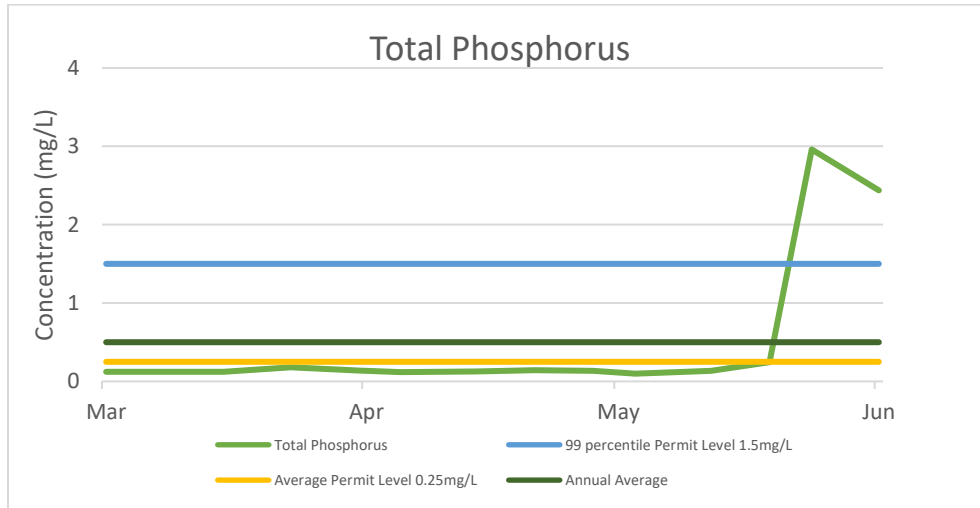


Figure 6 shows the monthly average BOD₅ of VWRC reclaimed water results from CARO Analytical Services during the lake discharge. All the samples were below the 10mg/L BOD₅ permit level.

Figure 6. BOD₅ Monthly Average During Lake Discharge in 2023

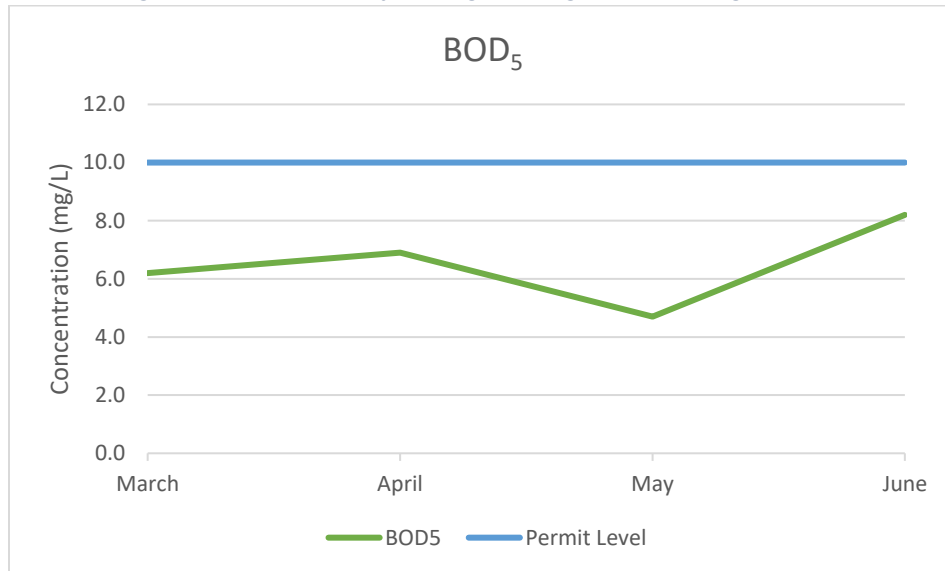


Figure 7 shows the weekly total nitrogen results of reclaimed water from CARO Analytical Services. Based on reclaimed water results from 2017-2019 notice was given to the Ministry of Environment and Climate Change Strategy for rationale for the total nitrogen concentration exceeding the threshold of 6 mg/L. The VWRC reclaimed water total nitrogen concentrations for March through June 2023 during the lake discharge had one sample above the 6 mg/L permit level.

Figure 7. Total Nitrogen Concentrations During Lake Discharge in 2023

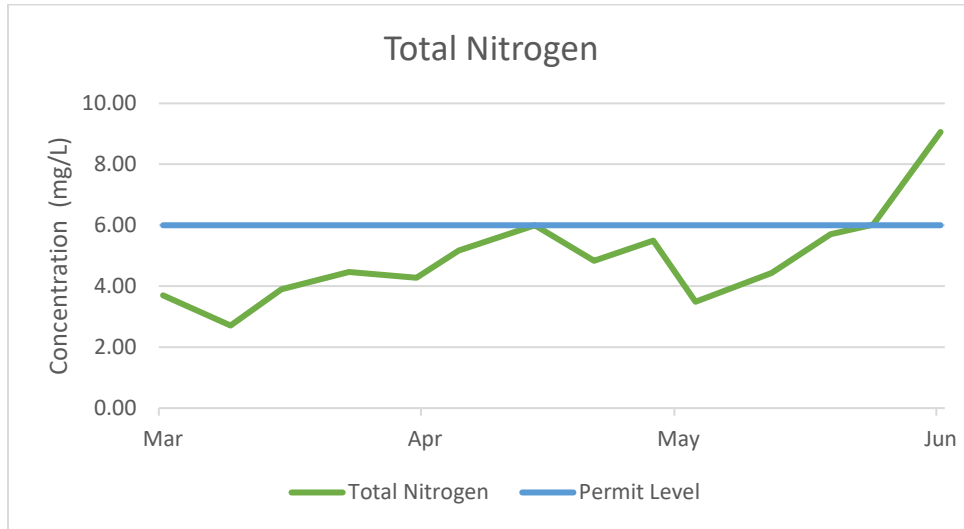


Figure 8 shows the monthly average of total suspended solids (TSS) results from CARO Analytical Services. The VWRC treated effluent met the TSS OC limits for the lake discharge of 10mg/L.

Figure 8. Monthly Average for Total Suspended Solids During Lake Discharge in 2023

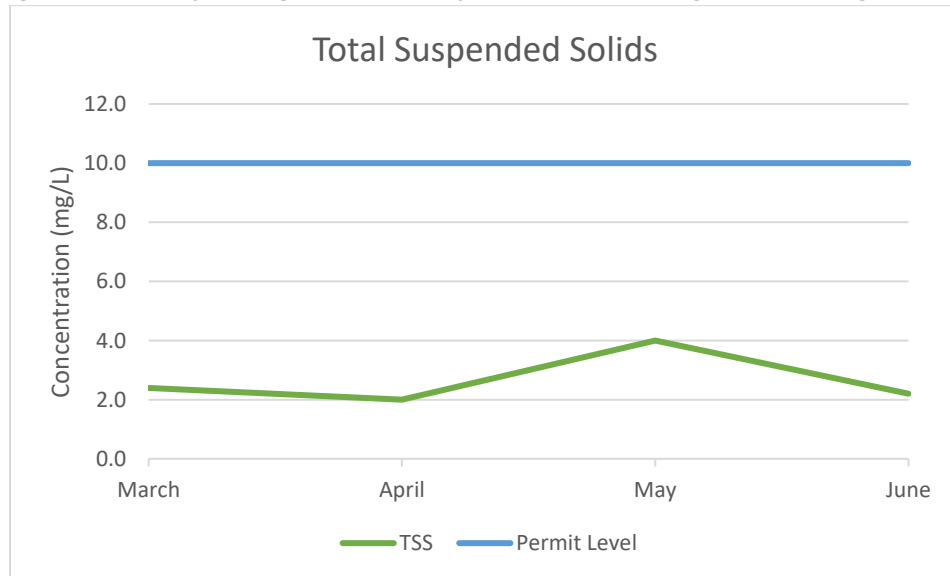
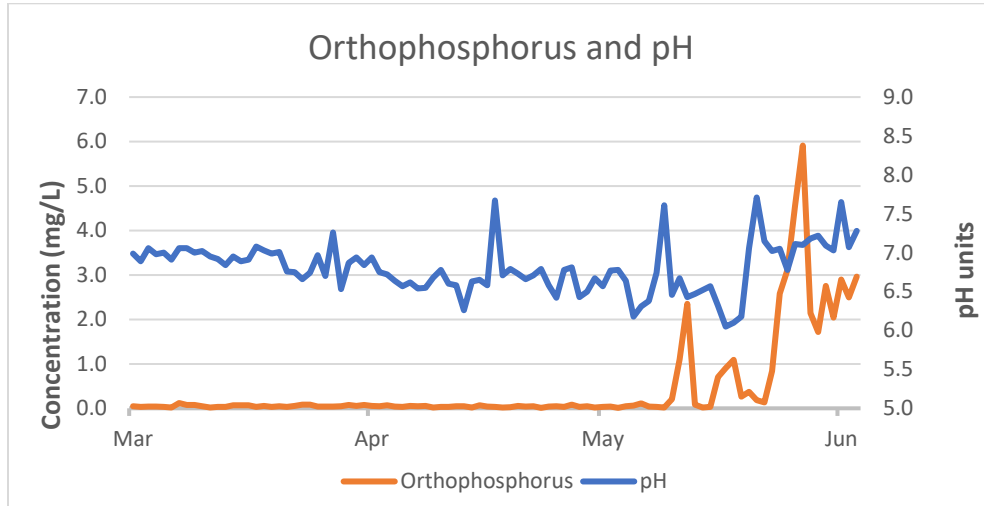


Figure 9 shows the daily pH and orthophosphorus (OP) results as per section 8.5.2 of OC ME 12215. Samples were collected daily and analyzed at the VWRC Laboratory. The Alum System was online during the lake discharge and the orthophosphorus closely monitored. As the concentration increases the alum dosing rate increases to aid in total phosphorus removal.

Figure 9. Daily Results of Orthophosphorus and pH During Lake Discharge in 2023



Lake Monitoring

Lake sampling was completed by Larratt Aquatic Consulting as per section 8.8 in the OC. Additional sampling took place during the discharge to assist with providing supplementary information. See Appendix F- Vernon Discharge of Reclaimed Water to Okanagan Lake – 2023 Summary Report

Spray Irrigation Program

MacKay Reservoir

Since 1977 the VWRC has been utilizing MacKay Reservoir as a reclaimed water storage basin for the Spray Irrigation Program. The Spray Irrigation Program is operational from May to October, as per section 7.2 of the OC. MacKay Reservoir levels and use are dependent on the weather, the volume of reclaimed water treated at the VWRC and the volume used for beneficial reuse. Currently, beneficial reuse of reclaimed water is provided to four seed orchards, three golf courses, grazing lands, pastures, soccer fields, baseball diamonds, regional compost facility, and residential landscape irrigation (Appendix G – Spray Irrigation Areas).

The City of Vernon continues to look for ways to manage MacKay Reservoir levels (Appendix H- Liquid Waste Management Plan). First, the City of Vernon has extended the opportunity to provide spray irrigation to land parcels owned by the Detachment National Defense (DND) and the Okanagan Indian Band (OKIB). Through various correspondences with the DND the request was not supported due to the lands being Critical Habitat under the Species at Risk Act (SARA). Initial conversations with staff members of the OKIB have occurred and staff have agreed to bring the opportunity to their Council members. There was support from staff in regards to the beneficial use of reclaimed water, however, they did not feel there was any short-term requirements. Secondly, the City of Vernon has been updating infrastructure and equipment for the Spray Irrigation Program. By doing so, assists by less time spent on repairs and more time setting up equipment for irrigation, allowing greater beneficial reuse.

MacKay Reservoir level is measured weekly at EMS site # E228540. Figure 10 shows the annual supply of reclaimed water and irrigation demand at MacKay Reservoir for the last 8 years. Figure 11 shows the MacKay Reservoir elevation trend from 2017 – 2023. In conclusion, the Spray Irrigation Program was able to utilize 4,484,070m³ of water from MacKay Reservoir during the 2023 irrigation season.

Figure 10. VWRC Influent Flow and Irrigation Usage 2016 - 2023

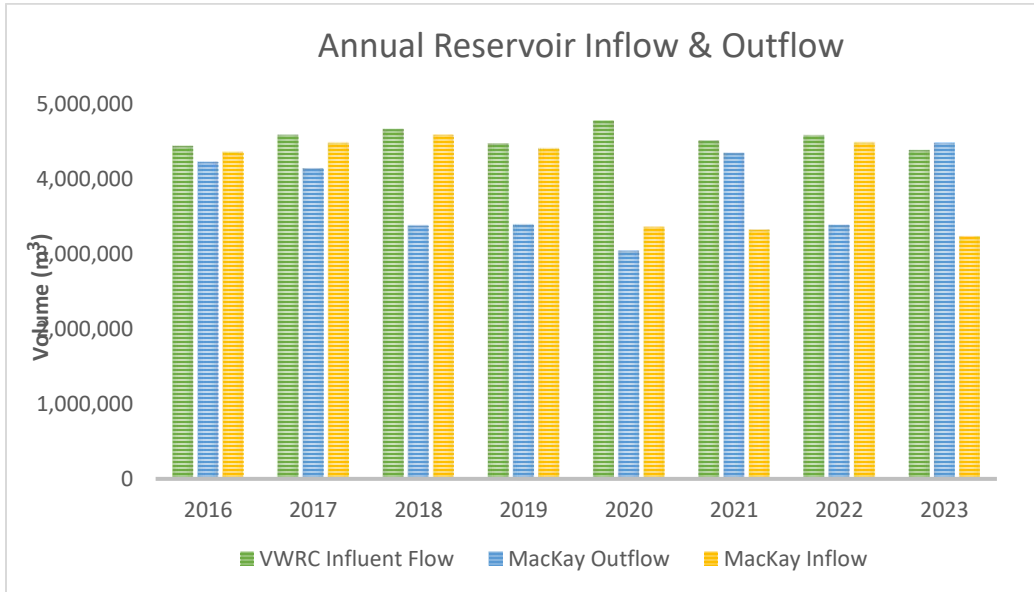
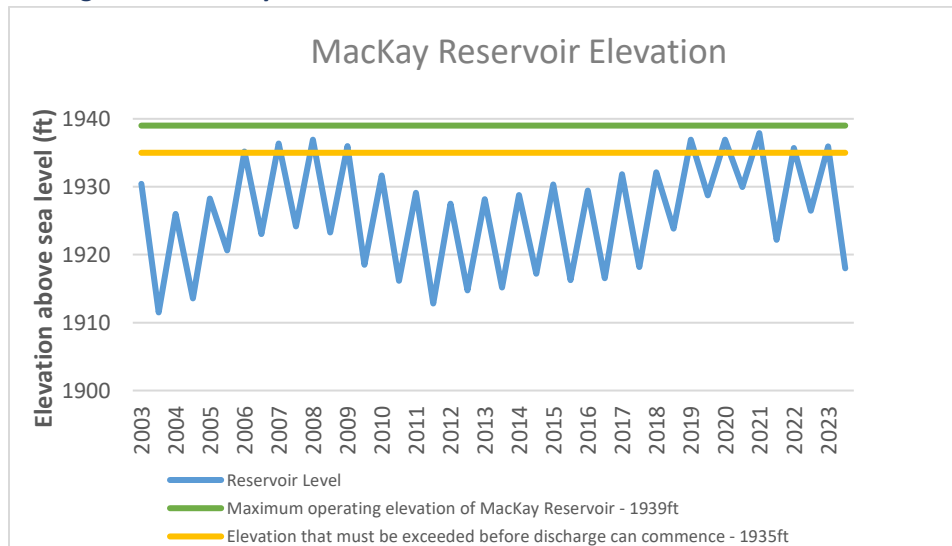


Figure 11. MacKay Reservoir Elevation Trend 2017 to 2023 - EMS #E228540



Irrigation

Water is withdrawn from MacKay Reservoir and distributed to users during the irrigation season. It is chlorinated prior to use. Chlorine residuals are tested weekly at Clay Valve #4 throughout the irrigation season and the chlorine residual was above 0.5mg/L. As per section 2.2 of the OC, Table 7 displays the monthly water quality results from the distribution system at Clay Valve #4. EMS site #228539 (Appendix I– Irrigation Water Quality Results).

Table 7. 2023 Irrigation Quality at Clay Valve #4

Irrigation from MacKay Reservoir								
2023		OC Permit						
		May	June	July	Aug	Sept		
BOD ₅	mg/L	10	7.8	<7.4	<5.6	<6.4	<6.5	
TSS	mg/L	10	<2.0	<2.0	<2.0	5.4	5	
pH	pH units	6 to 9	7.63	8.11	8.17	8.1	7.97	
Total Phosphorus	mg/L		0.695	0.79	0.687	0.915	1.15	
Total Dissolved Phosphorus	mg/L		0.68	0.77	0.65	0.89	1.13	
Ortho Phosphate	mg/L		0.389	0.351	0.264	0.524	0.743	
Total Nitrogen	mg/L		2.32	2.49	2.12	2.77	2.84	
Organic Nitrogen	mg/L		0.899	1.04	0.878	1.04	1.17	
Ammonia N	mg/L		0.456	0.552	0.455	0.785	1.25	
Nitrate N	mg/L		0.967	0.87	0.783	0.87	0.38	
Nitrite N	mg/L		<0.010	0.028	<0.010	0.072	0.04	
Total Coliform	(MPN/100mL)		7	<1	4	<1	3	
Fecal Coliform	(MPN/100mL)	2.2	<1	<1	<1	<1	3	

Table 8 summarizes the reclaimed water quality for direct irrigation. Reclaimed water is supplied to the Rise Golf Course from VWRC following sand filtration, UV disinfection and chlorination. The turbidity samples were less than 2 NTU. As per section 2.2 of the OC, the reclaimed water quality used for direct irrigation meets the OC requirements (Appendix J).

Table 8. 2023 Irrigation Quality to The Rise Golf Course – EMS site # 229578

Direct to Irrigation								
2023		OC Limits						
		May	June	July	Aug	Sept		
BOD ₅	(mg/L)	10	<5.2	<5.9	<1.2	1.1	<1.4	
TSS	(mg/L)	10	<2.0	<2.0	4	<2.0	2.2	
pH	pH units	6 to 9	6.74	6.81	7.78	7.9	7.91	
Fecal Coliforms	(MPN/100mL)	2.2	<1	<1	<1	<1	<1	

Groundwater Monitoring Program

Monthly grab samples of Bailey Springs, EMS site #0500578, are analyzed at CARO Analytical Services. Table 9 summarizes the results of the grab samples (Appendix K – Bailey Spring Water Quality Results). The annual groundwater monitoring program was completed by Associated Environmental and attached as Appendix L – Reclaimed Water Irrigation Groundwater Monitoring Program.

Table 9. 2023 Bailey Springs Results – EMS Site # 0500578

		Bailey Springs												
		AVG	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pH	pH Units	8.380	8.370	8.290	8.330	8.360	8.470	8.310	8.420	8.460	8.490	8.300	8.380	8.380
Total Phosphorus	mg/L	0.134	0.099	0.142	0.107	0.092	0.114	0.189	0.166	0.188	0.166	0.118	0.103	0.128
Total Dissolved Phosphorus	mg/L	0.112	0.093	0.137	0.101	0.086	0.095	0.136	0.132	0.142	0.135	0.088	0.095	0.110
Ortho-Phosphorus	mg/L	0.044	0.061	0.048	0.040	0.025	0.032	0.006	0.031	0.075	0.015	0.032	0.057	0.105
Total Nitrogen	mg/L	0.703	0.824	1.050	0.803	0.640	0.540	0.941	0.618	0.792	0.637	0.497	0.579	0.510
Organic Nitrogen	mg/L	0.482	0.19	0.48	0.42	0.32	0.45	0.71	0.62	0.71	0.64	0.50	0.45	0.320
Ammonia Nitrogen	mg/L	0.316	0.294	<0.050	<0.50	0.640	<0.50	0.123	<0.50	0.085	<0.50	<0.50	<0.050	<0.050
Nitrate Nitrogen	mg/L	0.176	0.344	0.573	0.387	0.254	0.090	0.108	<0.010	<0.010	<0.010	<0.010	0.128	0.190
Nitrite Nitrogen	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Sodium	mg/L	132	124	128	134	125	131	134	130	136	132	133	148	133
Chloride	mg/L	165	133	162	177	174	177	180	168	158	165	153	167	171
Specific Conductivity	uS/cm	1302	1310	1320	1360	1320	1310	1250	1250	1240	1310	1310	1300	1340
Total Coliform	MPN/100 mL	2899	435	579	77	201	1550	> 2420	> 2420	21000	866	2410	412	1460
Fecal Coliform	MPN/100 mL	206.17	33.00	2.00	5.00	67.00	10.00	921.00	488.00	770.00	132.00	31.00	3.00	12.00

Sanitary Sewer Use Bylaw

The City of Vernon Sanitary Use Bylaw (#4863) is attached as Appendix M – Sanitary Use Bylaw.

Contingency Plan

An Emergency Response Manual is available for the Staff of the VWRC to refer to in such case of emergency.

Authorized Works

Attached in Appendix N is an updated VWRC schematic of the treatment process.

Biosolids Management

Biosolids from the Vernon Water Reclamation Center is made up of thickened primary sludge and secondary sludge. Regional Compost Facility processes the biosolids into nutrient rich Ogogrow Compost. The VWRC samples monthly for Biosolids from the Vernon Water Reclamation Centre.

New Works

In 2023, the VWRC added a High Rate Anaerobic Digester (HRAD) treatment process (Appendix O - HRAD Schematic). This advanced treatment process is based on an anaerobic digestion process. The facility was commissioned in May and surpassed rigorous performance testing. The addition of this process provides a high level of effectiveness in the removal of Chemical and Biological Oxygen Demand. This is beneficial addition to the VWRC which allows reclaimed water to maintain OC requirements.

Operation and Maintenance

The staff at the Vernon Water Reclamation Center perform routine preventive and corrective maintenance. Maintenance records are kept daily and software programs are used for tracking purposes.

Table 10. Facility Staffing

Position	Name	EOCP Designation
Manager	Serge Kozin	MWWT IV
Operator III	Mark Hawthorne	MWWT III
Operator II	Kevin Holman	MWWT III
Operator II	Nick Morrison	MWWT II
Operator II	Ryan Powell	MWWT III
Operator II	Kevin Walters	MWWT III
Operator I	Rob Morris	MWWT III
Operator I	Dustan Hoff	MWWT I
Reclaimed Operator	Derek Anderson	MWWT I
Reclaimed Operator	David McGean	WD II
Reclaimed / VWRC Laborer	John Gardener	
Lab Technician	Carlee Heater	
Instrumentation Tech/electrician	Trevor Schikowski	
Instrumentation Tech/electrician (Temporary)	Kenny Simms	

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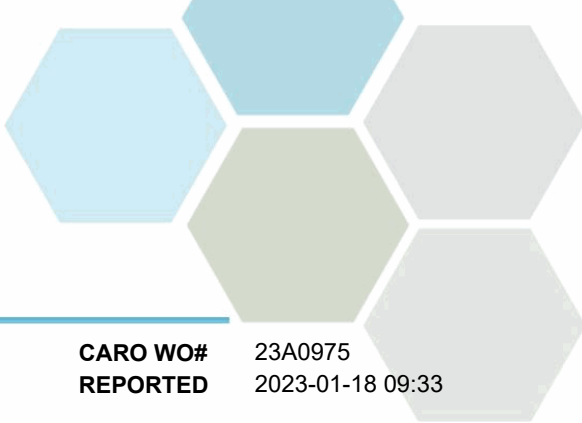
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Appendix C – Reclaimed Water Quality Results
Appendix D – LT50 Trout Results
Appendix E – Water Quality of Reclaimed Water to Okanagan Lake
Appendix F – Vernon Discharge of Reclaimed Water to Okanagan Lake 2023 Summary Report
Appendix G – Spray Irrigation Areas
Appendix H - Liquid Waste Management Plan
Appendix I – Irrigation Water Quality Results for Clay Valve 4
Appendix J – Irrigation Water Quality Results for Direct to Rise Golf Course
Appendix K – Bailey Springs Water Quality Results
Appendix L – 2023 Reclaimed Water Irrigation Groundwater Monitoring Report
Appendix M – Sanitary Use Bylaw
Appendix N – VWRC Process Schematic
Appendix O – HRAD Process Schematic
Appendix P – Letter of Non-Compliance

Appendix A

Influent Results

Caro Analytical Services



TEST RESULTS

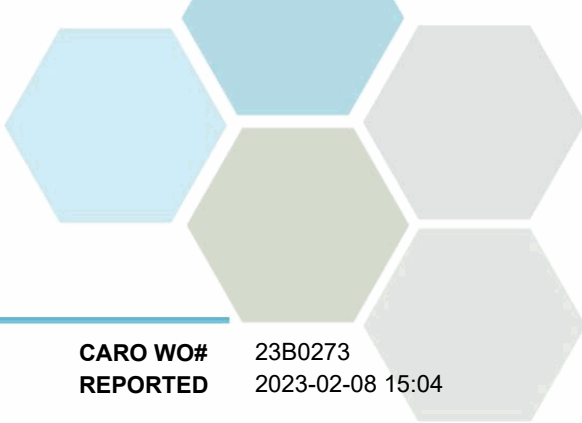
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

CARO WO# REPORTED 23A0975
2023-01-18 09:33

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Influent E228537 (23A0975-01) Matrix: Water Sampled: 2023-01-10 00:00 To 2023-01-11 00:00						FILT, PRES
Anions						
Chloride	133	± 7	0.10	mg/L	2023-01-13	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-01-13	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-01-13	
Phosphate (as P)	4.87	± 0.85	0.0050	mg/L	2023-01-13	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	56.4		2.00	mg/L	N/A	
Nitrogen, Organic	21.2		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	35.2	± 3.2	0.050	mg/L	2023-01-14	
BOD, 5-day	454	± 95	2.0	mg/L	2023-01-17	
Conductivity (EC)	1310	± 32	2.0	µS/cm	2023-01-12	
Nitrogen, Total Kjeldahl	56.4	± 7.0	0.050	mg/L	2023-01-17	
pH	7.22	± 0.02	0.10	pH units	2023-01-12	HT2
Phosphorus, Total (as P)	10.2	± 1.1	0.0050	mg/L	2023-01-16	
Phosphorus, Total Dissolved	6.17	± 0.73	0.0050	mg/L	2023-01-16	
Solids, Total Suspended	290	± 23	2.0	mg/L	2023-01-13	
Total Metals						
Sodium, total	120	± 22	0.10	mg/L	2023-01-17	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

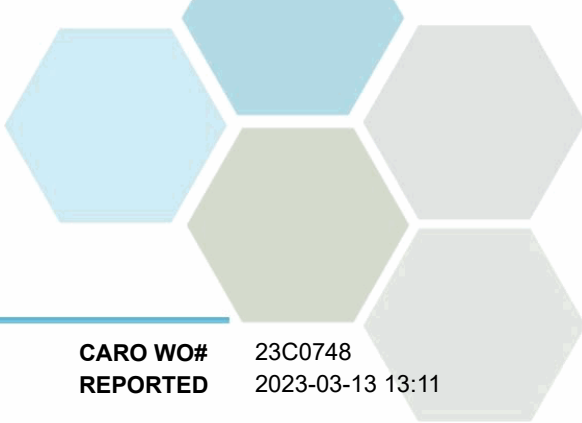
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

CARO WO# REPORTED 23B0273
2023-02-08 15:04

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Influent (24hr Comp.) E228537 (23B0273-01) Matrix: Fresh Water Sampled: 2023-01-31 00:00 To 2023-02-01 00:00						FILT, PRES
Anions						
Chloride	90.5	± 5.0	0.10	mg/L	2023-02-04	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-02-04	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-02-04	
Phosphate (as P)	4.67	± 0.81	0.0050	mg/L	2023-02-04	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	55.0		2.00	mg/L	N/A	
Nitrogen, Organic	19.9		2.00	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO ₃)	282	± 16	1.0	mg/L	2023-02-04	
Alkalinity, Phenolphthalein (as CaCO ₃)	< 1.0		1.0	mg/L	2023-02-04	
Alkalinity, Bicarbonate (as CaCO ₃)	282		1.0	mg/L	2023-02-04	
Alkalinity, Carbonate (as CaCO ₃)	< 1.0		1.0	mg/L	2023-02-04	
Alkalinity, Hydroxide (as CaCO ₃)	< 1.0		1.0	mg/L	2023-02-04	
Ammonia, Total (as N)	35.1	± 3.2	0.050	mg/L	2023-02-04	
BOD, 5-day	459	± 93	2.0	mg/L	2023-02-08	
Conductivity (EC)	1140	± 27	2.0	µS/cm	2023-02-04	
Nitrogen, Total Kjeldahl	55.0	± 6.8	0.050	mg/L	2023-02-05	
pH	7.27	± 0.02	0.10	pH units	2023-02-04	HT2
Phosphorus, Total (as P)	8.02	± 0.89	0.0050	mg/L	2023-02-06	
Phosphorus, Total Dissolved	5.07	± 0.60	0.0050	mg/L	2023-02-06	
Solids, Total Suspended	263	± 20	2.0	mg/L	2023-02-05	
Total Metals						
Sodium, total	82.9	± 15.1	0.10	mg/L	2023-02-07	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

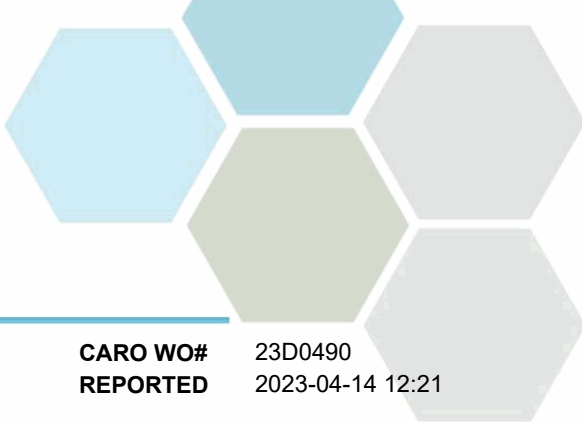
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

CARO WO# REPORTED 23C0748
2023-03-13 13:11

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Influent E228537 (23C0748-01) Matrix: Water Sampled: 2023-03-06 00:00 To 2023-03-07 00:00						FILT, PRES
Anions						
Chloride	93.7	± 5.2	0.10	mg/L	2023-03-08	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-03-08	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-03-08	
Phosphate (as P)	3.84	± 0.67	0.0050	mg/L	2023-03-08	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	57.4		2.00	mg/L	N/A	
Nitrogen, Organic	20.0		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	37.5	± 3.4	0.050	mg/L	2023-03-08	
BOD, 5-day	236	± 51	2.0	mg/L	2023-03-13	
Conductivity (EC)	1090	± 26	2.0	µS/cm	2023-03-09	
Nitrogen, Total Kjeldahl	57.4	± 7.1	0.050	mg/L	2023-03-09	
pH	7.77	± 0.02	0.10	pH units	2023-03-09	HT2
Phosphorus, Total (as P)	6.66	± 0.74	0.0050	mg/L	2023-03-09	
Phosphorus, Total Dissolved	4.21	± 0.50	0.0050	mg/L	2023-03-09	
Solids, Total Suspended	170	± 13	2.0	mg/L	2023-03-09	RE2
Total Metals						
Sodium, total	77.0	± 14.1	0.10	mg/L	2023-03-12	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.
- RE2 Result was confirmed by re-analysis prior to reporting.



TEST RESULTS

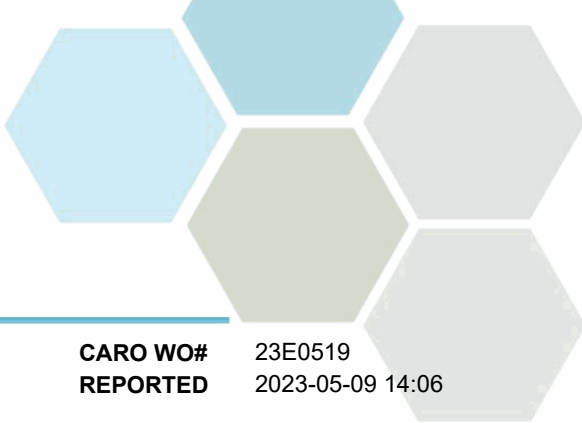
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

CARO WO# REPORTED 23D0490
2023-04-14 12:21

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Influent E228537 (23D0490-01) Matrix: Water Sampled: 2023-04-04 00:00 To 2023-04-05 00:00						FILT, PRES
Anions						
Chloride	94.6	± 5.2	0.10	mg/L	2023-04-07	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-04-07	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-04-07	
Phosphate (as P)	3.55	± 0.62	0.0050	mg/L	2023-04-07	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	63.4		2.00	mg/L	N/A	
Nitrogen, Organic	25.3		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	38.1	± 3.4	0.050	mg/L	2023-04-11	
BOD, 5-day	283	± 62	2.0	mg/L	2023-04-12	
Conductivity (EC)	1090	± 26	2.0	µS/cm	2023-04-13	
Nitrogen, Total Kjeldahl	63.4	± 7.8	0.050	mg/L	2023-04-13	
pH	7.39	± 0.02	0.10	pH units	2023-04-13	HT2
Phosphorus, Total (as P)	6.83	± 0.76	0.0050	mg/L	2023-04-06	
Phosphorus, Total Dissolved	4.10	± 0.48	0.0050	mg/L	2023-04-06	
Solids, Total Suspended	316	± 24	2.0	mg/L	2023-04-07	
Total Metals						
Sodium, total	76.6	± 14.0	0.10	mg/L	2023-04-13	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

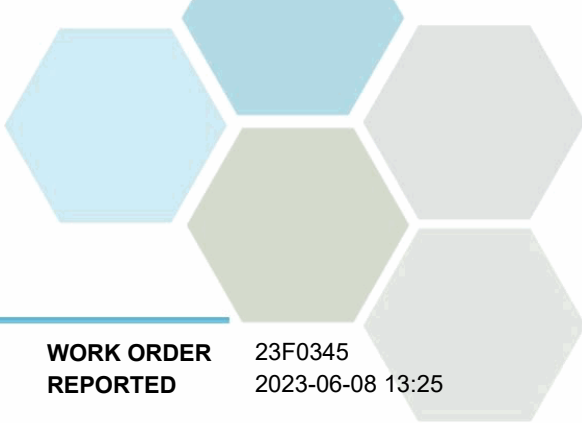
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

CARO WO# REPORTED 23E0519
2023-05-09 14:06

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Influent E228537 (23E0519-01) Matrix: Water Sampled: 2023-05-02 00:00 To 2023-05-03 00:00						FILT, PRES
Anions						
Chloride	100	± 6		0.10 mg/L	2023-05-05	
Nitrate (as N)	< 0.010			0.010 mg/L	2023-05-05	
Nitrite (as N)	< 0.010			0.010 mg/L	2023-05-05	
Phosphate (as P)	3.55	± 0.62		0.0050 mg/L	2023-05-05	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100			0.0100 mg/L	N/A	
Nitrogen, Total	64.6			2.00 mg/L	N/A	
Nitrogen, Organic	29.1			2.00 mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	35.5	± 3.2		0.050 mg/L	2023-05-05	
BOD, 5-day	377	± 78		2.0 mg/L	2023-05-09	
Conductivity (EC)	1120	± 27		2.0 µS/cm	2023-05-05	
Nitrogen, Total Kjeldahl	64.6	± 7.9		0.050 mg/L	2023-05-07	
pH	7.55	± 0.02		0.10 pH units	2023-05-05	HT2
Phosphorus, Total (as P)	7.79	± 0.86		0.0050 mg/L	2023-05-05	
Phosphorus, Total Dissolved	4.12	± 0.49		0.0050 mg/L	2023-05-05	
Solids, Total Suspended	296	± 23		2.0 mg/L	2023-05-06	
Total Metals						
Sodium, total	78.4	± 14.3		0.10 mg/L	2023-05-08	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

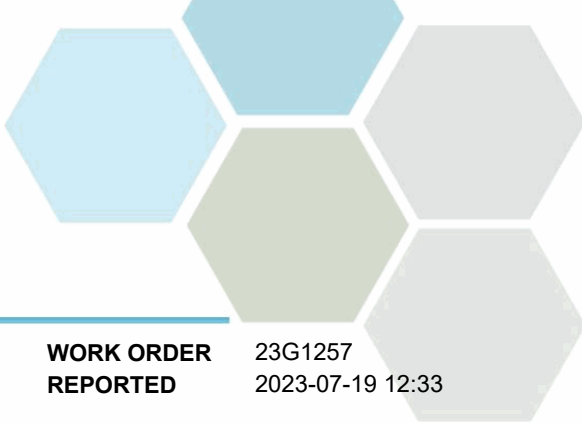
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23F0345
2023-06-08 13:25

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Influent E228537 (23F0345-01) Matrix: Water Sampled: 2023-05-31 00:00 To 2023-06-01 00:00						FILT, PRES
Anions						
Chloride	84.3	± 4.6	0.10	mg/L	2023-06-03	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-06-03	
Nitrite (as N)	0.017	± 0.002	0.010	mg/L	2023-06-03	
Phosphate (as P)	3.90	± 0.68	0.0050	mg/L	2023-06-03	
Calculated Parameters						
Nitrate+Nitrite (as N)	0.0171		0.0100	mg/L	N/A	
Nitrogen, Total	47.8		2.00	mg/L	N/A	
Nitrogen, Organic	18.8		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	29.0	± 2.6	0.050	mg/L	2023-06-05	
BOD, 5-day	370	± 78	2.0	mg/L	2023-06-07	
Conductivity (EC)	1030	± 25	2.0	µS/cm	2023-06-08	
Nitrogen, Total Kjeldahl	47.8	± 5.9	0.050	mg/L	2023-06-07	
pH	6.97	± 0.02	0.10	pH units	2023-06-08	HT2
Phosphorus, Total (as P)	7.09	± 0.79	0.0050	mg/L	2023-06-06	
Phosphorus, Total Dissolved	4.32	± 0.51	0.0050	mg/L	2023-06-06	
Solids, Total Suspended	248	± 20	2.0	mg/L	2023-06-06	
Total Metals						
Sodium, total	96.8	± 17.7	0.10	mg/L	2023-06-06	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23G1257
2023-07-19 12:33

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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VWRC Influent E228537 (23G1257-01) | Matrix: Water | Sampled: 2023-07-10 00:00 To 2023-07-11 00:00

Anions

Chloride	78.8	± 4.3	0.10	mg/L	2023-07-13	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-07-13	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-07-13	
Phosphate (as P)	3.47	± 0.60	0.0050	mg/L	2023-07-13	

Calculated Parameters

Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	49.6		2.00	mg/L	N/A	
Nitrogen, Organic	14.2		2.00	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	35.5	± 3.2	0.050	mg/L	2023-07-12	
BOD, 5-day	319	± 66	2.0	mg/L	2023-07-17	
Conductivity (EC)	1090	± 26	2.0	µS/cm	2023-07-13	
Nitrogen, Total Kjeldahl	49.6	± 6.1	0.050	mg/L	2023-07-17	
pH	7.63	± 0.02	0.10	pH units	2023-07-13	HT2
Phosphorus, Total (as P)	9.03	± 1.00	0.0050	mg/L	2023-07-14	
Phosphorus, Total Dissolved	5.04	± 0.60	0.0050	mg/L	2023-07-14	
Solids, Total Suspended	290	± 22	2.0	mg/L	2023-07-13	

Total Metals

Sodium, total	94.0	± 17.2	0.10	mg/L	2023-07-15	
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VWRC Influent E228537 Duplicate (23G1257-02) | Matrix: Water | Sampled: 2023-07-10 00:00 To 2023-07-11 00:00

Anions

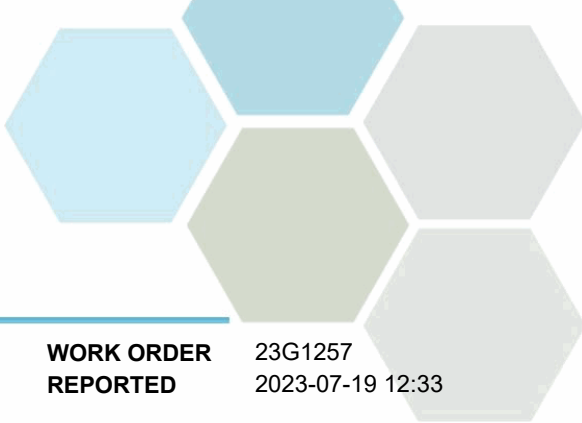
Chloride	77.6	± 4.3	0.10	mg/L	2023-07-13	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-07-13	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-07-13	
Phosphate (as P)	3.44	± 0.60	0.0050	mg/L	2023-07-13	

Calculated Parameters

Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	48.3		2.00	mg/L	N/A	
Nitrogen, Organic	14.2		2.00	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	34.1	± 3.1	0.050	mg/L	2023-07-12	
BOD, 5-day	332	± 69	2.0	mg/L	2023-07-17	
Conductivity (EC)	1080	± 26	2.0	µS/cm	2023-07-13	
Nitrogen, Total Kjeldahl	48.3	± 6.0	0.050	mg/L	2023-07-17	
pH	7.58	± 0.02	0.10	pH units	2023-07-13	HT2
Phosphorus, Total (as P)	9.23	± 1.02	0.0050	mg/L	2023-07-14	
Phosphorus, Total Dissolved	5.35	± 0.63	0.0050	mg/L	2023-07-14	



TEST RESULTS

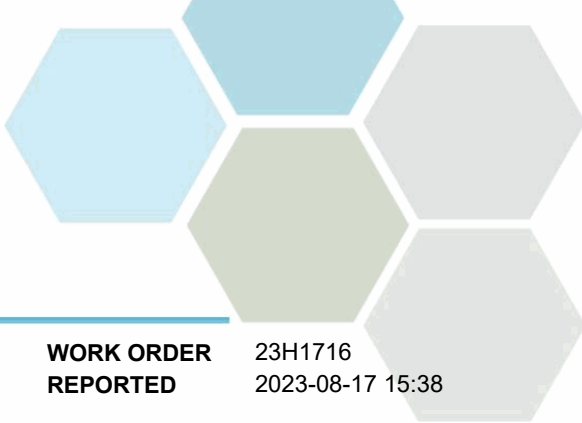
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23G1257
2023-07-19 12:33

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Influent E228537 Duplicate (23G1257-02) Matrix: Water Sampled: 2023-07-10 00:00 To 2023-07-11 00:00, Continued						
<i>General Parameters, Continued</i>						
Solids, Total Suspended	280	± 21		2.0 mg/L	2023-07-13	
<i>Total Metals</i>						
Sodium, total	93.0	± 17.0		0.10 mg/L	2023-07-15	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

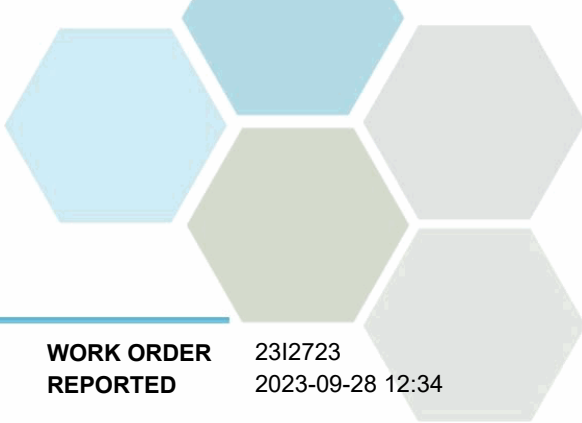
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23H1716
2023-08-17 15:38

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Influent E228537 (23H1716-01) Matrix: Water Sampled: 2023-08-10						FILT, PRES
Anions						
Chloride	81.9	± 4.5	0.10	mg/L	2023-08-14	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-08-13	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-08-13	
Phosphate (as P)	3.48	± 0.60	0.0050	mg/L	2023-08-13	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	66.4		2.00	mg/L	N/A	
Nitrogen, Organic	33.2		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	33.3	± 3.0	0.050	mg/L	2023-08-13	
BOD, 5-day	475	± 112	2.0	mg/L	2023-08-17	
Conductivity (EC)	1100	± 26	2.0	µS/cm	2023-08-16	
Nitrogen, Total Kjeldahl	66.4	± 8.2	0.050	mg/L	2023-08-16	
pH	7.37	± 0.02	0.10	pH units	2023-08-16	HT2
Phosphorus, Total (as P)	10.5	± 1.2	0.0050	mg/L	2023-08-16	
Phosphorus, Total Dissolved	4.73	± 0.56	0.0050	mg/L	2023-08-16	
Solids, Total Suspended	440	± 33	2.0	mg/L	2023-08-15	
Total Metals						
Sodium, total	95.5	± 17.5	0.10	mg/L	2023-08-17	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

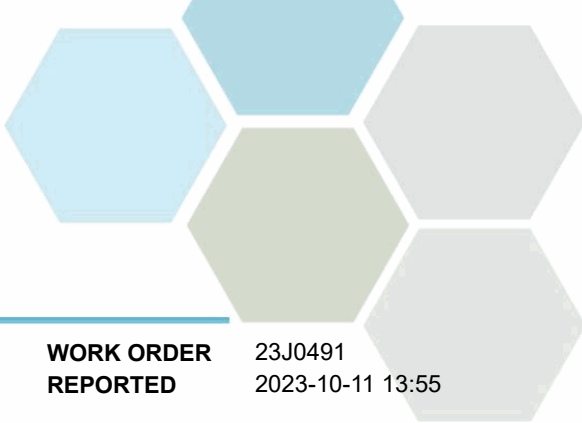
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 2312723
2023-09-28 12:34

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Influent E228537 (2312723-01) Matrix: Water Sampled: 2023-09-21						FILT, PRES
Anions						
Chloride	84.6	± 4.7	0.10	mg/L	2023-09-23	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-09-23	
Nitrite (as N)	0.011	± 0.001	0.010	mg/L	2023-09-23	
Phosphate (as P)	3.68	± 0.64	0.0050	mg/L	2023-09-23	
Calculated Parameters						
Nitrate+Nitrite (as N)	0.0106		0.0100	mg/L	N/A	
Nitrogen, Total	59.3		2.00	mg/L	N/A	
Nitrogen, Organic	19.2		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	40.1	± 3.6	0.050	mg/L	2023-09-26	
BOD, 5-day	355	± 74	2.0	mg/L	2023-09-27	
Conductivity (EC)	1120	± 27	2.0	µS/cm	2023-09-24	
Nitrogen, Total Kjeldahl	59.3	± 7.3	0.050	mg/L	2023-09-27	
pH	7.23	± 0.02	0.10	pH units	2023-09-24	HT2
Phosphorus, Total (as P)	8.03	± 0.89	0.0050	mg/L	2023-09-25	
Phosphorus, Total Dissolved	4.68	± 0.55	0.0050	mg/L	2023-09-25	
Solids, Total Suspended	284	± 22	2.0	mg/L	2023-09-27	
Total Metals						
Sodium, total	83.8	± 15.3	0.10	mg/L	2023-09-25	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

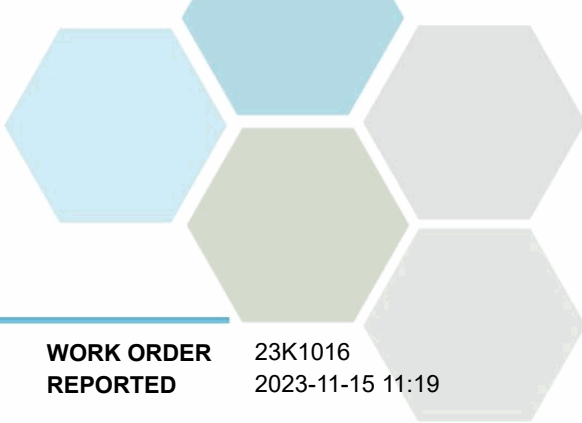
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23J0491
2023-10-11 13:55

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Influent E228537 (23J0491-01) Matrix: Water Sampled: 2023-10-04						FILT, PRES
Anions						
Chloride	89.2	± 4.9	0.10	mg/L	2023-10-06	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-10-06	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-10-06	
Phosphate (as P)	3.52	± 0.61	0.0050	mg/L	2023-10-06	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	59.9		2.00	mg/L	N/A	
Nitrogen, Organic	20.7		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	39.2	± 3.5	0.050	mg/L	2023-10-06	
BOD, 5-day	313	± 66	2.0	mg/L	2023-10-10	
Conductivity (EC)	1050	± 25	2.0	µS/cm	2023-10-09	
Nitrogen, Total Kjeldahl	59.9	± 7.4	0.050	mg/L	2023-10-11	
pH	7.47	± 0.02	0.10	pH units	2023-10-09	HT2
Phosphorus, Total (as P)	7.05	± 0.78	0.0050	mg/L	2023-10-06	
Phosphorus, Total Dissolved	4.07	± 0.48	0.0050	mg/L	2023-10-06	
Solids, Total Suspended	268	± 21	2.0	mg/L	2023-10-10	
Total Metals						
Sodium, total	75.3	± 13.8	0.10	mg/L	2023-10-10	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

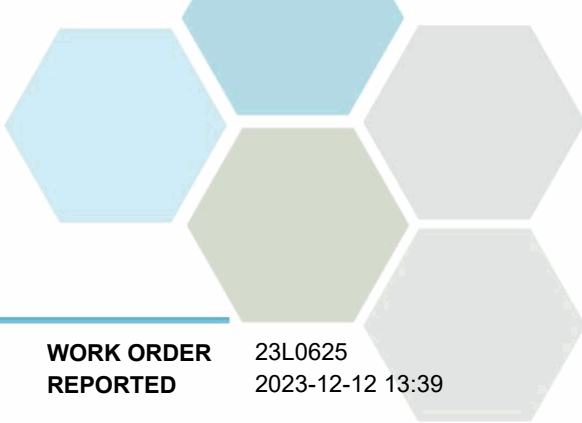
REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23K1016
2023-11-15 11:19

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Influent E228537 (23K1016-01) Matrix: Water Sampled: 2023-11-07						FILT, PRES
Anions						
Chloride	78.6	± 4.3	0.10	mg/L	2023-11-13	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-11-13	HT1
Nitrite (as N)	< 0.010		0.010	mg/L	2023-11-13	HT1
Phosphate (as P)	4.69	± 0.81	0.0050	mg/L	2023-11-13	HT1
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	58.4		2.00	mg/L	N/A	
Nitrogen, Organic	19.3		2.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	39.0	± 3.5	0.050	mg/L	2023-11-10	
BOD, 5-day	313	± 64	2.0	mg/L	2023-11-14	
Conductivity (EC)	1120	± 27	2.0	µS/cm	2023-11-11	
Nitrogen, Total Kjeldahl	58.4	± 7.2	0.050	mg/L	2023-11-10	
pH	7.64	± 0.02	0.10	pH units	2023-11-11	HT2
Phosphorus, Total (as P)	8.60	± 0.95	0.0050	mg/L	2023-11-10	
Phosphorus, Total Dissolved	5.57	± 0.66	0.0050	mg/L	2023-11-10	
Solids, Total Suspended	344	± 26	2.0	mg/L	2023-11-09	
Total Metals						
Sodium, total	101	± 18	0.10	mg/L	2023-11-11	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of Influent (ME12215) - EMS

WORK ORDER REPORTED 23L0625
2023-12-12 13:39

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Influent E228537 (23L0625-01) Matrix: Water Sampled: 2023-12-04 00:00 To 2023-12-05 00:00						FILT, PRES
Anions						
Chloride	132	± 7	0.10	mg/L	2023-12-07	
Nitrate (as N)	< 0.010		0.010	mg/L	2023-12-07	
Nitrite (as N)	< 0.010		0.010	mg/L	2023-12-07	
Phosphate (as P)	5.00	± 0.87	0.0050	mg/L	2023-12-07	
Calculated Parameters						
Nitrate+Nitrite (as N)	< 0.0100		0.0100	mg/L	N/A	
Nitrogen, Total	61.6		1.00	mg/L	N/A	
Nitrogen, Organic	14.7		1.00	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	46.9	± 4.2	0.050	mg/L	2023-12-07	
BOD, 5-day	328	± 68	2.0	mg/L	2023-12-12	
Conductivity (EC)	1420	± 34	2.0	µS/cm	2023-12-07	
Nitrogen, Total Kjeldahl	61.6	± 7.6	0.050	mg/L	2023-12-11	
pH	7.70	± 0.02	0.10	pH units	2023-12-07	HT2
Phosphorus, Total (as P)	9.72	± 1.08	0.0050	mg/L	2023-12-11	
Phosphorus, Total Dissolved	6.37	± 0.75	0.0050	mg/L	2023-12-11	
Solids, Total Suspended	376	± 29	2.0	mg/L	2023-12-07	
Total Metals						
Sodium, total	120	± 22	0.10	mg/L	2023-12-08	

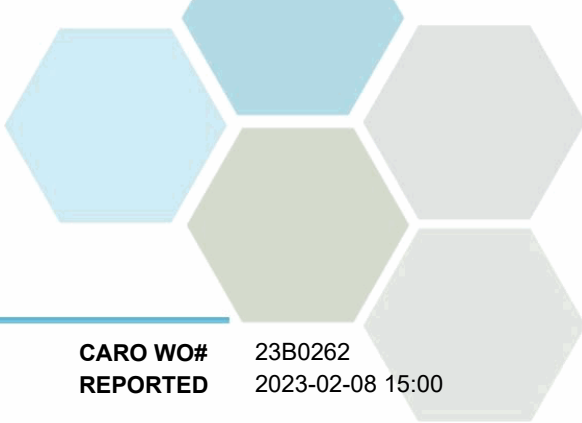
Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

Appendix B

30-day Reclaimed Water Quality Results

Caro Analytical Services

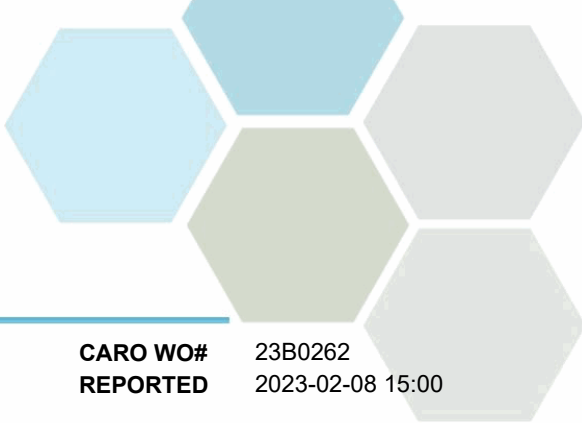


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23B0262
2023-02-08 15:00

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23B0262-01) Matrix: Fresh Water Sampled: 2023-02-01 00:00 To 2023-02-02 00:00						FILT, PRES
Anions						
Chloride	89.1	± 4.9	0.10	mg/L	2023-02-03	
Nitrate (as N)	3.36	± 0.21	0.010	mg/L	2023-02-03	
Nitrite (as N)	0.177	± 0.018	0.010	mg/L	2023-02-03	
Phosphate (as P)	0.0069	± 0.0015	0.0050	mg/L	2023-02-03	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.53		0.0100	mg/L	N/A	
Nitrogen, Total	5.81		0.0500	mg/L	N/A	
Nitrogen, Organic	1.81		0.0500	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	191	± 11	1.0	mg/L	2023-02-04	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0		1.0	mg/L	2023-02-04	
Alkalinity, Bicarbonate (as CaCO3)	191		1.0	mg/L	2023-02-04	
Alkalinity, Carbonate (as CaCO3)	< 1.0		1.0	mg/L	2023-02-04	
Alkalinity, Hydroxide (as CaCO3)	< 1.0		1.0	mg/L	2023-02-04	
Ammonia, Total (as N)	0.467	± 0.043	0.050	mg/L	2023-02-04	
BOD, 5-day	13.8	± 3.3	2.0	mg/L	2023-02-08	
BOD, 5-day Carbonaceous	7.9	± 1.9	2.0	mg/L	2023-02-08	
Conductivity (EC)	829	± 20	2.0	µS/cm	2023-02-04	
Nitrogen, Total Kjeldahl	2.28	± 0.28	0.050	mg/L	2023-02-05	
pH	7.48	± 0.02	0.10	pH units	2023-02-04	HT2
Phosphorus, Total (as P)	0.197	± 0.022	0.0050	mg/L	2023-02-06	
Phosphorus, Total Dissolved	0.0994	± 0.0117	0.0050	mg/L	2023-02-06	
Solids, Total Suspended	3.4	± 0.4	2.0	mg/L	2023-02-04	
Total Metals						
Sodium, total	83.4	± 15.3	0.10	mg/L	2023-02-07	



TEST RESULTS

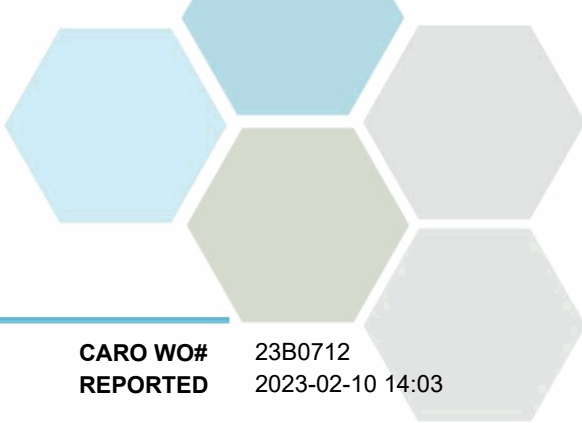
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23B0262
2023-02-08 15:00

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - Grab - E228121 (23B0262-02) Matrix: Water Sampled: 2023-02-02 09:30						
<i>Microbiological Parameters</i>						
Coliforms, Total (Q-Tray)	816		1	MPN/100 mL	2023-02-02	
Coliforms, Fecal (Q-Tray)	87		1	MPN/100 mL	2023-02-02	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

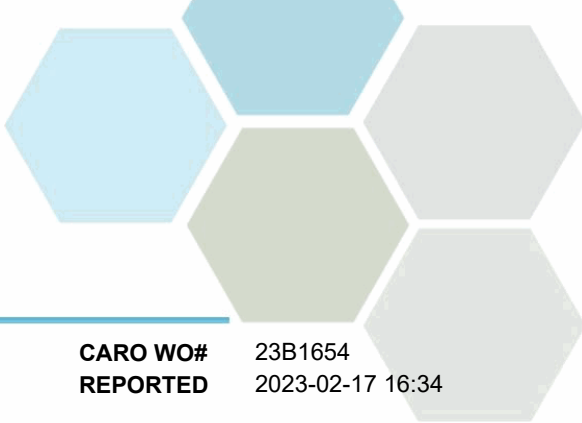
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23B0712
2023-02-10 14:03

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23B0712-01) Matrix: Fresh Water Sampled: 2023-02-06 00:00 To 2023-02-07 00:00						FILT, PRES
Anions						
Nitrate (as N)	3.71	± 0.23	0.010	mg/L	2023-02-08	
Nitrite (as N)	0.108	± 0.011	0.010	mg/L	2023-02-08	
Phosphate (as P)	0.0077	± 0.0016	0.0050	mg/L	2023-02-08	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.82		0.0100	mg/L	N/A	
Nitrogen, Total	6.10		0.0500	mg/L	N/A	
Nitrogen, Organic	1.83		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.451	± 0.041	0.050	mg/L	2023-02-08	
Nitrogen, Total Kjeldahl	2.28	± 0.28	0.050	mg/L	2023-02-09	
pH	7.71	± 0.02	0.10	pH units	2023-02-09	HT2
Phosphorus, Total (as P)	0.147	± 0.016	0.0050	mg/L	2023-02-09	
Phosphorus, Total Dissolved	0.0739	± 0.0087	0.0050	mg/L	2023-02-09	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

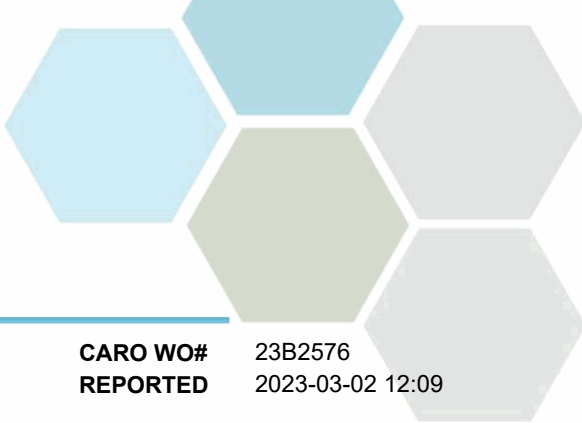
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23B1654
2023-02-17 16:34

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23B1654-02) Matrix: Fresh Water Sampled: 2023-02-14 00:00 To 2023-02-15 00:00						
Anions						
Nitrate (as N)	3.07	± 0.19	0.010	mg/L	2023-02-16	
Nitrite (as N)	0.106	± 0.011	0.010	mg/L	2023-02-16	
Phosphate (as P)	< 0.0050		0.0050	mg/L	2023-02-16	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.18		0.0100	mg/L	N/A	
Nitrogen, Total	5.96		0.0500	mg/L	N/A	
Nitrogen, Organic	2.28		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.502	± 0.046	0.050	mg/L	2023-02-17	
Nitrogen, Total Kjeldahl	2.78	± 0.34	0.050	mg/L	2023-02-17	
pH	7.71	± 0.02	0.10	pH units	2023-02-16	HT2
Phosphorus, Total (as P)	0.130	± 0.014	0.0050	mg/L	2023-02-17	
Phosphorus, Total Dissolved	0.0649	± 0.0077	0.0050	mg/L	2023-02-17	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

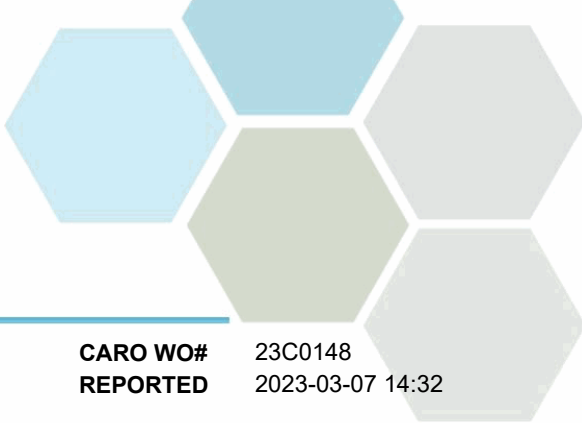


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23B2576
2023-03-02 12:09

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - E228121 (23B2576-01) Matrix: Water Sampled: 2023-02-22 00:00 To 2023-02-23 00:00						FILT, PRES
Anions						
Nitrate (as N)	3.00	± 0.19	0.010	mg/L	2023-02-26	
Nitrite (as N)	0.100	± 0.010	0.010	mg/L	2023-02-26	
Phosphate (as P)	< 0.0050		0.0050	mg/L	2023-02-26	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.10		0.0100	mg/L	N/A	
Nitrogen, Total	5.38		0.0500	mg/L	N/A	
Nitrogen, Organic	1.66		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.624	± 0.057	0.050	mg/L	2023-02-25	
BOD, 5-day Carbonaceous	< 6.2		2.0	mg/L	2023-03-02	
Nitrogen, Total Kjeldahl	2.28	± 0.28	0.050	mg/L	2023-02-28	
pH	7.70	± 0.02	0.10	pH units	2023-02-25	HT2
Phosphorus, Total (as P)	0.134	± 0.015	0.0050	mg/L	2023-02-27	
Phosphorus, Total Dissolved	0.0638	± 0.0075	0.0050	mg/L	2023-02-27	
Solids, Total Suspended	3.2	± 0.4	2.0	mg/L	2023-02-28	

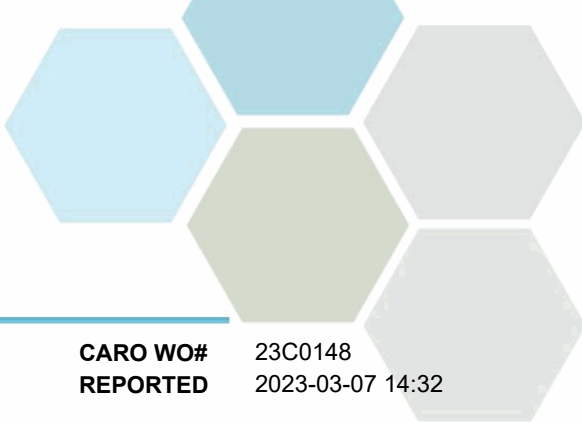


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C0148
2023-03-07 14:32

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23C0148-01) Matrix: Fresh Water Sampled: 2023-02-26 00:00 To 2023-02-27 00:00						FILT, PRES
Anions						
Nitrate (as N)	3.24	± 0.20	0.010	mg/L	2023-03-03	HT1
Nitrite (as N)	0.112	± 0.012	0.010	mg/L	2023-03-03	HT1
Phosphate (as P)	0.0076	± 0.0016	0.0050	mg/L	2023-03-03	HT1, RE2
Calculated Parameters						
Nitrate+Nitrite (as N)	3.35		0.0100	mg/L	N/A	
Nitrogen, Total	5.65		0.0500	mg/L	N/A	
Nitrogen, Organic	1.38		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.915	± 0.083	0.050	mg/L	2023-03-02	
BOD, 5-day	1.6	± 0.5	2.0	mg/L	2023-03-07	
Nitrogen, Total Kjeldahl	2.30	± 0.28	0.050	mg/L	2023-03-03	
pH	7.85	± 0.02	0.10	pH units	2023-03-03	HT2
Phosphorus, Total (as P)	0.113	± 0.013	0.0050	mg/L	2023-03-03	
Phosphorus, Total Dissolved	0.0583	± 0.0069	0.0050	mg/L	2023-03-03	
Solids, Total Suspended	2.2	± 0.4	2.0	mg/L	2023-03-02	



TEST RESULTS

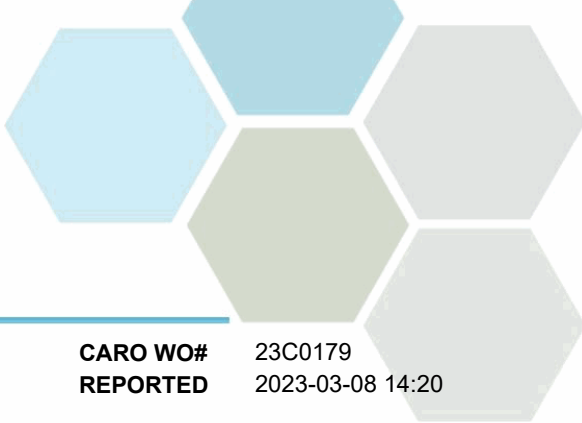
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C0148
2023-03-07 14:32

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23C0148-02) Matrix: Fresh Water Sampled: 2023-02-27 00:00 To 2023-02-28 00:00						FILT, PRES
Anions						
Nitrate (as N)	2.83	± 0.18	0.010	mg/L	2023-03-02	
Nitrite (as N)	0.102	± 0.011	0.010	mg/L	2023-03-02	
Phosphate (as P)	0.0118	± 0.0022	0.0050	mg/L	2023-03-02	
Calculated Parameters						
Nitrate+Nitrite (as N)	2.93		0.0100	mg/L	N/A	
Nitrogen, Total	4.97		0.0500	mg/L	N/A	
Nitrogen, Organic	1.47		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.569	± 0.052	0.050	mg/L	2023-03-02	
BOD, 5-day	2.1	± 0.5	2.0	mg/L	2023-03-07	
Nitrogen, Total Kjeldahl	2.04	± 0.25	0.050	mg/L	2023-03-03	
pH	7.97	± 0.02	0.10	pH units	2023-03-03	HT2
Phosphorus, Total (as P)	0.124	± 0.014	0.0050	mg/L	2023-03-03	
Phosphorus, Total Dissolved	0.0639	± 0.0076	0.0050	mg/L	2023-03-03	
Solids, Total Suspended	2.2	± 0.4	2.0	mg/L	2023-03-02	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.
- RE2 Result was confirmed by re-analysis prior to reporting.

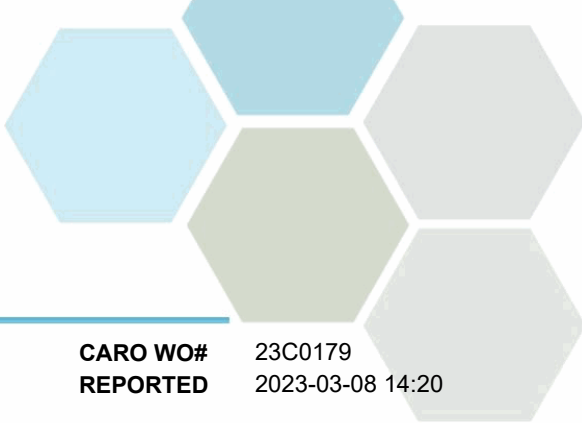


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C0179
2023-03-08 14:20

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23C0179-01) Matrix: Fresh Water Sampled: 2023-02-28 00:00 To 2023-03-01 00:00						F2, FILT, PRES
Anions						
Chloride	90.8	± 5.0	0.10	mg/L	2023-03-03	
Nitrate (as N)	2.44	± 0.15	0.010	mg/L	2023-03-03	
Nitrite (as N)	0.086	± 0.009	0.010	mg/L	2023-03-03	
Phosphate (as P)	0.0056	± 0.0013	0.0050	mg/L	2023-03-03	
Calculated Parameters						
Nitrate+Nitrite (as N)	2.52		0.0100	mg/L	N/A	
Nitrogen, Total	4.53		0.0500	mg/L	N/A	
Nitrogen, Organic	1.80		0.0500	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	191	± 11	1.0	mg/L	2023-03-04	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0		1.0	mg/L	2023-03-04	
Alkalinity, Bicarbonate (as CaCO3)	191		1.0	mg/L	2023-03-04	
Alkalinity, Carbonate (as CaCO3)	< 1.0		1.0	mg/L	2023-03-04	
Alkalinity, Hydroxide (as CaCO3)	< 1.0		1.0	mg/L	2023-03-04	
Ammonia, Total (as N)	0.200	± 0.019	0.050	mg/L	2023-03-03	
BOD, 5-day	6.2	± 2.2	2.0	mg/L	2023-03-08	
BOD, 5-day Carbonaceous	4.9	± 1.8	2.0	mg/L	2023-03-08	
Conductivity (EC)	856	± 21	2.0	µS/cm	2023-03-04	
Nitrogen, Total Kjeldahl	2.00	± 0.25	0.050	mg/L	2023-03-03	
pH	7.76	± 0.02	0.10	pH units	2023-03-04	HT2
Phosphorus, Total (as P)	0.126	± 0.014	0.0050	mg/L	2023-03-03	
Phosphorus, Total Dissolved	0.0670	± 0.0079	0.0050	mg/L	2023-03-03	
Solids, Total Suspended	2.4	± 0.4	2.0	mg/L	2023-03-04	
Total Metals						
Sodium, total	88.0	± 16.1	0.10	mg/L	2023-03-05	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C0179
2023-03-08 14:20

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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VWRC Treated UV Effluent - Grab - E228121 (23C0179-02) | Matrix: Water | Sampled: 2023-02-28 00:00 To 2023-03-01 00:00

Microbiological Parameters

Coliforms, Total (Q-Tray)	86		1	MPN/100 mL	2023-03-02	
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-03-02	

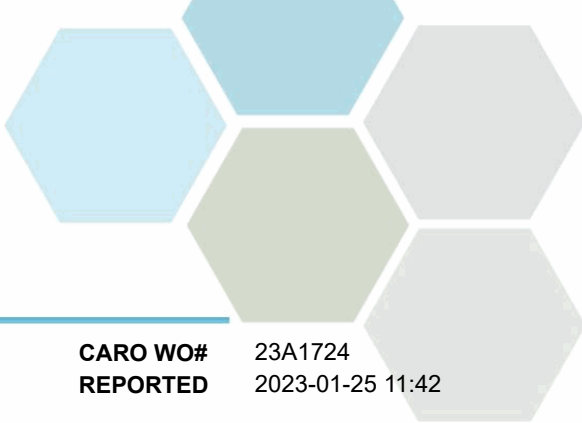
Sample Qualifiers:

- F2 The sample was not field-preserved with HNO₃ and was therefore preserved in the laboratory and held for at least 16 hours prior to analysis for total metals.
- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

Appendix C

Reclaimed Water Quality Results

Caro Analytical Services



TEST RESULTS

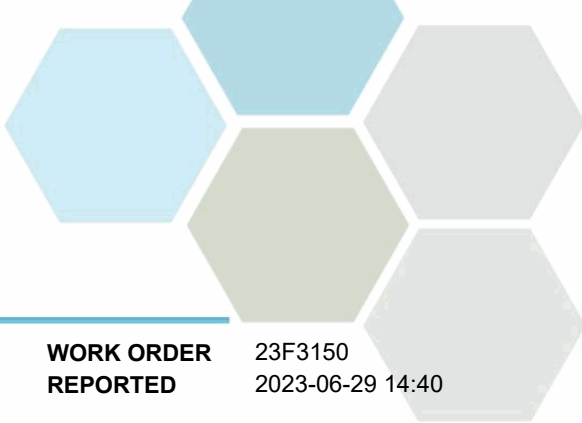
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23A1724
2023-01-25 11:42

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Final Treated Effluent - 24hr Comp. - E105004 (23A1724-01) Matrix: Fresh Water Sampled: 2023-01-17 00:00 To 2023-01-18 00:00						FILT, PRES
Anions						
Chloride	84.4	± 4.6	0.10	mg/L	2023-01-20	
Nitrate (as N)	2.92	± 0.18	0.010	mg/L	2023-01-20	
Nitrite (as N)	0.262	± 0.027	0.010	mg/L	2023-01-20	
Phosphate (as P)	0.0104	± 0.0020	0.0050	mg/L	2023-01-20	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.18		0.0100	mg/L	N/A	
Nitrogen, Total	7.37		0.100	mg/L	N/A	
Nitrogen, Organic	3.78		0.100	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.417	± 0.038	0.050	mg/L	2023-01-20	
BOD, 5-day	18.1	± 4.2	2.0	mg/L	2023-01-24	
Conductivity (EC)	840	± 20	2.0	µS/cm	2023-01-21	
Nitrogen, Total Kjeldahl	4.19	± 0.52	0.050	mg/L	2023-01-23	
pH	7.62	± 0.02	0.10	pH units	2023-01-21	HT2
Phosphorus, Total (as P)	0.643	± 0.071	0.0050	mg/L	2023-01-20	
Phosphorus, Total Dissolved	0.0750	± 0.0089	0.0050	mg/L	2023-01-20	
Solids, Total Suspended	18.4	± 1.5	2.0	mg/L	2023-01-21	
Total Metals						
Sodium, total	79.3	± 14.5	0.10	mg/L	2023-01-25	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23F3150
2023-06-29 14:40

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - E105004 (23F3150-01) Matrix: Water Sampled: 2023-06-21 00:00 To 2023-06-22 00:00						F2, FILT, PRES

Anions

Chloride	91.0	± 5.0	0.10	mg/L	2023-06-29	
Nitrate (as N)	4.04	± 0.25	0.010	mg/L	2023-06-29	HT1
Nitrite (as N)	< 0.100		0.010	mg/L	2023-06-29	HT1, RA1
Phosphate (as P)	0.102	± 0.020	0.0050	mg/L	2023-06-29	HT1

Calculated Parameters

Nitrate+Nitrite (as N)	4.04		0.100	mg/L	N/A	
Nitrogen, Total	6.57		0.100	mg/L	N/A	
Nitrogen, Organic	2.00		0.0500	mg/L	N/A	

General Parameters

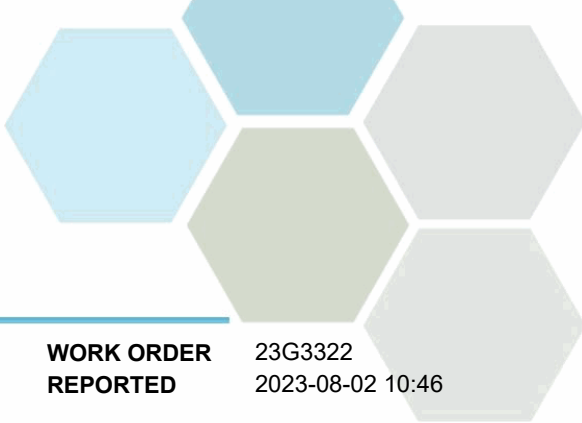
Ammonia, Total (as N)	0.527	± 0.048	0.050	mg/L	2023-06-26	
Conductivity (EC)	860	± 21	2.0	µS/cm	2023-06-27	
Nitrogen, Total Kjeldahl	2.53	± 0.31	0.050	mg/L	2023-06-27	
pH	7.90	± 0.02	0.10	pH units	2023-06-27	HT2
Phosphorus, Total (as P)	0.262	± 0.029	0.0050	mg/L	2023-06-27	
Phosphorus, Total Dissolved	0.128	± 0.015	0.0050	mg/L	2023-06-27	

Total Metals

Sodium, total	111	± 20	0.10	mg/L	2023-06-27	
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Sample Qualifiers:

- F2 The sample was not field-preserved with HNO3 and was therefore preserved in the laboratory and held for at least 16 hours prior to analysis for total metals.
- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.
- RA1 The Reporting Limit for this sample has been raised due to matrix interference.



TEST RESULTS

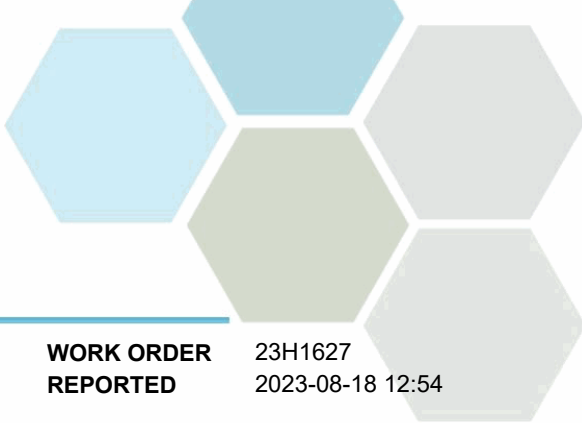
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23G3322
2023-08-02 10:46

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - E105004 (23G3322-01) Matrix: Water Sampled: 2023-07-25 00:00 To 2023-07-26 00:00						FILT, PRES
Anions						
Chloride	78.5	± 4.3	0.10	mg/L	2023-07-27	
Nitrate (as N)	5.72	± 0.36	0.010	mg/L	2023-07-27	
Nitrite (as N)	0.029	± 0.003	0.010	mg/L	2023-07-27	
Phosphate (as P)	0.0468	± 0.0082	0.0050	mg/L	2023-07-27	
Calculated Parameters						
Nitrate+Nitrite (as N)	5.75		0.0100	mg/L	N/A	
Nitrogen, Total	8.20		0.0500	mg/L	N/A	
Nitrogen, Organic	2.17		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.285	± 0.027	0.050	mg/L	2023-07-30	
BOD, 5-day	7.5	± 1.8	2.0	mg/L	2023-08-02	
Conductivity (EC)	818	± 20	2.0	µS/cm	2023-07-28	
Nitrogen, Total Kjeldahl	2.45	± 0.30	0.050	mg/L	2023-07-29	
pH	7.84	± 0.02	0.10	pH units	2023-07-28	HT2
Phosphorus, Total (as P)	0.753	± 0.084	0.0050	mg/L	2023-07-27	
Phosphorus, Total Dissolved	0.195	± 0.023	0.0050	mg/L	2023-07-27	
Solids, Total Suspended	9.7	± 0.9	2.0	mg/L	2023-07-28	
Total Metals						
Sodium, total	97.8	± 17.9	0.10	mg/L	2023-07-29	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

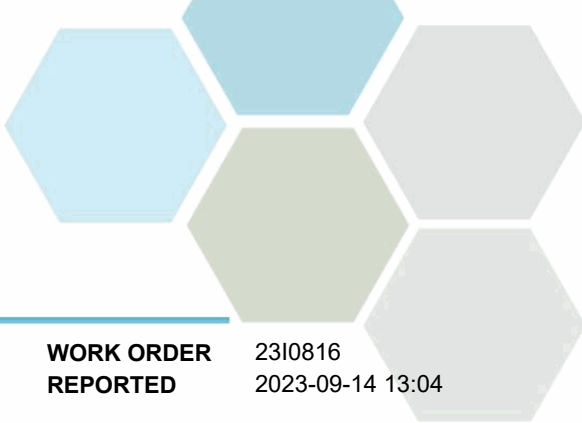
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23H1627
2023-08-18 12:54

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated Effluent (FTE) E105004 (23H1627-01) Matrix: Fresh Water Sampled: 2023-08-10						FILT, PRES
Anions						
Chloride	84.9	± 4.7	0.10	mg/L	2023-08-11	
Nitrate (as N)	5.76	± 0.36	0.010	mg/L	2023-08-11	
Nitrite (as N)	0.030	± 0.003	0.010	mg/L	2023-08-11	
Phosphate (as P)	< 0.0050		0.0050	mg/L	2023-08-11	
Calculated Parameters						
Nitrate+Nitrite (as N)	5.79		0.0100	mg/L	N/A	
Nitrogen, Total	8.07		0.0500	mg/L	N/A	
Nitrogen, Organic	2.12		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.155	± 0.016	0.050	mg/L	2023-08-13	
BOD, 5-day	3.5	± 0.8	2.0	mg/L	2023-08-16	
Conductivity (EC)	870	± 21	2.0	µS/cm	2023-08-15	
Nitrogen, Total Kjeldahl	2.28	± 0.28	0.050	mg/L	2023-08-15	
pH	8.05	± 0.02	0.10	pH units	2023-08-15	HT2
Phosphorus, Total (as P)	0.433	± 0.048	0.0050	mg/L	2023-08-14	
Phosphorus, Total Dissolved	0.0591	± 0.0070	0.0050	mg/L	2023-08-14	
Solids, Total Suspended	< 2.9		2.0	mg/L	2023-08-14	
Total Metals						
Sodium, total	98.3	± 18.0	0.10	mg/L	2023-08-17	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 2310816
2023-09-14 13:04

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated Effluent (FTE) E105004 (2310816-01) Matrix: Fresh Water Sampled: 2023-09-06 00:00 To 2023-09-07 00:00						FILT, PRES

Anions

Chloride	103	± 6	0.10	mg/L	2023-09-08	
Nitrate (as N)	5.74	± 0.36	0.010	mg/L	2023-09-08	
Nitrite (as N)	0.078	± 0.008	0.010	mg/L	2023-09-08	
Phosphate (as P)	1.62	± 0.28	0.0050	mg/L	2023-09-08	

Calculated Parameters

Nitrate+Nitrite (as N)	5.81		0.0100	mg/L	N/A	
Nitrogen, Total	7.78		0.0500	mg/L	N/A	
Nitrogen, Organic	1.85		0.0500	mg/L	N/A	

General Parameters

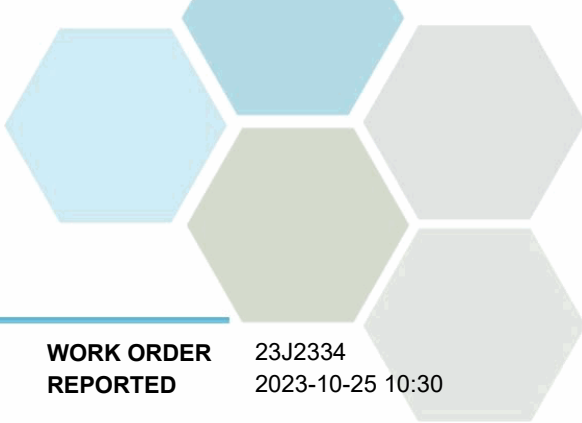
Ammonia, Total (as N)	0.117	± 0.013	0.050	mg/L	2023-09-10	
BOD, 5-day	3.6	± 0.8	2.0	mg/L	2023-09-14	
Conductivity (EC)	844	± 20	2.0	µS/cm	2023-09-10	
Nitrogen, Total Kjeldahl	1.97	± 0.24	0.050	mg/L	2023-09-13	
pH	8.02	± 0.02	0.10	pH units	2023-09-10	HT2
Phosphorus, Total (as P)	2.16	± 0.24	0.0050	mg/L	2023-09-13	
Phosphorus, Total Dissolved	1.94	± 0.23	0.0050	mg/L	2023-09-13	
Solids, Total Suspended	6.4	± 0.6	2.0	mg/L	2023-09-12	

Total Metals

Sodium, total	98.5	± 18.0	0.10	mg/L	2023-09-12	
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Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

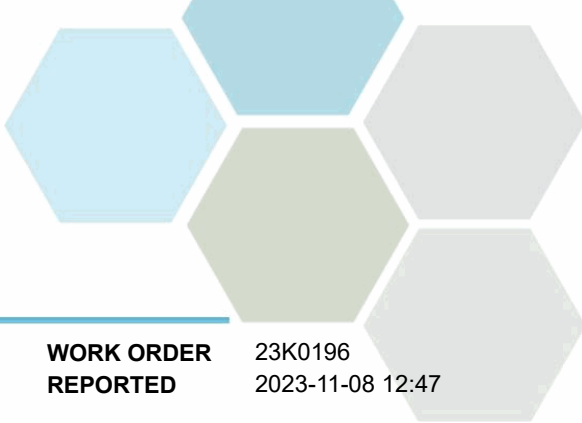
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23J2334
2023-10-25 10:30

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Treated Effluent (FTE) E105004 (23J2334-01) Matrix: Fresh Water Sampled: 2023-10-18						FILT, PRES
Anions						
Chloride	83.8	± 4.6	0.10	mg/L	2023-10-22	
Nitrate (as N)	8.77	± 0.55	0.010	mg/L	2023-10-22	HT1
Nitrite (as N)	0.084	± 0.009	0.010	mg/L	2023-10-22	HT1
Phosphate (as P)	1.78	± 0.31	0.0050	mg/L	2023-10-22	HT1
Calculated Parameters						
Nitrate+Nitrite (as N)	8.85		0.0100	mg/L	N/A	
Nitrogen, Total	10.5		0.0500	mg/L	N/A	
Nitrogen, Organic	1.62		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	< 0.050		0.050	mg/L	2023-10-22	
BOD, 5-day	5.3	± 1.1	2.0	mg/L	2023-10-25	
Conductivity (EC)	793	± 19	2.0	µS/cm	2023-10-23	
Nitrogen, Total Kjeldahl	1.62	± 0.20	0.050	mg/L	2023-10-25	
pH	7.77	± 0.02	0.10	pH units	2023-10-23	HT2
Phosphorus, Total (as P)	2.40	± 0.27	0.0050	mg/L	2023-10-23	
Phosphorus, Total Dissolved	2.27	± 0.27	0.0050	mg/L	2023-10-23	
Solids, Total Suspended	3.8	± 0.5	2.0	mg/L	2023-08-24	HT1
Total Metals						
Sodium, total	78.3	± 14.3	0.10	mg/L	2023-10-24	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

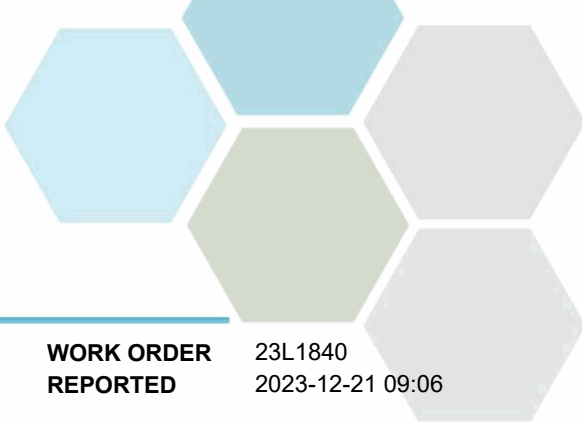
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23K0196
2023-11-08 12:47

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated Effluent (FTE) E105004 (23K0196-01) Matrix: Fresh Water Sampled: 2023-11-01						FILT, PRES
Anions						
Chloride	78.4	± 4.3	0.10	mg/L	2023-11-03	
Nitrate (as N)	6.54	± 0.41	0.010	mg/L	2023-11-03	
Nitrite (as N)	0.044	± 0.005	0.010	mg/L	2023-11-03	
Phosphate (as P)	0.0250	± 0.0044	0.0050	mg/L	2023-11-03	
Calculated Parameters						
Nitrate+Nitrite (as N)	6.59		0.0100	mg/L	N/A	
Nitrogen, Total	8.42		0.0500	mg/L	N/A	
Nitrogen, Organic	1.76		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.068	± 0.009	0.050	mg/L	2023-11-03	
BOD, 5-day	7.4	± 1.5	2.0	mg/L	2023-11-08	
Conductivity (EC)	791	± 19	2.0	µS/cm	2023-11-04	
Nitrogen, Total Kjeldahl	1.83	± 0.23	0.050	mg/L	2023-11-05	
pH	7.71	± 0.02	0.10	pH units	2023-11-04	HT2
Phosphorus, Total (as P)	0.292	± 0.033	0.0050	mg/L	2023-11-03	
Phosphorus, Total Dissolved	0.128	± 0.016	0.0050	mg/L	2023-11-03	
Solids, Total Suspended	8.2	± 0.7	2.0	mg/L	2023-11-02	
Total Metals						
Sodium, total	88.6	± 16.2	0.10	mg/L	2023-11-06	

Sample Qualifiers:

- FILT The sample has been filtered for Diss P in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for Diss P in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23L1840
2023-12-21 09:06

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated Effluent (FTE) E105004 (23L1840-01) Matrix: Fresh Water Sampled: 2023-12-13						FILT, PRES
Anions						
Chloride	81.2	± 4.5	0.10	mg/L	2023-12-15	
Nitrate (as N)	4.71	± 0.30	0.010	mg/L	2023-12-15	
Nitrite (as N)	0.180	± 0.019	0.010	mg/L	2023-12-15	
Phosphate (as P)	0.0590	± 0.0103	0.0050	mg/L	2023-12-15	
Calculated Parameters						
Nitrate+Nitrite (as N)	4.89		0.0100	mg/L	N/A	
Nitrogen, Total	8.45		0.100	mg/L	N/A	
Nitrogen, Organic	2.19		0.100	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	1.37	± 0.12	0.050	mg/L	2023-12-18	
BOD, 5-day	9.9	± 2.1	2.0	mg/L	2023-12-20	
Conductivity (EC)	844	± 20	2.0	µS/cm	2023-12-21	
Nitrogen, Total Kjeldahl	3.56	± 0.44	0.050	mg/L	2023-12-20	
pH	7.51	± 0.02	0.10	pH units	2023-12-20	HT2
Phosphorus, Total (as P)	0.375	± 0.042	0.0050	mg/L	2023-12-19	
Phosphorus, Total Dissolved	0.136	± 0.016	0.0050	mg/L	2023-12-19	
Solids, Total Suspended	10.6	± 0.9	2.0	mg/L	2023-12-19	
Total Metals						
Sodium, total	102	± 19	0.10	mg/L	2023-12-19	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

Appendix D

LT50 Trout Results

Nautilus Environmental Company Inc.



Acute Toxicity Test Results

Sample Treated Effluent,
collected April 19, 2023

Final Report

May 4, 2023

Submitted to: **Vernon Water Reclamation Centre**
Vernon, BC

SAMPLE INFORMATION

Sample ID	Dates		Rainbow trout test initiation	Receipt temperature
	Collected	Received		
Treated Effluent	19-Apr-23 at 1030h	20-Apr-23 at 0933h	20-Apr-23 at 1300h	9.3°C

TESTS

- Rainbow trout 96-h LT50 test (median lethal time) with pH-stabilization using aeration with CO₂-supplemented air (approximately 10.0% CO₂ gas mix)

RESULTS

Toxicity test results

Sample ID	LT50 (hours)
Treated Effluent	>96

LT=Lethal Time

QA/QC

QA/QC summary	Rainbow trout
Reference toxicant LC50 (95% CL)	1.8 (1.6 – 2.2) g/L KCl ¹
Reference toxicant historical mean (2 SD range)	1.5 (0.7 – 3.2) g/L KCl
Reference toxicant CV	41%
Organism health history	Acceptable
Protocol deviations	Yes
Water quality range deviations	None
Control performance	Acceptable

¹ Test Date: Apr 19, 2023, LC = Lethal Concentration, CL = Confidence Limits, SD = Standard Deviation, CV = Coefficient of Variation



Report By:
Ian Cronshaw, B.Sc.
Laboratory Biologist



Reviewed By:
Emma Marus, B.Sc.
Biologist

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

APPENDIX A – Summary of test conditions

Table 1. Summary of test conditions: 96-h rainbow trout (*Oncorhynchus mykiss*) pH stabilized LT50 test.

Test species	<i>Oncorhynchus mykiss</i>
Organism source	Hatchery
Organism age	Juvenile
Test type	Static
Test duration	96 hours
Test vessel	20-L glass aquarium
Test volume	10 to 20 L (depending on size of fish)
Test solution depth	≥15 cm
Test concentrations	100% (undiluted) sample with CO ₂ -supplemented aeration, plus laboratory control
Test replicates	1 per treatment
Number of organisms	10 per replicate
Control/dilution water	Dechlorinated Metro Vancouver municipal tap water
Test solution renewal	None
Test temperature	15 ± 1°C
Feeding	None
Light intensity	100 to 500 lux
Photoperiod	16 hours light / 8 hours dark
Aeration	6.5 ± 1 mL/min/L (2-4% CO ₂ gas mix)
Test measurements	Temperature, pH, and dissolved oxygen measured daily with additional pH measurements at 0.5, 1, 2, and 3h; ammonia, salinity, hardness, and alkalinity measured in the undiluted sample at test initiation; conductivity measured at test initiation and termination; survival checked at 1h, 2h, 4h and daily thereafter
Test protocol	Environment Canada (2000), EPS 1/RM/13, with 2007 & 2016 amendments Environment Canada (2008) EPS 1/RM/50
Test endpoints	Time (hours) to 50% mortality
Test acceptability criterion for controls	Survival ≥90%
Reference toxicant	Potassium chloride (KCl)

APPENDIX B – Toxicity test data

Rainbow Trout Summary Sheet

Client: Vernon Water Reclamation Centre Start Date/Time: Apr 20/23 @ 1300h

Work Order No.: 230661 Test Species: Oncorhynchus mykiss

Sample Information:

Sample ID: Treated Effluent
Sample Date: Apr 19/23
Date Received: Apr 20/23
Sample Volume: 1 x 20L
Other: -

Test Validity Criteria:
≥ 90% Control Survival
WQ Ranges:
T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Dilution Water:

Type: Dechlorinated Municipal Tap Water
Hardness (mg/L CaCO₃): 19
Alkalinity (mg/L CaCO₃): 21

Test Organism Information:

Batch No.: 030723
Source: AquaFarms
No. Fish/Volume (L): 10/12
Loading Density (g/L): 0.31
Mean Length ± SD (mm): 35 ± 2 Range: 33 - 39
Mean Weight ± SD (g): 0.37 ± 0.08 Range: 0.27 - 0.49

KCI Reference Toxicant Results:

Reference Toxicant ID: RBTK66
KCI Lot #: 213248
Date Initiated: Apr. 19, 2023
96-h LC50 (95% CL) [g/L KCI]: 1.8 (1.6-2.2)

Reference Toxicant Mean and Historical Range [g/L KCI]: 1.5 (0.7-3.2)
Reference Toxicant CV (%): 41%

Test Results: The LT50 is estimated to be >96h, (with CO2 aeration).

Reviewed by: Emm Date reviewed: May 3/2023

**96-Hour Rainbow Trout Toxicity Test Data Sheet with CO₂ aeration
(Injection Technique)**

Client/Project #: Vernon Water Reclamation Centre
 Sample I.D.: Treated Effluent
 W.O. #: 230661
 RBT Batch #: 030723
 Date Collected/Time: April 19, 2023/1030h
 Date Setup/Time: April 20, 2023/1300h
 CER #: 7
 Sample Setup By: BAM

Number Fish/Volume: 10/15^{BAM} 10/12L
 7-d % Mortality: 0.28
 Total Pre-aeration Time (mins): 30
 Aeration rate adjusted to 6.5 ± 1 mL/min/L? (Y/N): Y

Thermometer: CER#7
 D.O. meter/probe: 82152
 pH meter/probe: 515
 Cond./Salinity meter/probe: 515

Undiluted Sample WQ			
Parameters	Initial WQ	Adjustment	30 min WQ
Temp °C	14.0		14.0
D.O. (mg/L)	5.5	<i>BAM</i>	7.3
pH	6.5		7 ^{BAM} 6.5
Cond. (µS/cm)	771		770
Salinity (ppt)	0.4		0.4
% of CO ₂ gas mix: 10		Average pH in 100% (v/v): 6.5	

Concentration	Survival				Temperature (°C)					Dissolved Oxygen (mg/L)					pH										Conductivity (µS/cm)	
	LT50				0	24	48	72	96	0	24	48	72	96	Pre	0	0.5	1	2	3 ^{BAM}	24	48	72	96	0	96
% (v/v)	24	48	72	96	0	24	48	72	96	0	24	48	72	96	Pre	0	0.5	1	2	3 ^{BAM}	24	48	72	96	0	96
Ctrl	10	10	10	10	15.0	15.0	15.0	15.5	15.0	9.9	9.6	9.6	9.9	9.8	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.0	7.1	7.3	50	58
100	10	10	10	10	14.0	15.0	15.0	15.5	15.0	7.3	9.5	9.7	9.7	9.7	6.5	6.5	6.5	6.5	6.5	6.5	6.6	6.6	6.6	6.8	770	812
Initials	MJK	JRC	BAM	MJK	BAM	MJK	JRC	BAM	MJK	BAM	MJK	JRC	BAM	MJK	BAM	BAM	BAM	BAM	T.C.	MJK	MJK	BAM	BAM	MJK	BAM	MJK

Sample Description/Comments: Yellow, clear, odourless, w/ no particulates
 Fish Description at 96 h: All fish appear normal Number of Stressed Fish at 96 h: 0
 Other Observations: Survival in the 100% v/v (non- CO2 aerated) at: 1hr: 10 2hr: 10 4hr: 10
 Survival in the 100% v/v (CO2 aerated) at: 1hr: 10 2hr: 10 4hr: 10

Reviewed by: EMM Date Reviewed: May 3, 2023

Nautilus Environmental Water Quality Data For Ammonia

Client: Vernon Water Reclamation Centre Species: O. Mykiss
 Work Order No: 230661 Sample Type: Water
 Date Measured: April 20, 2023

Date	Sample ID	Temperature (°C)	pH	Total Ammonia as N (mg/L)	Unionized Ammonia as N (mg/L)	Tech. Init.
April 20/23	Ctrl	15.0	7.1	0.00	0.000	Bgm
↓						↓
	100	14.0	6.5	0.04	0.000	

Ammonia Salicylate Lot #: A2152

Ammonia Cyanurate Lot #: A2206

Comments: _____

Reviewed by: EMM

Date Reviewed: may 3, 2023

Client: Vernon Water Reclamation Centre

W.O.#: 230661

Hardness and Alkalinity Datasheet

Sample ID	Alkalinity						Hardness			Technician
	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H ₂ SO ₄ used to pH 4.5	(mL) of 0.02N HCL/H ₂ SO ₄ used to pH 4.2	Total Alkalinity (mg/L CaCO ₃)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L CaCO ₃)	
Ctrl	Apr 20/23	Apr 20/23	100	2.2	2.3	21	100	1.9	19	BAM
Treated Effluent	↓	↓	100	1.6	1.8	140	100	2.1	210	BAM

Notes: Diluted to 100mL w/ DI H₂O

Reviewed by: EMM Date Reviewed: May 3, 2023

APPENDIX C – Chain-of-custody form



TESTING LOCATION (Please Circle)

Burnaby
 8664 Commerce Court
 Burnaby, British Columbia, Canada
 V5A 4N7
 Phone 604.420.8773

Calgary
 10823 27 Street SE
 Calgary, Alberta, Canada
 T2Z 3V9
 Phone 403.253.7121

Point Edward
 704 Mara Street, Suite 122
 Point Edward, Ontario, Canada
 N7V 1X4
 Phone 519.339.8787

Chain of Custody

Date _____ Page _____ of _____

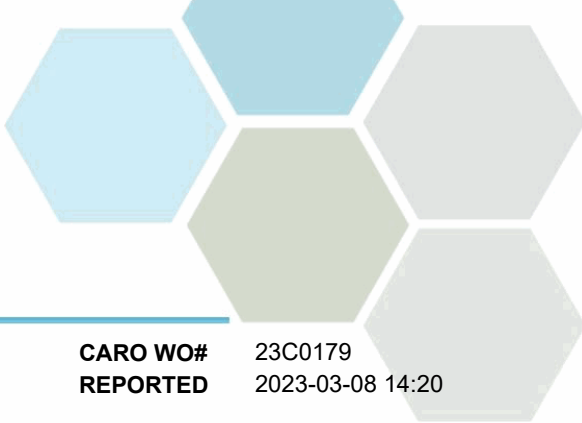
Report to: Company: Vernon Water Reclamation Centre Address: 2100 - 43rd Street City/Prov/PC: Vernon, BC Contact: Ryan Powell Phone: (250) 550 3627 Email: rpowell@vernon.ca				Invoice To: Company: Vernon Water Reclamation Centre Address: 3400 30th street City/Prov/PC: Vernon, BC Contact: Phone: Email: covap@vernon.ca PO No.:				ANALYSES REQUIRED																																																																																														
Sample Collection By: Ryan Powell				Sample Type: Grab <input checked="" type="radio"/> OR Composite <input type="radio"/>				<input checked="" type="checkbox"/> 96-h RBT LT50 ph stab.																																																																																														
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:10%;">SAMPLE ID</th> <th style="width:10%;">DATE (DD/MM/YY)</th> <th style="width:10%;">TIME</th> <th style="width:10%;">MATRIX</th> <th style="width:15%;"># OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)</th> <th style="width:45%;">COMMENTS</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>19/04/23</td> <td>10:30</td> <td>Water</td> <td>1 x 20L</td> <td></td> </tr> <tr><td>2</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>3</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>4</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>5</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>6</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>7</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>8</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>9</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>10</td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>				SAMPLE ID	DATE (DD/MM/YY)	TIME	MATRIX	# OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)	COMMENTS	1	19/04/23	10:30	Water	1 x 20L		2						3						4						5						6						7						8						9						10						<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:5%; text-align: center;">9.3</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </table>												9.3																				Receipt Temperature (°C)
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(Printed Name) _____ (Signature) <i>Tyrene</i> (Company) _____				(Printed Name) _____ (Signature) <i>TH</i> (Company) _____				Our liability is limited to the cost of the test requested. The test results only relate to the sample as received. No liability in whole or in part is assumed for the collection, handling, or transport of the sample, application or interpretation of the test data or results in part or in whole.																																																																																														
(Date DD/MM/YY and Time) _____				(Date DD/MM/YY and Time) Apr. 20/23 09:33																																																																																																		

END OF REPORT

Appendix E

Water Quality of Reclaimed Water to Okanagan Lake

Caro Analytical Services

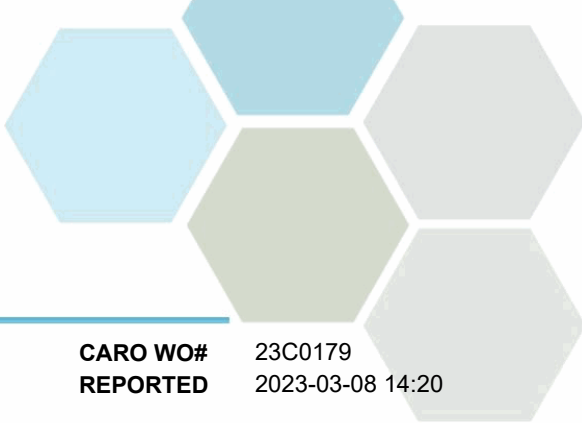


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C0179
2023-03-08 14:20

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23C0179-01) Matrix: Fresh Water Sampled: 2023-02-28 00:00 To 2023-03-01 00:00						F2, FILT, PRES
Anions						
Chloride	90.8	± 5.0	0.10	mg/L	2023-03-03	
Nitrate (as N)	2.44	± 0.15	0.010	mg/L	2023-03-03	
Nitrite (as N)	0.086	± 0.009	0.010	mg/L	2023-03-03	
Phosphate (as P)	0.0056	± 0.0013	0.0050	mg/L	2023-03-03	
Calculated Parameters						
Nitrate+Nitrite (as N)	2.52		0.0100	mg/L	N/A	
Nitrogen, Total	4.53		0.0500	mg/L	N/A	
Nitrogen, Organic	1.80		0.0500	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	191	± 11	1.0	mg/L	2023-03-04	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0		1.0	mg/L	2023-03-04	
Alkalinity, Bicarbonate (as CaCO3)	191		1.0	mg/L	2023-03-04	
Alkalinity, Carbonate (as CaCO3)	< 1.0		1.0	mg/L	2023-03-04	
Alkalinity, Hydroxide (as CaCO3)	< 1.0		1.0	mg/L	2023-03-04	
Ammonia, Total (as N)	0.200	± 0.019	0.050	mg/L	2023-03-03	
BOD, 5-day	6.2	± 2.2	2.0	mg/L	2023-03-08	
BOD, 5-day Carbonaceous	4.9	± 1.8	2.0	mg/L	2023-03-08	
Conductivity (EC)	856	± 21	2.0	µS/cm	2023-03-04	
Nitrogen, Total Kjeldahl	2.00	± 0.25	0.050	mg/L	2023-03-03	
pH	7.76	± 0.02	0.10	pH units	2023-03-04	HT2
Phosphorus, Total (as P)	0.126	± 0.014	0.0050	mg/L	2023-03-03	
Phosphorus, Total Dissolved	0.0670	± 0.0079	0.0050	mg/L	2023-03-03	
Solids, Total Suspended	2.4	± 0.4	2.0	mg/L	2023-03-04	
Total Metals						
Sodium, total	88.0	± 16.1	0.10	mg/L	2023-03-05	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C0179
2023-03-08 14:20

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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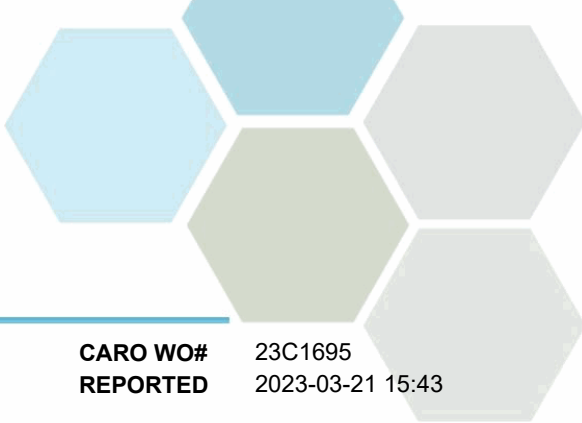
VWRC Treated UV Effluent - Grab - E228121 (23C0179-02) | Matrix: Water | Sampled: 2023-02-28 00:00 To 2023-03-01 00:00

Microbiological Parameters

Coliforms, Total (Q-Tray)	86		1	MPN/100 mL	2023-03-02	
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-03-02	

Sample Qualifiers:

- F2 The sample was not field-preserved with HNO₃ and was therefore preserved in the laboratory and held for at least 16 hours prior to analysis for total metals.
- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

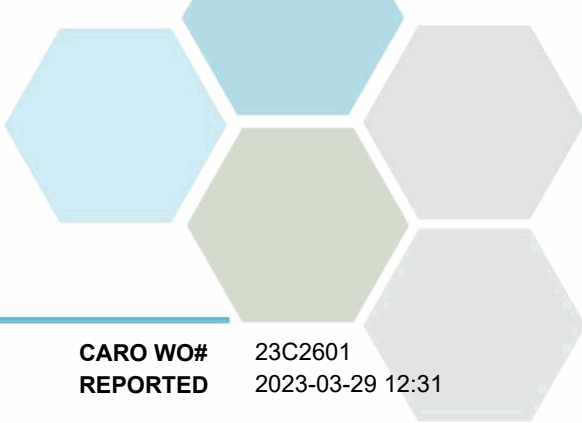
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C1695
2023-03-21 15:43

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23C1695-01) Matrix: Fresh Water Sampled: 2023-03-14 00:00 To 2023-03-15 00:00						FILT, PRES
Anions						
Nitrate (as N)	1.78	± 0.11	0.010	mg/L	2023-03-16	
Nitrite (as N)	0.068	± 0.007	0.010	mg/L	2023-03-16	
Phosphate (as P)	0.0078	± 0.0016	0.0050	mg/L	2023-03-16	
Calculated Parameters						
Nitrate+Nitrite (as N)	1.84		0.0100	mg/L	N/A	
Nitrogen, Total	3.70		0.0500	mg/L	N/A	
Nitrogen, Organic	1.58		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.275	± 0.026	0.050	mg/L	2023-03-16	
BOD, 5-day Carbonaceous	< 4.2		2.0	mg/L	2023-03-21	
Nitrogen, Total Kjeldahl	1.86	± 0.23	0.050	mg/L	2023-03-17	
pH	7.75	± 0.02	0.10	pH units	2023-03-16	HT2
Phosphorus, Total (as P)	0.121	± 0.013	0.0050	mg/L	2023-03-17	
Phosphorus, Total Dissolved	0.0711	± 0.0084	0.0050	mg/L	2023-03-17	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

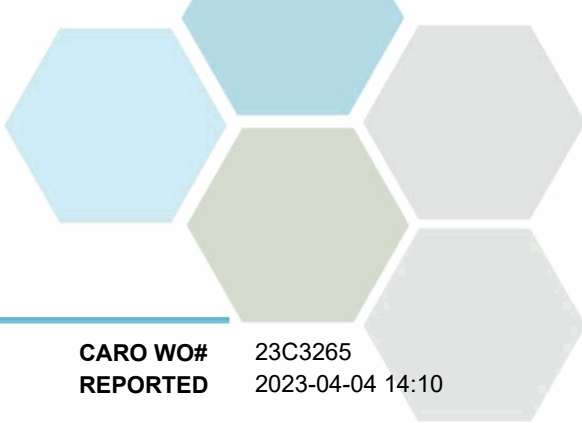
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C2601
2023-03-29 12:31

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - E228121 (23C2601-01) Matrix: Water Sampled: 2023-03-22 00:00 To 2023-03-23 00:00						FILT, PRES
Anions						
Nitrate (as N)	0.932	± 0.058	0.010	mg/L	2023-03-24	
Nitrite (as N)	0.111	± 0.011	0.010	mg/L	2023-03-24	
Phosphate (as P)	0.0050	± 0.0012	0.0050	mg/L	2023-03-24	
Calculated Parameters						
Nitrate+Nitrite (as N)	1.04		0.0100	mg/L	N/A	
Nitrogen, Total	2.71		0.0500	mg/L	N/A	
Nitrogen, Organic	1.51		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.160	± 0.016	0.050	mg/L	2023-03-26	
BOD, 5-day	< 4.8		2.0	mg/L	2023-03-29	
Nitrogen, Total Kjeldahl	1.67	± 0.21	0.050	mg/L	2023-03-27	
pH	7.52	± 0.02	0.10	pH units	2023-03-24	HT2
Phosphorus, Total (as P)	0.123	± 0.014	0.0050	mg/L	2023-03-24	
Phosphorus, Total Dissolved	0.0815	± 0.0096	0.0050	mg/L	2023-03-24	
Solids, Total Suspended	2.2	± 0.4	2.0	mg/L	2023-03-27	

Sample Qualifiers:

FILT The sample has been filtered for Diss phos in the laboratory. Results may not reflect conditions at the time of sampling.
 HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
 PRES Sample has been preserved for Diss phos in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23C3265
2023-04-04 14:10

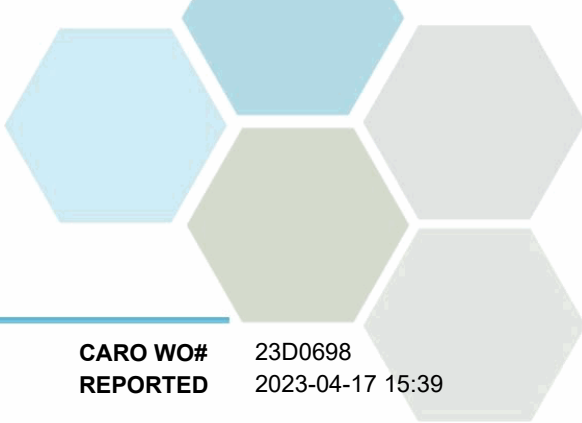
Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23C3265-01) Matrix: Fresh Water Sampled: 2023-03-28 00:00 To 2023-03-29 00:00						FILT, PRES
Anions						
Nitrate (as N)	1.88	± 0.12	0.010	mg/L	2023-03-31	
Nitrite (as N)	0.146	± 0.015	0.010	mg/L	2023-03-31	
Phosphate (as P)	< 0.0050		0.0050	mg/L	2023-03-31	
Calculated Parameters						
Nitrate+Nitrite (as N)	2.03		0.0100	mg/L	N/A	
Nitrogen, Total	3.90		0.0500	mg/L	N/A	
Nitrogen, Organic	1.71		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.162	± 0.016	0.050	mg/L	2023-03-31	
BOD, 5-day Carbonaceous	< 6.7		2.0	mg/L	2023-04-04	
Nitrogen, Total Kjeldahl	1.87	± 0.23	0.050	mg/L	2023-04-03	
pH	7.68	± 0.02	0.10	pH units	2023-03-31	HT2
Phosphorus, Total (as P)	0.123	± 0.014	0.0050	mg/L	2023-03-31	
Phosphorus, Total Dissolved	0.0637	± 0.0075	0.0050	mg/L	2023-03-31	

Sample Qualifiers:

FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

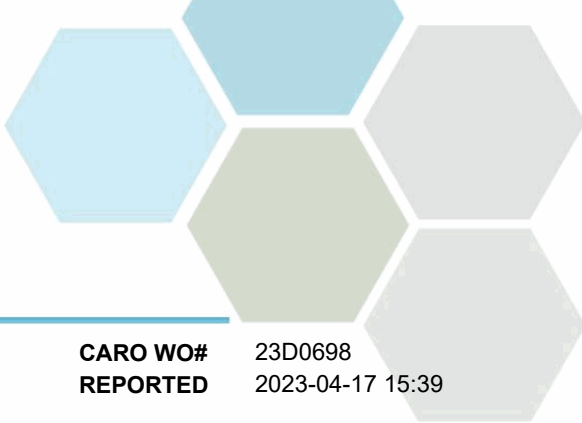


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23D0698
2023-04-17 15:39

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - Grab - E228121 (23D0698-01) Matrix: Water Sampled: 2023-04-06						
<i>Microbiological Parameters</i>						
Coliforms, Total (Q-Tray)	34		1	MPN/100 mL	2023-04-06	
Coliforms, Fecal (Q-Tray)	6		1	MPN/100 mL	2023-04-06	



TEST RESULTS

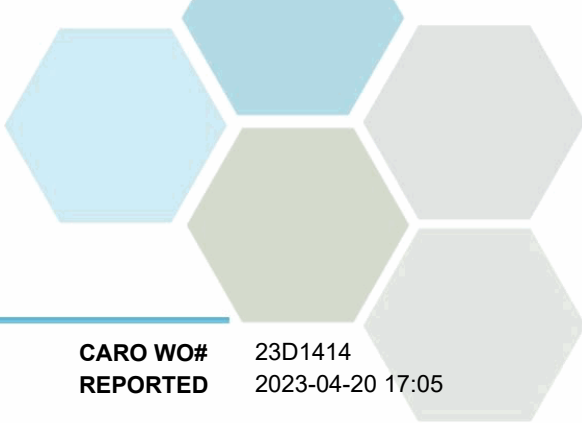
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23D0698
2023-04-17 15:39

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Treated UV Effluent - 24hr Comp. - E228121 (23D0698-02) Matrix: Fresh Water Sampled: 2023-04-05 00:00 To 2023-04-06 00:00						FILT, PRES
Anions						
Chloride	90.8	± 5.0	0.10	mg/L	2023-04-08	
Nitrate (as N)	2.03	± 0.13	0.010	mg/L	2023-04-08	
Nitrite (as N)	0.020	± 0.002	0.010	mg/L	2023-04-08	
Phosphate (as P)	0.0158	± 0.0029	0.0050	mg/L	2023-04-08	RE2
Calculated Parameters						
Nitrate+Nitrite (as N)	2.05		0.0100	mg/L	N/A	
Nitrogen, Total	4.47		0.0500	mg/L	N/A	
Nitrogen, Organic	1.78		0.0500	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	178	± 10	1.0	mg/L	2023-04-17	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0		1.0	mg/L	2023-04-17	
Alkalinity, Bicarbonate (as CaCO3)	178		1.0	mg/L	2023-04-17	
Alkalinity, Carbonate (as CaCO3)	< 1.0		1.0	mg/L	2023-04-17	
Alkalinity, Hydroxide (as CaCO3)	< 1.0		1.0	mg/L	2023-04-17	
Ammonia, Total (as N)	0.637	± 0.058	0.050	mg/L	2023-04-12	
BOD, 5-day	< 7.6		2.0	mg/L	2023-04-12	
BOD, 5-day Carbonaceous	< 6.5		2.0	mg/L	2023-04-12	
Conductivity (EC)	811	± 20	2.0	µS/cm	2023-04-17	
Nitrogen, Total Kjeldahl	2.42	± 0.30	0.050	mg/L	2023-04-13	
pH	7.75	± 0.02	0.10	pH units	2023-04-17	HT2
Phosphorus, Total (as P)	0.180	± 0.020	0.0050	mg/L	2023-04-12	
Phosphorus, Total Dissolved	0.105	± 0.012	0.0050	mg/L	2023-04-12	
Solids, Total Suspended	2.4	± 0.4	2.0	mg/L	2023-04-14	
Total Metals						
Sodium, total	79.0	± 14.4	0.10	mg/L	2023-04-13	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.
- RE2 Result was confirmed by re-analysis prior to reporting.

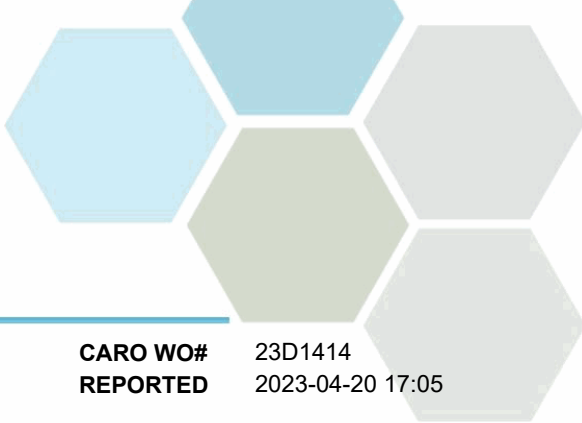


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23D1414
2023-04-20 17:05

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23D1414-01) Matrix: Fresh Water Sampled: 2023-04-13 00:00 To 2023-04-14 00:00						FILT, PRES
Anions						
Chloride	81.7	± 4.5	0.10	mg/L	2023-04-15	
Nitrate (as N)	2.07	± 0.13	0.010	mg/L	2023-04-15	
Nitrite (as N)	0.216	± 0.022	0.010	mg/L	2023-04-15	
Phosphate (as P)	0.0115	± 0.0022	0.0050	mg/L	2023-04-15	
Calculated Parameters						
Nitrate+Nitrite (as N)	2.29		0.0100	mg/L	N/A	
Nitrogen, Total	4.28		0.0500	mg/L	N/A	
Nitrogen, Organic	1.63		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.360	± 0.033	0.050	mg/L	2023-04-16	
BOD, 5-day	< 6.9		2.0	mg/L	2023-04-20	
BOD, 5-day Carbonaceous	< 6.8		2.0	mg/L	2023-04-20	
Conductivity (EC)	779	± 19	2.0	µS/cm	2023-04-19	
Nitrogen, Total Kjeldahl	1.99	± 0.24	0.050	mg/L	2023-04-18	
pH	7.62	± 0.02	0.10	pH units	2023-04-19	HT2
Phosphorus, Total (as P)	0.138	± 0.015	0.0050	mg/L	2023-04-17	
Phosphorus, Total Dissolved	0.0828	± 0.0098	0.0050	mg/L	2023-04-17	
Solids, Total Suspended	2.0	± 0.4	2.0	mg/L	2023-04-19	
Total Metals						
Sodium, total	85.5	± 15.6	0.10	mg/L	2023-04-20	



TEST RESULTS

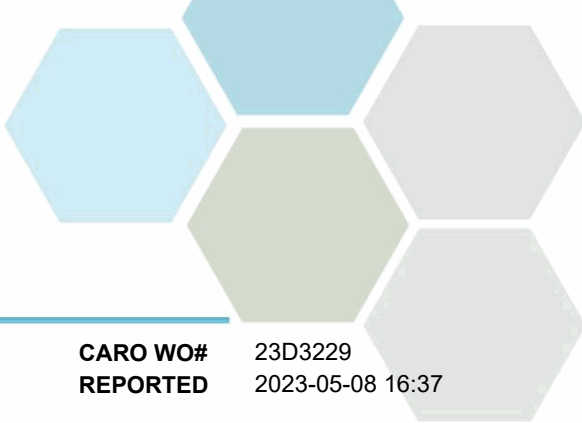
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23D1414
2023-04-20 17:05

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - Grab - E228121 (23D1414-02) Matrix: Water Sampled: 2023-04-14 09:15						
<i>Microbiological Parameters</i>						
Coliforms, Total (Q-Tray)	4		1	MPN/100 mL	2023-04-14	
Coliforms, Fecal (Q-Tray)	1		1	MPN/100 mL	2023-04-14	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

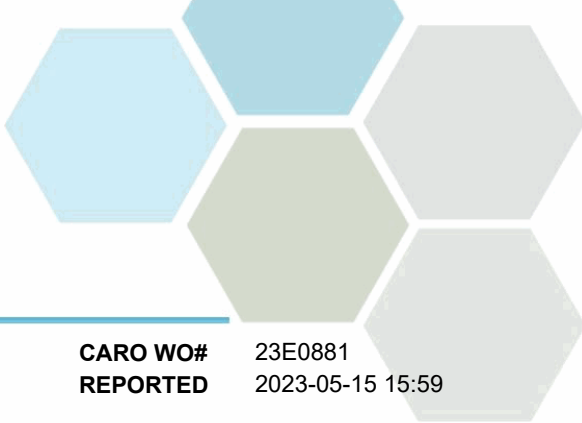
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23D3229
2023-05-08 16:37

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23D3229-01) Matrix: Fresh Water Sampled: 2023-04-27 00:00 To 2023-04-28 00:00						FILT, PRES
Anions						
Nitrate (as N)	2.82	± 0.18	0.010	mg/L	2023-04-29	
Nitrite (as N)	0.537	± 0.055	0.010	mg/L	2023-04-29	
Phosphate (as P)	0.0087	± 0.0017	0.0050	mg/L	2023-04-29	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.36		0.0100	mg/L	N/A	
Nitrogen, Total	6.00		0.0500	mg/L	N/A	
Nitrogen, Organic	1.93		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.715	± 0.065	0.050	mg/L	2023-05-02	
Nitrogen, Total Kjeldahl	2.64	± 0.32	0.050	mg/L	2023-05-02	
pH	7.35	± 0.02	0.10	pH units	2023-05-03	HT2
Phosphorus, Total (as P)	0.127	± 0.014	0.0050	mg/L	2023-05-01	
Phosphorus, Total Dissolved	0.0550	± 0.0065	0.0050	mg/L	2023-05-01	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

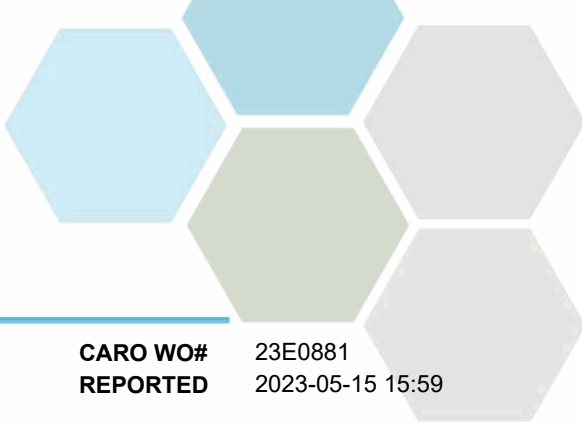


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23E0881
2023-05-15 15:59

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - Grab - E228121 (23E0881-01) Matrix: Water Sampled: 2023-05-04 00:00 To 2023-05-05 00:00						
<i>Microbiological Parameters</i>						
Coliforms, Total (Q-Tray)	44		1	MPN/100 mL	2022-05-06	
Coliforms, Fecal (Q-Tray)	6		1	MPN/100 mL	2022-05-06	



TEST RESULTS

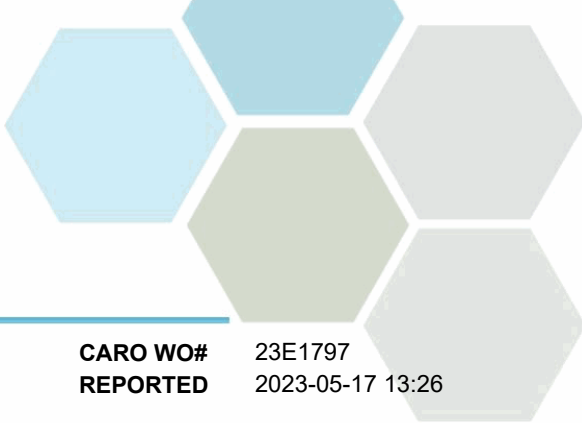
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23E0881
2023-05-15 15:59

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23E0881-02) Matrix: Fresh Water Sampled: 2023-05-04 00:00 To 2023-05-05 00:00						FILT, PRES
Anions						
Chloride	97.3	± 5.3	0.10	mg/L	2023-05-07	
Nitrate (as N)	2.11	± 0.13	0.010	mg/L	2023-05-07	
Nitrite (as N)	0.534	± 0.055	0.010	mg/L	2023-05-07	
Phosphate (as P)	0.0052	± 0.0012	0.0050	mg/L	2023-05-07	
Calculated Parameters						
Nitrate+Nitrite (as N)	2.65		0.0100	mg/L	N/A	
Nitrogen, Total	4.83		0.0500	mg/L	N/A	
Nitrogen, Organic	1.74		0.0500	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	179	± 10	1.0	mg/L	2023-05-07	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0		1.0	mg/L	2023-05-07	
Alkalinity, Bicarbonate (as CaCO3)	179		1.0	mg/L	2023-05-07	
Alkalinity, Carbonate (as CaCO3)	< 1.0		1.0	mg/L	2023-05-07	
Alkalinity, Hydroxide (as CaCO3)	< 1.0		1.0	mg/L	2023-05-07	
Ammonia, Total (as N)	0.449	± 0.041	0.050	mg/L	2023-05-07	
BOD, 5-day	4.8	± 1.7	2.0	mg/L	2023-05-11	
BOD, 5-day Carbonaceous	4.7	± 1.5	2.0	mg/L	2023-05-11	
Conductivity (EC)	847	± 20	2.0	µS/cm	2023-05-07	
Nitrogen, Total Kjeldahl	2.19	± 0.27	0.050	mg/L	2023-05-10	
pH	7.83	± 0.02	0.10	pH units	2023-05-07	HT2
Phosphorus, Total (as P)	0.141	± 0.016	0.0050	mg/L	2023-05-08	
Phosphorus, Total Dissolved	0.0679	± 0.0080	0.0050	mg/L	2023-05-08	
Solids, Total Suspended	4.0	± 0.4	2.0	mg/L	2023-05-10	
Total Metals						
Sodium, total	80.0	± 14.6	0.10	mg/L	2023-05-14	

Sample Qualifiers:

- FILT The sample has been filtered for Diss phos in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for Diss phos in the laboratory and the holding time has been extended.



TEST RESULTS

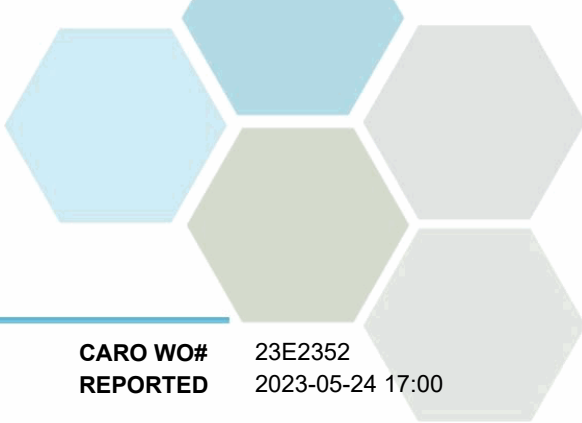
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23E1797
2023-05-17 13:26

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23E1797-01) Matrix: Fresh Water Sampled: 2023-05-12 15:20						
Anions						
Nitrate (as N)	2.91	± 0.18	0.010	mg/L	2023-05-14	
Nitrite (as N)	0.548	± 0.056	0.010	mg/L	2023-05-14	
Phosphate (as P)	0.0115	± 0.0022	0.0050	mg/L	2023-05-14	
Calculated Parameters						
Nitrate+Nitrite (as N)	3.46		0.0100	mg/L	N/A	
Nitrogen, Total	5.50		0.0500	mg/L	N/A	
Nitrogen, Organic	1.70		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.347	± 0.032	0.050	mg/L	2023-05-14	
Nitrogen, Total Kjeldahl	2.04	± 0.25	0.050	mg/L	2023-05-17	
pH	7.13	± 0.02	0.10	pH units	2023-05-16	HT2
Phosphorus, Total (as P)	0.133	± 0.015	0.0050	mg/L	2023-05-17	
Phosphorus, Total Dissolved	0.0768	± 0.0091	0.0050	mg/L	2023-05-17	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

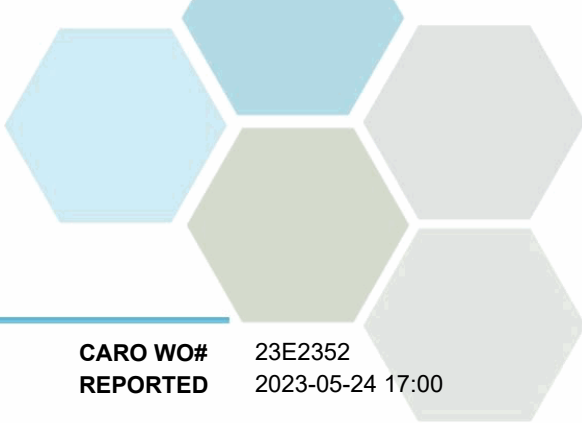


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23E2352
2023-05-24 17:00

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - 24hr Comp. - E228121 (23E2352-01) Matrix: Fresh Water Sampled: 2023-05-16 00:00 To 2023-05-17 00:00						FILT, PRES
Anions						
Nitrate (as N)	1.66	± 0.10	0.010	mg/L	2023-05-18	
Nitrite (as N)	0.160	± 0.016	0.010	mg/L	2023-05-18	
Phosphate (as P)	< 0.0050		0.0050	mg/L	2023-05-18	
Calculated Parameters						
Nitrate+Nitrite (as N)	1.82		0.0100	mg/L	N/A	
Nitrogen, Total	3.34		0.0500	mg/L	N/A	
Nitrogen, Organic	1.46		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.072	± 0.010	0.050	mg/L	2023-05-19	
BOD, 5-day Carbonaceous	< 4.8		2.0	mg/L	2023-05-23	
Nitrogen, Total Kjeldahl	1.53	± 0.19	0.050	mg/L	2023-05-22	
pH	7.01	± 0.02	0.10	pH units	2023-05-19	HT2
Phosphorus, Total (as P)	0.100	± 0.011	0.0050	mg/L	2023-05-19	
Phosphorus, Total Dissolved	0.0598	± 0.0071	0.0050	mg/L	2023-05-19	
Solids, Total Suspended	< 2.0		2.0	mg/L	2023-05-18	



TEST RESULTS

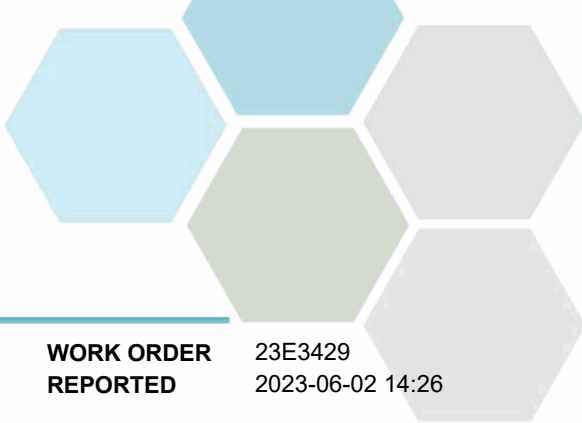
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

CARO WO# REPORTED 23E2352
2023-05-24 17:00

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent (2) - 24hr Comp. - E228121 (23E2352-02) Matrix: Fresh Water Sampled: 2023-05-16 00:00 To 2023-05-17 00:00						FILT, PRES
Anions						
Nitrate (as N)	1.66	± 0.10	0.010	mg/L	2023-05-18	
Nitrite (as N)	0.151	± 0.016	0.010	mg/L	2023-05-18	
Phosphate (as P)	< 0.0050		0.0050	mg/L	2023-05-18	
Calculated Parameters						
Nitrate+Nitrite (as N)	1.81		0.0100	mg/L	N/A	
Nitrogen, Total	3.49		0.0500	mg/L	N/A	
Nitrogen, Organic	1.60		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.081	± 0.010	0.050	mg/L	2023-05-19	
BOD, 5-day Carbonaceous	< 4.8		2.0	mg/L	2023-05-23	
Nitrogen, Total Kjeldahl	1.68	± 0.21	0.050	mg/L	2023-05-22	
pH	7.39	± 0.02	0.10	pH units	2023-05-19	HT2
Phosphorus, Total (as P)	0.0986	± 0.0109	0.0050	mg/L	2023-05-19	
Phosphorus, Total Dissolved	0.0624	± 0.0074	0.0050	mg/L	2023-05-19	
Solids, Total Suspended	3.0	± 0.4	2.0	mg/L	2023-05-18	

Sample Qualifiers:

- FILT The sample has been filtered for Diss phos in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for Diss phos in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23E3429
2023-06-02 14:26

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
WVRC Treated UV Effluent - 24hr Comp. - E228121 (23E3429-01) Matrix: Fresh Water Sampled: 2023-05-24 00:00 To 2023-05-25 00:00						FILT, PRES

Anions

Nitrate (as N)	3.24	± 0.20	0.010	mg/L	2023-05-27	
Nitrite (as N)	0.417	± 0.043	0.010	mg/L	2023-05-27	
Phosphate (as P)	1.06	± 0.18	0.0050	mg/L	2023-05-27	

Calculated Parameters

Nitrate+Nitrite (as N)	3.66		0.0100	mg/L	N/A	
Nitrogen, Total	5.13		0.0500	mg/L	N/A	
Nitrogen, Organic	1.46		0.0500	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	< 0.050		0.050	mg/L	2023-05-27	
Nitrogen, Total Kjeldahl	1.46	± 0.18	0.050	mg/L	2023-06-01	
pH	6.84	± 0.02	0.10	pH units	2023-05-29	HT2
Phosphorus, Total (as P)	1.36	± 0.15	0.0050	mg/L	2023-05-31	
Phosphorus, Total Dissolved	1.29	± 0.15	0.0050	mg/L	2023-05-31	

WVRC Treated UV Effluent - 24hr Comp. - E228121 (23E3429-02) | Matrix: Fresh Water | Sampled: 2023-05-25 00:00 To 2023-05-26 00:00

FILT,
PRES

Anions

Nitrate (as N)	2.94	± 0.18	0.010	mg/L	2023-05-27	
Nitrite (as N)	0.174	± 0.018	0.010	mg/L	2023-05-27	
Phosphate (as P)	0.0243	± 0.0043	0.0050	mg/L	2023-05-27	

Calculated Parameters

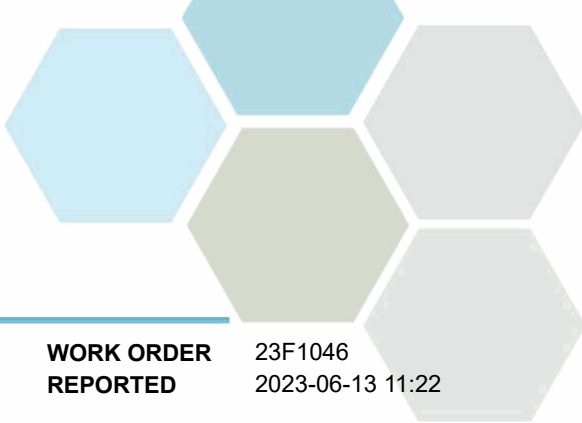
Nitrate+Nitrite (as N)	3.12		0.0100	mg/L	N/A	
Nitrogen, Total	4.43		0.0500	mg/L	N/A	
Nitrogen, Organic	1.31		0.0500	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	< 0.050		0.050	mg/L	2023-05-28	
Nitrogen, Total Kjeldahl	1.31	± 0.16	0.050	mg/L	2023-06-01	
pH	6.95	± 0.02	0.10	pH units	2023-05-29	HT2
Phosphorus, Total (as P)	0.134	± 0.015	0.0050	mg/L	2023-05-31	
Phosphorus, Total Dissolved	0.0979	± 0.0116	0.0050	mg/L	2023-05-31	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

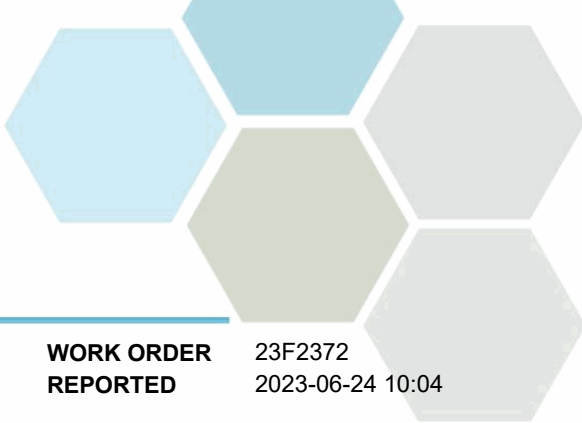
REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23F1046
2023-06-13 11:22

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent - E228121 (23F1046-01) Matrix: Water Sampled: 2023-06-06 00:00 To 2023-06-07 00:00						FILT, PRES
Anions						
Nitrate (as N)	3.68	± 0.23	0.010	mg/L	2023-06-09	
Nitrite (as N)	0.777	± 0.080	0.010	mg/L	2023-06-09	
Phosphate (as P)	2.02	± 0.35	0.0050	mg/L	2023-06-09	
Calculated Parameters						
Nitrate+Nitrite (as N)	4.46		0.0100	mg/L	N/A	
Nitrogen, Total	6.02		0.0500	mg/L	N/A	
Nitrogen, Organic	1.51		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.057	± 0.009	0.050	mg/L	2023-06-08	
Nitrogen, Total Kjeldahl	1.57	± 0.19	0.050	mg/L	2023-06-12	
pH	7.18	± 0.02	0.10	pH units	2023-06-12	HT2
Phosphorus, Total (as P)	2.96	± 0.33	0.0050	mg/L	2023-06-09	
Phosphorus, Total Dissolved	2.82	± 0.33	0.0050	mg/L	2023-06-09	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23F2372
2023-06-24 10:04

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
VWRC Treated UV Effluent E228121 (23F2372-01) Matrix: Fresh Water Sampled: 2023-06-14 00:00 To 2023-06-15 00:00						FILT, PRES
Anions						
Nitrate (as N)	6.88	± 0.43	0.010	mg/L	2023-06-20	HT1
Nitrite (as N)	0.369	± 0.038	0.010	mg/L	2023-06-20	HT1
Phosphate (as P)	1.76	± 0.30	0.0050	mg/L	2023-06-20	HT1
Calculated Parameters						
Nitrate+Nitrite (as N)	7.25		0.0100	mg/L	N/A	
Nitrogen, Total	9.06		0.0500	mg/L	N/A	
Nitrogen, Organic	1.65		0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	0.152	± 0.015	0.050	mg/L	2023-06-19	
Nitrogen, Total Kjeldahl	1.80	± 0.22	0.050	mg/L	2023-06-22	
pH	7.88	± 0.02	0.10	pH units	2023-06-19	HT2
Phosphorus, Total (as P)	2.44	± 0.27	0.0050	mg/L	2023-06-19	
Phosphorus, Total Dissolved	2.39	± 0.28	0.0050	mg/L	2023-06-19	

VWRC Treated UV Effluent E228121 (23F2372-02) | Matrix: Fresh Water | Sampled: 2023-06-15 00:00 To 2023-06-16 00:00

General Parameters						
BOD, 5-day Carbonaceous	< 2.0		2.0	mg/L	2023-06-22	
Solids, Total Suspended	5.2	± 0.5	2.0	mg/L	2023-06-20	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

Appendix F

Summary Report Discharge of Reclaimed Water to Okanagan Lake 2023

Larratt Aquatic Consulting Ltd.



Vernon Discharge of Reclaimed Water to
Okanagan Lake
2023 Summary Report



Prepared for City of Vernon

Executive Summary

Larratt Aquatic monitored Okanagan Lake near the City of Vernon’s 60 m deep outfall before, during, and after the discharge of 1.0 million m³ of reclaimed water. Water was released from the Vernon Water Reclamation Centre from March 14 until June 16, 2023. Three sites with increasing distance from the outfall were monitored during this study to determine if an effect from the release of reclaimed water into Okanagan Lake could be detected and quantified.

Results Summary

- No statistically significant difference in temperature was detected between the sites closest and those farthest from the outfall, or between the outfall site and the north basin background site at Okanagan Centre.
- The plume was identified within the IDZ via an in-situ multimeter transect.
- Chloride and nutrient concentrations were significantly higher in the reclaimed water than in Okanagan Lake but there were no differences between the three sites or between the outfall site and the ENV background site at Okanagan Centre.
- Fecal bacteria results were very low in all lake samples because the reclaimed water was disinfected with UV prior to release.
- A small increase in phytoplankton densities occurred at the two sites closest to the outfall during the first half of the discharge window. This result suggests a weak effect of nutrients from the reclaimed water discharge on phytoplankton productivity.
- Zooplankton feed upon phytoplankton and serve as food for many types of fish including immature kokanee salmon. Total zooplankton densities did not indicate an effect from the reclaimed water plume.

Summary Table

Parameter	Impact From Discharge Detected?
Temperature	No
Water Clarity	No
Chloride	No
TN	No
DIN	No
TP	No
Chl-a	No
Phytoplankton	Potential transient increase in nutrient favouring taxa
Zooplankton	No

This study did not detect a statistically significant effect on water temperature, water clarity, nutrient concentrations, or the zooplankton community resulting from the release of reclaimed water into Okanagan Lake. This study did detect a small potential effect on the phytoplankton community that was transient and was overshadowed in magnitude by natural seasonal variation. Rapid dilution of the reclaimed water plume in Okanagan Lake from the combined effect of the diffuser assembly and lake water currents likely account for these findings.

Preferred Citation

Self, J. and H. Larratt, 2023. Vernon Discharge of Reclaimed Water to Okanagan Lake - 2023 Summary Report. Prepared by Larratt Aquatic Consulting Ltd. Prepared for City of Vernon

Report prepared by: Larratt Aquatic Consulting Ltd.

Author: Jamie Self: BSc, R.P. Bio.

Senior Aquatic Biologist



Special Thanks to Serge Kozin and Carlee Heater of City of Vernon for their assistance in preparing this report.

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Definitions

The following terms are defined as they are used in this report.

Term	Definition
Algae bloom	A superabundant growth of algae
Anoxic	Devoid of oxygen
Bioavailable	Available for use by plants or animals
Chlorophyll-a	Primary photosynthetic pigment in algae; used as a measure of photosynthetic activity
Cyanobacteria	Bacteria-like algae having cyanochrome as the main photosynthetic pigment
Diatoms	Algae that have hard, silica-based cell walls called frustules
Discharge window	The period from Feb 17 – Jun 1 when reclaimed water was released into Okanagan Lake
Spring/Fall overturn	Point when lake becomes uniform density from surface to sediment and mixes, removing stratification
Effluent/Reclaimed Water	Fully treated and disinfected liquid released from the wastewater treatment facility
Eutrophic/hypereutrophic	Nutrient-rich, biologically productive water body
Harmful Algae Bloom	Algae bloom that produces negative impacts on human or wildlife health
Macronutrient	The major constituents of cells: nitrogen, phosphorus, carbon, sulphate, H
Microflora	The sum of algae, bacteria, fungi, <i>Actinomyces</i> , etc., in water or biofilms
Nutrient limitation	A nutrient will limit or control the potential growth of organisms e.g. P or N
Phytoplankton	Algae that float, drift or swim in water columns of reservoirs and lakes
Plankton	Those organisms that float or swim in water
Secchi depth	Depth where a 20 cm Secchi disk can be seen; measures water transparency
Statistical significance	Use of a statistical test (e.g. ANOVA) was used to determine with >95% certainty that data supports a statement
Thermocline	The lake zone of greatest change in water temperature with depth (> 1°C/m); it separates the surface water (epilimnion) from the cold hypolimnion below
Zooplankton	Minute animals that graze algae, bacteria and detritus in water bodies

Term	Definition
AFDM	Ash-free dry mass
Chl-a	Chlorophyll-a units µg/L
DO	Dissolved oxygen units mg/L
EMS	British Columbia Environmental Monitoring System (a database of water chemistry data)
ENV	British Columbia Ministry of Environment and Climate Change Strategy
N	Nitrogen units mg/L as N
Ortho-P	Orthophosphate ≈ SRP monomeric inorganic phosphorus units mg/L as N
P	Phosphorus units mg/L as P
DIN	Dissolved inorganic nitrogen = ammonia + nitrate + nitrite units mg/L as N
TDN	Total dissolved nitrogen = ammonia + nitrate + nitrite + dissolved organic N units mg/L as N
TDP/DP	Total dissolved phosphorus units mg/L as P
TN	Total nitrogen: organic + dissolved units mg/L as N
TP	Total phosphorus: organic + dissolved units mg/L as P

Lake Classification by Trophic Status Indicators (Nordin, 1985)

Trophic Status	chlorophyll-a (µg/L)	Total P (µg/L)	Total N (µg/L)	Secchi disc (m)	primary production (mg C/m ² /day)
Oligotrophic	0 – 2	1 – 10	<100	> 6	50- 300
Mesotrophic	2 – 5	10 – 20	100 – 500	3 – 6	250 – 1000
Eutrophic	>5	> 20	500-1000	< 3	>1000

Nutrient Balance Definitions for Microflora (Dissolved Inorganic N : Dissolved Inorganic P) (Nordin,1985)

Phosphorus Limitation	Co-Limitation of N and P	Nitrogen Limitation
>15 : 1	<15 : 1 – 5 : 1	5 : 1 or less

Project Background

City of Vernon (herein called Vernon) discharges reclaimed water from the Vernon Water Reclamation Centre (VWRC) to MacKay Reservoir (Figure 1). MacKay Reservoir is a temporary storage and balancing reservoir for the spray irrigation system. Vernon also has a large outfall pipe in Okanagan Lake at a depth of 60 m (Figure 1) that is utilized when all applicable regulatory requirements are met and the MacKay Reservoir elevation exceeds 1935 fasl. MacKay Reservoir met the regulatory requirements during 2023 and a discharge was planned for early 2023. The discharge began on March 14 and ended when process issues led to a premature suspension of the discharge on June 16. A total of 1,055,018 m³ of reclaimed water from the VWRC, that would have otherwise been pumped to MacKay Reservoir, was released into Okanagan Lake¹.



Figure 1: Map of sampling points and City of Vernon reclaimed water distribution system

¹ As a comparison, City of Kelowna released 13.2 million m³ into Okanagan Lake during 2022 while Mission Creek contributed 264 million m³ during 2022

Sampling Methodology

LAC conducted sampling at three pre-determined GPS locations north of Ellison Provincial Park (Figure 1). Three sample sites were chosen:

- **OUTFALL:** The closest site is directly adjacent to the outfall to monitor discharge prior to significant dilution
- **EDGE OF IDZ:** The proximal site is the edge of the initial dilution zone (270 m north of the outfall)
- **UPGRADIENT** The upgradient control site (4.2 km north of the outfall) to reflect background conditions

Sampling commenced in late-January and concluded in mid-June² (Table 1). All three sites were sampled on the same day during each of the five sampling trips. Field data and laboratory samples were collected at each location, following all BC ENV protocols for Okanagan Lake.

Table 1: Schedule of Sampling

Details	Number of sample sets	Dates Sampled
Prior to discharge	1	Jan 25
During discharge	3	Mar 22, Apr 13, May 2
After discharge ceased	1	Jul 13

Chemistry samples were collected as composites of the epilimnion (1, 5, 10 m) and hypolimnion (30, 45, 60 m) zones using standard BC ENV sampling protocols. Samples were sent to both CARO Labs Kelowna and ALS Labs in Burnaby to ensure that the most sensitive detection limits could be obtained for each parameter.

Table 2: Water chemistry parameters

Parameter	Units	RDL	Lab
Alkalinity	mg/L	1	ALS
Ammonia	mg/L as N	0.0050	ALS
Chloride	mg/L	0.5	ALS
Chlorophyll-a	µg/L	0.1	CARO
<i>E. coli</i>	MPN/100mL	1	CARO
Fecal coliforms	MPN/100mL	1	CARO
Hardness	mg/L	0.5	ALS
Nitrate	mg/L as N	0.0050	ALS
Nitrite	mg/L as N	0.0010	ALS
NO ₃ +NO ₂	mg/L as N	0.0050	ALS
Organic nitrogen	mg/L as N	0.050	ALS
Orthophosphate	mg/L as P	0.005	ALS
SO ₄	mg/L	1	CARO
Total dissolved phosphorus	mg/L as P	0.0020	ALS
Total nitrogen	mg/L as N	0.050	ALS
Total phosphorus	mg/L as P	0.0020	ALS
Total sodium	mg/L	0.1	CARO

² The discharge ended earlier than anticipated because of process issues at the VWRC

Biological samples – After the secchi depth reading on each date and at each site, chlorophyll-a, and phytoplankton were collected from a composite of 0.5 m, the secchi depth and twice the secchi depth; these were kept dark and cold. Zooplankton were collected through a vertical 45 m haul net (150 µm) and preserved with ethanol.

QA/QC Both Caro and ALS are CALA certified and follow analytic QA/QC. Similarly, Cordillera and LAC have internal QA/QC protocols that are available upon request.

Reclaimed Water Samples City of Vernon staff collected water chemistry samples from the reclaimed water prior to discharge from the plant. The results from these tests are included in this report.

Analysis Methodology

The data analyses used in this report compare the conditions between the three lake monitoring sites (Figure 1) and between the reclaimed water directly. Data from two long-term monitoring sites by ENV were also included to provide background context for this part of Okanagan Lake. More detail on the statistical tests and data handling is found in Appendix 3.

Results and Discussion

Data were collected across a suite of parameters including field data, chemistry samples, and biological samples. The results are summarized below. Whenever possible, the reclaimed water was compared to samples collected at the three lake monitoring sites (Figure 1).

Physical Conditions

Water Temperature

Water column temperature was similar between the three lake sampling sites (Figure 2), averaging 4.0 ± 0.5 °C at 60 m. By the final sample date (July 13) a distinct thermocline had established at 13 m at all three sites. The reclaimed water was much warmer than the receiving lake water, estimated at 15 °C³. While overall water column temperature profiles did not indicate a difference between sampling sites that could be attributed to impacts from the reclaimed water discharge, a series of transects through the plume on April 13 did detect the plume at 60 m below the surface (Figure 3). The plume was travelling east from the intake, and was about 50 m wide at 60 m depth. This was entirely within the 100 m IDZ.

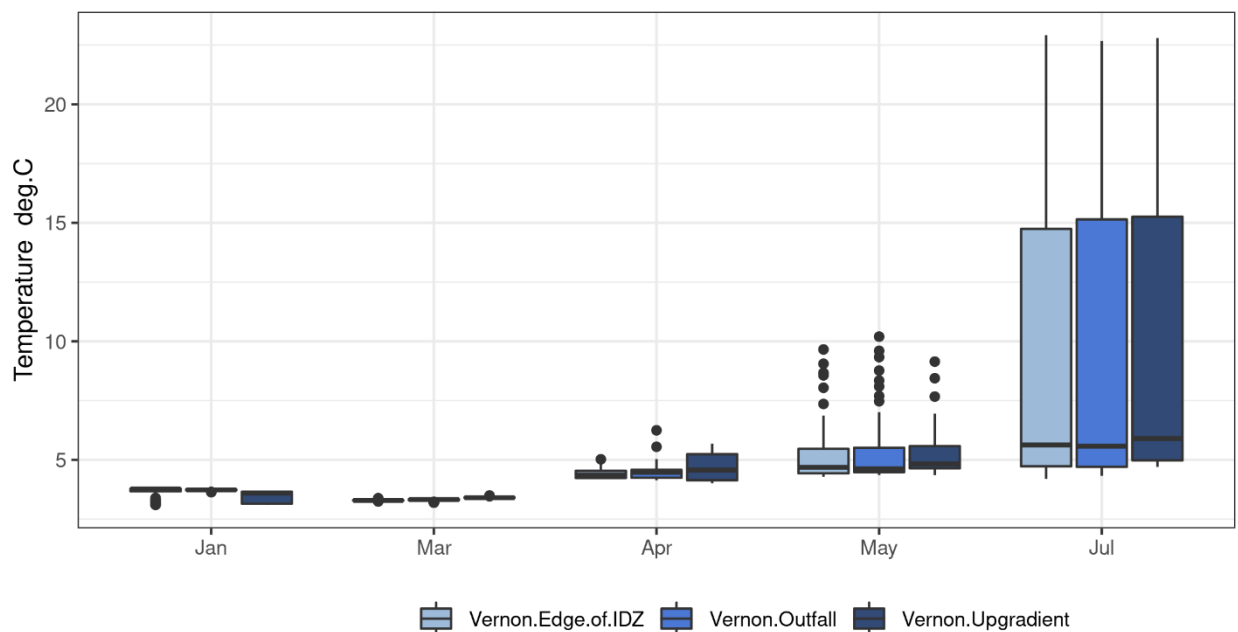


Figure 2: Water temperature from field meter profiles during the discharge window

³ Reclaimed water temperature was not logged at the VWRC during this discharge but was previously measured at between 13 and 19 °C during the 2021 discharge. This was assumed to be typical behaviour.

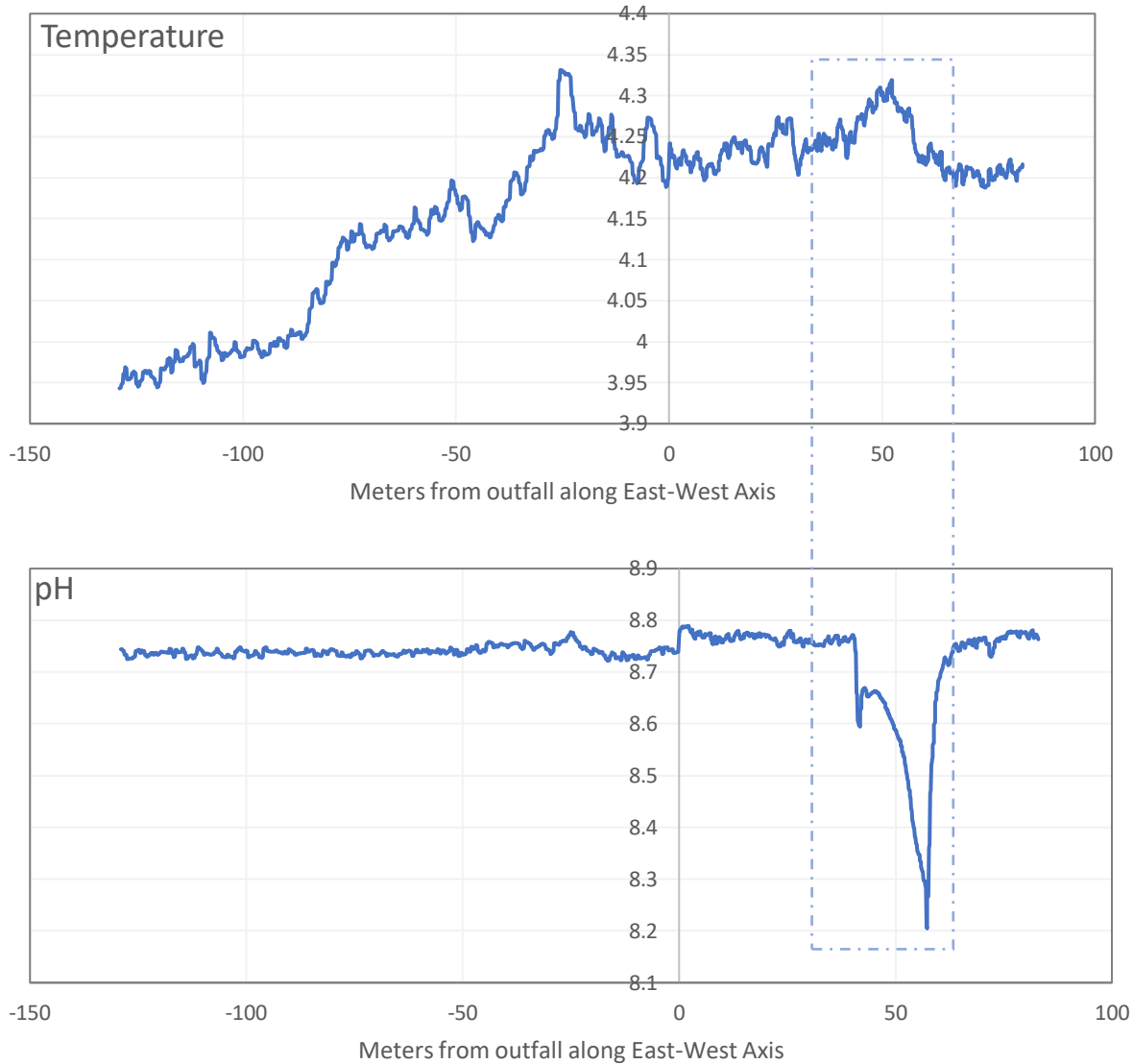


Figure 3: Temperature and pH as measured in East-West transect through the discharge plume at 60 m depth in Okanagan Lake on April 13, 2023

Note: Plume highlighted in dashed box

Water Clarity

Secchi depth at the outfall (6.8 ± 3.6 m) and edge of IDZ (5.9 ± 2.5 m) locations were similar while the upgradient site had lower water clarity (4.9 ± 2.6 , Figure 4). The lower water clarity at the upgradient site is related to the influence of the very productive Armstrong Arm where water clarity is consistently poorer than the rest of Okanagan Lake.

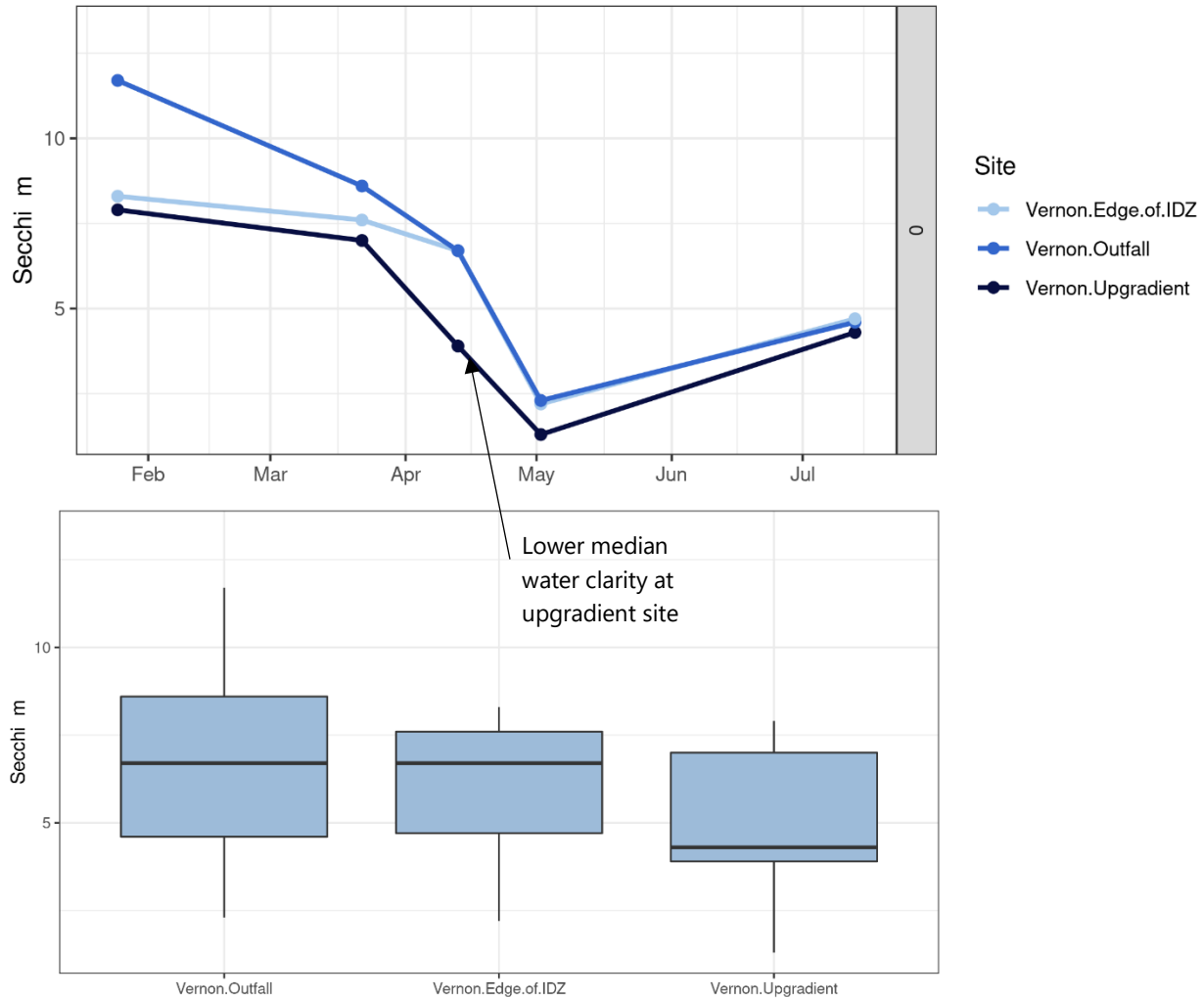


Figure 4: Secchi depth at Okanagan Lake sampling locations during discharge window

Chemistry Samples

General Parameters

Water chemistry samples were collected as epilimnion and hypolimnion composites from the three Okanagan Lake locations as well as from the reclaimed water prior to it entering Okanagan Lake. If an impact of the reclaimed water on Okanagan Lake occurred, we would expect a decreasing gradient with the outfall site being most like the reclaimed water (VWRC in boxplots) of the three lake sites.

Chloride

Chloride, a common marker of human impacts, was much higher in the reclaimed water (79.4 mg/L) than the lake samples, with the outfall location averaging only 6.0 ± 0.2 mg/L (Figure 5). There were no significant differences detected between the sites either in the epilimnion or hypolimnion samples. There was also a subtle north to south gradient where the Armstrong Arm had the highest and Okanagan Centre had the lowest (Figure 5).

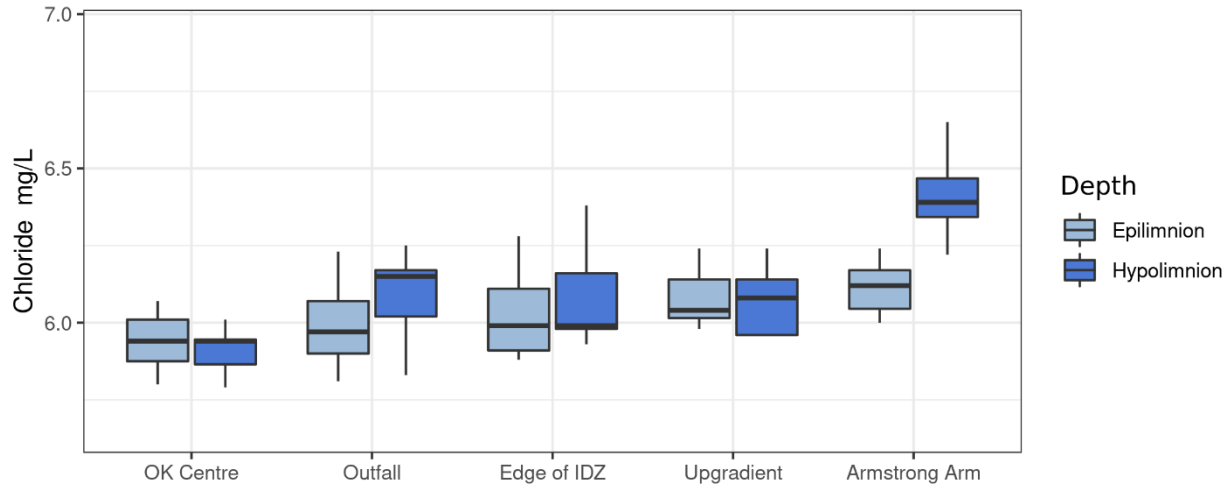


Figure 5: Chloride concentration in Okanagan Lake at sample locations during discharge window
 Note: Chloride concentration in VWRC outflow samples is above the scale of this graph and not displayed

Alkalinity and hardness

Alkalinity and hardness were statistically similar between the three lake sites with hardness averaging 123 ± 3 mg/L in the epilimnion and 123 ± 4 mg/L in the hypolimnion (Figure 6). The hardness and alkalinity data did not detect an impact from the reclaimed water (169 ± 17 mg/L) on Okanagan Lake.

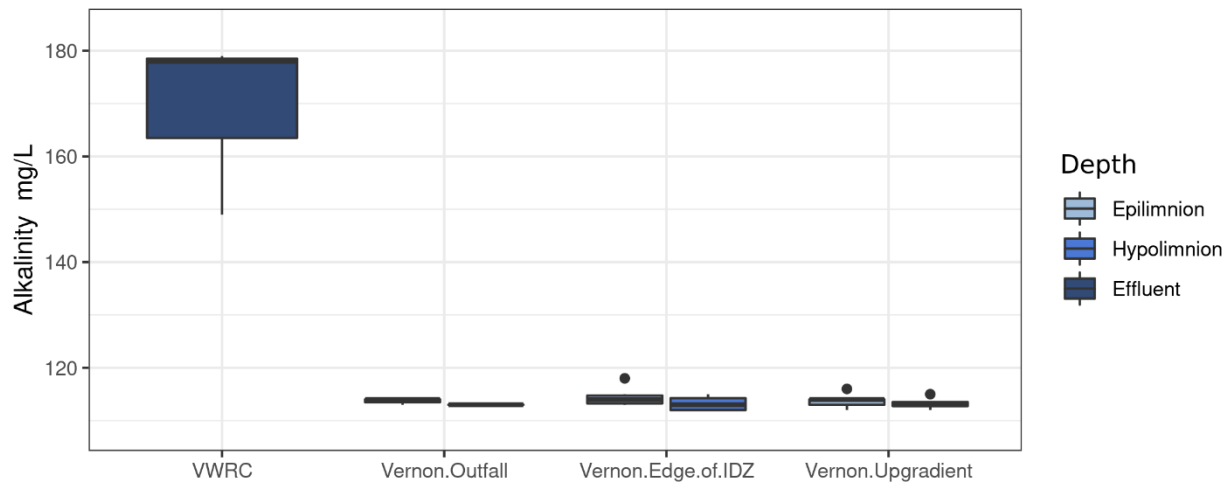


Figure 6: Hardness at Okanagan Lake sample sites compared to reclaimed water during discharge window

pH

pH was measured with a field probe throughout the water column at each lake site and was not significantly different at the outfall site (8.9 ± 0.3) than either the edge of IDZ or upgradient sites (8.8 ± 0.4 and 8.9 ± 0.3 respectively; KW-Tests). pH in the VRWC reclaimed water averaged 7.5 ± 0.3 .

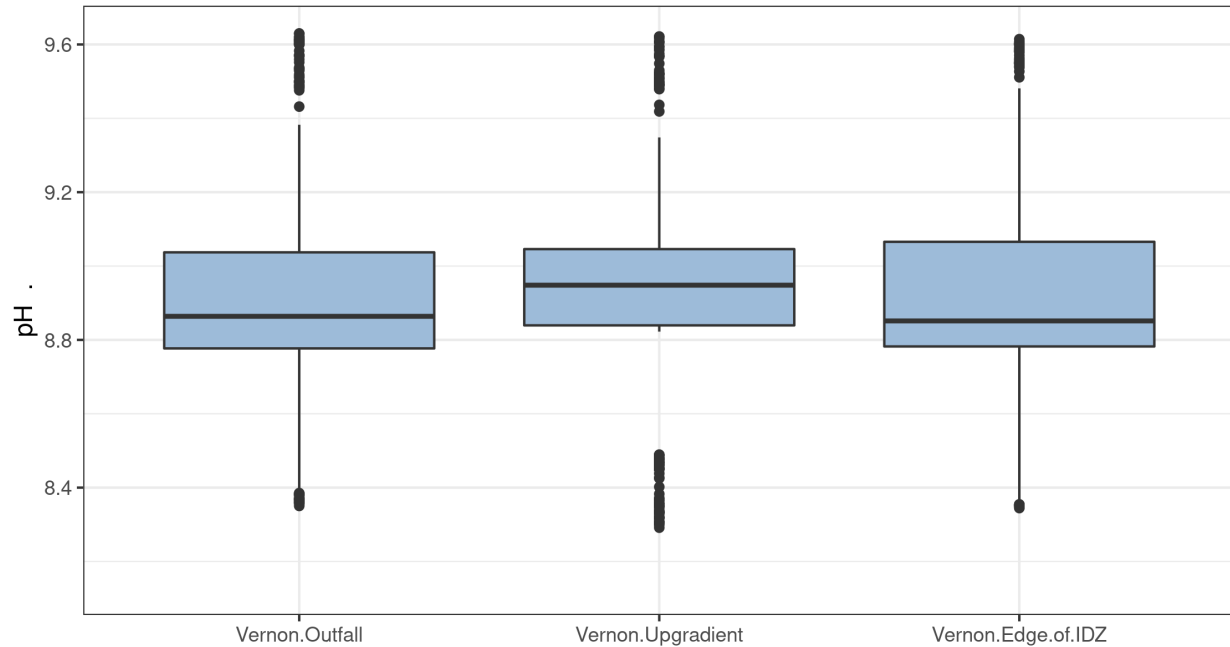


Figure 7: pH at Okanagan Lake sample sites during discharge window

Nutrients

The primary nutrients that control phytoplankton (algae) productivity within Okanagan Lake are the macronutrients, nitrogen and phosphorus.

Nitrogen

Nitrogen is found in both inorganic forms (NH_3 , NO_3) and in organic molecules (proteins, amino acids, etc.). Dissolved inorganic nitrogen (DIN) is highly bioavailable and can be taken up and immediately used by algae while organic forms require bacterial processing before they can be reused. For this reason, the concentration of DIN has a greater impact on production than total nitrogen which includes the organic forms.

The reclaimed water at the VRWC averaged 5.38 ± 1.60 mg/L as N of total nitrogen during the discharge window (Figure 8). There was a distinct increase in TN in the last samples at the end of the discharge window with a maximum of 9.52 mg/L as N on June 14. This may have been related to the total nitrogen averaged 0.241 ± 0.007 mg/L as N in the epilimnion and 0.240 ± 0.012 mg/L as N in the hypolimnion at the outfall location. There was not a statistically significant difference between the outfall, edge of IDZ, or upgradient sites for total nitrogen (KW-Test, $p=0.7$ for hypolimnion).

Total nitrogen concentrations exceeded the ENV objective at all sites and depths except the epilimnion of the upgradient site during March 2023⁴. The north basin and Armstrong Arm background sites also

⁴ The total nitrogen objective (<0.230 mg/L as N) is based on the spring maximum concentration that is typically collected during March.

exceeded the objective indicating that it is a lake-wide condition and not related to the reclaimed water discharge.

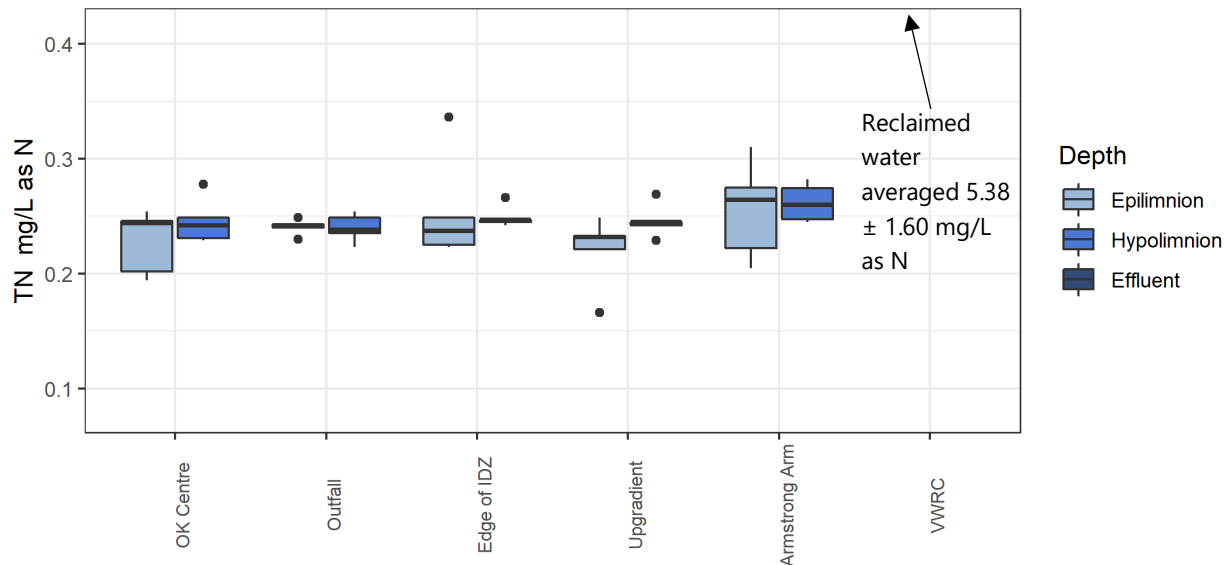


Figure 8: Total nitrogen concentration in Okanagan Lake compared to the reclaimed water during the discharge window

DIN in Okanagan Lake is dominated by nitrate (NO_3) averaging 0.070 ± 0.017 mg/L as N in the hypolimnion at the ENV long-term monitoring location at Okanagan Centre during the discharge window (OK Centre 0500730). Hypolimnion nitrate concentrations were similar between the outfall, edge of IDZ, and upgradient sites and the background ENV sites (KW-Test, $p=0.99$). The outfall site hypolimnion averaged 0.062 ± 0.036 mg/L as N during the discharge window (Figure 9). However, there appeared to be an increase in surface water nitrate closer to the outfall bringing the epilimnion concentration closer to the hypolimnion concentration than at either the edge of IDZ or the upgradient sites. This may indicate increased water column mixing at this site from the buoyant reclaimed water plume. The reclaimed water averaged 3.7 ± 1.5 mg/L as N during the decline window, 48 times higher than the samples collected from the hypolimnion at the outfall. The estimated load of nitrate added to Okanagan Lake during the discharge was 3087 kg or approximately 33 kg/day. For comparison, City of Kelowna released over 12 times the volume of treated effluent into Okanagan Lake and was most recently estimated at 41,700 kg of nitrate released into the lake during 2022 (Gosselin, 2023).

While nitrate is the dominant natural form of DIN in Okanagan Lake, ammonia can also be detected in the hypolimnion where phytoplankton consumption is minimal and ammonia can be generated by anoxic decomposition. Epilimnion ammonia was below detection nearly in all samples during this study and also at the long-term ENV sites (Figure 9). However, ammonia was detected in the hypolimnion at multiple sites but with the lowest concentration at the outfall site, the pattern of detection did not suggest a connection to the reclaimed water discharge. As with nitrate, a significant difference between the background site (ENV OK Centre) and the outfall location for ammonia was not detected (KW-Test, $p=0.9$; Figure 9), again indicating rapid dilution of the reclaimed water plume within Okanagan Lake.

Armstrong Arm experiences oxygen depletion and probable internal nutrient loading and therefore had the highest ammonia concentration of the monitored sites. Ammonia concentration in the effluent averaged 0.362 ± 0.411 mg/L as N with a maximum of 1.84 mg/L as N on April 5. There were no exceedances of the ammonia aquatic life MAC guideline in the effluent during the 2023 discharge⁵. The estimated load of ammonia added to Okanagan Lake during the discharge was 502 kg or approximately 5.3 kg/day.

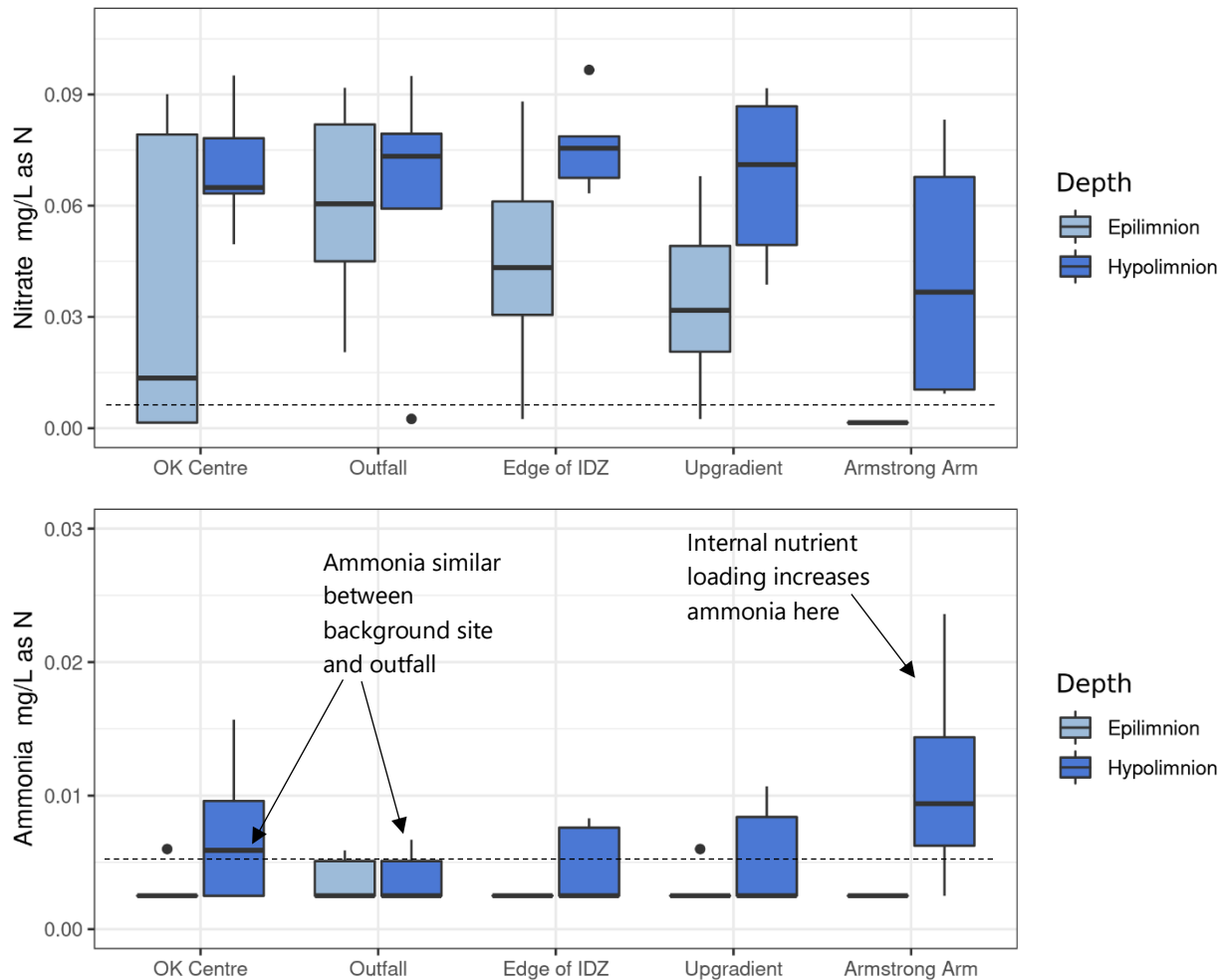


Figure 9: Nitrate + nitrite and ammonia in Okanagan Lake compared to the reclaimed water during the discharge window

Note: Ok Centre = ENV Site 0500730, Armstrong Arm = ENV Site 0500239; black dashed line indicates lab detection limit

Phosphorus

Phosphorus is the most important nutrient controlling productivity in Okanagan Lake. Total phosphorus (TP) in the reclaimed water averaged 0.861 ± 1.40 mg/L as P during the discharge window and was 140 times higher than the outfall location (0.0061 ± 0.0010 mg/L as P). As with nitrogen, there

⁵ Temperature data was not recorded for the effluent so 5 °C was assumed in the calculations as this was the maximum temperature of Okanagan Lake at the outfall depth.

was an increase in phosphorus at the end of the discharge window with concentrations rising to as high as 5.2 mg/L on June 9. This may have related to the process issues that led to the premature suspension of the discharge. There was no statistically significant difference detected in TP between the hypolimnion at the ENV background site (0.0067 ± 0.0016 mg/L as P) and the outfall location (Figure 10; KW-Test, $p=0.77$). The March 22 duplicate sample was collected at the Edge of IDZ site and had unusually high TP compared to the primary sample (exactly double). The cause of this anomaly was not known but all other samples were similar on that date near 0.06 mg/L as P. TP concentrations did not exceed the ENV objective at either of the three sampling sites during March 2023⁶. The north basin background site also met the objective while the Armstrong Arm background site exceeded the objective (Figure 10). The estimated load of total phosphorus added to Okanagan Lake during the discharge was 710 kg or approximately 7.5 kg/day; of this 627 kg was dissolved or 6.7 kg/day.

Total dissolved phosphorus (TDP) was also similar between the background and outfall locations (Figure 10). No significant differences were detected between the outfall, edge of IDZ, or upgradient sites for TP or TDP during the discharge window (KW-Tests) at any depth composite.

Orthophosphate was below detection in 85% of samples collected during this study and was also not significantly different between the monitoring sites (KW-Test, $p=0.50$).

⁶ The total nitrogen/phosphorus objective is based on the spring maximum concentration that is typically collected during March.

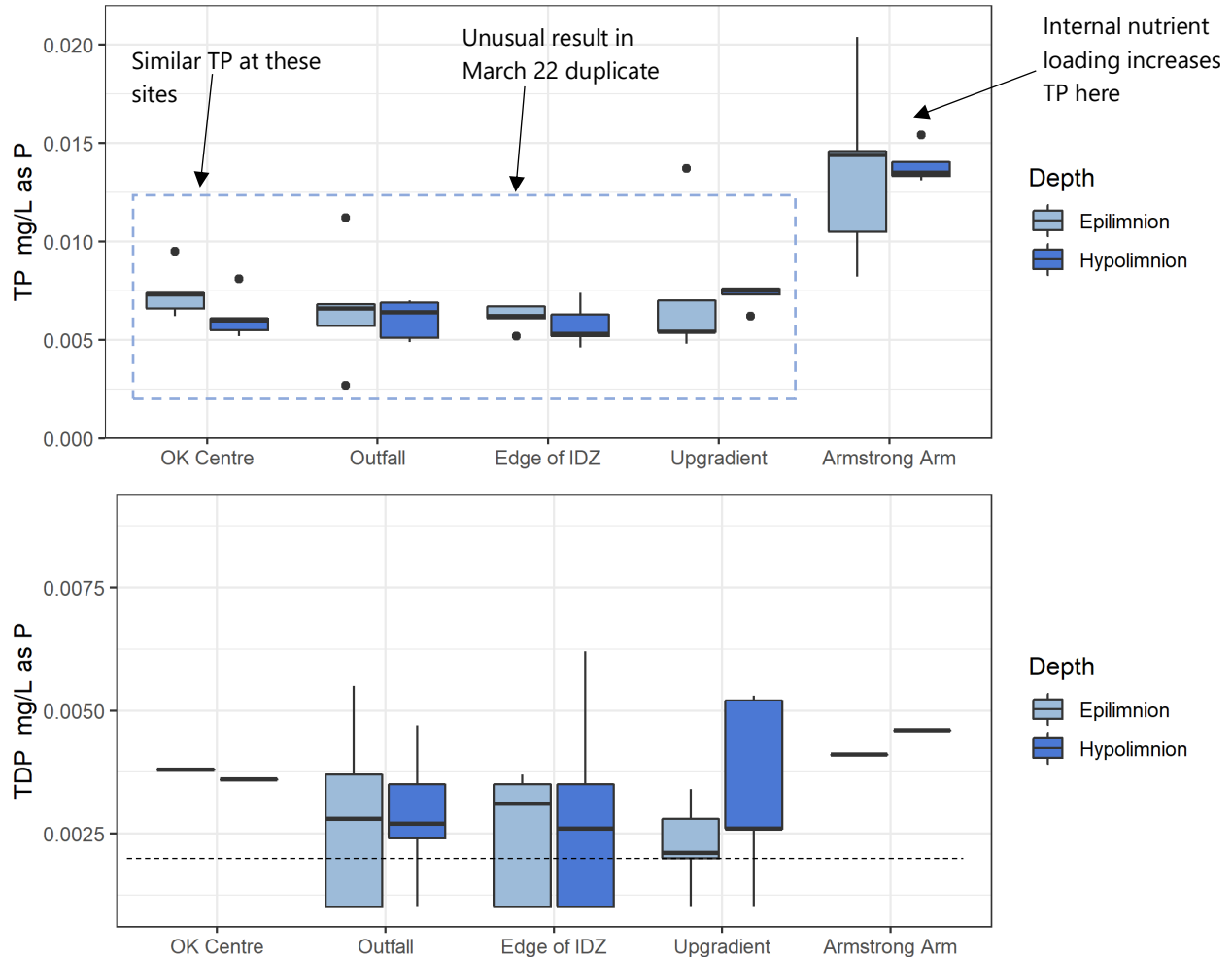


Figure 10: Total and dissolved phosphorus in Okanagan Lake during the discharge window

Note: Black dashed line represents lab detection limit

Nutrient ratios

Nutrient ratios describe the relative abundance of nitrogen to phosphorus and are useful because they explain nutrient limitation. Ratios greater than 15:1 indicate that phosphorus is the limiting nutrient while ratios lower than 5:1 indicate that nitrogen is limiting productivity. In addition to describing nutrient limitation, the ratio of nitrogen to phosphorus can be used to predict the types of phytoplankton that will grow. Cyanobacteria prefer nitrogen limited environments because some taxa can fix atmospheric nitrogen, greatly reducing their dependence on dissolved nitrogen. At higher ratios where phosphorus is limiting, green algae and diatoms tend to be more abundant.

The outfall and edge of IDZ sites were similar to the Okanagan Centre background site (KW-Test, $p=0.8$). While the difference was not statistically significant, the Armstrong Arm background site had the lowest ratio and this appeared to be affecting the nearby upgradient site. An impact from the release of reclaimed water into Okanagan Lake was not detected in the nutrient ratio data.

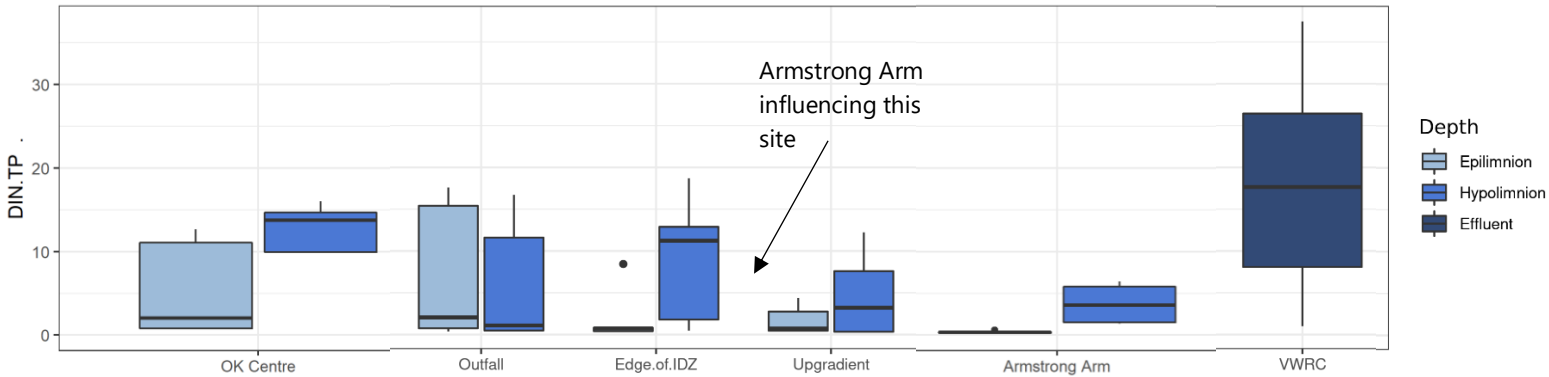


Figure 11: Dissolved inorganic nitrogen to total phosphorus ratio in Okanagan Lake during the discharge window

Biological Samples

Bacteria

Fecal bacteria were sampled for at each site and directly within the reclaimed water stream (VWRC in **Error! Reference source not found.**). All lake samples had *E.coli* concentrations below the detectable limit <1 MPN/100mL. The reclaimed water also had low concentrations but did occasionally contain measurable fecal coliforms (2.8 ± 2.9 MPN/100mL). Measurable fecal coliforms in the discharge are undesirable and may indicate inadequate disinfection prior to release. Despite this, the concentrations were low compared to natural tributaries in the Okanagan.

Phytoplankton

Chlorophyll-a is a pigment common to many types of algae and is used as a measure of algae production. As with other water chemistry parameters, chlorophyll-a was statistically similar between the three sites and averaged 2.03 ± 1.12 $\mu\text{g/L}$ at the outfall site (Figure 12; KW-Test, $p=0.76$).

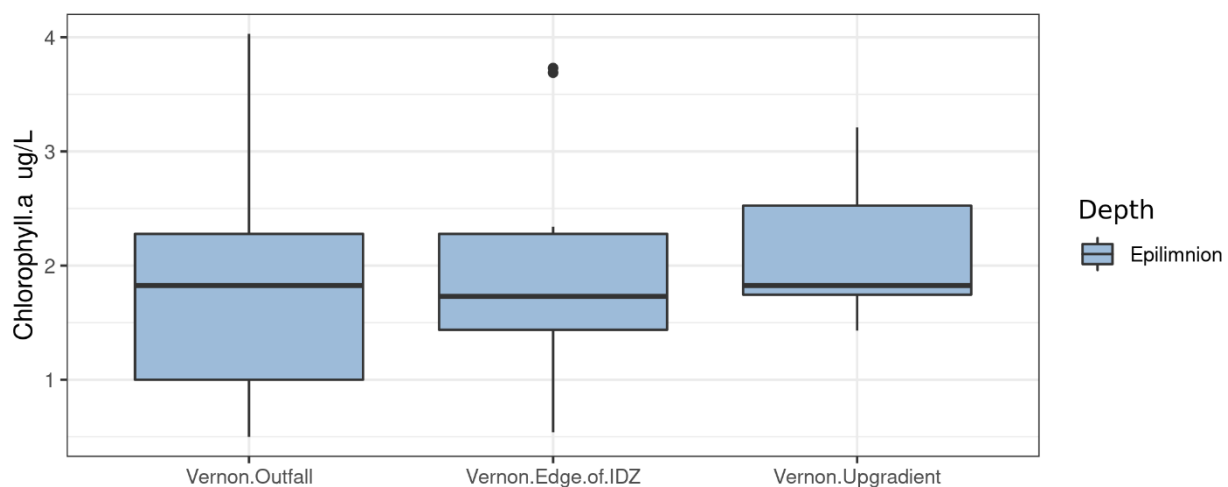


Figure 12: Chlorophyll-a at Okanagan Lake sample locations during discharge window

In addition to the chlorophyll-a measurements, algae samples were evaluated taxonomically to determine which species were present and their abundances. Total cell densities were similar between the outfall, edge of IDZ, and upgradient sites on most dates. Algae densities were high prior to the start of the discharge (Figure 13). Results from the first sample taken while the discharge was occurring indicated a large increase in algae densities at the outfall site with a smaller increase at the edge of IDZ site and no observed increase at the upgradient site. This pattern quickly faded as the discharge progressed with all sites ultimately having high algae densities by the end. The pattern of a brief localized increase in algae densities within the IDZ was also observed during the 2021 discharge supporting the hypothesis that the initial influx of nutrients temporarily alters the phytoplankton community composition (Figure 13).

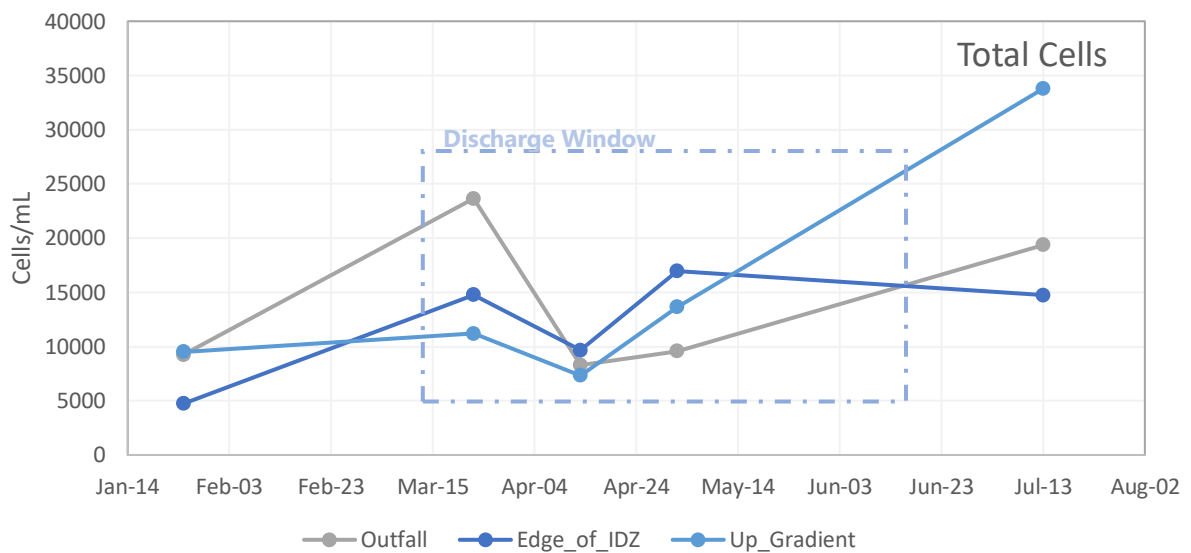


Figure 13: Total algae cell densities at Okanagan Lake sampling sites during discharge window

Cyanobacteria were the most numerous algae group at all sites throughout the study. The cyanobacteria were dominated by common taxa in Okanagan Lake including: *Planktolyngbya sp.*, *Planktothrix sp.*, *Pseudanabaena sp.* (Figure 14).

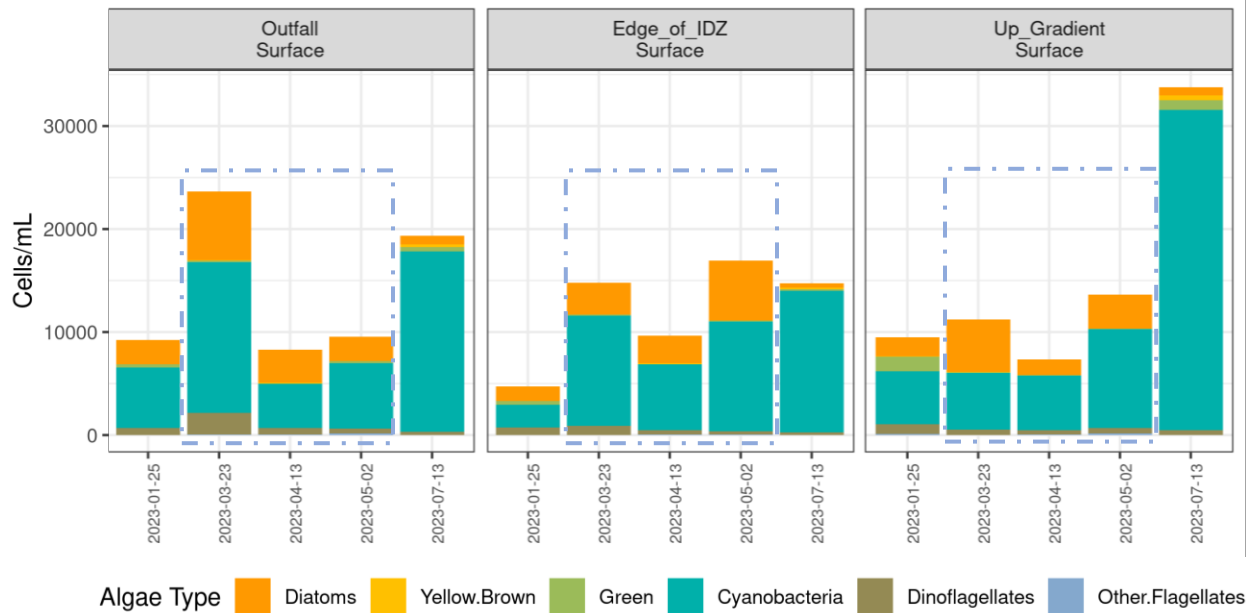


Figure 14: Algae densities by class from Okanagan Lake sample sites during discharge window

In these Okanagan Lake samples, cell size varied significantly. Diatom cells were often 100 times larger than cyanobacteria cells and green algae cells were often 10 times larger than cyanobacteria cells. Thus, while appearing less important in the abundance data, diatoms dominate the algal biovolume in Okanagan Lake.

Zooplankton

Zooplankton are microscopic aquatic animals that feed upon algae and serve as food for fish, including immature kokanee salmon. Total zooplankton were statistically similar between the outfall, edge of IDZ, and upgradient site (ANOVA, $p=0.36$). Densities increased during the discharge for all types of zooplankton at all sites and remained relatively higher after the discharge ended (Figure 15). This is likely related seasonal variation in Okanagan Lake. Total zooplankton averaged 7.4 ± 2.2 zoops/L at the outfall while the edge of the IDZ and upgradient sites averaged 6.5 ± 3.0 zoops/L and 4.9 ± 3.0 zoops/L respectively (Figure 15). Cladoceran zooplankton that are commonly used in toxicity testing. Concentrations of cladocerans increased at all sites but over the studied period (Figure 16).

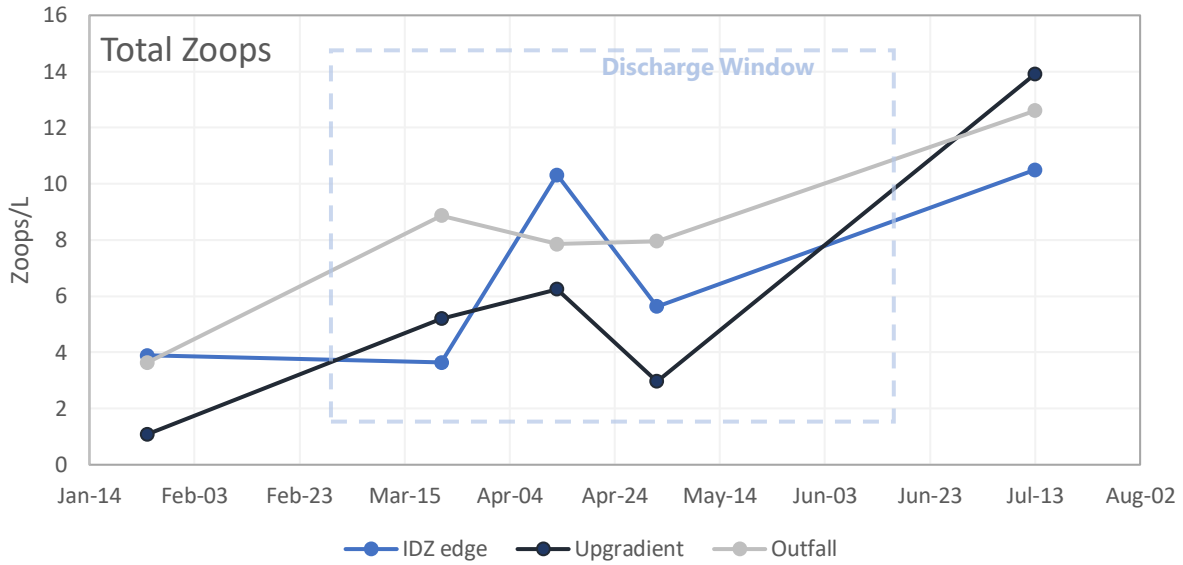


Figure 15: Total zooplankton densities at study locations in Okanagan Lake

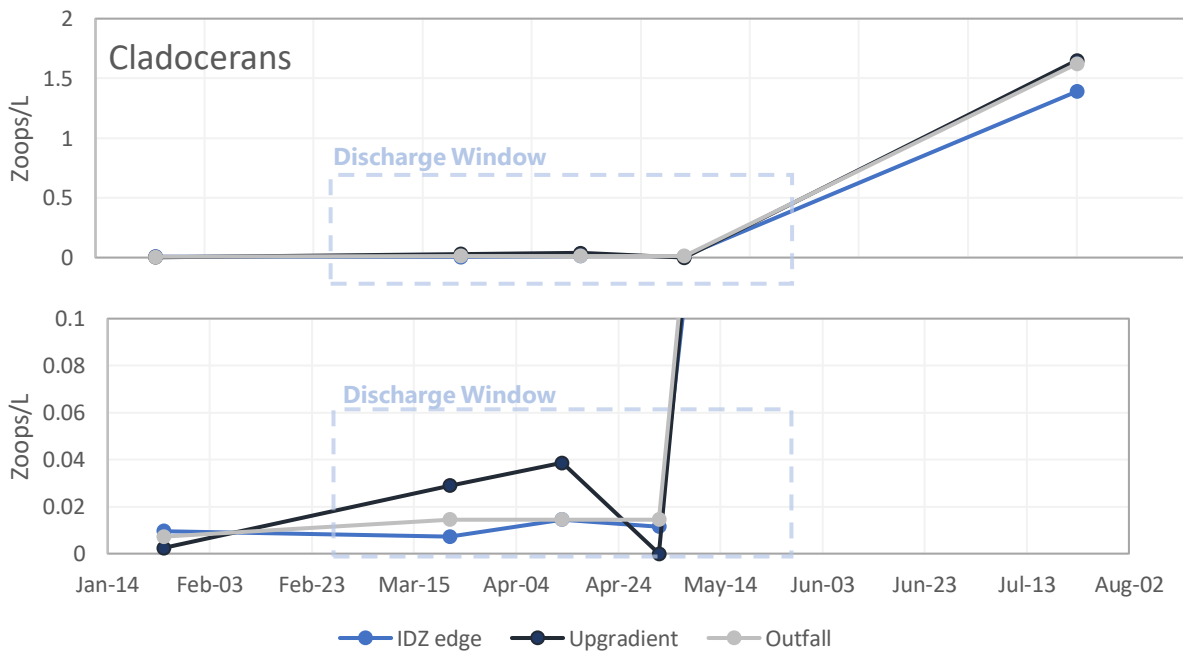


Figure 16: Cladoceran densities at study locations in Okanagan Lake

Note: top and bottom panels show the same data but with different y-axis scales to highlight the range in the data

Conclusions

This study monitored Okanagan Lake near the City of Vernon's 60 m deep outfall during the discharge of reclaimed water from March 14 – June 16, 2023. Three sites of increasing distance from the outfall were sampled on five occasions, once before, three times during, and once after the discharge. The goal of the monitoring was to determine if an effect from the release could be detected on the physical, chemical, and biological environment of Okanagan Lake.

The results did not indicate that the release of reclaimed water during the discharge window had a detectable impact on the water temperature, clarity, dissolved ions, nutrient concentrations, or zooplankton community of Okanagan Lake. However, there was a small potential effect in the phytoplankton community with greater densities at the sites closest to the outfall during the first half of the study period. The effect was subtle and did not persist through the spring when it was overshadowed by the normal seasonal increase in phytoplankton productivity.

The release of 1 million m³ of reclaimed water discharged to Okanagan Lake is better framed as a source of nutrient loading to the north basin of Okanagan Lake because of the rapid mixing of the reclaimed water plume. In this way it represented an addition of approximately 3087 kg of nitrate, 502 kg of ammonia, and 710 kg of phosphorus, a relatively small contribution for lake as large as Okanagan Lake.

Recommendations

The goal of this study was to determine if an impact from the release of reclaimed water from the VWRC could be detected on Okanagan Lake. This study did not detect a statistically confirmed effect. The following recommendations are made for consideration should this study be repeated:

- Increase the amount of data collected to strengthen statistical analysis by:
 - Increasing sampling frequency
 - 2-3 sample trips prior to release
 - Twice monthly trips during release
 - 2-3 trips after release
 - Consider replicating the entire sampling program during a year without a release to control for normal seasonal variability
- Consider joining the Okanagan Lake Collaborative Monitoring Program and establish a permanent monitoring location near the outfall. This would provide a better long-term comparison point for the background conditions at the outfall. This would also provide seasonal variation data in years without a release of reclaimed water.

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Appendices

Appendix 1: Raw Data

CARO Analytical Services	Client	Larratt Aquatic Consulting										
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CLIENT ID		Outfall Epilimnion Composite	Outfall hypolimnion composite	IDZ epilimnion composite	IDZ hypolimnion composite	Upgradient epilimnion composite	Upgradient hypolimnion comp	Outfall Chlorophyll - A	IDZ chlorophyll - A	Upgradient chlorophyll - A		
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DATE RECEIVED		2023-01-25	2023-01-26	2023-01-26	2023-01-26	2023-01-26	2023-01-26	2023-01-26	2023-01-26	2023-01-26		
MATRIX		Water	Water	Water	Water	Water	Water	Water	Water	Water		
General Method	Analyte	Units	MRL									
CARO	Chlorophyll a	ug/L	0.1							<1.00	1.43	1.79
CARO	Coliforms, Fecal (Q-Tray)	MPN/100 ml	1	<1	<1	<1	<1	<1	<1			
CARO	E. coli (Q-Tray)	MPN/100 ml	1	<1	<1	<1	<1	<1	<1			
Physical Tests (Matrix: Water)												
ALS	Hardness (as CaCO3), from total Ca/Mg	0.50	mg/L	121	121	124	121	123	122			
Anions and Nutrients (Matrix: Water)												
ALS	Ammonia, total (as N)	0.0050	mg/L	0.0051	<0.0050	<0.0050	0.0083	<0.0050	<0.0050			
ALS	Bromide	0.050	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050			
ALS	Chloride	0.50	mg/L	5.81	5.83	5.88	5.98	6.01	6.08			
ALS	Fluoride	0.020	mg/L	0.179	0.178	0.181	0.181	0.183	0.182			
ALS	Kjeldahl nitrogen, total [TKN]	0.050	mg/L	0.177	0.162	0.186	0.168	0.188	0.161			
ALS	Nitrate (as N)	0.0050	mg/L	0.0918	0.0950	0.0881	0.0675	0.0680	0.0917			
ALS	Nitrite (as N)	0.0010	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010			
ALS	Nitrogen, total	0.030	mg/L	0.249	0.249	0.237	0.245	0.232	0.242			
ALS	Nitrogen, total organic	0.050	mg/L	0.172	0.162	0.186	0.160	0.188	0.161			
ALS	Phosphate, ortho-, dissolved (as P)	0.0010	mg/L	0.0021	0.0021	<0.0010	0.0020	<0.0010	0.0024			
ALS	Phosphorus, total	0.0020	mg/L	0.0068	0.0064	0.0061	0.0046	0.0054	0.0075			
ALS	Phosphorus, total dissolved	0.0020	mg/L	0.0055	0.0047	0.0037	0.0062	0.0028	0.0053			
ALS	Sulfate (as SO4)	0.30	mg/L	29.8	29.9	30.3	30.6	30.7	30.6			
Total Metals (Matrix: Water)												
ALS	Sodium, total	0.050	mg/L	11.3	11.6	11.7	11.8	11.6	11.8			

CARO Analytical Services		Client Larratt Aquatic Consulting																
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MATRIX				Water	Water	Water	Water	Water	Water	Water		Water	Water	Water				
General Method	Analyte	Units	MRL															
General Parameters	Chlorophyll a	ug/L	0.1									2.31	2.34	2.58				
Microbiological Parameters	Coliforms, Fecal (Q-Tray)	MPN/100 ml	1	<1	<1	<1	<1	<1	<1	<1								
Microbiological Parameters	E. coli (Q-Tray)	MPN/100 ml	1	<1	<1	<1	<1	<1	<1	<1								
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Time Sampled				10:00	10:15	11:00	11:15	11:15	12:00	12:15	11:15	11:15	12:00	12:00				
ALS Sample ID				VA23A6231-001	VA23A6231-002	VA23A6231-003	VA23A6231-004	VA23A6231-005	VA23A6231-006	VA23A6231-007	VA23A6231-008							
Analyte	Lowest Detection Limit	Units		Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water	Sub-Matrix: Water							
Physical Tests (Matrix: Water)																		
Alkalinity, total (as CaCO ₃)	2.0	mg/L		114	113	113	115	114	115	115	116							
Hardness (as CaCO ₃), from total Ca/Mg	0.50	mg/L		120	118	117	120	120	120	120	120							
Anions and Nutrients (Matrix: Water)																		
Ammonia, total (as N)	0.0050	mg/L		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050							
Bromide	0.050	mg/L		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050							
Chloride	0.50	mg/L		6.07	6.17	6.09	6.16	6.15	6.14	6.13	6.13							
Kjeldahl nitrogen, total [TKN]	0.050	mg/L		0.184	0.186	0.189	0.190	0.184	0.189	0.177	0.192							
Nitrate (as N)	0.0050	mg/L		0.0605	0.0592	0.0611	0.0633	0.0508	0.0494	0.0612	0.0475							
Nitrite (as N)	0.0010	mg/L		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010							
Nitrogen, total	0.030	mg/L		0.243	0.235	0.336	0.242	0.233	0.245	0.241	0.236							
Nitrogen, total organic	0.050	mg/L		0.184	0.186	0.189	0.190	0.184	0.189	0.177	0.192							
Phosphate, ortho-, dissolved (as P)	0.0010	mg/L		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010							
Phosphorus, total	0.0020	mg/L		0.0066	0.0051	0.0062	0.0052	0.0054	0.0076	0.0123	0.0058							
Phosphorus, total dissolved	0.0020	mg/L		0.0028	0.0027	0.0031	0.0026	0.0020	0.0026	0.0027	0.0022							
Sulfate (as SO ₄)	0.30	mg/L		31.6	31.8	31.7	31.7	32.0	31.9	31.8	31.8							
Total Metals (Matrix: Water)																		

CARO Analytical Services				Client Larratt Aquatic Consulting											
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CLIENT ID				Outfall Epilimnion Composite	Outfall Hypolimnion Composite	IDZ Epilimnion Composite	IDZ Hypolimnion Composite	Upgradient Epilimnion Composite	Upgradient Hypolimnion Composite	Outfall Chlorophyll-A	IDZ Chlorophyll-A	Upgradient Chlorophyll-A	IDZ Epi comp dup	Upgradient Epi comp dup	
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MATRIX				Water	Water	Water	Water	Water	Water	Water	Water	Water			
General Method	Analyte	Units	MRL												
General Parameters	Chlorophyll a	ug/L	0.1							2.18	2.09	2.36			
Microbiological Parameters	Coliforms, Fecal (Q-Tray)	MPN/100 mL	1	<1	<1	<1	<1	<1	<1						
Microbiological Parameters	E. coli (Q-Tray)	MPN/100 mL	1	<1	<1	<1	<1	<1	<1						
Physical Tests (Matrix: Water)															
Alkalinity, total (as CaCO3)	1.0	mg/L		113	113	118	112	114	113				113	114	
Hardness (as CaCO3), from total Ca/Mg	0.50	mg/L		120	119	120	123	124	122				121	122	
Anions and Nutrients (Matrix: Water)															
Ammonia, total (as N)	0.0050	mg/L		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0084				<0.0050	<0.0050	
Chloride	0.50	mg/L		5.90	6.15	5.90	5.99	5.98	5.96				5.92	6.02	
Kjeldahl nitrogen, total [TKN]	0.050	mg/L		0.176	0.167	0.178	0.169	0.199	0.198				0.182	0.177	
Nitrate (as N)	0.0050	mg/L		0.0450	0.0794	0.0414	0.0787	0.0186	0.0387				0.0433	0.0226	
Nitrate + Nitrite (as N)	0.0050	mg/L		0.0450	0.0794	0.0414	0.0787	0.0186	0.0387				0.0433	0.0226	
Nitrite (as N)	0.0010	mg/L		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010				<0.0010	<0.0010	
Nitrogen, total	0.030	mg/L		0.241	0.238	0.223	0.247	0.166	0.229				0.202	0.183	
Nitrogen, total organic	0.050	mg/L		0.176	0.167	0.178	0.169	0.199	0.190				0.182	0.177	
Phosphate, ortho-, dissolved (as P)	0.0010	mg/L		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010				<0.0010	<0.0010	
Phosphorus, total	0.0020	mg/L		0.0027	0.0049	0.0052	0.0063	0.0048	0.0062				0.0040	0.0040	
Phosphorus, total dissolved	0.0020	mg/L		<0.0020	0.0024	<0.0020	<0.0020	0.0021	0.0026				0.0021	0.0020	
Sulfate (as SO4)	0.30	mg/L		30.2	30.2	30.2	30.2	30.6	30.5				30.3	31.0	
Total Metals (Matrix: Water)															
Sodium, total	0.050	mg/L		12.4	12.2	12.0	12.2	12.4	12.3				12.0	12.1	

CARO Analytical Services				Client Larratt Aquatic Consulting											
FINAL Analytical Testing Report				Attention Heather Larratt											
Work Order: 23E0248				Project Vernon Discharge											
Report Date: 2023-05-05 15:46:11				Project Info [none]											
<i>Note: This is not the original data. Please refer to PDF / Hardcopy report.</i>															
LAB ID				23E0248-01	23E0248-02	23E0248-03	23E0248-04	23E0248-05	23E0248-06	23E0248-07	23E0248-08	23E0248-09	VA23A9585-007	VA23A9585-008	VA23A9585-009
CLIENT ID				Outfall Epilimnion Composite	Outfall Hypolimnion Composite	IDZ Epilimnion Composite	IDZ Hypolimnion Composite	Upgradient Epilimnion Composite	Upgradient Hypolimnion Composite	Outfall Chlorophyll-A	IDZ Chlorophyll-A	Upgradient Chlorophyll-A	IDZ Epi comp dup	Upgradient Epi comp dup	Travel Blank
DATE SAMPLED				2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	02-May-2023	02-May-2023	02-May-2023
DATE RECEIVED				2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02	2023-05-02			
MATRIX				Water	Water	Water	Water	Water	Water	Water	Water	Water			
General Method	Analyte	Units	MRL												
General Parameters	Chlorophyll a	ug/L	0.1							3.57	3.69	2.87			
Microbiological Parameters	Coliforms, Fecal (Q-Tray)	MPN/100 ml	1	<1	<1	<1	<1	<1	<1						
Microbiological Parameters	E. coli (Q-Tray)	MPN/100 ml	1	<1	<1	<1	<1	<1	<1						
Physical Tests (Matrix: Water)															
	Alkalinity, total (as CaCO3)	mg/L	1.0	114	113	114	112	112	112				113	115	<1.0
	Hardness (as CaCO3), from total Ca/Mg	mg/L	0.50	127	128	123	127	128	127				126	125	<0.50
Anions and Nutrients (Matrix: Water)															
	Ammonia, total (as N)	mg/L	0.0050	<0.0050	0.0067	<0.0050	0.0076	0.0060	0.0107				0.0052	0.0061	<0.0050
	Chloride	mg/L	0.50	6.23	6.25	6.28	6.38	6.24	6.24				6.30	6.28	<0.50
	Kjeldahl nitrogen, total [TKN]	mg/L	0.050	0.201	0.188	0.210	0.203	0.225	0.193				0.248	0.258	<0.050
	Nitrate (as N)	mg/L	0.0050	0.0205	0.0733	0.0197	0.0755	0.0318	0.0711				0.0202	0.0318	<0.0050
	Nitrate + Nitrite (as N)	mg/L	0.0050	0.0205	0.0733	0.0197	0.0755	0.0318	0.0711				0.0202	0.0318	<0.0051
	Nitrite (as N)	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010				<0.0010	<0.0010	<0.0010
	Nitrogen, total	mg/L	0.030	0.230	0.254	0.249	0.266	0.249	0.269				0.236	0.256	<0.030
	Nitrogen, total organic	mg/L	0.050	0.201	0.181	0.210	0.195	0.219	0.182				0.243	0.252	<0.050
	Phosphate, ortho-, dissolved (as P)	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010				<0.0010	0.0019	<0.0010
	Phosphorus, total	mg/L	0.0020	0.0112	0.0069	0.0271	0.0074	0.0137	0.0255				0.0109	0.0140	<0.0020
	Phosphorus, total dissolved	mg/L	0.0020	0.0037	0.0035	0.0035	0.0035	0.0034	0.0052				0.0038	0.0039	<0.0020
	Sulfate (as SO4)	mg/L	0.30	32.4	32.3	32.7	32.7	32.8	32.4				32.8	32.9	<0.30
Total Metals (Matrix: Water)															
	Sodium, total	mg/L	0.050	11.6	12.5	11.7	11.9	11.7	11.9				11.8	11.5	<0.050

CARO Analytical Services	Client	Larratt Aquatic Consulting									
FINAL Analytical Testing Report	Attention	Jamie Self									
Work Order: 23G1671	Project	Vernon Discharge									
Report Date: 2023-07-19 10:29:03	Project Info	[none]									
<i>Note: This is not the original data. Please refer to PDF / Hardcopy report.</i>											
LAB ID		23G1671-01	23G1671-02	23G1671-03	23G1671-04	23G1671-05	23G1671-06	23G1671-07	23G1671-08	23G1671-09	
CLIENT ID		Outfall Epilir	Outfall Hycp	IDZ Epilimnic	IDZ Hypolim	Upgradient	Upgradient	Outfall Chlo	IDZ Chlorop	Upgradient	
DATE SAMPLED		2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	
DATE RECEIVED		2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	2023-07-13	
MATRIX		Water	Water	Water	Water	Water	Water	Water	Water	Water	
General Method	Analyte	Units	MRL								
General Parameters	Chlorophyll a	ug/L	0.1						1.6	1.66	1.73
Microbiological Parameters	Coliforms, Fecal (Q-Tray)	MPN/100 m	1	<1	<1	<1	<1	<1	<1		
Microbiological Parameters	E. coli (Q-Tray)	MPN/100 m	1	<1	<1	<1	<1	<1	<1		
Physical Tests (Matrix: Water)											
Alkalinity, total (as CaCO3)		mg/L	1.0	114	114	114	114	113	113		
Hardness (as CaCO3), from total Ca/Mg		mg/L	0.50	127	125	126	130	122	128		
Anions and Nutrients (Matrix: Water)											
Ammonia, total (as N)		mg/L	0.0050	0.0059	0.0051	<0.0050	<0.0050	<0.0050	<0.0050		
Chloride		mg/L	0.50	5.97	6.02	5.99	5.93	6.04	5.96		
Kjeldahl nitrogen, total [TKN]		mg/L	0.050	0.174	0.237	0.227	0.170	0.229	0.231		
Nitrate (as N)		mg/L	0.0050	0.0819	<0.0050	<0.0050	0.0966	<0.0050	0.0868		
Nitrate + Nitrite (as N)		mg/L	0.0050	0.0819	<0.0051	<0.0051	0.0966	<0.0051	0.0868		
Nitrite (as N)		mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Nitrogen, total		mg/L	0.030	0.240	0.223	0.225	0.247	0.221	0.245		
Nitrogen, total organic		mg/L	0.050	0.168	0.232	0.227	0.170	0.229	0.231		
Phosphate, ortho-, dissolved (as P)		mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Phosphorus, total		mg/L	0.0020	0.0057	0.0070	0.0067	0.0053	0.0070	0.0073		
Phosphorus, total dissolved		mg/L	0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020		
Sulfate (as SO4)		mg/L	0.30	30.6	30.3	30.1	30.5	30.5	30.6		
Total Metals (Matrix: Water)											
Sodium, total		mg/L	0.050	12.5	12.5	12.5	13.2	12.2	12.4		

CORDILLERA CONSULTING
FRESHWATER INVERTEBRATE TAXONOMY

Project: Vernon Discharge Zooplankton
Larratt Aquatic Consulting
Taxonomist: Scott Finlayson
scottfinlayson@cordilleraconsulting.ca
250-494-7553

Site:	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023	2023
Sample:	gradient tow Jan	edge of IDZ tow Jan	outfall tow Jan	gradient tow Mar	IDZ tow March	Outfall tow March	gradient tow Apr	IDZ tow April	Outfall tow April	gradient tow Ma	IDZ tow May	Outfall tow May
Sample Collection Date:	25-Jan-23	25-Jan-23	25-Jan-23	22-Mar-23	22-Mar-23	22-Mar-23	13-Apr-23	13-Apr-23	13-Apr-23	2-May-23	2-May-23	2-May-23
CC#:	CC240046	CC240047	CC240048	CC240049	CC240050	CC240051	CC240052	CC240053	CC240054	CC240124	CC240125	CC240126
EMS:												
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0
Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0
Order: Diptera	0	0	0	0	0	0	0	0	0	0	0	0
Family: Chironomidae	0	0	0	0	0	0	0	0	0	0	0	0
Subfamily: Orthocladinae	0	0	0	0	0	0	0	0	0	0	0	0
<i>Parakiefferiella</i>	0	0	0	0	0	0	85	0	0	0	0	0
Class: Copepoda Nauplii	43	0	0	171	0	128	597	0	0	205	0	0
Class: Maxillipoda	0	0	0	0	0	0	0	0	0	0	0	0
Order: Calanoida	875	256	704	9557	7040	18176	15275	28160	21504	3584	10138	20096
Family: Diaptomidae	704	3584	4160	4523	5440	11904	10496	9088	8448	5325	12083	15360
<i>Leptodiaptomus ashlandi</i>	405	4352	4608	1792	4224	7936	3925	6912	5376	3123	6042	6784
Family: Temoridae	0	0	0	0	0	0	0	0	0	0	0	0
<i>Epischura</i>	64	256	704	0	0	256	0	0	0	0	0	0
Order: Cyclopoida	0	0	0	0	0	0	0	0	0	0	0	0
Family: Cyclopidae	2923	11093	15104	15189	8512	25472	10837	24832	23040	5427	10547	10752
<i>Diacyclops</i>	4331	14507	6464	12629	6656	13568	10923	21120	9984	6042	9728	14336
<i>Macrocyclus</i>	21	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0
Class: Branchiopoda	0	0	0	0	0	0	0	0	0	0	0	0
Order: Diplostraca	0	0	0	0	0	0	0	0	0	0	0	0
Family: Bosminidae	0	0	0	0	0	0	0	0	0	0	0	0
<i>Bosmina longirostris</i>	21	85	64	256	64	128	341	128	128	0	102	128
Phylum: Rotifera	0	0	0	0	0	0	0	0	0	0	0	0
Class: Monogonta	0	0	0	0	0	0	0	0	0	0	0	0
Order: Ploima	0	0	0	0	0	0	0	0	0	0	0	0
Family: Brachionidae	0	0	0	0	0	0	0	0	0	0	0	0
<i>Kellicottia longispina</i>	192	256	320	1536	128	768	2560	896	640	2150	1126	2176
<i>Notholca</i>	0	0	0	256	128	0	171	0	256	358	0	640
Totals:	9579	34389	32128	45909	32192	78336	55210	91136	69376	26214	49766	70272
Taxa present but not included:												
Totals:	0	0	0	0	0	0	0	0	0	0	0	0

Site:	2023	2023	2023
Sample:	gradient tow July	edge of IDZ tow July	Outfall tow July
Sample Collection Date:	13-Jul-23	13-Jul-23	13-Jul-23
CC#:	CC241591	CC241592	CC241593
EMS:			
Phylum: Arthropoda	0	0	0
Class: Copepoda Nauplii	256	0	0
Class: Maxillipoda	0	0	0
Order: Calanoida	5376	6554	10496
Family: Diaptomidae	22016	15974	19712
<i>Leptodiaptomus ashlandi</i>	1792	3277	4352
Family: Temoridae	0	0	0
<i>Epischura</i>	3328	3891	2560
Order: Cyclopoida	0	0	0
Family: Cyclopidae	67584	40346	41216
<i>Diacyclops</i>	7680	8192	14848
Subphylum: Crustacea	0	0	0
Class: Branchiopoda	0	0	0
<i>Holopedium gibberum</i>	256	205	256
Order: Cladocera	0	0	0
Family: Daphniidae	0	0	0
<i>Daphnia</i>	2304	3482	5120
<i>Daphnia galeata mendotae</i>	2048	2662	1024
Family: Sidae	0	0	0
<i>Diaphanosoma</i>	9472	5734	7680
<i>Sida crystallina</i>	0	0	256
Order: Diplostraca	0	0	0
<i>Leptodora kindtii</i>	256	205	0
Family: Bosminidae	0	0	0
<i>Bosmina longirostris</i>	256	0	0
Phylum: Rotifera	0	0	0
Class: Monogonta	0	0	0
Order: Ploima	0	0	0
Family: Brachionidae	0	0	0
<i>Kellicottia longispina</i>	256	2253	3840
Totals:	122880	92775	111360
Taxa present but not included:			
Totals:	0	0	0

Appendix 2: Guidelines & Objectives

Okanagan Lake has objectives set by the Ministry of Environment. Each objective has a set value and also a time frame upon which to apply that value. For most parameters the growing season (Apr-Sep) average is applied against the guideline and this would not be applicable to this study. However, for total nitrogen (TN) and total phosphorus (TP), the value measured during March (called spring maximum) is considered. This value was used to compare against the results from this study.

Table A 1: Okanagan Lake water quality objectives

Parameter (Nordin, 2005)	Summerland	Kelowna	OK Centre	Armstrong Arm
Secchi Depth (growing season average: Apr-Sep)	>7m	>6m	>6m	>5m
Dissolved Oxygen (minimum in bottom waters)	-	-	-	>5 mg/L
TP (mg/L as P) (maximum at spring overturn)	<0.007	<0.008	<0.008	<0.01
Chlorophyll-a (µg/L) (maximum seasonal average)	<4.5	<4.5	<4	<5
TN (mg/L as N) (maximum at spring overturn)	<0.230	<0.230	<0.230	<0.250
N:P Ratio (spring weighted ratio)	>25:1	>25:1	>25:1	>25:1
Algae Taxonomy (% heterocystous cyanobacteria)	<5%	<5%	<5%	<5%
Algae Biomass (µL/L) (growing season average)	<0.75	<0.75	<0.75	<0.75
Zooplankton Biomass (µg/L) (growing season average)	>50	>50	>50	>50
Zooplankton Taxonomy (% cladocerans)	>5%	>5%	>5%	>5%

Note: Okanagan Centre objectives for the north basin applied to this study

Table A 2: Comparison of total nitrogen and total phosphorus against Okanagan Lake spring objective for the north basin of Okanagan Lake

Site	Depth	TN	TP
Outfall	Epilimnion	0.243	0.0066
	Hypolimnion	0.235	0.0051
Edge of IDZ	Epilimnion	0.336	0.0062
	Hypolimnion	0.242	0.0052
Upgradient	Epilimnion	0.233	0.0054
	Hypolimnion	0.245	0.0076
OK Centre	Epilimnion	0.244	0.0073
	Hypolimnion	0.249	0.0061
Armstrong Arm	Epilimnion	0.222	0.0144
	Hypolimnion	0.245	0.0136

Notes: -orange shading = exceeded objective, green shading = achieved objective
 -All sites compared to OK Centre objective except Armstrong Arm

Appendix 3: Statistical information

Statistical analyses were performed on data to support interpretations made throughout this report. The use of the word 'significantly' within this report is understood to signify that the claim being made has stood up under statistical analysis. Unless otherwise stated, all statistical analyses were performed to a confidence of greater than or equal to 95% ($p \leq 0.05$). The \pm symbol indicates plus or minus the standard deviation throughout this report.

Water quality data often contains non-detect values for many parameters. Non-detect values were converted to $\frac{1}{2}$ detection limit for all calculations.

Throughout this report the monthly sampling data was grouped seasonally for additional analyses. March, April, and May data were combined as "Spring"; June, July, and August as "Summer"; and September as "Fall".

Correlations were performed using the Pearson's Correlation method and all R values reported at Pearson's Correlation Coefficients.

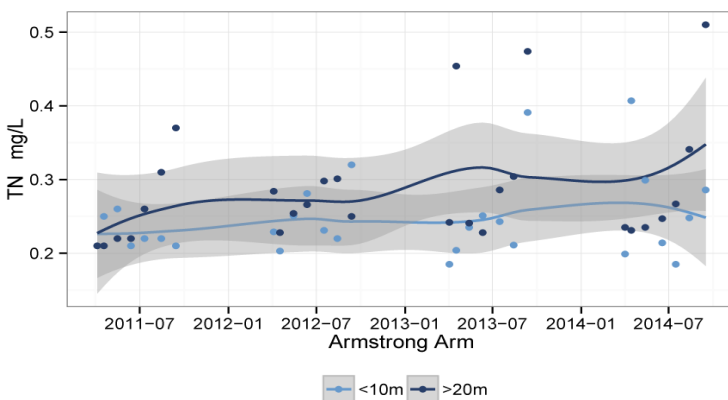


Figure i: Example scatterplot and boxplot
Includes all data for a parameter sorted by depth, LOESS polynomial trendlines and the standard errors of those trendlines are also included. Example boxplot is labeled with key information. Whiskers represent the distance to the highest or lowest point within $1.5 * IQR$ where IQR represents the range between the upper and lower quartiles.

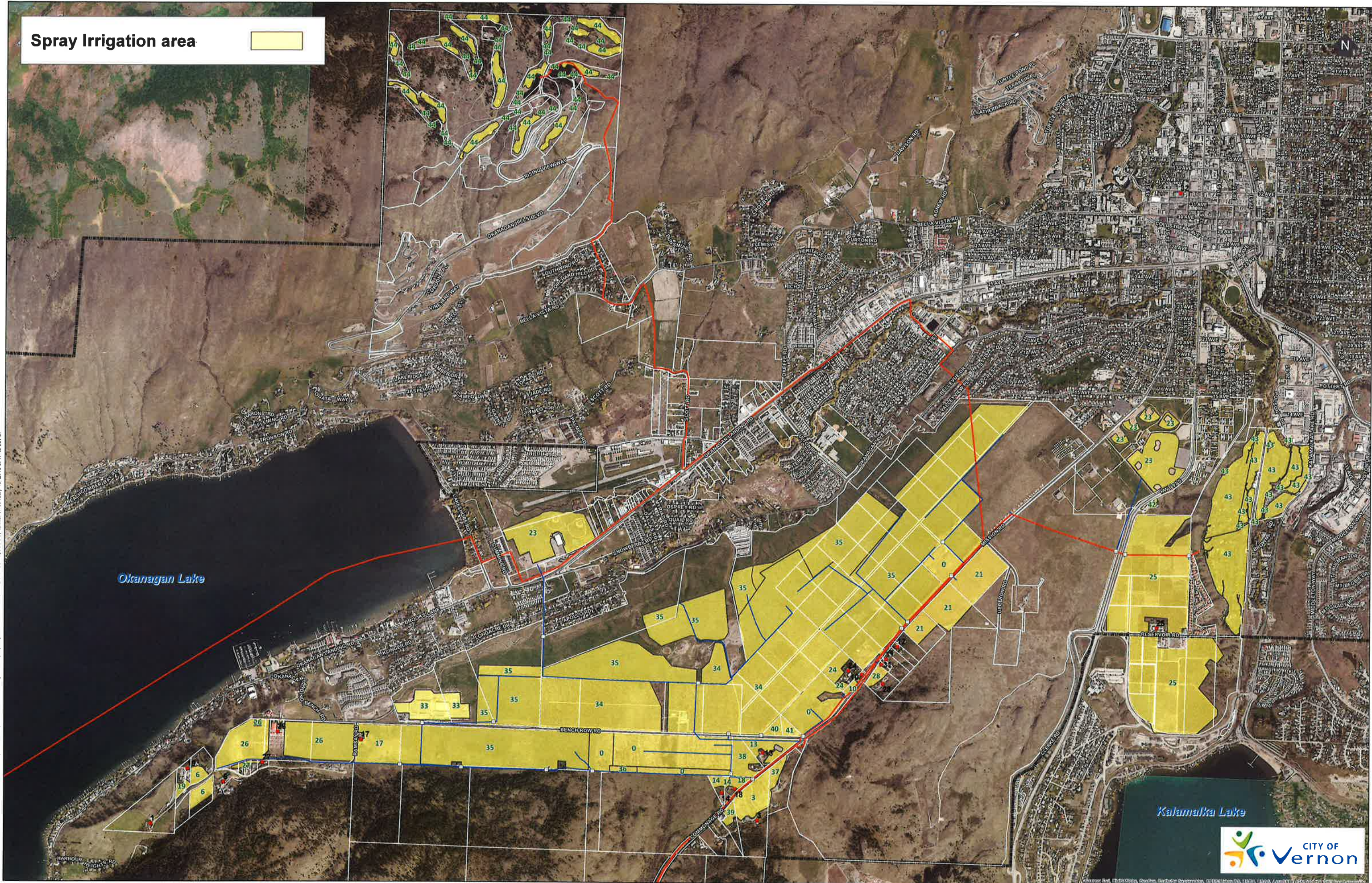
The Kruskal–Wallis One-Way Analysis of Variance by Ranks is a non-parametric method for testing if samples originate from the same distribution, that is, if the means of two variables are significantly different. It is used to compare more than two independent or non-related samples. It is the non-parametric equivalent of the more traditional ANOVA statistical test that was also used in this report. These calculations produces a p-value from which statistical significance is determined (Spurrier, 2003).

----- END OF REPORT -----

Appendix G

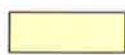
Spray Irrigation Areas

Spray Irrigation area



U:\Projects_KEL\1186\02\01\15-Drafting-Design-Analysis\GIS\GIS-Pro-act\GIS\GIS-Pro-act\GIS\GIS-Pro-act\Figure 1 - Spray Irrigation Area 2017 - North.mxd Last updated by bpauf on January 18, 2018 at 11:42:28 AM

Spray Irrigation area



Okanagan Lake

MacKay Reservoir

Kalamalka Lake



U:\Projects_VEL\184002\012-Drafting-Design-Analyses\GIS\Project\MXD\Curren\Figure 2 - Spray Irrigation Area 2017 - South.mxd Last updated by bobulian_january 18 2018 at 11:45:02 AM

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Appendix H

Liquid Waste Management Plan

File: 5350

January 11, 2023

Email: (melanie.mamoser@gov.bc.ca)

Dear Ms. Mamoser:

Re: Update City of Vernon Liquid Waste Management Plan (LWMP) Commitments

Please accept the following letter as an update regarding the City of Vernon's current status of LWMP commitments regarding reclaimed water and the reply letter titled "Discharge Plan to Okanagan Lake During Winter 2020/2021", dated January 27, 2021.

In the letter the Ministry made note of items identified in the City of Vernon LWMP and inquired about their current status. The items included were:

- Explore a partnership with the RDNO of supplying reclaimed water to agricultural customers in the regional system (non-potable supply).
- Market reclaimed water as an incentive for economic development for industrial commercial and agricultural customers.
- Report on the cost-benefit of extending the system for various areas throughout the region.
- Determine the suitability of a city program for private-building, on site reclamation of grey water through the B.C. Building Code.

Since 2021, City Administration have continued to make progress on the action items identified in the Liquid Waste Management Plan and the continued improvement, expansion and optimization of the City's Spray Irrigation program. Items of note include the following:

- The Spray Irrigation System has been added to the City's Asset Management plan, ensuring the long-term reliability and performance of the spray irrigation system with a stable long-term funding source. Seven (7) irrigation hose reels purchased in 2021 and 2022 at a cost of \$250,000 as part of this program.
- The purchase of six (6) additional hose reels have been included in the 2023 capital budget at a cost of \$240,000.
- Three (3) additional low volume residential use customers were added to the system.
- In 2021 the City Administration made a request to the Department of National Defense (DND) to lease approximately 150 acres of additional land



- to include in the spray irrigation program. This land had been used for this purpose in the past, but was removed by the DND in 2005. DND officials have yet to respond to our request
- City Administration met with RDNO Administration to discuss the potential of partnering with the RDNO on expanding use of non-potable water supply into RDNO jurisdiction. RDNO administration has provided a formal response as per the attached letter.
 - RDNO Administration have committed to including supply and expansion discussions for future development applications in their jurisdictions. This has already occurred for two recent proposed developments including the proposed Gondola project, Aquilini Development and Okanagan Indian Band (OKIB) O'Keefe property.
 - City Administration is currently in preliminary discussion with the Okanagan Indian Band (OKIB) regarding potential expansion of the Spray Irrigation Program into the O'Keefe Ranchlands (2,310 acres) recently purchased by OKIB.
 - City Administration has instituted new processes for development review, where potential spray irrigation customers are identified during the development review process and applicants are informed of the spray irrigation program and the use of spray irrigation as an alternative source.
 - City building officials are currently in the process of reviewing the use of on-site grey water reclamation for new developments. A detailed response will be provided to the Ministry this year regarding the feasibility of this item.
 - City Administration is preparing to engage a qualified professional to complete a report regarding the cost benefits of extending the Spray Irrigation Program into surrounding areas. This report is scheduled to be completed by the end of the year and will be provided to the Ministry when available.

Thank you for your time and guidance as the City of Vernon continues to address LWMP objectives. If you require any other information please contact myself.

Yours truly,

Chris Ovens
City of Vernon
General Manager, Public Works

Attached: RDNO response letter





REGIONAL DISTRICT NORTH OKANAGAN

MEMBER MUNICIPALITIES:

CITY OF ARMSTRONG	VILLAGE OF LUMBY
CITY OF ENDERBY	CITY OF VERNON
DISTRICT OF COLDSTREAM	TOWNSHIP OF SPALLUMCHEEN

ELECTORAL AREAS:

"B" – SWAN LAKE	"E" – CHERRYVILLE
"C" – BX DISTRICT	"F" – ENDERBY (RURAL)
"D" – LUMBY (RURAL)	

OFFICE OF: UTILITIES

OUR FILE No.: 5730.15.15

January 19, 2023

City of Vernon
 Att: Chris Ovens, BBA
 1900 48 Avenue
 Vernon, BC V1T 8Y7

Via e-mail: covens@vernon.ca

Dear Mr. Ovens:

RE: Reclaimed Water

Thank you for your inquiry regarding a partnership with the RDNO with regards to supplying reclaimed water to agricultural customers in the regional system (non-potable supply). As discussed at our meeting on January 6, 2023, the priority for Greater Vernon Water is the construction of the Mission Hill Water Filtration Plant (MHWFP); however, after commissioning of the MHWFP, Greater Vernon Water will be updating their Master Water Plan and would be amenable to include review of this issue in detail with the City of Vernon during that process.

Please do not hesitate to include us in your planning exercises as a preliminary to this review. Due to the uncertainties of climate change in the future, secure water sources will be important for our region and we appreciate the opportunity to work on this important issue with your team in the future.

Sincerely,

Zee Marcolin, P. Eng.
 General Manager, Utilities
 Permit to Practice #1002639

ZM/lS



Associated Environmental Consultants Inc.
Suite 200, 2800 29 Street
Vernon, BC, Canada, V1T 9P9

January 18, 2022
File: 2021-8917.010

TEL: 250.545.3672
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www.ae.ca | ISO 9001 & 14001 Certified

Chris Ovens
General Manager, Public Works
City of Vernon
1900 48th Avenue
Vernon, BC V1T 8Y7

Re: SUPPLEMENTAL INFORMATION ON RECLAIMED WATER USE FOR DND LANDS

Dear Mr. Ovens:

We understand that the City of Vernon (the City) has recently had discussions with land representatives from the Department of National Defence (DND) about the potential to use reclaimed water to irrigate two parcels of lands located off Highway 97 and Mission Road in Vernon, BC. To help inform these discussions, the City asked Associated Environmental Consultants Inc. (Associated) to prepare a letter that:

- Summarizes the reclaimed water program,
- Identifies the sensitive/at-risk wildlife species that may be present on the parcels and outlines the implications of irrigation for these species,
- Identifies potential agricultural and other land use options for the parcels, and
- Briefly summarizes the potential benefits and limitations of irrigating the parcels.

1 RECLAIMED WATER HISTORY

Municipal wastewater generated by the City of Vernon is treated to an advanced (tertiary) level and ultimately beneficially reused as reclaimed water for irrigation in the southwestern half of Vernon. Lands beneficially using the reclaimed water include agricultural land, forest nurseries, golf courses, and parks. This program was originally authorized in 1997 by the BC Ministry of Environment and Climate Change Strategy (ENV) through Operational Certificate ME 12215 and was most recently reviewed and amended in 2014 when the City completed a Liquid Waste Management Plan.¹ Use of reclaimed water for irrigation purposes benefits the community and the local environment by reducing the need to draw from the potable water supply or natural streams for irrigation purposes, and by reducing the need to discharge treated effluent to Okanagan Lake.

¹ British Columbia Ministry of Environment. 2008. Operational Certificate ME 12215. Issued to the Corporation of the City of Vernon. Date issued: October 31, 1997.

2 REGULATORY FRAMEWORK

The program is regulated by Operational Certificate ME 12215 (the OC), which stipulates the required level of treatment, maximum volume for discharge, monitoring and reporting requirements, and irrigation areas and requirements.¹

2.1 IRRIGATION WATER QUALITY

Wastewater is treated to an advanced level (including Biological Nutrient Removal to reduce the nitrogen and phosphorus content of wastewater) at the Vernon Water Reclamation Centre (VWRC) and pumped to the MacKay Reservoir on Commonage Road in Vernon. Prior to being stored in the reservoir, Biological Oxygen Demand (BOD) must be ≤ 26 mg/L and Total Suspended Solids (TSS) must be ≤ 25 mg/L. Reclaimed water is then withdrawn from MacKay Reservoir during the irrigation season, disinfected (through chlorination), and pumped to users for irrigation.

The City is required to test the irrigation water withdrawn from MacKay Reservoir monthly during the irrigation season for BOD, TSS, total phosphorus, ortho-phosphorus, total dissolved phosphorus, total nitrogen, ammonia-N, nitrate-N, nitrite-N, organic nitrogen, pH, fecal coliforms, and total coliforms. The OC does not specify limits at that sample point (referred to as Clay Valve #4 in the OC). For the purposes of this report, Associated compared data from 2010 to 2021 to the quality limits prescribed for reclaimed water use under the BC *Municipal Wastewater Regulation* (MWR). Because the City operates under an OC, the MWR does not apply, but the level of treatment for various land uses/exposure potentials provides a benchmark for comparison.

Table 2-1 provides a summary of the irrigation water quality since 2010, compared with the MWR limits under the Greater Exposure Potential (GEP). The GEP option was selected for comparison purposes only, as it is more conservative. It applies where public contact is likely or reclaimed water use could present a risk to the receiving environment and includes applications such as agricultural crops, golf courses, cemeteries, residential lawns, greenhouses, silviculture operations, urban reuse, parks, playgrounds, and schools. The irrigation water from MacKay Reservoir has met these concentrations in most cases. In the past 11 years, BOD and fecal coliforms have each exceeded the MWR GEP thresholds once (in August 2011 and July 2014, respectively), and pH was within acceptable levels for all samples. Total suspended solids (TSS) were above the threshold of 10 mg/L a total of 11 times, but only once within the past five years (i.e., since 2017). Average TSS has decreased from 8.0 mg/L between 2010 and 2016 to 2.4 mg/L between 2017 and 2021.

Table 2-1: Irrigation water quality (Clay Valve #4) compared with MWR limits

	BOD	TSS	pH	Fecal Coliforms
MWR Limits for GEP ¹	10 mg/L	10 mg/L	6.5-9	Median < 1 CFU/100 mL or < 2.2 MPN/100 mL; maximum 14 CFU/100 mL
Number of samples (n)	67	67	67	67
% non-detectable	99%	46%	0	96%
Range of values	<5 to 13 mg/L	<2 to 81 mg/L	7.25 to 8.98	<1 to 36
Average ^{2,3}	<10	5.5	8.1	<2
Number of times MWR threshold for GEP not met	1	11	0	1

Notes:

Based on data from 2010 to 2021 for Clay Valve #4 sample point (provided by the City).

GEP = Greater Exposure Potential

¹The MWR also sets a limit for turbidity (average 2 NTU, maximum of 5 NTU). Testing of turbidity is not required in the City's OC, and therefore data are limited; however, five turbidity samples were analyzed in 2021, and all were < 2 NTU.

² For BOD and fecal coliforms, the average cannot be calculated as > 95% of results were below the laboratory detection limit.

³ For average calculations for TSS, results that were below detection were taken at one-half the detection limit.

Given that there are documented sensitive/at-risk species in the area (Section 3), Associated also compared the 2020 to 2021 data from Clay Valve #4 to the BC Water Quality Guidelines for the Protection of Aquatic Life and Wildlife, and to the Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life (short-term, acute guidelines only). All results met these guidelines.

2.2 ADDITIONAL REQUIREMENTS UNDER THE OC

Other key relevant requirements under the OC include the following:

- **Groundwater monitoring:** The City is required to retain a Qualified Professional to conduct an annual groundwater monitoring program to assess for impacts related to reclaimed water use. That report is submitted to ENV each year as part of the City's overall annual reporting requirements.
- **Irrigation best practices:** Users are required to beneficially reuse irrigation water, and to not over-irrigate. Surface runoff and ponding of reclaimed water is not permitted, and the maximum slope of irrigated surfaces must be less than 20%. Irrigation rates are to follow BC

guidance documents or the specific land/crop use. Irrigation water must also be managed to prevent aerosol drift from leaving irrigated lands.

- **Set-backs:** Reclaimed water is not to be used within 15 m of the edge of flowing streams or bodies of water, or within 30 m of any well or in-ground reservoir used for domestic purposes.

3 SENSITIVE/AT RISK SPECIES

As federal government land, development and activities on the DND property are subject to the Canada *Species at Risk Act* (SARA). Generally, SARA prohibits killing or harming listed species, destruction of their dens or nests, and destruction of their critical habitats. The subject lands are comprised of grasslands with a narrow band of mature deciduous trees along Mission Road, which bisects the properties. The grassland areas have been used for agriculture and military purposes for many years and are vegetated with a mix of native, agronomic, and non-native plants. The area is at the height of land and relatively flat, with no mapped watercourses on either property². A small pond is located adjacent to the west of the subject lands, on a portion of the property managed by the Allan Brooks Nature Centre (Figure 1; attached). This pond may be used Great Basin spadefoot (*Spea intermontana*) for breeding and may be used by painted turtles (*Chrysemys picta*, pop. 2).

Wildlife species at risk with moderate to high potential to occur at the site because of habitat suitability and presence in the general area are listed in Table 3-1.

² British Columbia DataBC. 2021. iMapBC. Available at: <https://maps.gov.bc.ca/ess/hm/imap4m/>

Table 3-1: Wildlife species at risk with moderate to high potential to occur at the site

Common Name	Scientific Name	BC Listing ¹	SARA Listing ²	Potential to Occur on Site
Great Basin spadefoot	<i>Spea intermontana</i>	Blue	1 - Threatened	High
Gopher snake	<i>Pituophis catenifer deserticola</i>	Blue	1 - Threatened	High
Western rattlesnake	<i>Crotalus oreganus</i>	Blue	1 - Threatened	High
North American racer	<i>Coluber constrictor</i>	Blue	1 – Special Concern	High
Northern rubber boa	<i>Charina bottae</i>	-	1 – Special Concern	High
Painted turtle, intermountain Rocky Mountain Population	<i>Chrysemys picta pop. 2</i>	Blue	1 – Special Concern	Moderate
American badger	<i>Taxidea taxus jeffersonii</i>	Red	1 – Special Concern	Moderate
Western harvest mouse	<i>Reithrodontomys megalotis</i>	Blue	1 – Special Concern	High
Grasshopper sparrow	<i>Ammodramus savannarum</i>	Red	-	High
Okanagan hammertail	<i>Efferia okangana</i>	Red	Endangered	Moderate

¹B.C. Status: Red listed: indigenous species or subspecies (taxa) considered *Extirpated, Endangered, or Threatened* in BC.; Blue listed: indigenous taxa considered vulnerable in BC.

²Status under *Species at Risk Act* (SARA): federally designated species listed as *Extirpated, Endangered, Threatened, or of Special Concern* are listed as Schedule 1. Once listed as Schedule 1, measures to protect and recover listed species are implemented.

Table 3-1 shows that the subject properties are potentially capable of providing suitable habitat for these Species at Risk, based on habitat and documented observations in the general area. In addition to these species, the subject parcels likely provide habitat for a number of other non-listed native birds, small mammals, and other species.

In addition to wildlife species with the potential to occur on site, Table 3-2 lists five vegetation ecosystems at risk that are known to occur within 3 km of the properties.

Table 3-2: Ecosystems at risk with moderate to high potential to occur at or adjacent to the site

Common Name	Scientific Name	BC Listing ¹	SARA Listing	Potential to Occur on Site
Trembling aspen/common snowberry/Kentucky bluegrass	<i>Populus tremuloides</i> / <i>Symphoricarpos albus</i> / <i>Poa pratensis</i>	Red	-	Moderate
Baltic rush-common silverweed	<i>Juncus balticus</i> - <i>Potentilla anserina</i>	Blue	-	Moderate
Black cottonwood/common snowberry/roses	<i>Populus trichocarpa</i> / <i>Symphoricarpos albus</i> - <i>Rosa spp.</i>	Red	-	Moderate
Hard-stemmed bulrush deep marsh	<i>Schoenoplectus acutus</i> <i>Deep Marsh</i>	Blue	-	Moderate
Black cottonwood-Douglas fir/common snowberry-red osier dogwood	<i>Populus trichocarpa</i> - <i>Pseudotsuga menziesii</i> / <i>Symphoricarpos albus</i> - <i>Cornus sericea</i>	Red	-	Moderate

¹B.C. Status: Red listed: indigenous species or subspecies (taxa) considered *Extirpated, Endangered, or Threatened* in BC.; Blue listed: indigenous taxa considered vulnerable in BC.

Except for the narrow band of trees adjacent to Mission Road, there are no trees on the properties; therefore, it is assumed that none of these communities currently occur within the properties. Baltic rush and hard-stemmed bulrush are found adjacent to wetlands, and the Baltic rush-common silverweed and hard-stemmed bulrush deep marsh ecosystems may occur along the pond on the Allan Brooks Nature Centre property. All of these vegetation communities are known to occur in moist or wet sites and may benefit from irrigation of the site.

The irrigation water is generally considered to be high-quality (Section 2.1), and following all requirements of the OC (specifically, following irrigation best practices and ensuring setbacks from surface water bodies are met and that surface ponding and runoff does not occur) should reduce the likelihood of wildlife species coming into direct contact with the water. Irrigation should be restricted to

the grassland areas, and a further setback (e.g. at least 30 m) from the Allan Brooks Nature Centre property line would provide added safety.

The installation of any irrigation infrastructure should occur during the appropriate time of year and follow best practices to avoid disturbing or harming wildlife, especially breeding birds. It is also important that reclaimed water use not significantly change the ecological structure or habitat of the area.

4 LAND USE OPTIONS

The OC allows for livestock on lands where reclaimed water is used, although lag times following irrigation are specified for any livestock intended for human consumption (3-days) or dairy cattle (6-days). However, we understand that livestock grazing is not currently planned for the subject properties. In the past, we understand that the land was leased for cattle grazing on occasion when the lands were irrigated with reclaimed water.³ Moving forward, the City and DND may wish to consider agricultural uses other than irrigated pasture. This section provides a brief evaluation of agricultural potential, based solely on site characteristics and provincial mapping. However, before proceeding with any options, confirmation the crop is allowed in conjunction with reclaimed water use would be required.

Soils on the subject properties are mapped by the BC government as mostly a mix of Armstrong and Spallumcheen Series soils, with a small area of Nickel Plate soils. Table 4-1 lists the potential crops that could be grown on the lands as an alternative to livestock grazing. In general, with irrigation, the flat to gently sloping lands can likely support a wide range of the crops that are currently grown in the North Okanagan region. On slopes that are 9% or steeper (up to 20%) there are more limitations, but many of the crops grown on similar slopes in the local area are possible including nursery trees, Christmas trees, hay, and alfalfa.

Another feasible crop for the subject lands is hybrid poplar trees. The City, with the assistance of the BC Ministry of Forests, has planted hybrid “fast growth” poplars on several nearby sites. These trees take up and transpire relatively high volumes of irrigation water and have other potential advantages including carbon sequestration, local cooling, and the provision of wildlife habitat. Other tree species could also be considered.

³ Kozin, S. Manager, Vernon Water Reclamation Centre. December 13, 2021. Personal communication (email) with Nicole Penner of Associated.

Table 4-1: Potential crops based on existing soil mapping⁴

Soil	Well-Suited Crops	Suited Crops	General Management Needs
Spallumcheen (Gleyed elluviated lack, silty clay, imperfectly drained)	Slopes <9%: Alfalfa, forage crops, cereals, vegetables (non-root vegetables) Slopes ≥9%: None (pasture only)	Slopes <9%: Corn, nursery and Christmas trees, root vegetables (plus all well- suited crops). Slopes 9% - 15%: Blueberries, forage crops; possibly grapes, berries, tree fruits. Slopes >15%: None (pasture only).	Periodic sub-soiling, organic matter inputs (e.g. manure, cover crops), stone removal, erosion control, fertilization. Sub-surface drainage may be needed on some sites.
Armstrong and Nickel Plate (Orthic black, sandy loam, well-drained)	Slopes <9%: All climatically adopted crops (where surface soils are stone free and deeper than 50 cm). Slopes ≥9%: None (pasture only).	Slopes <9%: Alfalfa, annual vegetable crops (except root crops), blueberries, corn, cereals, forage crops; possibly ginseng, grapes, nursery & Christmas trees, tree fruits. Slopes 9% - 15%: As listed above except ginseng, nursery/Christmas trees & strawberries. Slopes >15%: Possibly grapes and apples. Pasture.	Organic matter inputs (e.g. manure, cover crops), stone removal, erosion control, fertilization

Note: The above information is based on site characteristics and soil mapping only. Any change in crop would need to be evaluated considering reclaimed water use. For example, food crops are generally not allowed unless reclaimed water meets the requirements for Indirect Potable Use under the MWR, and irrigation on slopes > 20% is prohibited by the OC.

5 BENEFITS AND RISKS

Reclaimed water use, when following regulatory requirements and authorized by ENV, presents a number of benefits. It allows for irrigation without using public potable water supply or natural streamflows, which is becoming more important with increased drought frequency. It also reduces the frequency of discharging treated effluent directly to Okanagan Lake, which is authorized by the OC under specified conditions but generally not considered to be the public's preference. Lastly, keeping grasses and other vegetation irrigated throughout the summer months may help to reduce interface wildfire risk on adjacent residential areas.

⁴ Gough, N., Hughes-Games, G. & Nikkel, D. 1994. Soil Management Handbook For The Okanagan And Similkameen Valleys. Resource Management Branch, B.C. Ministry of Agriculture. 1st Edition.

The subject properties provide suitable habitat for multiple Species at Risk; however, the quality of the reclaimed water is high (Section 2.1) and risks associated with the program can generally be mitigated by:

- Installing any irrigation infrastructure during the appropriate time of year to avoid disturbing or harming wildlife, especially breeding birds.
- Following irrigation best practices and the requirements in the OC, specifically by not over-irrigating, preventing surface run-off, and following all setback requirements (e.g., no use within 15 m of a surface water body or 30 m of a domestic water supply).
- Establishing a minimum 30 m buffer between the irrigated area and the property boundary with the Allan Brooks Nature Centre and in particular, the pond on the eastern edge of the property.
- When evaluating land use options, ensure that reclaimed water use does not significantly change the ecological structure or habitat of the area.

6 CLOSURE

Please contact the undersigned if you require more information or have any questions.

Yours truly,



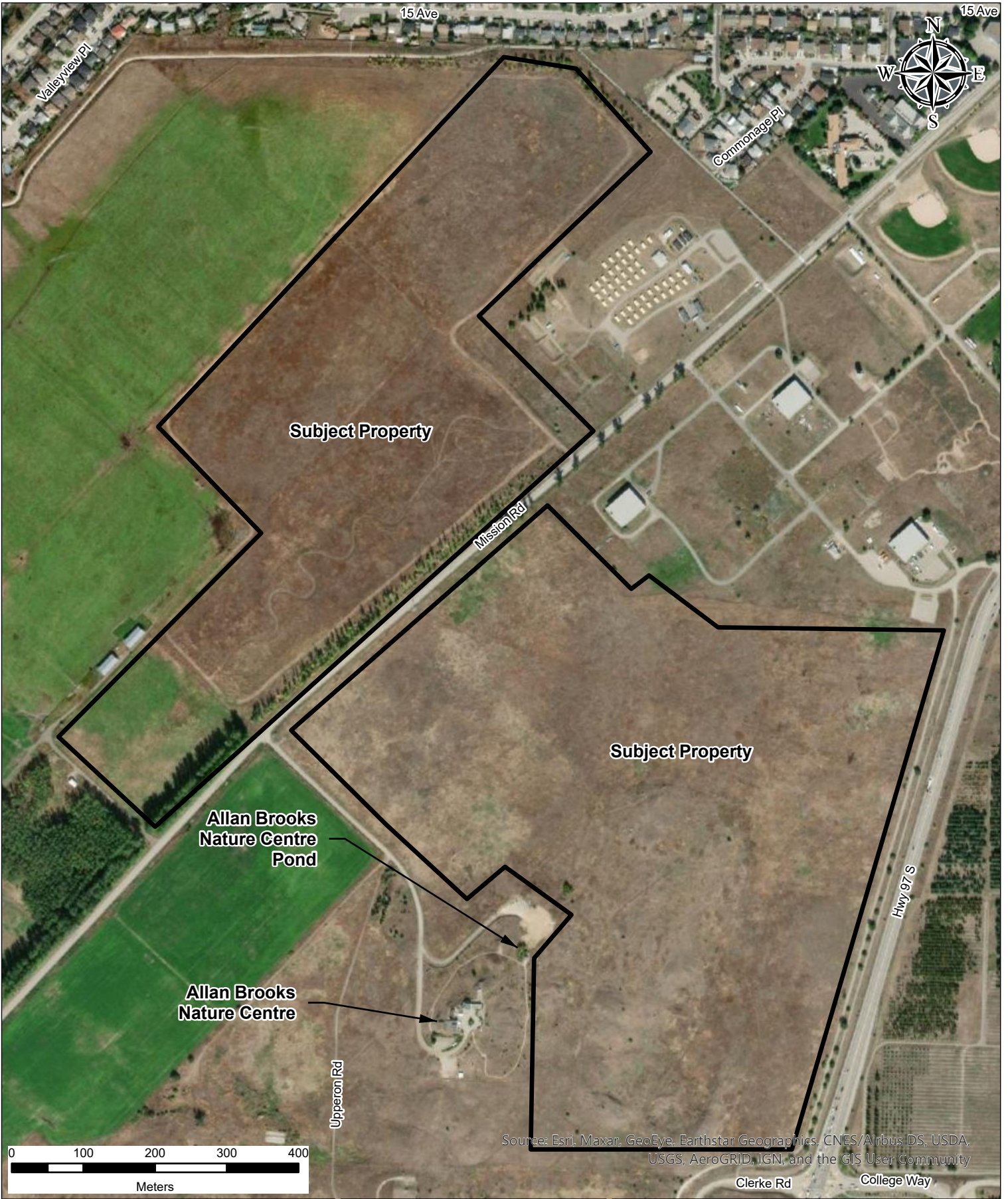
Nicole Penner, P.Ag.
Environmental Scientist



Heather Taylor, R.P.Bio, P.Ag.
Environmental Scientist

Attachments:

Figure 1



cov_dnd.aprx / 2021-12-10 / 2:43 PM



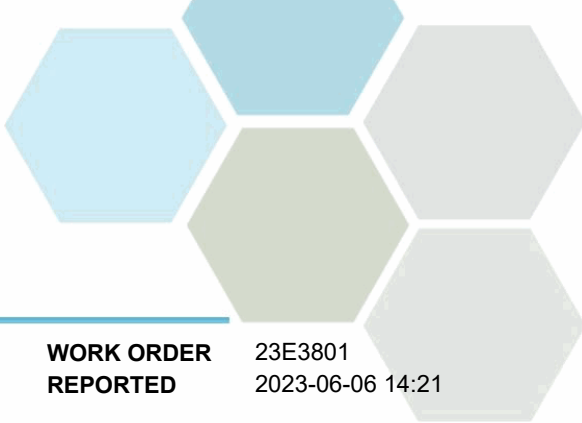
PROJECT NO.: 2021-8917
 DATE: December 2021
 DRAWN BY: BdJ

FIGURE 1: SITE PLAN

City of Vernon
 Reclaimed Water Use Potential on DND
 Lands

Appendix I

Irrigation Water Quality Results for Clay Valve 4
Caro Analytical Services



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23E3801
2023-06-06 14:21

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23E3801-01) | Matrix: Water | Sampled: 2023-05-30 09:30

Anions

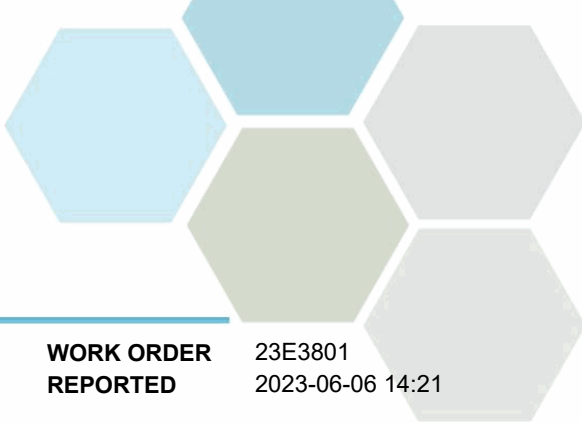
Chloride	91.7	0.10	mg/L	2023-06-01	
Fluoride	0.20	0.10	mg/L	2023-06-01	
Nitrate (as N)	0.984	0.010	mg/L	2023-06-01	
Nitrite (as N)	0.011	0.010	mg/L	2023-06-01	
Phosphate (as P)	0.355	0.0050	mg/L	2023-06-01	
Sulfate	84.6	1.0	mg/L	2023-06-01	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	203	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.995	0.0100	mg/L	N/A	
Nitrogen, Total	2.25	0.0500	mg/L	N/A	
Nitrogen, Organic	0.780	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	0.0050	mg/L	2023-06-05	
Antimony, dissolved	0.00027	0.00020	mg/L	2023-06-05	
Arsenic, dissolved	0.00092	0.00050	mg/L	2023-06-05	
Barium, dissolved	0.0328	0.0050	mg/L	2023-06-05	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2023-06-05	
Bismuth, dissolved	< 0.00010	0.00010	mg/L	2023-06-05	
Boron, dissolved	0.224	0.0500	mg/L	2023-06-05	
Cadmium, dissolved	0.000011	0.000010	mg/L	2023-06-05	
Calcium, dissolved	40.6	0.20	mg/L	2023-06-05	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2023-06-05	
Cobalt, dissolved	0.00028	0.00010	mg/L	2023-06-05	
Copper, dissolved	0.00545	0.00040	mg/L	2023-06-05	
Iron, dissolved	0.025	0.010	mg/L	2023-06-05	
Lead, dissolved	< 0.00020	0.00020	mg/L	2023-06-05	
Lithium, dissolved	0.00983	0.00010	mg/L	2023-06-05	
Magnesium, dissolved	24.6	0.010	mg/L	2023-06-05	
Manganese, dissolved	0.0684	0.00020	mg/L	2023-06-05	
Molybdenum, dissolved	0.00341	0.00010	mg/L	2023-06-05	
Nickel, dissolved	0.00198	0.00040	mg/L	2023-06-05	
Phosphorus, dissolved	0.788	0.050	mg/L	2023-06-05	
Potassium, dissolved	19.6	0.10	mg/L	2023-06-05	
Selenium, dissolved	0.00060	0.00050	mg/L	2023-06-05	
Silicon, dissolved	1.8	1.0	mg/L	2023-06-05	
Silver, dissolved	< 0.000050	0.000050	mg/L	2023-06-05	
Sodium, dissolved	105	0.10	mg/L	2023-06-05	
Strontium, dissolved	0.576	0.0010	mg/L	2023-06-05	
Sulfur, dissolved	32.6	3.0	mg/L	2023-06-05	
Tellurium, dissolved	< 0.00050	0.00050	mg/L	2023-06-05	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2023-06-05	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23E3801
2023-06-06 14:21

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23E3801-01) | Matrix: Water | Sampled: 2023-05-30 09:30, Continued

Dissolved Metals, Continued

Thorium, dissolved	< 0.00010	0.00010	mg/L	2023-06-05	
Tin, dissolved	< 0.00020	0.00020	mg/L	2023-06-05	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2023-06-05	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2023-06-05	
Uranium, dissolved	0.00167	0.000020	mg/L	2023-06-05	
Vanadium, dissolved	< 0.0050	0.0050	mg/L	2023-06-05	
Zinc, dissolved	0.0291	0.0040	mg/L	2023-06-05	
Zirconium, dissolved	< 0.00010	0.00010	mg/L	2023-06-05	

General Parameters

Ammonia, Total (as N)	0.471	0.050	mg/L	2023-06-01	
BOD, 5-day	< 6.7	2.0	mg/L	2023-06-05	
Nitrogen, Total Kjeldahl	1.25	0.050	mg/L	2023-06-04	
pH	7.65	0.10	pH units	2023-06-03	HT2
Phosphorus, Total (as P)	0.712	0.0050	mg/L	2023-06-01	
Phosphorus, Total Dissolved	< 0.0100	0.0050	mg/L	2023-06-01	
Solids, Total Dissolved	517	15	mg/L	2023-06-02	
Solids, Total Suspended	< 3.3	2.0	mg/L	2023-05-31	
Turbidity	0.66	0.10	NTU	2023-05-31	

Microbiological Parameters

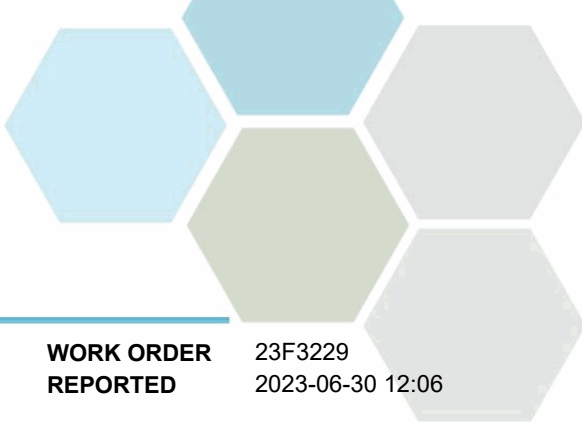
Coliforms, Total (Q-Tray)	45	1	MPN/100 mL	2023-05-31	
Coliforms, Fecal (Q-Tray)	< 1	1	MPN/100 mL	2023-05-31	

Total Metals

Sodium, total	89.1	0.10	mg/L	2023-06-04	
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Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23F3229
2023-06-30 12:06

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23F3229-01) | Matrix: Water | Sampled: 2023-06-23 09:00

Anions

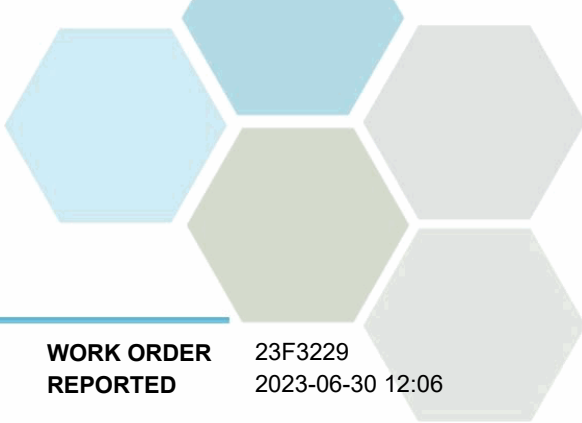
Chloride	94.3	0.10	mg/L	2023-06-25	
Nitrate (as N)	0.870	0.010	mg/L	2023-06-25	
Nitrite (as N)	0.028	0.010	mg/L	2023-06-25	
Phosphate (as P)	0.351	0.0050	mg/L	2023-06-25	
Sulfate	85.8	1.0	mg/L	2023-06-25	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	231	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.897	0.0100	mg/L	N/A	
Nitrogen, Total	2.49	0.0500	mg/L	N/A	
Nitrogen, Organic	1.04	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	0.0050	mg/L	2023-06-28	
Antimony, dissolved	0.00023	0.00020	mg/L	2023-06-28	
Arsenic, dissolved	0.00074	0.00050	mg/L	2023-06-28	
Barium, dissolved	0.0312	0.0050	mg/L	2023-06-28	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2023-06-28	
Bismuth, dissolved	< 0.00010	0.00010	mg/L	2023-06-28	
Boron, dissolved	0.173	0.0500	mg/L	2023-06-28	
Cadmium, dissolved	< 0.000010	0.000010	mg/L	2023-06-28	
Calcium, dissolved	55.1	0.20	mg/L	2023-06-28	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2023-06-28	
Cobalt, dissolved	0.00027	0.00010	mg/L	2023-06-28	
Copper, dissolved	0.00448	0.00040	mg/L	2023-06-28	
Iron, dissolved	0.026	0.010	mg/L	2023-06-28	
Lead, dissolved	< 0.00020	0.00020	mg/L	2023-06-28	
Lithium, dissolved	0.00867	0.00010	mg/L	2023-06-28	
Magnesium, dissolved	22.7	0.010	mg/L	2023-06-28	
Manganese, dissolved	0.0746	0.00020	mg/L	2023-06-28	
Molybdenum, dissolved	0.00332	0.00010	mg/L	2023-06-28	
Nickel, dissolved	0.00176	0.00040	mg/L	2023-06-28	
Phosphorus, dissolved	0.715	0.050	mg/L	2023-06-28	
Potassium, dissolved	20.4	0.10	mg/L	2023-06-28	
Selenium, dissolved	0.00057	0.00050	mg/L	2023-06-28	
Silicon, dissolved	2.0	1.0	mg/L	2023-06-28	
Silver, dissolved	< 0.000050	0.000050	mg/L	2023-06-28	
Sodium, dissolved	93.2	0.10	mg/L	2023-06-28	
Strontium, dissolved	0.548	0.0010	mg/L	2023-06-28	
Sulfur, dissolved	30.5	3.0	mg/L	2023-06-28	
Tellurium, dissolved	< 0.00050	0.00050	mg/L	2023-06-28	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2023-06-28	
Thorium, dissolved	< 0.00010	0.00010	mg/L	2023-06-28	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23F3229
2023-06-30 12:06

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23F3229-01) | Matrix: Water | Sampled: 2023-06-23 09:00, Continued

Dissolved Metals, Continued

Tin, dissolved	< 0.00020	0.00020	mg/L	2023-06-28	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2023-06-28	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2023-06-28	
Uranium, dissolved	0.00174	0.000020	mg/L	2023-06-28	
Vanadium, dissolved	< 0.0050	0.0050	mg/L	2023-06-28	
Zinc, dissolved	0.0245	0.0040	mg/L	2023-06-28	
Zirconium, dissolved	0.00011	0.00010	mg/L	2023-06-28	

General Parameters

Ammonia, Total (as N)	0.552	0.050	mg/L	2023-06-26	
BOD, 5-day	< 7.4	2.0	mg/L	2023-06-28	
Nitrogen, Total Kjeldahl	1.59	0.050	mg/L	2023-06-26	
pH	8.11	0.10	pH units	2023-06-27	HT2
Phosphorus, Total (as P)	0.790	0.0050	mg/L	2023-06-27	
Phosphorus, Total Dissolved	0.770	0.0050	mg/L	2023-06-27	
Solids, Total Dissolved	519	15	mg/L	2023-06-26	
Solids, Total Suspended	< 2.0	2.0	mg/L	2023-06-25	
Turbidity	1.61	0.10	NTU	2023-06-24	

Microbiological Parameters

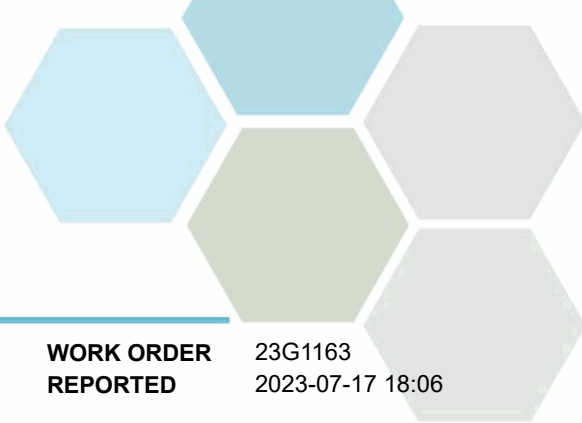
Coliforms, Total (Q-Tray)	< 1	1	MPN/100 mL	2023-06-23	
Coliforms, Fecal (Q-Tray)	< 1	1	MPN/100 mL	2023-06-23	

Total Metals

Sodium, total	89.1	0.10	mg/L	2023-06-28	
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Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23G1163
2023-07-17 18:06

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23G1163-01) | Matrix: Water | Sampled: 2023-07-10

Anions

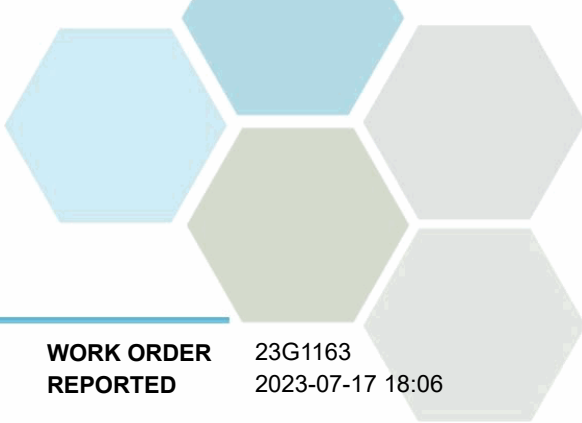
Chloride	91.7	0.10	mg/L	2023-07-12	
Nitrate (as N)	0.783	0.010	mg/L	2023-07-12	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-07-12	
Phosphate (as P)	0.264	0.0050	mg/L	2023-07-12	
Sulfate	84.1	1.0	mg/L	2023-07-12	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	241	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.783	0.0100	mg/L	N/A	
Nitrogen, Total	2.12	0.0500	mg/L	N/A	
Nitrogen, Organic	0.878	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	0.0050	mg/L	2023-07-14	
Antimony, dissolved	0.00025	0.00020	mg/L	2023-07-14	
Arsenic, dissolved	0.00091	0.00050	mg/L	2023-07-14	
Barium, dissolved	0.0288	0.0050	mg/L	2023-07-14	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2023-07-14	
Bismuth, dissolved	< 0.00010	0.00010	mg/L	2023-07-14	
Boron, dissolved	0.198	0.0500	mg/L	2023-07-14	
Cadmium, dissolved	0.000011	0.000010	mg/L	2023-07-14	
Calcium, dissolved	56.0	0.20	mg/L	2023-07-14	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2023-07-14	
Cobalt, dissolved	0.00027	0.00010	mg/L	2023-07-14	
Copper, dissolved	0.00435	0.00040	mg/L	2023-07-14	
Iron, dissolved	0.019	0.010	mg/L	2023-07-14	
Lead, dissolved	< 0.00020	0.00020	mg/L	2023-07-14	
Lithium, dissolved	0.0104	0.00010	mg/L	2023-07-14	
Magnesium, dissolved	24.5	0.010	mg/L	2023-07-14	
Manganese, dissolved	0.0595	0.00020	mg/L	2023-07-14	
Molybdenum, dissolved	0.00295	0.00010	mg/L	2023-07-14	
Nickel, dissolved	0.00166	0.00040	mg/L	2023-07-14	
Phosphorus, dissolved	0.700	0.050	mg/L	2023-07-14	
Potassium, dissolved	21.3	0.10	mg/L	2023-07-14	
Selenium, dissolved	0.00054	0.00050	mg/L	2023-07-14	
Silicon, dissolved	2.2	1.0	mg/L	2023-07-14	
Silver, dissolved	< 0.000050	0.000050	mg/L	2023-07-14	
Sodium, dissolved	101	0.10	mg/L	2023-07-14	
Strontium, dissolved	0.545	0.0010	mg/L	2023-07-14	
Sulfur, dissolved	33.3	3.0	mg/L	2023-07-14	
Tellurium, dissolved	< 0.00050	0.00050	mg/L	2023-07-14	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2023-07-14	
Thorium, dissolved	< 0.00010	0.00010	mg/L	2023-07-14	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23G1163
2023-07-17 18:06

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23G1163-01) | Matrix: Water | Sampled: 2023-07-10, Continued

Dissolved Metals, Continued

Tin, dissolved	< 0.00020	0.00020	mg/L	2023-07-14	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2023-07-14	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2023-07-14	
Uranium, dissolved	0.00171	0.000020	mg/L	2023-07-14	
Vanadium, dissolved	< 0.0050	0.0050	mg/L	2023-07-14	
Zinc, dissolved	0.0263	0.0040	mg/L	2023-07-14	
Zirconium, dissolved	< 0.00010	0.00010	mg/L	2023-07-14	

General Parameters

Ammonia, Total (as N)	0.455	0.050	mg/L	2023-07-12	
BOD, 5-day	< 5.6	2.0	mg/L	2023-07-17	
Nitrogen, Total Kjeldahl	1.33	0.050	mg/L	2023-07-17	
pH	8.17	0.10	pH units	2023-07-12	HT2
Phosphorus, Total (as P)	0.687	0.0050	mg/L	2023-07-14	
Phosphorus, Total Dissolved	0.649	0.0050	mg/L	2023-07-14	
Solids, Total Dissolved	533	15	mg/L	2023-07-12	
Solids, Total Suspended	< 2.0	2.0	mg/L	2023-07-13	
Turbidity	0.65	0.10	NTU	2023-07-12	

Microbiological Parameters

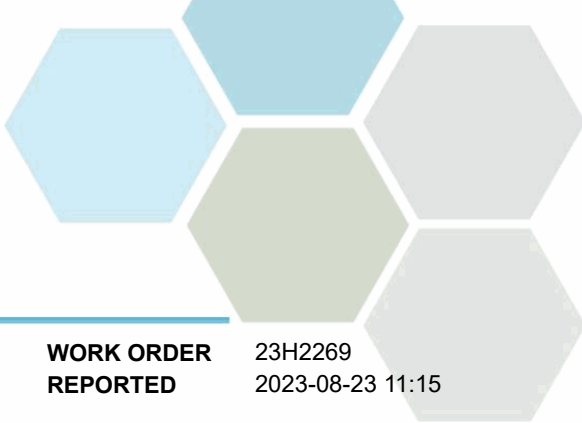
Coliforms, Total (Q-Tray)	4	1	MPN/100 mL	2023-07-11	
Coliforms, Fecal (Q-Tray)	< 1	1	MPN/100 mL	2023-07-11	

Total Metals

Sodium, total	87.5	0.10	mg/L	2023-07-15	
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Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23H2269
2023-08-23 11:15

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23H2269-01) | Matrix: Water | Sampled: 2023-08-16 09:15

Anions

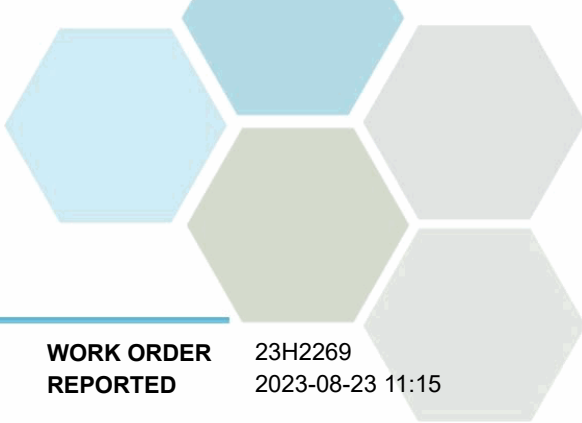
Chloride	94.6	0.10	mg/L	2023-08-18	
Nitrate (as N)	0.870	0.010	mg/L	2023-08-18	
Nitrite (as N)	0.072	0.010	mg/L	2023-08-18	
Phosphate (as P)	0.524	0.0050	mg/L	2023-08-18	
Sulfate	88.2	1.0	mg/L	2023-08-18	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	239	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.942	0.0100	mg/L	N/A	
Nitrogen, Total	2.77	0.0500	mg/L	N/A	
Nitrogen, Organic	1.04	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	0.0050	mg/L	2023-08-20	
Antimony, dissolved	0.00029	0.00020	mg/L	2023-08-20	
Arsenic, dissolved	0.00088	0.00050	mg/L	2023-08-20	
Barium, dissolved	0.0284	0.0050	mg/L	2023-08-20	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2023-08-20	
Bismuth, dissolved	< 0.00010	0.00010	mg/L	2023-08-20	
Boron, dissolved	0.187	0.0500	mg/L	2023-08-20	
Cadmium, dissolved	< 0.000010	0.000010	mg/L	2023-08-20	
Calcium, dissolved	57.9	0.20	mg/L	2023-08-20	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2023-08-20	
Cobalt, dissolved	0.00030	0.00010	mg/L	2023-08-20	
Copper, dissolved	0.00262	0.00040	mg/L	2023-08-20	
Iron, dissolved	0.072	0.010	mg/L	2023-08-20	
Lead, dissolved	< 0.00020	0.00020	mg/L	2023-08-20	
Lithium, dissolved	0.00999	0.00010	mg/L	2023-08-20	
Magnesium, dissolved	23.0	0.010	mg/L	2023-08-20	
Manganese, dissolved	0.115	0.00020	mg/L	2023-08-20	
Molybdenum, dissolved	0.00275	0.00010	mg/L	2023-08-20	
Nickel, dissolved	0.00204	0.00040	mg/L	2023-08-20	
Phosphorus, dissolved	0.936	0.050	mg/L	2023-08-20	
Potassium, dissolved	21.0	0.10	mg/L	2023-08-20	
Selenium, dissolved	< 0.00050	0.00050	mg/L	2023-08-20	
Silicon, dissolved	2.2	1.0	mg/L	2023-08-20	
Silver, dissolved	< 0.000050	0.000050	mg/L	2023-08-20	
Sodium, dissolved	102	0.10	mg/L	2023-08-20	
Strontium, dissolved	0.561	0.0010	mg/L	2023-08-20	
Sulfur, dissolved	33.8	3.0	mg/L	2023-08-20	
Tellurium, dissolved	< 0.00050	0.00050	mg/L	2023-08-20	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2023-08-20	
Thorium, dissolved	< 0.00010	0.00010	mg/L	2023-08-20	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23H2269
2023-08-23 11:15

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23H2269-01) | Matrix: Water | Sampled: 2023-08-16 09:15, Continued

Dissolved Metals, Continued

Tin, dissolved	< 0.00020	0.00020	mg/L	2023-08-20	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2023-08-20	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2023-08-20	
Uranium, dissolved	0.00132	0.000020	mg/L	2023-08-20	
Vanadium, dissolved	< 0.0050	0.0050	mg/L	2023-08-20	
Zinc, dissolved	0.0241	0.0040	mg/L	2023-08-20	
Zirconium, dissolved	< 0.00010	0.00010	mg/L	2023-08-20	

General Parameters

Ammonia, Total (as N)	0.785	0.050	mg/L	2023-08-20	
BOD, 5-day	< 6.4	2.0	mg/L	2023-08-22	
Nitrogen, Total Kjeldahl	1.83	0.050	mg/L	2023-08-20	
pH	8.10	0.10	pH units	2023-08-19	HT2
Phosphorus, Total (as P)	0.915	0.0050	mg/L	2023-08-18	
Phosphorus, Total Dissolved	0.893	0.0050	mg/L	2023-08-18	
Solids, Total Dissolved	537	15	mg/L	2023-08-17	
Solids, Total Suspended	5.4	2.0	mg/L	2023-08-18	
Turbidity	1.59	0.10	NTU	2023-08-17	

Microbiological Parameters

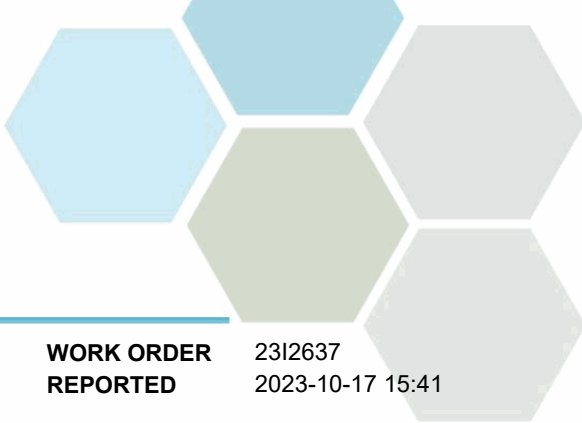
Coliforms, Total (Q-Tray)	< 1	1	MPN/100 mL	2023-08-17	
Coliforms, Fecal (Q-Tray)	< 1	1	MPN/100 mL	2023-08-17	

Total Metals

Sodium, total	96.9	0.10	mg/L	2023-08-19	
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Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 2312637
2023-10-17 15:41

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (2312637-01) | Matrix: Water | Sampled: 2023-09-20 09:15

Anions

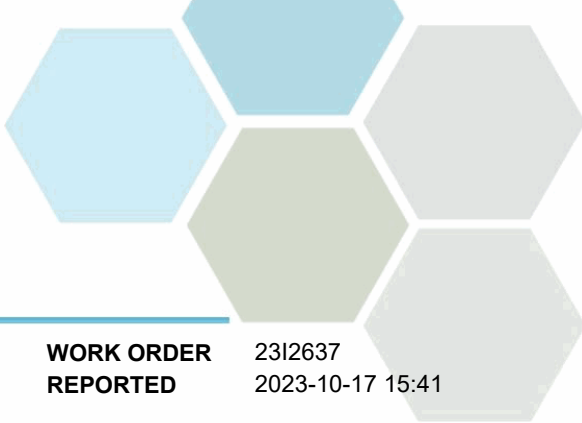
Chloride	103	0.10	mg/L	2023-09-23	
Nitrate (as N)	0.380	0.010	mg/L	2023-09-23	
Nitrite (as N)	0.040	0.010	mg/L	2023-09-23	
Phosphate (as P)	0.743	0.0050	mg/L	2023-09-23	
Sulfate	110	1.0	mg/L	2023-09-23	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	236	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.420	0.0100	mg/L	N/A	
Nitrogen, Total	2.84	0.0500	mg/L	N/A	
Nitrogen, Organic	1.17	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	0.0053	0.0050	mg/L	2023-10-11	
Antimony, dissolved	0.00029	0.00020	mg/L	2023-10-11	
Arsenic, dissolved	0.00090	0.00050	mg/L	2023-10-11	
Barium, dissolved	0.0278	0.0050	mg/L	2023-10-11	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	
Bismuth, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	
Boron, dissolved	0.194	0.0500	mg/L	2023-10-11	
Cadmium, dissolved	0.000012	0.000010	mg/L	2023-10-11	
Calcium, dissolved	55.5	0.20	mg/L	2023-10-11	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2023-10-11	
Cobalt, dissolved	0.00031	0.00010	mg/L	2023-10-11	
Copper, dissolved	0.00322	0.00040	mg/L	2023-10-11	
Iron, dissolved	0.107	0.010	mg/L	2023-10-11	
Lead, dissolved	< 0.00020	0.00020	mg/L	2023-10-11	
Lithium, dissolved	0.0100	0.00010	mg/L	2023-10-11	
Magnesium, dissolved	23.7	0.010	mg/L	2023-10-11	
Manganese, dissolved	0.179	0.00020	mg/L	2023-10-11	
Molybdenum, dissolved	0.00279	0.00010	mg/L	2023-10-11	
Nickel, dissolved	0.00199	0.00040	mg/L	2023-10-11	
Phosphorus, dissolved	1.24	0.050	mg/L	2023-10-11	
Potassium, dissolved	21.9	0.10	mg/L	2023-10-11	
Selenium, dissolved	0.00051	0.00050	mg/L	2023-10-11	
Silicon, dissolved	2.6	1.0	mg/L	2023-10-11	
Silver, dissolved	< 0.000050	0.000050	mg/L	2023-10-11	
Sodium, dissolved	102	0.10	mg/L	2023-10-11	
Strontium, dissolved	0.556	0.0010	mg/L	2023-10-11	
Sulfur, dissolved	37.0	3.0	mg/L	2023-10-11	
Tellurium, dissolved	< 0.00050	0.00050	mg/L	2023-10-11	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2023-10-11	
Thorium, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 2312637
2023-10-17 15:41

Analyte	Result	RL	Units	Analyzed	Qualifier
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23I2637-01) | Matrix: Water | Sampled: 2023-09-20 09:15, Continued

Dissolved Metals, Continued

Tin, dissolved	< 0.00020	0.00020	mg/L	2023-10-11	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2023-10-11	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2023-10-11	
Uranium, dissolved	0.00124	0.000020	mg/L	2023-10-11	
Vanadium, dissolved	< 0.0050	0.0050	mg/L	2023-10-11	
Zinc, dissolved	0.0238	0.0040	mg/L	2023-10-11	
Zirconium, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	

General Parameters

Ammonia, Total (as N)	1.25	0.050	mg/L	2023-09-26	
BOD, 5-day	15.0	2.0	mg/L	2023-09-27	RA5
Nitrogen, Total Kjeldahl	2.42	0.050	mg/L	2023-09-26	
pH	7.97	0.10	pH units	2023-09-23	HT2
Phosphorus, Total (as P)	1.15	0.0050	mg/L	2023-09-25	
Phosphorus, Total Dissolved	1.13	0.0050	mg/L	2023-09-25	
Solids, Total Dissolved	573	15	mg/L	2023-09-26	
Solids, Total Suspended	5.0	2.0	mg/L	2023-09-26	
Turbidity	3.33	0.10	NTU	2023-09-23	

Microbiological Parameters

Coliforms, Total (Q-Tray)	3	1	MPN/100 mL	2023-09-22	HT1
Coliforms, Fecal (Q-Tray)	3	1	MPN/100 mL	2023-09-22	HT1

Total Metals

Sodium, total	98.6	0.10	mg/L	2023-09-25	
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Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23I2637-02) | Matrix: Water | Sampled: 2023-09-20 09:15

Anions

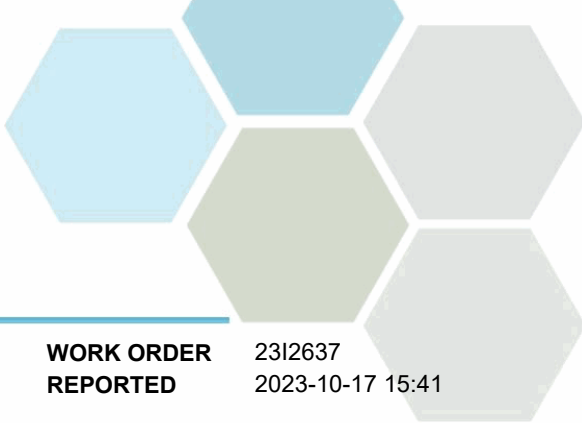
Chloride	100	0.10	mg/L	2023-09-23	
Nitrate (as N)	0.367	0.010	mg/L	2023-09-23	
Nitrite (as N)	0.042	0.010	mg/L	2023-09-23	
Phosphate (as P)	0.772	0.0050	mg/L	2023-09-23	
Sulfate	99.0	1.0	mg/L	2023-09-23	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	234	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.409	0.0100	mg/L	N/A	
Nitrogen, Total	2.74	0.0500	mg/L	N/A	
Nitrogen, Organic	1.09	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	0.0050	mg/L	2023-10-11	
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TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 2312637
2023-10-17 15:41

Analyte	Result	RL	Units	Analyzed	Qualifier
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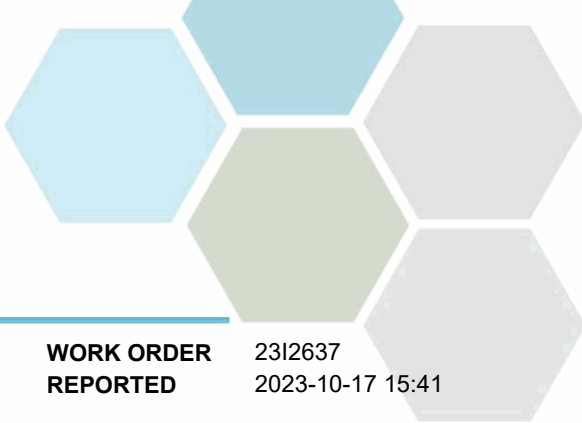
Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (2312637-02) | Matrix: Water | Sampled: 2023-09-20 09:15, Continued

Dissolved Metals, Continued

Antimony, dissolved	0.00031	0.00020	mg/L	2023-10-11	
Arsenic, dissolved	0.00095	0.00050	mg/L	2023-10-11	
Barium, dissolved	0.0277	0.0050	mg/L	2023-10-11	
Beryllium, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	
Bismuth, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	
Boron, dissolved	0.194	0.0500	mg/L	2023-10-11	
Cadmium, dissolved	0.000015	0.000010	mg/L	2023-10-11	
Calcium, dissolved	55.1	0.20	mg/L	2023-10-11	
Chromium, dissolved	< 0.00050	0.00050	mg/L	2023-10-11	
Cobalt, dissolved	0.00032	0.00010	mg/L	2023-10-11	
Copper, dissolved	0.00314	0.00040	mg/L	2023-10-11	
Iron, dissolved	0.109	0.010	mg/L	2023-10-11	
Lead, dissolved	< 0.00020	0.00020	mg/L	2023-10-11	
Lithium, dissolved	0.0100	0.00010	mg/L	2023-10-11	
Magnesium, dissolved	23.4	0.010	mg/L	2023-10-11	
Manganese, dissolved	0.180	0.00020	mg/L	2023-10-11	
Molybdenum, dissolved	0.00283	0.00010	mg/L	2023-10-11	
Nickel, dissolved	0.00197	0.00040	mg/L	2023-10-11	
Phosphorus, dissolved	1.25	0.050	mg/L	2023-10-11	
Potassium, dissolved	21.7	0.10	mg/L	2023-10-11	
Selenium, dissolved	< 0.00050	0.00050	mg/L	2023-10-11	
Silicon, dissolved	2.6	1.0	mg/L	2023-10-11	
Silver, dissolved	< 0.000050	0.000050	mg/L	2023-10-11	
Sodium, dissolved	101	0.10	mg/L	2023-10-11	
Strontium, dissolved	0.570	0.0010	mg/L	2023-10-11	
Sulfur, dissolved	37.6	3.0	mg/L	2023-10-11	
Tellurium, dissolved	< 0.00050	0.00050	mg/L	2023-10-11	
Thallium, dissolved	< 0.000020	0.000020	mg/L	2023-10-11	
Thorium, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	
Tin, dissolved	< 0.00020	0.00020	mg/L	2023-10-11	
Titanium, dissolved	< 0.0050	0.0050	mg/L	2023-10-11	
Tungsten, dissolved	< 0.0010	0.0010	mg/L	2023-10-11	
Uranium, dissolved	0.00125	0.000020	mg/L	2023-10-11	
Vanadium, dissolved	< 0.0050	0.0050	mg/L	2023-10-11	
Zinc, dissolved	0.0228	0.0040	mg/L	2023-10-11	
Zirconium, dissolved	< 0.00010	0.00010	mg/L	2023-10-11	

General Parameters

Ammonia, Total (as N)	1.25	0.050	mg/L	2023-09-26	
BOD, 5-day	17.0	2.0	mg/L	2023-09-27	RA5
Nitrogen, Total Kjeldahl	2.34	0.050	mg/L	2023-09-26	
pH	8.02	0.10	pH units	2023-09-23	HT2
Phosphorus, Total (as P)	1.15	0.0050	mg/L	2023-09-25	



TEST RESULTS

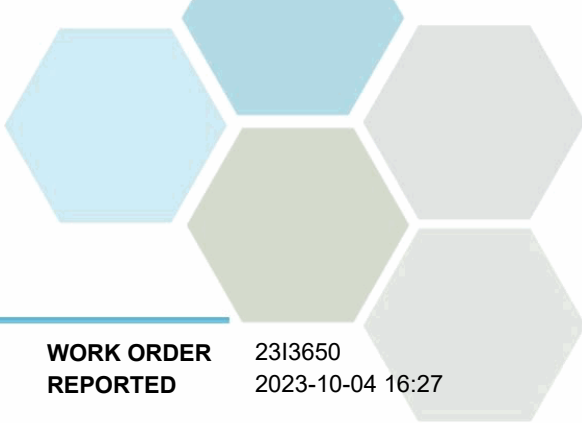
REPORTED TO PROJECT Vernon Water Reclamation, City of
MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 23I2637
2023-10-17 15:41

Analyte	Result	RL	Units	Analyzed	Qualifier
Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (23I2637-02) Matrix: Water Sampled: 2023-09-20 09:15, Continued					
<i>General Parameters, Continued</i>					
Phosphorus, Total Dissolved	1.12	0.0050	mg/L	2023-09-25	
Solids, Total Dissolved	565	15	mg/L	2023-09-26	
Solids, Total Suspended	5.0	2.0	mg/L	2023-09-26	
Turbidity	2.94	0.10	NTU	2023-09-23	
<i>Microbiological Parameters</i>					
Coliforms, Total (Q-Tray)	2	1	MPN/100 mL	2023-09-22	HT1
Coliforms, Fecal (Q-Tray)	2	1	MPN/100 mL	2023-09-22	HT1
<i>Total Metals</i>					
Sodium, total	97.5	0.10	mg/L	2023-09-25	

Sample Qualifiers:

- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- RA5 The sample cannot be accurately quantified due to matrix interference. Result is Semi-Quantitative.

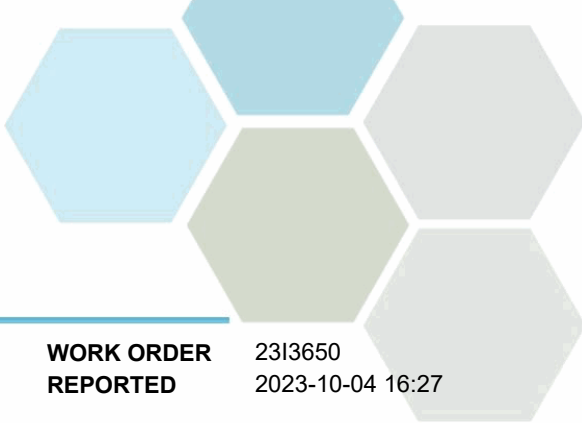


TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 2313650
2023-10-04 16:27

Analyte	Result	RL	Units	Analyzed	Qualifier
Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (2313650-01) Matrix: Water Sampled: 2023-09-28 08:15					
<i>General Parameters</i>					
BOD, 5-day	< 6.5		2.0 mg/L	2023-10-04	
Mackay Reservoir Effluent to Irrigation (Clay Valve 4) E228539 (2313650-02) Matrix: Water Sampled: 2023-09-28 08:15					
<i>General Parameters</i>					
BOD, 5-day	< 6.5		2.0 mg/L	2023-10-04	



APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT Vernon Water Reclamation, City of MacKay Reservoir Effluent (ME 12215) - EMS

WORK ORDER REPORTED 2313650
2023-10-04 16:27

Analysis Description	Method Ref.	Technique	Accredited	Location
Biochemical Oxygen Demand in Water	SM 5210 B (2019)	Dissolved Oxygen Meter	✓	Kelowna

Glossary of Terms:

RL	Reporting Limit (default)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
mg/L	Milligrams per litre
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

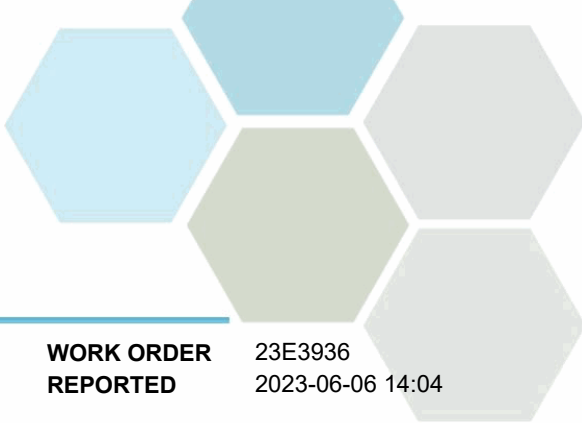
General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed. The quality control (QC) data is available upon request

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.

Appendix J

Direct to Rise Golf Course Water Quality Results
Caro Analytical Services



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23E3936
2023-06-06 14:04

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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**VWRC Treated UV Effluent to Direct Irrigation (FFE) E229578 (23E3936-01) | Matrix: Fresh Water |
Sampled: 2023-05-30 10:10**

General Parameters

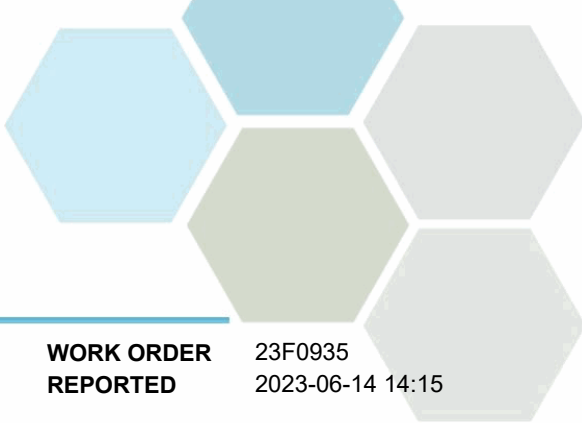
BOD, 5-day	< 6.3		2.0	mg/L	2023-06-06	
pH	7.31	± 0.02	0.10	pH units	2023-06-04	HT2
Solids, Total Suspended	< 3.3		2.0	mg/L	2023-05-31	
Turbidity	0.97	± 0.05	0.10	NTU	2023-06-01	

Microbiological Parameters

Coliforms, Total (Q-Tray)	4		1	MPN/100 mL	2023-05-31	
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-05-31	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23F0935
2023-06-14 14:15

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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VWRC Treated UV Effluent to Direct Irrigation (FFE) E229578 (23F0935-01) | Matrix: Fresh Water | Sampled: 2023-06-07 09:50

General Parameters

BOD, 5-day	< 5.2		2.0	mg/L	2023-06-13	
pH	6.74	± 0.02	0.10	pH units	2023-06-12	HT2
Solids, Total Suspended	< 2.0		2.0	mg/L	2023-06-13	
Turbidity	1.33	± 0.07	0.10	NTU	2023-06-09	

Microbiological Parameters

Coliforms, Total (Q-Tray)	14		1	MPN/100 mL	2023-06-08	
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-06-08	

VWRC Treated UV Effluent to Direct Irrigation (FFE) E229578 (23F0935-02) | Matrix: Fresh Water | Sampled: 2023-06-07 09:50

General Parameters

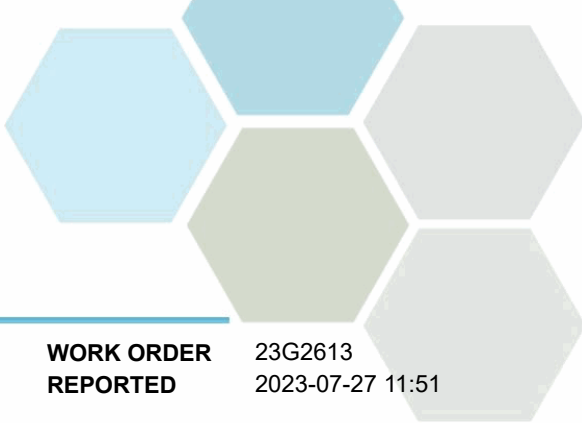
BOD, 5-day	< 5.9		2.0	mg/L	2023-06-14	
pH	6.81	± 0.02	0.10	pH units	2023-06-12	HT2
Solids, Total Suspended	< 2.0		2.0	mg/L	2023-06-13	
Turbidity	0.97	± 0.05	0.10	NTU	2023-06-11	HT1

Microbiological Parameters

Coliforms, Total (Q-Tray)	4		1	MPN/100 mL	2023-06-08	
Coliforms, Fecal (Q-Tray)	1		1	MPN/100 mL	2023-06-08	

Sample Qualifiers:

- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23G2613
2023-07-27 11:51

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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**VWRC Treated UV Effluent to Direct Irrigation (FFE) E229578 (23G2613-01) | Matrix: Fresh Water |
Sampled: 2023-07-20 08:00**

General Parameters

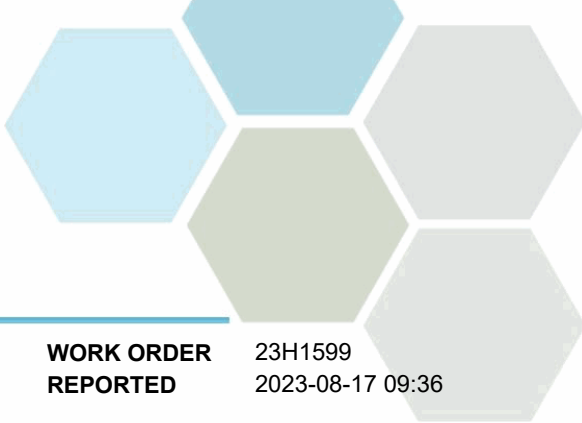
BOD, 5-day	< 1.2		2.0	mg/L	2023-07-27	
pH	7.78	± 0.02	0.10	pH units	2023-07-23	HT2
Solids, Total Suspended	4.0	± 0.5	2.0	mg/L	2023-07-25	
Turbidity	0.54	± 0.03	0.10	NTU	2023-07-22	

Microbiological Parameters

Coliforms, Total (Q-Tray)	10		1	MPN/100 mL	2023-07-21	HT1
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-07-21	HT1

Sample Qualifiers:

- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 23H1599
2023-08-17 09:36

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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**VWRC Treated UV Effluent to Direct Irrigation (FFE) E229578 (23H1599-01) | Matrix: Fresh Water |
Sampled: 2023-08-10 10:00**

General Parameters

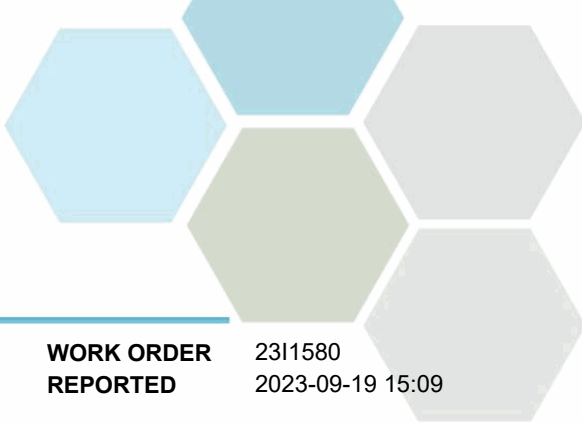
BOD, 5-day	1.1	± 0.4	2.0	mg/L	2023-08-16	
pH	7.90	± 0.02	0.10	pH units	2023-08-12	HT2
Solids, Total Suspended	< 2.0		2.0	mg/L	2023-08-14	
Turbidity	0.61	± 0.04	0.10	NTU	2023-08-11	

Microbiological Parameters

Coliforms, Total (Q-Tray)	21		1	MPN/100 mL	2023-08-11	
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-08-11	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of
Final Treated Effluent (ME12215) - EMS

WORK ORDER REPORTED 2311580
2023-09-19 15:09

Analyte	Result	Uncertainty	RL	Units	Analyzed	Qualifier
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**VWRC Treated UV Effluent to Direct Irrigation (FFE) E229578 (23I1580-01) | Matrix: Fresh Water |
Sampled: 2023-09-13 10:00**

General Parameters

BOD, 5-day	< 1.4		2.0	mg/L	2023-09-19	
pH	7.91	± 0.02	0.10	pH units	2023-09-15	HT2
Solids, Total Suspended	2.2	± 0.4	2.0	mg/L	2023-09-15	
Turbidity	0.66	± 0.04	0.10	NTU	2023-09-14	

Microbiological Parameters

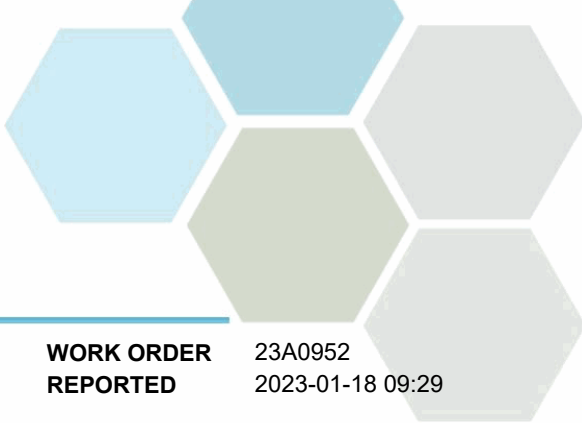
Coliforms, Total (Q-Tray)	105		1	MPN/100 mL	2023-09-14	
Coliforms, Fecal (Q-Tray)	< 1		1	MPN/100 mL	2023-09-14	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

Appendix K

Bailey Springs Water Quality Results
Caro Analytical Services



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23A0952
2023-01-18 09:29

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) (23A0952-01) Matrix: Fresh Water Sampled: 2023-01-10 14:30					FILT, PRES

Anions

Chloride	133	0.10	mg/L	2023-01-12	
Nitrate (as N)	0.344	0.010	mg/L	2023-01-12	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-01-12	
Phosphate (as P)	0.0608	0.0050	mg/L	2023-01-12	

Calculated Parameters

Nitrate+Nitrite (as N)	0.344	0.0100	mg/L	N/A	
Nitrogen, Total	0.824	0.0500	mg/L	N/A	
Nitrogen, Organic	0.186	0.0500	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	0.294	0.050	mg/L	2023-01-14	
Conductivity (EC)	1310	2.0	µS/cm	2023-01-12	
Nitrogen, Total Kjeldahl	0.480	0.050	mg/L	2023-01-17	
pH	8.37	0.10	pH units	2023-01-12	HT2
Phosphorus, Total (as P)	0.0992	0.0050	mg/L	2023-01-16	
Phosphorus, Total Dissolved	0.0927	0.0050	mg/L	2023-01-16	

Microbiological Parameters

Coliforms, Total (Q-Tray)	435	1	MPN/100 mL	2023-01-11	
Coliforms, Fecal (Q-Tray)	33	1	MPN/100 mL	2023-01-11	

Total Metals

Sodium, total	124	0.10	mg/L	2023-01-16	
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Bailey Springs (0500578) Duplicate (23A0952-02) | Matrix: Fresh Water | Sampled: 2023-01-10 14:30

FILT, PRES

Anions

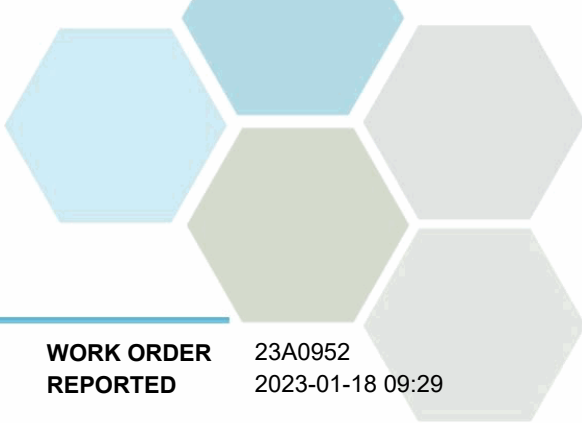
Chloride	150	0.10	mg/L	2023-01-13	
Nitrate (as N)	0.345	0.010	mg/L	2023-01-13	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-01-13	
Phosphate (as P)	0.0658	0.0050	mg/L	2023-01-13	

Calculated Parameters

Nitrate+Nitrite (as N)	0.345	0.0100	mg/L	N/A	
Nitrogen, Total	0.809	0.0500	mg/L	N/A	
Nitrogen, Organic	0.387	0.0500	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	0.077	0.050	mg/L	2023-01-14	
Conductivity (EC)	1300	2.0	µS/cm	2023-01-12	
Nitrogen, Total Kjeldahl	0.464	0.050	mg/L	2023-01-17	
pH	8.38	0.10	pH units	2023-01-12	HT2
Phosphorus, Total (as P)	0.0994	0.0050	mg/L	2023-01-16	



TEST RESULTS

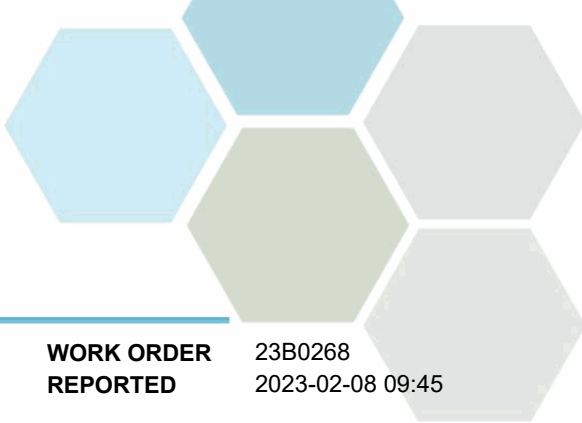
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23A0952
2023-01-18 09:29

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) Duplicate (23A0952-02) Matrix: Fresh Water Sampled: 2023-01-10 14:30, Continued					FILT, PRES
<i>General Parameters, Continued</i>					
Phosphorus, Total Dissolved	0.0913	0.0050	mg/L	2023-01-16	
<i>Microbiological Parameters</i>					
Coliforms, Total (Q-Tray)	580	1	MPN/100 mL	2023-01-11	
Coliforms, Fecal (Q-Tray)	16	1	MPN/100 mL	2023-01-11	
<i>Total Metals</i>					
Sodium, total	125	0.10	mg/L	2023-01-16	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

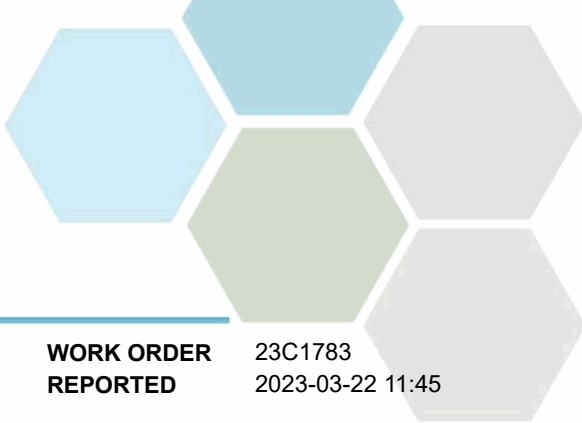
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23B0268
2023-02-08 09:45

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) (23B0268-01) Matrix: Fresh Water Sampled: 2023-02-02 09:00					FILT, PRES
Anions					
Chloride	162	0.10	mg/L	2023-02-03	
Nitrate (as N)	0.573	0.010	mg/L	2023-02-03	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-02-03	
Phosphate (as P)	0.0482	0.0050	mg/L	2023-02-03	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.573	0.0100	mg/L	N/A	
Nitrogen, Total	1.05	0.0500	mg/L	N/A	
Nitrogen, Organic	0.478	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-02-04	
Conductivity (EC)	1320	2.0	µS/cm	2023-02-04	
Nitrogen, Total Kjeldahl	0.478	0.050	mg/L	2023-02-05	
pH	8.29	0.10	pH units	2023-02-04	HT2
Phosphorus, Total (as P)	0.142	0.0050	mg/L	2023-02-06	
Phosphorus, Total Dissolved	0.137	0.0050	mg/L	2023-02-06	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	579	1	MPN/100 mL	2023-02-02	
Coliforms, Fecal (Q-Tray)	2	1	MPN/100 mL	2023-02-02	
Total Metals					
Sodium, total	128	0.10	mg/L	2023-02-07	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

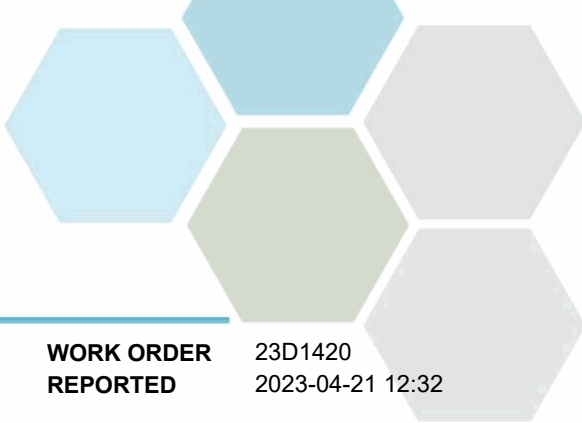
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23C1783
2023-03-22 11:45

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) (23C1783-01) Matrix: Fresh Water Sampled: 2023-03-15 09:00					FILT, PRES
Anions					
Chloride	177	0.10	mg/L	2023-03-17	
Nitrate (as N)	0.387	0.010	mg/L	2023-03-17	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-03-17	
Phosphate (as P)	0.0403	0.0050	mg/L	2023-03-17	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.387	0.0100	mg/L	N/A	
Nitrogen, Total	0.803	0.0500	mg/L	N/A	
Nitrogen, Organic	0.416	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-03-16	
Conductivity (EC)	1360	2.0	µS/cm	2023-03-17	
Nitrogen, Total Kjeldahl	0.416	0.050	mg/L	2023-03-17	
pH	8.32	0.10	pH units	2023-03-17	HT2
Phosphorus, Total (as P)	0.107	0.0050	mg/L	2023-03-17	
Phosphorus, Total Dissolved	0.101	0.0050	mg/L	2023-03-17	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	77	1	MPN/100 mL	2023-03-16	
Coliforms, Fecal (Q-Tray)	5	1	MPN/100 mL	2023-03-16	
Total Metals					
Sodium, total	134	0.10	mg/L	2023-03-21	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

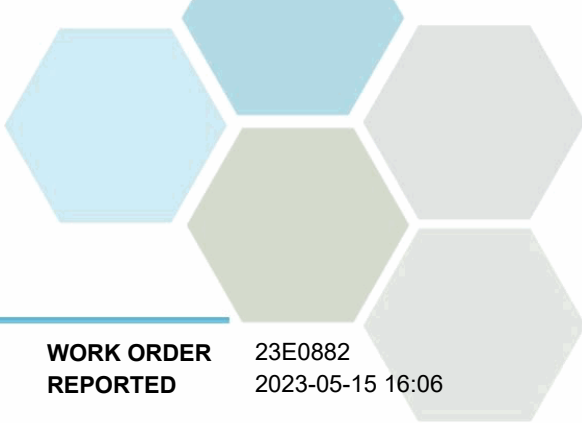
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23D1420
2023-04-21 12:32

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) (23D1420-01) Matrix: Fresh Water Sampled: 2023-04-14					FILT, PRES
Anions					
Chloride	174	0.10	mg/L	2023-04-15	
Nitrate (as N)	0.254	0.010	mg/L	2023-04-15	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-15	
Phosphate (as P)	0.0245	0.0050	mg/L	2023-04-15	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.254	0.0100	mg/L	N/A	
Nitrogen, Total	0.640	0.0500	mg/L	N/A	
Nitrogen, Organic	0.317	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	0.069	0.050	mg/L	2023-04-16	
Conductivity (EC)	1320	2.0	µS/cm	2023-04-19	
Nitrogen, Total Kjeldahl	0.386	0.050	mg/L	2023-04-18	
pH	8.36	0.10	pH units	2023-04-19	HT2
Phosphorus, Total (as P)	0.0924	0.0050	mg/L	2023-04-17	
Phosphorus, Total Dissolved	0.0861	0.0050	mg/L	2023-04-17	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	201	1	MPN/100 mL	2023-04-14	
Coliforms, Fecal (Q-Tray)	67	1	MPN/100 mL	2023-04-14	
Total Metals					
Sodium, total	125	0.10	mg/L	2023-04-20	

Sample Qualifiers:

FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
 HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
 PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

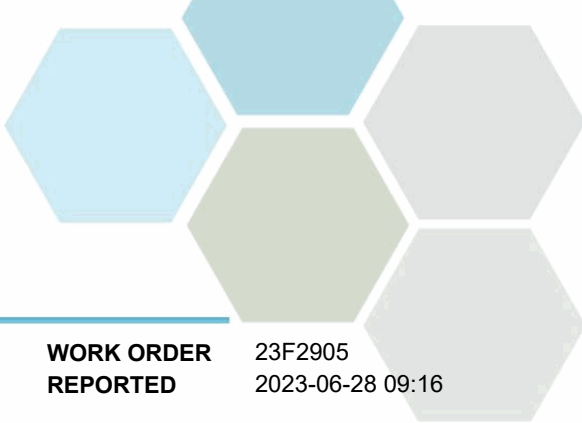
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23E0882
2023-05-15 16:06

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) (23E0882-01) Matrix: Fresh Water Sampled: 2023-05-05					FILT, PRES
Anions					
Chloride	177	0.10	mg/L	2023-05-07	
Nitrate (as N)	0.090	0.010	mg/L	2023-05-07	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-05-07	
Phosphate (as P)	0.0315	0.0050	mg/L	2023-05-07	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.0895	0.0100	mg/L	N/A	
Nitrogen, Total	0.540	0.0500	mg/L	N/A	
Nitrogen, Organic	0.451	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-05-07	
Conductivity (EC)	1310	2.0	µS/cm	2023-05-07	
Nitrogen, Total Kjeldahl	0.451	0.050	mg/L	2023-05-10	
pH	8.47	0.10	pH units	2023-05-07	HT2
Phosphorus, Total (as P)	0.114	0.0050	mg/L	2023-05-08	
Phosphorus, Total Dissolved	0.0945	0.0050	mg/L	2023-05-08	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	1550	1	MPN/100 mL	2022-05-06	
Coliforms, Fecal (Q-Tray)	10	1	MPN/100 mL	2022-05-06	
Total Metals					
Sodium, total	131	0.10	mg/L	2023-05-14	

Sample Qualifiers:

- FILT The sample has been filtered for Diss phos in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for Diss phos in the laboratory and the holding time has been extended.



TEST RESULTS

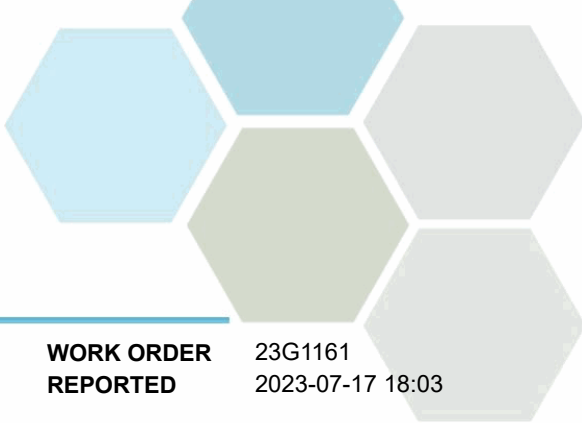
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23F2905
2023-06-28 09:16

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (23F2905-01) Matrix: Water Sampled: 2023-06-21 08:00					
Anions					
Chloride	180	0.10	mg/L	2023-06-23	
Nitrate (as N)	0.108	0.010	mg/L	2023-06-23	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-06-23	
Phosphate (as P)	0.0056	0.0050	mg/L	2023-06-23	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.108	0.0100	mg/L	N/A	
Nitrogen, Total	0.941	0.0500	mg/L	N/A	
Nitrogen, Organic	0.710	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	0.123	0.050	mg/L	2023-06-23	
Conductivity (EC)	1250	2.0	µS/cm	2023-06-23	
Nitrogen, Total Kjeldahl	0.833	0.050	mg/L	2023-06-25	
pH	8.31	0.10	pH units	2023-06-23	HT2
Phosphorus, Total (as P)	0.189	0.0050	mg/L	2023-06-23	
Phosphorus, Total Dissolved	0.136	0.0050	mg/L	2023-06-23	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	> 2420	1	MPN/100 mL	2023-06-22	
Coliforms, Fecal (Q-Tray)	921	1	MPN/100 mL	2023-06-22	
Total Metals					
Sodium, total	134	0.10	mg/L	2023-06-24	

Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



TEST RESULTS

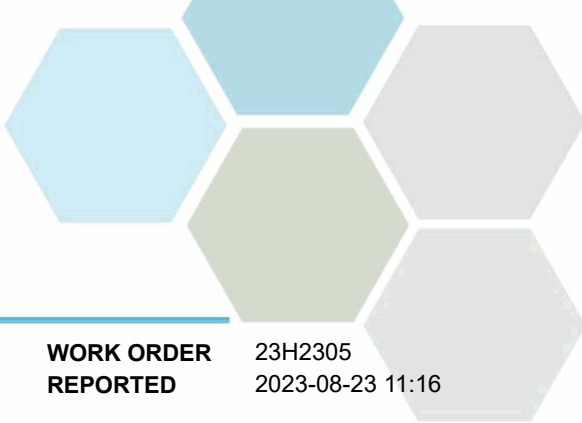
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23G1161
2023-07-17 18:03

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs (0500578) (23G1161-01) Matrix: Fresh Water Sampled: 2023-07-10 08:54					FILT, PRES
Anions					
Chloride	168	0.10	mg/L	2023-07-12	
Nitrate (as N)	< 0.010	0.010	mg/L	2023-07-12	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-07-12	
Phosphate (as P)	0.0313	0.0050	mg/L	2023-07-12	
Calculated Parameters					
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L	N/A	
Nitrogen, Total	0.618	0.0500	mg/L	N/A	
Nitrogen, Organic	0.618	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-07-12	
Conductivity (EC)	1250	2.0	µS/cm	2023-07-12	
Nitrogen, Total Kjeldahl	0.618	0.050	mg/L	2023-07-14	
pH	8.42	0.10	pH units	2023-07-12	HT2
Phosphorus, Total (as P)	0.166	0.0050	mg/L	2023-07-14	
Phosphorus, Total Dissolved	0.132	0.0050	mg/L	2023-07-14	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	> 2420	1	MPN/100 mL	2023-07-11	HT1
Coliforms, Fecal (Q-Tray)	488	1	MPN/100 mL	2023-07-11	HT1
Total Metals					
Sodium, total	130	0.10	mg/L	2023-07-15	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23H2305
2023-08-23 11:16

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs 0500578 (23H2305-01) Matrix: Fresh Water Sampled: 2023-08-16 09:30					FILT, PRES

Anions

Chloride	158	0.10	mg/L	2023-08-18	
Nitrate (as N)	< 0.010	0.010	mg/L	2023-08-18	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-08-18	
Phosphate (as P)	0.0749	0.0050	mg/L	2023-08-18	

Calculated Parameters

Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L	N/A	
Nitrogen, Total	0.792	0.0500	mg/L	N/A	
Nitrogen, Organic	0.707	0.0500	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	0.085	0.050	mg/L	2023-08-20	
Conductivity (EC)	1240	2.0	µS/cm	2023-08-19	
Nitrogen, Total Kjeldahl	0.792	0.050	mg/L	2023-08-21	
pH	8.46	0.10	pH units	2023-08-19	HT2
Phosphorus, Total (as P)	0.188	0.0050	mg/L	2023-08-18	
Phosphorus, Total Dissolved	0.142	0.0050	mg/L	2023-08-18	

Microbiological Parameters

Coliforms, Total (Q-Tray)	21000	1	MPN/100 mL	2023-08-17	
Coliforms, Fecal (Q-Tray)	770	1	MPN/100 mL	2023-08-17	

Total Metals

Sodium, total	136	0.10	mg/L	2023-08-19	
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Bailey Springs 0500579 Duplicate (23H2305-02) | Matrix: Fresh Water | Sampled: 2023-08-16 09:30

FILT, PRES

Anions

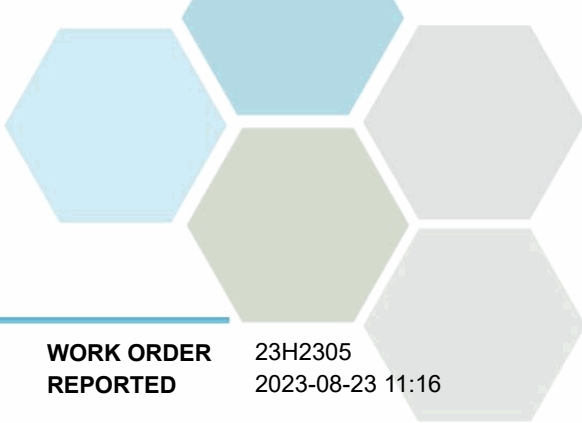
Chloride	160	0.10	mg/L	2023-08-18	
Nitrate (as N)	< 0.010	0.010	mg/L	2023-08-18	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-08-18	
Phosphate (as P)	0.0771	0.0050	mg/L	2023-08-18	

Calculated Parameters

Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L	N/A	
Nitrogen, Total	0.823	0.0500	mg/L	N/A	
Nitrogen, Organic	0.740	0.0500	mg/L	N/A	

General Parameters

Ammonia, Total (as N)	0.083	0.050	mg/L	2023-08-20	
Conductivity (EC)	1250	2.0	µS/cm	2023-08-19	
Nitrogen, Total Kjeldahl	0.823	0.050	mg/L	2023-08-21	
pH	8.46	0.10	pH units	2023-08-19	HT2
Phosphorus, Total (as P)	0.189	0.0050	mg/L	2023-08-18	



TEST RESULTS

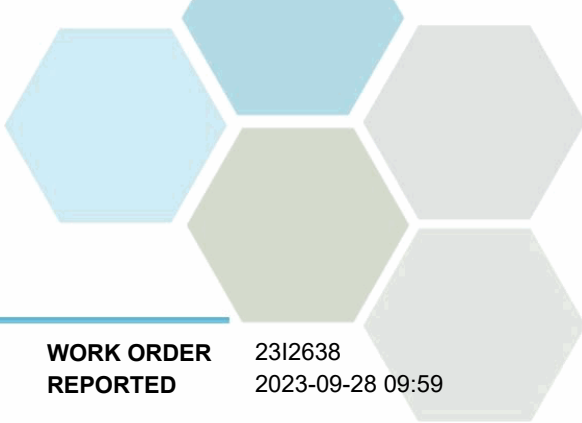
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23H2305
2023-08-23 11:16

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs 0500579 Duplicate (23H2305-02) Matrix: Fresh Water Sampled: 2023-08-16 09:30, Continued					FILT, PRES
<i>General Parameters, Continued</i>					
Phosphorus, Total Dissolved	0.144	0.0050	mg/L	2023-08-18	
<i>Microbiological Parameters</i>					
Coliforms, Total (Q-Tray)	26000	1	MPN/100 mL	2023-08-17	
Coliforms, Fecal (Q-Tray)	921	1	MPN/100 mL	2023-08-17	
<i>Total Metals</i>					
Sodium, total	137	0.10	mg/L	2023-08-19	

Sample Qualifiers:

- FILT The sample has been filtered for DP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for DP in the laboratory and the holding time has been extended.



TEST RESULTS

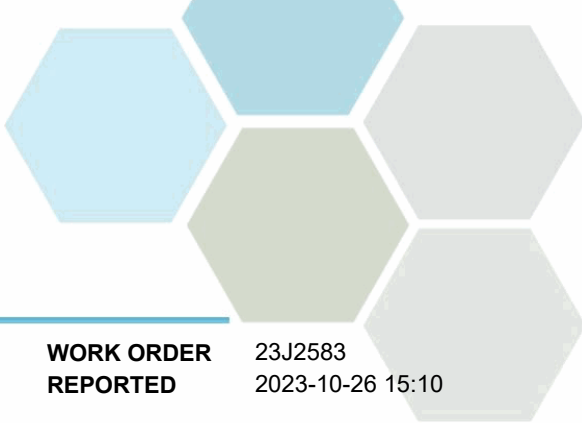
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 2312638
2023-09-28 09:59

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs 0500578 (2312638-01) Matrix: Fresh Water Sampled: 2023-09-21 09:30					FILT, PRES
Anions					
Chloride	165	0.10	mg/L	2023-09-23	
Nitrate (as N)	< 0.010	0.010	mg/L	2023-09-23	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-23	
Phosphate (as P)	0.0145	0.0050	mg/L	2023-09-23	
Calculated Parameters					
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L	N/A	
Nitrogen, Total	0.637	0.0500	mg/L	N/A	
Nitrogen, Organic	0.637	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-26	
Conductivity (EC)	1310	2.0	µS/cm	2023-09-23	
Nitrogen, Total Kjeldahl	0.637	0.050	mg/L	2023-09-26	
pH	8.49	0.10	pH units	2023-09-23	HT2
Phosphorus, Total (as P)	0.166	0.0050	mg/L	2023-09-25	
Phosphorus, Total Dissolved	0.135	0.0050	mg/L	2023-09-25	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	5630	1	MPN/100 mL	2023-09-22	
Coliforms, Fecal (Q-Tray)	866	1	MPN/100 mL	2023-09-22	
Total Metals					
Sodium, total	132	0.10	mg/L	2023-09-25	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

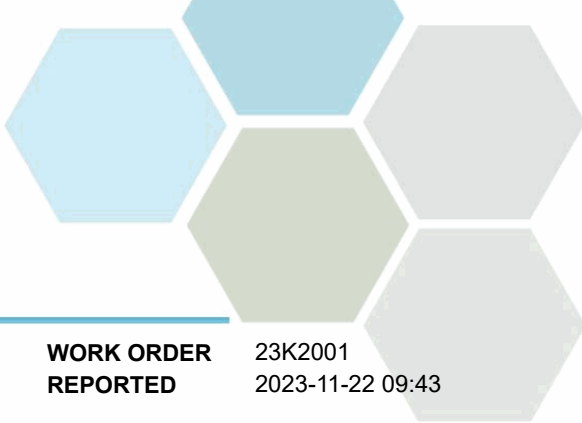
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23J2583
2023-10-26 15:10

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs 0500578 (23J2583-01) Matrix: Fresh Water Sampled: 2023-10-20 08:30					FILT, PRES
Anions					
Chloride	153	0.10	mg/L	2023-10-24	
Nitrate (as N)	< 0.010	0.010	mg/L	2023-10-24	HT1
Nitrite (as N)	< 0.010	0.010	mg/L	2023-10-24	HT1
Phosphate (as P)	0.0321	0.0050	mg/L	2023-10-24	HT1
Calculated Parameters					
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L	N/A	
Nitrogen, Total	0.497	0.0500	mg/L	N/A	
Nitrogen, Organic	0.497	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-10-23	
Conductivity (EC)	1310	2.0	µS/cm	2023-10-26	
Nitrogen, Total Kjeldahl	0.497	0.050	mg/L	2023-10-26	
pH	8.30	0.10	pH units	2023-10-26	HT2
Phosphorus, Total (as P)	0.118	0.0050	mg/L	2023-10-25	
Phosphorus, Total Dissolved	0.0882	0.0050	mg/L	2023-10-25	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	2410	1	MPN/100 mL	2023-10-20	
Coliforms, Fecal (Q-Tray)	31	1	MPN/100 mL	2023-10-20	
Total Metals					
Sodium, total	133	0.10	mg/L	2023-10-25	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT1 The sample was prepared and/or analyzed past the recommended holding time.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

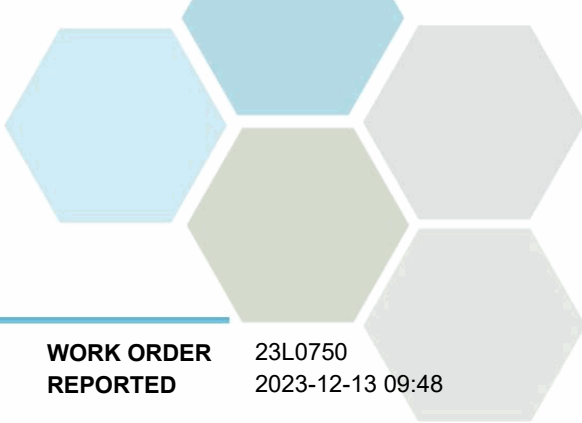
REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23K2001
2023-11-22 09:43

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs 0500578 (23K2001-01) Matrix: Fresh Water Sampled: 2023-11-16 09:15					FILT, PRES
Anions					
Chloride	167	0.10	mg/L	2023-11-17	
Nitrate (as N)	0.128	0.010	mg/L	2023-11-17	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-11-17	
Phosphate (as P)	0.0571	0.0050	mg/L	2023-11-17	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.128	0.0100	mg/L	N/A	
Nitrogen, Total	0.579	0.0500	mg/L	N/A	
Nitrogen, Organic	0.451	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-11-19	
Conductivity (EC)	1300	2.0	µS/cm	2023-11-20	
Nitrogen, Total Kjeldahl	0.451	0.050	mg/L	2023-11-21	
pH	8.38	0.10	pH units	2023-11-19	HT2
Phosphorus, Total (as P)	0.103	0.0050	mg/L	2023-11-20	
Phosphorus, Total Dissolved	0.0945	0.0050	mg/L	2023-11-20	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	412	1	MPN/100 mL	2023-11-17	
Coliforms, Fecal (Q-Tray)	3	1	MPN/100 mL	2023-11-17	
Total Metals					
Sodium, total	148	0.10	mg/L	2023-11-21	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.



TEST RESULTS

REPORTED TO PROJECT Vernon Water Reclamation, City of Bailey Springs (ME12215) - EMS

WORK ORDER REPORTED 23L0750
2023-12-13 09:48

Analyte	Result	RL	Units	Analyzed	Qualifier
Bailey Springs 0500578 (23L0750-01) Matrix: Fresh Water Sampled: 2023-12-06 08:30					FILT, PRES
Anions					
Chloride	171	0.10	mg/L	2023-12-07	
Nitrate (as N)	0.190	0.010	mg/L	2023-12-07	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-12-07	
Phosphate (as P)	0.105	0.0050	mg/L	2023-12-07	
Calculated Parameters					
Nitrate+Nitrite (as N)	0.190	0.0100	mg/L	N/A	
Nitrogen, Total	0.510	0.0500	mg/L	N/A	
Nitrogen, Organic	0.320	0.0500	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-12-10	
Conductivity (EC)	1340	2.0	µS/cm	2023-12-07	
Nitrogen, Total Kjeldahl	0.320	0.050	mg/L	2023-12-12	
pH	8.38	0.10	pH units	2023-12-07	HT2
Phosphorus, Total (as P)	0.128	0.0050	mg/L	2023-12-11	
Phosphorus, Total Dissolved	0.110	0.0050	mg/L	2023-12-11	
Microbiological Parameters					
Coliforms, Total (Q-Tray)	1460	1	MPN/100 mL	2023-12-07	
Coliforms, Fecal (Q-Tray)	12	1	MPN/100 mL	2023-12-07	
Total Metals					
Sodium, total	133	0.10	mg/L	2023-12-09	

Sample Qualifiers:

- FILT The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
- HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
- PRES Sample has been preserved for TDP in the laboratory and the holding time has been extended.

Appendix L

2023 Reclaimed Water Irrigation Groundwater Monitoring Program

Associated Environmental Consultants Inc.

REPORT

City of Vernon

Reclaimed Water Irrigation 2023 Groundwater Monitoring Program



MARCH 2024

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1 INTRODUCTION

1.1 Background

The City of Vernon (the City) treats municipal wastewater at the Vernon Water Reclamation Centre. The treated wastewater (referred to as “reclaimed water”) is then stored in the MacKay Reservoir and used to irrigate approximately 1,500 ha of agricultural land on the south side of the City. The irrigation program is authorized by the BC Ministry of Environment and Climate Change Strategy (ENV) through Operational Certificate (OC) ME 12215 (MOE 2008). Under the OC, groundwater monitoring must be completed each year and an annual report submitted to ENV.

In 2010, the City retained Summit Environmental Consultants Inc. (now Associated Environmental Consultants Inc. [Associated]) to design and implement a groundwater monitoring program to assess the potential impacts of the reclaimed water irrigation operations on groundwater (Summit 2010). The groundwater monitoring program has been completed annually since that time, and reports are submitted to ENV each year. This report presents the results of the 2023 monitoring program. For more details on the historical program, see the previous annual reports (Summit 2010; Associated 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023).

1.2 Objective and Scope

The objective of the 2023 monitoring program was to monitor for potential effects of irrigation operations on groundwater, as required under Section 8.6 of the OC (MOE 2008). To meet this objective, Associated conducted the following scope of work:

- Completed the annual groundwater sampling program from a network of monitoring and domestic wells;
- Compared the water quality data to applicable guidelines and historical data;
- Reviewed groundwater level data collected from data loggers installed in two monitoring wells (DMW-3 and MW-2) to better understand groundwater fluctuation; and
- Prepared an annual report that discusses the results of the 2023 monitoring program.

In addition, Associated compared water quality data for Bailey Springs¹ (provided by the City) to applicable guidelines and historical data, and included the results in this report.

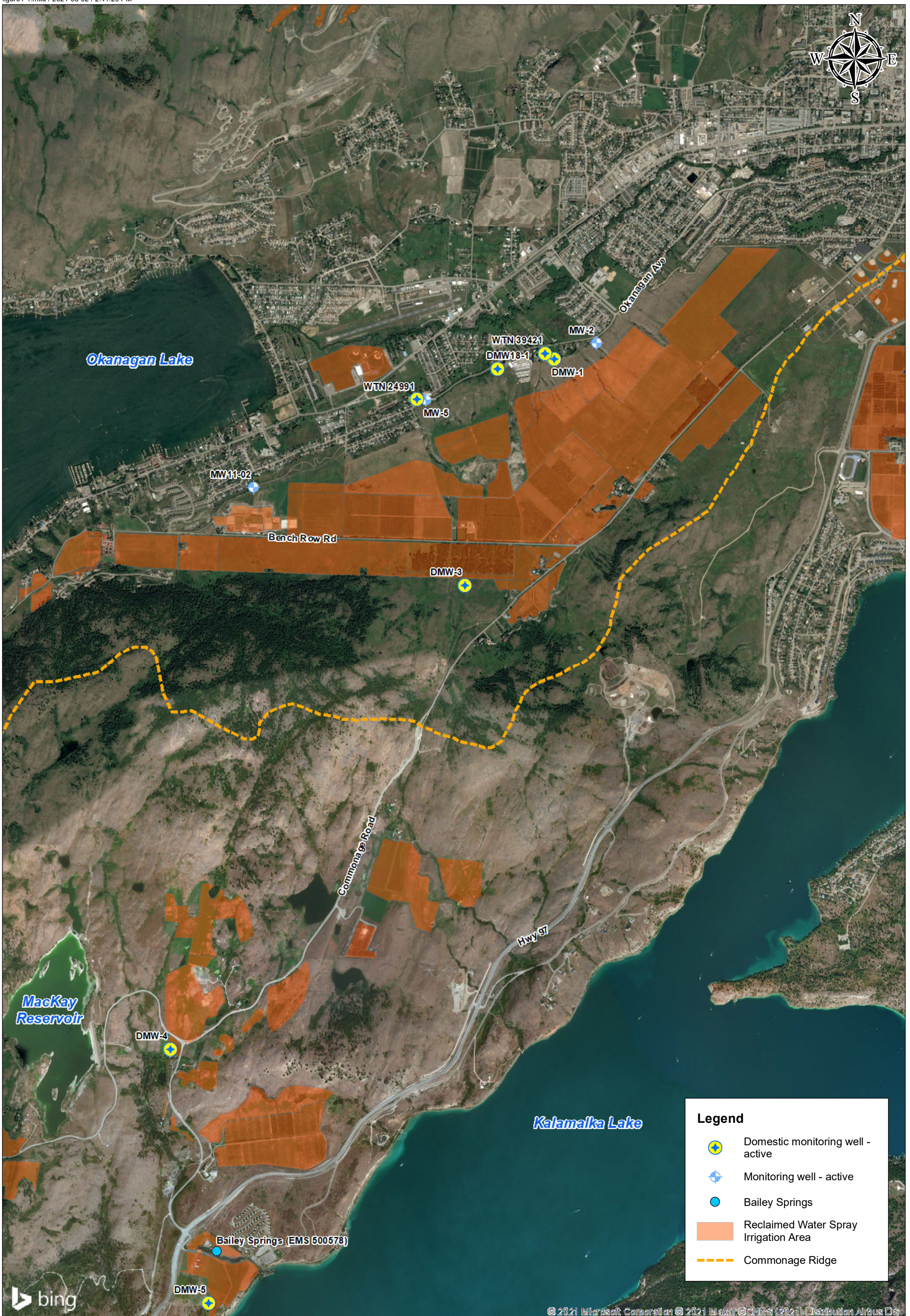
1.3 Study Area

The City’s reclaimed water irrigation distribution system is located on the lands between Kalamalka and Okanagan Lakes, as indicated by the orange areas in Figure 1-1. The study area includes lands within and south of the City limits to just beyond the MacKay Reservoir, including Townships 9, 10, 13, and 14.






The study area includes a northeast- to southwest-trending ridge (the Commonage Ridge) (Figure 1-1), where Commonage Road bisects the top of the ridge that descends to Okanagan Lake (northwest) and Kalamalka Lake (southeast). Several gullies with ephemeral streams draining toward Okanagan Lake are located on the bench lands to the west and east of Commonage Road.

¹ Section 8.9 of the OC requires the City to collect samples from a stream referred to as Bailey Springs (EMS 500578) (MOE 2008). Bailey Springs is a surface watercourse that originates south of the MacKay Reservoir and discharges to Kalamalka Lake.

Reclaimed water is applied to five major areas: the Rise Golf Course, Vernon Golf and Country Club, Predator Ridge Golf Resort, individual private properties in the Commonage area, and the City-managed area on the hillside northwest of Commonage Road (Figure 1-1). The current groundwater monitoring program focuses on the reclaimed water that is applied to the City-managed area on the hillside northwest of Commonage Road. Land use in this irrigated area includes forage production, livestock grazing, irrigated pasture, and a forest tree seedling nursery. The OC states that the “general philosophy of the operation of the reclaimed water irrigation system shall be for beneficial reuse of reclaimed water” (OC, Section 11.5.1). The City has control over irrigation rates in the City-managed area. For all other areas, the City manages irrigation use through Bylaw 4899 (COV 2005) and by providing all lessees with a copy of Appendix A of the OC each year (as required) to remind them of their requirements regarding irrigation rates, aerosol drift, buffers, prevention of surface runoff, and other factors. Over the past several years, the City has been working with the lessees to improve water use practices and reduce instances of over-irrigation, which could cause saturated soils or surface runoff.



Legend

-  Domestic monitoring well - active
-  Monitoring well - active
-  Bailey Springs
-  Reclaimed Water Spray Irrigation Area
-  Commonage Ridge



PROJECT NO.: 2022-8307
 DATE: March 2023

0 200 400 600 800 1,000 Meters

FIGURE 1-1: RECLAIMED WATER IRRIGATION AREA AND MONITORING WELL NETWORK
 City of Vernon
 City of Vernon Groundwater Monitoring Program

2 CONCEPTUAL MODEL OF GROUNDWATER FLOW

Associated (2019) completed an in-depth review of available information to create a conceptual model of groundwater flow. The review focused on the study area north of the Commonage Ridge as this is where the larger aquifers are located and where the more complex groundwater flow patterns are likely to occur. The following sections provide a summary of that review, supplemented by additional data collected from 2019 to 2023.

2.1 Lithology

Associated (2019) reviewed borehole lithology data from publicly available sources and from well logs of monitoring wells drilled by Associated for other City projects in the area. The lithology observed in the boreholes is consistent with that described by Nasmith (1962) and Fulton et al. (1965). The study area north of the Commonage Ridge comprises undivided glacial deposits (i.e., sand, gravel, clay, and till) along the hillside and predominantly fluvial/alluvial deposits in the valley bottom, which is commonly called Priest Valley.

ENV most recently updated the aquifer mapping for the North Okanagan in 2019; these updates were based on extensive work completed by Hassan et al. (2019). Four aquifers are mapped in the study area (ENV 2024) (Table 2-1).

Table 2-1 Aquifers in the Study Area

Aquifer Information	Aquifer 346	Aquifer 347	Aquifer 1227	Aquifer 471
Name	South Vernon Unconfined	South Vernon Confined	Okanagan Landing Deep Confined	Unnamed
Productivity	Moderate	High	High	Low
Vulnerability	Moderate	Low	Low	Moderate
Lithology	Likely alluvium or stream terrace deposits	Sands and gravels from alluvium or stream terrace deposits	Sand and gravel dominated, but can be silty; contact with bedrock	Fractured crystalline bedrock; granite and alkali feldspar
Groundwater recharge	Assumed to be from precipitation, leakage from creeks/alluvial fans, and mountain block recharge	Predominantly from leakage through overlying confining unit from Aquifer 346; also from mountain block recharge and leakage from sediments along the valley margins	Expected predominantly from mountain block recharge via seepage from fractures and faults	Likely occurs from direct infiltration of precipitation at bedrock outcrops, slow leakage, and/or from surface water features
Size (km ²)	14.7	6.8	3.75	127.6
Number of registered wells correlated to the aquifer	105	114	6	116
Median well depth (m)	13.7	38.1	112.8	85.34
Number of registered flowing artesian wells	17 (16% of wells)	47 (41% of wells)	2 (33% of wells)	1 (<1% of wells)

Source: ENV 2024

Cross-sections generated by Associated (2019) are provided in Appendix A.² Figure A-1 shows the locations of the cross-sections. Cross-section A-A' (Figure A-2) has been updated from Associated (2019) given the information in Hassan et al. (2019) and shows the distinction between the South Vernon Confined Aquifer (Aquifer 347), the South Vernon Unconfined Aquifer (Aquifer 347), and the Okanagan Landing Deep Confined Aquifer (Aquifer 1227) (the boundaries between these units are extrapolated and have not been confirmed, except where wells are).

Cross-sections B-B' and C-C' (Figures A-3 and A-4, respectively) show that the lithology on the hillside is complex and that lithological units are not laterally extensive east-west.

2.2 Groundwater Levels

In October 2017, Associated installed pressure-transducer data loggers in monitoring wells MW-2 (WTN 58804) and DMW-3 (WTN 58803), both of which are included in the long-term groundwater monitoring program (Section 3), to measure and record groundwater levels every 6 hours. Approximately once every 3 months since that time, the City has retrieved data from the loggers and recorded a manual groundwater level reading. Data are available between October 25, 2017, and December 31, 2023 (Figure 2-1).

Monitoring well DMW-3 is located south of Bench Row Road and north of the Commonage Ridge (Figure 1-1). It is the only well in the monitoring program that is not in the area irrigated with reclaimed water. The monitoring well was installed in May 1989, and the well log indicates 1.83 m of red, sandy clay overlying fractured bedrock. The borehole was drilled to 5.79 m below ground (m bg), and the monitoring well was screened between 2.74 and 5.79 m bg (across the fractured bedrock).

DMW-3 is situated near an ephemeral drainage that drains to the north. Groundwater levels in the well are typically at approximately 2.5 m below top of casing (m btoc) throughout the year, except in spring (March–May), when groundwater levels rise to approximately 0.75 to 0.90 m btoc. Throughout the period of record, groundwater levels rise rapidly in March, during freshet (e.g., groundwater levels rose by as much as 0.76 m in a period of 24 hours [March 17, 2018]). Fieldwork completed at the well (e.g., water sampling) suggests that the surface seal of the well head is competent and that the annual increase in water level is due to a higher water level in the aquifer, not solely a higher water level in the well. Lower groundwater levels have been recorded in the past 3 years, and of note, the freshet increase typically observed in March was not as prominent in 2023.

Monitoring well MW-2 is approximately 35 m south of Okanagan Avenue, in the eastern portion of the study area within the area irrigated by reclaimed water (Figure 1-1). It is at a higher elevation than some of the other wells in the valley bottom, and the groundwater level in this well is comparable to the perceived potentiometric level in the flowing artesian wells located at lower elevations.³ The well log indicates that the well is partially screened across a semi-confined layer of coarse gravel from 12.8 to 14.3 m bg (likely Aquifer 347). The static groundwater level is between 2.6 and 3.6 m btoc throughout the period of record. The response to freshet in this well is less noticeable, which is expected due to the overlying confining layers inhibiting direct recharge of the aquifer. Recharge to this

² The accuracy of the cross-sections relies on the lithological information from publicly available well logs and the accuracy of the available elevation data. Monitoring wells installed for the Hesperia Landfill groundwater monitoring program (MW17-1, MW17-5, MW17-6, MW2018-1, MW2018-2, MW2018-3) have been surveyed to geodetic datum (+/- 1 cm) (Associated 2019). The ground elevations for other wells used were determined based on elevation data available from the City and have an accuracy of +/- 1 m (COV 2016). The borehole logs used to develop the cross-sections are provided in Associated (2019).

³ The potentiometric level is the imaginary level to which water in a confined aquifer would rise if it were completely pierced with a well. When the potentiometric level is above ground, a flowing artesian well results. Associated does not have confirmed data on the potentiometric levels of the flowing artesian wells on Okanagan Avenue, but a level of 1–2 m above ground would line up with the groundwater elevation at MW-2.

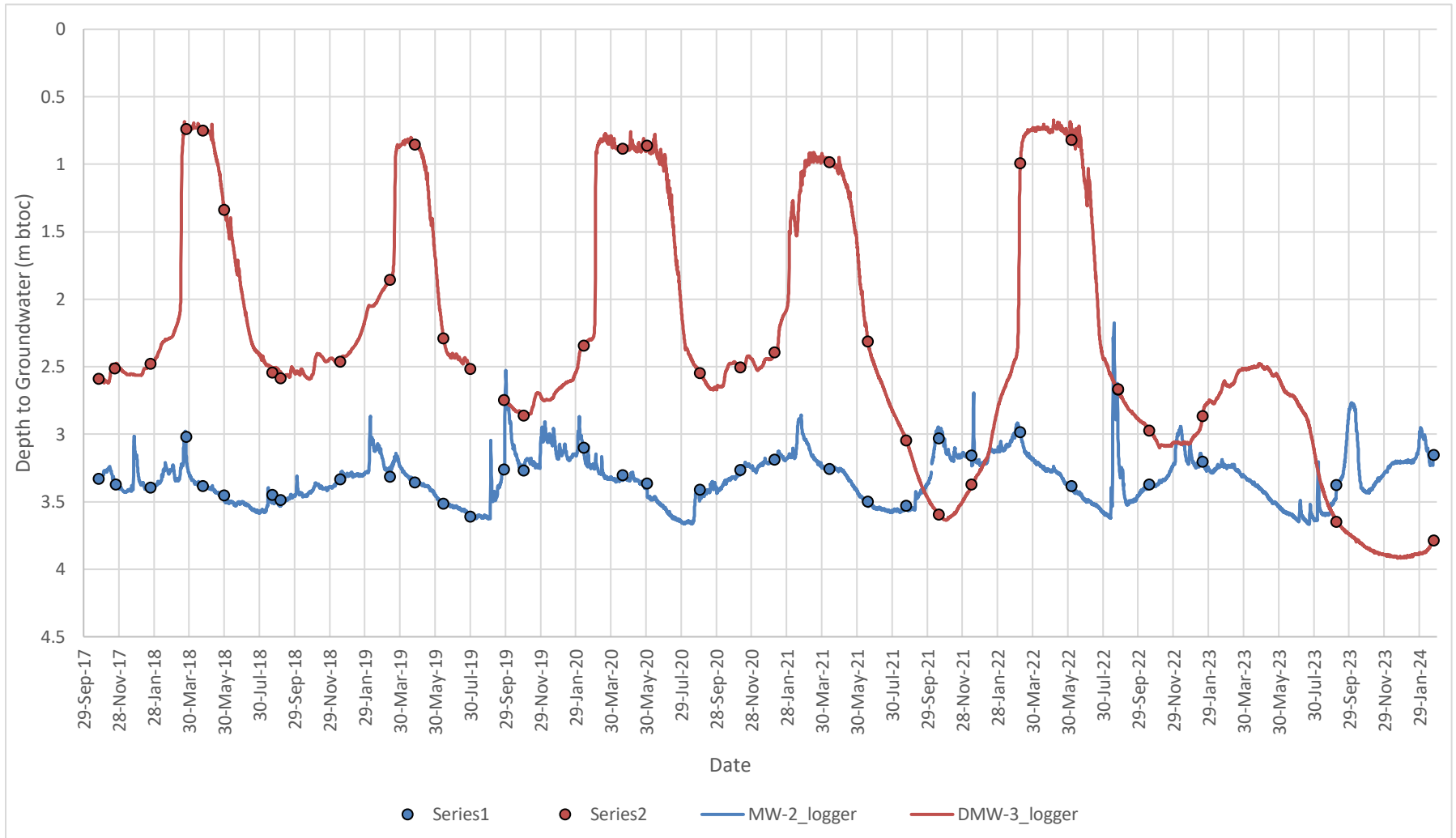
aquifer likely comes from the highlands to the south. Because coarse gravel aquifers typically have a large storativity value,⁴ changes in water levels, which would indicate recharge and discharge of water from the aquifer, are less noticeable. There seems to be a strong seasonal lag from freshet to high groundwater levels in this well; this is consistent with a well in a confined aquifer that is a large distance away from the recharge zone. Previous trilinear diagrams (Stiff diagrams) (Associated 2021), summarized in Section 2.3, confirm that groundwater in MW-2 is consistent with water having a long residence time.

The sawtooth pattern observed in MW-2 in Figure 2-1 indicates that the well is being influenced by a neighbouring pumping well. The minimal drawdown/recovery observed here suggests that the pumping well is a great distance away and/or the aquifer has high transmissivity.⁵

⁴ Storativity is a measure of an aquifer's ability to store water.

⁵ Transmissivity is a measure of an aquifer's ability to transmit water.

Figure 2-1 Groundwater Levels at MW-2 and DMW-2 (October 2017 to February 2024)



2.3 Groundwater Chemistry

Associated (2021) developed trilinear diagrams (i.e., Piper, extended Durov, and Stiff diagrams) to support conceptual model interpretation using data from 2011 to 2020. Trilinear diagrams aid with assessing groundwater “type” and can help classify different groundwater regimes. Groundwater flowing in an aquifer during the natural cycle is influenced by residence time and interaction with the host rock or material along the flow path, and can be generally classified as more freshly recharged (i.e., low mineralization) or having a long residence time (i.e., higher mineralization). Details of this assessment, including the trilinear diagrams, are provided in Associated 2021. The trilinear plots were not updated for this report; the following points summarize the findings from the 2021 assessment:

- Groundwater wells north of the Commonage Ridge typically plot as calcium-bicarbonate, calcium-magnesium, and calcium-sulphate water types, which suggests short to moderate residence times. Wells south of the Commonage Ridge (i.e., DMW-4 and DMW-5) plot as mainly calcium-sulphate.
- Five chemical signatures were evident in the Stiff diagrams:
 - MW11-02 is at the western extent of the study area and has higher concentrations of all ions.
 - WTN 24991 and MW-5 are located centrally along Okanagan Avenue and are flowing artesian. These wells show younger, more recently recharged groundwater.
 - DMW-1, MW-2, WTN 39421, and DMW18-1 are located at the eastern end of the study area, and all except for DMW-1 are installed to relatively similar depths. Although MW-2 is similar to the others, it has a slightly different source influencing its chemistry and may be isolated from the other wells.
 - DMW-3 is the upgradient well, and based on groundwater level data (Section 2.2), it is closely tied to surface water. It contains high concentrations of ions and is therefore potentially influenced by other upgradient activities (e.g., road salt, animal pasture).
 - DMW-4 and DMW-5 are located south of the Commonage Ridge and are unique from the others, based on their higher levels of sodium, potassium, and alkalinity.
- Some of the deeper, flowing artesian wells (WTN 24991 and MW-5) exhibit water that is typical of freshly recharged (i.e., younger) groundwater. This is counterintuitive since deeper aquifers typically host older groundwater.⁶ A potential reason for this is a pathway of higher transmissivity (e.g., a fracture or fault within the bedrock). WTN 39421 is a flowing artesian well located on Okanagan Avenue that has higher equivalents of sulphate and calcium, suggesting a different aquifer from WTN 24991 and MW-5.
- Although there is no confirmed lithological log for DMW-1, it is much shallower than WTN 39421 and is likely installed across a different aquifer. Based on the available lithological data for the study area, DMW-1 and WTN 39421 are likely separated by a 30–40 m thick unit of clay (Figure A-2, in Appendix A). Both wells have similar water quality and similar signatures, which may be due to similar material hosting the aquifers (i.e., although these two wells are separated by a thick clay unit, the geological depositional environment for the aquifers could be similar).

Since groundwater chemistry throughout the study area varies spatially and with depth, it is difficult to ascertain true background water quality for the area. Monitoring well DMW-3 is upgradient of the reclaimed water irrigation area but is installed across a bedrock aquifer and is closely tied to surface water. This makes it unique among other wells within the irrigation area that are typically much deeper and installed in unconsolidated aquifers. Monitoring well MW11-02 is within the irrigation area and has several parameters that are orders of magnitude higher than other wells, suggesting some additional influence(s) compared to other monitoring wells.

⁶ While it is typically the case that deeper aquifers host older groundwater, deeper aquifers can host younger groundwater when the hydraulic conductivity and/or hydraulic gradient is higher.

3 GROUNDWATER QUALITY

3.1 Methods

3.1.1 Monitoring Network

The groundwater monitoring network consists of monitoring wells and domestic water supply wells, as listed in Table 3-1 and shown in Figure 1-1. Sampling in 2023 occurred on October 11 and 12, at the end of the irrigation season, which aligns with previous sampling programs. Table 3-1 also summarizes the depth to water and depth to bottom of each well in the monitoring program, and indicates whether a well log is available. All available well logs are provided in Appendix A.

Table 3-1 2023 Groundwater Monitoring Network and Well Details

Location ID	Well Type	Well Log Available?	Depth to Water	Well Depth	UTM Coordinates (11U) ^a	
					Easting	Northing
MW-2	Monitoring well	Yes (WTN 58804)	3.16 m btoc ^b	15.0 m ^b	335363	5568422
MW-5	Flowing artesian well	No	Flowing artesian	49.8 m btoc ^b	334066	5567984
MW11-02	Monitoring well	Yes	32.84 m btoc ^b	34.6 m btoc ^d	332740	5567306
DMW-1	Private domestic well (dug well)	Possibly WTN 8414 ^c	0.39 m btoc ^b	2.4 m ^d	335045	5568305
DMW-3	Monitoring well	Yes (WTN 58803)	3.80 m btoc ^b	6.7 m btoc ^b	334351	5566559
DMW-4	Private domestic well	No	0.6 m btoc ^e	4 m (estimated) ^f	332092	5563015
DMW-5	Private domestic well	No	Flowing artesian	Unknown	332398	5561078
WTN 39421	Water supply well	Yes (WTN 39421)	Flowing artesian	45 m ^d	334975	5568344
WTN 24991	Water supply well	Yes (WTN 24991)	Flowing artesian	113 m ^d	333994	5567989
DMW18-1	Private domestic well	Yes (WTN 1950)	6 m ^d	8.5 m ^d	334611	5568228

^a UTM coordinates were collected using a hand-held GPS, with an estimated accuracy of +/- 5 m. ^b Depth is based on field measurements (October 2023). ^c This is an assumed WTN based on well location and field-measured depth to bottom, but it has not been confirmed. ^d This depth is based on information in the registered well log. ^e Depth to water was measured in September 2018; the wellhead has been inaccessible since that time. ^f This depth is based on anecdotal information from the property owner. m – metre (taken from registered well log; therefore, it is unknown whether the measurement is below top of casing or below ground); m btoc – metres below top of casing; m bg – metres below ground

This monitoring network is the same one used in 2020, 2021, and 2022 (Associated 2021, 2022, 2023). Groundwater well DMW18-1 is tested biannually (it was tested quarterly before 2022) as part of the City’s Hesperia Landfill

monitoring program (Associated 2024), but data are included in this report for interpretation as it is a potential domestic receptor in the study area.

3.1.2 Sampling Methodology and Parameters Tested

Groundwater samples were collected following standard BC methods (MOE 2013). Before sampling, groundwater wells were purged to remove at least three times the well volume, until dry or until field parameters stabilized, using a submersible pump, peristaltic pump, or foot-valve inertial pumping system, depending on well depth. Field parameters (i.e., temperature, conductivity, pH, dissolved oxygen, oxidation-reduction potential, and turbidity) were measured using field meters during purging. Domestic wells were generally purged using existing pumps until field parameters stabilized. DMW-1, which is a dug well that cannot be purged, was sampled directly using a bailer. MW-2 and MW-5 were purged using a submersible pump, and MW11-02 was purged using Waterra tubing and a Hydrolift.

Groundwater samples were collected as grab samples in laboratory-supplied bottles, filtered and preserved in the field (where necessary), and shipped via chain-of-custody protocols to CARO Analytical Services (CARO), an accredited laboratory in Kelowna, BC, for analysis of the following parameters:⁷

- Alkalinity, bromide, chloride, fluoride, sodium, sulphate, total dissolved solids (TDS), hardness (total as CaCO₃), and dissolved organic carbon;
- Ammonia-N, nitrate-N, nitrite-N, total Kjeldahl nitrogen (TKN), organic nitrogen, and total nitrogen;
- Orthophosphate, dissolved phosphorus, and total phosphorus; and
- Dissolved metals.

A quality assurance and quality control (QA/QC) program was also followed, which included collecting field duplicate and blank samples. Detailed methods are provided in Section 3.1.5 and the results are in Section 3.2.3.

3.1.3 Comparison to Guidelines

Given the objective of the groundwater monitoring program (i.e., to establish whether irrigating with reclaimed water is impacting groundwater), the groundwater quality results were assessed relative to water quality guidelines. To protect nearby receptors (i.e., domestic wells used for drinking water and irrigation purposes, and groundwater discharging to surface waterbodies), the 2023 groundwater quality results were compared to the following water quality guidelines:

- Guidelines for Canadian Drinking Water Quality (Health Canada DW) (Health Canada 2022);
- British Columbia Source Drinking Water Quality Guidelines (BC DW) (ENV 2020);
- BC Approved and Working Water⁸ Quality Guidelines for aquatic life (BC AL) (acute guidelines only), irrigation water (BC IW), and livestock water (BC LW) (ENV 2021, ENV 2023a); and
- BC *Contaminated Sites Regulation* (CSR) Schedule 3.2, generic numerical water standards for drinking water (DW), irrigation (IW), livestock (LW), and freshwater aquatic life (AW) (BC Reg. 253/16).

⁷ DMW18-1, which is sampled quarterly as part of a different monitoring program (Associated 2024), was tested for the same parameters listed here, except for bromide, fluoride, organic nitrogen, dissolved phosphorus, and orthophosphate.

⁸ Some BC water quality guidelines are considered working guidelines, but for the purposes of discussion in this report, they are given equal weight as approved guidelines.

Drinking Water

For drinking water, comparison was made to CSR DW standards and Health Canada DW and BC DW guidelines, as the monitoring program includes domestic wells that are used for drinking water purposes. The Health Canada DW guidelines apply to final, treated water, whereas the BC DW guidelines apply to water sourced for drinking water purposes. Although there is an important difference, the guidelines are applied equally throughout this report given that the program includes testing of domestic wells. This report uses whichever guideline (Health Canada or BC) is more stringent and refers to it as the DW guideline.

The Health Canada DW and BC DW guideline levels are designated as either a maximum acceptable concentration (MAC) or an aesthetic objective (AO) (Health Canada 2022, ENV 2020). The MAC guidelines are health risk-based and are determined based on the known health effects associated with the substance. The AO guidelines apply to those variables that adversely affect taste or the intended, typical water uses (e.g., staining of laundry) but do not pose a health hazard.

After sampling, the results from the domestic supply wells were compared to the Health Canada DW and BC DW guidelines. Associated provided the well owners with a summary of the results and the original laboratory report, as a courtesy for participating in the study and to notify well owners of any drinking water guideline exceedances.

BC Water Quality Guidelines

Note that as per ENV (2023a), exceeding a BC Approved or Working Water Quality Guideline does not imply there are unacceptable risks, but rather that the potential for adverse effects may be increased and additional investigation may be required. **Comparing the groundwater results to the BC Approved and Working Water Quality Guidelines (BC AL, BC IW, and BC LW) is considered a conservative approach, particularly for the protection of aquatic life.**

Further guidance on applying the aquatic life guidelines specific to groundwater is provided in ENV 2017, which states that CSR AW standards should be used for groundwater samples collected >10 m from the high-water mark of a receiving environment, while water below the high-water mark should be compared to the BC AL. The area between the high-water mark and the 10 m distance is referred to as the dilution zone, where “concentration limits are not specified” and a risk-based approach should be followed (ENV 2017). The CSR AW standards are based on the assumption that groundwater will be diluted at least 10-fold before it is discharged to a receiving waterbody (ENV 2017). Most of the wells included in the program are more than 10 m from the nearest mapped watercourse, but numerous aquatic receiving environments (e.g., streams) exist throughout the project area, and investigations to confirm sample points relative to the high-water mark have not been completed.

3.1.4 Comparison to Background, Reclaimed Water Quality, and Historical Data

Water quality data and guideline exceedances were assessed and interpreted primarily by comparing results to reclaimed water quality and historical data, as well as the limited background water quality data.

Background Groundwater Quality

The complex hydrogeological setting of the area (Section 2) and extensive nature of the irrigation area makes it difficult to assess background water quality. Of the wells included in the standard monitoring program (Table 3-1), only monitoring well DMW-3 is upgradient of the reclaimed water irrigation area. However, as described in Section 2, DMW-3 likely does not represent background water quality for most wells because it is closely tied to surface water and is installed across fractured bedrock, which has a different chemical signature than the downgradient wells (which are generally installed in unconsolidated sand and gravel material). A review of the lithology in the area indicates that

any additional monitoring wells intended as representative upgradient samples would also likely need to be installed across fractured bedrock (similar to DMW-3) because the unconsolidated sediments are very thin on the upper valley walls and are typically not water bearing.

ENV (2023b) provides regional background concentrations for select metals for the Thompson-Okanagan Region; these concentrations were used to aid with the interpretation of exceeding values (Section 3.2.2).

Reclaimed Water Quality

In addition to the wells listed in Table 3-1, water quality data collected for the program also included Clay Valve #4, which is at the distribution point after the MacKay Reservoir (i.e., these samples reflect the quality of the reclaimed water before irrigation). This location is sampled monthly by City staff during the irrigation season, as required by the OC (MOE 2008).

In 2023, City staff collected samples at Clay Valve #4 monthly during the irrigation season (i.e., between May and September) and submitted the samples to CARO for analysis of the following parameters:

- Biochemical oxygen demand;
- pH, total suspended solids, chloride, sodium, sulphate, and fluoride;
- Nitrogen (ammonia-N, nitrate-N, nitrite-N, TKN, organic nitrogen, and total nitrogen);
- Phosphorus (orthophosphate, dissolved phosphorus, and total phosphorus);
- Total coliforms and fecal coliforms; and
- Dissolved metals.

The Clay Valve #4 analytical list includes the parameters required under Section 8.3.4 of the OC, plus fluoride (tested only in May 2023), chloride, sodium, sulphate, and dissolved metals. These were added to make the list more consistent with groundwater analysis, to aid with interpretation.

Each year, the City provides the water quality results from this location to Associated for inclusion in the water quality database.

Historical Water Quality Data

For most of the groundwater sampling locations, the dataset begins in 2011, when the groundwater monitoring program was initiated. The exceptions are DMW18-1 (first tested in 2018) and DMW-3 and MW-2 (part of a previous monitoring program conducted by ENV between 1979 and 1995). The prior program collected data for DMW-3 from 1989 to 1995 and for MW-2 from 1979 to 1995.

3.1.5 Quality Assurance and Quality Control

The QA/QC measures applied as part of the sampling program included calibrating instruments before sampling, wearing nitrile gloves, and using either dedicated well equipment or thoroughly decontaminating and rinsing equipment between wells. In addition, a blind duplicate sample was collected at DMW-4. Collection and analysis of duplicate samples provides information on the combined (field and analytical) precision of the sampling and the analytical program. The individual analytical results for each analyte in each sample of the duplicate pair were compared, and the relative percent difference (RPD) value was calculated for each analyte pair as follows:

$$RPD = \left(\frac{(|a - b|)}{\left(\frac{a + b}{2}\right)} \right) \times 100$$

where a and b are duplicate pair values in identical units.

An RPD value of 20% or less is generally considered acceptable, whereas an RPD value greater than 20% may indicate a problem with either sampling or analysis (MOE 2013). This limit may vary depending on the analysis involved and the concentration of the analyte. The RPD value also tends to increase as the result approaches the detection limit. Therefore, use of this threshold is restricted to duplicate pair values that are greater than five times their detection limit (MOE 2013).

In addition to collecting duplicate samples, trip and field blank samples were collected. Trip blanks are deionized water in sealed containers that are provided by the laboratory. These are taken into the field and remain in sample coolers during sampling; they are not opened. Field blank samples are deionized water provided by the laboratory, but these samples are handled the same way as monitoring well samples. Bottles are filled in the field using the same procedure for the samples being collected. Laboratory analytical results for both sample types are then compared to the analytical results expected for deionized water.

3.2 Results and Discussion

3.2.1 Guideline Exceedances

Table 3-2 identifies the parameters that exceeded the applicable drinking water, aquatic life, irrigation water, and/or livestock water guidelines and/or standards in the 2023 groundwater samples. All 2023 results, tabulated and compared to all applicable guidelines, are included in Appendix B. Plots showing temporal changes in concentrations for these parameters are included in Appendix C. The original laboratory reports for 2023 are provided in Appendix D.

Table 3-2 Exceedances of Applicable Guidelines and/or Standards in Groundwater in 2023

Parameter	DMW-1	DMW-3	DMW-4	DMW-5	MW-2	MW11-02	MW-5	WTN 24991	WTN 39421	DMW18-1
Conductivity (field-measured)	X	X	X	X		X			X	X
pH (field-measured)			X							
Chloride		X	X	X		X				
Fluoride				X						
Total dissolved solids	X	X	X	X	X	X			X	X
Sodium (dissolved)				X						
Sulphate						X				
Nitrate-N						X				
Chromium (dissolved)	X					X			X	X
Cobalt (dissolved)						X				
Lithium (dissolved)		X	X	X		X				X
Manganese (dissolved)				X			X	X		
Molybdenum (dissolved)			X	X	X	X				X
Selenium (dissolved)	X					X			X	X
Uranium (dissolved)	X			X		X				X

Although dissolved oxygen was below the BC aquatic life guideline in groundwater, it is not included as an exceedance in this table as dissolved oxygen in groundwater is not representative of dissolved oxygen in surface water.

X indicates an exceedance of the applicable guidelines and/or standards (listed in Section 3.1.3), differentiated as follows:

X - exceedance of the applicable drinking water guidelines/standards

X - exceedance of the applicable irrigation and/or livestock water guidelines/standards

■ - exceedance of the applicable aquatic life guidelines/standards

The DW MAC exceedances are considered to represent the highest concern because much of the study area is not serviced by public water supply, and domestic wells are used for consumption purposes. Exceedances of a DW MAC in 2023 included:

- Cobalt (MW11-02);
- Manganese (DMW-5);
- Nitrate-N (MW11-02);

- Lithium⁹ (DMW-3, DMW-4, DMW-5, MW11-02, and DMW18-1);
- Selenium (DMW-1, MW11-02, WTN 39421, and DMW18-1); and
- Uranium (DMW-5 and MW11-02).

3.2.2 Comparison to Background, Reclaimed Water Quality, and Historical Data

The following sections provide a brief interpretation and historical comparison of parameters that exceeded guidelines in groundwater in 2023 (Table 3-2) and key wastewater parameters. Plots showing temporal changes in concentrations for these parameters are included in Appendix C. Historical data can be found in Associated 2018. As described in Section 3.1.4, Clay Valve #4 is the distribution point after the MacKay Reservoir (i.e., the samples collected at Clay Valve #4 reflect the quality of the reclaimed water before irrigation). The results from Clay Valve #4 in 2023 are provided in Appendix B (Table B-3).

3.2.2.1 Routine Parameters

Conductivity and pH

There are no DW, AW, or LW guidelines for conductivity. The BC IW guideline for conductivity varies based on crop type. In 2023, conductivity exceeded the guideline for low-tolerance crops¹⁰ (700 µS/cm) in all wells except MW-2, MW-5, and WTN 24991, and exceeded the guideline for slightly tolerant crops¹¹ (1,200 µS/cm) in DMW-5 and MW11-02. Conductivity in the wells has remained relatively consistent since monitoring began (**Figure C-1**), and it is not measured in Clay Valve #4 (and is not required, according to the OC).

In 2023, field-measured pH met the guidelines in all wells except DMW-4, which was slightly below the DW AO guideline range (7.0–10.5). pH has remained relatively consistent since monitoring began (**Figure C-2**) and generally in the 7.0–8.0 range except in artesian well MW-5, which consistently has a higher pH (9.0 and 9.5). In 2023, laboratory-measured pH in Clay Valve #4 water ranged from 7.63 to 8.17.

Chloride

In 2023, chloride concentrations met all guidelines except the most stringent BC and CSR IW (100 mg/L) in DMW-3, DMW-4, DMW-5, and MW11-02. Historically, chloride has been highest at DMW-5, but concentrations have been decreasing since 2018 (**Figure C-3**). In the other wells, chloride has either decreased (notably in DMW-3, DMW-4, and MW-2) or remained relatively consistent, except in DMW-1, where it has steadily increased from <50 mg/L in 2011 to 93.7 mg/L in 2023. The cause of the increase and the reason it is isolated to DMW-1 are unknown.

Chloride in Clay Valve #4, which was tested in 2003 and 2015–2023, has remained relatively consistent, ranging from 75.9 to 175 mg/L,¹² with an average of 93.8 mg/L.

⁹ Neither Health Canada DW nor the BC DW guidelines specify a limit for lithium in drinking water. Because the CSR does not specify guidelines as either MAC or AO, lithium was assumed to fall in the MAC category. The CSR DW is based on the 2015 United States Environmental Protection Agency's regional screening levels for tap water.

¹⁰ Low-tolerance crops include strawberry, raspberry, bean, and carrot (ENV 2021).

¹¹ Slightly tolerant crops include all other fruits and berries, corn, sweet corn, onion, parsnip, radish, pea, pumpkin, lettuce, pepper, muskmelon, sweet potato, potato, celery, cabbage, kohlrabi, cauliflower, cowpea, broadbean, flax, sunflower, and clover (ENV 2021).

¹² The maximum chloride concentration of 175 mg/L in Clay Valve #4 occurred in July 2003 and is inconsistent with other results, which have remained below 105 mg/L.

Fluoride

In 2023, fluoride met the guidelines in all wells except DMW-5 (1.27 mg/L), which exceeded the CSR IW and CSR LW (1.0 mg/L) but met all other guidelines. Trends in fluoride have remained relatively stable since monitoring began (Figure C-4). Fluoride testing in Clay Valve #4 is not required as per the OC, but this parameter has been analyzed from 2020 onward. Concentrations have ranged from <0.1 to 0.3 mg/L, notably lower than those in DMW-5.

Sodium

In 2023, sodium met the DW AO and CSR DW (200 mg/L) in all wells except DMW-5, where it slightly exceeded (203 mg/L). The pattern of sodium in DMW-5 is similar to that of chloride (i.e., increasing from 2011–2016, and generally decreasing/stabilizing since that time) in the same well (Figure C-5). In other wells, sodium has remained relatively consistent or has decreased since monitoring began. Sodium in Clay Valve #4 in 2023 ranged from 87.5 mg/L to 98.6 mg/L (total) and from 93.2 to 105.0 mg/L (dissolved), and the concentrations are mid-range compared to the concentrations in the wells.

Sulphate

In 2023, sulphate concentrations met the guidelines in all wells except MW11-02, which exceeded the DW AO and CSR DW (500 mg/L). Historically, sulphate concentrations in MW11-02 have been approximately double (i.e., ~700 to 900 mg/L) those found in the other monitoring wells (<400 mg/L). Sulphate in MW11-02 has generally increased since monitoring began, but it has remained relatively stable in other wells (Figure C-6). Clay Valve #4 typically has lower sulphate concentrations (ranging from 80.8 mg/L to 110.0 mg/L in 2023) than all other wells, except for WTN 24991. This suggests that the concentrations in MW11-02 are unrelated to reclaimed water irrigation operations and may be caused by other sources (discussed further in Section 3.2.2.2).

Total Dissolved Solids

TDS was added to the monitoring program in 2019. In 2023, TDS in all wells except artesian wells MW-5 and WTN 24991 exceeded the DW AO and BC IW guidelines (500 mg/L). In DMW-5 and MW11-02, TDS also exceeded the BC LW guideline (1,000 mg/L). Concentrations have remained relatively consistent since 2019 (Figure C-7).

3.2.2.2 Nitrogen

The different forms of nitrogen that make up the total nitrogen in soils and water are organic nitrogen, nitrate, nitrite, ammonia, and ammonium. Some of the organic nitrogen in soils and shallow groundwater is converted by microbes to ammonia and ammonium through the process of ammonification. Ammonium is converted to nitrite and then nitrate through microbial nitrification. Because of these processes, nitrogen in groundwater is typically found primarily as nitrate. Of the nitrogen forms, ammonia is most toxic to aquatic life, whereas nitrate is of higher concern for human health (i.e., drinking water). In addition, nitrate is an anion (a negatively charged particle) and tends not to bind with clay and organic matter, both of which are also mostly negatively charged. Therefore, it is soluble in water and is transported readily in groundwater via advective flow.

Clay Valve #4

Because inorganic nitrogen is converted readily between forms, it is important to assess all forms of nitrogen in reclaimed water, including total nitrogen. The City is not specifically required to treat for nitrogen under the OC (i.e., no maximum limit is specified), nor are limits set for nitrogen in reclaimed water under the BC *Municipal Wastewater Regulation* (BC Reg. 87/2012). However, in 2005, the treatment system was upgraded to include biological nutrient removal (BNR), which reduces the nitrogen and phosphorus content of wastewater.

Table 3-3 lists the average concentrations of key nitrogen parameters in Clay Valve #4 before BNR (before 2006) and after BNR (i.e., 2006–2023), and the range of concentrations in 2023. The most stringent applicable guidelines are provided in Table 3-3 for context, but note that these guidelines apply to the receiving environment (i.e., groundwater and surface water), not to Clay Valve #4. In 2023, the concentrations of nitrate-N and total nitrogen were lower than the average concentrations after BNR was introduced.

Table 3-3 Average and 2023 Nitrogen Concentrations in Clay Valve #4

Nitrogen Form	Average Before BNR ¹	Average After BNR ²	Average in 2023	Range in 2023	Guideline for Comparison Purposes Only
Ammonia-N (mg/L)	9.8	0.55	0.746	0.455–1.25	Drinking water: none Aquatic life: ³ 0.681 to 21.6 mg/L (BC); 1.3 to 18.5 mg/L (CSR)
Nitrate-N (mg/L)	2.0	1.21	0.746	0.367–0.984	Drinking water: 10 mg/L Aquatic life: 32.8 mg/L (BC); 400 mg/L (CSR)
Nitrite-N (mg/L)	0.17	0.033	0.029	<0.010–0.072	Drinking water: 1 mg/L Aquatic life: ⁴ 0.06 to 0.60 mg/L (BC); 0.2 to 2.0 mg/L (CSR)
Total nitrogen (mg/L)	13.9	2.9	2.5	2.1–2.8	None

For further information on guidelines, refer to Section 3.1.3. ¹ The average is based on all available pre-2006 data, which include two samples from 1979 and samples from 1996 to 2005. ² The average is based on data from 2006 to 2023. ³ The guideline/standard varies based on the water pH and temperature; the range for all temperatures and for pH range of 7.1 to 9.0 is shown (historical pH range for Clay Valve #4). ⁴ The guideline/standard varies based on the chloride concentration; the range based on chloride concentrations is shown. BNR – biological nutrient removal; CSR – *Contaminated Sites Regulation*

Nitrogen (in Groundwater)

In 2023, ammonia-N and nitrite in groundwater met all applicable guidelines, and nitrate-N met guidelines in all wells except MW11-02 (discussed further below). The applicable guidelines/standards for nitrate-N range from 10 mg/L (DW MAC and CSR DW) to 400 mg/L (CSR AW).

MW11-02

The nitrate-N concentration in MW11-02 was 11.8 mg/L in October 2023, which exceeded the DW MAC and CSR DW standard. To confirm the exceeding concentration, MW11-02 was re-tested in November 2023, with a result of 10.5 mg/L. As reported previously (Associated 2021, 2022), nitrate-N in MW11-02 has consistently been elevated, but it had decreased from a high of 20.1 mg/L in 2012 to below the DW MAC over the past few years (**Figure C-8**). Given that the concentrations in this well are consistently higher than in all other wells and in Clay Valve #4, additional localized nitrate sources are suspected, potentially from the PRT commercial tree seedling nursery that is upgradient of MW11-02.

In 2021 (as reported in the 2021 annual report [Associated 2022]), Associated contacted PRT on behalf of the City. PRT indicated they were aware of the elevated nitrate concentrations and had been improving their irrigation and nutrient management through source control (i.e., testing the water before adding nitrogen fertilizer) and constructing a ditch (planted with willows) downslope of their operations to better capture runoff to extract nutrients before

infiltration below the rooting zone (O. Bonnefoy, personal communication, 2021, as reported in Associated 2022). The general decrease in nitrate-N at MW11-02 was viewed as a positive sign that reflected the on-site improvements implemented by PRT.

With the increase in nitrate-N in 2023, Associated contacted PRT again on behalf of the City to discuss their nutrient management process. PRT indicated that they follow a comprehensive nutrient management plan. Fertilizer is injected into the irrigation system (i.e., fertigation) and used to irrigate their commercial crops. Although the fertigation waters are directed onto the crop, some excess water reaches the ground and runs off. The runoff water is collected in a pond and irrigated onto the grass field located between the nursery and the paved trail that runs east-west (J. Sevilla, personal communication, 2024). In fall 2023, PRT staff noted that irrigation water was migrating off site, into the drainage ditch next to MW11-02, and that they intend to address this issue before the 2024 irrigation season begins (J. Sevilla, personal communication, 2024).

Based on these results, additional testing of nitrate at MW11-02 and a review of the water management practice at PRT is warranted. Recommendations are provided in Section 5.2.

Other Wells

Nitrate-N in all other wells remained below the applicable guidelines but is found at levels that are not likely naturally occurring in some wells. Key anthropogenic sources of nitrate include agricultural activities (e.g., cattle manure, fertilizers) and human wastewater (e.g., from municipal treatment systems and private septic systems) (Health Canada 2013). The local baseline concentration of nitrate is difficult to determine due to the long history of development and agriculture in the area; however, natural processes typically result in nitrate concentrations of less than 1 mg/L in groundwater in BC, and concentrations above 3 mg/L usually suggest anthropogenic effects (Gov BC 2021, Rivera 2014). In 2023, the lowest nitrate concentrations were in MW-2, MW-5, and WTN 24991 (<0.010 mg/L), followed by DMW-3 (0.452 mg/L). Nitrate was between 1 and 3 mg/L in DMW-4, DMW-5, and WTN 39421, and between 3 and 5 mg/L in DMW-1 and DMW18-1.

The trends in nitrate-N in groundwater since 2011 are not consistent (**Figure C-8**). DMW18-1 has experienced significant fluctuation and exceeding nitrate at times, although concentrations remained below guidelines in 2023. Nitrate has generally decreased in DMW-4 since 2011 and in DMW-5 since 2018. In DMW-1, nitrate has increased from 2.43 mg/L in 2011 to a high of 3.79 mg/L in 2023, but it remains below guidelines.

Nitrogen movement through groundwater can vary depending on crop cover, soil texture and organic matter content, and geology and infiltration rate. In some cases, nitrate that infiltrates below the rooting zone can remain in a groundwater system for a long time. Although the reclaimed water use may be contributing somewhat to the detected nitrate levels and the increases noted at DMW-1, the elevated concentration at MW11-02 and fluctuations at DMW18-1 are more likely the result of land use activities (i.e., horticulture, livestock, local residential septic fields, or lawn care products). However, nitrate remains a key parameter of concern and ongoing monitoring is needed.

3.2.2.3 Phosphorus

The *Municipal Wastewater Regulation* does not set standards for phosphorus for reclaimed water, and there are no applicable guidelines for phosphorus in groundwater. The BC DW AO (0.01 mg/L) and BC AL (0.015 mg/L) guidelines apply only to lakes (ENV 2020, 2023a), and the other guidelines do not specify limits for total or dissolved phosphorus. However, phosphorus is discussed in this section as it is a key wastewater parameter. As a comparison, at ground

dispersal sites (septic fields), inorganic phosphorus (orthophosphate) readily adsorbs onto the surface of soil particles, reducing the likelihood of its transport in groundwater.

Figure C-9 and **Figure C-10** show the concentrations of total and dissolved phosphorus in groundwater since 2011. Similar to previous years, the highest concentrations of phosphorus in 2023 were in DMW-4, at 0.374 mg/L (total) and 0.368 mg/L (dissolved), but concentrations have remained relatively consistent over the 2011–2023 monitoring period. With the exception of MW11-02, which has shown notable fluctuations in total phosphorus only, concentrations of total phosphorus and dissolved phosphorus have remained relatively steady in all wells.

Total phosphorus in the reclaimed water at Clay Valve #4 in 2023 ranged from 0.687 to 1.10 mg/L, and dissolved phosphorus ranged from <0.010 to 1.13 mg/L, similar to previous years.

3.2.2.4 Metals

Metals concentrations have exceeded the guidelines since groundwater testing began in 2011. Two possible mechanisms exist by which irrigation with treated effluent could influence metals concentrations in groundwater:

1. Metals may be added to groundwater if they are present at elevated levels in the irrigation water. To assess this condition, the City has been testing metals in Clay Valve #4 samples since 2016.
2. Metals that are naturally present in the soil can be mobilized as irrigation water infiltrates and may result in elevated concentrations in groundwater over time. Note, however, that the average pH of the irrigation water (at Clay Valve #4) is typically near neutral, and heavy metal mobilization generally tends to be more significant when the pH of the water is lower (more acidic) than the observed range (USGS 2016). Some metals, such as selenium, are mobilized more readily when the pH is higher (more alkaline) (WHO 2003).

In 2023, dissolved metals that exceeded the applicable guidelines included chromium, cobalt, lithium, manganese, molybdenum, selenium, and uranium. Exceedances of dissolved metals guidelines are common in BC, and many metals are naturally occurring. Obtaining representative upgradient samples to assess the range of background levels is difficult, as described in Section 2. Exceedances in groundwater are interpreted by comparing to the concentrations in Clay Valve #4. Regional background concentrations for the Thompson-Okanagan Region, provided in Protocol 9 for Contaminated Sites (ENV 2023b) and summarized in Table 3-4, were also used to assess potential background concentrations for the project area.¹³

¹³ Provincial mapping (iMap BC) shows the area in which these background concentrations apply. The boundary of the applicable area encompasses all wells included in the program except MW11-02, DMW-3, DMW-4, and DMW-5. The background concentrations generally suggest that these metals can be found in the Thompson-Okanagan Region at levels above the applicable guidelines/standards.

Table 3-4 Regional Background Concentrations of Exceeding Metals for the Thompson-Okanagan Region

Parameter	Regional Background Concentration (mg/L)
Chromium	0.019
Cobalt	0.016
Lithium	0.096
Manganese	7.6
Molybdenum	0.045
Selenium	0.120
Uranium	0.087

Source: ENV 2023b

Figures C-11 to C-17 show the changes in concentrations in these dissolved metals parameters. In all cases, the concentrations measured in 2023 were below the regional background concentrations listed in Table 3-4. Furthermore, concentrations of chromium, cobalt, molybdenum, selenium, and uranium were also substantially lower in Clay Valve #4 than in the wells that exceeded guidelines. Lithium and manganese are also generally lower in Clay Valve #4 than in the exceeding wells, but less so than the other parameters.

The wells in which the highest concentrations are typically found are not consistent across the monitoring program. For example, chromium is highest in DMW-1; cobalt and uranium in MW11-02; lithium, molybdenum, and manganese in DMW-5; and selenium in WTN 39421. In some cases, concentrations of these exceeding parameters have decreased since monitoring began (e.g., chromium in DMW-1, selenium in DMW-1 and DMW18-1, cobalt in MW11-02, and uranium and molybdenum in DMW-4). In other cases, they have generally been consistent. The exceptions that show an increase are molybdenum in DMW18-1, which increased up to the end of 2022 but decreased in 2023, and uranium in DMW-1 and MW11-02.

Based on the concentrations recorded at Clay Valve #4, the regional background concentrations, and the general trends observed in the data, all of the metals exceedances are attributable to sources other than the reclaimed water, including, at least in part, background concentrations.

3.2.3 Quality Assurance and Quality Control

A duplicate sample was collected at DMW-1 in October. After values less than five times their respective detection limit were removed (Section 3.1.5), the RPD ranged from 0 to 6.0% (average 1.8%). Results from the trip and field blank samples were consistent with those expected for deionized water (i.e., below detection limits).

Overall, the QA/QC results indicate acceptable precision of the analytical data. Further information about the laboratory's QA/QC is provided in the laboratory reports (Appendix D).

4 BAILEY SPRINGS WATER QUALITY

4.1 Methods

4.1.1 Sampling Location, Frequency, and Methodology

Section 8.9 of the OC requires monthly sampling of Bailey Springs. In 2023, samples from Bailey Springs were collected monthly by City staff and submitted to CARO for analysis of the following parameters:

- pH, conductivity, chloride, and sodium;
- Nitrogen (ammonia-N, nitrate-N, nitrite-N, TKN, organic nitrogen, and total nitrogen);
- Phosphorus (orthophosphate, dissolved phosphorus, and total phosphorus); and
- Total coliforms and fecal coliforms.

The analytical list includes the parameters required under Section 8.9 of the OC. Testing of dissolved metals was discontinued in 2020, based on the recommendations in Associated 2020. Metals are not required by the OC, and based on the results of the previous monitoring programs, there does not appear to be an effect on metals in Bailey Springs from the reclaimed water program (Associated 2020). Field-measured temperature was recorded at the time of sampling in March and May.

Each year, the City provides the water quality results from Bailey Springs to Associated for inclusion in the water quality database, and Associated compares the data to applicable guidelines and historical data.

4.1.2 Comparison to Guidelines and Historical Data

To assess the potential risk to aquatic life receptors, results from Bailey Springs were compared to the BC AL (ENV 2021, 2023a). CSR AW standards were not applied to surface water, as they are designed for groundwater that flows to surface water. For this reason, in many cases, the CSR AW standards apply a dilution factor and are therefore less stringent than the BC AL. The BC AL guideline represents the levels of constituents that are considered protective for aquatic life (e.g., in a stream).

For some parameters, the BC AL guideline includes two maximum levels: chronic (or long-term average) and acute (or short-term maximum). Compliance with chronic guidelines is typically assessed by calculating the average concentration over a specified period (e.g., five samples in 30 days). The chronic guidelines are more stringent than the acute guidelines because they are designed to protect aquatic life from ongoing exposure. For screening purposes, the individual concentrations measured in Bailey Springs were assessed against both the chronic and the acute AL guidelines.

The results from Bailey Springs were also compared to the BC Recreational Water Quality Guidelines (BC REC) (ENV 2019), as the outflow to Kalamalka Lake is next to a commercial campground, beach area, and boat launch (Figure 1-1).

4.2 Results and Discussion

4.2.1 Guideline Exceedances

In 2023, all tested parameters in Bailey Springs met the BC AL and/or BC REC guidelines except for chloride (Section 4.2.2). All results, tabulated and compared to the guidelines, are included in Appendix B. The sampling point for Bailey Springs is downstream of where the creek crosses Highway 97 and is in an agricultural area.

4.2.2 Comparison to Historical Data

Bailey Springs has been tested since 1976; therefore, there is a significant historical dataset. The following sections provide a brief interpretation and historical comparison of parameters that exceeded guidelines in Bailey Springs in 2023 and/or are considered key parameters of interest for reclaimed water. Plots showing temporal changes in concentrations for these parameters are included in Appendix C. Historical data are found in Associated 2018.

4.2.2.1 Chloride

In 2023, chloride concentrations at Bailey Springs met the acute BC AL guideline of 600 mg/L at all times, but they were above the chronic BC AL guideline of 150 mg/L in all months except January. There are no BC REC guidelines for chloride. Historically, chloride concentrations at Bailey Springs increased from 1980 (<50 mg/L) to 2013 (239 mg/L), then decreased to 2017, at which point they remained relatively consistent and below guidelines until 2022 (**Figure C-18**). However, 2023 concentrations were generally higher and exceeded the chronic BC AL, ranging from 133 mg/L (January) to 180 mg/L (June) (**Figure C-19**). The cause of the higher concentrations in 2023 is unknown, but they are not likely related directly to irrigation water at Clay Valve #4, which has averaged 93.8 mg/L since testing began and was relatively consistent in concentration through 2023.

4.2.2.2 Nitrogen

In 2023, nitrite-N was not detected in Bailey Springs.

Nitrate-N remained well below the chronic and acute BC AL guidelines of 3.0 and 32.8 mg/L, respectively, and the BC REC guideline of 10 mg/L throughout 2023. The lowest levels were found in July through October, when nitrate-N was below the laboratory detection limit. During the other months, it ranged from 0.090 mg/L (in May) to 0.573 mg/L (in February). Nitrate-N concentrations have been relatively consistent in Bailey Springs over time (**Figure C-20**).

Ammonia-N in Bailey Springs was below the laboratory detection limit in eight of the 12 months it was tested in 2023. It was detected only in January, April, June, and August, with a maximum of 0.294 mg/L (January). The BC AL for ammonia is calculated for each sample based on the water pH and temperature. Temperature was recorded only in March and May 2023; however, based on the range of pH in Bailey Springs in 2023 (8.3–8.5), the lowest possible BC AL guideline is 0.261 mg/L (which corresponds to a water temperature of 20°C) (ENV 2023a). Because the highest concentration (0.294 mg/L) occurred in January, when water temperatures are significantly lower, all results are inferred to have met the guideline throughout 2023. Similar to nitrate, concentrations of ammonia-N have remained relatively stable over the period of record, although concentrations have increased slightly since 2017 (**Figure C-21**).

4.2.2.3 Phosphorus

Phosphorus is not toxic to aquatic life in the concentrations found in municipal effluent; however, compared to other macronutrients required by aquatic plants, phosphorus is the least abundant and commonly the first nutrient that limits biological productivity (e.g., algal growth). It is a concern primarily for lakes, where increased phosphorus input can lead to increased algal growth, which can sometimes lead to decreased dissolved oxygen levels in water to levels that are harmful to aquatic life. There are no BC AL or REC guidelines for phosphorus in streams because there are other factors (e.g., flow velocity, light, temperature, and invertebrate grazing pressure) that affect algal growth.

Bailey Springs flows into Kalamalka Lake, so the concern is whether the spring contributes phosphorus-elevated water to the lake. The BC AL for total and dissolved phosphorus applies to lakes, and the guideline states that it is not possible to specify a single acceptable phosphorus concentration to protect aquatic life, but it suggests a range of

0.005 to 0.015 mg/L (ENV 2023a). Furthermore, ENV has proposed a water quality objective (WQO) for total phosphorus in Kalamalka Lake of 0.008 mg/L (MOE 2001). The BC REC guideline for total and dissolved phosphorus in lakes is 0.01 mg/L.

In 2023, total and dissolved phosphorus in Bailey Springs were higher than the Kalamalka Lake WQO, BC AL, and BC REC during all months of the year. These are not considered exceedances because the guidelines do not apply to streams. Total phosphorus in Bailey Springs in 2023 ranged from 0.0924 mg/L (in April) to 0.189 mg/L (in June and August), and dissolved phosphorus ranged from 0.0861 mg/L (in April) to 0.144 mg/L (in August). Total and dissolved phosphorus in Bailey Springs increased between 1976 and 2001; since that time, concentrations have been more stable (**Figure C-22 and C-23**).

Before 2006, when the treatment process was improved to include BNR, the average concentration of total (**Figure C-24**) and dissolved (**Figure C-25**) phosphorus in the irrigation water at Clay Valve #4 was 3.66 and 3.26 mg/L, respectively. Since 2006, total and dissolved phosphorus concentrations have averaged 1.32 and 1.17 mg/L, respectively. In 2023, total phosphorus in Clay Valve #4 ranged from 0.687 to 1.15 mg/L, and dissolved phosphorus ranged from <0.010 to 1.13 mg/L. These levels are slightly lower than in 2019, 2020, and 2021.

The increasing trend noted in total and dissolved phosphorus in Bailey Springs from 1976 to the early 2000s may be related to reclaimed water use, as concentrations in Clay Valve #4 water were historically higher. Concentrations appear to be more stable over the past 10 years, possibly relating to the improved treatment processes since 2006, but statistical trend analysis has not been completed. It is difficult to ascertain the source of the phosphorus in Bailey Springs in more recent years, as the creek is in the reclaimed water use area and is downstream of the MacKay Reservoir, but it is also in an agricultural area, where cattle are present and farmers may use phosphorus fertilizers.

Of note, Section 7.3.2 of the OC requires that no irrigation water be applied within 15 m of the edge of any flowing streams or bodies of water (MOE 2008). Following this requirement is important to reduce direct phosphorus inputs to streams such as Bailey Springs.

4.2.2.4 Coliform Bacteria

Fecal coliforms and total coliforms are tested by the City at Bailey Springs and Clay Valve #4, as per the requirements of the OC. There is no BC AL guideline for fecal coliforms or total coliforms, unless the water is used for growing and harvesting shellfish (ENV 2023). There is also no BC REC guideline for fecal or total coliforms. The BC REC guideline for *Escherichia coli* is a maximum of ≤ 400 colony-forming units (CFU) per 100 mL and a geometric mean (based on a minimum of five samples) of ≤ 200 CFU/100 mL. Testing of *E. coli* at Bailey Springs is not required under the OC.¹⁴

In 2023, fecal coliforms in Bailey Springs ranged from a most probable number (MPN) of 2 per 100 mL (in February) to 921 MPN/100 mL (in June and August) (**Figure C-26**). Total coliforms ranged from 77 MPN/100 mL (in March) to 26,000 MPN/100 mL (in August). If it was assumed that all the fecal coliforms present are *E. coli*, concentrations in June, July, August, and September (ranging from 488 to 921 MPN/100 mL) would have exceeded the BC REC guideline. Coliforms are commonly found in surface water, especially where agricultural activity and cattle are present, as at Bailey Springs.

¹⁴ Historically, guidelines were based on fecal coliforms, which were considered an indicator of disease risk from pathogenic bacteria; more recently, guidelines have shifted to specify *E. coli*.

Given that the water from Clay Valve #4 is disinfected before use and that coliform counts are generally low or below detection, elevated fecal coliforms in Bailey Springs are not attributable to the use of reclaimed water. The OC requires disinfection such that fecal coliforms are <2.2 CFU/100 mL for irrigation water in unrestricted public access areas and <200 CFU/100 mL for use in restricted public access areas (MOE 2008). In 2022, fecal coliforms were non-detectable (<1 MPN/100 mL) in all Clay Valve #4 irrigation water samples except in September (3 MPN/100 mL).

5 SUMMARY AND RECOMMENDATIONS

5.1 Summary

On behalf of the City, Associated completed the 2023 groundwater monitoring program for the City's reclaimed water irrigation operations to meet Section 8.6 of OC 12215. The monitoring program in 2023 followed the program completed in previous years. It consisted of groundwater sampling at the end of the 2023 irrigation season (early October) from a network of monitoring wells and domestic wells, comparing the results to applicable water quality guidelines and historical data, and preparing the annual monitoring report (this document).

Under Section 8.9 of the OC, the City is also required to collect monthly samples from Bailey Springs, a surface watercourse. Data from those samples, which were collected directly by the City, were provided to Associated for inclusion in the 2023 groundwater monitoring program report. The City also provided data from Clay Valve #4, which represent the quality of the water before irrigation, to Associated to aid with interpretation.

5.1.1 Conceptual Model of Groundwater Flow

The conceptual model of groundwater flow in the study area can be divided into two parts: flow south of the Commonage Ridge and flow north of the Commonage Ridge. Groundwater flow south of this hydraulic divide is toward the south and is predominantly constrained to shallow surficial sediments and fractured bedrock. Groundwater eventually discharges to Kalamalka Lake. Flow north of the Commonage Ridge is more complex. Groundwater recharge occurs around Bench Row Road, as evidenced by the large influx of water at DMW-3 during freshet. Groundwater then flows toward the north, where it enters a deeper flow regime. From here, groundwater recharges the unconfined and confined valley aquifers before finally discharging to Vernon Creek and/or Okanagan Lake. Groundwater flow on the hillside is complicated by lithological units that are not laterally extensive, and perched aquifers can exist on top of some units with lower permeability.

The water chemistry of the downgradient wells further suggests variable flow paths; all of the wells along Okanagan Avenue show variable concentrations of constituents and variable water types. Data are inconsistent and, in some cases, counterintuitive. For example, deeper wells indicate younger groundwater, which suggests a shorter residence time in the aquifer, so it is possible that a pathway of high transmissivity (high porosity) exists at deeper depths. If the younger water was associated with reclaimed water irrigation, higher concentrations of nitrate-N and chloride would be expected. However, these constituents are lowest in some of these wells. The variety of groundwater types evident suggests that aquifers and lithological units are not connected throughout the study area.

5.1.2 Groundwater Quality

The complex hydrogeological setting north of the Commonage Ridge makes it difficult to assess background water quality. All of the wells in the irrigated lands are in unconsolidated materials, but upgradient from the irrigation areas, the unconsolidated materials are too thin to host any appreciable aquifers. Therefore, upgradient monitoring wells have to be installed in the bedrock (such as DMW-3, the only current upgradient well), which can show different chemistry than wells installed in unconsolidated aquifers. However, even though background wells are difficult to install outside the irrigation area and in the unconsolidated aquifers, the results can be interpreted in several ways. Given the available water quality data, the monitoring program is likely sufficient to identify potential widespread impacts on groundwater.

Potential groundwater receptors include downgradient domestic wells and aquatic life in surface waterbodies to which groundwater may discharge. To address potential risks to these receptors, groundwater results were compared to drinking water, aquatic life, irrigation, and livestock guidelines. Of highest concern are the following parameters, which exceeded a human health-based (MAC) drinking water guideline in groundwater:

- Cobalt (MW11-02);
- Manganese (DMW-5);
- Nitrate-N (MW11-02);
- Lithium (DMW-3, DMW-4, DMW-5, MW11-02, and DMW18-1);
- Selenium (DMW-1, MW11-02, WTN 39421, and DMW18-1); and
- Uranium (DMW-5 and MW11-02).

Although it is difficult to assess background groundwater quality, it is unlikely that these exceedances are related to reclaimed water use. Cobalt, lithium, manganese, selenium, and uranium concentrations in all wells were below the regional background concentrations established for the Thompson-Okanagan Region, which suggests that these parameters are naturally occurring in the Vernon area. Furthermore, the concentrations are lower in Clay Valve #4 (reclaimed water) than in the groundwater samples.

Although historically elevated, with the highest concentration occurring in 2012, nitrate-N concentrations in MW11-02 had decreased to below the relevant guidelines; however, the concentrations exceeded guidelines in 2023. Given that the concentrations are consistently higher in MW11-02 than in all other wells and in Clay Valve #4, additional localized nitrate sources are suspected, potentially from the commercial tree nursery that is upgradient of this well. Associated communicated with the nursery in 2021 and 2023 and learned that the nursery is aware of the elevated nitrate concentrations and of a more recent drainage issue of nutrient-rich water identified in 2023. PRT has reported that it intends to address these issues before irrigating in 2024; nevertheless, Associated recommends that the City engage directly with the nursery and ensure they (and other reclaimed water users) meet the requirements specified in Appendix A of the OC, including the requirement to ensure there is no surface runoff from irrigated lands. Monitoring well MW11-02 should be monitored more frequently in 2024 to assess how nitrate concentrations change throughout the year in response to the nursery's efforts. Recommendations are provided in Section 5.2.

Nitrate-N in all other wells remained below guidelines in 2023, but some have concentrations that are generally higher than what is likely to occur naturally (i.e., more than approximately 3 mg/L), particularly in DMW-1 and DMW18-1. Some of this nitrate may have resulted from the City irrigation program; however, the spatial variability of these nitrate-N levels across the study area indicates that other localized sources are likely contributing, particularly where there are notable fluctuations. Nonetheless, the ongoing assessment of nitrate-N in groundwater remains an important component of this annual monitoring program.

Generally, concentrations of most parameters appear to be relatively consistent, but a few trends are apparent. However, these trends are not consistent across the monitoring program with respect to parameter or location. For example, some of the parameters that were previously noted to be increasing over time in DMW-5 appear to be stabilizing or decreasing (e.g., chloride, sodium, conductivity, lithium, and uranium). In DMW18-1, some metals (e.g., molybdenum) have increased and others (e.g., selenium and uranium) have decreased. In DMW-1, chromium and selenium have decreased, but uranium, chloride, and nitrate have increased. In MW11-02, several parameters are elevated relative to the other wells (e.g., sulphate, nitrate, cobalt, and uranium), but the trends are not consistent (e.g., sulphate and uranium have increased, whereas cobalt has decreased).

5.1.3 Bailey Springs

The results from Bailey Springs in 2023 met applicable guidelines, except chloride, which met the acute BC AL guideline at all times but exceeded the chronic BC AL guideline. Chloride previously exceeded chronic BC AL guidelines regularly from 2003 to 2016, but it mostly remained below guidelines until late 2022 and throughout 2023. The cause of the higher chloride in 2023 is unknown, as there are several potential sources to consider.

Similar to previous years, dissolved and total phosphorus in Bailey Springs (which discharges to Kalamalka Lake, approximately 450 m below the sampling point) consistently exceeded the WQO for Kalamalka Lake in 2023 during all months. Total and dissolved phosphorus in Bailey Springs increased between 1976 and 2001; since that time, concentrations have been more stable. The improved treatment processes in 2006, which resulted in reduced total and dissolved phosphorus, may have contributed to the phosphorus concentrations levelling off over the past 10 years. It is difficult to ascertain the source of the phosphorus in Bailey Springs, as it is in the reclaimed water use area and is downstream of the MacKay Reservoir, but it is also in an agricultural area, where cattle are present. Continuing to follow the OC requirement to ensure no irrigation water is applied within 15 m of the edge of any flowing streams or bodies of water is particularly important to reduce direct phosphorus inputs to streams such as Bailey Springs.

5.2 Recommendations for 2024

Associated recommends that the City continue the monitoring program in 2024 to remain compliant with Sections 8.6 and 8.9 of the OC. Specifically:

- Sample groundwater annually, at the end of the irrigation season, from the same monitoring well network and for the same parameters that were tested in 2023.
- In addition to the standard program, nitrate-N should be tested in MW11-02 before the irrigation season begins (April 2024) and during the irrigation season (e.g., in late June or early July 2024).
- Continue to test Clay Valve #4 for chloride, sodium, sulphate, fluoride, TDS, and dissolved metals monthly during the irrigation season, in addition to the parameters required by the OC. These data are necessary to compare concentrations in groundwater.
- Test Bailey Springs for the same parameters tested in 2023, including field temperature (needed to calculate the guideline for ammonia).
- Follow up with any reclaimed water users who are not meeting the requirements set out in Appendix A of the OC, such as the requirement to ensure there is no surface runoff from the irrigated lands.

CLOSURE

This report was prepared for the City of Vernon to document the results of the 2023 groundwater monitoring program for the City's reclaimed water use program.

The services provided by Associated Environmental Consultants Inc. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Environmental Consultants Inc.

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Reviewed by:



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PERMIT TO PRACTICE
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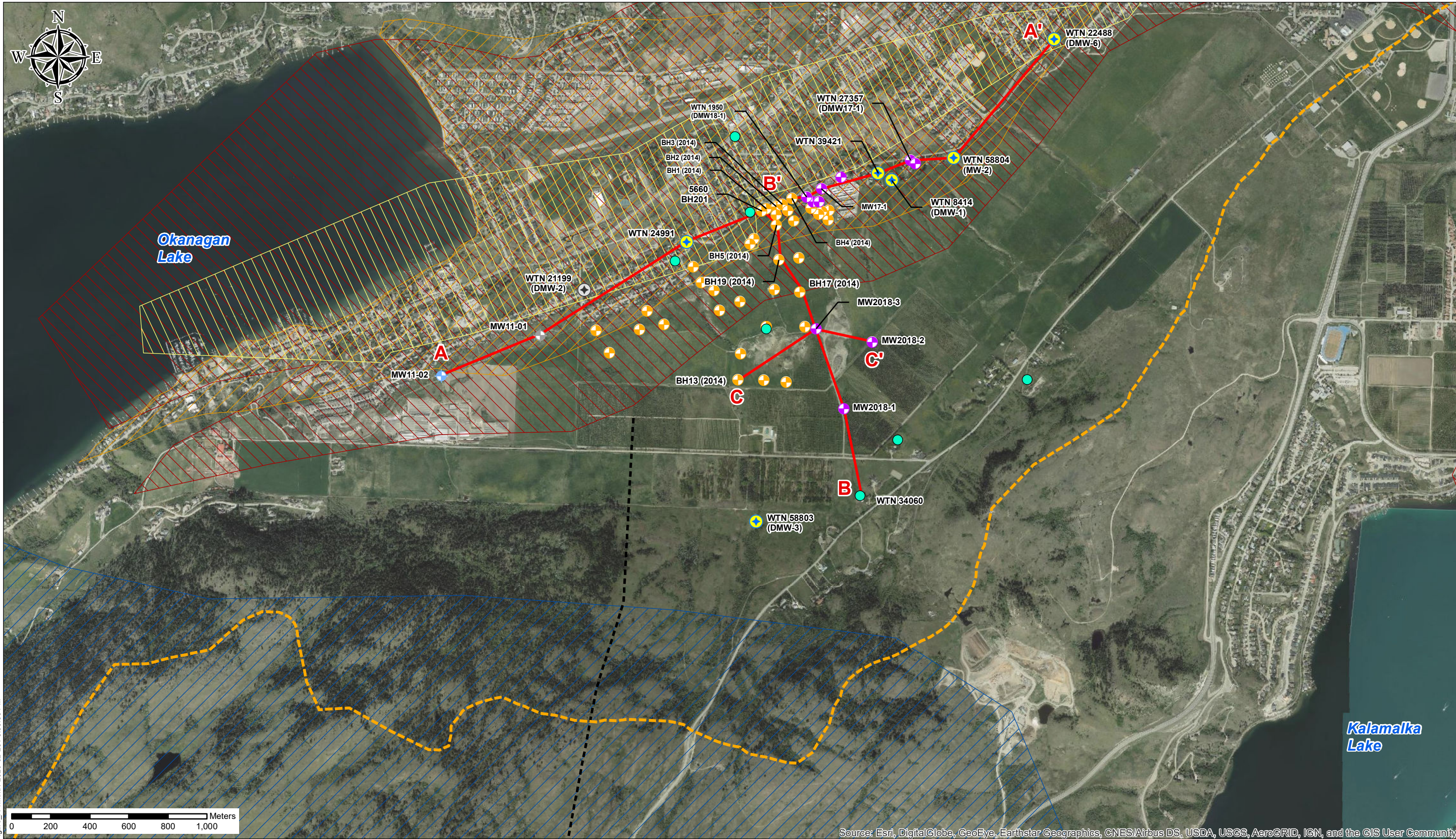
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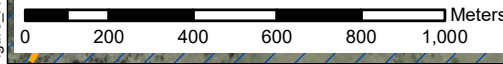
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APPENDIX A – CROSS-SECTIONS AND WELL LOGS



Figure_A-1.mxd / 2020-02-25 / 3:50:56 PM



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



- | | | | | |
|-----------------------------------|--------------------------|---------------------|-----------------|-----|
| Domestic Monitoring Well - Active | Monitoring Well - Closed | Cross-section lines | Aquifers | 346 |
| Domestic Monitoring Well - Closed | Fletcher Paine Borehole | Commonage Ridge | 347 | 471 |
| Monitoring Well - Active | Hesperia Monitoring Well | Fault (Approximate) | 1227 | |
| Other Well | | | | |

PROJECT NO.: 2019-8456
 DATE: February 2020
 DRAWN BY: BdJ

FIGURE A-1: CROSS-SECTIONS & LITHOLOGICAL INFORMATION USED FOR INTERPRETATION
 City of Vernon
 City of Vernon Groundwater Monitoring Program



PROJECT NO.: 2019-8456

DATE: February 2020

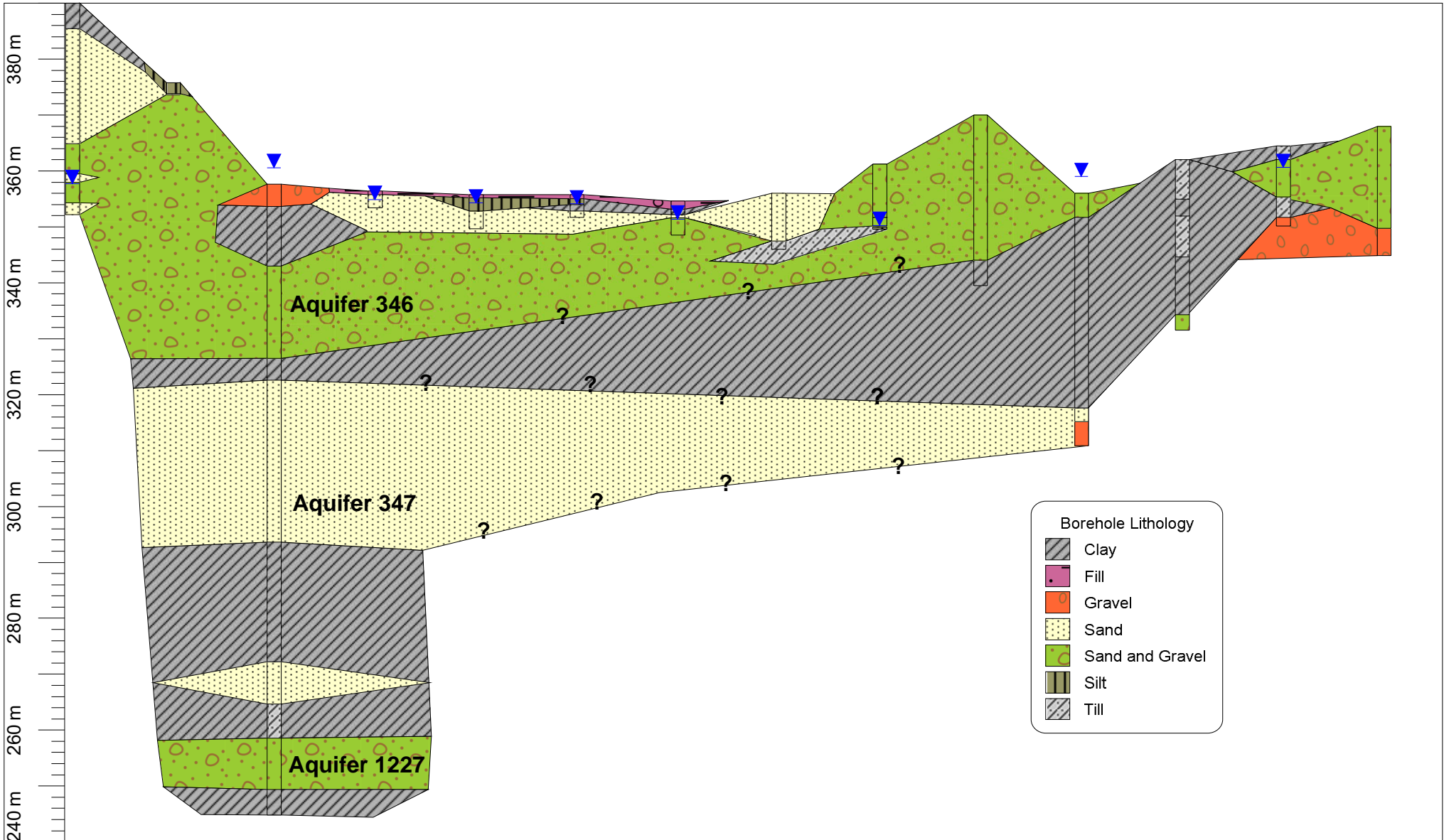
DRAWN BY: MW

FIGURE A-2: CROSS SECTION A-A'

City of Vernon

2019 Spray Irrigation Monitoring

MW11-02 -545.9 m- MW11-01 -890.1 m- WTN 24991 416.2 m 5660 BH201 -78.4 m- BH2 (2014) -32.3 m- BH3 (2014) -57.5 m- BH4 (2014) 76.3 m WTN 1950 (DMW18-1) 86.8 m MW17-1 116.1 m WTN 17878 (DMW17-7) 191.0 m WTN 39421 178.6 m WTN 27357 (DMW17-1) WTN 58804 (MW-2) WTN 22488 (DMW-6) 221.4 m 796.2 m





PROJECT NO.: 2019-8456.000

DATE: January 2019

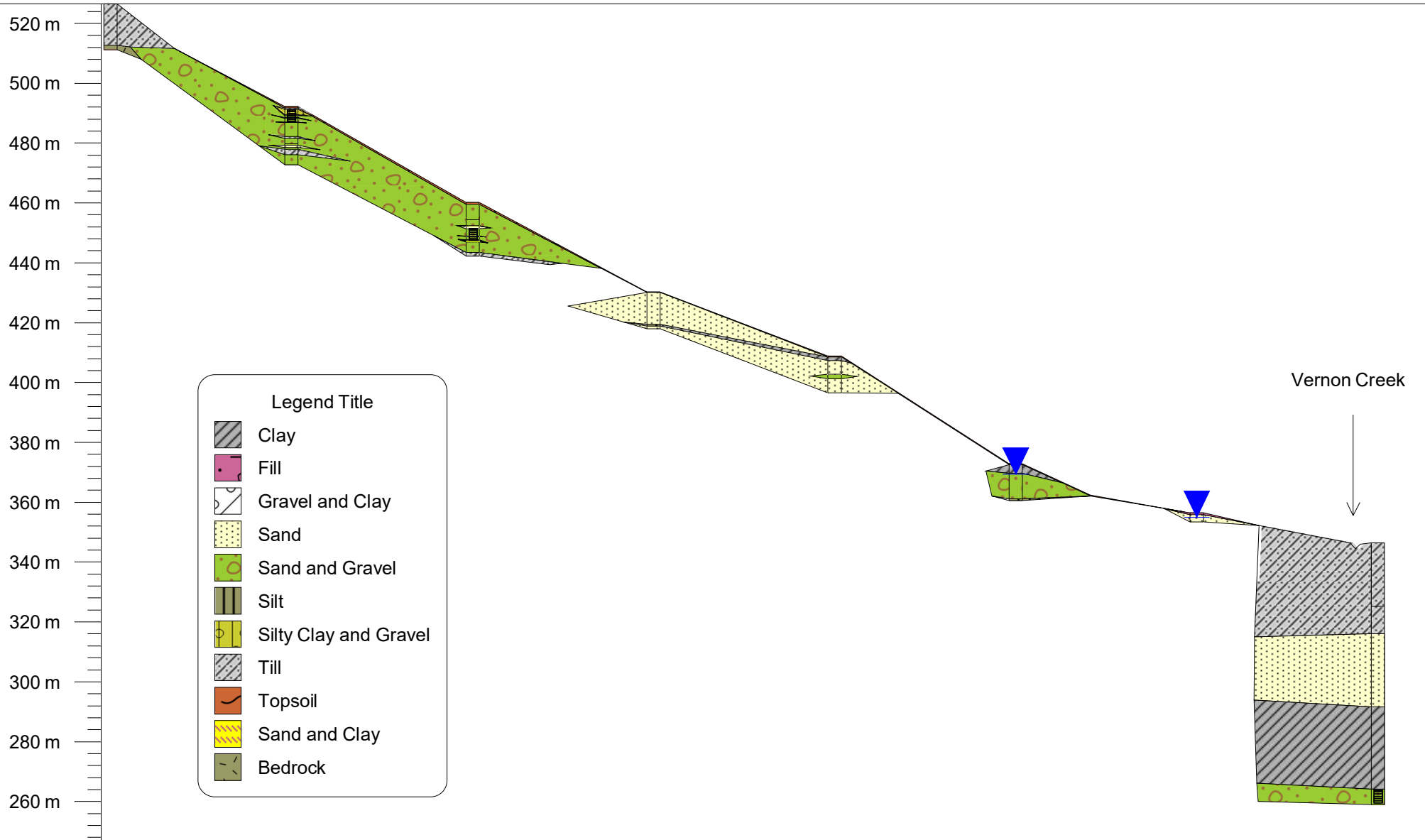
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FIGURE A-3: CROSS SECTION B-B'

City of Vernon

2019 Groundwater Monitoring Program - Reclaimed Water Use

WTN 34060 MW2018-1 MW2018-3 BH17 (2014) BH19 (2014) BH5 (2014) 5660 BH201 WTN 25262
● -454.1 m- ● -433.2 m- ● -206.0 m- ● -196.4 m- ● -178.4 m- ● -104.0 m- ● -404.5 m- ●





PROJECT NO.: 2019-8456.000

DATE: February 2019

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FIGURE A-4: CROSS SECTION C-C'

City of Vernon

2019 Groundwater Monitoring Program - Reclaimed Water Use

BH15 (2014)

197.0 m

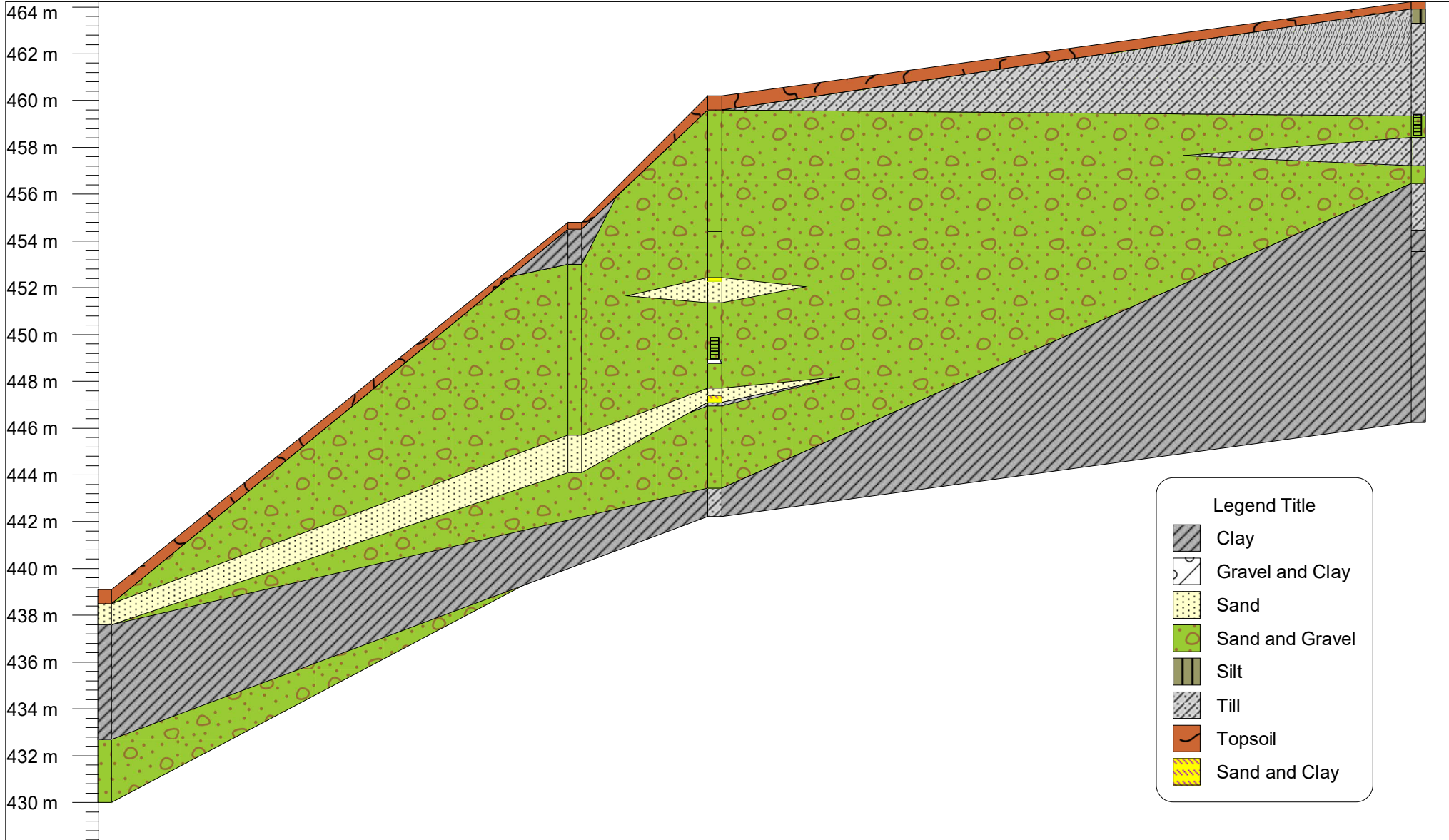
BH16 (2014)

58.7 m

MW2018-3

294.8 m

MW2018-2



Project No: 2010-8911.010

Client: City of Vernon

Location: Okanagan Landing, Vernon, BC

Logged by/ Checked by: CDH

Test Hole / Borehole I.D.: BH11-05

Well I.D.: MW11-02

Location on site: Below PRT site

Northing/ Easting: 0

Elevation: 0

SUBSURFACE PROFILE			SAMPLE		WELL		
Depth	Symbol	Description	Type	I.D.	flag for analysis	Well Details	Well Completion
-5 ft m		Ground Surface				Monument stick-up casing protector	
5		SILTY CLAY Dk. brown silty clay -some f-m gravel @ 7'					Bentonite Seal 0.3-1.5m
15		SAND Brown v.f.-m sand, tr.-some lt. brown silt					Cuttings (clayey) 1.5-9.1m
25		SAND Brown- lt. brown+ tan f-c sand, tr. moist, tr. v.f. gravel				-slightly more silty 30-32'	Bentonite Seal 9.1-9.8m
35		SAND Lt. brown v.f.-m sand, tr. silt, tr. v.c. sand, sl. moist					
45		SAND Lt. brown v.f.-m sand, tr. v.c. sand, tr. silt, dry. -some f. gravel, well rounded, dry.				- f. gravel 52-55'	Bentonite Seal 15.2-15.8m
55		SAND Tan-brown f-m sand, tr. c sand, tr. silt, sl. moist -dry, less silt					
65							



Contractor: Kel Drilling

Operator(s): Kelvin Marte

Drill Method: ODEX

Ground conditions: clay over sand

Date: Oct. 15, 2011

Time:

Temperature:

Sheet: 1 of 2

Project No: 2010-8911.010

Test Hole / Borehole I.D.: BH11-05

Client: City of Vernon

Well I.D.: MW11-02

Location: Okanagan Landing, Vernon, BC

Location on site: Below PRT site

Logged by/ Checked by: CDH

Northing/ Easting: 0

Elevation: 0

SUBSURFACE PROFILE			SAMPLE			WELL	
Depth	Symbol	Description	Type	I.D.	flag for analysis	Well Details	Well Completion
75		SAND Brown-lt. brown v.f-m sand, some silt, moist - some-tr. f-gravel, dry				- moist silt, not wet 68' - granule - v.f. gravel 71-73'	
85		SAND Lt. brown -brown v.f-m sand, tr.- some f. gravel				- f-c sand + f gravel 83-84'	
95		SAND + GRAVEL Lt. brown f-c sand + f. gravel, coated gravels				- moist, coated sands and gravels 98-100'	
105		SAND Lt. brown f-v.c. sand, some f. gravel					
115		SAND + GRAVEL Brown f-v.c. sand + f. gravel - some gravel moist -wet					
125		SILTY SAND Blue-brown silty f-c sand, loss of water in return					
135		End of Borehole				Drilled using ODEX 4" casing with NWJ rods, 10' lengths. Rental 175-400 compressor pushing under 400 cfm.	



Contractor: Kel Drilling

Date: Oct. 15, 2011

Operator(s): Kelvin Marte

Time:

Drill Method: ODEX

Temperature:

Ground conditions: clay over sand

Sheet: 2 of 2

DMW18-1



Report 1 - Detailed Well Record

Well Tag Number: 1950	Construction Date: 1940-01-01 00:00:00
Owner: L FUHR	Driller: Unknown
Address:	Well Identification Plate Number:
Area: VERNON	Plate Attached By:
WELL LOCATION:	Where Plate Attached:
OSOYOOS (ODYD) Land District	PRODUCTION DATA AT TIME OF DRILLING:
District Lot: Plan: Lot:	Well Yield: 0 (Driller's Estimate)
Township: Section: Range:	Development Method:
Indian Reserve: Meridian: Block:	Pump Test Info Flag: N
Quarter:	Artesian Flow:
Island:	Artesian Pressure (ft):
BCGS Number (NAD 83): 082L024144 Well: 45	Static Level: 20 feet
Class of Well:	WATER QUALITY:
Subclass of Well:	Character:
Orientation of Well:	Colour:
Status of Well: New	Odour:
Licence General Status: UNLICENSED	Well Disinfected: N
Well Use: Private Domestic	EMS ID:
Observation Well Number:	Water Chemistry Info Flag:
Observation Well Status:	Field Chemistry Info Flag:
Construction Method: Dug	Site Info (SEAM):
Diameter: 0.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
	Water Supply System Well Name:

Well Depth: 28 feet				
Elevation: 0 feet (ASL)	SURFACE SEAL:			
Final Casing Stick Up: inches	Flag: N			
Well Cap Type:	Material:			
Bedrock Depth: feet	Method:			
Lithology Info Flag: N	Depth (ft):			
File Info Flag: N	Thickness (in):			
Sieve Info Flag: N				
Screen Info Flag: N	WELL CLOSURE INFORMATION:			
	Reason For Closure:			
Site Info Details:	Method of Closure:			
Other Info Flag:	Closure Sealant Material:			
Other Info Details:	Closure Backfill Material:			
	Details of Closure:			
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS:				
LITHOLOGY INFORMATION:				
From	to	28	SANDY CLAY	
0	Ft.			
From	to	0	HARDPAN, WATER ON TOP OF	
28	Ft.		HARDPAN	

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DMW-1



Report 1 - Detailed Well Record

Well Tag Number: 8414	Construction Date: 1950-01-01 00:00:00
Owner: W E DOUGLAS	Driller: Unknown
Address:	Well Identification Plate Number:
Area:	Plate Attached By:
WELL LOCATION:	Where Plate Attached:
OSOYOOS (ODYD) Land District	PRODUCTION DATA AT TIME OF DRILLING:
District Lot: Plan: Lot:	Well Yield: 0 (Driller's Estimate)
Township: Section: Range:	Development Method:
Indian Reserve: Meridian: Block:	Pump Test Info Flag:
Quarter:	Artesian Flow:
Island:	Artesian Pressure (ft):
BCGS Number (NAD 83): 082L024144 Well: 5	Static Level: 3 feet
Class of Well:	WATER QUALITY:
Subclass of Well:	Character:
Orientation of Well:	Colour:
Status of Well: New	Odour:
Licence General Status: UNLICENSED	Well Disinfected: N
Well Use: Private Domestic	EMS ID:
Observation Well Number:	Water Chemistry Info Flag:
Observation Well Status:	Field Chemistry Info Flag:
Construction Method: Dug	Site Info (SEAM):
Diameter: 0.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
	Water Supply System Well Name:

Well Depth: 8 feet				
Elevation: 0 feet (ASL)	SURFACE SEAL:			
Final Casing Stick Up: inches	Flag:			
Well Cap Type:	Material:			
Bedrock Depth: feet	Method:			
Lithology Info Flag:	Depth (ft):			
File Info Flag:	Thickness (in):			
Sieve Info Flag:				
Screen Info Flag:	WELL CLOSURE INFORMATION:			
	Reason For Closure:			
Site Info Details:	Method of Closure:			
Other Info Flag:	Closure Sealant Material:			
Other Info Details:	Closure Backfill Material:			
	Details of Closure:			
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS:				
LITHOLOGY INFORMATION:				
From	0 to	0 Ft.	NO LOG- SOIL, CLAY & ROCK	

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DMW-3

Report 1 - Detailed Well Record

<p>Well Tag Number: 58803</p> <p>Owner: CITY OF VERNON</p> <p>Address: BENCH ROW RD</p> <p>Area: VERNON</p> <p>WELL LOCATION: OSOYOOS (ODYD) Land District District Lot: Plan: Lot: Township: 9 Section: 20 Range: Indian Reserve: Meridian: Block: Quarter: SW Island: BCGS Number (NAD 27): 082L024142 Well: 12</p> <p>Class of Well: Subclass of Well: Orientation of Well: Status of Well: New Well Use: Private Domestic Observation Well Number: Observation Well Status: Construction Method: Drilled Diameter: 6.0 inches Casing drive shoe: Well Depth: 19 feet Elevation: 0 feet (ASL) Final Casing Stick Up: inches Well Cap Type: Bedrock Depth: 6 feet Lithology Info Flag: File Info Flag: Sieve Info Flag: Screen Info Flag:</p> <p>Site Info Details: Other Info Flag: Other Info Details:</p>	<p>Construction Date: 1989-05-12 00:00:00.0</p> <p>Driller: Dan Gare Drilling Well Identification Plate Number: Plate Attached By: Where Plate Attached:</p> <p>PRODUCTION DATA AT TIME OF DRILLING: Well Yield: 0 (Driller's Estimate) Development Method: Pump Test Info Flag: Artesian Flow: Artesian Pressure (ft): Static Level: 10 feet</p> <p>WATER QUALITY: Character: Colour: Odour: Well Disinfected: N EMS ID: Water Chemistry Info Flag: Field Chemistry Info Flag: Site Info (SEAM):</p> <p>Water Utility: Water Supply System Name: Water Supply System Well Name:</p> <p>SURFACE SEAL: Flag: Material: Method: Depth (ft): Thickness (in):</p> <p>WELL CLOSURE INFORMATION: Reason For Closure: Method of Closure: Closure Sealant Material: Closure Backfill Material: Details of Closure:</p>			
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS: MONITOR WELL				
LITHOLOGY INFORMATION:				
From	0 to	6 Ft.	SANDY CLAY,RED	
From	6 to	10 Ft.	BROKEN BEDROCK	
From	10 to	19 Ft.	FRACTURED BEDROCK	

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DMW-6



Report 1 - Detailed Well Record

Well Tag Number: 22488	Construction Date: 1969-06-18 00:00:00
Owner: PAUL WARWICK	Driller: Pacific Water Wells
Address: OK AVENUE	Well Identification Plate Number:
Area: VERNON	Plate Attached By:
	Where Plate Attached:
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
OSOYOOS (ODYD) Land District	Well Yield: 30 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: Plan: B3911 Lot:	Development Method:
Township: 9 Section: 28 Range:	Pump Test Info Flag:
Indian Reserve: Meridian: Block:	Artesian Flow:
Quarter: NW	Artesian Pressure (ft):
Island:	Static Level: 32 feet
BCGS Number (NAD 83): 082L024322 Well: 38	WATER QUALITY:
Class of Well:	Character:
Subclass of Well:	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID:
Well Use: Unknown Well Use	Water Chemistry Info Flag:
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM):
Construction Method: Drilled	Water Utility:
Diameter: 6.0 inches	Water Supply System Name:
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 76 feet	
Elevation: 0 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag:	Depth (ft):
File Info Flag:	Thickness (in):
Sieve Info Flag:	
Screen Info Flag:	WELL CLOSURE INFORMATION:
Site Info Details:	Reason For Closure:
Other Info Flag:	Method of Closure:
Other Info Details:	Closure Sealant Material:
	Closure Backfill Material:

Details of Closure:				
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
GENERAL REMARKS:				
LITHOLOGY INFORMATION:				
From	0 to	60 Ft.	SANDY GRAVEL	
From	60 to	76 Ft.	GRAVEL WATER-BEARING	

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Report 1 - Detailed Well Record

Well Tag Number: 58804	Construction Date: 1989-05-12 00:00:00
Owner: CITY OF VERNON	Driller: Dan Gare Drilling
Address: OKANAGAN AVE.	Well Identification Plate Number:
Area: VERNON	Plate Attached By:
WELL LOCATION:	Where Plate Attached:
OSOY00S (ODYD) Land District	PRODUCTION DATA AT TIME OF DRILLING:
District Lot: 64 Plan: 2591 Lot: B	Well Yield: 0 (Driller's Estimate)
Township: 9 Section: Range:	Development Method:
Indian Reserve: Meridian: Block:	Pump Test Info Flag:
Quarter:	Artesian Flow:
Island:	Artesian Pressure (ft):
BCGS Number (NAD 83): 082L024144 Well: 48	Static Level: 39 feet
Class of Well:	WATER QUALITY:
Subclass of Well:	Character:
Orientation of Well:	Colour:
Status of Well: New	Odour:
Licence General Status: UNLICENSED	Well Disinfected: N
Well Use: Private Domestic	EMS ID:
Observation Well Number:	Water Chemistry Info Flag:
Observation Well Status:	Field Chemistry Info Flag:
Construction Method: Drilled	Site Info (SEAM):
Diameter: 6.0 inches	Water Utility:
Casing drive shoe:	Water Supply System Name:
Well Depth: 47 feet	Water Supply System Well Name:
Elevation: 0 feet (ASL)	SURFACE SEAL:

Final Casing Stick Up: inches	Flag:
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag:	Depth (ft):
File Info Flag:	Thickness (in):
Sieve Info Flag:	
Screen Info Flag:	WELL CLOSURE INFORMATION:
	Reason For Closure:
Site Info Details:	Method of Closure:
Other Info Flag:	Closure Sealant Material:
Other Info Details:	Closure Backfill Material:
	Details of Closure:
Screen from _____ to feet _____ Type _____	Slot Size
Casing from _____ to feet _____ Diameter _____	Material _____ Drive Shoe _____
GENERAL REMARKS:	
LITHOLOGY INFORMATION:	
From 0 to 8 Ft.	CLAY & ROCKS
From 8 to 30 Ft.	SAND & GRAVEL, RED
From 30 to 42 Ft.	CLAY & ROCKS
From 42 to 47 Ft.	COARSE GRAVEL

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Report 1 - Detailed Well Record

Well Tag Number: 39421	Construction Date: 1978-03-28 00:00:00
Owner: CROWN VILLA MHP - CAROL GOLDSTONE	Driller: Okanagan Rotary Well Drilling
Address: 6080 OKANAGAN AVE	Well Identification Plate Number: 10073
Area: VERNON	Plate Attached By: MIKE KAPINIAK
	Where Plate Attached: WELL CASING
WELL LOCATION:	PRODUCTION DATA AT TIME OF DRILLING:
OSOYOOS (ODYD) Land District	Well Yield: 80 (Driller's Estimate) Gallons per Minute (U.S./Imperial)
District Lot: 62 Plan: 4685 Lot: 1	Development Method:
Township: Section: Range:	Pump Test Info Flag: N
Indian Reserve: Meridian: Block:	Artesian Flow: 3 Gallons per Minute (U.S./Imperial)
Quarter:	Artesian Pressure (ft):
Island:	Static Level:
BCGS Number (NAD 83): 082L024144 Well: 9	WATER QUALITY:
Class of Well: Water supply	Character:
Subclass of Well: Domestic	Colour:
Orientation of Well:	Odour:
Status of Well: New	Well Disinfected: N
Licence General Status: UNLICENSED	EMS ID: E262160
Well Use: Water Supply System	Water Chemistry Info Flag: N
Observation Well Number:	Field Chemistry Info Flag:
Observation Well Status:	Site Info (SEAM): N
Construction Method: Drilled	Water Utility: N
Diameter: inches	Water Supply System Name: CROWN VILLA MHP WATER SYSTEM
Casing drive shoe:	Water Supply System Well Name:
Well Depth: 148 feet	
Elevation: 1171.3 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag: Y	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	Liner from To: feet
Screen Info Flag: N	
Site Info Details:	WELL CLOSURE INFORMATION:
Other Info Flag:	Reason For Closure:
	Method of Closure:

Other Info Details:		Closure Sealant Material:		
		Closure Backfill Material:		
		Details of Closure:		
Screen from	to feet	Type	Slot Size	
Casing from	to feet	Diameter	Material	Drive Shoe
0	16	null	null	null
GENERAL REMARKS:				
LITHOLOGY INFORMATION:				
From	0 to	14 Ft.	SAND & GRAVEL (DRY)	0 nothing entered
From	14 to	23 Ft.	BROWN CLAY	
From	23 to	60 Ft.	HARD GRAYISH BLUE CLAY	
From	60 to	100 Ft.	SOFT LIGHT GRAY CLAY	
From	100 to	126 Ft.	VERY HARD STIFF DARK GRAY CLAY	
From	126 to	134 Ft.	FINE SAND	
From	134 to	148 Ft.	CLEAN GRAVEL (WATER)	0 nothing entered

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Report 1 - Detailed Well Record

Well Tag Number: 24991	Construction Date: 1971-06-24 00:00:00
Owner: CLAIRMONT UTILITIES	Driller: Pacific Water Wells
Address:	Well Identification Plate Number: 10033
Area: OKANAGAN LANDING	Plate Attached By:
WELL LOCATION:	Where Plate Attached:
OSOYOOS (ODYD) Land District	PRODUCTION DATA AT TIME OF DRILLING:
District Lot: 62 & 63 Plan: Lot:	Well Yield: 30 (Driller's Estimate) U.S. Gallons per Minute
Township: Section: Range:	Development Method:
Indian Reserve: Meridian: Block:	Pump Test Info Flag: Y
Quarter:	Artesian Flow:
Island:	Artesian Pressure (ft):
BCGS Number (NAD 83): 082L024143 Well: 44	Static Level: 8 feet
Class of Well: Water supply	WATER QUALITY:
Subclass of Well: Domestic	Character:
Orientation of Well:	Colour:
Status of Well: New	Odour:
Licence General Status: UNLICENSED	Well Disinfected: N
Well Use: Water Supply System	EMS ID: E262182
Observation Well Number:	Water Chemistry Info Flag: Y
Observation Well Status:	Field Chemistry Info Flag:
Construction Method: Drilled	Site Info (SEAM): N
Diameter: 8 inches	Water Utility: Y
Casing drive shoe:	Water Supply System Name: CLAREMONT UTILITIES
Well Depth: 370 feet	Water Supply System Well Name: WELL NO. 2
Elevation: 1177.8 feet (ASL)	SURFACE SEAL:
Final Casing Stick Up: inches	Flag: N
Well Cap Type:	Material:
Bedrock Depth: feet	Method:
Lithology Info Flag: Y	Depth (ft):
File Info Flag: N	Thickness (in):
Sieve Info Flag: N	

Screen Info Flag: Y	WELL CLOSURE INFORMATION:			
Site Info Details:	Reason For Closure:			
Other Info Flag:	Method of Closure:			
Other Info Details:	Closure Sealant Material:			
	Closure Backfill Material:			
	Details of Closure:			
Screen from	to feet	Type	Slot Size	
334	null		20	
null	null		30	
null	null		50	
null	355		80	
Casing from	to feet	Diameter	Material	Drive Shoe
0	210	10	null	null
210	335	8	null	null
GENERAL REMARKS:				
DRAWDOWN AT 1.6 X 108 TO THE 4TH. SPECIFIC CAPACITY = 2.54 USGM				
LITHOLOGY INFORMATION:				
From	0 to	13 Ft.	COBBLES, GRAVEL	
From	13 to	48 Ft.	CLAY	
From	48 to	102 Ft.	TIGHT GRAVEL, WATER-BEARING	
From	102 to	115 Ft.	CLAY	
From	115 to	210 Ft.	SAND, FINE SILTY	
From	210 to	280 Ft.	CLAY	
From	280 to	305 Ft.	SILTY SAND	
From	305 to	325 Ft.	STONEY CLAY	
From	325 to	355 Ft.	SAND GRAVEL	
From	355 to	370 Ft.	CLAY, BACKFILLED TO 355'	

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APPENDIX B – TABULATED 2023 WATER QUALITY DATA

Table B-1: 2023 Groundwater Quality Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

Legend for Table B-1:

<	Less than reported detection limit
GCDWQ AO	Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives
GCDWQ MAC	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations
BC SDWQG AO	BC Source Drinking Water Quality Guidelines - Aesthetic Objectives
BC SDWQG MAC	BC Source Drinking Water Quality Guidelines - Maximum Acceptable Concentrations
BCAWQG AL (ST)	BC Approved Water Quality Guidelines for freshwater aquatic life (Short-term acute)
BCWWQG AL	BC Working Water Quality Guidelines for Freshwater Aquatic Life
BCAWQG I	BC Approved Water Quality Guidelines for Irrigation
BCWWQG I	BC Working Water Quality Guidelines for Irrigation
BCAWQG L	BC Approved Water Quality Guidelines for Livestock
BCWWQG L	BC Working Water Quality Guidelines for Livestock
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
CSR AW	BC CSR Generic Numerical Water Standards for Freshwater Aquatic Life
CSR DW	BC CSR Generic Numerical Water Standards for Drinking Water
CSR IW	BC CSR Generic Numerical Water Standards for Irrigation
CSR LW	BC CSR Generic Numerical Water Standards for Livestock
m asl	metres above sea level
N	Narrative type of guideline or standard, or Result Note.
NG	No Guideline
GCDWQ AO	Highlighted value exceeds GCDWQ AO
GCDWQ MAC	Highlighted value exceeds GCDWQ MAC
BC SDWQG AO	Highlighted value exceeds BC SDWQG AO
BC SDWQG MAC	Highlighted value exceeds BC SDWQG MAC
CSR DW	Highlighted value exceeds CSR DW
<u>BCAWQG I</u>	Highlighted value exceeds BCAWQG I
<u>BCWWQG I</u>	Highlighted value exceeds BCWWQG I
<u>CSR IW</u>	Highlighted value exceeds CSR IW
BCAWQG L	Highlighted value exceeds BCAWQG L
BCWWQG L	Highlighted value exceeds BCWWQG L
CSR LW	Highlighted value exceeds CSR LW
BCAWQG AL (ST)	Highlighted value exceeds BCAWQG AL (ST)
BCWWQG AL	Highlighted value exceeds BCWWQG AL
CSR AW	Highlighted value exceeds CSR AW

Table B-1: 2023 Groundwater Quality Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

Analyte	Unit	Guideline														DMW-1	DMW-1	DMW18-1	DMW18-1	DMW18-1	DMW-3	DMW-4
		GCDWQ	GCDWQ	BC SDWQG	BC SDWQG	CSR DW	BCAWQG I	BCWWQG I	CSR IW	BCAWQG L	BCWWQG L	CSR LW	BCAWQG	BCWWQG	CSR AW	11-Oct-23	11-Oct-23	08-May-23	28-Sep-23	28-Sep-23	11-Oct-23	11-Oct-23
		MAC	AO	MAC	AO								AL (ST)	AL	AW	23J1402-04	23J1402-10	23E1367-03	23I3778-03	23I3778-04	23J1402-05	23J1402-06
Sample Type	Normal	Duplicate	Normal	Normal	Duplicate	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Field Results																						
Conductivity	µS/cm	NG	NG	NG	NG	NG	NG	700 ^{7.1}	NG	NG	NG	NG	NG	NG	NG	879	879	707	783	783	1026	987
Depth to Water	m	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.39	0.39	-	-	-	3.8	-
Oxidation reduction potential	mV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	144.3	144.3	60.8	143.3	143.3	150.4	116.8
Dissolved oxygen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	min 5 ^{12.1}	NG	NG	4.11	4.11	2.46	3.13	3.13	2.88	4.87
pH		NG	7.0 - 10.5 ^{2.1}	NG	NG	NG	5.0 - 9.5 ^{6.1}	NG	NG	5.0 - 9.5 ^{9.1}	NG	NG	NG	NG	NG	7.54	7.54	7.44	7.25	7.25	7.01	6.96
Temperature	°C	NG	15	NG	15	NG	N ^{6.2}	NG	NG	N ^{9.2}	NG	NG	19 ^{12.2}	NG	NG	11.9	11.9	12.2	12.5	12.5	11.4	14.5
Turbidity	NTU	N ^{1.1}	NG	N ^{3.1}	NG	NG	N ^{6.3}	NG	NG	N ^{9.3}	NG	NG	N ^{12.3}	NG	NG	0.38	0.38	0.06	0.1	0.1	4.68	0.36
Lab Results																						
General																						
Alkalinity (bicarbonate, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	252	252	188	304	302	464	350
Alkalinity (carbonate, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (hydroxide, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (phenolphthalein, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	N ^{13.1}	NG	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Alkalinity (total, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	N ^{13.2}	NG	252	252	188	304	302	464	350
Bromide	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.10	<0.10	-	-	-	<0.10	<0.10
Dissolved organic carbon	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	2.84	1.95	1.63	2.06	2.19	6.41	9.02
Chloride	mg/L	NG	250	NG	250	250 ^{5.1}	100	NG	100 ^{8.1}	600 ^{9.4}	NG	600	600 ^{12.4}	NG	1500	93.7	91.2	23.7	23.5	23.6	124	139
Fluoride	mg/L	1.5	NG	1.5	NG	1.500	2.0 ^{6.4}	NG	1.000	1.5 ^{9.5}	NG	1.000 ^{11.1}	Calc ^{12.5}	NG	Calc ^{14.1}	0.19	0.14	-	-	-	0.43	0.39
Hardness (as CaCO3), dissolved	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	550	555	521	496	493	676	383
Total suspended solids	mg/L	NG	NG	NG	NG	NG	N ^{6.5}	NG	NG	N ^{9.6}	NG	NG	N ^{12.6}	NG	NG	-	-	<2.0	-	-	-	-
Sulphate	mg/L	NG	500 ^{2.2}	NG	500	500 ^{5.2}	NG	NG	NG	1000	1000 ^{10.1}	1000	NG	NG	Calc ^{14.2}	274	258	351	348	345	169	129
Nutrients																						
Ammonia (total, as N)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	Calc ^{12.7}	NG	Calc ^{14.3}	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.052
Nitrate (as N)	mg/L	10	NG	10	NG	10 ^{5.3}	NG	NG	NG	100 ^{9.7}	NG	100 ^{11.2}	32.8 ^{12.8}	NG	400 ^{14.4}	3.63	3.79	3.54	5.03	5.00	0.452	1.41
Nitrate + Nitrite (as N)	mg/L	10 ^{1.2}	NG	NG	NG	10 ^{5.4}	NG	NG	NG	100 ^{9.8}	NG	100 ^{11.3}	NG	NG	400 ^{14.5}	3.63	3.79	-	5.03	5.00	0.452	1.41
Nitrite (as N)	mg/L	1	NG	1.0	NG	1	NG	NG	NG	10 ^{9.9}	NG	10.000	Calc ^{12.9}	NG	Calc ^{14.6}	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	3.83	3.95	-	5.26	5.29	0.825	2.20
Total kjeldahl nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.197	0.161	-	0.227	0.286	0.373	0.791
Total organic nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.197	0.161	-	-	-	0.373	0.739
Orthophosphate (dissolved, as P)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.0050	<0.0050	-	-	-	<0.0050	0.156
Phosphorus (total, APHA 4500-P)	mg/L	NG	NG	NG	N ^{4.1}	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.0167	0.0164	0.0097	0.0111	0.0110	0.0090	0.374
Phosphorus (dissolved, APHA 4500-P)	mg/L	NG	NG	NG	N ^{4.2}	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.0166	0.0160	-	-	-	0.0070	0.368
Potassium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	6.50	6.52	6.36	6.23	6.10	7.71	17.4
Dissolved Metals																						
Aluminum (dissolved)	mg/L	2.9 ^{1.3}	0.100 ^{2.3}	9.5	NG	9.500 ^{5.5}	5 ^{6.6}	NG	5.000	5 ^{9.10}	NG	5.000	NG	NG	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Antimony (dissolved)	mg/L	0.006	NG	0.006	NG	0.006	NG	NG	NG	NG	NG	NG	0.250 ^{12.10}	NG	0.090	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Arsenic (dissolved)	mg/L	0.010 ^{1.4}	NG	0.01	NG	0.010	0.100 ^{6.7}	NG	0.100	0.025 ^{9.11}	NG	0.025	NG	NG	0.050	0.00078	0.00077	0.00255	0.00230	0.00236	0.00070	0.00266
Barium (dissolved)	mg/L	2.0 ^{1.5}	NG	NG	NG	1.000	NG	NG	NG	NG	NG	NG	NG	1	10.000	0.0395	0.0397	0.0269	0.0297	0.0297	0.0293	0.0327
Beryllium (dissolved)	mg/L	NG	NG	NG	NG	0.008	NG	0.100	0.100	NG	0.100	0.100	NG	0.00013	0.0015	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Boron (dissolved)	mg/L	5	NG	5.0	NG	5.000	0.5 ^{6.8}	NG	0.500 ^{8.2}	5 ^{9.12}	NG	5.000	NG	NG	12.000	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	0.205
Cadmium (dissolved)	mg/L	0.007 ^{1.6}	NG	0.005	NG	0.005	NG	0.0051 ^{7.2}	0.005	NG	0.080 ^{10.2}	0.080	Calc ^{12.11}	NG	Calc ^{14.7}	0.000020	0.000014	0.000022	0.000020	0.000023	0.000045	0.000375

Table B-1: 2023 Groundwater Quality Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

Analyte	Unit	Guideline														Sampling Location							
		GCDWQ MAC	GCDWQ AO	BC SDWQG MAC	BC SDWQG AO	CSR DW	BCAWQG I	BCWWQG I	CSR IW	BCAWQG L	BCWWQG L	CSR LW	BCAWQG AL (ST)	BCWWQG AL	CSR AW	DMW-1 11-Oct-23 23J1402-04 Normal	DMW-1 11-Oct-23 23J1402-10 Duplicate	DMW18-1 08-May-23 23E1367-03 Normal	DMW18-1 28-Sep-23 23I3778-03 Normal	DMW18-1 28-Sep-23 23I3778-04 Duplicate	DMW-3 11-Oct-23 23J1402-05 Normal	DMW-4 11-Oct-23 23J1402-06 Normal	
Calcium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	1000	1000	NG	N ^{13.3}	NG	113	116	83.3	82.8	84.6	193	111	
Chromium (dissolved)	mg/L	0.05	NG	0.05	NG	0.050 ^{5.6}	NG	0.0049 ^{7.3}	0.005 ^{8.3}	NG	0.050 ^{10.3}	0.050 ^{11.4}	NG	0.001 ^{13.4}	0.010 ^{14.8}	<u>0.00548</u>	<u>0.00527</u>	0.00169	0.00267	0.00264	<0.00050	<0.00050	
Cobalt (dissolved)	mg/L	NG	NG	0.001	NG	0.020 ^{5.7}	NG	0.050 ^{7.4}	0.050	NG	1	1.000	0.110 ^{12.12}	NG	0.040	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00031
Copper (dissolved)	mg/L	2 ^{1.7}	1 ^{2.4}	2.0 ^{3.2}	1.0	1.500 ^{5.8}	0.200 ^{6.9}	NG	0.200	0.300 ^{9.13}	NG	0.300	Calc ^{12.13}	NG	Calc ^{14.9}	<0.00040	<0.00040	0.00227	0.00251	0.00243	0.00231	0.0107	
Iron (dissolved)	mg/L	NG	0.3	NG	0.3	6.500 ^{5.9}	NG	NG	5.000 ^{8.4}	NG	NG	NG	0.35 ^{12.14}	NG	NG	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.026	
Lead (dissolved)	mg/L	0.005 ^{1.8}	NG	0.005	NG	0.010	0.200 ^{6.10}	NG	0.200	0.100 ^{9.14}	NG	0.100	Calc ^{12.15}	NG	Calc ^{14.10}	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Lithium (dissolved)	mg/L	NG	NG	NG	NG	0.008	NG	0.75 ^{7.5}	2.500 ^{8.5}	NG	NG	5.000	NG	NG	NG	0.00788	0.00794	0.0102	0.0107	0.0110	0.0183	0.0160	
Magnesium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	64.9	64.6	76.0	70.1	68.3	47.1	25.6	
Manganese (dissolved)	mg/L	0.12 ^{1.9}	0.02 ^{2.5}	0.12	0.02	1.500 ^{5.10}	NG	0.200	0.200 ^{8.6}	NG	NG	NG	Calc ^{12.16}	NG	NG	<0.00020	<0.00020	0.00132	0.00033	0.00033	0.00675	0.00039	
Mercury (dissolved)	mg/L	0.001	NG	0.001	NG	0.001	0.0020 ^{6.11}	NG	0.001	0.0030 ^{9.15}	NG	0.002	NG	NG	0.00025	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Molybdenum (dissolved)	mg/L	NG	NG	0.088	NG	0.250	0.01 ^{6.12}	NG	0.010 ^{8.7}	0.016 ^{9.16}	NG	0.050	46 ^{12.17}	NG	10.000	0.00664	0.00672	<u>0.0151</u>	<u>0.0110</u>	<u>0.0107</u>	0.00622	<u>0.0119</u>	
Nickel (dissolved)	mg/L	NG	NG	0.08	NG	0.080	NG	0.200	0.200	NG	1	1.000	NG	Calc ^{13.5}	Calc ^{14.11}	0.00105	0.00109	0.00043	<0.00040	0.00041	0.00130	0.00165	
Selenium (dissolved)	mg/L	0.05	NG	0.01	NG	0.010	0.010 ^{6.13}	NG	0.020 ^{8.8}	0.0300 ^{9.17}	NG	0.030	NG	NG	0.020	<u>0.0290</u>	<u>0.0294</u>	<u>0.0114</u>	0.00715	0.00729	0.00482	<0.00050	
Silicon (dissolved, as Si)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	10.8	10.7	10.7	9.6	9.9	13.2	9.6	
Silver (dissolved)	mg/L	NG	NG	NG	NG	0.020	NG	NG	NG	NG	NG	NG	Calc ^{12.18}	NG	Calc ^{14.12}	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Sodium (dissolved)	mg/L	NG	200	NG	NG	200 ^{5.11}	NG	NG	NG	NG	NG	NG	NG	NG	NG	49.5	48.8	75.4	72.7	71.8	67.5	128	
Strontium (dissolved)	mg/L	7.0 ^{1.10}	NG	7.0	NG	2.500	NG	NG	NG	NG	NG	NG	NG	NG	NG	1.20	1.21	0.912	0.992	0.983	1.31	0.918	
Sulphur (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	94.9	95.8	140	101	103	60.9	47.0	
Tellurium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Thallium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.0008 ^{13.6}	0.003	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	
Thorium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Tin (dissolved)	mg/L	NG	NG	NG	NG	2.500	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.00093	0.00064	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Titanium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	1.000	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
Tungsten (dissolved)	mg/L	NG	NG	NG	NG	0.003	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Uranium (dissolved)	mg/L	0.02	NG	0.02	NG	0.020	NG	0.010	0.010	NG	0.200	0.200	NG	0.0085	0.085	<u>0.0193</u>	<u>0.0199</u>	<u>0.0123</u>	<u>0.0179</u>	<u>0.0176</u>	0.00407	0.00513	
Vanadium (dissolved)	mg/L	NG	NG	NG	NG	0.020	NG	0.100	0.100	NG	0.100	0.100	NG	NG	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
Zinc (dissolved)	mg/L	NG	5.0	3.0	5.0	3.000 ^{5.12}	1.000 ^{6.14}	NG	1.000 ^{8.9}	2.000 ^{9.18}	NG	2.000	Calc ^{12.19}	NG	Calc ^{14.13}	<0.0040	<0.0040	0.0199	0.0113	0.0109	0.0248	0.0490	
Zirconium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00014	



Table B-1: 2023 Groundwater Quality Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

																Sampling Location	DMW-5	MW-2	MW11-02	MW11-02	MW-5	WTN 24991	WTN 39421
																Date Sampled	11-Oct-23	11-Oct-23	11-Oct-23	21-Nov-23	11-Oct-23	12-Oct-23	12-Oct-23
																Lab Sample ID	23J1402-07	23J1402-01	23J1402-03	23K2796-01	23J1402-02	23J1402-09	23J1402-08
																Sample Type	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Analyte	Unit	Guideline																					
		GCDWQ MAC	GCDWQ AO	BC SDWQG MAC	BC SDWQG AO	CSR DW	BCAWQG I	BCWWQG I	CSR IW	BCAWQG L	BCWWQG L	CSR LW	BCAWQG AL (ST)	BCWWQG AL	CSR AW								
Field Results																							
Conductivity	µS/cm	NG	NG	NG	NG	NG	NG	700 ^{7.1}	NG	NG	NG	NG	NG	NG	NG	<u>1343</u>	623	<u>1530</u>	<u>1345</u>	412	368	<u>756</u>	
Depth to Water	m	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	-	3.16	32.84	32.79	0	-	-	
Oxidation reduction potential	mV	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	41.7	-	83.5	83.4	150.7	-5.2	103	
Dissolved oxygen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	min 5 ^{12.1}	NG	NG	1.01	1.17	7.41	5.95	0.91	2.33	3.42	
pH		NG	7.0 - 10.5 ^{2.1}	NG	NG	NG	5.0 - 9.5 ^{6.1}	NG	NG	5.0 - 9.5 ^{9.1}	NG	NG	NG	NG	NG	7.02	7.55	7.41	7.15	9.15	7.87	7.49	
Temperature	°C	NG	15	NG	15	NG	N ^{6.2}	NG	NG	N ^{9.2}	NG	NG	19 ^{12.2}	NG	NG	12.9	11.1	10.1	10.4	11.3	12	11.8	
Turbidity	NTU	N ^{1.1}	NG	N ^{3.1}	NG	NG	N ^{6.3}	NG	NG	N ^{9.3}	NG	NG	N ^{12.3}	NG	NG	0.06	1.35	-	9.44	18.7	1.08	0.29	
Lab Results																							
General																							
Alkalinity (bicarbonate, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	481	194	391	367	74.0	205	198	
Alkalinity (carbonate, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<1.0	<1.0	<1.0	<1.0	26.5	<1.0	<1.0	
Alkalinity (hydroxide, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Alkalinity (phenolphthalein, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	N ^{13.1}	NG	NG	<1.0	<1.0	<1.0	<1.0	13.3	<1.0	<1.0	
Alkalinity (total, as CaCO3)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	N ^{13.2}	NG	NG	481	194	391	367	101	205	198	
Bromide	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Dissolved organic carbon	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	6.45	1.61	3.67	2.24	1.56	1.19	1.60	
Chloride	mg/L	NG	250	NG	250	250 ^{5.1}	100	NG	100 ^{8.1}	600 ^{9.4}	NG	600	600 ^{12.4}	NG	1500	<u>191</u>	11.7	<u>106</u>	<u>122</u>	8.56	1.56	41.6	
Fluoride	mg/L	1.5	NG	1.5	NG	1.500	2.0 ^{6.4}	NG	1.000	1.5 ^{9.5}	NG	1.000 ^{11.1}	Calc ^{12.5}	NG	Calc ^{14.1}	<u>1.27</u>	0.27	0.22	0.21	<0.10	0.23	0.15	
Hardness (as CaCO3), dissolved	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	555	414	1090	1040	184	213	486	
Total suspended solids	mg/L	NG	NG	NG	NG	NG	N ^{6.5}	NG	NG	N ^{9.6}	NG	NG	N ^{12.6}	NG	NG	-	-	-	-	-	-	-	
Sulphate	mg/L	NG	500 ^{2.2}	NG	500	500 ^{5.2}	NG	NG	NG	1000	1000 ^{10.1}	1000	NG	NG	Calc ^{14.2}	218	294	741	795	203	81.0	309	
Nutrients																							
Ammonia (total, as N)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	Calc ^{12.7}	NG	Calc ^{14.3}	0.054	0.050	0.050	<0.050	0.495	0.151	<0.050	
Nitrate (as N)	mg/L	10	NG	10	NG	10 ^{5.3}	NG	NG	NG	100 ^{9.7}	NG	100 ^{11.2}	32.8 ^{12.8}	NG	400 ^{14.4}	2.34	<0.010	11.8	10.5	<0.010	<0.010	2.90	
Nitrate + Nitrite (as N)	mg/L	10 ^{1.2}	NG	NG	NG	10 ^{5.4}	NG	NG	NG	100 ^{9.8}	NG	100 ^{11.3}	NG	NG	400 ^{14.5}	2.34	<0.0100	11.8	10.5	<0.0100	<0.0100	2.90	
Nitrite (as N)	mg/L	1	NG	1.0	NG	1	NG	NG	NG	10 ^{9.9}	NG	10.000	Calc ^{12.9}	NG	Calc ^{14.6}	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	
Total nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	2.91	<0.0500	12.2	10.9	0.478	0.164	3.01	
Total kjeldahl nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.572	<0.050	0.417	0.365	0.478	0.164	0.111	
Total organic nitrogen	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.518	<0.0500	0.367	0.365	<0.0500	<0.0500	0.111	
Orthophosphate (dissolved, as P)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
Phosphorus (total, APHA 4500-P)	mg/L	NG	NG	NG	N ^{4.1}	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.0272	0.0226	0.126	0.0420	0.0074	0.0168	0.0150	
Phosphorus (dissolved, APHA 4500-P)	mg/L	NG	NG	NG	N ^{4.2}	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.0267	0.0202	0.0344	0.0261	<0.0050	0.0166	0.0093	
Potassium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	10.3	5.47	9.40	9.17	3.06	3.56	6.34	
Dissolved Metals																							
Aluminum (dissolved)	mg/L	2.9 ^{1.3}	0.100 ^{2.3}	9.5	NG	9.500 ^{5.5}	5 ^{6.6}	NG	5.000	5 ^{9.10}	NG	5.000	NG	NG	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
Antimony (dissolved)	mg/L	0.006	NG	0.006	NG	0.006	NG	NG	NG	NG	NG	NG	0.250 ^{12.10}	NG	0.090	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Arsenic (dissolved)	mg/L	0.010 ^{1.4}	NG	0.01	NG	0.010	0.100 ^{6.7}	NG	0.100	0.025 ^{9.11}	NG	0.025	NG	NG	0.050	<0.00050	0.00068	0.00064	0.00065	<0.00050	0.00112	0.00060	
Barium (dissolved)	mg/L	2.0 ^{1.5}	NG	NG	NG	1.000	NG	NG	NG	NG	NG	NG	NG	1	10.000	0.0679	0.0320	0.0267	0.0265	<0.0050	0.0186	0.0447	
Beryllium (dissolved)	mg/L	NG	NG	NG	NG	0.008	NG	0.100	0.100	NG	0.100	0.100	NG	0.00013	0.0015	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Bismuth (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	
Boron (dissolved)	mg/L	5	NG	5.0	NG	5.000	0.5 ^{6.8}	NG	0.500 ^{8.2}	5 ^{9.12}	NG	5.000	NG	NG	12.000	0.105	<0.0500	0.123	0.157	<0.0500	<0.0500	<0.0500	
Cadmium (dissolved)	mg/L	0.007 ^{1.6}	NG	0.005	NG	0.005	NG	0.0051 ^{7.2}	0.005	NG	0.080 ^{10.2}	0.080	Calc ^{12.11}	NG	Calc ^{14.7}	<0.000020	0.000025	0.000091	0.000077	<0.000010	<0.000010	<0.000010	

Table B-1: 2023 Groundwater Quality Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

Analyte	Unit	Guideline														Sampling Location						
		GCDWQ MAC	GCDWQ AO	BC SDWQG MAC	BC SDWQG AO	CSR DW	BCAWQG I	BCWWQG I	CSR IW	BCAWQG L	BCWWQG L	CSR LW	BCAWQG AL (ST)	BCWWQG AL	CSR AW	DMW-5	MW-2	MW11-02	MW11-02	MW-5	WTN 24991	WTN 39421
																Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled
Calcium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	1000	1000	NG	N ^{13.3}	NG	136	82.2	223	204	7.14	53.5	114	
Chromium (dissolved)	mg/L	0.05	NG	0.05	NG	0.050 ^{5.6}	NG	0.0049 ^{7.3}	0.005 ^{8.3}	NG	0.050 ^{10.3}	0.050 ^{11.4}	NG	0.001 ^{13.4}	0.010 ^{14.8}	<0.00050	<0.00050	0.00207	0.00183	<0.00050	<0.00050	0.00137
Cobalt (dissolved)	mg/L	NG	NG	0.001	NG	0.020 ^{5.7}	NG	0.050 ^{7.4}	0.050	NG	1	1.000	0.110 ^{12.12}	NG	0.040	0.00024	<0.00010	0.00273	0.00264	<0.00010	<0.00010	<0.00010
Copper (dissolved)	mg/L	2 ^{1.7}	1 ^{2.4}	2.0 ^{3.2}	1.0	1.500 ^{5.8}	0.200 ^{6.9}	NG	0.200	0.300 ^{9.13}	NG	0.300	Calc ^{12.13}	NG	Calc ^{14.9}	0.00129	<0.00040	0.00171	0.00163	<0.00040	<0.00040	<0.00040
Iron (dissolved)	mg/L	NG	0.3	NG	0.3	6.500 ^{5.9}	NG	NG	5.000 ^{8.4}	NG	NG	NG	0.35 ^{12.14}	NG	NG	0.014	<0.010	<0.010	<0.010	<0.010	0.227	0.043
Lead (dissolved)	mg/L	0.005 ^{1.8}	NG	0.005	NG	0.010	0.200 ^{6.10}	NG	0.200	0.100 ^{9.14}	NG	0.100	Calc ^{12.15}	NG	Calc ^{14.10}	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Lithium (dissolved)	mg/L	NG	NG	NG	NG	0.008	NG	0.75 ^{7.5}	2.500 ^{8.5}	NG	NG	5.000	NG	NG	NG	0.0529	0.00502	0.0177	0.0204	0.00114	0.00339	0.00639
Magnesium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	52.4	50.5	129	130	40.4	19.2	48.5
Manganese (dissolved)	mg/L	0.12 ^{1.9}	0.02 ^{2.5}	0.12	0.02	1.500 ^{5.10}	NG	0.200	0.200 ^{8.6}	NG	NG	NG	Calc ^{12.16}	NG	NG	0.206	0.00179	0.00040	<0.00020	0.0363	0.0813	0.00423
Mercury (dissolved)	mg/L	0.001	NG	0.001	NG	0.001	0.0020 ^{6.11}	NG	0.001	0.0030 ^{9.15}	NG	0.002	NG	NG	0.00025	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (dissolved)	mg/L	NG	NG	0.088	NG	0.250	0.01 ^{6.12}	NG	0.010 ^{8.7}	0.016 ^{9.16}	NG	0.050	46 ^{12.17}	NG	10.000	<u>0.0142</u>	<u>0.0118</u>	0.00889	<u>0.0101</u>	0.00351	0.00861	0.00665
Nickel (dissolved)	mg/L	NG	NG	0.08	NG	0.080	NG	0.200	0.200	NG	1	1.000	NG	Calc ^{13.5}	Calc ^{14.11}	0.00304	<0.00040	0.0131	0.0131	<0.00040	<0.00040	0.00089
Selenium (dissolved)	mg/L	0.05	NG	0.01	NG	0.010	0.010 ^{6.13}	NG	0.020 ^{8.8}	0.0300 ^{9.17}	NG	0.030	NG	NG	0.020	<0.00050	<0.00050	0.0217	0.0242	0.00126	<0.00050	0.0316
Silicon (dissolved, as Si)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	14.7	9.1	14.0	13.5	<1.0	10.2	11.6
Silver (dissolved)	mg/L	NG	NG	NG	NG	0.020	NG	NG	NG	NG	NG	NG	Calc ^{12.18}	NG	Calc ^{14.12}	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Sodium (dissolved)	mg/L	NG	200	NG	NG	200 ^{5.11}	NG	NG	NG	NG	NG	NG	NG	NG	NG	203	34.6	133	134	45.7	32.4	39.7
Strontium (dissolved)	mg/L	7.0 ^{1.10}	NG	7.0	NG	2.500	NG	NG	NG	NG	NG	NG	NG	NG	NG	1.89	0.848	1.44	1.33	0.0518	0.504	1.12
Sulphur (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	81.6	106	276	252	75.8	29.3	113
Tellurium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	0.0008 ^{13.6}	0.003	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Thorium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (dissolved)	mg/L	NG	NG	NG	NG	2.500	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	1.000	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (dissolved)	mg/L	NG	NG	NG	NG	0.003	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (dissolved)	mg/L	0.02	NG	0.02	NG	0.020	NG	0.010	0.010	NG	0.200	0.200	NG	0.0085	0.085	0.0204	0.00566	0.0345	0.0411	<0.000020	0.00147	0.00422
Vanadium (dissolved)	mg/L	NG	NG	NG	NG	0.020	NG	0.100	0.100	NG	0.100	0.100	NG	NG	NG	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Zinc (dissolved)	mg/L	NG	5.0	3.0	5.0	3.000 ^{5.12}	1.000 ^{6.14}	NG	1.000 ^{8.9}	2.000 ^{9.18}	NG	2.000	Calc ^{12.19}	NG	Calc ^{14.13}	<0.0040	0.0338	<0.0040	<0.0040	<0.0040	<0.0040	0.0142
Zirconium (dissolved)	mg/L	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010



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1. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)
Note 1.1 for Turbidity:
Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ. For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU. For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU.
Note 1.2 for Nitrate + Nitrite (as N):
The MAC for Nitrate (as N) is 10 mg/L
Note 1.3 for Aluminum (dissolved):
The maximum acceptable concentration (MAC) for total aluminum in drinking water is 2.9 mg/L (2 900 µg/L) based on a locational running annual average of a minimum of quarterly samples taken in the distribution system. (Update March 5, 2021)
Note 1.4 for Arsenic (dissolved):
Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.
Note 1.5 for Barium (dissolved):
Update January 24, 2020. The MAC was revised from 1.0 mg/L to 2.0 mg/L.
Note 1.6 for Cadmium (dissolved):
A maximum acceptable concentration (MAC) of 0.007 mg/L (7 µg/L) is established for total cadmium in drinking water, based on a sample of water taken at the tap. (Update July 14, 2020)
Note 1.7 for Copper (dissolved):
A maximum acceptable concentration (MAC) of 2 mg/L is established for total copper in drinking water, based on a sample of water taken at the tap. Guidelines for Canadian Drinking Water Quality - Guideline Technical Document on Copper, June 2019.
Note 1.8 for Lead (dissolved):
The maximum acceptable concentration (MAC) for total lead in drinking water is 0.005 mg/L (5 µg/L), based on a sample of water taken at the tap and using the appropriate protocol for the type of building being sampled. Every effort should be made to maintain lead levels in drinking water as low as reasonably achievable (or ALARA). (GCDWQ: Guideline Technical Document; March, 2019)
Note 1.9 for Manganese (dissolved):
Guidelines for Canadian Drinking Water Quality - Guideline Technical Document on manganese, May 2019.
Note 1.10 for Strontium (dissolved):
Guidelines for Canadian Drinking Water Quality - Guideline Technical Document on strontium, May 2019.
2. Notes for Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)
Note 2.1 for pH:
The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.
Note 2.2 for Sulphate:
There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L. Health authorities should be notified of drinking water sources containing above 500 mg/L.
Note 2.3 for Aluminum (dissolved):
The operational guidance (OG) value for total aluminum in drinking water is 0.100 mg/L (100 µg/L) to optimize water treatment and distribution system operations. This value is based on a locational running annual average. The sampling frequency required to calculate the locational running annual average will vary based on the type of treatment facility and the sampling location. (Update March 5, 2021)
Note 2.4 for Copper (dissolved):
Guidelines for Canadian Drinking Water Quality - Guideline Technical Document on Copper, June 2019.
Note 2.5 for Manganese (dissolved):
Guidelines for Canadian Drinking Water Quality - Guideline Technical Document on manganese, May 2019.
3. Notes for BC Source Drinking Water Quality Guidelines - Maximum Acceptable Concentrations (2020 and updates) (BC SDWQG MAC)
General Notes:
Reference: British Columbia Ministry of Environment and Climate Change Strategy. 2020. B.C. Source Drinking Water Quality Guidelines: Guideline Summary. The source drinking water quality guidelines apply to the ambient water before it is treated and distributed for domestic use. The guidelines apply to drinking water sources from surface water and groundwater.
Note 3.1 for Turbidity:
For raw drinking water without treatment for particulates the guideline is: ≤ 1 NTU of turbidity. For raw drinking water with treatment for particulates the guideline is: Natural background turbidity is ≤ 50 NTU: Change from background should not exceed 5 NTU. Natural background turbidity is > 50 NTU: Change from background should not exceed 10% of the background turbidity.
Note 3.2 for Copper (dissolved):
Includes short-term and long-term exposure.
4. Notes for BC Source Drinking Water Quality Guidelines - Aesthetic Objectives (2020 and updates) (BC SDWQG AO)
General Notes:
Reference: British Columbia Ministry of Environment and Climate Change Strategy. 2020. B.C. Source Drinking Water Quality Guidelines: Guideline Summary. The source drinking water quality guidelines apply to the ambient water before it is treated and distributed for domestic use. The guidelines apply to drinking water sources from surface water and groundwater.
Note 4.1 for Phosphorus (total, APHA 4500-P):
The AO for lakes is 0.01 mg/L. For lakes with residence time > 6 months, measure total P during spring overturn. For lakes with residence time < 6 months, measure mean epilimnetic total P during the growing season (ENV 1985).
Note 4.2 for Phosphorus (dissolved, APHA 4500-P):
The AO for lakes is 0.01 mg/L. For lakes with residence time > 6 months, measure total P during spring overturn. For lakes with residence time < 6 months, measure mean epilimnetic total P during the growing season (ENV 1985).
5. Notes for BC CSR Generic Numerical Water Standards for Drinking Water (CSR DW)
General Notes:
BC Contaminated Sites Regulation, Generic Numerical Water Standards, Schedule 3.2; includes amendments up to B.C. Reg. 13/2019, January 24, 2019. Drinking water standards are for unfiltered samples obtained at the point of consumption. Heavy metals, metalloids and inorganic ions are expressed as total substance concentrations unless otherwise indicated.
Note 5.1 for Chloride:
Standard to protect against taste and odour concerns.
Note 5.2 for Sulphate:
Standard to protect against taste and odour concerns.
Note 5.3 for Nitrate (as N):
Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.
Note 5.4 for Nitrate + Nitrite (as N):
Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.
Note 5.5 for Aluminum (dissolved):
Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.

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Note 5.6 for Chromium (dissolved):
Analytical results for chromium (all species) in water may be used to demonstrate compliance with the standards. Where the standards cannot be met based on analytical results for chromium (all species), chromium speciation may be necessary. Standard is 50 µg/L for chromium, hexavalent. Standard is 6000 µg/L for chromium, trivalent. The standard of 50 µg/L was used to identify exceedances for dissolved chromium in order to demonstrate compliance with the standards.
Note 5.7 for Cobalt (dissolved):
The standard in Schedule 3.2 is 1 µg/L. However the BC Ministry of Environment and Climate Change Strategy has set an interim background groundwater concentration estimate of 20 ug/L for Cobalt at sites in the Province. Therefore a standard of 20 ug/L has been used for this criteria set.
Note 5.8 for Copper (dissolved):
Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.
Note 5.9 for Iron (dissolved):
Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as (a) item A6, A7, A8 or A11 (b) item C1, C2, C3, C4 or C6, (c) item D2, D3, D5, or D6 (d) item E4, or (e) item H14. Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above. Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.
Note 5.10 for Manganese (dissolved):
Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as (a) item B1 (b) item C1, C3 or C4 (c) item D2, D3, D5, or D6 (d) item E4, or (e) item H3 or H14. Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above. Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups. Standard may not address aesthetic (organoleptic) concerns related to drinking water quality. Water treatment may be required.
Note 5.11 for Sodium (dissolved):
Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.
Note 5.12 for Zinc (dissolved):
Standard is specific to protection of human health. Standard is derived with TRV protective of adults. Standard may not adequately protect other age groups.
6. Notes for BC Approved Water Quality Guidelines for irrigation (BCAWQG I)
General Notes:
References: British Columbia Ministry of Environment and Climate Change Strategy. 2021. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary; and B.C. Guideline Overview and Technical Reports.
Note 6.1 for pH:
Update August 2019 Summary Report.
Note 6.2 for Temperature:
The recommended guideline for temperature is + or - 1 degree Celsius change from natural ambient background.
Note 6.3 for Turbidity:
Induced turbidity should not exceed 10 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 20 % of background when background is greater than 50 NTU.
Note 6.4 for Fluoride:
Total fluoride in irrigation water should not exceed 1.0 mg/L as a 30-day average or a maximum of 2.0 mg/L.
Note 6.5 for Total suspended solids:
Induced suspended sediments should not exceed 20 mg/L when background suspended sediments is less than or equal to 100 mg/L, nor should induced suspended sediments be more than 20 % of background when background is greater than 100 mg/L.
Note 6.6 for Aluminum (dissolved):
The guideline maximum for total aluminum is 5 mg/L. A separate guideline for dissolved aluminum is not provided.
Note 6.7 for Arsenic (dissolved):
The interim guideline for total arsenic is 100 µg/L.
Note 6.8 for Boron (dissolved):
The guideline for total boron depends on the crop, and varies from 0.5 mg/L to 6 mg/L. The most stringent guideline maximum of 0.5 mg/L, for very sensitive and sensitive crops, was used to identify exceedances for this report.
Note 6.9 for Copper (dissolved):
The guideline maximum for total copper is 200 µg/L.
Note 6.10 for Lead (dissolved):
For neutral and alkaline fine-textured soils the total lead concentration in irrigation water should not exceed 400 µg/L at any time. The concentration of total lead in irrigation water for use on all other soils should not exceed 200 µg/L at any time. / The most stringent guideline maximum was used in this report.
Note 6.11 for Mercury (dissolved):
The guideline maximum for total mercury is 2.0 µg/L.
Note 6.12 for Molybdenum (dissolved):
The long-term chronic guidelines for total molybdenum are as follows: Forage crops-poorly drained soil: 0.01 mg/L Forage crops-well drained soil: 0.02 mg/L Non-forage crops: 0.028 mg/L. This guideline is intended to be protective of terrestrial plants and is not necessarily protective of livestock consuming these plants. The most stringent guideline (0.01 mg/L for forage crops-poorly drained soil) has been used.
Note 6.13 for Selenium (dissolved):
The guideline for total selenium is 10 µg/L mean. The mean concentrations in the water column are based on at least 5 weekly samples taken over a 30-day period.
Note 6.14 for Zinc (dissolved):
The guideline maximum for total zinc for irrigation is as follows: - Soil pH less than 6: 1000 µg/L. - Soil pH equal to or greater than 6, and less than 7: 2000 µg/L. - Soil pH greater than or equal to 7: 5000 µg/L. / The most stringent guideline maximum was used in this report.
7. Notes for BC Working Water Quality Guidelines for Irrigation (2021) (BCWWQG I)
General Notes:
Reference: B.C. Ministry of Environment and Climate Change Strategy. 2021. Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the "Notes" for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.
Note 7.1 for Conductivity:
The guideline varies from 700 to 5000 µS/cm depending on the type of crop. The most stringent guideline has been used for this report.

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Note 7.2 for Cadmium (dissolved):
This is a Short-term maximum guideline.
Note 7.3 for Chromium (dissolved):
The guideline for Cr(VI) is 8 µg/L (total). The guideline for Cr(III) is 4.9 µg/L (total). The guideline of 4.9 µg/L for Cr(III) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.
Note 7.4 for Cobalt (dissolved):
Continuous or intermittent use on all soils.
Note 7.5 for Lithium (dissolved):
The guideline is 2.5 mg/L for non-citrus crops (May not be protective of barley and other cereal crops; 1.0 mg/L suggested for cereal crops). The guideline is 0.75 mg/L for citrus crops. / The most stringent guideline was used in this report.
8. Notes for BC CSR Generic Numerical Water Standards for Irrigation (CSR IW)
General Notes:
BC Contaminated Sites Regulation, Generic Numerical Water Standards, Schedule 3.2; includes amendments up to B.C. Reg. 13/2019, January 24, 2019. Standards for all organic substances are for total substance concentrations. Any water sample to be analyzed for organic substances should not be filtered. Standards for surface water samples to be analyzed for heavy metals, metalloids and inorganic ions are total substance concentrations. In addition, it is recommended that surface water samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for dissolved substance concentrations. Standards for groundwater samples for heavy metals, metalloids and inorganic ions are for dissolved substance concentrations. In addition, it is recommended that groundwater samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for total substance concentrations. Standards apply to irrigation of all soil types, unless otherwise indicated. There are several different standards for site-specific factors for some analytes. The most stringent standards were used for this criteria set.
Note 8.1 for Chloride:
Standard to protect all types of crops.
Note 8.2 for Boron (dissolved):
Standard varies depending on crop. This standard is for blackberry crop.
Note 8.3 for Chromium (dissolved):
Analytical results for chromium (all species) in water may be used to demonstrate compliance with the standards. Where the standards cannot be met based on analytical results for chromium (all species), chromium speciation may be necessary. Standard is 8 µg/L for chromium, hexavalent. Standard is 5 µg/L for chromium, trivalent. The standard of 5 µg/L was used to identify exceedances for dissolved chromium in order to demonstrate compliance with the standards.
Note 8.4 for Iron (dissolved):
Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as (a) item A6, A7, A8 or A11 (b) item C1, C2, C3, C4 or C6, (c) item D2, D3, D5, or D6 (d) item E4, or (e) item H14. Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above.
Note 8.5 for Lithium (dissolved):
Standard to protect all types of crops.
Note 8.6 for Manganese (dissolved):
Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as (a) item B1 (b) item C1, C3 or C4 (c) item D2, D3, D5, or D6 (d) item E4, or (e) item H3 or H14. Standard applies to a site used for an industrial or commercial purpose or activity set out in Schedule 2 as item H11 or H20, but only if the site was used for the purpose or activity in conjunction with or as a result of the site also being used for at least one of the purposes or activities set out above.
Note 8.7 for Molybdenum (dissolved):
Standard varies with crop, soil drainage and Mo:Cu ratio. Standard is 10 – 30 µg/L. Consult a director for further advice. The most stringent standard of 10 µg/L has been used.
Note 8.8 for Selenium (dissolved):
Standard varies with type of application; continuous or intermittent. This standard is for continuous applications on crops.
Note 8.9 for Zinc (dissolved):
The standard varies (from 1000 to 5000 µg/L) with soil pH. This standard (which is the most stringent) is for soil pH less than 6.0
9. Notes for BC Approved Water Quality Guidelines for livestock (BCAWQG L)
General Notes:
References: British Columbia Ministry of Environment and Climate Change Strategy. 2021. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary; and B.C. Guideline Overview and Technical Reports.
Note 9.1 for pH:
Update August 2019 Summary Report.
Note 9.2 for Temperature:
The recommended guideline for temperature is + or - 1 degree Celsius change from natural ambient background.
Note 9.3 for Turbidity:
Induced turbidity should not exceed 5 NTU when background turbidity is less than or equal to 50 NTU, nor should induced turbidity be more than 10 % of background when background is greater than 50 NTU.
Note 9.4 for Chloride:
The water quality guideline for chloride for livestock watering is 600 mg/L.
Note 9.5 for Fluoride:
The total fluoride recommendation for dairy cows, breeding stock and other long-lived animals is 1.0 mg/L as a 30-day mean and 1.5 mg/L as a maximum. Total fluoride should not exceed 2.0 mg/L as a 30-day mean or 4.0 mg/L maximum in the drinking water of all other types of livestock, unless fluoride is provided in the diet by bone meal or mineral additives, in which case 1.0 mg/L as a 30-day mean and 2.0 mg/L maximum is recommended. / The most stringent guideline maximum was used in this report.
Note 9.6 for Total suspended solids:
Induced suspended sediments should not exceed 10 mg/L when background suspended sediments is less than or equal to 100 mg/L, nor should induced suspended sediments be more than 10 % of background when background is greater than 100 mg/L.
Note 9.7 for Nitrate (as N):
Overview Report Update, September 2009.
Note 9.8 for Nitrate + Nitrite (as N):
The guideline maximum for nitrate as nitrogen is 100 mg/l. Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed this value. Overview Report Update, September 2009.
Note 9.9 for Nitrite (as N):
Overview Report Update, September 2009.
Note 9.10 for Aluminum (dissolved):
The guideline maximum for total aluminum is 5 mg/L. A separate guideline for dissolved aluminum is not provided.

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Note 9.11 for Arsenic (dissolved):
The interim guideline for total arsenic is 25 µg/L.
Note 9.12 for Boron (dissolved):
The guideline maximum for total boron is 5 mg/L.
Note 9.13 for Copper (dissolved):
The guideline maximum for total copper is 300 µg/L.
Note 9.14 for Lead (dissolved):
The guideline maximum for total lead is 100 µg/L.
Note 9.15 for Mercury (dissolved):
The guideline maximum for total mercury is 3.0 µg/L.
Note 9.16 for Molybdenum (dissolved):
Interim guidelines for total molybdenum are based on differences in sensitivity to molybdenum exposure: 1) ruminant livestock, 0.016 mg/L; and 2) non-ruminant livestock: 0.284 mg/L. The most stringent guideline (0.016 mg/L for ruminant livestock) has been used.
Note 9.17 for Selenium (dissolved):
The guideline for total selenium is 30.0 µg/L mean. The mean concentrations in the water column are based on at least 5 weekly samples taken over a 30-day period.
Note 9.18 for Zinc (dissolved):
The guideline maximum for total zinc is 2000 µg/L.
10. Notes for BC Working Water Quality Guidelines for Livestock (2021) (BCWWQG L)
General Notes:
Reference: B.C. Ministry of Environment and Climate Change Strategy. 2021. Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the “Notes” for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.
Note 10.1 for Sulphate:
The guideline is for dissolved sulphate.
Note 10.2 for Cadmium (dissolved):
This is a Short-term maximum guideline.
Note 10.3 for Chromium (dissolved):
The guideline for Cr(VI) is 50 µg/L (total). The guideline for Cr(III) is 50 µg/L (total). The guideline of 50 µg/L for Cr(VI), and for Cr(III) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.
11. Notes for BC CSR Generic Numerical Water Standards for Livestock (CSR LW)
General Notes:
BC Contaminated Sites Regulation, Generic Numerical Water Standards, Schedule 3.2; includes amendments up to B.C. Reg. 13/2019, January 24, 2019. Standards for all organic substances are for total substance concentrations. Any water sample to be analyzed for organic substances should not be filtered. Standards for surface water samples to be analyzed for heavy metals, metalloids and inorganic ions are total substance concentrations. In addition, it is recommended that surface water samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for dissolved substance concentrations. Standards for groundwater samples for heavy metals, metalloids and inorganic ions are for dissolved substance concentrations. In addition, it is recommended that groundwater samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for total substance concentrations.
Note 11.1 for Fluoride:
Standard varies with type of livestock. Consult a director for further advice.
Note 11.2 for Nitrate (as N):
Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.
Note 11.3 for Nitrate + Nitrite (as N):
Where nitrate and nitrite are present, total nitrate plus nitrite-nitrogen should not exceed this value.
Note 11.4 for Chromium (dissolved):
Analytical results for chromium (all species) in water may be used to demonstrate compliance with the standards. Where the standards cannot be met based on analytical results for chromium (all species), chromium speciation may be necessary. Standard is 50 µg/L for chromium, hexavalent. Standard is 50 µg/L for chromium, trivalent. The standard of 50 µg/L was used to identify exceedances for dissolved chromium in order to demonstrate compliance with the standards.
12. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (Short-term acute) (BCAWQG AL (ST))
General Notes:
References: British Columbia Ministry of Environment and Climate Change Strategy. November 2023. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary; and B.C. Guideline Overview and Technical Reports. / There are two types of water quality guidelines: the short-term acute guideline (i.e. maximum), and the long-term chronic guideline (i.e. average). Only the short-term acute guidelines are included in this criteria set.
Note 12.1 for Dissolved oxygen:
The aquatic life instantaneous minimum guideline for dissolved oxygen is 5 mg/L for all life stages other than buried embryo/alevin. The instantaneous minimum guideline for dissolved oxygen in the water column is 9 mg/L for buried embryo/alevin. The instantaneous minimum guideline for dissolved oxygen in interstitial water is 6 mg/L for buried embryo/alevin.
Note 12.2 for Temperature:
The freshwater aquatic life guideline for streams with unknown fish distribution is: Maximum daily temperature of 19 degrees Celsius; MWT = 18 degrees Celsius. (MWT, mean weekly short-term temperature, is defined as the average of the warmest daily short-term temperatures for 7 consecutive days; Hourly rate of change not to exceed 1 degree Celsius; Short-term incubation temperature = 12 degrees Celsius (in spring and fall). See BC MOE Overview Report for additional details for streams with unknown fish distribution, and specific guidelines for streams with known fish distribution, and guideline for lakes and impoundments.
Note 12.3 for Turbidity:
Aquatic life guidelines for turbidity are: Change from background of 8 NTU at any one time for a duration of 24 h in all waters during clear flows or in clear waters; Change from background of 2 NTU at any one time for a duration of 30 d in all waters during clear flows or in clear waters; Change from background of 5 NTU at any time when background is 8 - 50 NTU during high flows or in turbid waters; Change from background of 10% when background is > 50 NTU at any time during high flows or in turbid waters.
Note 12.4 for Chloride:
To protect freshwater aquatic life from acute and lethal effects, the maximum concentration of chloride (mg/L as NaCl) at any time should not exceed 600 mg/L. When ambient chloride concentrations exceed guidelines, increases in chloride due to human activities should be avoided.
Note 12.5 for Fluoride:
The freshwater aquatic life short-term acute Interim guideline for total fluoride is as follows: If hardness is less than or equal to 10 mg/L then the guideline is 0.4 mg/L; If hardness is greater than 10 mg/L then the guideline (in units mg/L) is based on the equation: WQG = [-51.73 + 92.57 log ₁₀ (hardness)] × 0.01. Hardness is as CaCO ₃ in units mg/L. The equation applies to water hardness (as CaCO ₃) between 10 – 385 mg/L, and is an interim WQG until carefully controlled experiments can determine the appropriate levels of fluoride under various combinations of water temperature and hardness. When water hardness exceeds highest hardness tested (i.e. upper bound), a site-specific assessment may be required.

**Guideline Notes for Table B-1: 2023 Groundwater Quality Results
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Note 12.6 for Total suspended solids:
Aquatic life guidelines for total suspended solids are: Change from background of 25 mg/L at any one time for a duration of 24 h in all waters during clear flows or in clear waters; Change from background of 5 mg/L at any one time for a duration of 30 d in all waters during clear flows or in clear waters; Change from background of 10 mg/L at any time when background is 25 - 100 mg/L during high flows or in turbid waters; Change from background of 10% when background is > 100 mg/L at any time during high flows or in turbid waters.
Note 12.7 for Ammonia (total, as N):
The freshwater aquatic life short-term acute guideline for ammonia varies as a function of pH and temperature. See Table 3 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia for this report. If a lab pH result was not available then the field pH result was used.
Note 12.8 for Nitrate (as N):
Freshwater aquatic life short-term acute guideline.
Note 12.9 for Nitrite (as N):
The freshwater aquatic life short-term acute guideline for nitrite as N is: 0.06 mg/L if chloride less than 2 mg/L 0.12 mg/L if chloride is 2 to 4 mg/L 0.18 mg/L if chloride is 4 to 6 mg/L 0.24 mg/L if chloride is 6 to 8 mg/L 0.30 mg/L if chloride is 8 to 10 mg/L 0.60 mg/L if chloride is greater than 10 mg/L.
Note 12.10 for Antimony (dissolved):
The guideline is for total antimony.
Note 12.11 for Cadmium (dissolved):
Freshwater aquatic life short-term acute guideline: The guideline for cadmium is determined on a site-specific basis according to the local water hardness. The guideline for cadmium (dissolved) in µg/L is determined by the following equations for short term exposure: 1. If hardness (as CaCO ₃) is less than 7 mg/L then maximum is 0.0380 µg/L 2. If hardness (as CaCO ₃) is from 7 to 45 mg/L then maximum is based on equation: e to the power of $\{1.03[\ln(\text{hardness})] - 5.274\}$ 3. If hardness (as CaCO ₃) is greater than 455 mg/L then maximum is 2.8 µg/L. When water hardness is greater than the upper bound (i.e., highest water hardness tested), a site-specific assessment may be required.
Note 12.12 for Cobalt (dissolved):
Freshwater aquatic life short-term acute guideline.
Note 12.13 for Copper (dissolved):
The BC AL for copper is determined using the Biotic Ligand Model, which predicts toxicity under varying site-specific chemistry conditions. It requires, at a minimum, pH, hardness, and dissolved organic carbon (DOC). The hardness concentration measured at all groundwater sites was above the upper bound under which the model has been developed (hardness of 236.8 mg/L) (ENV 2019b). Results were compared against the guideline using the upper bound for hardness and all results were below their respective calculated guidelines for 2023. References: (1) B.C. Ministry of Environment and Climate Change Strategy 2019. Copper Water Quality Guideline for the Protection of Freshwater Aquatic Life- Technical Report. WQG-03-1, and (2) B.C. Ministry of Environment and Climate Change Strategy. 2019. Copper Water Quality Guideline for Protection of Freshwater Aquatic Life-User's Guide. WQG-03-3.
Note 12.14 for Iron (dissolved):
Freshwater aquatic life short-term acute guideline.
Note 12.15 for Lead (dissolved):
The freshwater aquatic life short-term acute guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO ₃ is 3 µg/L. When water hardness exceeds 8 mg/L (as CaCO ₃) the short-term acute guideline (µg/L) is given by the following equation: $\exp(1.273 \ln(\text{hardness}) - 1.460)$. The guideline applies to water hardness up to 360 mg/L (as CaCO ₃). If natural levels exceed the guideline, then any allowed increase in total lead above natural levels should be based on site-specific data. When water hardness exceeds highest hardness tested (i.e. upper bound), a site-specific assessment may be required.
Note 12.16 for Manganese (dissolved):
The freshwater aquatic life short-term acute guideline for total manganese in mg/L is determined by the following relationship: $0.01102 \text{ hardness} + 0.54$ where water hardness is reported as mg/L of CaCO ₃ . The guideline applies to water hardness between 25 - 259 mg/L CaCO ₃ . When water hardness is outside hardness range tested (i.e. lower or upper bound), a site-specific assessment may be required.
Note 12.17 for Molybdenum (dissolved):
The guideline is for total molybdenum.
Note 12.18 for Silver (dissolved):
The freshwater aquatic life short-term acute guideline for total silver is: 0.1 µg/L maximum if hardness less than or equal to 100 mg/L 3.0 µg/L maximum if hardness greater than 100 mg/L.
Note 12.19 for Zinc (dissolved):
The freshwater aquatic life short-term acute guideline for total zinc (µg/L) is: When water hardness is less than or equal to 90 mg/L as CaCO ₃ the guideline is 33 µg/L; When water hardness exceeds 90 mg/L CaCO ₃ , the guideline in µg/L for total zinc is the value determined by the following relationship: $33 + 0.75 * (\text{hardness} - 90)$ where water hardness is reported as mg/L of CaCO ₃ . The short-term acute guideline formula applies to water hardness between 90 - 500 mg/L CaCO ₃ .
13. Notes for BC Working Water Quality Guidelines for Freshwater Aquatic Life (BCWWQG AL)
General Notes:
Reference: B.C. Ministry of Environment and Climate Change Strategy. 2021. Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. WWQG values are long-term (i.e. average) concentrations unless identified as a short-term maximum in the "Notes" for a specific analyte. Long-term WWQGs represent average substance concentrations calculated from 5 samples in 30 days. WWQG are given for total substance concentrations unless otherwise noted.
Note 13.1 for Alkalinity (phenolphthalein, as CaCO₃):
The guideline for alkalinity (total as CaCO ₃) is as follows: - Less than 10 mg/L, highly sensitive to acid inputs - 10 to 20 mg/L, moderately sensitive to acid inputs - Greater than 20 mg/L, low sensitivity to acid inputs. Sensitivity to acid inputs can be determined by the concentration of dissolved calcium: < 4 mg/L is highly sensitive to acid inputs; 4 to 8 mg/L is moderately sensitive; and > 8 mg/L is low sensitivity.
Note 13.2 for Alkalinity (total, as CaCO₃):
The guideline for alkalinity (total as CaCO ₃) is as follows: - Less than 10 mg/L, highly sensitive to acid inputs - 10 to 20 mg/L, moderately sensitive to acid inputs - Greater than 20 mg/L, low sensitivity to acid inputs. Sensitivity to acid inputs can be determined by the concentration of dissolved calcium: < 4 mg/L is highly sensitive to acid inputs; 4 to 8 mg/L is moderately sensitive; and > 8 mg/L is low sensitivity.

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Note 13.3 for Calcium (dissolved):
The guideline for dissolved calcium in mg/L is as follows: - Less than 4, highly sensitive to acid inputs - 4 to 8, moderately sensitive - Greater than 8, low sensitivity.
Note 13.4 for Chromium (dissolved):
The guideline for Cr(VI) is 1 µg/L (total). The guideline for Cr(III) is 8.9 µg/L (total). The guideline of 1 µg/L for Cr(VI) was used, in this report, to identify exceedances for dissolved chromium, and total chromium as a means for determining the potential for exceeding the Cr(VI) and/or Cr(III) guidelines.
Note 13.5 for Nickel (dissolved):
The guideline for nickel in µg/L is determined as follows: When the water hardness is 0 to ≤ 60 mg/L, the maximum is 25 µg/L At hardness > 60 to ≤ 180 mg/L the maximum is calculated using the equation: $e^{\{0.76[\ln(\text{hardness})] + 1.06\}}$ At hardness >180 mg/L, the maximum is 150 µg/L Where water hardness is reported as mg/L CaCO ₃ . If the water hardness is unknown, the maximum is 25 µg/L.
Note 13.6 for Thallium (dissolved):
30-day average, site-specific objective for the lower Columbia River, BC
14. Notes for BC CSR Generic Numerical Water Standards for Freshwater Aquatic Life (CSR AW)
General Notes:
BC Contaminated Sites Regulation, Generic Numerical Water Standards, Schedule 3.2; includes amendments up to B.C. Reg. 179/2021, July 7, 2021. Aquatic life standards assume minimum 1:10 dilution available, and are to protect freshwater life. Standards for all organic substances are for total substance concentrations. Any water sample to be analyzed for organic substances should not be filtered. Standards for surface water samples to be analyzed for heavy metals, metalloids and inorganic ions are total substance concentrations. In addition, it is recommended that surface water samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for dissolved substance concentrations. Standards for groundwater samples for heavy metals, metalloids and inorganic ions are for dissolved substance concentrations. In addition, it is recommended that groundwater samples being analyzed for heavy metals, metalloids and inorganic ions should also be analyzed for total substance concentrations.
Note 14.1 for Fluoride:
The standard for fluoride is: 2000 µg/L @ H < 50 3000 µg/L @ H ≥ 50 Where H means water hardness in mg/L as CaCO ₃ .
Note 14.2 for Sulphate:
The standard for sulfate is: 1280 mg/L @ H ≤ 30 2180 mg/L @ H 31 - 75 3090 mg/L @ H 76 - 180 4290 mg/L @ H > 180 Where H means water hardness in mg/L as CaCO ₃ .
Note 14.3 for Ammonia (total, as N):
Standard varies with pH and temperature. 10 degrees C is assumed. Consult a director for further advice. The standard for ammonia, total (as N) is: 1,310 µg/L @ pH ≥ to 8.5 3,700 µg/L @ pH 8.0 - < 8.5 11,300 µg/L @ pH 7.5 - < 8.0 18,500 µg/L @ pH 7.0 - < 7.5 18,400 µg/L @ pH < 7.0
Note 14.4 for Nitrate (as N):
Standard may not protect all amphibians. Consult director for further advice.
Note 14.5 for Nitrate + Nitrite (as N):
Standard may not protect all amphibians. Consult director for further advice.
Note 14.6 for Nitrite (as N):
Standard varies with chloride concentration. Consult a director for further advice. The standard for nitrite (as N) is: 200 µg/L (Cl < 2 mg/L) 400 µg/L (Cl 2 - < 4 mg/L) 600 µg/L (Cl 4 - < 6 mg/L) 800 µg/L (Cl 6 - < 8 mg/L) 1,000 µg/L (Cl 8 - < 10 mg/L) 2,000 µg/L (Cl ≥ 10 mg/L)
Note 14.7 for Cadmium (dissolved):
The standard for cadmium is as follows: 0.5 µg/L @ H < 30 1.5 µg/L @ H 30 - < 90 2.5 µg/L @ H 90 - < 150 3.5 µg/L @ H 150 - < 210 4 µg/L @ H ≥ 210 Where H means water hardness in mg/L as CaCO ₃ .
Note 14.8 for Chromium (dissolved):
Analytical results for chromium (all species) in water may be used to demonstrate compliance with the standards. Where the standards cannot be met based on analytical results for chromium (all species), chromium speciation may be necessary. Standard is 10 µg/L for chromium, hexavalent. Standard is 90 µg/L for chromium, trivalent. The standard of 10 µg/L was used to identify exceedances for dissolved chromium in order to demonstrate compliance with the standards.
Note 14.9 for Copper (dissolved):
The standard for copper is as follows: 20 µg/L @ H < 50 30 µg/L @ H 50 - < 75 40 µg/L @ H 75 - < 100 50 µg/L @ H 100 - < 125 60 µg/L @ H 125 - < 150 70 µg/L @ H 150 - < 175 80 µg/L @ H 175 - < 200 90 µg/L @ H ≥ 200 Where H means water hardness in mg/L as CaCO ₃ .

**Guideline Notes for Table B-1: 2023 Groundwater Quality Results
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Note 14.10 for Lead (dissolved):

The standard for lead is as follows:

40 µg/L @ H < 50

50 µg/L @ H 50 - < 100

60 µg/L @ H 100 - < 200

110 µg/L @ H 200 - < 300

160 µg/L @ ≥ 300

Where H means water hardness in mg/L as CaCO₃.

Note 14.11 for Nickel (dissolved):

The standard for nickel is as follows:

250 µg/L @ H < 60

650 µg/L @ H 60 - < 120

1,100 µg/L @ H 120 - < 180

1,500 µg/L @ H ≥ 180

Where H means water hardness in mg/L as CaCO₃.

Note 14.12 for Silver (dissolved):

The standard for silver is:

0.5 µg/L @ H ≤ 100

15 µg/L @ H > 100

Where H means water hardness in mg/L as CaCO₃.

Note 14.13 for Zinc (dissolved):

The standard for zinc is as follows:

75 µg/L @ H < 90

150 µg/L @ H = 90 - < 100

900 µg/L @ H = 100 - < 200

1,650 µg/L @ H = 200 - < 300

2,400 µg/L @ H = 300 - < 400

3,150 µg/L @ H = 400 - < 500

If H ≥ 500 then use following formula:

Standard (µg/L) = $10 \times [7.5 + \{(0.75)(H - 90)\}]$

Where H means water hardness in mg/L as CaCO₃.

There are special ministry approval and data reporting requirements for water hardness values ≥ 500 mg/L as CaCO₃.

Reference is Schedule 3.2 and Protocol 10.

Table B-2: 2023 Bailey Springs Results
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Legend for Table B-2:

<	Less than reported detection limit
>	Greater than reported upper detection limit
BC RWQG	BC Recreational Water Quality Guidelines (2019)
BCAWQG AL (LT)	BC Approved Water Quality Guidelines for freshwater aquatic life (Long-term chronic)
BCAWQG AL (ST)	BC Approved Water Quality Guidelines for freshwater aquatic life (Short-term acute)
BCWWQG AL	BC Working Water Quality Guidelines for Freshwater Aquatic Life
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
N	Narrative type of guideline or standard, or Result Note.
NG	No Guideline
BC RWQG	Highlighted value exceeds BC RWQG
BCAWQG AL (LT)	Highlighted value exceeds BCAWQG AL (LT)
BCAWQG AL (ST)	Highlighted value exceeds BCAWQG AL (ST)
BCWWQG AL	Highlighted value exceeds BCWWQG AL

Table B-2: 2023 Bailey Springs Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

Analyte	Unit	Guideline				Sample Type	Sampling Location	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	Bailey Springs	
		BCAWQG AL (ST)	BCAWQG AL (LT)	BCWWQG AL	BC RWQG		Date Sampled	10-Jan-23	10-Jan-23	02-Feb-23	15-Mar-23	14-Apr-23	05-May-23	21-Jun-23	10-Jul-23	16-Aug-23	16-Aug-23	21-Sep-23	20-Oct-23	16-Nov-23	06-Dec-23
		AL (ST)	AL (LT)	AL			Normal	Duplicate	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Field Results																					
Temperature	°C	19 ^{1.1}	NG	NG	N ^{3.1}	-	-	-	5	-	12	-	-	-	-	-	-	-	-		
Lab Results																					
General																					
Chloride	mg/L	600 ^{1.2}	150 ^{2.1}	NG	NG	133	150	162	177	174	177	180	168	158	160	165	153	167	171		
Conductivity	µS/cm	NG	NG	NG	NG	1310	1300	1320	1360	1320	1310	1250	1250	1240	1250	1310	1310	1300	1340		
pH		NG	N ^{2.2}	NG	5.0 - 9.0	8.37	8.38	8.29	8.32	8.36	8.47	8.31	8.42	8.46	8.46	8.49	8.3	8.38	8.38		
Nutrients																					
Ammonia (total, as N)	mg/L	Calc ^{1.3}	Calc ^{2.3}	NG	NG	0.294	0.077	<0.050	<0.050	0.069	<0.050	0.123	<0.050	0.085	0.083	<0.050	<0.050	<0.050	<0.050		
Nitrate (as N)	mg/L	32.8 ^{1.4}	3.0 ^{2.4}	NG	10	0.344	0.345	0.573	0.387	0.254	0.09	0.108	<0.010	<0.010	<0.010	<0.010	<0.010	0.128	0.19		
Nitrate + Nitrite (as N)	mg/L	NG	NG	NG	NG	0.344	0.345	0.573	0.387	0.254	0.0895	0.108	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.128	0.19		
Nitrite (as N)	mg/L	Calc ^{1.5}	Calc ^{2.5}	NG	1.0	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Total nitrogen	mg/L	NG	NG	NG	NG	0.824	0.809	1.05	0.803	0.64	0.54	0.941	0.618	0.792	0.823	0.637	0.497	0.579	0.51		
Total kjeldahl nitrogen	mg/L	NG	NG	NG	NG	0.48	0.464	0.478	0.416	0.386	0.451	0.833	0.618	0.792	0.823	0.637	0.497	0.451	0.32		
Total organic nitrogen	mg/L	NG	NG	NG	NG	0.186	0.387	0.478	0.416	0.317	0.451	0.71	0.618	0.707	0.74	0.637	0.497	0.451	0.32		
Orthophosphate (dissolved, as P)	mg/L	NG	NG	NG	NG	0.0608	0.0658	0.0482	0.0403	0.0245	0.0315	0.0056	0.0313	0.0749	0.0771	0.0145	0.0321	0.0571	0.105		
Phosphorus (total, APHA 4500-P)	mg/L	NG	N ^{2.6}	NG	N ^{3.2}	0.0992	0.0994	0.142	0.107	0.0924	0.114	0.189	0.166	0.188	0.189	0.166	0.118	0.103	0.128		
Phosphorus (dissolved, APHA 4500-P)	mg/L	NG	N ^{2.7}	NG	N ^{3.3}	0.0927	0.0913	0.137	0.101	0.0861	0.0945	0.136	0.132	0.142	0.144	0.135	0.0882	0.0945	0.11		
Microbiological																					
Total coliforms (MPN)	MPN/100 mL	NG	NG	NG	NG	435	580	579	77	201	1550	>2420	>2420	21000	26000	5630	2410	412	1460		
Fecal coliforms (MPN)	MPN/100 mL	NG	N ^{2.8}	NG	NG	33	16	2	5	67	10	921	488	770	921	866	31	3	12		
Total Metals																					
Sodium (total)	mg/L	NG	NG	NG	NG	124	125	128	134	125	131	134	130	136	137	132	133	148	133		



Guideline Notes for Table B-2: 2023 Bailey Springs Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

1. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (Short-term acute) (BCAWQG AL (ST))

General Notes:

References: British Columbia Ministry of Environment and Climate Change Strategy. November 2023. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary; and B.C. Guideline Overview and Technical Reports. / There are two types of water quality guidelines: the short-term acute guideline (i.e. maximum), and the long-term chronic guideline (i.e. average). Only the short-term acute guidelines are included in this criteria set.

Note 1.1 for Temperature:

The freshwater aquatic life guideline for streams with unknown fish distribution is:
 Maximum daily temperature of 19 degrees Celsius;
 MWMT = 18 degrees Celsius. (MWMT, mean weekly short-term temperature, is defined as the average of the warmest daily short-term temperatures for 7 consecutive days;
 Hourly rate of change not to exceed 1 degree Celsius;
 Short-term incubation temperature = 12 degrees Celsius (in spring and fall).
 See BC MOE Overview Report for additional details for streams with unknown fish distribution, and specific guidelines for streams with known fish distribution, and guideline for lakes and impoundments.

Note 1.2 for Chloride:

To protect freshwater aquatic life from acute and lethal effects, the maximum concentration of chloride (mg/L as NaCl) at any time should not exceed 600 mg/L. When ambient chloride concentrations exceed guidelines, increases in chloride due to human activities should be avoided.

Note 1.3 for Ammonia (total, as N):

The freshwater aquatic life short-term acute guideline for ammonia varies as a function of pH and temperature. See Table 3 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia for this report. If a lab pH result was not available then the field pH result was used.

Note 1.4 for Nitrate (as N):

Freshwater aquatic life short-term acute guideline.

Note 1.5 for Nitrite (as N):

The freshwater aquatic life short-term acute guideline for nitrite as N is:
 0.06 mg/L if chloride less than 2 mg/L
 0.12 mg/L if chloride is 2 to 4 mg/L
 0.18 mg/L if chloride is 4 to 6 mg/L
 0.24 mg/L if chloride is 6 to 8 mg/L
 0.30 mg/L if chloride is 8 to 10 mg/L
 0.60 mg/L if chloride is greater than 10 mg/L.

2. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (Long-term chronic) (BCAWQG AL (LT))

General Notes:

References: British Columbia Ministry of Environment and Climate Change Strategy. November 2023. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture - Guideline Summary; and B.C. Guideline Overview and Technical Reports. / There are two types of water quality guidelines: the short-term acute guideline (i.e. maximum), and the long-term chronic guideline (i.e. average). Only the long-term chronic guidelines are included in this criteria set.

Note 2.1 for Chloride:

To protect freshwater aquatic life from chronic effects, the average (arithmetic mean computed from five weekly samples collected over a 30-day period) concentration of chloride (mg/L as NaCl) should not exceed 150 mg/L. When ambient chloride concentrations exceed guidelines, increases in chloride due to human activities should be avoided.

Note 2.2 for pH:

The freshwater aquatic life long-term chronic guideline is:
 pH less than 6.5: No statistically significant decrease in pH from background;
 pH from 6.5 to 9.0: Unrestricted change permitted within this range;
 pH over 9.0: No statistically significant increase in pH from background.
 See BC MOE Overview Report for additional details.

Note 2.3 for Ammonia (total, as N):

The freshwater aquatic life long-term chronic guideline for ammonia varies as a function of pH and temperature. See Table 4 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia concentration for this report. If a lab pH result was not available then the field pH result was used.

Guideline Notes for Table B-2: 2023 Bailey Springs Results
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Note 2.4 for Nitrate (as N):
Freshwater aquatic life long-term chronic guideline.
Note 2.5 for Nitrite (as N):
The freshwater aquatic life long-term chronic guideline for nitrite as N is: 0.02 mg/L if chloride less than 2 mg/L 0.04 mg/L if chloride is 2 to 4 mg/L 0.06 mg/L if chloride is 4 to 6 mg/L 0.08 mg/L if chloride is 6 to 8 mg/L 0.10 mg/L if chloride is 8 to 10 mg/L 0.20 mg/L if chloride is greater than 10 mg/L.
Note 2.6 for Phosphorus (total, APHA 4500-P):
Streams: None proposed for streams. Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.
Note 2.7 for Phosphorus (dissolved, APHA 4500-P):
Streams: None proposed for streams. Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.
Note 2.8 for Fecal coliforms (MPN):
There are insufficient data to set criteria for microbiological indicators for the protection of the health of aquatic organisms. The criteria below are for fresh or marine waters used for the growth and harvesting of shellfish for human consumption where the shellfish may be eaten raw and are used directly without a cleansing period prior to killing. The fecal coliform density in fresh and marine waters used for the growing and harvesting of shellfish for human consumption should not exceed a median MPN of 14/100 mL over 30 days, and at least 90% of the samples in a 30-day period should not exceed 43/100 mL.
3. Notes for BC Recreational Water Quality Guidelines (2019) (BC RWQG)
General Notes:
Reference: British Columbia Ministry of Environment and Climate Change Strategy. 2019. B.C. Recreational Water Quality Guidelines: Guideline Summary. The guidelines are for primary contact recreational uses. Primary contact is defined as activities, such as swimming (this includes bathing/wading for the purposes of this document), windsurfing and waterskiing, as well as secondary contact activities, such as canoeing or fishing, in natural waters through intentional or incidental immersion.
Note 3.1 for Temperature:
No numerical guideline is recommended. Precise guideline values for the temperature of waters to be used for swimming cannot be established. Tolerance to water temperatures can vary considerably from individual to individual. Users should not engage in recreational activities at temperature-time combinations sufficient to cause an appreciable increase or decrease in their core body temperature (Health Canada 2012).
Note 3.2 for Phosphorus (total, APHA 4500-P):
The guideline for lakes is 0.01 mg/L.
Note 3.3 for Phosphorus (dissolved, APHA 4500-P):
The guideline for lakes is 0.01 mg/L.

Table B-3: 2023 Clay Valve #4 Results
City of Vernon Reclaimed Water Irrigation Groundwater Monitoring Program

Sampling Location		Clay Valve #4	Clay Valve #4	Clay Valve #4	Clay Valve #4	Clay Valve #4	Clay Valve #4	Clay Valve #4	Clay Valve #4	Clay Valve #4
Date Sampled		30-May-23	31-May-23	23-Jun-23	10-Jul-23	16-Aug-23	20-Sep-23	20-Sep-23	28-Sep-23	28-Sep-23
Lab Sample ID										
Sample Type		Normal	Normal	Normal	Normal	Normal	Normal	Duplicate	Normal	Normal
Analyte	Unit									
Lab Results										
General										
Biochemical oxygen demand	mg/L	<6.7	7.8	<7.4	<5.6	<6.4			<6.5	<6.5
Chloride	mg/L	91.7	91.3	94.3	91.7	94.6	103	100		
Fluoride	mg/L	0.2	0.2							
Hardness (as CaCO3), dissolved	mg/L	203	209	231	241	239				
pH		7.65	7.63	8.11	8.17	8.1	7.97	8.02		
Total dissolved solids	mg/L	517	504	519	533	537	573	565		
Total suspended solids	mg/L	<3.3	<2.0	<2.0	<2.0	5.4	5	5		
Sulphate	mg/L	84.6	80.8	85.8	84.1	88.2	110	99		
Turbidity	NTU	0.66	0.88	1.61	0.65	1.59	3.33	2.94		
Nutrients										
Ammonia (total, as N)	mg/L	0.471	0.456	0.552	0.455	0.785	1.25	1.25		
Nitrate (as N)	mg/L	0.984	0.967	0.87	0.783	0.87	0.38	0.367		
Nitrate + Nitrite (as N)	mg/L	0.995	0.967	0.897	0.783	0.942	0.42	0.409		
Nitrite (as N)	mg/L	0.011	<0.010	0.028	<0.010	0.072	0.04	0.042		
Total nitrogen	mg/L	2.25	2.32	2.49	2.12	2.77	2.84	2.74		
Total kjeldahl nitrogen	mg/L	1.25	1.36	1.59	1.33	1.83	2.42	2.34		
Total organic nitrogen	mg/L	0.78	0.899	1.04	0.878	1.04	1.17	1.09		
Orthophosphate (dissolved, as P)	mg/L	0.355	0.389	0.351	0.264	0.524	0.743	0.772		
Phosphorus (total, APHA 4500-P)	mg/L	0.712	0.695	0.79	0.687	0.915	1.15	1.15		
Phosphorus (dissolved, APHA 4500-P)	mg/L	<0.0100	0.683	0.77	0.649	0.893	1.13	1.12		
Potassium (dissolved)	mg/L	19.6	21.9	20.4	21.3	21	21.9	21.7		
Microbiological										
Total coliforms (MPN)	MPN/100 mL	45	7	<1	4	<1	3	2		
Fecal coliforms (MPN)	MPN/100 mL	<1	<1	<1	<1	<1	3	2		
Total Metals										
Sodium (total)	mg/L	89.1	98.2	89.1	87.5	96.9	98.6	97.5		
Dissolved Metals										
Aluminum (dissolved)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0053	<0.0050		
Antimony (dissolved)	mg/L	0.00027	0.00028	0.00023	0.00025	0.00029	0.00029	0.00031		
Arsenic (dissolved)	mg/L	0.00092	0.00089	0.00074	0.00091	0.00088	0.0009	0.00095		
Barium (dissolved)	mg/L	0.0328	0.0308	0.0312	0.0288	0.0284	0.0278	0.0277		
Beryllium (dissolved)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		
Bismuth (dissolved)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		
Boron (dissolved)	mg/L	0.224	0.191	0.173	0.198	0.187	0.194	0.194		
Cadmium (dissolved)	mg/L	0.000011	0.00001	<0.000010	0.000011	<0.000010	0.000012	0.000015		
Calcium (dissolved)	mg/L	40.6	45.3	55.1	56	57.9	55.5	55.1		
Chromium (dissolved)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Cobalt (dissolved)	mg/L	0.00028	0.00027	0.00027	0.00027	0.0003	0.00031	0.00032		
Copper (dissolved)	mg/L	0.00545	0.00466	0.00448	0.00435	0.00262	0.00322	0.00314		
Iron (dissolved)	mg/L	0.025	0.022	0.026	0.019	0.072	0.107	0.109		
Lead (dissolved)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Lithium (dissolved)	mg/L	0.00983	0.0105	0.00867	0.0104	0.00999	0.01	0.01		
Magnesium (dissolved)	mg/L	24.6	23.3	22.7	24.5	23	23.7	23.4		
Manganese (dissolved)	mg/L	0.0684	0.0574	0.0746	0.0595	0.115	0.179	0.18		
Molybdenum (dissolved)	mg/L	0.00341	0.00329	0.00332	0.00295	0.00275	0.00279	0.00283		
Nickel (dissolved)	mg/L	0.00198	0.00179	0.00176	0.00166	0.00204	0.00199	0.00197		
Selenium (dissolved)	mg/L	0.0006	0.00052	0.00057	0.00054	<0.00050	0.00051	<0.00050		
Silicon (dissolved, as Si)	mg/L	1.8	1.8	2	2.2	2.2	2.6	2.6		
Silver (dissolved)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		
Sodium (dissolved)	mg/L	105	96.6	93.2	101	102	102	101		
Strontium (dissolved)	mg/L	0.576	0.565	0.548	0.545	0.561	0.556	0.57		
Sulphur (dissolved)	mg/L	32.6	31.7	30.5	33.3	33.8	37	37.6		
Tellurium (dissolved)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050		
Thallium (dissolved)	mg/L	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020		
Thorium (dissolved)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010		
Tin (dissolved)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Titanium (dissolved)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		
Tungsten (dissolved)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Uranium (dissolved)	mg/L	0.00167	0.00166	0.00174	0.00171	0.00132	0.00124	0.00125		
Vanadium (dissolved)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		
Zinc (dissolved)	mg/L	0.0291	0.0268	0.0245	0.0263	0.0241	0.0238	0.0228		
Zirconium (dissolved)	mg/L	<0.00010	<0.00010	0.00011	<0.00010	<0.00010	<0.00010	<0.00010		



APPENDIX C – TIME-SERIES PLOTS

List of Acronyms:

GCDWQ MAC	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations
GCDWQ AO	Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives
BC SDWQG MAC	BC Source Drinking Water Quality Guidelines - Maximum Acceptable Concentrations
BC SDWQG AO	BC Source Drinking Water Quality Guidelines - Aesthetic Objectives
CSR DW	BC CSR Generic Numerical Water Standards for Drinking Water
BCAWQG I	BC Approved Water Quality Guidelines for Irrigation
BCWWQG I	BC Working Water Quality Guidelines for Irrigation
CSR IW	BC CSR Generic Numerical Water Standards for Irrigation
BCAWQG L	BC Approved Water Quality Guidelines for Livestock
BCWWQG L	BC Working Water Quality Guidelines for Livestock
CSR LW	BC CSR Generic Numerical Water Standards for Livestock
BCAWQG AL (ST)	BC Approved Water Quality Guidelines for Freshwater Aquatic Life (short-term; acute)
BCAWQG AL (LT)	BC Approved Water Quality Guidelines for Freshwater Aquatic Life (long-term; chronic – Bailey Springs only)
BCWWQG AL	BC Working Water Quality Guidelines for Freshwater Aquatic Life
CSR AW	BC CSR Generic Numerical Water Standards for Freshwater Aquatic Life
BC RWQG	BC Recreational Water Quality Guidelines (Bailey Springs only)
Calc	Calculated guideline: the guideline is dependent on the value of one or more other analytes, and is calculated from a formula or table. Therefore, it is not shown on the plot. Refer to guideline notes in Appendix C for further details.
N	Narrative type of guideline; therefore, it is not shown on the plot. Refer to guideline notes in Appendix C for further details.

Note: On all plots, results that were below detection are plotted at one-half the detection limit. Guidelines are only shown on the figures if there is an applicable guideline for that parameter.

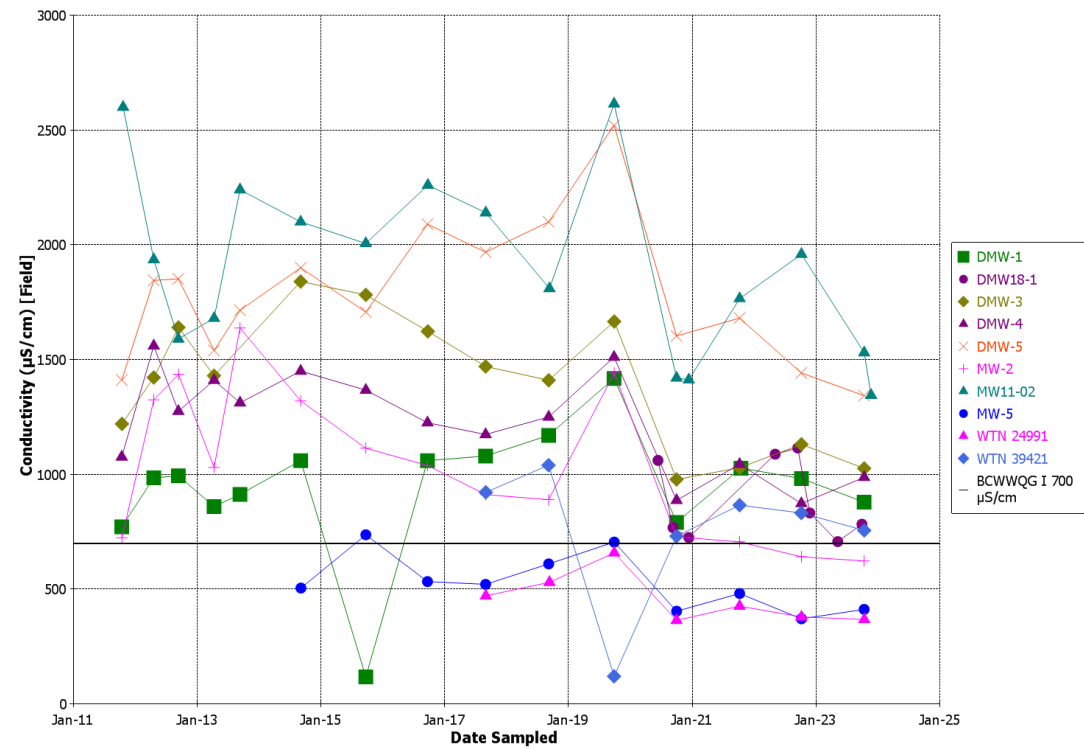


Figure C-1: Plot of field-measured conductivity in groundwater (all data since 2011)¹

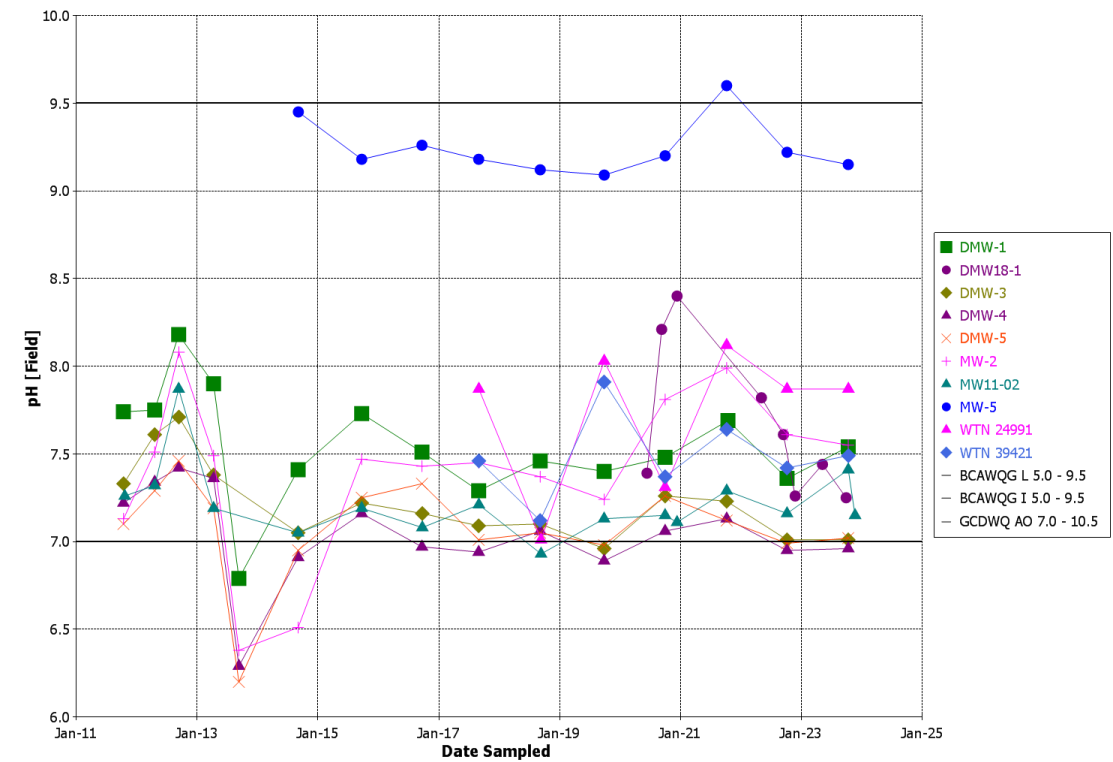


Figure C-2: Plot of field-measured pH in groundwater (all data since 2011)¹

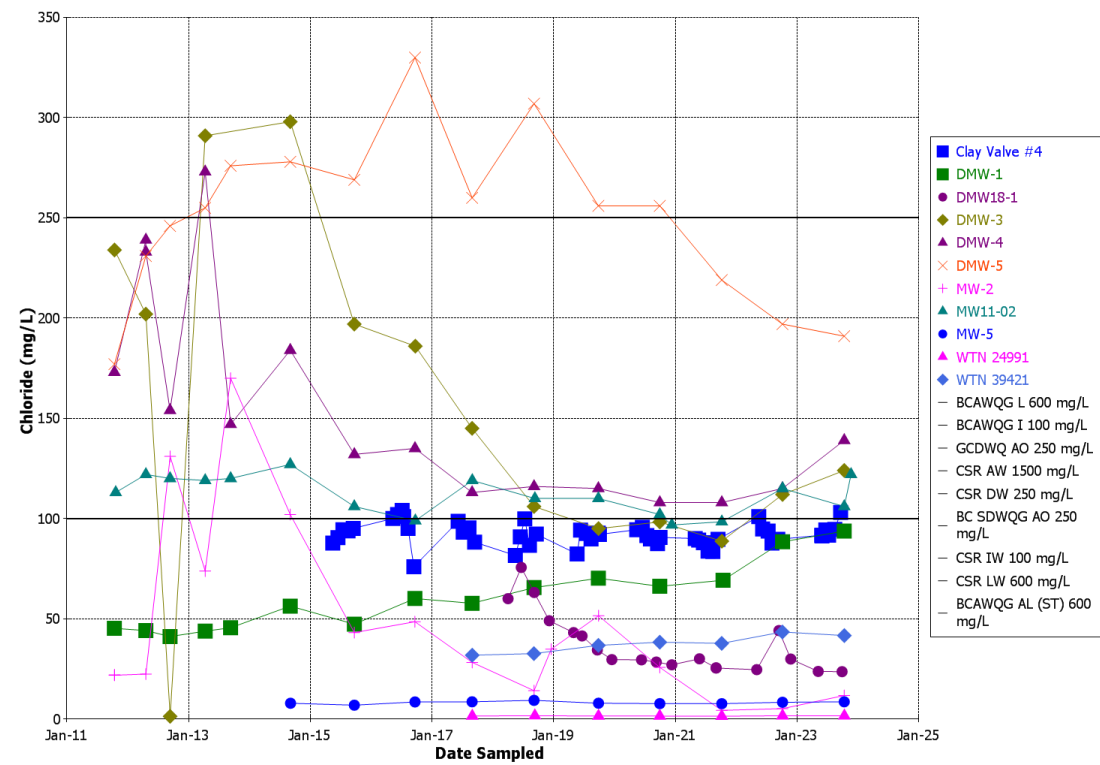


Figure C-3: Plot of chloride in groundwater and Clay Valve #4 (all data since 2011)

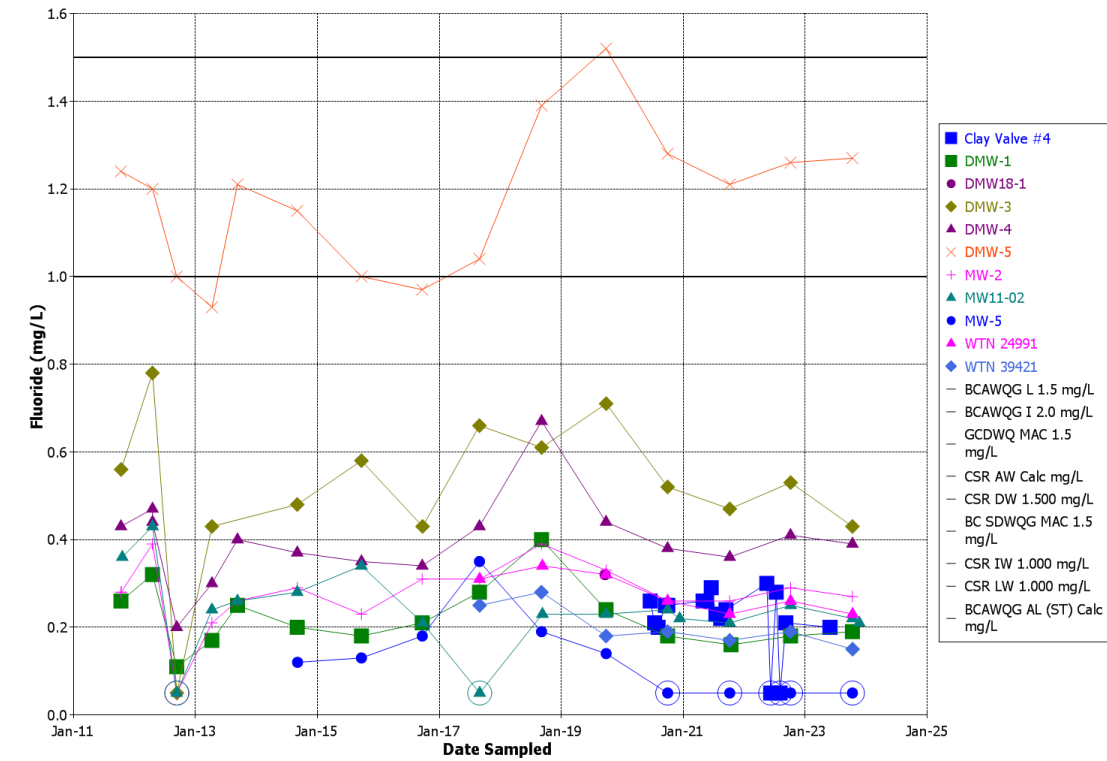


Figure C-4: Plot of fluoride in groundwater and Clay Valve #4 (all data since 2011)

¹ Conductivity and pH for Clay Valve #4 is not shown on Figures C-1 and C-2 because it is measured in the laboratory, and the figures show field-measured data only. Clay Valve #4 results from 2023 can be found in Appendix B.

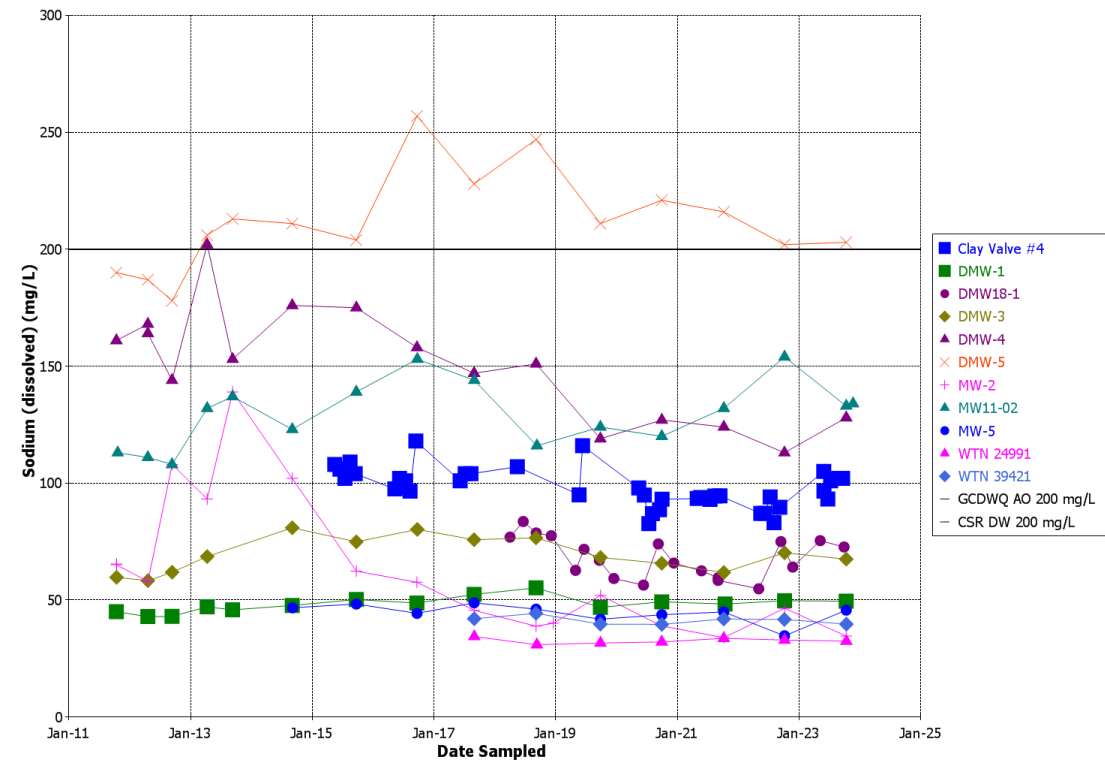


Figure C-5: Plot of dissolved sodium in groundwater and Clay Valve #4 (all data since 2011)

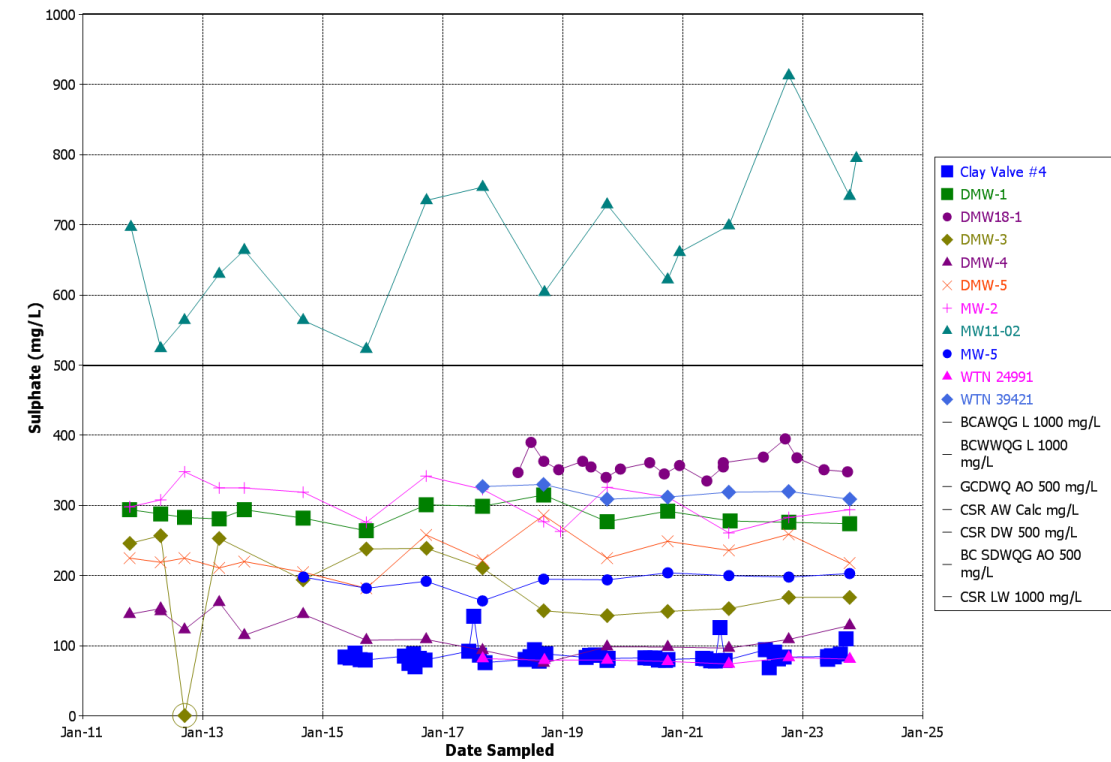


Figure C-6: Plot of sulphate in groundwater and Clay Valve #4 (all data since 2011)

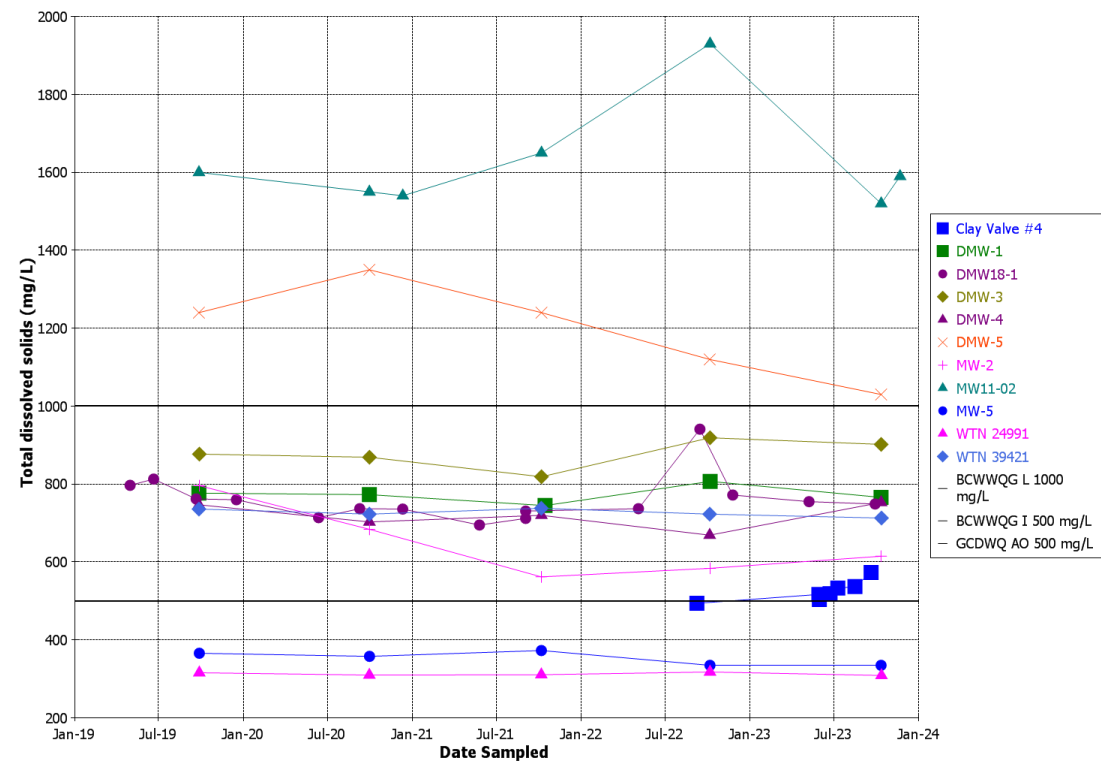


Figure C-7: Plot of TDS in groundwater since 2019 (i.e., since monitoring of TDS began)

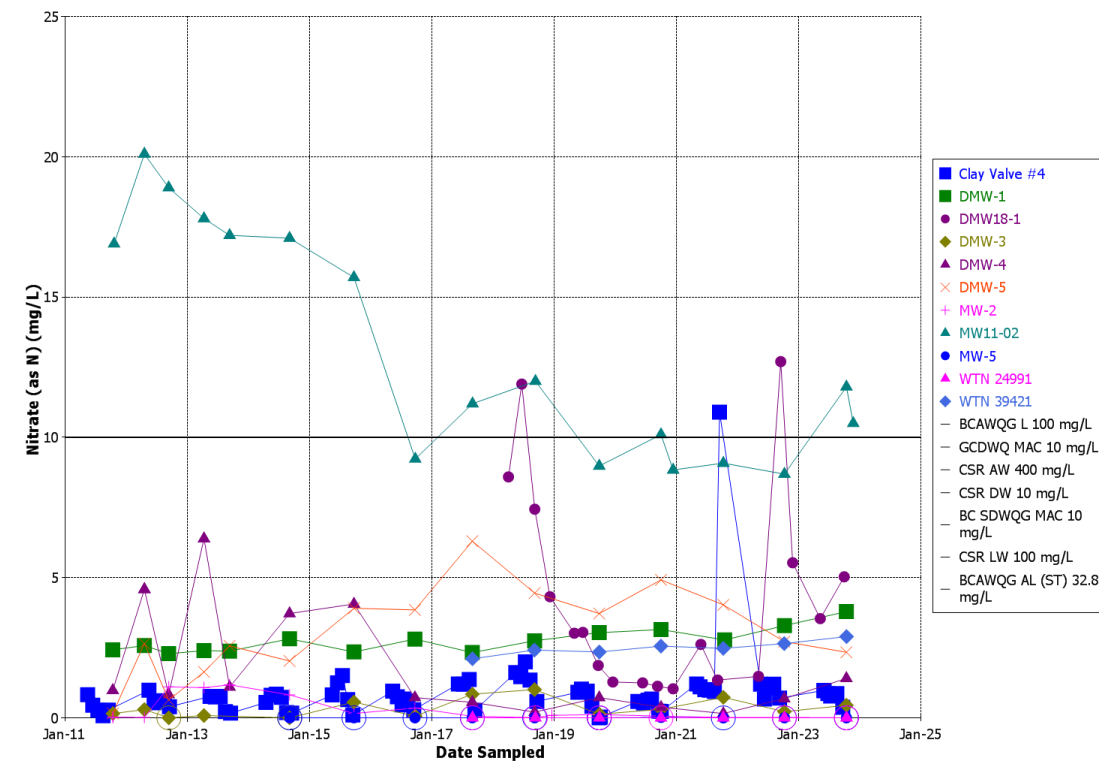


Figure C-8: Plot of nitrate-N in groundwater and Clay Valve #4 (all data since 2011)

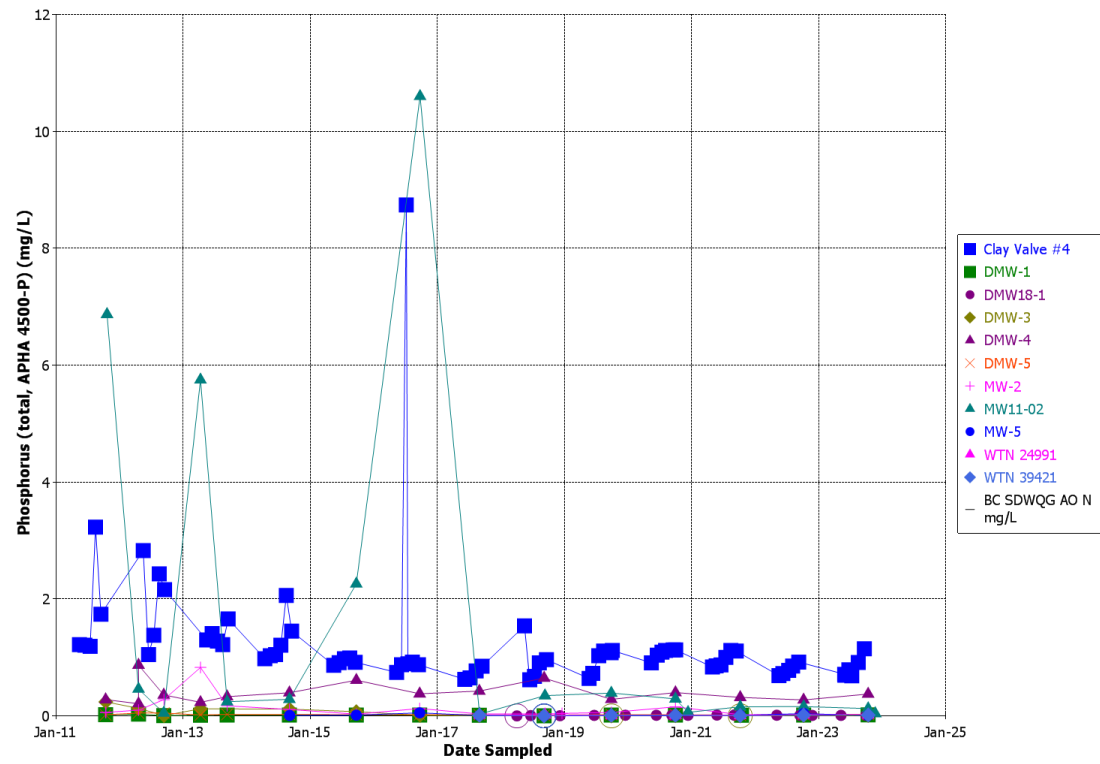


Figure C-9: Plot of total phosphorus in groundwater and Clay Valve #4 (all data since 2011)

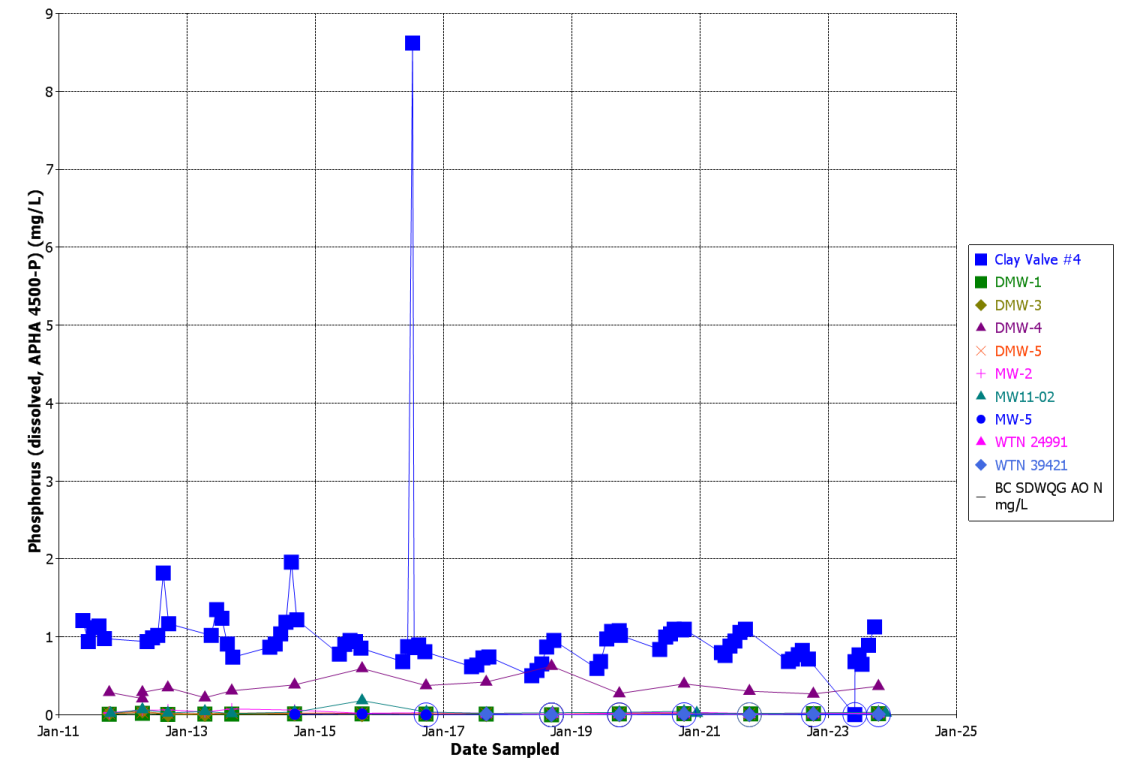


Figure C-10: Plot of dissolved phosphorus in groundwater and Clay Valve #4 (all data since 2011)

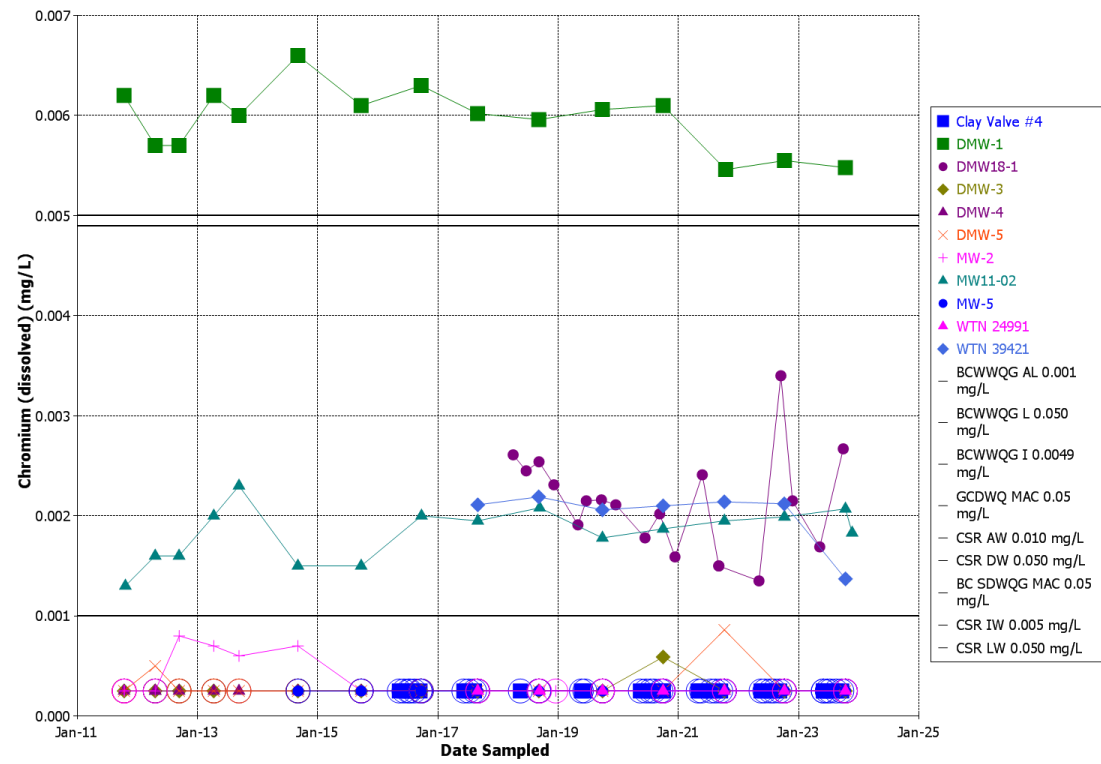


Figure C-11: Plot of dissolved chromium in groundwater and Clay Valve #4 (all data since 2011)

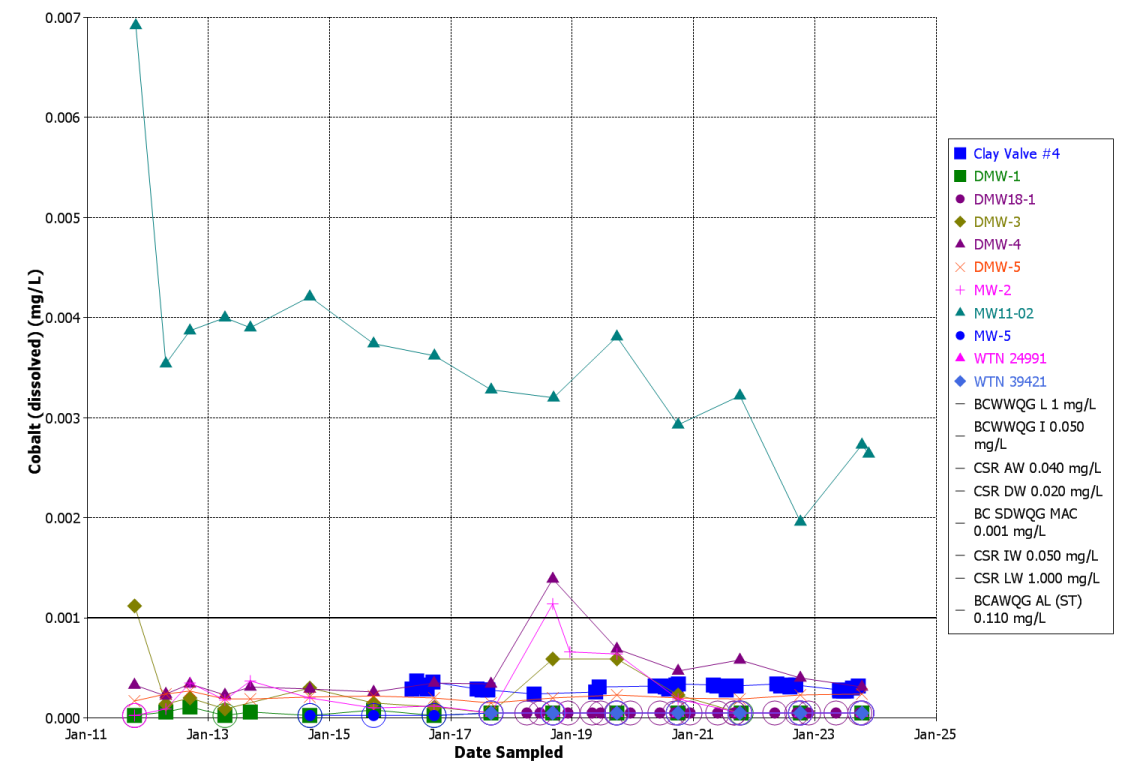


Figure C-12: Plot of dissolved cobalt in groundwater and Clay Valve #4 (all data since 2011)

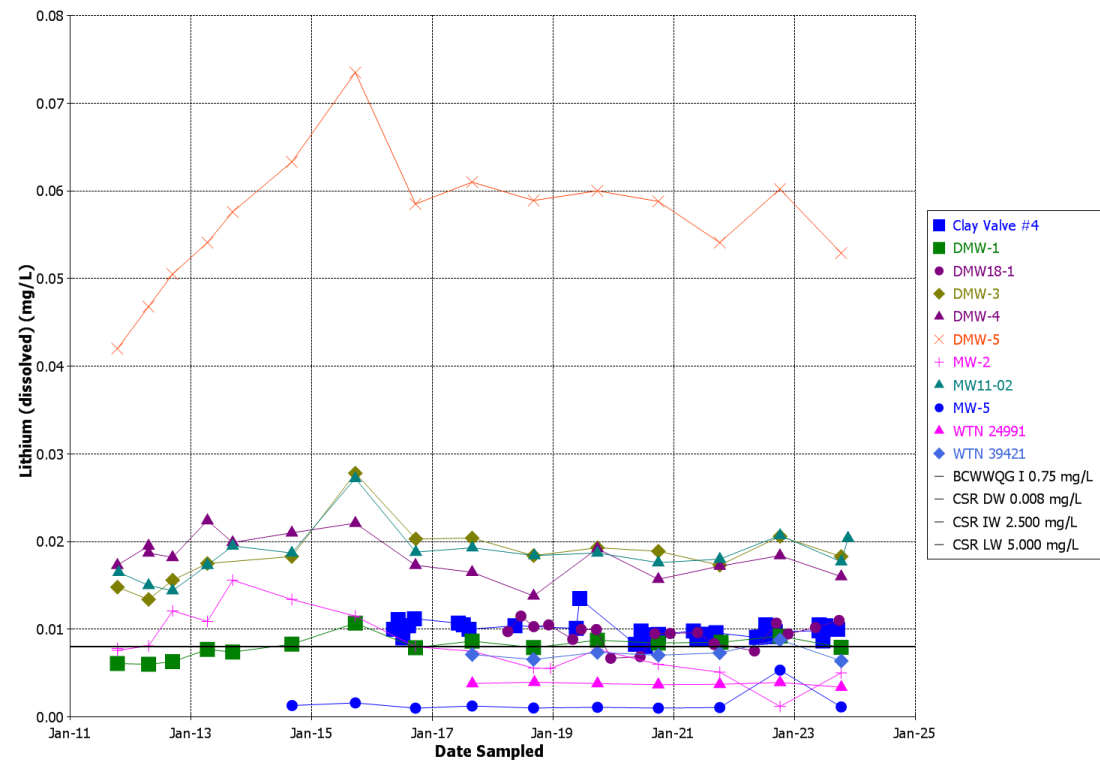


Figure C-13: Plot of dissolved lithium in groundwater and Clay Valve #4 (all data since 2011)

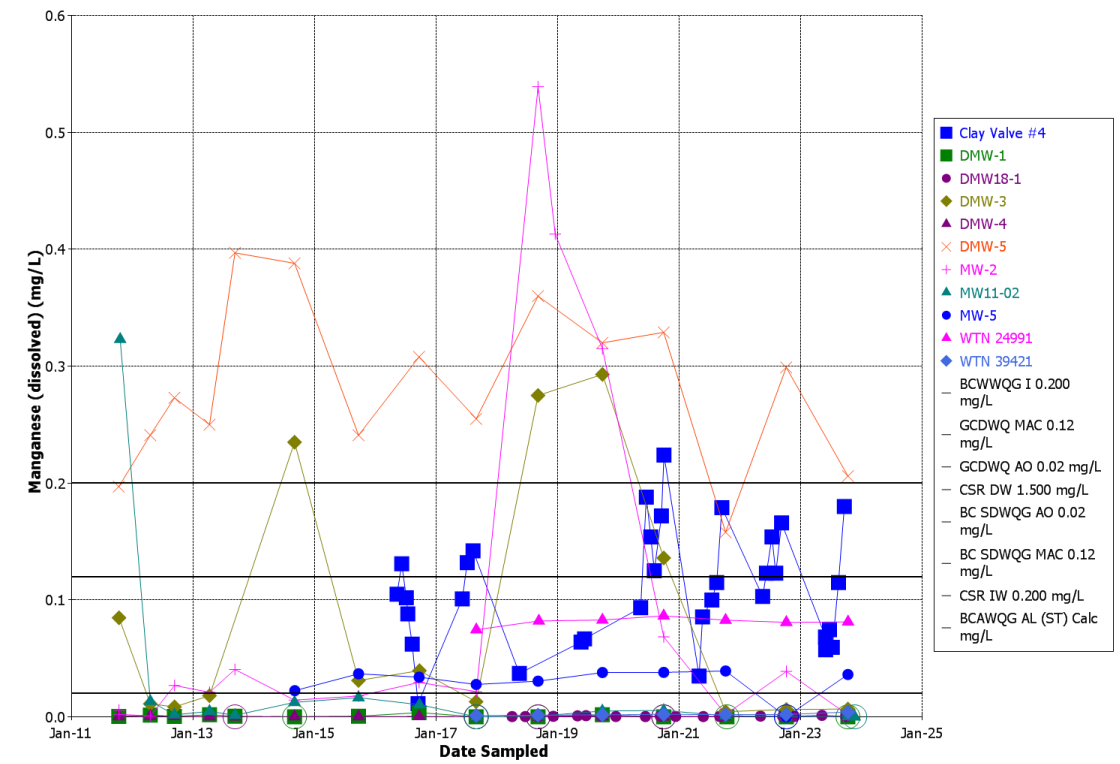


Figure C-14: Plot of dissolved manganese in groundwater and Clay Valve #4 (all data since 2011)

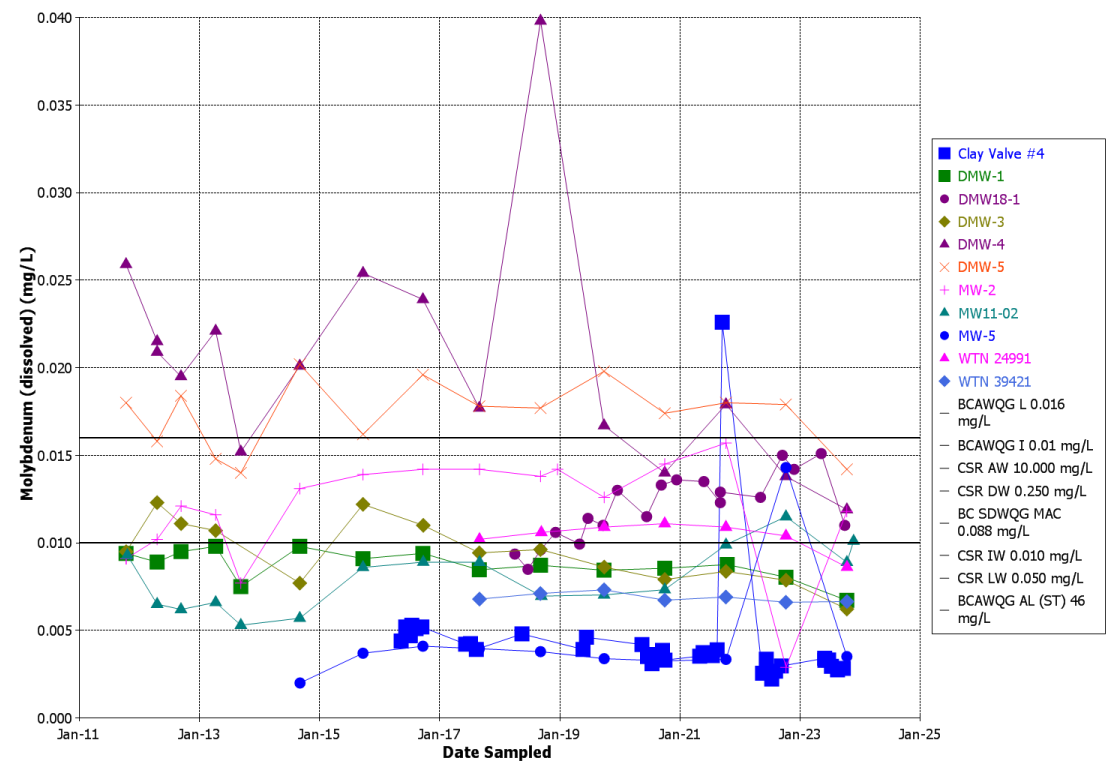


Figure C-15: Plot of dissolved molybdenum in groundwater and Clay Valve #4 (all data since 2011)

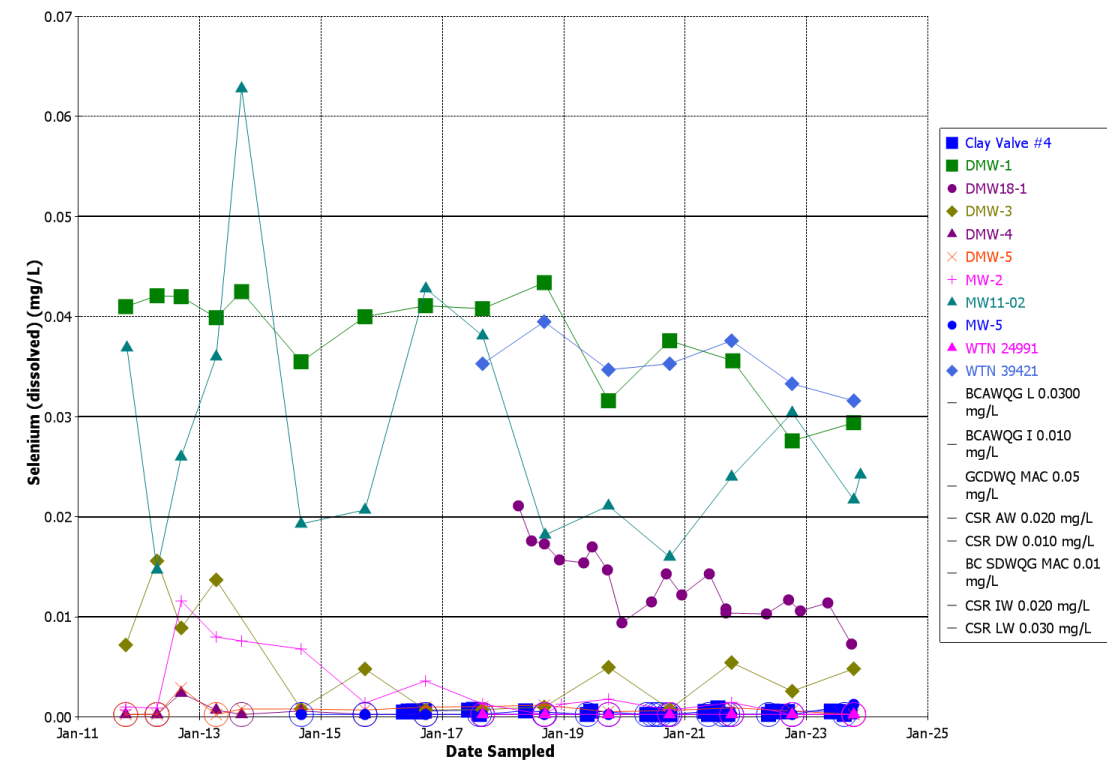


Figure C-16: Plot of dissolved selenium in groundwater and Clay Valve #4 (all data since 2011)

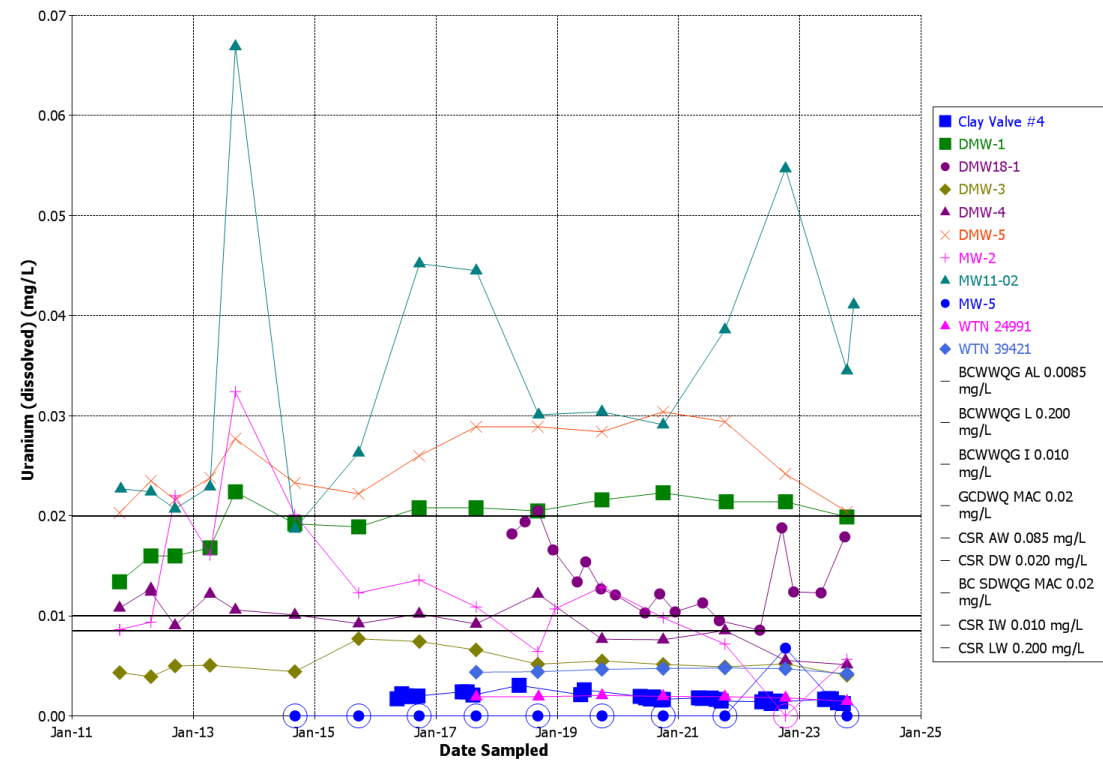


Figure C-17: Plot of dissolved uranium in groundwater and Clay Valve #4 (all data since 2011)

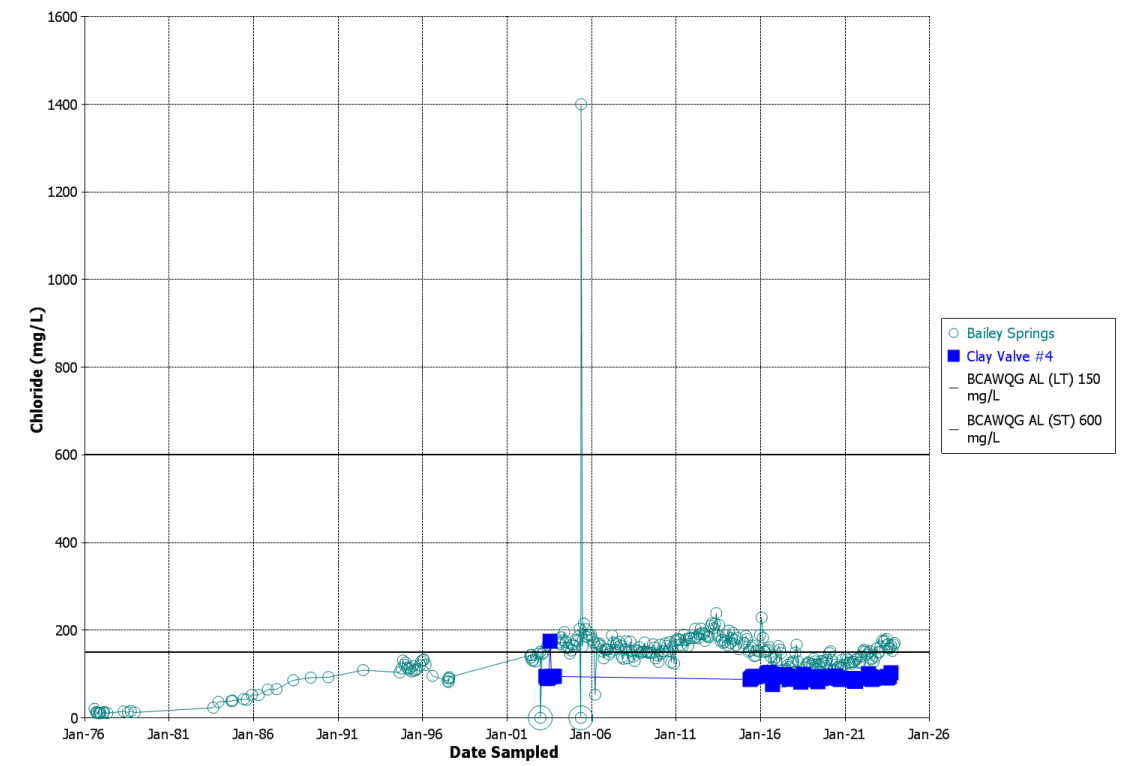


Figure C-18: Plot of chloride in Bailey Springs and Clay Valve #4 (all data)

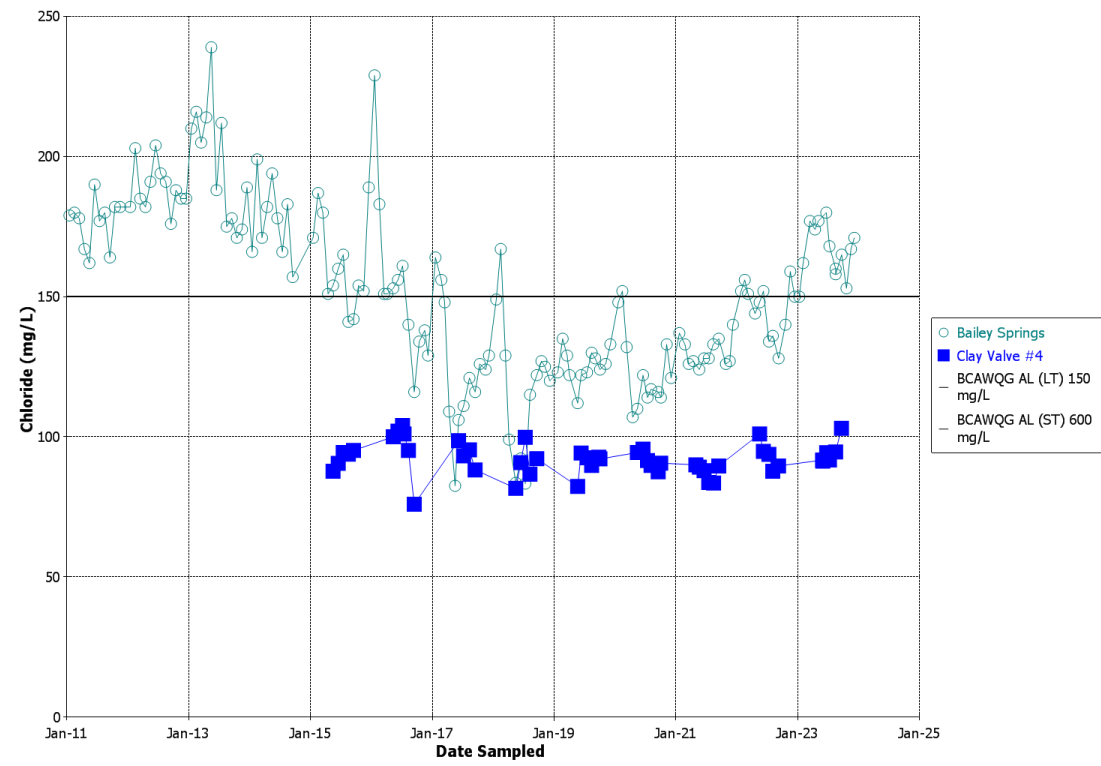


Figure C-19: Plot of chloride in Bailey Springs and Clay Valve #4 (data since 2011)

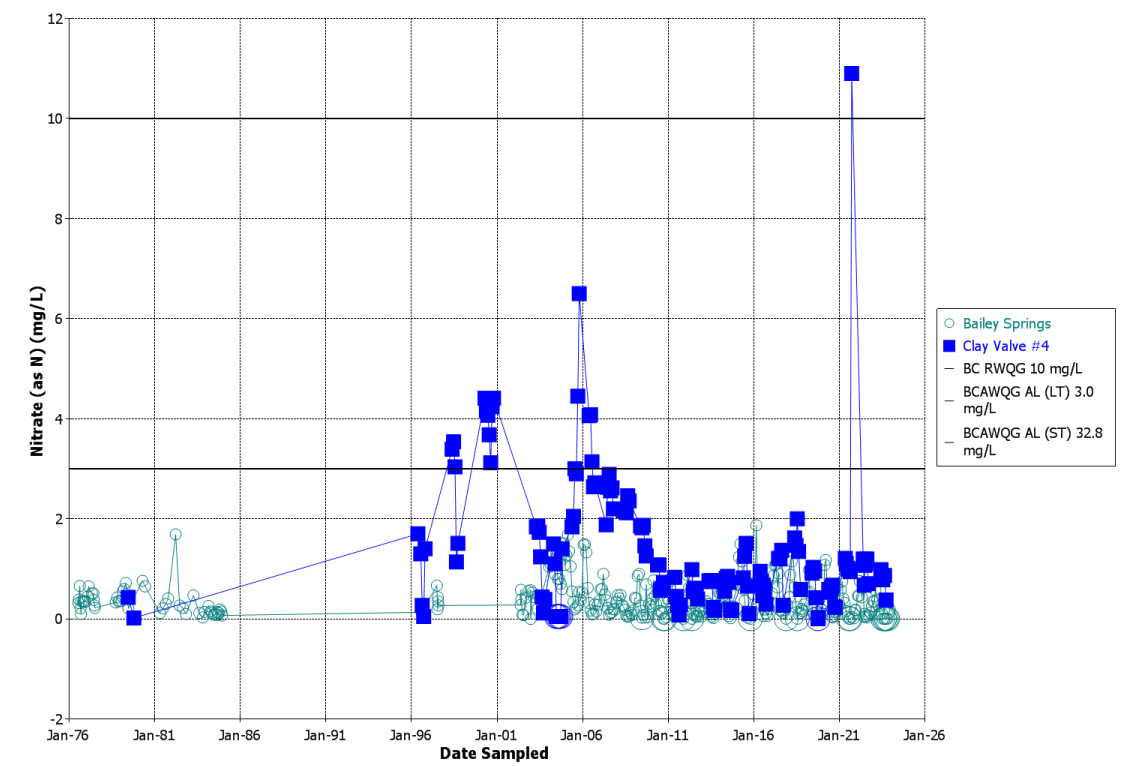


Figure C-20: Plot of nitrate-N in Bailey Springs and Clay Valve #4 (all data)

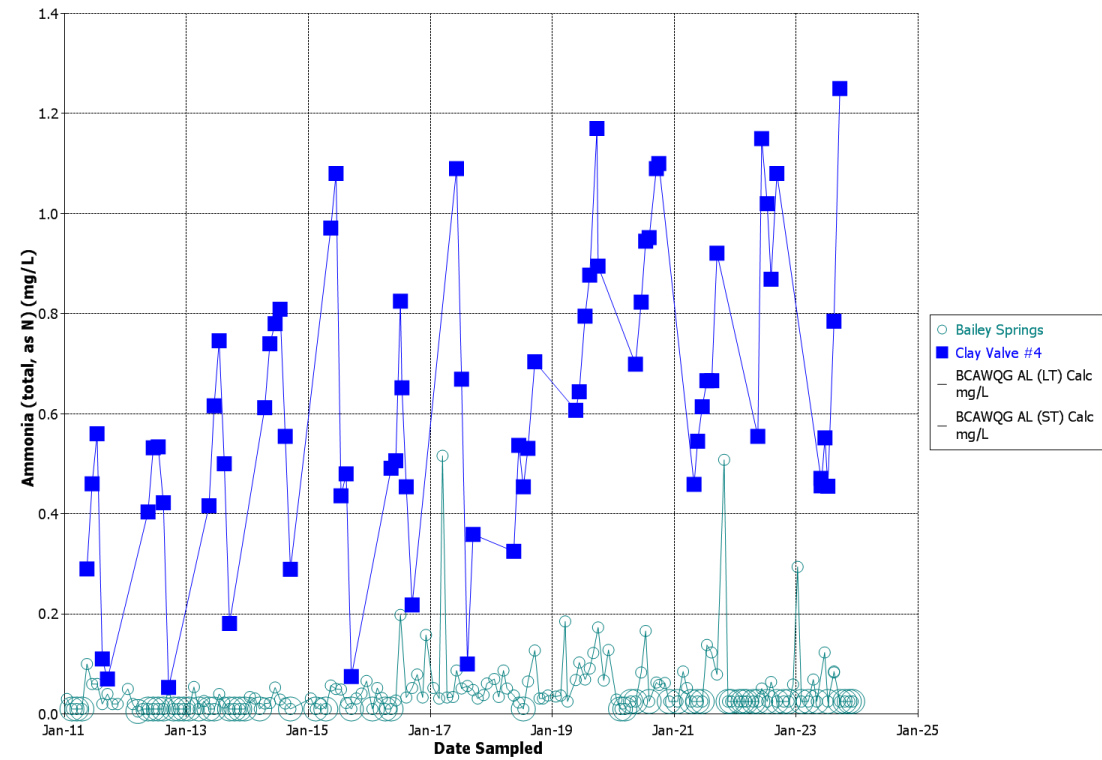


Figure C-21: Plot of ammonia-N in Bailey Springs and Clay Valve #4 (all data)

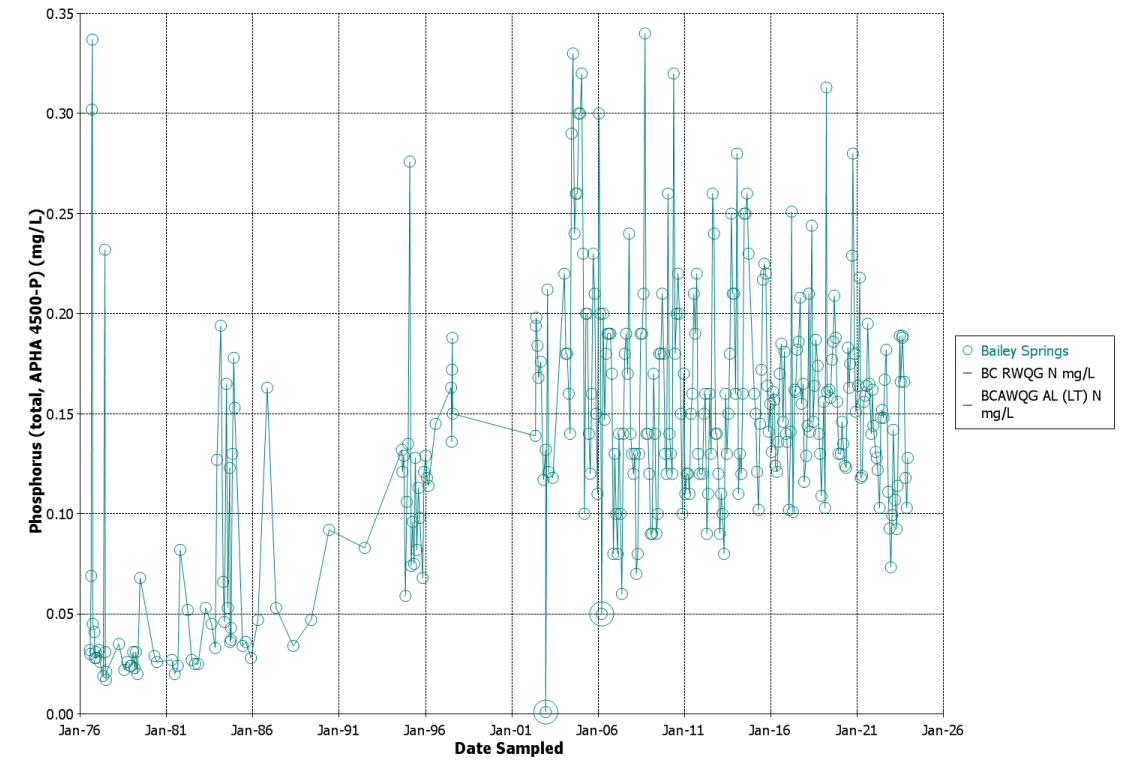


Figure C-22: Plot of total phosphorus in Bailey Springs (all data)

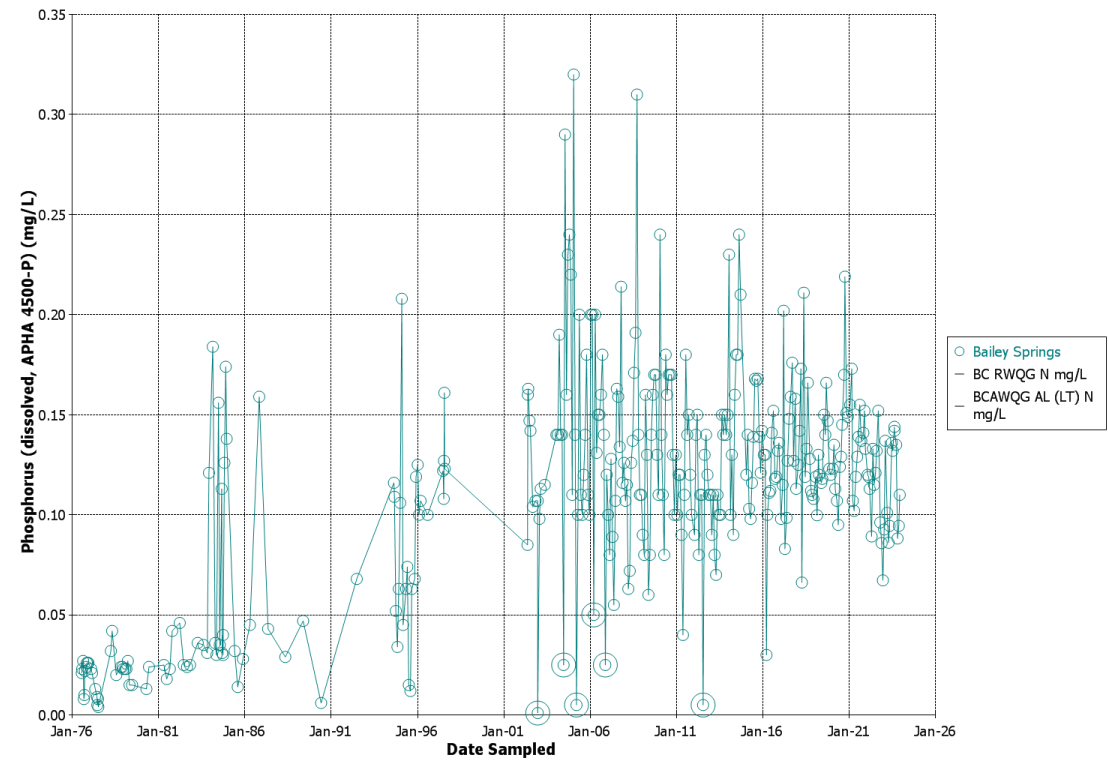


Figure C-23: Plot of dissolved phosphorus in Bailey Springs (all data)

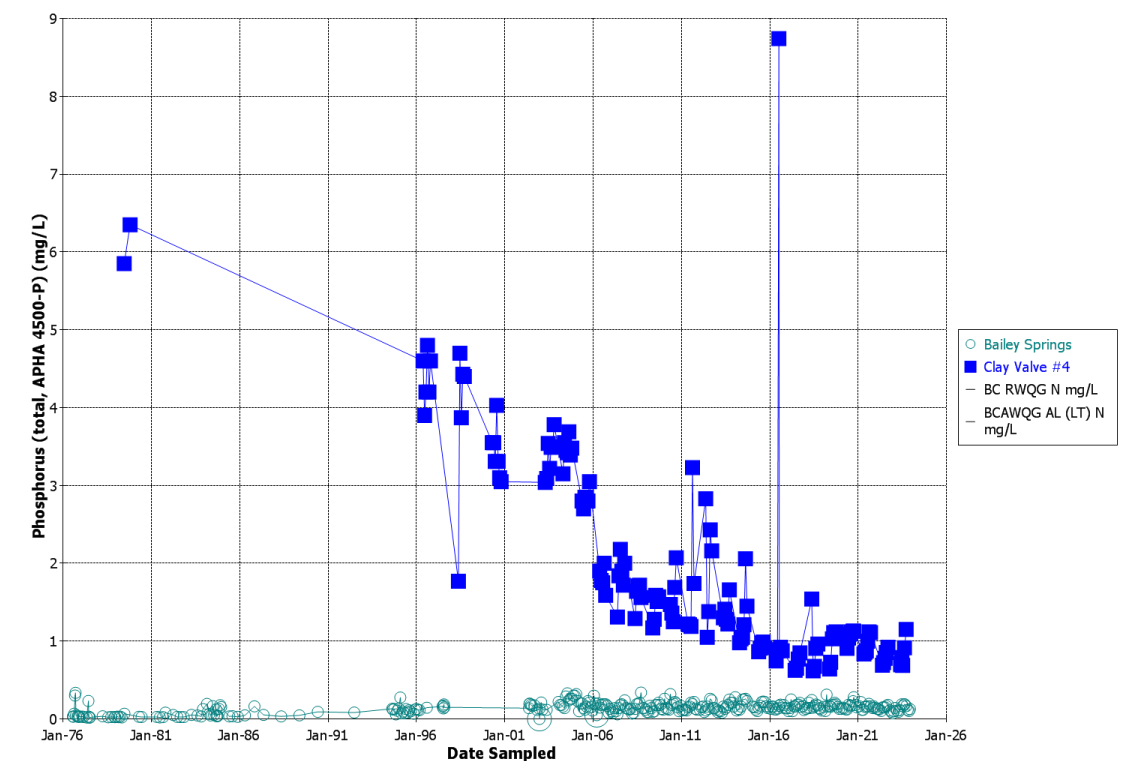


Figure C-24: Plot of total phosphorus in Bailey Springs and Clay Valve #4 (all data)

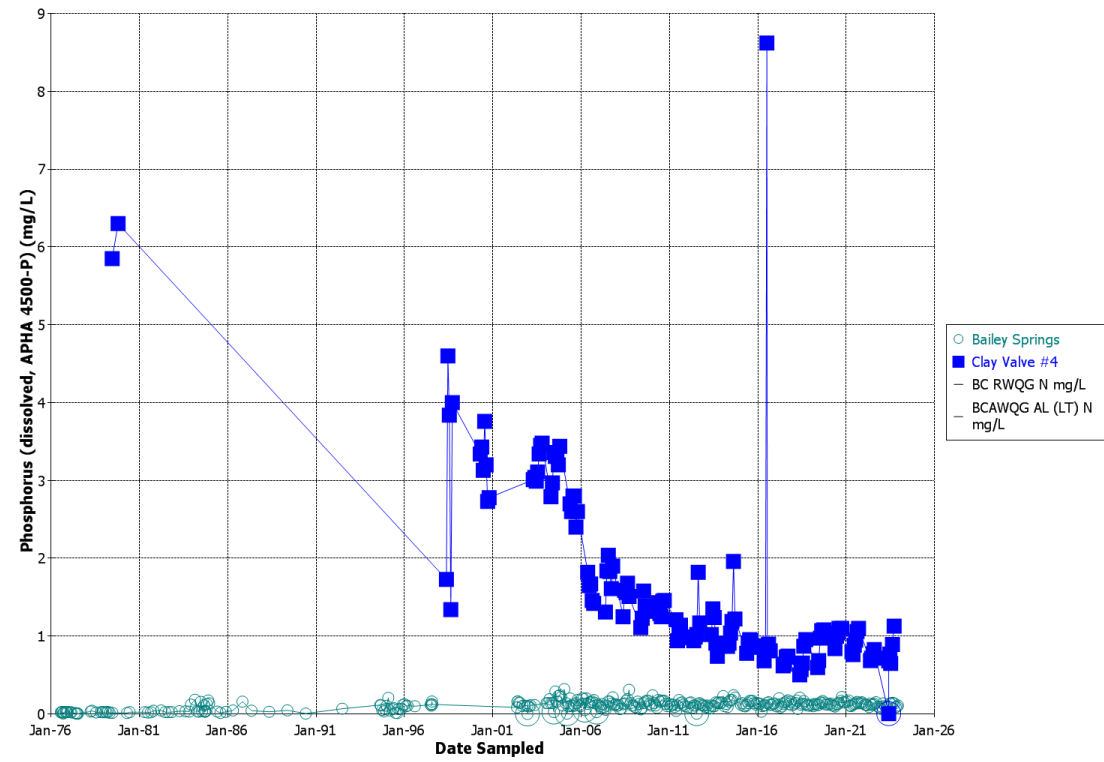


Figure C-25: Plot of dissolved phosphorus in Bailey Springs and Clay Valve #4 (all data)

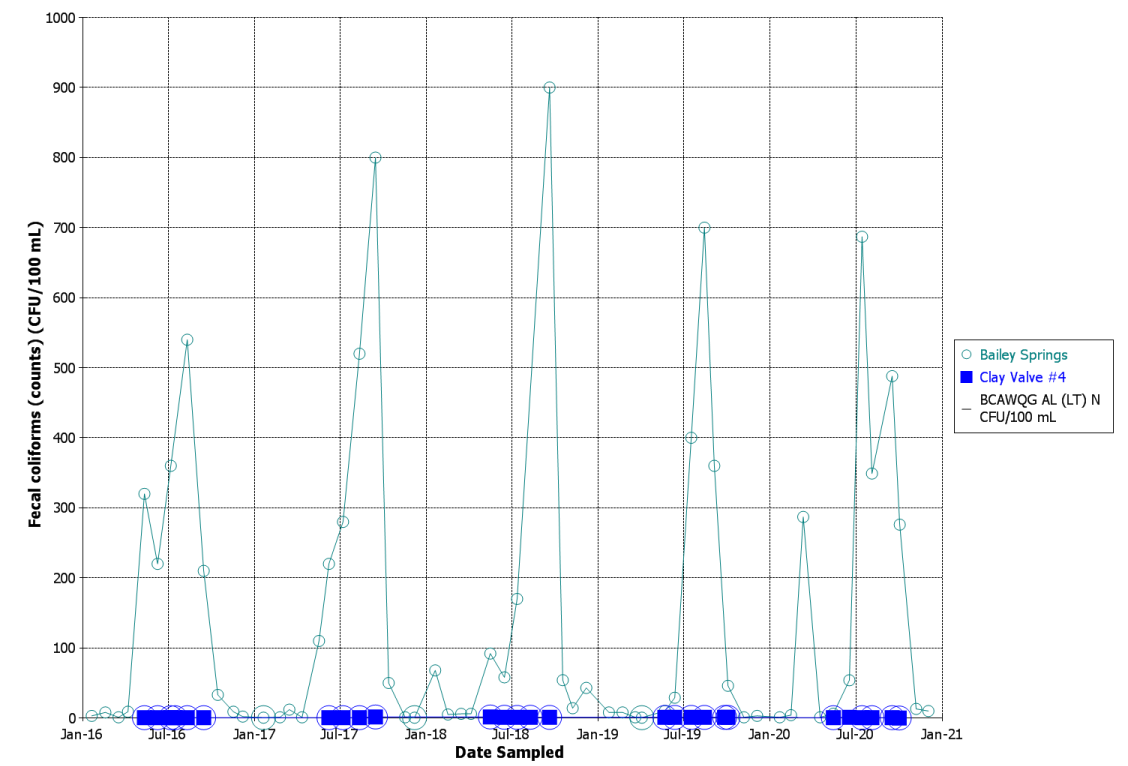


Figure C-26: Plot of fecal coliforms in Bailey Springs and Clay Valve #4 (data since 2016)²

² On Figure C-26, only data since 2016 is shown because the analytical method changed (MPN to CFU). Furthermore, a value of 8,700 CFU/100 mL was reported in Bailey Springs in August 2018 but is not shown on the above figure so as to not obscure trends from more recent data.

APPENDIX D – LABORATORY REPORTS



CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9	WORK ORDER	23J1402
ATTENTION	Nicole Penner	RECEIVED / TEMP REPORTED	2023-10-12 11:33 / 4.2°C
PO NUMBER		REPORTED	2024-01-02 13:05
PROJECT	2023-8537.000	COC NUMBER	No Number
PROJECT INFO	City of Vernon		

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

Work Order Comments:

This is a revised report; please refer to Appendix 3 for details.

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: <https://www.caro.ca/terms-conditions>

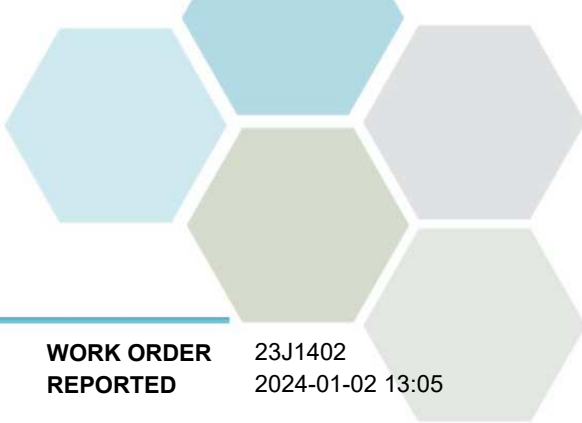
If you have any questions or concerns, please contact me at bwhitehead@caro.ca

Authorized By:

Brent Whitehead
Account Manager

1-888-311-8846 | www.caro.ca

#110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7 | #108 4475 Wayburne Drive Burnaby, BC V5G 4X4

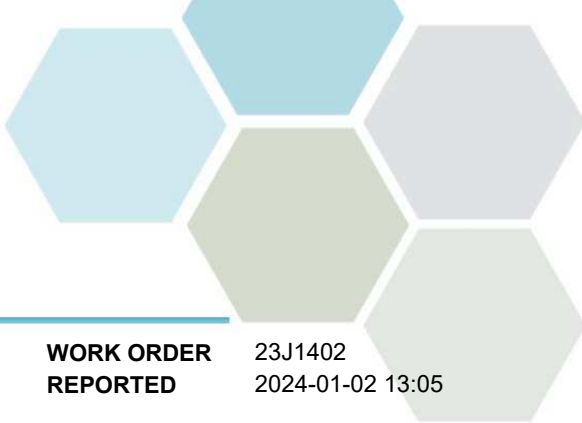


TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
MW-2 (23J1402-01) Matrix: Water Sampled: 2023-10-11 09:30					
Anions					
Bromide	< 0.10	N/A	0.10 mg/L	2023-10-14	
Chloride	11.7	AO ≤ 250	0.10 mg/L	2023-10-14	
Fluoride	0.27	MAC = 1.5	0.10 mg/L	2023-10-14	
Nitrate (as N)	< 0.010	MAC = 10	0.010 mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050 mg/L	2023-10-14	
Sulfate	294	AO ≤ 500	1.0 mg/L	2023-10-14	
Calculated Parameters					
Hardness, Dissolved (as CaCO3)	414	N/A	0.500 mg/L	N/A	
Nitrate+Nitrite (as N)	< 0.0100	N/A	0.0100 mg/L	N/A	
Nitrogen, Total	< 0.0500	N/A	0.0500 mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500 mg/L	N/A	
Dissolved Metals					
Aluminum, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Arsenic, dissolved	0.00068	N/A	0.00050 mg/L	2023-10-16	
Barium, dissolved	0.0320	N/A	0.0050 mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500 mg/L	2023-10-16	
Cadmium, dissolved	0.000025	N/A	0.000010 mg/L	2023-10-16	
Calcium, dissolved	82.2	N/A	0.20 mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040 mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010 mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Lithium, dissolved	0.00502	N/A	0.00010 mg/L	2023-10-16	
Magnesium, dissolved	50.5	N/A	0.010 mg/L	2023-10-16	
Manganese, dissolved	0.00179	N/A	0.00020 mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010 mg/L	2023-10-17	
Molybdenum, dissolved	0.0118	N/A	0.00010 mg/L	2023-10-16	
Nickel, dissolved	< 0.00040	N/A	0.00040 mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050 mg/L	2023-10-16	
Potassium, dissolved	5.47	N/A	0.10 mg/L	2023-10-16	
Selenium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	
Silicon, dissolved	9.1	N/A	1.0 mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050 mg/L	2023-10-16	
Sodium, dissolved	34.6	N/A	0.10 mg/L	2023-10-16	
Strontium, dissolved	0.848	N/A	0.0010 mg/L	2023-10-16	
Sulfur, dissolved	106	N/A	3.0 mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
MW-2 (23J1402-01) Matrix: Water Sampled: 2023-10-11 09:30, Continued						
<i>Dissolved Metals, Continued</i>						
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.00566	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	0.0338	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	194	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	194	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	0.050	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	1.61	N/A	0.50	mg/L	2023-10-20	
Nitrogen, Total Kjeldahl	< 0.050	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0226	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0202	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	615	AO ≤ 500	15	mg/L	2023-10-16	

MW-5 (23J1402-02) | Matrix: Water | Sampled: 2023-10-11 12:45

Anions

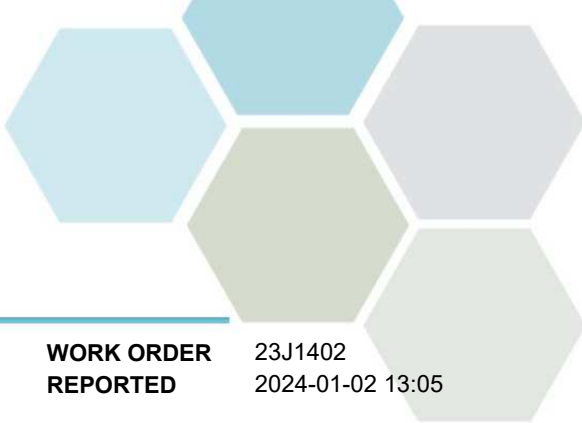
Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	8.56	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	< 0.10	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	203	AO ≤ 500	1.0	mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	184	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	< 0.0100	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	0.478	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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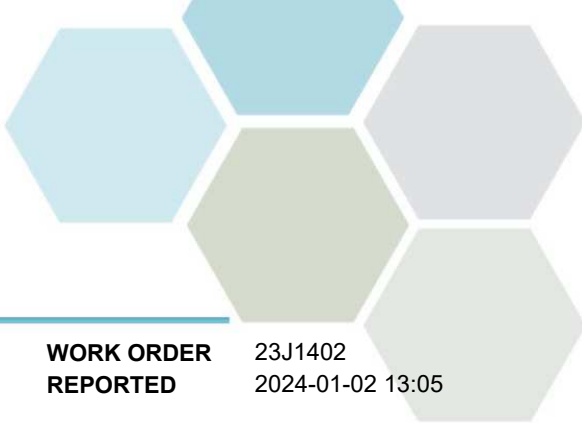
MW-5 (23J1402-02) | Matrix: Water | Sampled: 2023-10-11 12:45, Continued

Dissolved Metals, Continued

Barium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	7.14	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.00114	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	40.4	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	0.0363	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.00351	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	3.06	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	0.00126	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	< 1.0	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	45.7	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	0.0518	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	75.8	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	101	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	13.3	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	74.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	26.5	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	0.495	None Required	0.050	mg/L	2023-10-15	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
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MW-5 (23J1402-02) | Matrix: Water | Sampled: 2023-10-11 12:45, Continued

General Parameters, Continued

Carbon, Dissolved Organic	1.56	N/A	0.50 mg/L	2023-10-20	
Nitrogen, Total Kjeldahl	0.478	N/A	0.050 mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0074	N/A	0.0050 mg/L	2023-10-16	
Phosphorus, Total Dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Solids, Total Dissolved	335	AO ≤ 500	15 mg/L	2023-10-16	

MW11-02 (23J1402-03) | Matrix: Water | Sampled: 2023-10-11 18:45

Anions

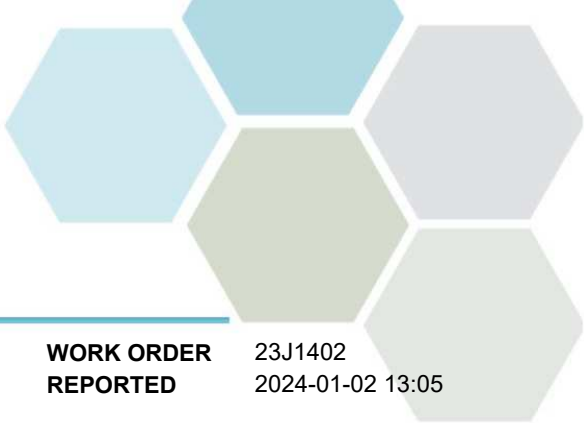
Bromide	< 0.10	N/A	0.10 mg/L	2023-10-14	
Chloride	106	AO ≤ 250	0.10 mg/L	2023-10-14	
Fluoride	0.22	MAC = 1.5	0.10 mg/L	2023-10-14	
Nitrate (as N)	11.8	MAC = 10	0.010 mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050 mg/L	2023-10-14	
Sulfate	741	AO ≤ 500	1.0 mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	1090	N/A	0.500 mg/L	N/A	
Nitrate+Nitrite (as N)	11.8	N/A	0.250 mg/L	N/A	
Nitrogen, Total	12.2	N/A	0.250 mg/L	N/A	
Nitrogen, Organic	0.367	N/A	0.0500 mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Arsenic, dissolved	0.00064	N/A	0.00050 mg/L	2023-10-16	
Barium, dissolved	0.0267	N/A	0.0050 mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Boron, dissolved	0.123	N/A	0.0500 mg/L	2023-10-16	
Cadmium, dissolved	0.000091	N/A	0.000010 mg/L	2023-10-16	
Calcium, dissolved	223	N/A	0.20 mg/L	2023-10-16	
Chromium, dissolved	0.00207	N/A	0.00050 mg/L	2023-10-16	
Cobalt, dissolved	0.00273	N/A	0.00010 mg/L	2023-10-16	
Copper, dissolved	0.00171	N/A	0.00040 mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010 mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Lithium, dissolved	0.0177	N/A	0.00010 mg/L	2023-10-16	
Magnesium, dissolved	129	N/A	0.010 mg/L	2023-10-16	
Manganese, dissolved	0.00040	N/A	0.00020 mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010 mg/L	2023-10-17	
Molybdenum, dissolved	0.00889	N/A	0.00010 mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
MW11-02 (23J1402-03) Matrix: Water Sampled: 2023-10-11 18:45, Continued					
<i>Dissolved Metals, Continued</i>					
Nickel, dissolved	0.0131	N/A	0.00040 mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050 mg/L	2023-10-16	
Potassium, dissolved	9.40	N/A	0.10 mg/L	2023-10-16	
Selenium, dissolved	0.0217	N/A	0.00050 mg/L	2023-10-16	
Silicon, dissolved	14.0	N/A	1.0 mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050 mg/L	2023-10-16	
Sodium, dissolved	133	N/A	0.10 mg/L	2023-10-16	
Strontium, dissolved	1.44	N/A	0.0010 mg/L	2023-10-16	
Sulfur, dissolved	276	N/A	3.0 mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020 mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010 mg/L	2023-10-16	
Uranium, dissolved	0.0345	N/A	0.000020 mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040 mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	

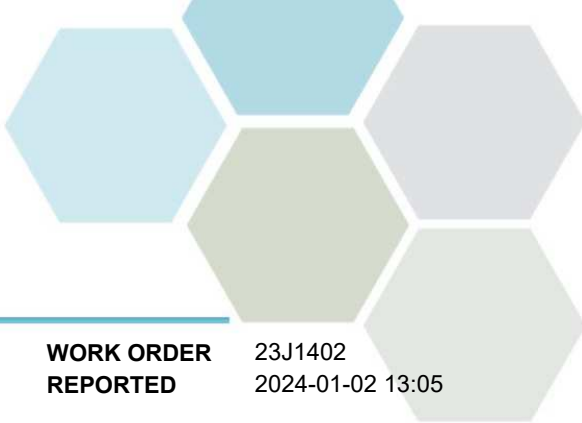
General Parameters

Alkalinity, Total (as CaCO3)	391	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	391	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Ammonia, Total (as N)	0.050	None Required	0.050 mg/L	2023-10-15	
Carbon, Dissolved Organic	3.67	N/A	0.50 mg/L	2023-10-20	
Nitrogen, Total Kjeldahl	0.417	N/A	0.050 mg/L	2023-10-18	
Phosphorus, Total (as P)	0.126	N/A	0.0050 mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0344	N/A	0.0050 mg/L	2023-10-16	
Solids, Total Dissolved	1520	AO ≤ 500	15 mg/L	2023-10-16	

DMW-1 (23J1402-04) | Matrix: Water | Sampled: 2023-10-11 10:45

Anions

Bromide	< 0.10	N/A	0.10 mg/L	2023-10-14	
Chloride	93.7	AO ≤ 250	0.10 mg/L	2023-10-14	
Fluoride	0.19	MAC = 1.5	0.10 mg/L	2023-10-14	
Nitrate (as N)	3.63	MAC = 10	0.010 mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050 mg/L	2023-10-14	
Sulfate	274	AO ≤ 500	1.0 mg/L	2023-10-14	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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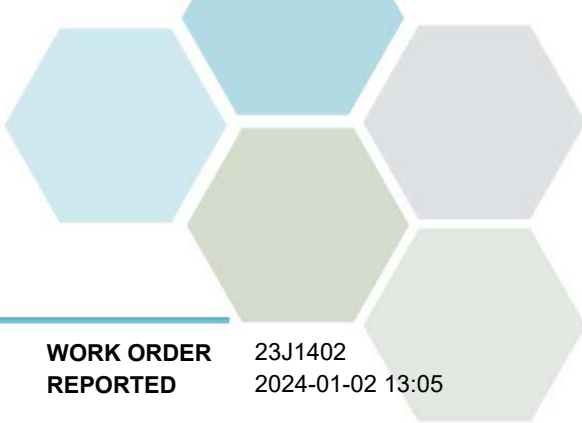
DMW-1 (23J1402-04) | Matrix: Water | Sampled: 2023-10-11 10:45, Continued

Calculated Parameters

Hardness, Dissolved (as CaCO3)	550	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	3.63	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	3.83	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	0.197	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	0.00078	N/A	0.00050	mg/L	2023-10-16	
Barium, dissolved	0.0395	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	0.000020	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	113	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	0.00548	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.00788	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	64.9	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.00664	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	0.00105	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	6.50	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	0.0290	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	10.8	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	49.5	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	1.20	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	94.9	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	0.00093	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.0193	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

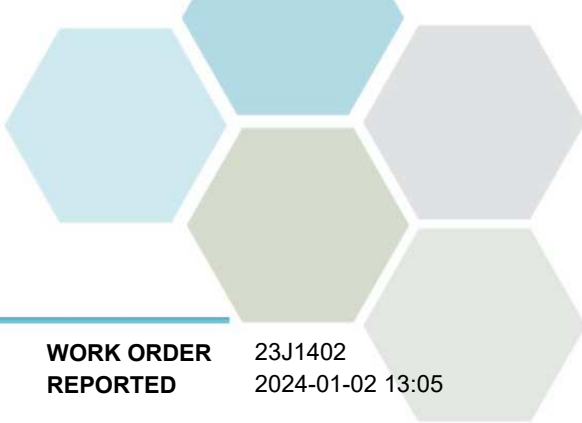
Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
DMW-1 (23J1402-04) Matrix: Water Sampled: 2023-10-11 10:45, Continued						
<i>Dissolved Metals, Continued</i>						
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
<i>General Parameters</i>						
Alkalinity, Total (as CaCO3)	252	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	252	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	2.84	N/A	0.50	mg/L	2023-10-20	
Nitrogen, Total Kjeldahl	0.197	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0167	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0166	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	756	AO ≤ 500	15	mg/L	2023-10-16	

DMW-3 (23J1402-05) | Matrix: Water | Sampled: 2023-10-11 15:55

<i>Anions</i>						
Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	124	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	0.43	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	0.452	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	169	AO ≤ 500	1.0	mg/L	2023-10-14	

<i>Calculated Parameters</i>						
Hardness, Dissolved (as CaCO3)	676	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	0.452	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	0.825	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	0.373	N/A	0.0500	mg/L	N/A	

<i>Dissolved Metals</i>						
Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	0.00070	N/A	0.00050	mg/L	2023-10-16	
Barium, dissolved	0.0293	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	0.000045	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	193	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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DMW-3 (23J1402-05) | Matrix: Water | Sampled: 2023-10-11 15:55, Continued

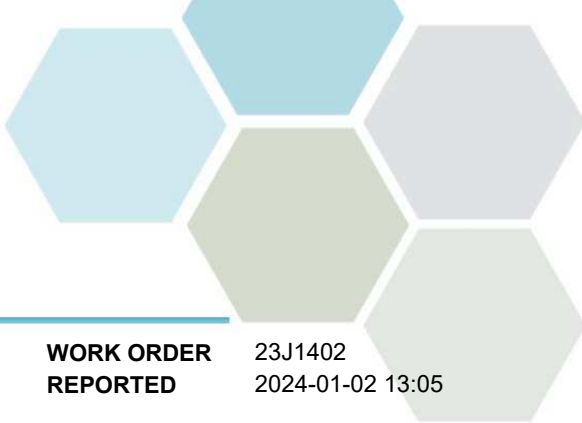
Dissolved Metals, Continued

Copper, dissolved	0.00231	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.0183	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	47.1	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	0.00675	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.00622	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	0.00130	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	7.71	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	0.00482	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	13.2	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	67.5	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	1.31	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	60.9	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.00407	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	0.0248	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	464	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	464	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	6.41	N/A	0.50	mg/L	2023-10-21	
Nitrogen, Total Kjeldahl	0.373	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0090	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0070	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	902	AO ≤ 500	15	mg/L	2023-10-17	

DMW-4 (23J1402-06) | Matrix: Water | Sampled: 2023-10-11 14:35



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

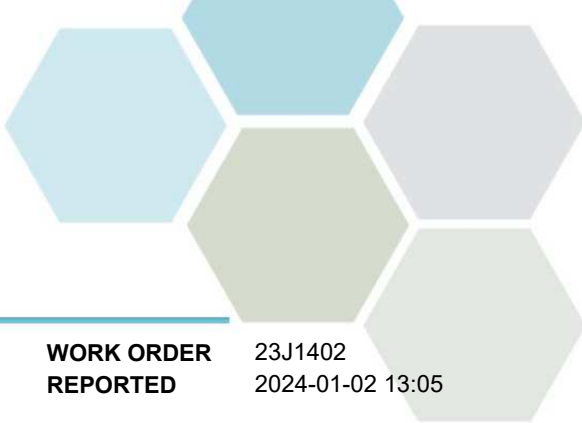
Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
DMW-4 (23J1402-06) Matrix: Water Sampled: 2023-10-11 14:35, Continued					
Anions					
Bromide	< 0.10	N/A	0.10 mg/L	2023-10-14	
Chloride	139	AO ≤ 250	0.10 mg/L	2023-10-14	
Fluoride	0.39	MAC = 1.5	0.10 mg/L	2023-10-14	
Nitrate (as N)	1.41	MAC = 10	0.010 mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2023-10-14	
Phosphate (as P)	0.156	N/A	0.0050 mg/L	2023-10-14	
Sulfate	129	AO ≤ 500	1.0 mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	383	N/A	0.500 mg/L	N/A	
Nitrate+Nitrite (as N)	1.41	N/A	0.0100 mg/L	N/A	
Nitrogen, Total	2.20	N/A	0.0500 mg/L	N/A	
Nitrogen, Organic	0.739	N/A	0.0500 mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Arsenic, dissolved	0.00266	N/A	0.00050 mg/L	2023-10-16	
Barium, dissolved	0.0327	N/A	0.0050 mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Boron, dissolved	0.205	N/A	0.0500 mg/L	2023-10-16	
Cadmium, dissolved	0.000375	N/A	0.000010 mg/L	2023-10-16	
Calcium, dissolved	111	N/A	0.20 mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	
Cobalt, dissolved	0.00031	N/A	0.00010 mg/L	2023-10-16	
Copper, dissolved	0.0107	N/A	0.00040 mg/L	2023-10-16	
Iron, dissolved	0.026	N/A	0.010 mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Lithium, dissolved	0.0160	N/A	0.00010 mg/L	2023-10-16	
Magnesium, dissolved	25.6	N/A	0.010 mg/L	2023-10-16	
Manganese, dissolved	0.00039	N/A	0.00020 mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010 mg/L	2023-10-17	
Molybdenum, dissolved	0.0119	N/A	0.00010 mg/L	2023-10-16	
Nickel, dissolved	0.00165	N/A	0.00040 mg/L	2023-10-16	
Phosphorus, dissolved	0.388	N/A	0.050 mg/L	2023-10-16	
Potassium, dissolved	17.4	N/A	0.10 mg/L	2023-10-16	
Selenium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	
Silicon, dissolved	9.6	N/A	1.0 mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050 mg/L	2023-10-16	
Sodium, dissolved	128	N/A	0.10 mg/L	2023-10-16	
Strontium, dissolved	0.918	N/A	0.0010 mg/L	2023-10-16	
Sulfur, dissolved	47.0	N/A	3.0 mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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DMW-4 (23J1402-06) | Matrix: Water | Sampled: 2023-10-11 14:35, Continued

Dissolved Metals, Continued

Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.00513	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	0.0490	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	0.00014	N/A	0.00010	mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	350	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	350	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	0.052	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	9.02	N/A	0.50	mg/L	2023-10-21	
Nitrogen, Total Kjeldahl	0.791	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.374	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.368	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	753	AO ≤ 500	15	mg/L	2023-10-17	

DMW-5 (23J1402-07) | Matrix: Water | Sampled: 2023-10-11 17:00

Anions

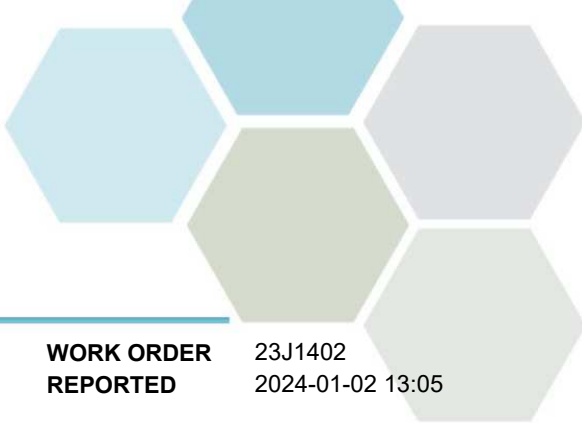
Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	191	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	1.27	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	2.34	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	218	AO ≤ 500	1.0	mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	555	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	2.34	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	2.91	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	0.518	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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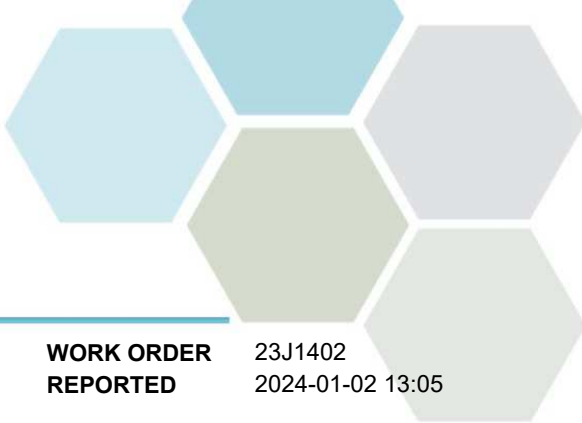
DMW-5 (23J1402-07) | Matrix: Water | Sampled: 2023-10-11 17:00, Continued

Dissolved Metals, Continued

Barium, dissolved	0.0679	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	0.105	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	< 0.000020	N/A	0.000010	mg/L	2023-10-16	RA1
Calcium, dissolved	136	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	0.00024	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	0.00129	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	0.014	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.0529	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	52.4	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	0.206	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.0142	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	0.00304	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	10.3	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	14.7	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	203	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	1.89	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	81.6	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.0204	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	481	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	481	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	0.054	None Required	0.050	mg/L	2023-10-15	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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DMW-5 (23J1402-07) | Matrix: Water | Sampled: 2023-10-11 17:00, Continued

General Parameters, Continued

Carbon, Dissolved Organic	6.45	N/A	0.50	mg/L	2023-10-21	
Nitrogen, Total Kjeldahl	0.572	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0272	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0267	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	1030	AO ≤ 500	15	mg/L	2023-10-17	

WTN 39421 (23J1402-08) | Matrix: Water | Sampled: 2023-10-12 09:30

Anions

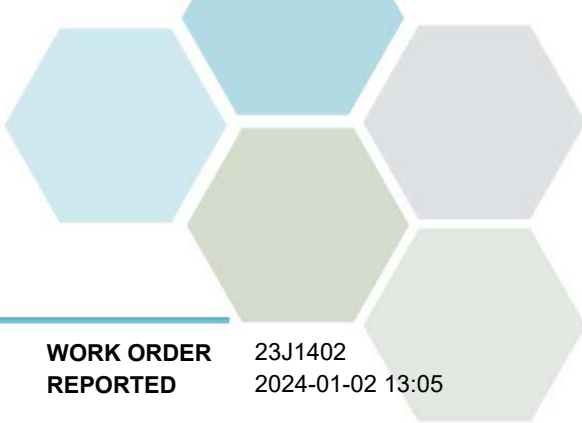
Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	41.6	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	0.15	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	2.90	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	309	AO ≤ 500	1.0	mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	486	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	2.90	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	3.01	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	0.111	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	0.00060	N/A	0.00050	mg/L	2023-10-16	
Barium, dissolved	0.0447	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	114	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	0.00137	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	0.043	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.00639	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	48.5	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	0.00423	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.00665	N/A	0.00010	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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WTN 39421 (23J1402-08) | Matrix: Water | Sampled: 2023-10-12 09:30, Continued

Dissolved Metals, Continued

Nickel, dissolved	0.00089	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	6.34	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	0.0316	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	11.6	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	39.7	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	1.12	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	113	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.00422	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	0.0142	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	

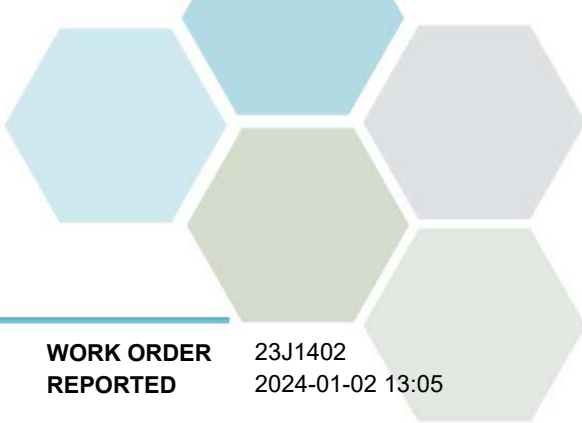
General Parameters

Alkalinity, Total (as CaCO3)	198	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	198	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	1.60	N/A	0.50	mg/L	2023-10-21	
Nitrogen, Total Kjeldahl	0.111	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0150	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0093	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	713	AO ≤ 500	15	mg/L	2023-10-17	

WTN 24991 (23J1402-09) | Matrix: Water | Sampled: 2023-10-12 08:45

Anions

Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	1.56	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	0.23	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	81.0	AO ≤ 500	1.0	mg/L	2023-10-14	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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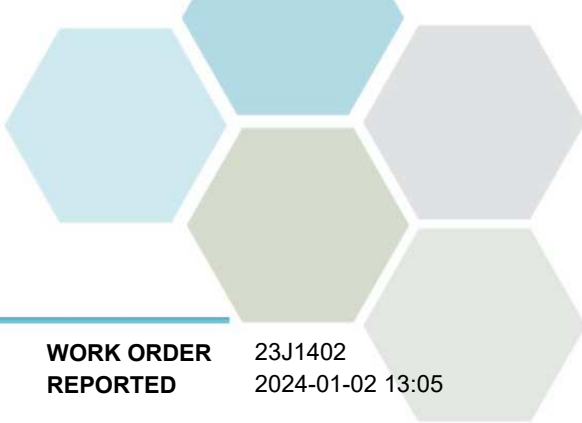
WTN 24991 (23J1402-09) | Matrix: Water | Sampled: 2023-10-12 08:45, Continued

Calculated Parameters

Hardness, Dissolved (as CaCO3)	213	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	< 0.0100	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	0.164	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	0.00112	N/A	0.00050	mg/L	2023-10-16	
Barium, dissolved	0.0186	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	53.5	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	0.227	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.00339	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	19.2	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	0.0813	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.00861	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	3.56	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	10.2	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	32.4	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	0.504	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	29.3	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.00147	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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WTN 24991 (23J1402-09) | Matrix: Water | Sampled: 2023-10-12 08:45, Continued

Dissolved Metals, Continued

Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
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General Parameters

Alkalinity, Total (as CaCO3)	205	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	205	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	0.151	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	1.19	N/A	0.50	mg/L	2023-10-21	
Nitrogen, Total Kjeldahl	0.164	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0168	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0166	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	309	AO ≤ 500	15	mg/L	2023-10-17	

DUP (23J1402-10) | Matrix: Water | Sampled: 2023-10-11 10:45

Anions

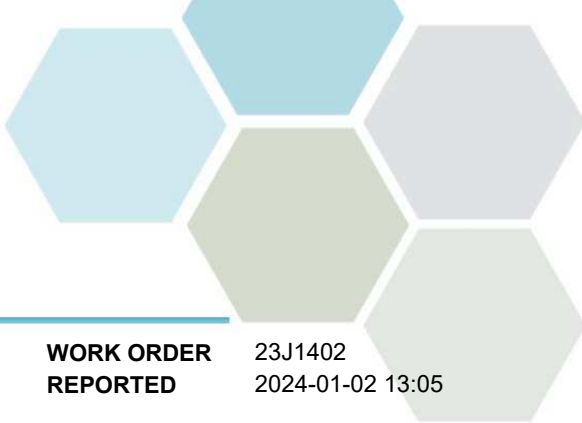
Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	91.2	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	0.14	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	3.79	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	258	AO ≤ 500	1.0	mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	555	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	3.79	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	3.95	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	0.161	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	0.00077	N/A	0.00050	mg/L	2023-10-16	
Barium, dissolved	0.0397	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	0.000014	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	116	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	0.00527	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	



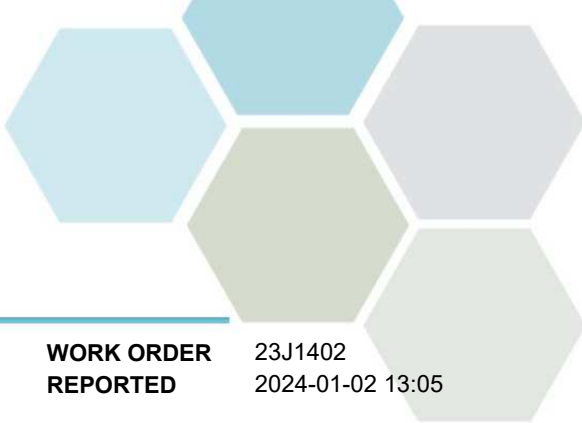
TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
DUP (23J1402-10) Matrix: Water Sampled: 2023-10-11 10:45, Continued						
<i>Dissolved Metals, Continued</i>						
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	0.00794	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	64.6	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	0.00672	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	0.00109	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	6.52	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	0.0294	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	10.7	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	48.8	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	1.21	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	95.8	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	0.00064	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	0.0199	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
<i>General Parameters</i>						
Alkalinity, Total (as CaCO3)	252	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	252	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2023-10-15	
Carbon, Dissolved Organic	1.95	N/A	0.50	mg/L	2023-10-21	
Nitrogen, Total Kjeldahl	0.161	N/A	0.050	mg/L	2023-10-18	
Phosphorus, Total (as P)	0.0164	N/A	0.0050	mg/L	2023-10-16	
Phosphorus, Total Dissolved	0.0160	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	766	AO ≤ 500	15	mg/L	2023-10-17	

Field Blank (23J1402-11) | Matrix: Water | Sampled: 2023-10-11 12:30



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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Field Blank (23J1402-11) | Matrix: Water | Sampled: 2023-10-11 12:30, Continued

Anions

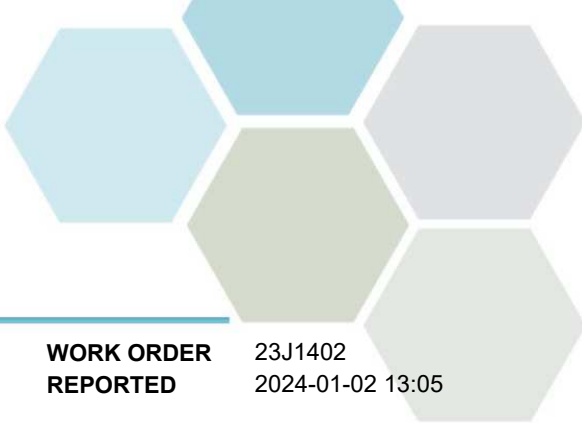
Bromide	< 0.10	N/A	0.10	mg/L	2023-10-14	
Chloride	< 0.10	AO ≤ 250	0.10	mg/L	2023-10-14	
Fluoride	< 0.10	MAC = 1.5	0.10	mg/L	2023-10-14	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-14	
Sulfate	< 1.0	AO ≤ 500	1.0	mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	< 0.500	N/A	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	< 0.0100	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	< 0.0500	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500	mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Arsenic, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Barium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	< 0.20	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-18	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	< 0.10	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	< 1.0	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	< 0.10	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	< 3.0	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
Field Blank (23J1402-11) Matrix: Water Sampled: 2023-10-11 12:30, Continued					
<i>Dissolved Metals, Continued</i>					
Thallium, dissolved	< 0.000020	N/A	0.000020 mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010 mg/L	2023-10-16	
Uranium, dissolved	< 0.000020	N/A	0.000020 mg/L	2023-10-18	
Vanadium, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040 mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0 mg/L	2023-10-15	
Ammonia, Total (as N)	< 0.050	None Required	0.050 mg/L	2023-10-15	
Nitrogen, Total Kjeldahl	< 0.050	N/A	0.050 mg/L	2023-10-18	
Phosphorus, Total (as P)	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Phosphorus, Total Dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Solids, Total Dissolved	< 15	AO ≤ 500	15 mg/L	2023-10-17	

Trip Blank (23J1402-12) | Matrix: Water | Sampled: 2023-10-12 09:30

Anions

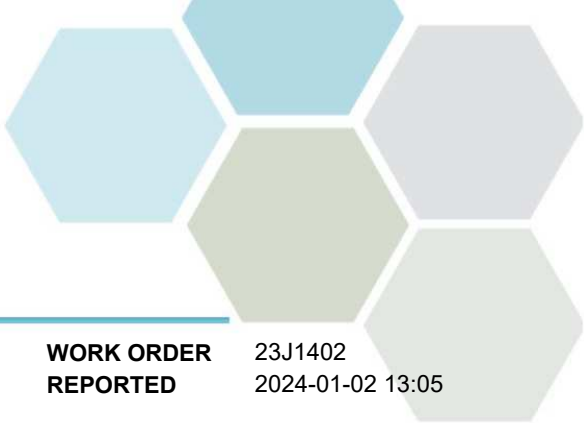
Bromide	< 0.10	N/A	0.10 mg/L	2023-10-14	
Chloride	< 0.10	AO ≤ 250	0.10 mg/L	2023-10-14	
Fluoride	< 0.10	MAC = 1.5	0.10 mg/L	2023-10-14	
Nitrate (as N)	< 0.010	MAC = 10	0.010 mg/L	2023-10-14	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2023-10-14	
Phosphate (as P)	< 0.0050	N/A	0.0050 mg/L	2023-10-14	
Sulfate	< 1.0	AO ≤ 500	1.0 mg/L	2023-10-14	

Calculated Parameters

Hardness, Dissolved (as CaCO3)	< 0.500	N/A	0.500 mg/L	N/A	
Nitrate+Nitrite (as N)	< 0.0100	N/A	0.0100 mg/L	N/A	
Nitrogen, Total	< 0.0500	N/A	0.0500 mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500 mg/L	N/A	

Dissolved Metals

Aluminum, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	
Antimony, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-10-16	
Arsenic, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-10-16	
Barium, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-10-16	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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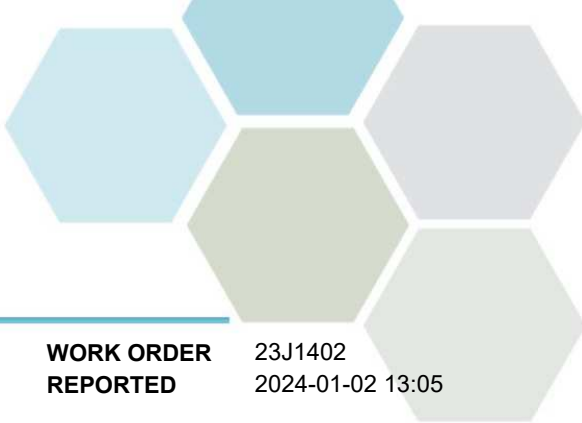
Trip Blank (23J1402-12) | Matrix: Water | Sampled: 2023-10-12 09:30, Continued

Dissolved Metals, Continued

Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2023-10-16	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-16	
Calcium, dissolved	< 0.20	N/A	0.20	mg/L	2023-10-16	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Copper, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Lithium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Magnesium, dissolved	< 0.010	N/A	0.010	mg/L	2023-10-16	
Manganese, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2023-10-17	
Molybdenum, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2023-10-16	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2023-10-16	
Potassium, dissolved	< 0.10	N/A	0.10	mg/L	2023-10-16	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Silicon, dissolved	< 1.0	N/A	1.0	mg/L	2023-10-16	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2023-10-16	
Sodium, dissolved	< 0.10	N/A	0.10	mg/L	2023-10-16	
Strontium, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Sulfur, dissolved	< 3.0	N/A	3.0	mg/L	2023-10-16	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2023-10-16	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-10-16	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-10-16	
Uranium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-10-16	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-10-16	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-10-16	

General Parameters

Alkalinity, Total (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-10-15	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2023-10-15	
Nitrogen, Total Kjeldahl	< 0.050	N/A	0.050	mg/L	2023-10-18	



TEST RESULTS

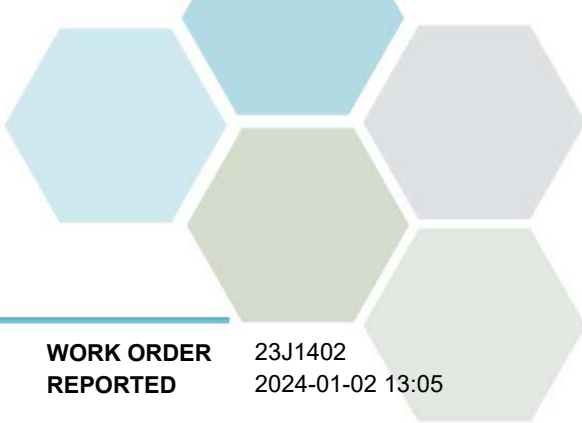
REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
Trip Blank (23J1402-12) Matrix: Water Sampled: 2023-10-12 09:30, Continued						
<i>General Parameters, Continued</i>						
Phosphorus, Total (as P)	< 0.0050	N/A	0.0050	mg/L	2023-10-16	
Solids, Total Dissolved	< 15	AO ≤ 500	15	mg/L	2023-10-17	

Sample Qualifiers:

RA1 The Reporting Limit for this sample has been raised due to matrix interference.



APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
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WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analysis Description	Method Ref.	Technique	Accredited	Location
Alkalinity in Water	SM 2320 B* (2021)	Titration with H2SO4	✓	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2021)	Automated Colorimetry (Phenate)	✓	Kelowna
Anions in Water	SM 4110 B (2020)	Ion Chromatography	✓	Kelowna
Carbon, Dissolved Organic in Water	SM 5310 B (2022)	Combustion, Infrared CO2 Detection	✓	Kelowna
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
Hardness in Water	SM 2340 B (2021)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	✓	N/A
Mercury, dissolved in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	✓	Richmond
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2021)	Block Digestion and Flow Injection Analysis	✓	Kelowna
Phosphorus, Total Dissolved in Water	SM 4500-P B.5* (2011) / SM 4500-P F (2021)	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	✓	Kelowna
Phosphorus, Total in Water	SM 4500-P B.5* (2011) / SM 4500-P F (2021)	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	✓	Kelowna
Solids, Total Dissolved in Water	Solids in Water, Filtered / SM 2540 C* (2020)	Solids in Water, Filtered / Gravimetry (Dried at 103-105C)	✓	Kelowna

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

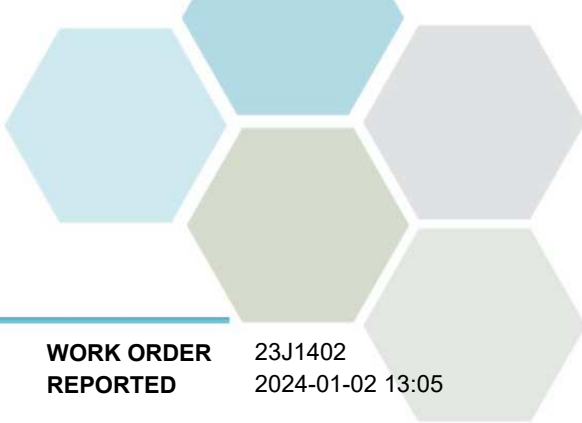
Glossary of Terms:

RL	Reporting Limit (default)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
AO	Aesthetic Objective
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

Guidelines Referenced in this Report:

[Guidelines for Canadian Drinking Water Quality \(Health Canada, September 2022\)](#)

Note: In some cases, the values displayed on the report represent the lowest guideline and are to be verified by the end user



APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

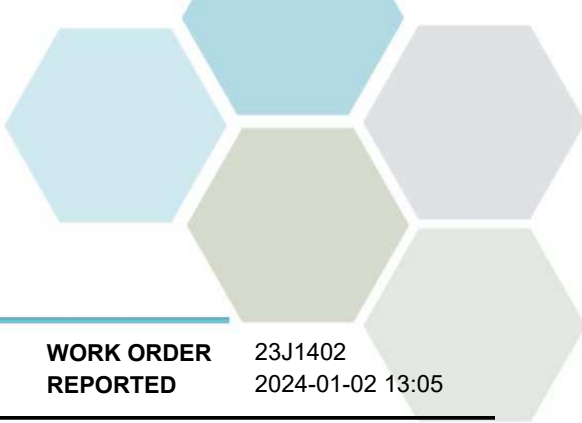
WORK ORDER REPORTED 23J1402
2024-01-02 13:05

General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager: bwhitehead@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

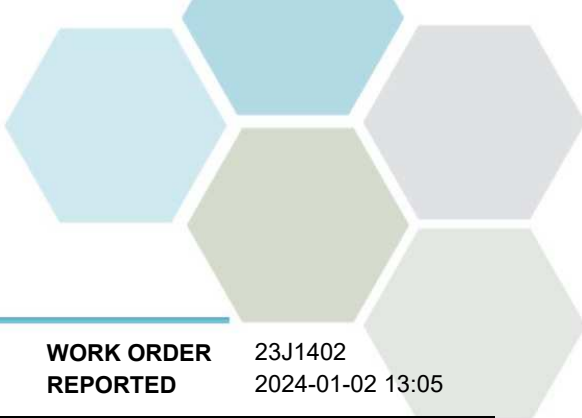
WORK ORDER REPORTED 23J1402
2024-01-02 13:05

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B3J1132									
Blank (B3J1132-BLK1)			Prepared: 2023-10-14, Analyzed: 2023-10-14						
Bromide	< 0.10	0.10 mg/L							
Chloride	< 0.10	0.10 mg/L							
Fluoride	< 0.10	0.10 mg/L							
Nitrate (as N)	< 0.005	0.005 mg/L							
Nitrite (as N)	< 0.005	0.005 mg/L							
Phosphate (as P)	< 0.0050	0.0050 mg/L							
Sulfate	< 1.0	1.0 mg/L							
Blank (B3J1132-BLK2)			Prepared: 2023-10-14, Analyzed: 2023-10-14						
Bromide	< 0.10	0.10 mg/L							
Chloride	< 0.10	0.10 mg/L							
Fluoride	< 0.10	0.10 mg/L							
Nitrate (as N)	< 0.005	0.005 mg/L							
Nitrite (as N)	< 0.005	0.005 mg/L							
Phosphate (as P)	< 0.0050	0.0050 mg/L							
Sulfate	< 1.0	1.0 mg/L							
Blank (B3J1132-BLK3)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Bromide	< 0.10	0.10 mg/L							
Chloride	< 0.10	0.10 mg/L							
Fluoride	< 0.10	0.10 mg/L							
Nitrate (as N)	< 0.005	0.005 mg/L							
Nitrite (as N)	< 0.005	0.005 mg/L							
Phosphate (as P)	< 0.0050	0.0050 mg/L							
Sulfate	< 1.0	1.0 mg/L							
LCS (B3J1132-BS1)			Prepared: 2023-10-14, Analyzed: 2023-10-14						
Bromide	3.85	0.10 mg/L	4.00		96	85-115			
Chloride	15.7	0.10 mg/L	16.0		98	90-110			
Fluoride	4.03	0.10 mg/L	4.00		101	88-108			
Nitrate (as N)	3.97	0.005 mg/L	4.00		99	90-110			
Nitrite (as N)	2.08	0.005 mg/L	2.00		104	85-115			
Phosphate (as P)	1.08	0.0050 mg/L	1.00		108	80-120			
Sulfate	15.7	1.0 mg/L	16.0		98	90-110			
LCS (B3J1132-BS2)			Prepared: 2023-10-14, Analyzed: 2023-10-14						
Bromide	4.14	0.10 mg/L	4.00		104	85-115			



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Anions, Batch B3J1132, Continued

LCS (B3J1132-BS2), Continued

Prepared: 2023-10-14, Analyzed: 2023-10-14

Chloride	15.7	0.10 mg/L	16.0		98	90-110			
Fluoride	4.03	0.10 mg/L	4.00		101	88-108			
Nitrate (as N)	4.07	0.005 mg/L	4.00		102	90-110			
Nitrite (as N)	2.07	0.005 mg/L	2.00		104	85-115			
Phosphate (as P)	0.904	0.0050 mg/L	1.00		90	80-120			
Sulfate	16.1	1.0 mg/L	16.0		100	90-110			

LCS (B3J1132-BS3)

Prepared: 2023-10-15, Analyzed: 2023-10-15

Bromide	3.96	0.10 mg/L	4.00		99	85-115			
Chloride	15.9	0.10 mg/L	16.0		99	90-110			
Fluoride	4.10	0.10 mg/L	4.00		103	88-108			
Nitrate (as N)	3.90	0.005 mg/L	4.00		97	90-110			
Nitrite (as N)	2.10	0.005 mg/L	2.00		105	85-115			
Phosphate (as P)	0.972	0.0050 mg/L	1.00		97	80-120			
Sulfate	16.3	1.0 mg/L	16.0		102	90-110			

Dissolved Metals, Batch B3J1467

Blank (B3J1467-BLK1)

Prepared: 2023-10-16, Analyzed: 2023-10-16

Aluminum, dissolved	< 0.0050	0.0050 mg/L							
Antimony, dissolved	< 0.00020	0.00020 mg/L							
Arsenic, dissolved	< 0.00050	0.00050 mg/L							
Barium, dissolved	< 0.0050	0.0050 mg/L							
Beryllium, dissolved	< 0.00010	0.00010 mg/L							
Bismuth, dissolved	< 0.00010	0.00010 mg/L							
Boron, dissolved	< 0.0500	0.0500 mg/L							
Cadmium, dissolved	< 0.000010	0.000010 mg/L							
Calcium, dissolved	< 0.20	0.20 mg/L							
Chromium, dissolved	< 0.00050	0.00050 mg/L							
Cobalt, dissolved	< 0.00010	0.00010 mg/L							
Copper, dissolved	< 0.00040	0.00040 mg/L							
Iron, dissolved	< 0.010	0.010 mg/L							
Lead, dissolved	< 0.00020	0.00020 mg/L							
Lithium, dissolved	< 0.00010	0.00010 mg/L							
Magnesium, dissolved	< 0.010	0.010 mg/L							
Manganese, dissolved	< 0.00020	0.00020 mg/L							
Molybdenum, dissolved	< 0.00010	0.00010 mg/L							
Nickel, dissolved	< 0.00040	0.00040 mg/L							
Phosphorus, dissolved	< 0.050	0.050 mg/L							
Potassium, dissolved	< 0.10	0.10 mg/L							
Selenium, dissolved	< 0.00050	0.00050 mg/L							
Silicon, dissolved	< 1.0	1.0 mg/L							
Silver, dissolved	< 0.000050	0.000050 mg/L							
Sodium, dissolved	< 0.10	0.10 mg/L							
Strontium, dissolved	< 0.0010	0.0010 mg/L							
Sulfur, dissolved	< 3.0	3.0 mg/L							
Tellurium, dissolved	< 0.00050	0.00050 mg/L							
Thallium, dissolved	< 0.000020	0.000020 mg/L							
Thorium, dissolved	< 0.00010	0.00010 mg/L							
Tin, dissolved	< 0.00020	0.00020 mg/L							
Titanium, dissolved	< 0.0050	0.0050 mg/L							
Tungsten, dissolved	< 0.0010	0.0010 mg/L							
Uranium, dissolved	< 0.000020	0.000020 mg/L							
Vanadium, dissolved	< 0.0050	0.0050 mg/L							
Zinc, dissolved	< 0.0040	0.0040 mg/L							
Zirconium, dissolved	< 0.00010	0.00010 mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B3J1467, Continued									
LCS (B3J1467-BS1)					Prepared: 2023-10-16, Analyzed: 2023-10-16				
Aluminum, dissolved	4.02	0.0050 mg/L	4.00		101	80-120			
Antimony, dissolved	0.0410	0.00020 mg/L	0.0400		103	80-120			
Arsenic, dissolved	0.403	0.00050 mg/L	0.400		101	80-120			
Barium, dissolved	0.0403	0.0050 mg/L	0.0400		101	80-120			
Beryllium, dissolved	0.0422	0.00010 mg/L	0.0400		106	80-120			
Bismuth, dissolved	0.0392	0.00010 mg/L	0.0400		98	80-120			
Boron, dissolved	0.425	0.0500 mg/L	0.400		106	80-120			
Cadmium, dissolved	0.0409	0.000010 mg/L	0.0400		102	80-120			
Calcium, dissolved	4.15	0.20 mg/L	4.00		104	80-120			
Chromium, dissolved	0.0397	0.00050 mg/L	0.0400		99	80-120			
Cobalt, dissolved	0.0403	0.00010 mg/L	0.0400		101	80-120			
Copper, dissolved	0.0403	0.00040 mg/L	0.0400		101	80-120			
Iron, dissolved	4.02	0.010 mg/L	4.00		100	80-120			
Lead, dissolved	0.0405	0.00020 mg/L	0.0400		101	80-120			
Lithium, dissolved	0.0415	0.00010 mg/L	0.0400		104	80-120			
Magnesium, dissolved	4.08	0.010 mg/L	4.00		102	80-120			
Manganese, dissolved	0.0401	0.00020 mg/L	0.0400		100	80-120			
Molybdenum, dissolved	0.0392	0.00010 mg/L	0.0400		98	80-120			
Nickel, dissolved	0.0396	0.00040 mg/L	0.0400		99	80-120			
Phosphorus, dissolved	4.07	0.050 mg/L	4.00		102	80-120			
Potassium, dissolved	4.07	0.10 mg/L	4.00		102	80-120			
Selenium, dissolved	0.404	0.00050 mg/L	0.400		101	80-120			
Silicon, dissolved	4.2	1.0 mg/L	4.00		105	80-120			
Silver, dissolved	0.0415	0.000050 mg/L	0.0400		104	80-120			
Sodium, dissolved	3.96	0.10 mg/L	4.00		99	80-120			
Strontium, dissolved	0.0405	0.0010 mg/L	0.0400		101	80-120			
Sulfur, dissolved	41.6	3.0 mg/L	40.0		104	80-120			
Tellurium, dissolved	0.0404	0.00050 mg/L	0.0400		101	80-120			
Thallium, dissolved	0.0412	0.000020 mg/L	0.0400		103	80-120			
Thorium, dissolved	0.0399	0.00010 mg/L	0.0400		100	80-120			
Tin, dissolved	0.0416	0.00020 mg/L	0.0400		104	80-120			
Titanium, dissolved	0.0406	0.0050 mg/L	0.0400		101	80-120			
Tungsten, dissolved	0.0404	0.0010 mg/L	0.0400		101	80-120			
Uranium, dissolved	0.0408	0.000020 mg/L	0.0400		102	80-120			
Vanadium, dissolved	0.0394	0.0050 mg/L	0.0400		99	80-120			
Zinc, dissolved	0.403	0.0040 mg/L	0.400		101	80-120			
Zirconium, dissolved	0.0415	0.00010 mg/L	0.0400		104	80-120			

Duplicate (B3J1467-DUP1)		Source: 23J1402-01		Prepared: 2023-10-16, Analyzed: 2023-10-16					
Aluminum, dissolved	< 0.0050	0.0050 mg/L	< 0.0050						20
Antimony, dissolved	< 0.00020	0.00020 mg/L	< 0.00020						20
Arsenic, dissolved	0.00067	0.00050 mg/L	0.00068						20
Barium, dissolved	0.0323	0.0050 mg/L	0.0320				< 1		20
Beryllium, dissolved	< 0.00010	0.00010 mg/L	< 0.00010						20
Bismuth, dissolved	< 0.00010	0.00010 mg/L	< 0.00010						20
Boron, dissolved	< 0.0500	0.0500 mg/L	< 0.0500						20
Cadmium, dissolved	0.000021	0.000010 mg/L	0.000025						20
Calcium, dissolved	83.4	0.20 mg/L	82.2				1		20
Chromium, dissolved	< 0.00050	0.00050 mg/L	< 0.00050						20
Cobalt, dissolved	< 0.00010	0.00010 mg/L	< 0.00010						20
Copper, dissolved	< 0.00040	0.00040 mg/L	< 0.00040						20
Iron, dissolved	< 0.010	0.010 mg/L	< 0.010						20
Lead, dissolved	< 0.00020	0.00020 mg/L	< 0.00020						20
Lithium, dissolved	0.00504	0.00010 mg/L	0.00502				< 1		20
Magnesium, dissolved	50.5	0.010 mg/L	50.5				< 1		20
Manganese, dissolved	0.00178	0.00020 mg/L	0.00179				< 1		20

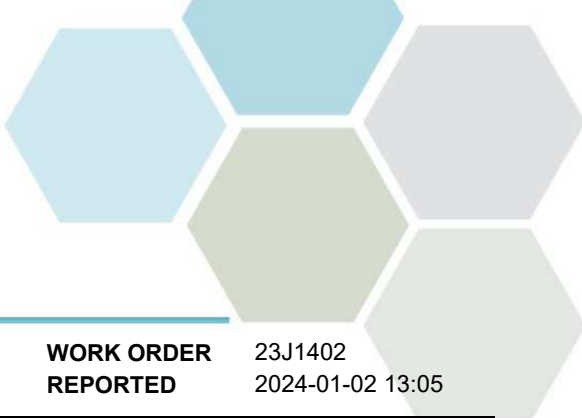
APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B3J1467, Continued									
Duplicate (B3J1467-DUP1), Continued		Source: 23J1402-01		Prepared: 2023-10-16, Analyzed: 2023-10-16					
Molybdenum, dissolved	0.0116	0.00010 mg/L		0.0118			2	20	
Nickel, dissolved	< 0.00040	0.00040 mg/L		< 0.00040				20	
Phosphorus, dissolved	< 0.050	0.050 mg/L		< 0.050				20	
Potassium, dissolved	5.59	0.10 mg/L		5.47			2	20	
Selenium, dissolved	< 0.00050	0.00050 mg/L		< 0.00050				20	
Silicon, dissolved	9.1	1.0 mg/L		9.1			< 1	20	
Silver, dissolved	< 0.000050	0.000050 mg/L		< 0.000050				20	
Sodium, dissolved	34.4	0.10 mg/L		34.6			< 1	20	
Strontium, dissolved	0.851	0.0010 mg/L		0.848			< 1	20	
Sulfur, dissolved	106	3.0 mg/L		106			< 1	20	
Tellurium, dissolved	< 0.00050	0.00050 mg/L		< 0.00050				20	
Thallium, dissolved	< 0.000020	0.000020 mg/L		< 0.000020				20	
Thorium, dissolved	< 0.00010	0.00010 mg/L		< 0.00010				20	
Tin, dissolved	< 0.00020	0.00020 mg/L		< 0.00020				20	
Titanium, dissolved	< 0.0050	0.0050 mg/L		< 0.0050				20	
Tungsten, dissolved	< 0.0010	0.0010 mg/L		< 0.0010				20	
Uranium, dissolved	0.00570	0.000020 mg/L		0.00566			< 1	20	
Vanadium, dissolved	< 0.0050	0.0050 mg/L		< 0.0050				20	
Zinc, dissolved	0.0333	0.0040 mg/L		0.0338			2	20	
Zirconium, dissolved	< 0.00010	0.00010 mg/L		< 0.00010				20	

Matrix Spike (B3J1467-MS1)		Source: 23J1402-02		Prepared: 2023-10-16, Analyzed: 2023-10-16					
Aluminum, dissolved	4.90	0.0050 mg/L	4.00	< 0.0050	123	70-130			
Antimony, dissolved	0.0359	0.00020 mg/L	0.0400	< 0.00020	90	70-130			
Arsenic, dissolved	0.437	0.00050 mg/L	0.400	< 0.00050	109	70-130			
Barium, dissolved	0.0470	0.0050 mg/L	0.0400	< 0.0050	113	70-130			
Beryllium, dissolved	0.0451	0.00010 mg/L	0.0400	< 0.00010	113	70-130			
Bismuth, dissolved	0.0288	0.00010 mg/L	0.0400	< 0.00010	72	70-130			
Boron, dissolved	0.427	0.0500 mg/L	0.400	< 0.0500	104	70-130			
Cadmium, dissolved	0.0453	0.000010 mg/L	0.0400	< 0.000010	113	70-130			
Calcium, dissolved	11.2	0.20 mg/L	4.00	7.14	100	70-130			
Chromium, dissolved	0.0417	0.00050 mg/L	0.0400	< 0.00050	104	70-130			
Cobalt, dissolved	0.0416	0.00010 mg/L	0.0400	< 0.00010	104	70-130			
Copper, dissolved	0.0403	0.00040 mg/L	0.0400	< 0.00040	101	70-130			
Iron, dissolved	4.11	0.010 mg/L	4.00	< 0.010	103	70-130			
Lead, dissolved	0.0417	0.00020 mg/L	0.0400	< 0.00020	104	70-130			
Lithium, dissolved	0.0471	0.00010 mg/L	0.0400	0.00114	115	70-130			
Magnesium, dissolved	42.8	0.010 mg/L	4.00	40.4	60	70-130			MS2
Manganese, dissolved	0.0770	0.00020 mg/L	0.0400	0.0363	102	70-130			
Molybdenum, dissolved	0.0429	0.00010 mg/L	0.0400	0.00351	99	70-130			
Nickel, dissolved	0.0402	0.00040 mg/L	0.0400	< 0.00040	100	70-130			
Phosphorus, dissolved	4.41	0.050 mg/L	4.00	< 0.050	110	70-130			
Potassium, dissolved	7.20	0.10 mg/L	4.00	3.06	103	70-130			
Selenium, dissolved	0.428	0.00050 mg/L	0.400	0.00126	107	70-130			
Silicon, dissolved	4.9	1.0 mg/L	4.00	< 1.0	116	70-130			
Silver, dissolved	0.0406	0.000050 mg/L	0.0400	< 0.000050	102	70-130			
Sodium, dissolved	47.0	0.10 mg/L	4.00	45.7	32	70-130			MS2
Strontium, dissolved	0.0938	0.0010 mg/L	0.0400	0.0518	105	70-130			
Sulfur, dissolved	117	3.0 mg/L	40.0	75.8	104	70-130			
Tellurium, dissolved	0.0401	0.00050 mg/L	0.0400	< 0.00050	100	70-130			
Thallium, dissolved	0.0429	0.000020 mg/L	0.0400	< 0.000020	107	70-130			
Thorium, dissolved	0.0402	0.00010 mg/L	0.0400	< 0.00010	100	70-130			
Tin, dissolved	0.0448	0.00020 mg/L	0.0400	< 0.00020	112	70-130			
Titanium, dissolved	0.0422	0.0050 mg/L	0.0400	< 0.0050	106	70-130			
Tungsten, dissolved	0.0406	0.0010 mg/L	0.0400	< 0.0010	101	70-130			
Uranium, dissolved	0.0419	0.000020 mg/L	0.0400	< 0.000020	105	70-130			



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Dissolved Metals, Batch B3J1467, Continued

Matrix Spike (B3J1467-MS1), Continued		Source: 23J1402-02		Prepared: 2023-10-16, Analyzed: 2023-10-16					
Vanadium, dissolved	0.0427	0.0050 mg/L	0.0400	< 0.0050	107	70-130			
Zinc, dissolved	0.423	0.0040 mg/L	0.400	< 0.0040	106	70-130			
Zirconium, dissolved	0.0457	0.00010 mg/L	0.0400	< 0.00010	114	70-130			

Dissolved Metals, Batch B3J1521

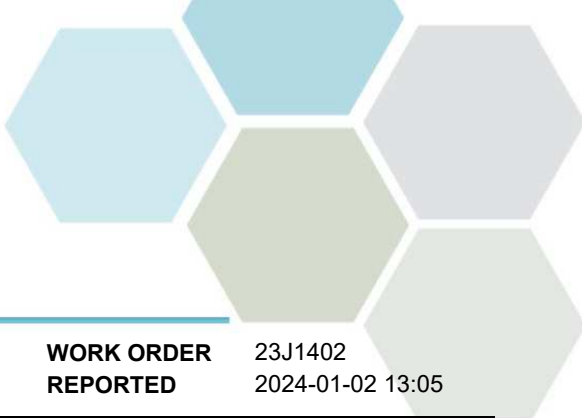
Blank (B3J1521-BLK1)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Mercury, dissolved	< 0.000010	0.000010 mg/L							
Blank (B3J1521-BLK2)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Mercury, dissolved	< 0.000010	0.000010 mg/L							
Blank (B3J1521-BLK3)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Mercury, dissolved	< 0.000010	0.000010 mg/L							
LCS (B3J1521-BS1)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Mercury, dissolved	0.000249	0.000010 mg/L	0.000250		100	80-120			
LCS (B3J1521-BS2)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Mercury, dissolved	0.000247	0.000010 mg/L	0.000250		99	80-120			
LCS (B3J1521-BS3)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Mercury, dissolved	0.000243	0.000010 mg/L	0.000250		97	80-120			
Duplicate (B3J1521-DUP2)		Source: 23J1402-05		Prepared: 2023-10-17, Analyzed: 2023-10-17					
Mercury, dissolved	< 0.000010	0.000010 mg/L		< 0.000010					20
Matrix Spike (B3J1521-MS2)		Source: 23J1402-06		Prepared: 2023-10-17, Analyzed: 2023-10-17					
Mercury, dissolved	0.000230	0.000010 mg/L	0.000250	< 0.000010	92	70-130			

General Parameters, Batch B3J1160

Blank (B3J1160-BLK1)			Prepared: 2023-10-20, Analyzed: 2023-10-20						
Carbon, Dissolved Organic	< 0.50	0.50 mg/L							
Blank (B3J1160-BLK2)			Prepared: 2023-10-21, Analyzed: 2023-10-23						
Carbon, Dissolved Organic	< 0.50	0.50 mg/L							
LCS (B3J1160-BS1)			Prepared: 2023-10-20, Analyzed: 2023-10-23						
Carbon, Dissolved Organic	9.13	0.50 mg/L	10.0		91	78-116			
LCS (B3J1160-BS2)			Prepared: 2023-10-21, Analyzed: 2023-10-23						
Carbon, Dissolved Organic	9.84	0.50 mg/L	10.0		98	78-116			

General Parameters, Batch B3J1321

Blank (B3J1321-BLK1)			Prepared: 2023-10-14, Analyzed: 2023-10-16						
Phosphorus, Total Dissolved	< 0.0050	0.0050 mg/L							
Blank (B3J1321-BLK2)			Prepared: 2023-10-14, Analyzed: 2023-10-16						
Phosphorus, Total (as P)	< 0.0050	0.0050 mg/L							
Blank (B3J1321-BLK3)			Prepared: 2023-10-14, Analyzed: 2023-10-16						
Phosphorus, Total (as P)	< 0.0050	0.0050 mg/L							
Phosphorus, Total Dissolved	< 0.0050	0.0050 mg/L							



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

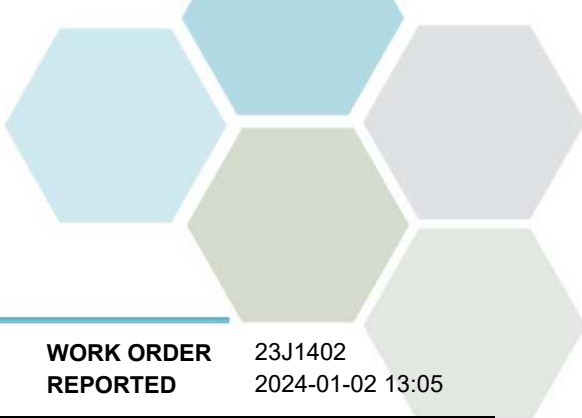
Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3J1321, Continued									
LCS (B3J1321-BS1)			Prepared: 2023-10-14, Analyzed: 2023-10-16						
Phosphorus, Total Dissolved	0.104	0.0050 mg/L	0.100		104	85-115			
LCS (B3J1321-BS2)			Prepared: 2023-10-14, Analyzed: 2023-10-16						
Phosphorus, Total (as P)	0.103	0.0050 mg/L	0.100		103	85-115			
LCS (B3J1321-BS3)			Prepared: 2023-10-14, Analyzed: 2023-10-16						
Phosphorus, Total (as P)	0.103	0.0050 mg/L	0.100		103	85-115			
Phosphorus, Total Dissolved	0.103	0.0050 mg/L	0.100		103	85-115			
Duplicate (B3J1321-DUP3)			Source: 23J1402-01		Prepared: 2023-10-14, Analyzed: 2023-10-16				
Phosphorus, Total (as P)	0.0228	0.0050 mg/L		0.0226					15
Phosphorus, Total Dissolved	0.0183	0.0050 mg/L		0.0202					15
Matrix Spike (B3J1321-MS3)			Source: 23J1402-01		Prepared: 2023-10-14, Analyzed: 2023-10-16				
Phosphorus, Total (as P)	0.124	0.0050 mg/L	0.102	0.0226	99	70-125			
Phosphorus, Total Dissolved	0.119	0.0050 mg/L	0.102	0.0202	97	70-125			

General Parameters, Batch B3J1329

Blank (B3J1329-BLK1)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							
Blank (B3J1329-BLK2)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							
LCS (B3J1329-BS1)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Alkalinity, Total (as CaCO3)	112	1.0 mg/L	100		112	80-120			
Alkalinity, Phenolphthalein (as CaCO3)	48.7	1.0 mg/L	50.0		97	0-200			
LCS (B3J1329-BS2)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Alkalinity, Total (as CaCO3)	113	1.0 mg/L	100		113	80-120			
Alkalinity, Phenolphthalein (as CaCO3)	52.7	1.0 mg/L	50.0		105	0-200			

General Parameters, Batch B3J1336

Blank (B3J1336-BLK1)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
Blank (B3J1336-BLK2)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
Blank (B3J1336-BLK3)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
Blank (B3J1336-BLK4)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
LCS (B3J1336-BS1)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	1.05	0.050 mg/L	1.00		105	85-115			



APPENDIX 2: QUALITY CONTROL RESULTS

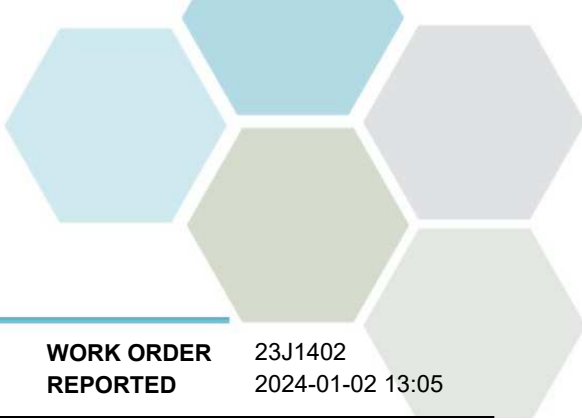
REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3J1336, Continued									
LCS (B3J1336-BS2)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	1.05	0.050 mg/L	1.00		105	85-115			
LCS (B3J1336-BS3)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	1.07	0.050 mg/L	1.00		107	85-115			
LCS (B3J1336-BS4)			Prepared: 2023-10-15, Analyzed: 2023-10-15						
Ammonia, Total (as N)	1.06	0.050 mg/L	1.00		106	85-115			
General Parameters, Batch B3J1409									
Blank (B3J1409-BLK1)			Prepared: 2023-10-16, Analyzed: 2023-10-16						
Solids, Total Dissolved	< 15	15 mg/L							
LCS (B3J1409-BS1)			Prepared: 2023-10-16, Analyzed: 2023-10-16						
Solids, Total Dissolved	232	15 mg/L	240		97	85-115			
General Parameters, Batch B3J1511									
Blank (B3J1511-BLK1)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Solids, Total Dissolved	< 15	15 mg/L							
LCS (B3J1511-BS1)			Prepared: 2023-10-17, Analyzed: 2023-10-17						
Solids, Total Dissolved	246	15 mg/L	240		102	85-115			
Duplicate (B3J1511-DUP1)			Source: 23J1402-07		Prepared: 2023-10-17, Analyzed: 2023-10-17				
Solids, Total Dissolved	1100	15 mg/L		1030			6	15	
General Parameters, Batch B3J1547									
Blank (B3J1547-BLK1)			Prepared: 2023-10-17, Analyzed: 2023-10-18						
Nitrogen, Total Kjeldahl	< 0.050	0.050 mg/L							
Blank (B3J1547-BLK2)			Prepared: 2023-10-17, Analyzed: 2023-10-18						
Nitrogen, Total Kjeldahl	< 0.050	0.050 mg/L							
LCS (B3J1547-BS1)			Prepared: 2023-10-17, Analyzed: 2023-10-18						
Nitrogen, Total Kjeldahl	1.01	0.050 mg/L	1.00		101	85-115			
LCS (B3J1547-BS2)			Prepared: 2023-10-17, Analyzed: 2023-10-18						
Nitrogen, Total Kjeldahl	1.01	0.050 mg/L	1.00		101	85-115			

QC Qualifiers:

MS2 The native sample concentration is greater than the spike concentration hence the matrix spike limits do not apply.



APPENDIX 3: REVISION HISTORY

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23J1402
2024-01-02 13:05

Sample ID	Changed	Change	Analysis	Analyte(s)
23J1402-01	2023-10-23	SampleRegID	N/A	N/A
23J1402-02	2023-10-23	SampleRegID	N/A	N/A
23J1402-03	2023-10-23	SampleRegID	N/A	N/A
23J1402-04	2023-10-23	SampleRegID	N/A	N/A
23J1402-05	2023-10-23	SampleRegID	N/A	N/A
23J1402-06	2023-10-23	SampleRegID	N/A	N/A
23J1402-07	2023-10-23	SampleRegID	N/A	N/A
23J1402-08	2023-10-23	SampleRegID	N/A	N/A
23J1402-09	2023-10-23	SampleRegID	N/A	N/A
23J1402-10	2023-10-23	SampleRegID	N/A	N/A
23J1402-11	2023-10-23	SampleRegID	N/A	N/A
23J1402-12	2023-10-23	SampleRegID	N/A	N/A
23J1402-11RE1	2023-10-25	Added	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-11RE2	2023-10-25	Added	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-12RE1	2023-10-25	Added	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-12RE2	2023-10-25	Added	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-10	2023-11-01	Date Sampled	N/A	N/A
23J1402-11	2024-01-02	Made Non-Reportable	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-11RE1	2024-01-02	Made Non-Reportable	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-11RE2	2024-01-02	Made Non-Reportable	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-12	2024-01-02	Made Non-Reportable	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-12RE1	2024-01-02	Made Non-Reportable	Carbon, Dissolved Organic	Carbon, Dissolved Organic
23J1402-12RE2	2024-01-02	Made Non-Reportable	Carbon, Dissolved Organic	Carbon, Dissolved Organic

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9	WORK ORDER	23K2796
ATTENTION	Nicole Penner	RECEIVED / TEMP REPORTED	2023-11-22 14:33 / 3.6°C 2023-11-29 09:22
PO NUMBER		COC NUMBER	No Number
PROJECT	2023-8537.000		
PROJECT INFO	City of Vernon		

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: <https://www.caro.ca/terms-conditions>

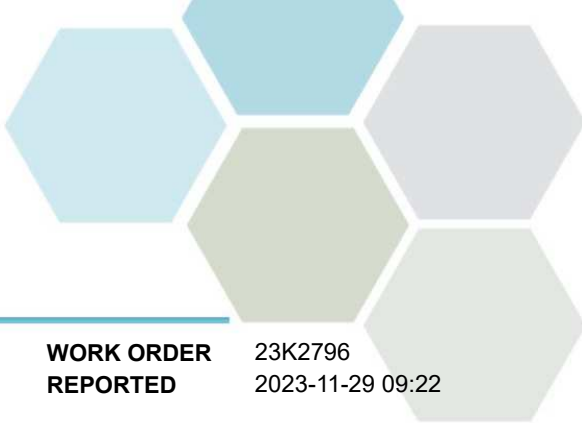
If you have any questions or concerns, please contact me at bwhitehead@caro.ca

Authorized By:

Brent Whitehead
Account Manager

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#110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7 | #108 4475 Wayburne Drive Burnaby, BC V5G 4X4

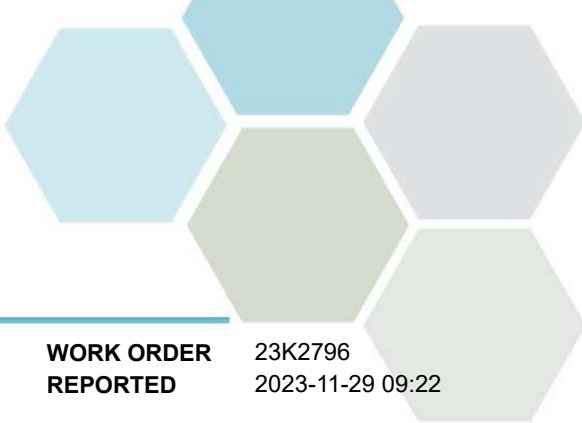


TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23K2796
2023-11-29 09:22

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
MW11-02 (23K2796-01) Matrix: Water Sampled: 2023-11-21 14:15					
Anions					
Bromide	< 0.10	N/A	0.10 mg/L	2023-11-24	
Chloride	122	AO ≤ 250	0.10 mg/L	2023-11-24	
Fluoride	0.21	MAC = 1.5	0.10 mg/L	2023-11-24	
Nitrate (as N)	10.5	MAC = 10	0.010 mg/L	2023-11-24	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2023-11-24	
Phosphate (as P)	< 0.0050	N/A	0.0050 mg/L	2023-11-24	
Sulfate	795	AO ≤ 500	1.0 mg/L	2023-11-24	
Calculated Parameters					
Hardness, Dissolved (as CaCO3)	1040	N/A	0.500 mg/L	N/A	
Nitrate+Nitrite (as N)	10.5	N/A	0.100 mg/L	N/A	
Nitrogen, Total	10.9	N/A	0.100 mg/L	N/A	
Nitrogen, Organic	0.365	N/A	0.0500 mg/L	N/A	
Dissolved Metals					
Aluminum, dissolved	< 0.0050	N/A	0.0050 mg/L	2023-11-28	
Antimony, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-11-28	
Arsenic, dissolved	0.00065	N/A	0.00050 mg/L	2023-11-28	
Barium, dissolved	0.0265	N/A	0.0050 mg/L	2023-11-28	
Beryllium, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-11-28	
Bismuth, dissolved	< 0.00010	N/A	0.00010 mg/L	2023-11-28	
Boron, dissolved	0.157	N/A	0.0500 mg/L	2023-11-28	
Cadmium, dissolved	0.000077	N/A	0.000010 mg/L	2023-11-28	
Calcium, dissolved	204	N/A	0.20 mg/L	2023-11-28	
Chromium, dissolved	0.00183	N/A	0.00050 mg/L	2023-11-28	
Cobalt, dissolved	0.00264	N/A	0.00010 mg/L	2023-11-28	
Copper, dissolved	0.00163	N/A	0.00040 mg/L	2023-11-28	
Iron, dissolved	< 0.010	N/A	0.010 mg/L	2023-11-28	
Lead, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-11-28	
Lithium, dissolved	0.0204	N/A	0.00010 mg/L	2023-11-28	
Magnesium, dissolved	130	N/A	0.010 mg/L	2023-11-28	
Manganese, dissolved	< 0.00020	N/A	0.00020 mg/L	2023-11-28	
Mercury, dissolved	< 0.000010	N/A	0.000010 mg/L	2023-11-27	
Molybdenum, dissolved	0.0101	N/A	0.00010 mg/L	2023-11-28	
Nickel, dissolved	0.0131	N/A	0.00040 mg/L	2023-11-28	
Phosphorus, dissolved	< 0.050	N/A	0.050 mg/L	2023-11-28	
Potassium, dissolved	9.17	N/A	0.10 mg/L	2023-11-28	
Selenium, dissolved	0.0242	N/A	0.00050 mg/L	2023-11-28	
Silicon, dissolved	13.5	N/A	1.0 mg/L	2023-11-28	
Silver, dissolved	< 0.000050	N/A	0.000050 mg/L	2023-11-28	
Sodium, dissolved	134	N/A	0.10 mg/L	2023-11-28	
Strontium, dissolved	1.33	N/A	0.0010 mg/L	2023-11-28	
Sulfur, dissolved	252	N/A	3.0 mg/L	2023-11-28	
Tellurium, dissolved	< 0.00050	N/A	0.00050 mg/L	2023-11-28	



TEST RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
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Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
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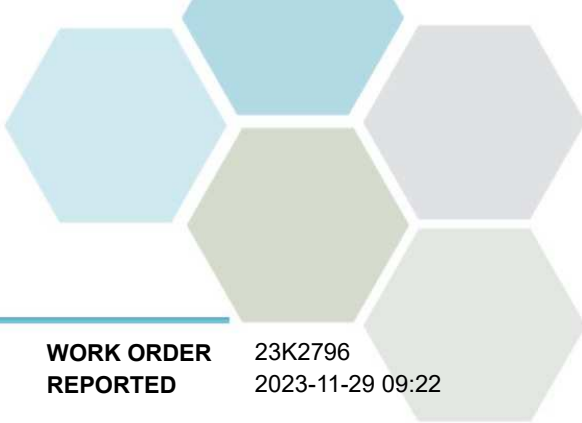
MW11-02 (23K2796-01) | Matrix: Water | Sampled: 2023-11-21 14:15, Continued

Dissolved Metals, Continued

Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2023-11-28	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-11-28	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2023-11-28	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-11-28	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2023-11-28	
Uranium, dissolved	0.0411	N/A	0.000020	mg/L	2023-11-28	
Vanadium, dissolved	< 0.0050	N/A	0.0050	mg/L	2023-11-28	
Zinc, dissolved	< 0.0040	N/A	0.0040	mg/L	2023-11-28	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2023-11-28	

General Parameters

Alkalinity, Total (as CaCO3)	367	N/A	1.0	mg/L	2023-11-25	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-11-25	
Alkalinity, Bicarbonate (as CaCO3)	367	N/A	1.0	mg/L	2023-11-25	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-11-25	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2023-11-25	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2023-11-25	
Carbon, Dissolved Organic	2.24	N/A	0.50	mg/L	2023-11-28	
Nitrogen, Total Kjeldahl	0.365	N/A	0.050	mg/L	2023-11-27	
Phosphorus, Total (as P)	0.0420	N/A	0.0050	mg/L	2023-11-24	
Phosphorus, Total Dissolved	0.0261	N/A	0.0050	mg/L	2023-11-24	
Solids, Total Dissolved	1590	AO ≤ 500	15	mg/L	2023-11-26	



APPENDIX 1: SUPPORTING INFORMATION

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Analysis Description	Method Ref.	Technique	Accredited	Location
Alkalinity in Water	SM 2320 B* (2021)	Titration with H2SO4	✓	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2021)	Automated Colorimetry (Phenate)	✓	Kelowna
Anions in Water	SM 4110 B (2020)	Ion Chromatography	✓	Kelowna
Carbon, Dissolved Organic in Water	SM 5310 B (2022)	Combustion, Infrared CO2 Detection	✓	Kelowna
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
Hardness in Water	SM 2340 B (2021)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	✓	N/A
Mercury, dissolved in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	✓	Richmond
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2021)	Block Digestion and Flow Injection Analysis	✓	Kelowna
Phosphorus, Total Dissolved in Water	SM 4500-P B.5* (2011) / SM 4500-P F (2021)	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	✓	Kelowna
Phosphorus, Total in Water	SM 4500-P B.5* (2011) / SM 4500-P F (2021)	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	✓	Kelowna
Solids, Total Dissolved in Water	Solids in Water, Filtered / SM 2540 C* (2020)	Solids in Water, Filtered / Gravimetry (Dried at 103-105C)	✓	Kelowna

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

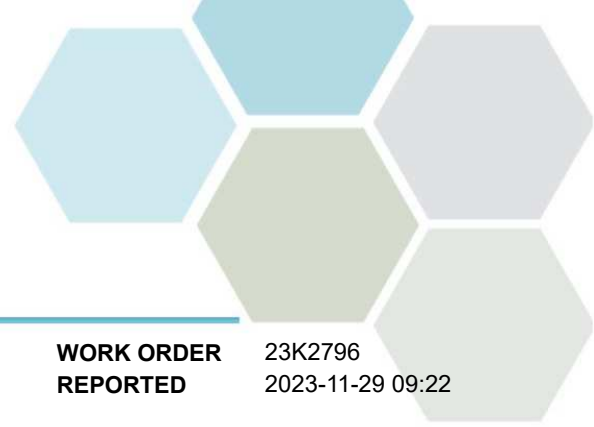
Glossary of Terms:

RL	Reporting Limit (default)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
AO	Aesthetic Objective
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

Guidelines Referenced in this Report:

[Guidelines for Canadian Drinking Water Quality \(Health Canada, September 2022\)](#)

Note: In some cases, the values displayed on the report represent the lowest guideline and are to be verified by the end user



APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
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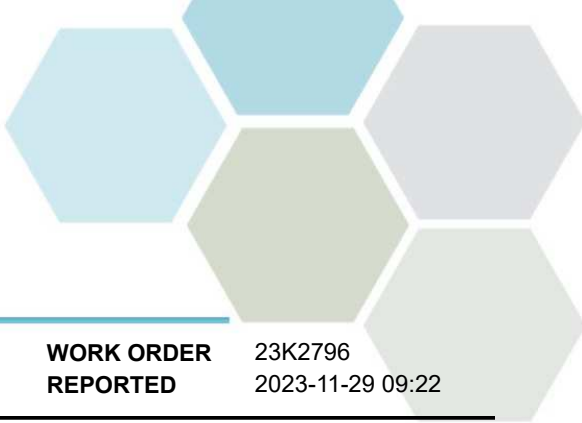
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General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager: bwhitehead@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline(s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.



APPENDIX 2: QUALITY CONTROL RESULTS

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Anions, Batch B3K2389

Blank (B3K2389-BLK1)			Prepared: 2023-11-24, Analyzed: 2023-11-24						
Bromide	< 0.10	0.10 mg/L							
Chloride	< 0.10	0.10 mg/L							
Fluoride	< 0.10	0.10 mg/L							
Nitrate (as N)	< 0.010	0.010 mg/L							
Nitrite (as N)	< 0.010	0.010 mg/L							
Phosphate (as P)	< 0.0050	0.0050 mg/L							
Sulfate	< 1.0	1.0 mg/L							

LCS (B3K2389-BS1)			Prepared: 2023-11-24, Analyzed: 2023-11-24						
Bromide	3.96	0.10 mg/L	4.00		99	85-115			
Chloride	16.1	0.10 mg/L	16.0		101	90-110			
Fluoride	4.12	0.10 mg/L	4.00		103	88-108			
Nitrate (as N)	3.92	0.010 mg/L	4.00		98	90-110			
Nitrite (as N)	2.10	0.010 mg/L	2.00		105	85-115			
Phosphate (as P)	0.980	0.0050 mg/L	1.00		98	80-120			
Sulfate	16.1	1.0 mg/L	16.0		101	90-110			

Dissolved Metals, Batch B3K2620

Blank (B3K2620-BLK1)			Prepared: 2023-11-26, Analyzed: 2023-11-27						
Mercury, dissolved	< 0.000010	0.000010 mg/L							
Blank (B3K2620-BLK2)			Prepared: 2023-11-26, Analyzed: 2023-11-27						
Mercury, dissolved	< 0.000010	0.000010 mg/L							
LCS (B3K2620-BS1)			Prepared: 2023-11-26, Analyzed: 2023-11-27						
Mercury, dissolved	0.000202	0.000010 mg/L	0.000250		81	80-120			
LCS (B3K2620-BS2)			Prepared: 2023-11-26, Analyzed: 2023-11-27						
Mercury, dissolved	0.000222	0.000010 mg/L	0.000250		89	80-120			

Dissolved Metals, Batch B3K2750

Blank (B3K2750-BLK1)			Prepared: 2023-11-28, Analyzed: 2023-11-28						
Aluminum, dissolved	< 0.0050	0.0050 mg/L							
Antimony, dissolved	< 0.00020	0.00020 mg/L							



APPENDIX 2: QUALITY CONTROL RESULTS

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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Dissolved Metals, Batch B3K2750, Continued

Blank (B3K2750-BLK1), Continued

Prepared: 2023-11-28, Analyzed: 2023-11-28

Arsenic, dissolved	< 0.00050	0.00050 mg/L							
Barium, dissolved	< 0.0050	0.0050 mg/L							
Beryllium, dissolved	< 0.00010	0.00010 mg/L							
Bismuth, dissolved	< 0.00010	0.00010 mg/L							
Boron, dissolved	< 0.0500	0.0500 mg/L							
Cadmium, dissolved	< 0.000010	0.000010 mg/L							
Calcium, dissolved	< 0.20	0.20 mg/L							
Chromium, dissolved	< 0.00050	0.00050 mg/L							
Cobalt, dissolved	< 0.00010	0.00010 mg/L							
Copper, dissolved	< 0.00040	0.00040 mg/L							
Iron, dissolved	< 0.010	0.010 mg/L							
Lead, dissolved	< 0.00020	0.00020 mg/L							
Lithium, dissolved	< 0.00010	0.00010 mg/L							
Magnesium, dissolved	< 0.010	0.010 mg/L							
Manganese, dissolved	< 0.00020	0.00020 mg/L							
Molybdenum, dissolved	< 0.00010	0.00010 mg/L							
Nickel, dissolved	< 0.00040	0.00040 mg/L							
Phosphorus, dissolved	< 0.050	0.050 mg/L							
Potassium, dissolved	< 0.10	0.10 mg/L							
Selenium, dissolved	< 0.00050	0.00050 mg/L							
Silicon, dissolved	< 1.0	1.0 mg/L							
Silver, dissolved	< 0.000050	0.000050 mg/L							
Sodium, dissolved	< 0.10	0.10 mg/L							
Strontium, dissolved	< 0.0010	0.0010 mg/L							
Sulfur, dissolved	< 3.0	3.0 mg/L							
Tellurium, dissolved	< 0.00050	0.00050 mg/L							
Thallium, dissolved	< 0.000020	0.000020 mg/L							
Thorium, dissolved	< 0.00010	0.00010 mg/L							
Tin, dissolved	< 0.00020	0.00020 mg/L							
Titanium, dissolved	< 0.0050	0.0050 mg/L							
Tungsten, dissolved	< 0.0010	0.0010 mg/L							
Uranium, dissolved	< 0.000020	0.000020 mg/L							
Vanadium, dissolved	< 0.0050	0.0050 mg/L							
Zinc, dissolved	< 0.0040	0.0040 mg/L							
Zirconium, dissolved	< 0.00010	0.00010 mg/L							

LCS (B3K2750-BS1)

Prepared: 2023-11-28, Analyzed: 2023-11-28

Aluminum, dissolved	3.92	0.0050 mg/L	4.00	98	80-120
Antimony, dissolved	0.0387	0.00020 mg/L	0.0400	97	80-120
Arsenic, dissolved	0.403	0.00050 mg/L	0.400	101	80-120
Barium, dissolved	0.0388	0.0050 mg/L	0.0400	97	80-120
Beryllium, dissolved	0.0413	0.00010 mg/L	0.0400	103	80-120
Bismuth, dissolved	0.0403	0.00010 mg/L	0.0400	101	80-120
Boron, dissolved	0.436	0.0500 mg/L	0.400	109	80-120
Cadmium, dissolved	0.0390	0.000010 mg/L	0.0400	97	80-120
Calcium, dissolved	4.06	0.20 mg/L	4.00	101	80-120
Chromium, dissolved	0.0413	0.00050 mg/L	0.0400	103	80-120
Cobalt, dissolved	0.0399	0.00010 mg/L	0.0400	100	80-120
Copper, dissolved	0.0408	0.00040 mg/L	0.0400	102	80-120
Iron, dissolved	3.96	0.010 mg/L	4.00	99	80-120
Lead, dissolved	0.0402	0.00020 mg/L	0.0400	101	80-120
Lithium, dissolved	0.0412	0.00010 mg/L	0.0400	103	80-120
Magnesium, dissolved	3.74	0.010 mg/L	4.00	94	80-120
Manganese, dissolved	0.0393	0.00020 mg/L	0.0400	98	80-120
Molybdenum, dissolved	0.0393	0.00010 mg/L	0.0400	98	80-120
Nickel, dissolved	0.0396	0.00040 mg/L	0.0400	99	80-120



APPENDIX 2: QUALITY CONTROL RESULTS

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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Dissolved Metals, Batch B3K2750, Continued

LCS (B3K2750-BS1), Continued

Prepared: 2023-11-28, Analyzed: 2023-11-28

Phosphorus, dissolved	3.93	0.050 mg/L	4.00		98	80-120			
Potassium, dissolved	3.67	0.10 mg/L	4.00		92	80-120			
Selenium, dissolved	0.410	0.00050 mg/L	0.400		103	80-120			
Silicon, dissolved	3.9	1.0 mg/L	4.00		99	80-120			
Silver, dissolved	0.0405	0.000050 mg/L	0.0400		101	80-120			
Sodium, dissolved	3.88	0.10 mg/L	4.00		97	80-120			
Strontium, dissolved	0.0389	0.0010 mg/L	0.0400		97	80-120			
Sulfur, dissolved	38.2	3.0 mg/L	40.0		95	80-120			
Tellurium, dissolved	0.0369	0.00050 mg/L	0.0400		92	80-120			
Thallium, dissolved	0.0400	0.000020 mg/L	0.0400		100	80-120			
Thorium, dissolved	0.0408	0.00010 mg/L	0.0400		102	80-120			
Tin, dissolved	0.0388	0.00020 mg/L	0.0400		97	80-120			
Titanium, dissolved	0.0347	0.0050 mg/L	0.0400		87	80-120			
Tungsten, dissolved	0.0402	0.0010 mg/L	0.0400		100	80-120			
Uranium, dissolved	0.0408	0.000020 mg/L	0.0400		102	80-120			
Vanadium, dissolved	0.0405	0.0050 mg/L	0.0400		101	80-120			
Zinc, dissolved	0.399	0.0040 mg/L	0.400		100	80-120			
Zirconium, dissolved	0.0386	0.00010 mg/L	0.0400		97	80-120			

Duplicate (B3K2750-DUP1)

Source: 23K2796-01

Prepared: 2023-11-28, Analyzed: 2023-11-28

Aluminum, dissolved	< 0.0050	0.0050 mg/L	< 0.0050						20
Antimony, dissolved	< 0.00020	0.00020 mg/L	< 0.00020						20
Arsenic, dissolved	0.00068	0.00050 mg/L	0.00065						20
Barium, dissolved	0.0269	0.0050 mg/L	0.0265				2		20
Beryllium, dissolved	< 0.00010	0.00010 mg/L	< 0.00010						20
Bismuth, dissolved	< 0.00010	0.00010 mg/L	< 0.00010						20
Boron, dissolved	0.159	0.0500 mg/L	0.157						20
Cadmium, dissolved	0.000086	0.000010 mg/L	0.000077				11		20
Calcium, dissolved	209	0.20 mg/L	204				3		20
Chromium, dissolved	0.00182	0.00050 mg/L	0.00183						20
Cobalt, dissolved	0.00264	0.00010 mg/L	0.00264				< 1		20
Copper, dissolved	0.00157	0.00040 mg/L	0.00163						20
Iron, dissolved	< 0.010	0.010 mg/L	< 0.010						20
Lead, dissolved	< 0.00020	0.00020 mg/L	< 0.00020						20
Lithium, dissolved	0.0198	0.00010 mg/L	0.0204				3		20
Magnesium, dissolved	133	0.010 mg/L	130				3		20
Manganese, dissolved	< 0.00020	0.00020 mg/L	< 0.00020						20
Molybdenum, dissolved	0.0102	0.00010 mg/L	0.0101				< 1		20
Nickel, dissolved	0.0129	0.00040 mg/L	0.0131				1		20
Phosphorus, dissolved	< 0.050	0.050 mg/L	< 0.050						20
Potassium, dissolved	9.33	0.10 mg/L	9.17				2		20
Selenium, dissolved	0.0244	0.00050 mg/L	0.0242				1		20
Silicon, dissolved	13.9	1.0 mg/L	13.5				3		20
Silver, dissolved	< 0.000050	0.000050 mg/L	< 0.000050						20
Sodium, dissolved	141	0.10 mg/L	134				5		20
Strontium, dissolved	1.35	0.0010 mg/L	1.33				2		20
Sulfur, dissolved	266	3.0 mg/L	252				5		20
Tellurium, dissolved	< 0.00050	0.00050 mg/L	< 0.00050						20
Thallium, dissolved	< 0.000020	0.000020 mg/L	< 0.000020						20
Thorium, dissolved	< 0.00010	0.00010 mg/L	< 0.00010						20
Tin, dissolved	< 0.00020	0.00020 mg/L	< 0.00020						20
Titanium, dissolved	< 0.0050	0.0050 mg/L	< 0.0050						20
Tungsten, dissolved	< 0.0010	0.0010 mg/L	< 0.0010						20
Uranium, dissolved	0.0421	0.000020 mg/L	0.0411				2		20
Vanadium, dissolved	< 0.0050	0.0050 mg/L	< 0.0050						20
Zinc, dissolved	< 0.0040	0.0040 mg/L	< 0.0040						20



APPENDIX 2: QUALITY CONTROL RESULTS

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WORK ORDER REPORTED 23K2796
2023-11-29 09:22

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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Dissolved Metals, Batch B3K2750, Continued

Duplicate (B3K2750-DUP1), Continued		Source: 23K2796-01		Prepared: 2023-11-28, Analyzed: 2023-11-28					
Zirconium, dissolved	< 0.00010	0.00010 mg/L		< 0.00010				20	

General Parameters, Batch B3K2292

Blank (B3K2292-BLK1)		Prepared: 2023-11-28, Analyzed: 2023-11-28							
Carbon, Dissolved Organic	< 0.50	0.50 mg/L							
Blank (B3K2292-BLK2)		Prepared: 2023-11-28, Analyzed: 2023-11-28							
Carbon, Dissolved Organic	< 0.50	0.50 mg/L							
Blank (B3K2292-BLK3)		Prepared: 2023-11-28, Analyzed: 2023-11-28							
Carbon, Dissolved Organic	< 0.50	0.50 mg/L							
LCS (B3K2292-BS1)		Prepared: 2023-11-28, Analyzed: 2023-11-28							
Carbon, Dissolved Organic	10.1	0.50 mg/L	10.0		101	78-116			
LCS (B3K2292-BS2)		Prepared: 2023-11-28, Analyzed: 2023-11-28							
Carbon, Dissolved Organic	9.39	0.50 mg/L	10.0		94	78-116			
LCS (B3K2292-BS3)		Prepared: 2023-11-28, Analyzed: 2023-11-28							
Carbon, Dissolved Organic	9.36	0.50 mg/L	10.0		94	78-116			

General Parameters, Batch B3K2405

Blank (B3K2405-BLK1)		Prepared: 2023-11-23, Analyzed: 2023-11-24							
Phosphorus, Total (as P)	< 0.0050	0.0050 mg/L							
Phosphorus, Total Dissolved	< 0.0050	0.0050 mg/L							
Blank (B3K2405-BLK2)		Prepared: 2023-11-23, Analyzed: 2023-11-24							
Phosphorus, Total (as P)	< 0.0050	0.0050 mg/L							
Phosphorus, Total Dissolved	< 0.0050	0.0050 mg/L							
LCS (B3K2405-BS1)		Prepared: 2023-11-23, Analyzed: 2023-11-24							
Phosphorus, Total (as P)	0.104	0.0050 mg/L	0.100		104	85-115			
Phosphorus, Total Dissolved	0.103	0.0050 mg/L	0.100		103	85-115			
LCS (B3K2405-BS2)		Prepared: 2023-11-23, Analyzed: 2023-11-24							
Phosphorus, Total (as P)	0.103	0.0050 mg/L	0.100		103	85-115			
Phosphorus, Total Dissolved	0.104	0.0050 mg/L	0.100		104	85-115			
Duplicate (B3K2405-DUP2)		Source: 23K2796-01		Prepared: 2023-11-23, Analyzed: 2023-11-24					
Phosphorus, Total (as P)	0.0414	0.0050 mg/L		0.0420			1	15	
Phosphorus, Total Dissolved	0.0271	0.0050 mg/L		0.0261			4	15	
Matrix Spike (B3K2405-MS2)		Source: 23K2796-01		Prepared: 2023-11-23, Analyzed: 2023-11-24					
Phosphorus, Total (as P)	0.147	0.0050 mg/L	0.102	0.0420	103	70-125			
Phosphorus, Total Dissolved	0.136	0.0050 mg/L	0.102	0.0261	108	70-125			

General Parameters, Batch B3K2561

Blank (B3K2561-BLK1)		Prepared: 2023-11-25, Analyzed: 2023-11-25							
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23K2796
2023-11-29 09:22

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3K2561, Continued									
Blank (B3K2561-BLK2)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							
LCS (B3K2561-BS1)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Alkalinity, Total (as CaCO3)	108	1.0 mg/L	100		108	80-120			
Alkalinity, Phenolphthalein (as CaCO3)	38.0	1.0 mg/L	50.0		76	0-200			
LCS (B3K2561-BS2)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Alkalinity, Total (as CaCO3)	110	1.0 mg/L	100		110	80-120			
Alkalinity, Phenolphthalein (as CaCO3)	22.5	1.0 mg/L	50.0		45	0-200			
General Parameters, Batch B3K2567									
Blank (B3K2567-BLK1)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
Blank (B3K2567-BLK2)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
Blank (B3K2567-BLK3)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
Blank (B3K2567-BLK4)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	< 0.050	0.050 mg/L							
LCS (B3K2567-BS1)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	0.928	0.050 mg/L	1.00		93	85-115			
LCS (B3K2567-BS2)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	0.920	0.050 mg/L	1.00		92	85-115			
LCS (B3K2567-BS3)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	0.928	0.050 mg/L	1.00		93	85-115			
LCS (B3K2567-BS4)			Prepared: 2023-11-25, Analyzed: 2023-11-25						
Ammonia, Total (as N)	0.920	0.050 mg/L	1.00		92	85-115			
General Parameters, Batch B3K2603									
Blank (B3K2603-BLK1)			Prepared: 2023-11-26, Analyzed: 2023-11-26						
Solids, Total Dissolved	< 15	15 mg/L							
LCS (B3K2603-BS1)			Prepared: 2023-11-26, Analyzed: 2023-11-26						
Solids, Total Dissolved	236	15 mg/L	240		98	85-115			
Duplicate (B3K2603-DUP1)			Prepared: 2023-11-26, Analyzed: 2023-11-26						
Solids, Total Dissolved	1620	15 mg/L		1590			2	15	
General Parameters, Batch B3K2629									
Blank (B3K2629-BLK1)			Prepared: 2023-11-26, Analyzed: 2023-11-27						
Nitrogen, Total Kjeldahl	< 0.050	0.050 mg/L							



APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)
2023-8537.000

WORK ORDER REPORTED 23K2796
2023-11-29 09:22

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B3K2629, Continued									
Blank (B3K2629-BLK2)				Prepared: 2023-11-26, Analyzed: 2023-11-27					
Nitrogen, Total Kjeldahl	< 0.050	0.050 mg/L							
LCS (B3K2629-BS1)				Prepared: 2023-11-26, Analyzed: 2023-11-27					
Nitrogen, Total Kjeldahl	1.01	0.050 mg/L	1.00		101	85-115			
LCS (B3K2629-BS2)				Prepared: 2023-11-26, Analyzed: 2023-11-27					
Nitrogen, Total Kjeldahl	0.998	0.050 mg/L	1.00		100	85-115			

Appendix M

Sanitary Use Bylaw



THE CORPORATION OF THE CITY OF VERNON

**SANITARY
USE
BYLAW
#4863**

Consolidated for convenience

BYLAW NUMBER 4863

THE CORPORATION OF THE CITY OF VERNON

BYLAW NUMBER 4863

BYLAW No.	ADOPTION	AMENDMENT
5100	September 10, 2007	Section 4.01 be deleted in its entirety.
		▪
		▪

BYLAW NUMBER 4863

THE CORPORATION OF THE CITY OF VERNON

BYLAW NUMBER 4863

A bylaw to regulate discharges
into the Sanitary Sewer System

WHEREAS pursuant to Section 8 of the Community Charter and amendments thereto, Council may, by bylaw, provide for the establishment of a system of sanitary sewer works and regulate the use of the sanitary sewer works of the City;

AND WHEREAS there are compounds in waste that in various concentrations are detrimental to the operation of the sanitary sewer works whose discharge must be regulated.

NOW THEREFORE BE IT RESOLVED that the Council of The Corporation of the City of Vernon, in open meeting assembled, enact as follows:

1.00 CITATION

1.01 This bylaw may be cited as the "City of Vernon Sanitary Sewer Use Bylaw Number 4863, 2005".

2.00 SCOPE

2.01 This bylaw regulates the use of the sanitary sewer system within the City of Vernon.

2.02 The provisions of this bylaw apply to all direct and indirect discharges to any part of the City of Vernon sanitary sewer system.

2.03 This bylaw regulates the quantity and quality of wastes that may be discharged to the City of Vernon sanitary sewer system and the degree of pre-treatment required.

2.04 All applicable fees associated with this bylaw are charged in accordance with the City's current Fees and Charges Bylaw, and all subsequent amendments.

2.05 Nothing in this bylaw relieves any person or organization from complying with any provision of any Federal or Provincial legislation or any other bylaw of the City of Vernon.

3.00 DEFINITIONS

3.01 In this bylaw, the following words and terms shall have the meanings hereinafter assigned to them:

“Adverse Effect” means impairment of or damage to the environment, human health or safety.

“Biosolids” means solids derived from primary, secondary, or advanced treatment of domestic wastewater which have been treated through one or more controlled processes that reduce pathogens, reduce volatile solids or chemically stabilize.

“B.O.D.” or “Biochemical Oxygen Demand” means the quantity of oxygen utilized in the biochemical oxidation of organic matter under standard laboratory conditions in five (5) days at 20°C, expressed in milligrams per liter as determined by the appropriate procedure in “Standard Methods”.

“BTEX” means the total of benzene, toluene, ethyl benzene, and xylene.

“Building Sanitary Sewer” means all pipes, conduits, drains and other equipment and facilities owned and maintained by the Owner for the purpose of collecting and transporting waste to the City of Vernon sanitary sewer.

“City” means the Corporation of the City of Vernon, in the Province of British Columbia.

“C.O.D.” or “Chemical Oxygen Demand” means the measure of the oxygen consuming capacity of organic and inorganic matter present in wastewater as determined by the appropriate procedure described in “Standard Methods”.

“Cooling Water” means untreated water originating from uses such as air conditioning, cooling or refrigeration where the only pollutant added to the water is heat.

“Compatible Pollutant” means B.O.D., S.S., pH and fecal coliform bacteria and such additional pollutants as are now, or may be in the future, specified and controlled in the City of Vernon Operational Certificate as issued by the Ministry of Water, Land and Air Protection, for its wastewater treatment works where said works have been designed and used to reduce or remove such pollutants.

“Composite Sample” means a sample which is composed of equal portions of a specified number of Grab Samples collected at the same sampling point at specified time intervals during a specified sampling period.

“Contaminant” means any substance, whether gaseous, liquid or solids, whether dissolved or suspended that:

- a. injures, or is capable of injuring, the health or safety of a person;
- b. injures, or is capable of injuring, property or any life form;
- c. interferes, or is capable of interfering, with the operation of a Sewer or Sewage Facility;
- d. causes, or is capable of causing, material physical discomfort to a person;

e. damages, or is capable of damaging, the environment.

“Domestic Wastewater” means wastewater that is composed of liquid and water carried wastes associated with the use of water for drinking, cooking, cleaning, washing, hygiene, sanitation or other domestic purposes.

“Effluent” means the liquid outflow of any facility designed to treat or convey wastewater.

“Garbage” means solid wastes from domestic and commercial preparation, cooking and dispensing of food, and from handling, storage and sale of food as well as any other refuse not normally associated with typical domestic wastewater.

“Grab Sample” means an aliquot of a sampled stream or discharge collected at one particular place and time.

“High Strength Wastes” means wastewater having;

- a. B.O.D. in excess of 500 mg/l as analyzed in a twenty-four-hour composite sample, 1000 mg/l as analyzed in a two-hour composite sample, or 2000 mg/l as analyzed in a grab sample or;
- b. C.O.D. in excess of 750 mg/l as analyzed in a twenty-four-hour composite sample, 1500 mg/l as analyzed in a two-hour composite sample, or 3000 mg/l as analyzed in a grab sample or;
- c. Suspended Solids (S.S.) in excess of 500 mg/l as analyzed in a twenty-four-hour composite sample, 1000 mg/l as analyzed in a two-hour composite sample, or 2000 mg/l as analyzed in a grab sample.

“Holding Tank” means a device or structure designed for the temporary storage of wastewater.

“Incompatible Pollutant” means any pollutant that is not a compatible pollutant as defined in this section.

“Industrial Wastewater” means wastewater that is composed of liquid and water carried wastes associated with processes employed in industrial manufacturing, trade, or commercial and business establishments, as distinct from domestic wastewater.

“mg/l” or “mg/litre” means milligrams per liter.

“Non Polluted Water” means water that does not contain any compatible pollutants or contaminants such as rainwater, groundwater, swimming pool water or any other non sewage wastewater.

“Oil and Grease” means organic substance including, but not limited to, hydrocarbons, esters, fats, oils, waxes and high molecular weight carboxylic acids.

“Owner” shall have the same meaning as assigned to it under the Community Charter.

“pH” means the logarithm of the reciprocal of the concentration of hydrogen ions in a solution.

“Pesticide” means an organism or material that is represented, sold, used or intended to be used to prevent, destroy, repel or mitigate a pest and includes a plant growth regulator, plant defoliator or plant desiccant and a control product, other than a device that is a control product under the Pest Control Products Act (Canada).

“Plumbing Fixture” means a receptacle, appliance, apparatus or device that discharges wastewater to the sanitary sewer.

“Pool” means any man made structure with a water depth exceeding 450 mm.

“Premises” means any residential, commercial or industrial structure that has a building sanitary sewer connected to the City of Vernon Sanitary Sewer System.

“Pretreatment” means application of physical, chemical and/or biological processes to reduce the amount of pollutants in, or alter the nature of the pollutant properties in a wastewater prior to discharging such wastewater to the sanitary sewer.

“Sanitary Sewer” means a Sewer which carries Domestic or Industrial Wastewater but is not intended to carry stormwater, cooling water, groundwater, or unpolluted water.

“Sanitary Sewer System” means all pipes, conduits, drains and other equipment and facilities owned or otherwise under the control of the City for collecting, pumping and transporting wastewater including all such pipes, conduits, drains and other equipment and facilities which connect to those owned or otherwise under the control of the City.

“Septic Tank” means a device or structure in which the solids contained in wastewater are decomposed by anaerobic bacteria and the effluent is disposed of to an infiltration field.

“Sewage Facility” means any works owned by or under the control or jurisdiction of the City that collects, transports, stores, treats, utilizes or discharges wastewater.

“Sewer Connection” means the sanitary sewer or storm sewer connecting pipe from the property line to the sewer.

“Significant User” means any User of the City’s Sanitary Sewer whose flow exceeds 125 m³ per day (27,500 imperial gallons per day) or whose discharge to the sanitary sewer system typically has a strength of 500 mg/l S.S. or 500 mg/l B.O.D.

“Special Waste” means special waste as defined in the *Environmental Management Act* of British Columbia.

“Special Waste Regulation” means the Hazardous Waste Regulation pursuant to the *Environmental Management Act* of British Columbia.

“Standard Methods” means the latest edition of Standard Methods for the Examination of Water and Wastewater as published by the American Public Health Association, American Waterworks Association and the Water Environment Federation.

“S.S.” means the solids matter, expressed in mg/l, in a liquid as determined according to Standard Methods.

“Stormwater” means water originating from rainwater, snowmelt or groundwater, including roof drain water.

“Twenty-Four-Hour Composite Sample” means a composite sample consisting of equal portions of 24 grab samples collected at 1 hour intervals.

“Two-Hour Composite Sample” means a composite sample consisting of equal portions of 8 grab samples collected at 15 minute intervals.

“Trucked Waste” means any waste that is collected and transported off site by means of a tank truck and discharged to the sanitary sewer system and includes septic tank waste (septage), holding tank waste and portable toilet waste.

“Unpolluted Water” is water not containing any pollutants limited or prohibited by the water quality standards in effect, or water whose discharge will not cause any violation of receiving water quality standards as established in Federal or Provincial legislation.

“User” means any person who discharges, causes or permits the discharge of wastewater into the City’s Sanitary Sewer system.

“Waste” or “Wastes” means any substance, whether gaseous, liquid or solid, that is discharged or discarded, directly or indirectly to a sanitary sewer or wastewater treatment facility.

“Wastewater” means domestic wastewater or industrial wastewater.

“Wastewater Treatment System” means all facilities and equipment owned or otherwise under the control of the City of Vernon to treat domestic and industrial wastewater such that following treatment the effluent is suitable for reuse by the City’s reclaimed water irrigation program or for discharge to Okanagan Lake via the deep lake outfall.

4.00 CONNECTION TO THE SANITARY SEWER

4.01 Every sanitary sewer connection shall be installed in accordance with the standards contained in the City’s current Subdivision and Development Servicing Bylaw, and all subsequent amendments, and shall be installed prior to the installation of the building sanitary sewer.

4.02 The owner or occupier of any premises upon which a new commercial or industrial facility will be operated and where, on average, it is projected that more than 300m³ of

non domestic wastewater will be discharged to the sanitary sewer system in any 30 day period, must obtain a Sewer Use Permit from the City of Vernon by completing a Sewer Use Permit Application prior to connection to the sanitary sewer system.

- 4.03 The owner or occupier of any premises upon which an existing commercial or industrial facility is operated and where, on average, more than 300m³ of non domestic wastewater is discharged to the sanitary sewer system in a 30 day period, must obtain a Sewer Use Permit from the City of Vernon by completing a Sewer Use Permit Application prior to any alteration or expansion of the facility.
- 4.04 Grease and oil interceptors shall be installed for all food preparation facilities sufficient to prevent the discharge of grease and oil to the sanitary sewer system.
- 4.05 Grease, oil and sand interceptors shall be installed at all vehicle repair and maintenance establishments sufficient to prevent the discharge of grease, oil and sand to the sanitary sewer system.
- 4.06 All interceptors shall be installed upstream of the sanitary sewer system service connection and shall be located so as to be readily accessible for inspection and maintenance.
- 4.07 The owner or occupier of any premises upon which an interceptor is installed shall maintain the interceptor in a serviceable condition at all times.
- 4.08 The City of Vernon may, at its sole discretion, request that the owner or occupier of any premises upon which a grease, oil or sand interceptor is installed to provide records of maintenance of the interceptor.
- 4.09 The control manhole shall be installed and maintained by the owner or occupier of the premises and shall be accessible to the City of Vernon at all times to inspect and sample material entering the sanitary sewer system.
- 4.010 The control manhole and flowmeter specification must be approved by the City of Vernon prior to connection to the sanitary sewer system.

5.00 MONITORING OF DISCHARGE TO THE SANITARY SEWER SYSTEM

- 5.01 Should it be determined through sampling and analysis that the discharge to the sanitary sewer system from a premises is in violation of this bylaw, the City of Vernon may direct the owner or occupier of the premises to take steps to comply with the bylaw and may require the owner or occupier to install monitoring equipment as necessary to demonstrate compliance with this bylaw.
- 5.02 All test, measurements, analysis and examinations of wastewater required to demonstrate compliance with this bylaw shall be at the cost of the owner or occupier of the premises where a discharge occurs.

6.00 PENALTIES

Any person who violates any provision of this bylaw will be deemed to have committed an offence and shall be liable upon summary conviction to the following penalties:

- a. a minimum fine of \$500.00;
- b. a maximum fine of \$10,000;
- c. in the case of a continuing offense, for each day that the offense continues, either or both of:
 1. a minimum fine under paragraph a.
 2. a maximum fine under paragraph b;
- d. in a prosecution of an offense against a municipal bylaw, the justice or court may impose all or part of the penalties applicable in relation to the offense, together with the costs of prosecution.

7.00 WASTE DISCHARGE

7.01 Prohibited Wastes

Except as otherwise provided in this bylaw, no person shall release or discharge, or permit the releasing or discharge into the sanitary sewer system of any Prohibited Waste as described in Schedule A.

7.02 Restricted Wastes

Except as otherwise provided in this bylaw, no person shall release or discharge, or permit the releasing or discharge into the sanitary sewer system of any Restricted Waste as described in Schedule B.

7.03 High Strength Wastes

The City may accept High Strength Wastes as defined in this bylaw into the sanitary sewer system at its sole discretion where the wastewater is not such that it can damage the sanitary sewer system or the wastewater treatment system. The City will impose a sewer service surcharge on High Strength Wastes as contained in the City's current Fees and Charges Bylaw, and all subsequent amendments.

7.04 Trucked Waste

All provisions in this bylaw apply to all trucked waste discharged to the sanitary sewer, with the exception of the limits for B.O.D. and S.S. contained in Schedule B, Section 1 and Section 3.

The City of Vernon will accept Trucked Waste from haulers holding a valid City of Vernon business license into the sanitary sewer system at the designated discharge location(s) and during the times designated by the City of Vernon. The location and times may vary at the discretion of the City of Vernon. The City of Vernon reserves the

right, at its sole discretion, to refuse to accept any load of trucked waste that it considers to be of questionable origin or quality.

The discharge of trucked waste to the sanitary sewer system at any location(s) other than those authorized by the City of Vernon are strictly prohibited and are subject to the penalties contained in this bylaw.

A properly completed load manifest for every load of trucked waste discharged to the City of Vernon sanitary sewer must be provided to the City of Vernon or its designated representative by the trucked waste hauler prior to discharge to the sanitary sewer. Failure to provide a properly completed load manifest will result in the refusal to accept the load of trucked waste.

Only trucked waste originating in the Regional District of the North Okanagan will be accepted.

Waste from commercial oil and grease separators and commercial car wash catch basins will not be accepted into the sanitary sewer.

In addition to the penalties described in this bylaw, the City of Vernon may, at its sole discretion, suspend or revoke access to the designated discharge location should a trucked waste hauler be found in violation of any of the provisions of this bylaw.

7.05 Non Polluted Water

No person shall release or discharge, or permit the releasing or discharge into the sanitary sewer system any non polluted water.

7.06 Pretreatment Requirements

Where wastewater discharged into the sanitary sewer collection system is found to have been deleterious to the sanitary sewer collection system or wastewater treatment plant, the City of Vernon may, by notice in writing to the owner or occupier of any premises:

- a. Refuse to allow any additional wastes to be discharged to the sanitary sewer system.
- b. Require the owner or occupier of any premises to construct, operate and maintain wastewater pre-treatment facilities to ensure compliance with this bylaw.
- c. Require the owner or occupier of any premises to construct, operate and maintain facilities to control the rate of discharge to the sanitary sewer system.
- d. Require the owner or occupier to pay additional charges to cover the added cost of treating the wastes discharged to the sanitary sewer system as contained in the City's current Fees and Charges Bylaw, and all subsequent amendments.

8.00 TEMPORARY DISCHARGE TO THE SANITARY SEWER

- 8.01 Any person who wishes to discharge wastewater to the sanitary sewer system on a temporary basis, must obtain a Temporary Sewer Use Permit from the City of Vernon by completing a Sewer Use Permit Application prior to any discharge to the sanitary sewer.
- 8.02 Charges for temporary discharges to the sanitary sewer system are as described in the City's current Fees and Charges Bylaw, and all subsequent amendments.

READ A FIRST TIME this 27 day of June, 2005.

READ A SECOND TIME this 27 day of June, 2005.

READ A THIRD TIME this 27 day of June, 2005.

ADOPTED this 11 day of July, 2005.

Mayor:

City Clerk:

PROHIBITED WASTE

The following are designated as Prohibited Waste:

1. Any material which causes or will cause an adverse effect.
2. Any stormwater or unpolluted water.
3. Any flammable or explosive material.
4. Any pesticides, insecticides, herbicides, or fungicides save and except chemicals contained in stormwater emanating from trees or vegetation treated in accordance with the Pesticide Control Act.
5. Any material capable of obstructing wastewater flow or interfering with the operation of any part of the sewage collection or treatment system. These materials include, but are not limited to, ashes, cinders, sand, mud, straw, grass clippings, insoluble shavings, metal, glass, rags, feathers, tar, asphalt, creosote, plastics, wood, animal paunch contents, offal, blood, bones, meat trimmings and waste, fish or fowl head, shrimp, crab or clam shells, fish scales, entrails, lard, mushrooms, tallow, baking dough, chemical residues, cannery or wine waste, bulk solids, hair and fleshings, spent grain and hops, whole or ground food or beverage containers, garbage, paint residues, cat box litter, slurries of concrete, cement, lime or mortar.
6. Any material, other than domestic wastewater, which by itself or in combination with another substance is capable of creating odours related to but not limited to hydrogen sulfide, carbon disulfide, other reduced sulfur compounds, amines or ammonia outside or in and around the wastewater collection system.
7. Any noxious or malodorous material which by itself or in combination with another material is capable of creating a public nuisance or hazard to life or may be prevent entry into a sewer or pump station for its maintenance or repair.
8. Any material with corrosive properties which by itself or in combination with another material may cause damage to any part of the sewage collection or wastewater treatment system.
9. Any infectious material which by itself or in combination with another material may create a contaminant in any part of the sewage collection or wastewater treatment system.
10. Grit removed from commercial or industrial premises including but not limited to grit removed from car washing establishments, automobile garages, restaurant sumps or interceptors.
11. Any material classified as a Special Waste.

PAGE 2
SCHEDULE "A"

12. Any material that may cause biosolids from the Water Reclamation Plant to fail to meet the criteria outlined in the British Columbia Organic Matter Recycling Regulation for any end use that the city may choose to undertake at any given time.

RESTRICTED WASTE

The following are designated as Restricted Waste:

1. Any wastewater having a B.O.D. in excess of 500 mg/l as analyzed in a twenty-four-hour composite sample, 1000 mg/l as analyzed in a two-hour composite sample, or 2000 mg/l as analyzed in a grab sample.
2. Any wastewater having a C.O.D. in excess of 750 mg/l as analyzed in a twenty-four-hour composite sample, 1500 mg/l as analyzed in a two-hour composite sample, or 3000 mg/l as analyzed in a grab sample.
3. Any wastewater having a S.S. in excess of 500 mg/l as analyzed in a twenty-four-hour composite sample, 1000 mg/l as analyzed in a two-hour composite sample, or 2000 mg/l as analyzed in a grab sample.
4. Any wastewater which contains oil and grease in a concentration that is in excess of 100 mg/l as analyzed in a twenty-four-hour composite sample, 200 mg/l as analyzed in a two-hour composite sample, or 400 mg/l as analyzed in a grab sample.
5. Any wastewater which contains oil and grease derived from a petroleum source in a concentration that is in excess of 15 mg/l as analyzed in a twenty-four-hour composite sample, 30 mg/l as analyzed in a two-hour composite sample, or 60 mg/l as analyzed in a grab sample.
6. Any material which may solidify or become viscous at temperatures above 0°C.
7. Any wastewater having a temperature greater than 65° C.
8. Any wastewater having a pH lower than 5.0 or higher than 11.0 as determined by a grab sample, or less than 5.5 or higher than 10.5 as determined by a two-hour composite sample.
9. Any wastes from the preparation, cooking and dispensing of food that has not been properly comminuted to 12mm or less in any dimension. Such waste must be shredded to such a degree that all particles will be freely carried under the flow conditions prevailing in the sanitary sewer collection system.
10. Any wastewater containing a hazardous, toxic or poisonous substance in sufficient quantity to injure or interfere with any sanitary sewer system or wastewater treatment system which could constitute a hazard to humans or animals, or create a hazard in areas receiving treated effluent from the wastewater treatment plant.
11. Any wastewater containing dyes or colouring material which pass through the sanitary sewer or wastewater treatment system and discolour any part of the sanitary sewer, wastewater treatment system or the treated effluent from wastewater treatment plant.

PAGE 2
SCHEDULE "B"

12. Any wastewater containing substances in concentrations that are not amenable to treatment or reduction in the wastewater treatment process being employed by the City at any given time or that cannot be treated to such a degree during the normal wastewater treatment process to meet the requirements of the City of Vernon's Ministry of Water, Land and air Protection Operational Certificate or any other applicable provincial or federal legislation that may be in effect.
13. Any wastewater with a concentration, in a combined or uncombined form, in excess of the levels set out below:

Substance	Expressed As	Concentration in mg/l		
		A	B	C
Aluminum	Al	50	100	200
Arsenic	As	1	2	4
Boron	B	50	100	200
Cadmium	Cd	0.2	0.4	0.8
Chromium	Cr	4	8	16
Cobalt	Co	5	10	20
Copper	Cu	2	4	8
Cyanide	Cn	1	2	4
Iron	Fe	10	20	40
Lead	Pb	1	2	4
Manganese	Mn	5	10	20
Mercury	Hg	0.05	0.1	0.2
Molybdenum	Mo	1	2	4
Nickel	Ni	2	4	8
Phenols		1	2	4
Phosphorus	P	12.5	25	50
Silver	Ag	1	2	4
Sulphate	SO ₄	1500	3000	6000
Sulphide	S	1	2	4
Tin	Sn	5	10	20
Zinc	Zn	3	6	12
A:	24 hour composite sample			
B:	2 hour composite sample			
C:	Grab sample			

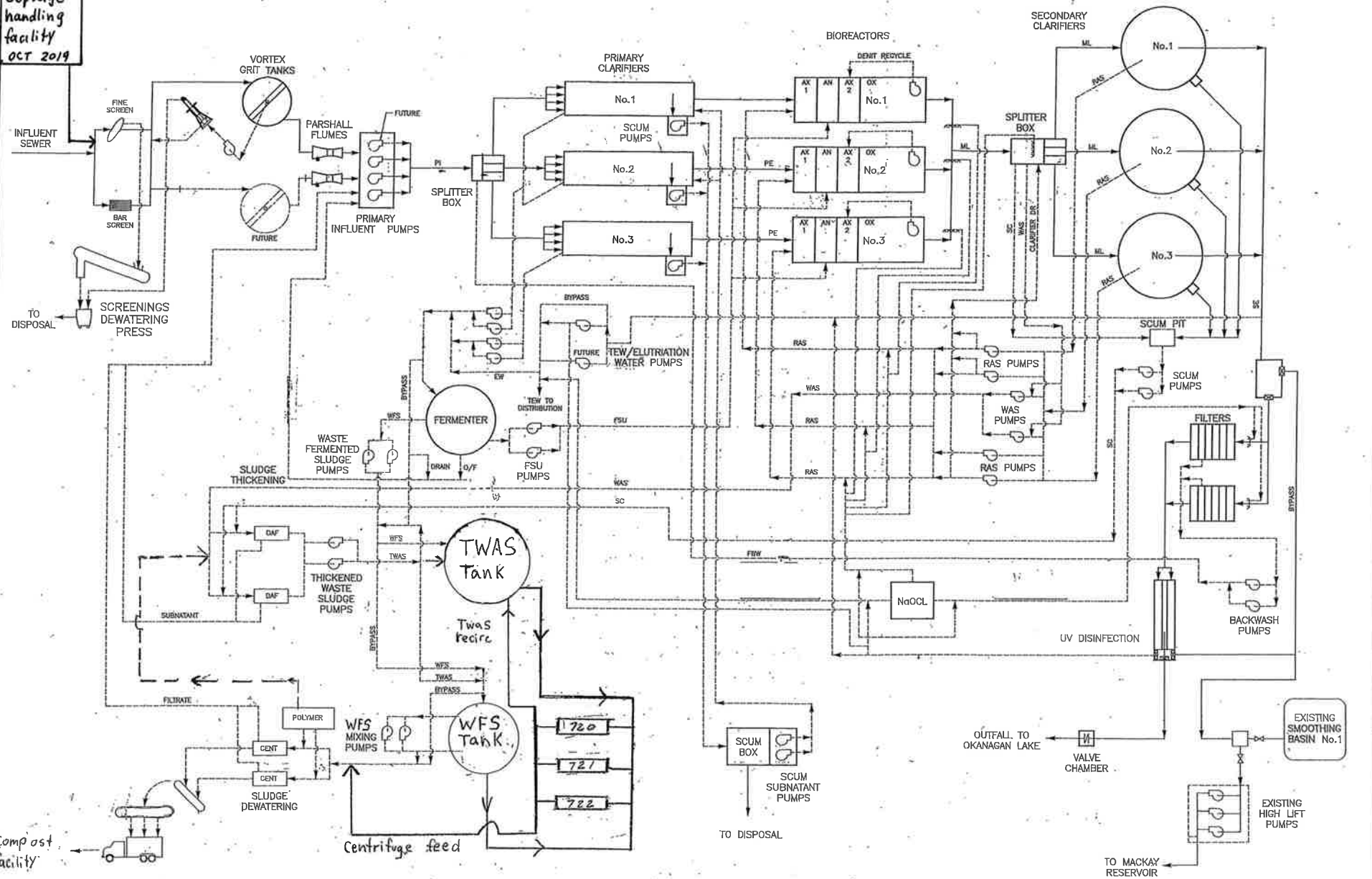
PAGE 3
SCHEDULE "B"

14. Any wastewater which contains additional water added solely for the purpose of diluting waste which would otherwise exceed the applicable maximum concentrations.

Appendix N

VWRC Process Schematic

Septage handling facility
OCT 2019



Compost facility

No.	DATE	DESCRIPTION	BY	APPROVED	No.	DESCRIPTION	DATE	APPROVED
4	11.10.04	ADD BEING TANK, TRENCH, SLOTTED PERFORATED PLATE, BAR SCREEN, EXCHANGE PUMP, MIXER, SPOOL	WAE	RLJ	6	MICROFILMED		
3	03.07.03	FOR REVIEW	WAE	RLJ	5	PLAN OF RECORD	03.17.08	RLJ
2	11.29.02	95% SUBMISSION	WAE	RLJ	4	APPROVAL FOR CONSTRUCTION	09.29.03	RLJ
1	08.02.02	FOR INFORMATION ONLY	WAE	RLJ	3	FOR TENDER	05.19.03	RLJ
1	08.02.02	FOR INFORMATION ONLY	WAE	RLJ	2	FOR APPROVAL		
1	08.02.02	FOR INFORMATION ONLY	WAE	RLJ	1	PRELIMINARY		

SEAL:



THE CORPORATION OF THE CITY OF VERNON

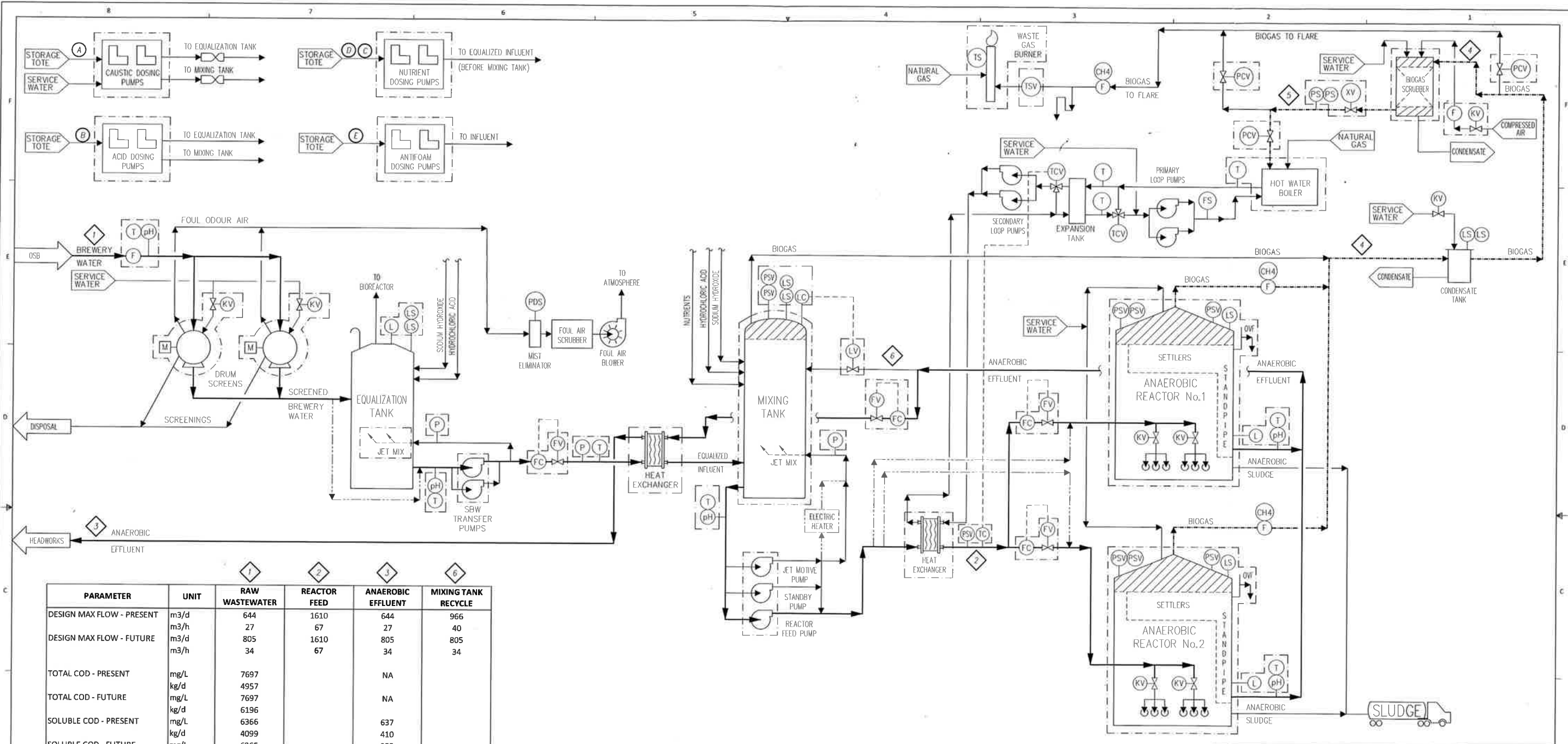
Stantec Consulting Ltd.
200, 2141 Springfield Road
Kelowna, BC V1Y 7X1
Tel: (250) 860 3225
Fax: (250) 860 3357
email: kel@stantec.com
www.stantec.com

DESIGNED: JLI	DRAWN: WAE
CHECKED: JLI	APPROVED: RAF
SCALE: NTS	

CLIENT: THE CORPORATION OF THE CITY OF VERNON	DATE: JULY 2002	SHEET:
TITLE: WATER RECLAMATION PLANT REPLACEMENT & ADDITION PROCESS SCHEMATIC & MASS BALANCE	JOB No. 116-22902	
REVISION: 4	STATUS: 5	DRAWING: G005

Appendix O

HRAD Process Schematic



PARAMETER	UNIT	RAW WASTEWATER	REACTOR FEED	ANAEROBIC EFFLUENT	MIXING TANK RECYCLE
DESIGN MAX FLOW - PRESENT	m ³ /d	644	1610	644	966
DESIGN MAX FLOW - FUTURE	m ³ /h	27	67	27	40
	m ³ /d	805	1610	805	805
	m ³ /h	34	67	34	34
TOTAL COD - PRESENT	mg/L	7697		NA	
	kg/d	4957			
TOTAL COD - FUTURE	mg/L	7697		NA	
	kg/d	6196			
SOLUBLE COD - PRESENT	mg/L	6366		637	
	kg/d	4099		410	
SOLUBLE COD - FUTURE	mg/L	6365		955	
	kg/d	5124		769	
TSS - PRESENT	mg/L	648		673	
	kg/d	417		433	
TSS - FUTURE	mg/L	648		662	
	kg/d	522		533	

NOTE: COD CONCENTRATIONS ARE BACK CALCULATED FROM THE DAILY FLOWS AND TCOD LOADINGS PROVIDED IN THE RFP.
AVERAGE SCOD/TCOD RATIO OF 0.827 IS USED FOR THE INFLUENT CONDITIONS PER RFP

PARAMETER	UNIT	DESIGN MAX FLOW (PRESENT)	DESIGN MAX FLOW (FUTURE)
TOTAL VOLUMETRIC FLOW	Nm ³ /d	1970	2324
	Nm ³ /h	82	97
H ₂ S (SCRUBBER INLET)	ppmv	2600	2600
H ₂ S (SCRUBBER OUTLET)	ppmv	130	130

NOTE: METHANE CONCENTRATION IS ASSUMED TO BE WITHIN THE RANGE 65%-70%

PARAMETER	UNIT	SODIUM HYDROXIDE	HYDROCHLORIC ACID	FERRIC CHLORIDE	MICRO NUTRIENT	ANTIFOAM
DESIGN MAX FLOW - PRESENT	Lpd	638 - 1277	0 - 200	3.3	1.2	0 - 50
DESIGN MAX FLOW - FUTURE	Lpd	757 - 1514	0 - 240	4.1	1.5	0 - 50

NOTE: SOME VARIANCE IS EXPECTED FOR THE ESTIMATED VALUES BASED ON REAL LIFE CONDITIONS

LEGEND

(T) - TEMPERATURE
(F) - FLOW
(K) - TIMER
(L) - LEVEL
(P) - PRESSURE
(PH) - pH
(X) - UNCLASSIFIED

C = CONTROL
S = SWITCH
SV = SAFETY VALVE
CV = CONTROL VALVE

PROCESS PIPING
—— (MAIN FLOW)
- - - (MAIN BIOGAS FLOW)
- · - · (SECONDARY FLOW)
- · - · (OPTIONAL FLOW)

UTILITY SUPPLY
BIOGAS HEADSPACE
BOUNDARY LIMITS

VWT SCOPE ITEMS

3	UPDATED MASS BALANCE INFORMATION	12-11-20	MTS	TD	US	FV
2	UPDATED WITH MASS BALANCE	29-10-20	MTS	TD	US	FV
1	FOR APPROVAL	13-10-20	MTS	ED	RC	TD

DESIGNER/DATE	M. SCHONE / 13-10-20	CHECKER/DATE	E. DAVY / 13-10-20	DATE	13-10-20
CLIENT	CITY OF VERNON BRITISH COLUMBIA, CANADA				
TITLE / FILE	HIGH STRENGTH WASTE PRETREATMENT FACILITY PROCESS FLOW DIAGRAM				

PROJECT / PROJECT DESIGN / DRAWING NUMBER / REVISION / SHEET NUMBER / SHEET TOTAL / REV / REV

5000220030 - PFD-0001-GEN-VWT 5760170001.700-00 1 / 1 3

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Appendix P

Non-Compliance Letter

VWRC

To: EnvironmentalCompliance@gov.bc.ca

Subject: Authorization ME 12215 Non-compliance start date June 15, 2023

Date of Non-compliance: 2023-06-16 0900 (24-hour clock)

Location of Non-compliance: Vernon Water Reclamation Center, 2100 43 Street, Vernon, BC
50.258°- 119.300°

Nature of Non-Compliance: The Total Phosphorus as P exceeded the Not to exceed 2.0 mg/L as set in the operating certificate ME 12215.

Initial Response/Actions taken: Immediate suspension of lake release from the City of Vernon Water Reclamation Centre

Monitoring conducted: The City continues to monitor treated wastewater and related processes for compliance with the Operational Certificate ME 12215.

Future action items: The City of Vernon will discharge to McKay Reservoir within compliance of Operation Certificate ME 12215.

The City will continue to monitor treated wastewater for compliance with the Operational Certificate ME 12215 before resuming lake discharge.

The City of Vernon is working with Aecom Engineering Consultants in an effort to adjust the process to meet the Operating Certificate water quality characteristics for lake discharge.

Contact information:

Serge Kozin, Manager

Vernon Water Reclamation Centre

Spray Irrigation Program

2100-43rd Street Vernon, BC

Office: 250- 550-3627 / Direct: 250- 550-3626 / Cell: 250-309-0256

Email: skozin@vernon.ca / www.vernon.ca

