Sanitary Sewer System 2023 Annual Report

Town of Oliver

February 2024

Project No. 302-088-011

ENGINEERING ■ PLANNING ■ URBAN DESIGN ■ LAND SURVEYING

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Report Submission

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List of Acronyms

AW	Aquatic Life
BOD_5	5-Day Biochemical Oxygen Demand
$cBOD_5$	5-Day Carbonaceous Biochemical Oxygen Demand
CPE	Chlorinated Polyethylene
CSR	Contaminated Sites Regulation
DW	Drinking Water
GIS	Geographic Information Systems
HDPE	High Density Polyethylene
IW	Irrigation Water
LS	Lift Station
LWMP	Liquid Waste Management Plan
masl	meters above sea level
MOE	Ministry of Environment
MOE	Ministry of Environ and Climate Change Strategy
MSR	Municipal Sewage Regulation
MW	Monitoring Well
MWR	Municipal Wastewater Regulation
OC	Operational Certificate
OCP	Official Community Plan
PVC	Polyvinyl Chloride
RIB	Rapid Infiltration Basin
TRUE	TRUE Consulting
TSS	Total Suspended Solids
WMP	Waste Management Plan
WWAL	Western Water Associates Ltd.
WWTP	Wastewater Treatment Plant

Units of Measure

ft	feet
lgpm	Imperial gallons per minute
km	kilometre
L/d	Litres per day
L/m	Litres per minute
L/s	Litres per second
lpcd	Litres per capita per day
m	metre
mg/L	milligrams per Litre
mm	millimetre
NTU	Nephelometric Turbidity Units
psi	pounds per square inch
USgpm	US gallons per minute

1.0 Operational Data

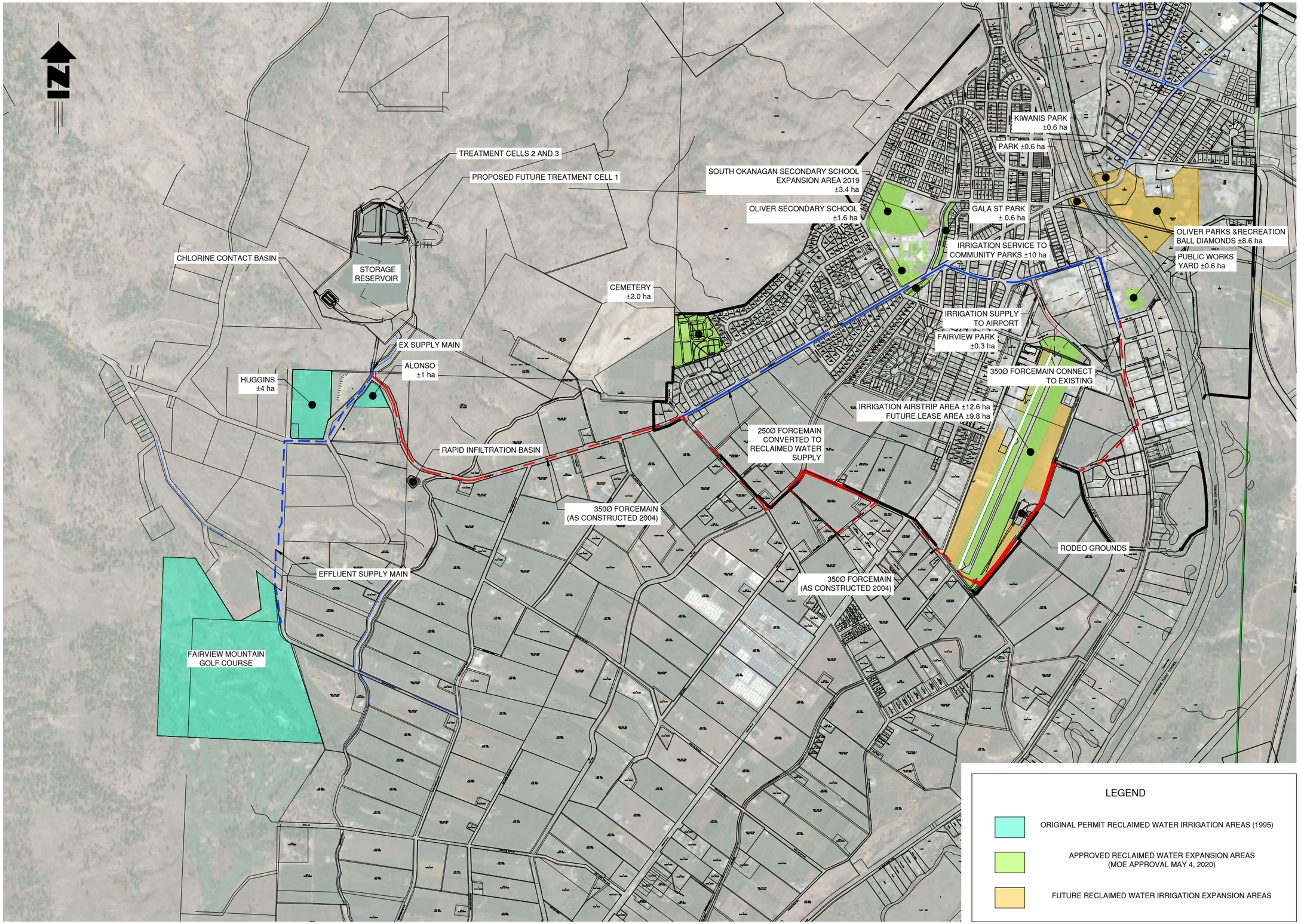
The following report summarizes the operational data for the Town of Oliver's Sanitary Sewer System for 2023. The report is formatted from collection to disposal. Appendix A contains a copy of the Operational Certificate (OC) for the system (PE 13717) issued by the Ministry of Environment (MOE) on December 14, 1995. When required, appropriate references will be made to the OC.

Section 1 of the OC outlines the specific authorized discharge requirements from the Town of Oliver's Wastewater Treatment Plant (WWTP) and are summarized as follows:

- The Town is authorized to discharge a maximum of 2,200m^3 per day from the aerated lagoons to the reclaimed wastewater storage reservoir, averaged on a daily basis.
- There is no maximum authorized discharge rate from the storage reservoir for beneficial use as irrigation water.
- The effluent discharged from the aerated lagoons to the storage reservoir must not exceed a 5-Day Biochemical Oxygen Demand (BOD_5) of 45 mg/L, and a Total Suspended Solids (TSS) of 60 mg/L.
    - As per the BC Municipal Wastewater Regulations (MWR), BOD_5 is described as the 5-Day Carbonaceous Biochemical Oxygen Demand ($cBOD_5$).
- A minimum reclaimed wastewater reservoir retention time of 60 days must be met prior to discharge of the reclaimed wastewater.
- Reclaimed wastewater utilized for irrigation shall conform to the effluent irrigation guidelines developed by the BC Ministry of Health. Fecal Coliforms shall not exceed 200 MPN per 100 mL for agricultural, silvicultural, and low public use lands, and shall not exceed 2.2 MPN per 100 mL for high public use land.

To assist the reader in assessing the system operational data, the following drawings are included:

- Figure 1-1: Overall Plan – Reclaimed Water Supply System and Irrigation Areas
- Figure 1-2: Aerated Lagoon Treatment System



CONSULTANT SEAL

TRUE CONSULTING

Town of Oliver
CANADA'S WINE CAPITAL

SANITARY SEWER ANNUAL REPORT

OVERALL PLAN RECLAIMED WATER SUPPLY SYSTEM AND IRRIGATION AREAS

SCALE	1:15000
DESIGN BY	TRU
DRAWN BY	SA
DATE	FEBRUARY 2023
PROJECT REFERENCE No.	306-088-010
DRAWING No.	FIG 1-1
SHEET	1 OF 1
ISSUE/REV.	

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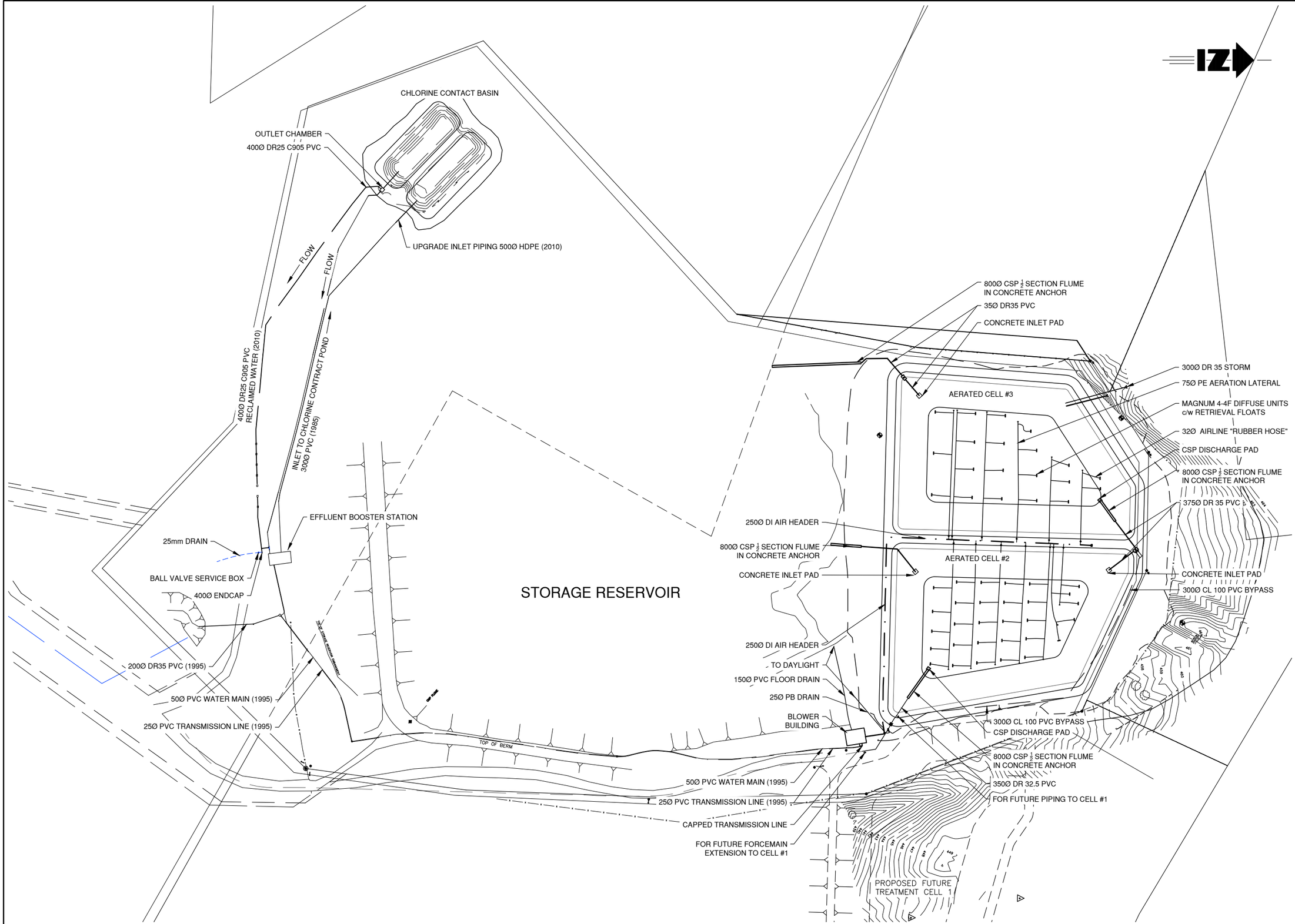

CONSULTANT SEAL

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Town of Oliver CANADA'S WINE CAPITAL

SANITARY SEWER ANNUAL REPORT

AERATED LAGOON TREATMENT SYSTEM LAYOUT AND INTERCELL PIPING

SCALE	1:2000
DESIGN BY	TRU
DRAWN BY	SA
DATE	FEBRUARY 2023
PROJECT REFERENCE No.	306-088-010
DRAWING No.	FIG 1-2
SHEET	1 OF 1
ISSUE/REV.	

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1.1 Influent

1.1.1 Influent Works (OC 6.4.2)

Influent from the sanitary sewer collection system is pumped through influent screens and piped into a two-cell flow equalization system ("equalization basins") located at the Town's Public Works Yard at 5971 Sawmill Road. The original equalization basin was constructed in 1984 and lined with a Chlorinated Polyethylene (CPE) membrane. The second equalization basin was constructed in 2009 and lined with a 60-mil high density polyethylene (HDPE) geomembrane. These liners provide a transfer barrier for liquids from the basins to the native subsurface material. There is no piped interconnection between the Okanagan River and the equalization basins.

A detailed description of the collection system and treatment process can be found in the Town of Oliver's 2018 Sanitary Capital Plan prepared by TRUE Consulting. This Capital Plan includes an update to the Liquid Waste Management Plan (LWMP). Further details can be found in the Oliver WWTP Operation and Maintenance Manual prepared by TRUE Consulting in February 2021.

1.1.2 Influent Flow Data (OC 7.1.2 and 7.2.4.7)

Wastewater is pumped from the equalization basin to the aerated lagoons via the High Lift station. 2023 daily flow data for the High Lift station is presented in Appendix B. The total volume pumped to the aerated lagoons in 2023 was 613,563 m^3, which equates to an average daily flow of 1,681 m^3/day. This is a decrease of 9,148 m^3 (-1.5%) as compared to 2022. A summary of total influent inflows from the period 1996 to 2023 can be seen in Table 1-1 and Figure 1-1, below.

TABLE 1-1: ANNUAL TOTAL AND AVERAGE DAILY INFLUENT FLOW DATA

Year	Total Influent Volume (m^3)	Average Daily Flow (m^3/d)
1996	654,361	1,788
1997	682,480	1,870
1998	666,322	1,826
1999	688,193	1,885
2000	702,688	1,920
2001	678,052	1,858
2002	726,354	1,990
2003	751,139	2,058
2004	766,048	2,093
2005	783,947	2,148
2006	829,413	2,272
2007	823,011	2,255
2008	777,154	2,123
2009	758,308	2,078
2010	701,475	1,922
2011	693,045	1,899
2012	658,002	1,798
2013	697,377	1,911
2014	634,649	1,739
2015	679,542	1,862
2016	639,794	1,753
2017	689,098	1,888
2018	666,376	1,826
2019	625,911	1,715
2020	655,853	1,792
2021	607,731	1,665
2022	622,711	1,706
2023	613,563	1,681

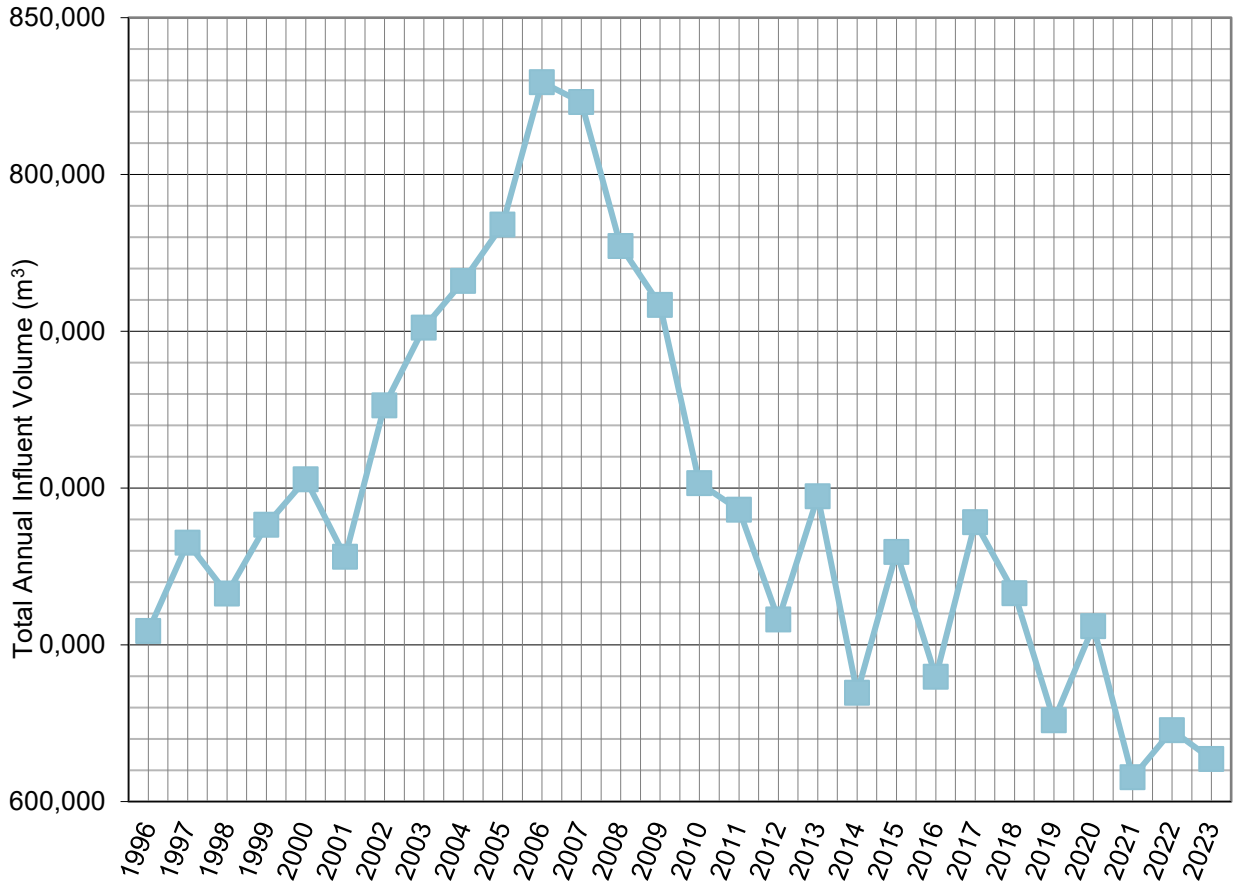


FIGURE 1-3: TOTAL ANNUAL INFLUENT SEWAGE FLOWS FOR 1996 AND 2023

1.1.3 Influent Wastewater Sampling (OC 6.1 and 7.1.2)

The past 20 years of influent sampling data for total phosphorus and orthophosphate concentrations are presented in Table 1-2. Historic values beginning from 1996 are provided in Appendix B. The average total phosphorous concentration from March and September 2023 sampling was 5.32 mg/L. This value is consistent with previous years. Orthophosphate was not sampled in 2023. The provided concentrations are for Phosphate.

TABLE 1-2: 20- YEAR INFLUENT SAMPLING ANALYSIS

Year	Date	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)
2003	Mar. 10	3.78	3.78
	Sep. 30	4.48	4.38
2004	Mar. 16	5.23	4.76
	Sep. 14	5.15	3.75
2005	Mar. 22	5.24	4.63
	Oct. 5	6.74	5.58
2006	Sep. 14	7.05	5.96
2007	Mar. 13	5.03	6.43*
	Sep. 11	6.03	5.03
2008	Sep. 3	7.44	3.3
2009	Mar. 5	8.18	3.84
	Sep. 1	5.31	1.38
2010	Mar. 9	4.26	0.558
	Sep. 2	3.36	2.16
2011	Mar. 8	4.9	0.316
	Sep. 8	11.00	0.859
2012	Mar. 1	6.16	2.23
	Sep. 11	7.76	3.72
2013	Mar. 7	5.75	2.57
	Sep. 11	4.62	1.89
2014	Mar. 5	4.28	0.82
	Sep. 17	3.82	not tested
2015	Mar. 11	5.36	2.66
	Sep. 16	4.55	2.96
2016	Mar. 7	4.17	1.21
	Sep. 6	2.35	0.36*
2017	Mar. 7	3.77	2.42
	Sep. 6	4.69	2.13
2018	Mar. 7	5.37	1.95
	Sep. 4	5.89	1.83
2019	Mar. 11	5.34	1.97
	Sep. 3	5.42	2.32
2020	Mar. 2	4.97	1.89
	Sep. 1	5.45	2.09
2021	Mar. 15	6.76	1.7
	Sep.14	5.59	2.28
2022	Mar. 1	6.88	2.12
	Sept. 6	Not Tested	1.26
2023	Mar. 16	5.32	2.00**
	Sept. 5	5.32	2.27**
Average for Period of Record		**5.48**	

* Suspected error

** Values are Phosphate

1.2 Wastewater Treatment (OC 6.2 and 7.1.2)

Effluent sampling results from the aerated lagoon system (Cell No. 3) prior to discharging to the storage reservoir are tabulated in Table 1-3. All TSS and $cBOD_5$ values were compliant with regulatory criteria for all sampling events.

TABLE 1-3: CELL NO.3 - EFFLUENT BOD_5, $cBOD_5$ AND TSS

Date	$CBOD_5$ (mg/L)	TSS (mg/L)
OC Limits	**45**	**60**
Jan-03 (2023)	16.8	12.8
Feb-06 (2023)	15.6	31
Mar-06 (2023)	16	26.4
Apr-24 (2023)	15.7	36.4
May-01 (2023)	15.4	33
Jun-05 (2023)	9.9	18
Jul-04 (2023)	12	26.4
Jul-10 (2023)	7.8	39
Aug-08 (2023)	<6.9	16.2
Sep-05 (2023)	15.9	10
Oct-03 (2023)	3.7	6.7
Nov-06 (2023)	4.1	10

Historical data trends for BOD_5 and TSS are shown in Figure 1-4, below. Values for $cBOD_5$ have been included in lieu of BOD_5 for 2021-2023.

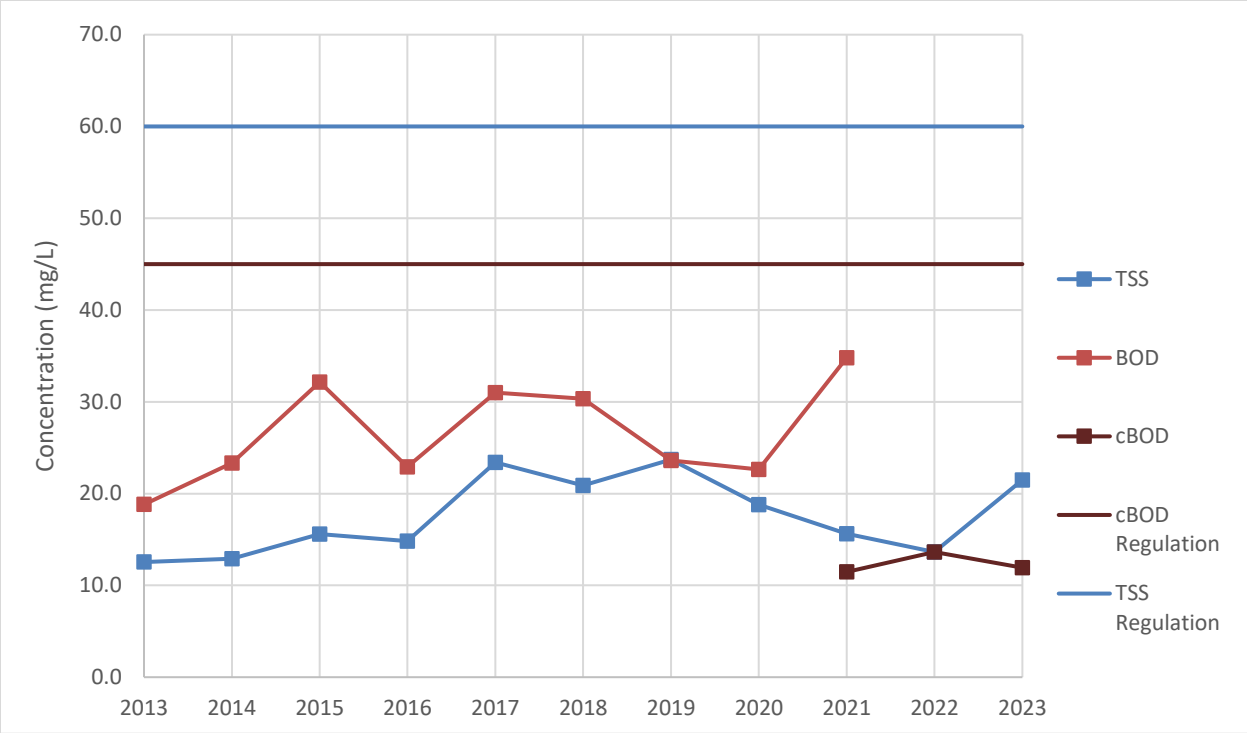


FIGURE 1-4: YEARLY AVERAGE TSS, BOD_5, AND $cBOD_5$ VALUES

As seen above, the 2023 yearly average $cBOD_5$ and TSS concentrations for reclaimed water are compliant with the regulatory criteria. The 2023 TSS data is consistent with historic trends. The 2023 $cBOD_5$ data is consistent with the concentrations measured from 2021-2023.

As per PE-13717, semi-annual analysis of effluent must include:

- Total phosphorous, ortho-phosphorous, and total dissolved phosphorus (all expressed in mg/L P)
- Total nitrogen, ammonia nitrogen, nitrate, nitrite, nitrogen, and organic nitrogen (all expressed as mg/L N)

A summary of semi-annual sampling for total nitrogen, ammonia, and nitrate from 1997 – 2023 is presented in Table 1-4. The complete suite of semi-annual sampling and compliance testing requirements are included in Appendix B.

Sampling events were completed on March 6th and September 5th, 2023. The accepted range for total nitrogen in domestic wastewater is 20 to 50 mg/L. Total nitrogen was within this range for both sampling events.

TABLE 1-4: CELL NO.3 EFFLUENT – NITROGEN

Year	September/October			March		
	Total Nitrogen (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Total Nitrogen (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)
1997	9.34	0.006	7.7	20.7	No Data	No Data
1998	10.8	0.005	8.89	25.1	No Data	No Data
1999	11.3	0.46	8.31	23.9	No Data	No Data
2000	No Data	0.48	9.77	29.1	No Data	No Data
2001	34.3	4.37	7.92	31.3	No Data	No Data
2002	17.7	0.013	16.3	23.6	No Data	No Data
2003	No Data	0.71	3.9	26.9	No Data	No Data
2004	9.8	8.46	0.29	17.2	No Data	No Data
2005	26.4	14.2	No Data	36.4	No Data	No Data
2006	12.1	0.78	5.97	No Data	No Data	No Data
2007	20	13.2	0.92	25.7	No Data	No Data
2008	10	9.55	0.297	24.1	No Data	No Data
2009	17	14	1	No Data	No Data	No Data
2010	16.3	8.44	3.6	27.8	No Data	No Data
2011	26	13.7	3.27	33.5	No Data	No Data
2012	5.28	1.95	2.17	32.2	No Data	No Data
2013	10.10	0.289	9.43	43.7	32.5	0.489
2014	No Data	No Data	No Data	32.8	31.2	0.046
2015	19.10	17.6	0.966	No Data	No Data	No Data
2016	12.80	1.82	5.33	33.2	31.2	1.05
2017	18.50	0.384	14.7	32	23.4	0.019
2018	11.9	0.916	8.2	32	31.1	0.282
2019	18.5	0.322	10.1	27.4	27.6	0.339
2020	21.9	15.6	2.36	35.3	25.2	1.2
2021	17.4	12.6	2.11	24.5	26	0.428
2022	5.92	No Data	4.31	33.3	30.6	0.266
2023	25.4	20.6	1.24	37.7	33.4	0.067

From 1997 to 2002, a significant proportion of ammonia nitrogen was nitrified through the Town's aerated lagoon system. From 2003 to 2015, the Town accepted wastewater influent from Vincor (a local winemaker), which resulted in modest levels of nitrification. In January 2012, Vincor implemented a pre-treatment system, resulting in approximately a 90% reduction in BOD. This resulted in reduced loadings which in turn resulted in increased nitrification. As of July 1, 2015, Vincor has been disconnected from the Town's wastewater system.

1.3 Winter Effluent Storage Reservoir

Weekly storage reservoir level data for 2023 is presented in Appendix C. All elevations given are relative to geodetic datum. The elevation data has been converted to total volume in storage above the minimum 60-day storage level. The storage calibration curve is also included in Appendix D.

As per Section 1.1.1 of the OC, the Town is authorized to a maximum effluent discharge rate of 2,200 m^3 per day from the aerated lagoon sewage treatment system to the reclaimed wastewater storage reservoir, averaged on a monthly basis. To measure this flow rate, it is assumed that the flow rate between the aerated lagoon to the storage reservoir is equal to the flow rate at the High Lift station (which pumps wastewater from the equalization basin to the aerated lagoons). This assumption is conservative because it does not account for water losses caused by evaporation and seepage. Monthly volumes are presented in Table 1-5 as follows:

TABLE 1-5: 2023 MONTHLY EFFLUENT DISCHARGE QUANTITIES

	Monthly m^3	Average m^3/day
January	47,443	1,581
February	44,969	1,606
March	49,168	1,639
April	47,537	1,585
May	52,801	1,703
June	56,478	1,883
July	56,983	1,838
August	53,757	1,734
September	53,137	1,714
October	48,592	1,567
November	45,870	1,480
December	56,828	1,833
Total	613,563	
Average		1,681

As shown in Table 1-5, the discharge values were compliant with the regulatory criteria. Annual operating data for the storage reservoir is summarized in Table 1-6. This includes a comparative summary from 2013 to 2023.

TABLE 1-6: EFFLUENT STORAGE RESERVOIR LEVEL DATA

Year		Date	Elevation (m)	Volume (m^3)
2013	Max.	25-Apr-13	445.52	355,000
	Min.	21-Aug-13	441.67	106,000
	End	31-Dec-13	444.56	284,000
2014	Max.	31-Mar-14	446.06	374,000
	Min.	15-Sep-14	441.39	92,000
	End	29-Dec-14	443.65	223,000
2015	Max.	7-Apr-15	445.62	351,000
	Min.	7-Oct-15	441.52	101,000
	End	4-Jan-16	443.50	214,000
2016	Max.	4-Apr-16	445.47	343,000
	Min.	19-Sep-16	441.60	105,000
	End	19-Dec-16	444.02	247,000
2017	Max.	22-May-17	446.17	379,000
	Min.	16-Oct-17	442.75	167,000
	End	18-Dec-17	444.43	275,000
2018	Max.	2-Apr-18	446.41	391,000
	Min.	10-Sep-18	443.17	193,000
	End	24-Dec-18	444.63	289,000
2019	Max.	8-Apr-19	446.43	397,000
	Min.	9-Sep-19	441.91	119,000
	End	23-Dec-19	443.98	245,000
2020	Max.	23-Mar-20	446.00	370,000
	Min.	14-Sep-20	441.55	102,000
	End	28-Dec-20	444.01	246,000
2021	Max.	22-Mar-21	445.8	360,000
	Min.	7-Sep-21	441.6	105,000
	End	20-Dec-21	443.6	221,000
2022	Max.	4-Apr-22	445.76	358,000
	Min.	17-Oct-22	442.30	136,000
	End	28-Dec-22	444.05	249,000
2023	Max.	18-Apr-23	446.16	378,000
	Min.	23-Sep-23	442.49	154,000
	End	26-Dec-23	444.43	275,000

The winter effluent storage reservoir year-end, maximum, and minimum operating elevations for the period of 2008 to 2023 are illustrated in Figure 1-5. Referring to this figure:

- The maximum elevation in 2023 (446.16 masl on April 18th, 2023) is 0.4 metres above the 2022 maximum level.
- The 2023 year-end storage of 275,000 m^3 is 26,000 m^3 more than the 2022 storage at year-end.

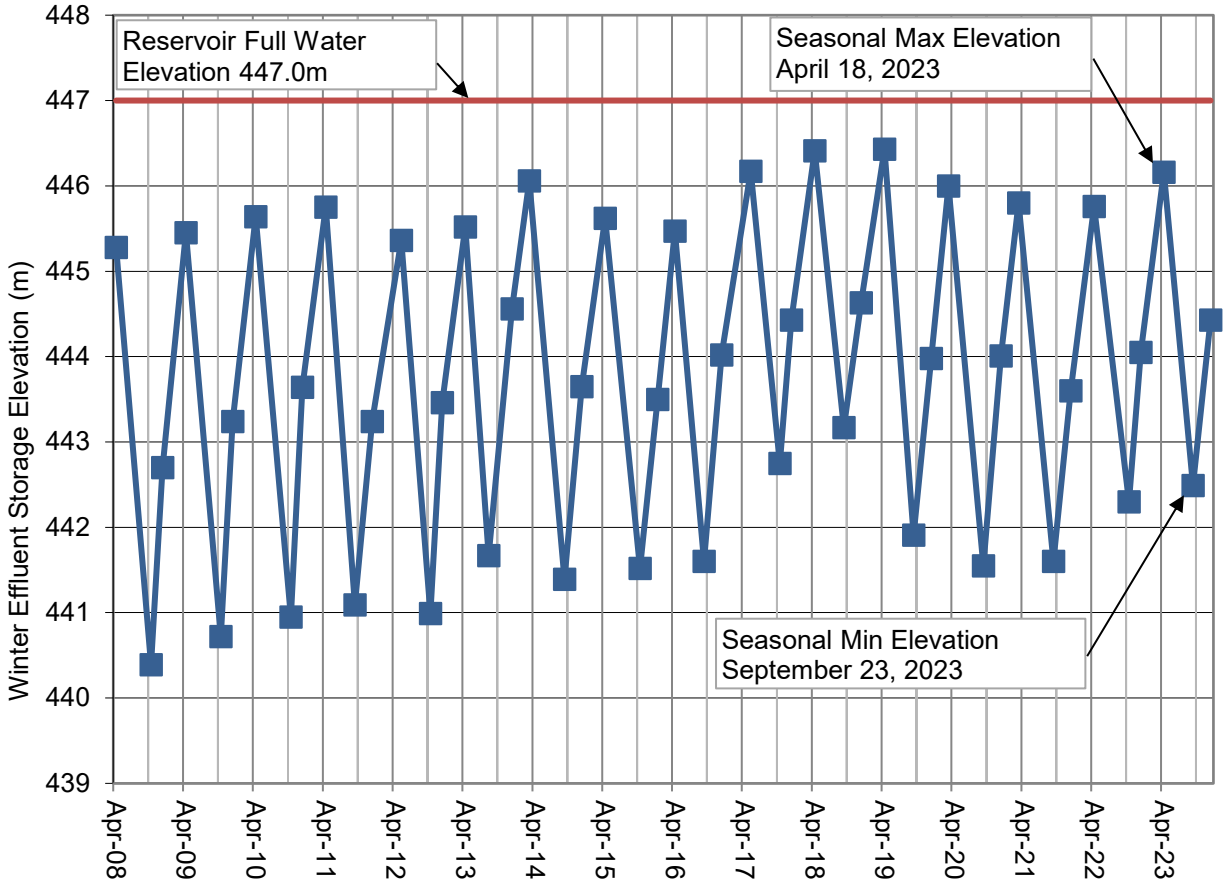


FIGURE 1-5: EFFLUENT STORAGE RESERVOIR LEVELS - 2008 TO 2023

1.4 Reclaimed Water Quantities and Quality

1.4.1 Irrigation Plan (OC 1.8)

The Town of Oliver currently provides reclaimed water to the Fairview Mountain Golf Course, Alonso Property, Higgins Property, Fairview Park, South Okanagan Secondary School, Public Works, the Airstrip, and Cemetery for irrigation purposes. This area has expanded since that outlined in Site Plan A of the OC.

On December 13, 2018, the Town submitted an irrigation area expansion notification to the Ministry. An updated plan was submitted to the Ministry on February 25, 2020, to include expansion to the South Okanagan Secondary School irrigation system. These expansion areas were authorized by the Director on May 24, 2020, in accordance with Clause 1.8 of OC 13717 (see Appendix D)

1.4.2 Irrigation Volumes (OC 7.2.4.2 and 6.4)

Total reclaimed water usage is measured by a flow meter in the booster station located adjacent to the reclaimed water storage reservoir. Meters are also located at the Cemetery, Gala Street Linear Park, Fairview Park, the Airport, Public Works Yard, Alonso property, Southern Okanagan Secondary School, and Huggins Property for the purposes of measuring total reclaimed water use at each location. The consumption at the Fairview Mt. Golf Course is not metered and it is calculated as total usage less all meter locations. Table 1-7 and Table 1-8 summarize the system consumption totals.

TABLE 1-7: ANNUAL RECLAIMED WATER USE BY CUSTOMER

Location	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fairview Mt. Golf Course	248,521	316,368	346,520	322,048	311,899	281,186	329,226	418,594*	356,416	352,234	313,985
Fairview Park										193**	6,382
Airport	185,687	124,892	115,743	98,511	101,780	99,601	69,143		32,276	28,254	39,424
Cemetery	19,160	15,996	14,354	14,843	13,400	12,651	16,986	17,499	18,291	18,336	20,577
Gala Street Linear Park	8,051	8,749	7,647	8,360	1,030*	5,928	8,858	1,245	11,676	7,896	7,394
Public Works Yard	7,086	7,393	7,380	8,095	8,341	6,261	5,940	8,320	5,388	6,103	4,488
Alonso	6,715	3,893	3,851	2,364	2,498	1,794	9,240	6,012	0	0	0
Huggins	1,290	0	8,554	0	0	0	4,614	0	0	0	0
Southern Okanagan Secondary School	0	4,874	0	0	2	0	25,744	27,420	24,694	18,545***	24,003
Infiltration Basin	0	0	0	0	23,322	38,391	16,858	11,117	2,256	3,752	1,735
Total Use	476,510	482,164	504,049	454,221	461,241	445,812	486,610	490,207	450,997	435,314	417,988

* The Airport flow meter was not working from May to September therefore the totals were grouped.
** Fairview Park flows were partitioned based on flow meter readings.
*** In 2022, the school did not turn on the reclaimed water meter until July. Prior to this, domestic water was used for irrigation.

From flow data contained in Appendix D, reclaimed water quantities for each “user” is described as follows:

- **Lot 723, Plan 2361 - Fairview Mountain Golf Course**

Total Usage	313,985 m^3
Crop Type	Turf and rough areas
Irrigated Area	45 ha
Irrigation Application Rate	0.70 m
Irrigation Period	April to October

- **Lot A, Plan 24065 - Oliver Cemetery**

Total Usage	20,577 m^3
Crop Type	Lawn, trees & shrubs
Irrigated Area	2.3 ha
Irrigation Application Rate	0.89 m
Irrigation Period	April to October

- **Gala Street Linear Park**

Total Usage	7,394 m^3
Crop Type	Lawn & trees
Irrigated Area	0.6 ha
Irrigation Application Rate	1.23 m
Irrigation Period	April and October

- **Fairview Park**

Total Usage	6,382 m^3
Crop Type	Lawn & trees
Irrigated Area	0.3 ha
Irrigation Application Rate	2.13 m
Irrigation Period	April and October

- **Lot A, Plan 38173 – Oliver Airport**

Total Usage	39,424 m^3
Crop Type	Forage Crops
Irrigated Area	12.6 ha
Irrigation Application Rate	0.31 m
Irrigation Period	June to September

Records were only completed between June and September.

- **Lot A, Plan 33094 – Oliver Public Works Yard**

Total Usage	4,488 m^3
Crop Type	Lawn, landscaping, compost piles
Irrigated Area	0.6 ha
Irrigation Application Rate	N/A
Irrigation Period	April to October

The principal use of reclaimed water at the Public Works Yard is for composting operations, lawn care and landscaping. Because composting use is not separately metered, application rates for the lawn and landscaping areas cannot be calculated independently.

- **Lot A, Plan 37929 – Alonso (former Moir)**

Total Usage	0 m^3
Crop Type	Vineyard
Irrigated Area	approximately 1.0 ha
Irrigation Application Rate	-

- **Lot 3, Plan 5881 – Huggins**

Total Usage	0 m^3
Crop Type	Vineyard
Irrigated Area	approximately 3.7 ha
Irrigation Application Rate	-

- **South Okanagan Secondary School**

Total Usage	24,003 m^3
Crop Type	Lawn and Trees
Irrigated Area	approximately 5.4 ha
Irrigation Application Rate	0.44 m
Irrigation Period	April to October

Reclaimed water use on the Fairview Mountain Golf Course has varied significantly on a year-to-year basis. Table 1-8 has been prepared adding seasonal precipitation to reclaimed water usage to derive an annual total. A summary of seasonal precipitation from 1992 to 2023 can be found in Appendix E. The tabulation shows that the sum of seasonal precipitation and reclaimed water use for 2023 is 0.81 m applied.

TABLE 1-8: 10-YEAR ANNUAL TOTAL APPLICATION RATE AT THE FAIRVIEW MOUNTAIN GOLF COURSE

Year	Total Usage (m^3)	Application Rate (m)	Seasonal Precipitation (mm)	Total (m)
2013	248,521	0.55	180	0.73
2014	316,367	0.70	175	0.88
2015	346,520	0.77	136	0.91
2016	332,048	0.74	166	0.90
2017	311,899	0.69	133	0.83
2018	281,186	0.62	210	0.83
2019	329,226	0.73	127	0.86
2020	418,594	0.73	186	0.92
2021	356,416	0.62	67.9	0.69
2022	352,234	0.63	127.5	0.76
2023	313,985	0.7	116.8	0.81

1.4.3 Rapid Infiltration

The Town infiltrates reclaimed water to the rapid infiltration basins located south of the wastewater treatment facility (see Figure 1-1). This allows the Town to lower the water level of the storage reservoirs when needed. In 2023, the Town discharged 1,735 m^3 to the rapid infiltration basins.

The Town discharged minimal flows to the rapid infiltration basins as 2023 was a drought year.

1.4.4 Hydraulic Balance (OC 7.2.4.1)

The annual overall storage reservoir hydraulic balance (January 1st to December 31st) for the period 2009 to 2023 is summarized in Table 1-9.

TABLE 1-9: HYDRAULIC BALANCE DATA FOR 2009 TO 2023

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Volume in Storage on Jan. 1	167,000	200,000	223,000	197,000	211,000	284,000	223,000	214,000	247,000	275,000	289,000	245,000	246,000	221,000	249,000
(+) Total Influent	758,308	701,475	693,045	658,002	697,377	634,649	679,500	639,793	689,098	666,376	625,911	655,853	607,731	622,711	613,563
(-)Effluent Irrigation	520,530	519,803	470,917	489,241	476,510	482,164	504,049	454,221	437,919	407,422	469,752	479,090	448,741	431,562	416,253
(-) Rapid Infiltration	0	0	0	0	0	0	0	0	23,322	38,391	16,858	11,117	2,256	3,752	1,735
(-) Unaccounted Losses	206,778	159,672	248,128	154,761	147,867	213,485	184,451	152,572	199,857	206,564	183,301	164,646	181,734	159,397	169,575
Net Storage at Year-End (m^3)	198,000	222,000	197,000	211,000	284,000	223,000	214,000	247,000	275,000	289,000	245,000	246,000	221,000	249,000	275,000

There is no freshwater contribution to the system. Unaccounted losses within the hydraulic balance include evaporation losses from the treatment lagoons and storage reservoir, seepage losses from both the treatment and storage cells, and flow meter inaccuracies. Unaccounted losses of 169,575 m^3 were calculated for 2023.

1.4.5 Irrigation Water Quality Data (OC 5.1 and 6.3)

Effluent quality for reclaimed water prior to irrigation is presented in Table 1-10. Section 5.1 of the OC requires that fecal coliforms do not exceed 200 MPN per 200 mL for agricultural, silvicultural, and low public use lands, or exceed 2.2 MPN per 100 mL for high use public land. Results for the 2023 irrigation season are compliant with the OC criteria.

To provide background data to assist with future assessment studies, the Town of Oliver continued to monitor phosphorus, nitrogen and chloride through 2023. Data for these parameters are tabulated in Table 1-10 and Table 1-11.

TABLE 1-10: SUMMARY OF RECLAIMED WATER QUALITY DATA

	Date	Fecal Coliforms	Total Coliforms	Total P	Total N	Free CL Res
OC Limit		***2.2 MPN/100 ml**	**n/a**	**n/a**	**n/a**	**n/a**
Unit		**MPN/100ml**	**MPN/100ml**	**mg/L**	**mg/L**	**mg/L**
April	24	<1	<1	5.71	24.9	0.22
May	1	<1	<1	6.13	25.4	0.2
June	5	<1	<1	4.32	26.7	0.42
July	10	<1	<1	5.16	19.6	0.49
August	8	<1	<1	5.04	18.3	0.31
September	5	<1	<1	4.11	15.6	0.39
October	3	<1	<1	5.59	17.4	0.25

* Note: The operational permit limit for fecal coliform in reclaimed water applied to agricultural land is 200 MPN per 100mL. Most of the reclaimed water in Oliver is applied on the Fairview Mountain Golf Course, which is classified as high public use, hence the lower limit of 2.2 MPN per 100 mL.

TABLE 1-11: HISTORICAL RECLAIMED WATER QUALITY DATA

Year	Seasonal Average Total Phosphorus (mg/L)	Seasonal Average Total Nitrogen (mg/L)	Seasonal Average Sodium (mg/L)
2000	2.92	12.5	
2001	2.46	14.1	
2002	2.75	13.4	
2003	1.2	6.8	114.3
2004	1.36	9.3	103.5
2005	2.87	11.9	94.4
2006	2.4	11.6	84.4
2007	3.91	11.9	84.2
2008	3.93	14.2	89.5
2009	3.27	12.1	93.7
2010	3.61	13.8	97.1
2011	3.88	16.9	111.2
2012	4.01	14.3	114.6
2013	4.77	19.4	112.6
2014	5.90	26.6	120.6
2015	4.04	20.3	112.3
2016	4.0	14.9	107.0
2017	4.5	16.9	108.0
2018	4.6	19.0	104.7
2019	4.6	18.6	112.5
2020	-	-	-
2021	4.1	18.5	96.9
2022	5.2	21.1	
2023	5.2	21.1	

As seen in Table 1-11, the average total phosphorus and nitrogen concentrations in 2023 are elevated compared to previous years. Also, the 2023 average values are the same as those for 2022.

In compliance with Section 6.9 of the OC a Soils Assessment Program was completed by Hamilton and Associates in June 2020. Within the report, it was noted that "*A ground assessment of any new areas to be irrigated, as shown in the "Irrigation Plan", shall be performed by a suitably qualified professional,*" and that the "*Assessment is to include any suggested restriction or recommendations that the suitably qualified professional deems necessary*." A recommendation presented in this report (see Section 4.3 Operational Considerations – Appendix H) is as follows:

"Periodic sampling (i.e. annually) and testing of reclaimed water for metals and ions (specifically sodium and chloride) should take place, with results compared to the applicable British Columbia and Canadian Water Quality Guidelines. This is in addition to testing BOD, TSS and nutrients under the OC."

1.5 Summary of 2023 Operational Data

Operation of the Town of Oliver's wastewater collection, treatment, and reclaimed water system for 2023 is summarized as follows:

- Total influent quantities were 613,563 m^3, a decrease of 9,148 m^3, or -1.5% as compared to 2022.
- Wastewater effluent quality for $cBOD_5$ in the Town's aerated lagoons were compliant with the OC criteria of 45mg/L. TSS values were compliant with the OC criteria of 60 mg/L.
- The maximum water level in the storage reservoir was 446.16 masl which equates to a volume of 378,000 m^3.
- Reclaimed water quality prior to irrigation use complied with the OC requirements.

2.0 Supplemental Information

2.1 Facility Classification and Operator Certification (OC 3.2 and 3.3)

The Town of Oliver Wastewater Treatment Facility (Facility No. 317) is classified as a Municipal Wastewater Treatment II (MWWT-II) under the Environmental Operations Certification Program. In compliance with OC Section 3.3 operator certifications are summarized as follows:

TABLE 2-1: OPERATOR CERTIFICATION

Operator	ECOP Certification
Trevor Burylo	Wastewater Collection Level I
Hector Murillo	Wastewater Collection Level I
	Wastewater Treatment Level I
Keith Postnikoff	Wastewater Collection Level II
Ryan Seiling	Wastewater Collection Level I
	Wastewater Treatment Level I
Martin Schori	Wastewater Collection Level II
	Wastewater Treatment Level II

2.2 Influent Waste Bylaw (OC 3.6 and 7.2.4.4)

2023 Capital Projects included:

- New sampling raft for Topping Lake Reservoir.
- New HVAC system for Topping Lake Reservoir building.
- Roof replacement for High Lift Station.
- Cured in place sanitary sewer main on Okanagan Street.

Future Capital Projects scheduled for 2024 include:

- SCADA upgrades for the entire sanitary sewer system to continue until 2028.
- Co-op Avenue sanitary sewer main reconstruction.
- Rotary Beach sanitary sewer bypass system for Rotary Beach Lift Station.
- Electrical upgrades to the system at Topping Lake Reservoir.

2.3 Influent Waste Bylaw (OC 3.6 and 7.2.4.4)

Sanitary Sewer System Use Bylaw No. 547 established regulations respecting the type, volume, and characteristics of wastewater discharged to the sanitary sewer system.

In January 2002, the Town of Oliver received an application from Vincor requesting approval to connect its winery located on the Osoyoos Indian Reserve, north of the Town boundaries, to the Town's sewerage system. This application relates to both process water and normal domestic sewage and was approved by the town.

Vincor was connected to the Town's sewerage system from October 2002 to July 01, 2015. During this period, Vincor's wastewater was sampled by the Town at least twice per month to confirm compliance with the terms and conditions of the connection agreement and for invoicing purposes. Since 2015, there has been no influent received from Vincor.

2.3.1 Infiltration, Inflow, and Cross Connection Reduction (OC 7.2.4.3 and 7.2.4.4)

The Town of Oliver has an ongoing video camera inspection program for the sewer collections system. In addition, they have prepared a 2019 Sanitary Capital Plan. Within the report, SCADA data was analyzed for possible Inflow and Infiltration (I&I) from 2015 to 2019. This I&I analysis will allow for correlations between peak rain events, surface water diversions, and failures within the pipe infrastructure.

The Town regulates provisions to identify, eliminate, and prevent cross contamination with non-potable water sources through Bylaw No. 1043.

2.4 Sludge Management Plan (OC 3.8 and 7.2.4.6)

The Town's Sludge Management Plan was updated in February 2019 and is included in Appendix F. The Plan provides an overview of the system design, sludge characterization, sludge sampling and monitoring, sludge removal, and system recommendations.

Consistent with historical practices, the Town completed sludge depth and analytical sampling in Aerated Lagoon Cell No. 2 in 2021. The analytical data is provided in Appendix F.

2.5 Groundwater Monitoring Plan

In compliance with Section 6.8 of the OC, the Town of Oliver retained the services of Golder Associates to prepare a groundwater monitoring plan in 1997. A hydrogeological review of the Town's reclaimed wastewater irrigation groundwater monitoring program, including irrigation expansion areas, was completed by Western Water Associates Ltd. (WWAL) in 2021 and is included in Appendix I.

A summary of all monitoring wells, their location, and name are provided in Table 2-2 below. Monitoring wells that were implemented in 2021 are denoted.

TABLE 2-2: SUMMARY OF MONITORING WELLS

Well Identification Number	Location/"Nickname"	Completion Date
Well #1	"Air Cadet"	2005
Well #2	"Rodeo Grounds"	2005
Well #3	"91A Street"	2005
MW-1	Near Higgins/Alonso Property	1997 (Inactive)
MW-2	Near Higgins/Alonso Property	1997 (Inactive)
MW-3	Near Higgins/Alonso Property	1997 (Inactive)
MW-4	"Sand Pit"	2000
MW-5	125th Street	2000
MW-6	Fairview Golf Course	2000
MW-7	Road No. 5	2000 (Abandoned)
MW-8	South Side of Town Public Works Yard	4-May-21
MW-9	South end of Oliver Cemetery	5-May-21
MW-10	Gala Street Linear Park	6-May-21
MW-11	Road No. 5	7-May-21

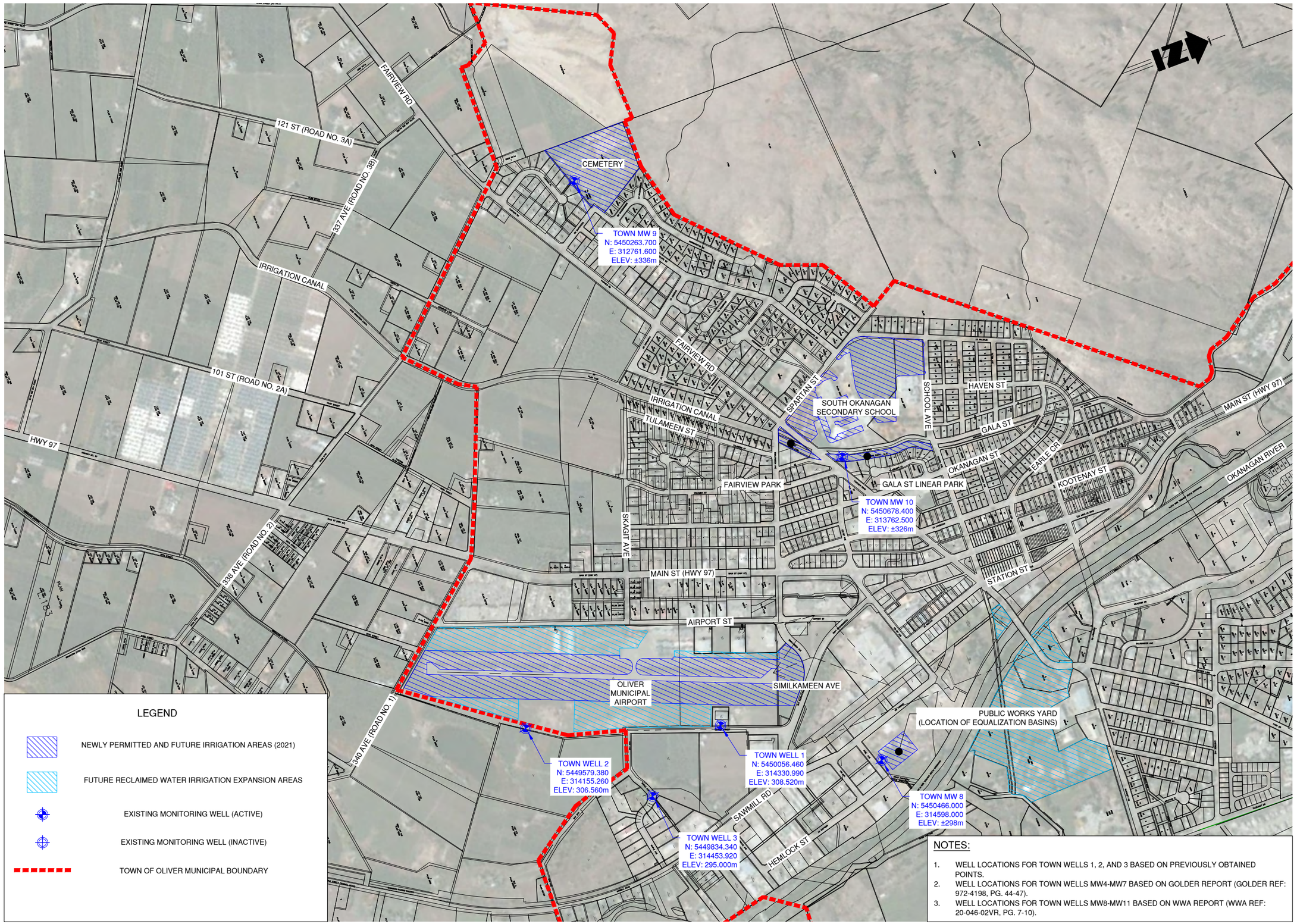
Please note that the nomenclature of the wells has changed slightly due to the commissioning and decommissioning of monitoring wells in the area.

In May of 2021, WWAL retained Mud Bay Drilling to address the recommendations of the 2021 hydrogeological review. The following well installations were completed:

- Three new monitoring wells were installed to provide coverage for new areas receiving reclaimed wastewater for irrigation. This included: the Town Public Works Yard (MW-8), Oliver cemetery (MW-9), and Gala Street Linear Park (MW-10).
- Well MW-11 was installed as a replacement well for Town MW-7 located on Road No. 5.

- To address recommendations to replace MW-6, WWAL attempted to re-develop MW-6 and was successful. Approximately 0.4 m of sediment was removed, and a water quality sample was obtained.

The technical memorandum detailing the installation of the new wells can be seen in Appendix H. For further detail, the Hydrogeological Review of the Town of Oliver Reclaimed Wastewater Irrigation Groundwater Monitoring Program can be viewed in Appendix I. Groundwater monitoring wells located throughout the Town are shown on Figure 2-1 and Figure 2-2.



CONSULTANT SEAL

TRUE CONSULTING

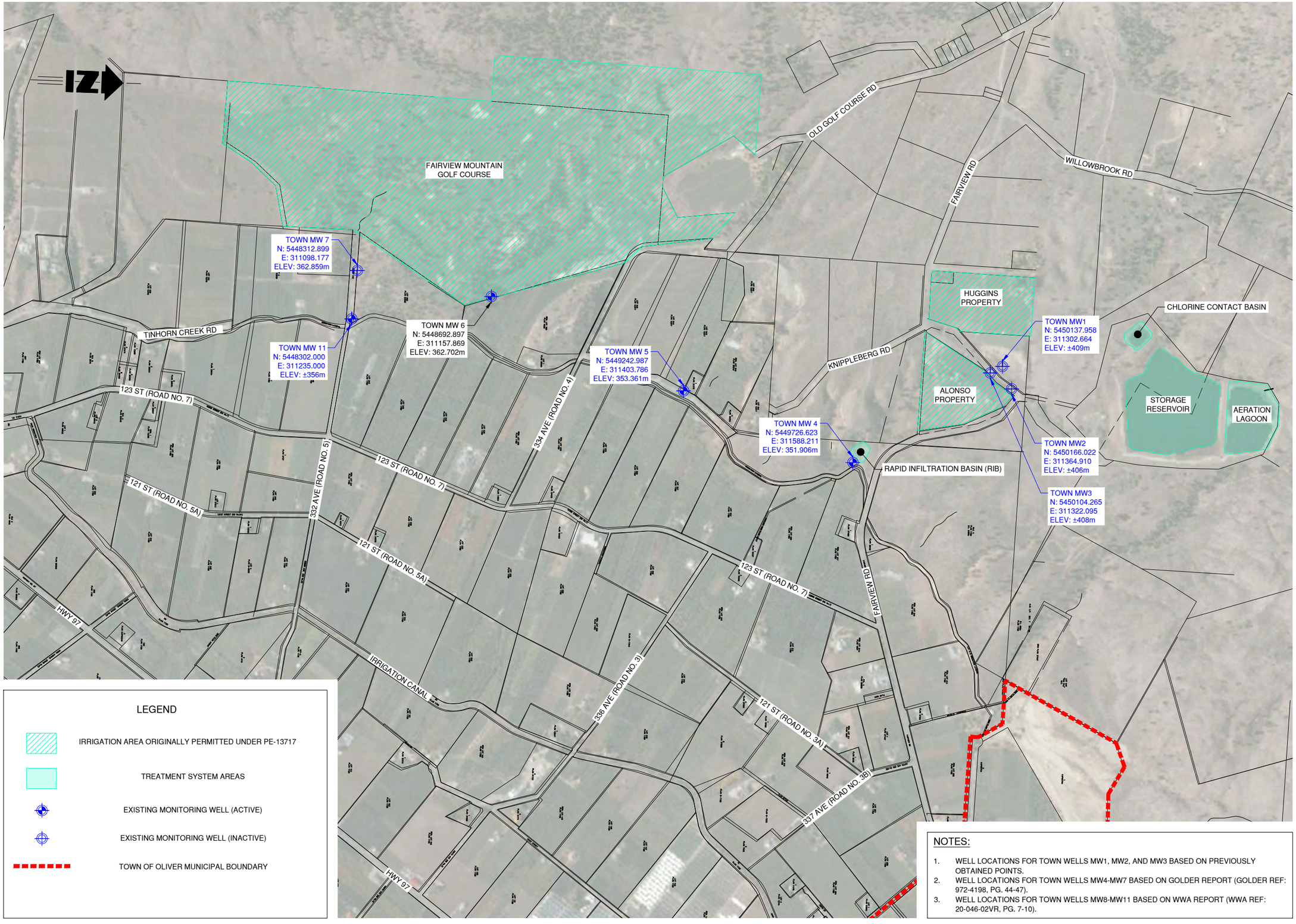
Town of Oliver
CANADA'S WINE CAPITAL

SANITARY SEWER ANNUAL REPORT

GROUND MONITORING WELLS NEAR OLIVER AIRPORT

SCALE	1:10000
DESIGN BY	TRU
DRAWN BY	SA
DATE	FEBRUARY 2023
PROJECT REFERENCE No.	306-088-010
DRAWING No.	FIG 2-1
SHEET	1 OF 1
ISSUE/REV.	

FILE: r:\clients\300-399\306\306-088-010\03 drawings\cad\02 design drawings\306-088-010 am.dwg



LEGEND

- IRRIGATION AREA ORIGINALLY PERMITTED UNDER PE-13717
- TREATMENT SYSTEM AREAS
- EXISTING MONITORING WELL (ACTIVE)
- EXISTING MONITORING WELL (INACTIVE)
- TOWN OF OLIVER MUNICIPAL BOUNDARY

NOTES:

1. WELL LOCATIONS FOR TOWN WELLS MW1, MW2, AND MW3 BASED ON PREVIOUSLY OBTAINED POINTS.
2. WELL LOCATIONS FOR TOWN WELLS MW4-MW7 BASED ON GOLDER REPORT (GOLDER REF: 972-4198, PG. 44-47).
3. WELL LOCATIONS FOR TOWN WELLS MW8-MW11 BASED ON WWA REPORT (WWA REF: 20-046-02VR, PG. 7-10).

CONSULTANT SEAL

TRUE CONSULTING

Town of Oliver
CANADA'S WINE CAPITAL

SANITARY SEWER ANNUAL REPORT

GROUND MONITORING WELLS NEAR FAIRVIEW MOUNTAIN

SCALE	1:10000
DESIGN BY	TRU
DRAWN BY	SA
DATE	FEBRUARY 2023
PROJECT REFERENCE No.	306-088-010
DRAWING No.	FIG 2-2
SHEET	1 OF 1
ISSUE/REV.	

FILE: r:\clients\300-399\306\306-088-010\03 drawings\cad\02 design drawings\306-088-010 sm.dwg

2.5.1 Groundwater Monitoring Leading Indicators

Typical parameters tested for analyzing impacts on groundwater include chloride, ammonia, nitrate and nitrite, and total hardness. Based on the chemical characteristics of each parameter, concentrations will indicate the transport and impact of reclaimed water on the groundwater system.

Chloride does not biochemically degrade and is considered a conservative ion. Its presence is indicative of the extent of anthropogenic influence. It is typically present in low concentrations in freshwater aquifer systems. Elevated chloride can be attributed to anthropogenic activities. This includes reclaimed water irrigation, wastewater effluent disposal to ground, road salting, industrial process and agricultural activity.

Ammonia is the primary form of nitrogen in raw wastewater. It is oxidized to nitrate and nitrite during the wastewater treatment process. When ammonia concentrations are high in the groundwater, it indicates the source is nearby. Anthropogenic sources include wastewater effluent, agricultural activities, urban development, and industrial activities.

Nitrate is seldom present in natural water systems. Concentrations above 3 mg/L are considered by the Province to reflect human impact. Common sources include agricultural activities, wastewater disposal to ground and industrial/mining processes. Nitrite is an unstable ion and rapidly oxidizes to nitrate or nitrogen gas.

Water hardness is a measure of the dissolved mineral content in water, predominantly dissolved ions of calcium and magnesium. It does not have a maximum allowable concentration of aesthetic objective according to the Guidelines for Canadian Drinking Water Quality.

2.5.2 Airport Monitoring Wells No. 1 to 3

There are three monitoring wells proximate to the airport site (Well #1, Well #2, Well #3). These wells are located down gradient from the reclaimed water use area.

In 2011, the Town renamed streets. For clarity, historic street names are referenced in parenthesis in Figure 2-1 and Figure 2-2.

Ten-year groundwater level and analytical data for these wells are summarized in Table 2-3 and Table 2-4. For complete historical data sets and trends, see Appendix G.

The average groundwater table elevation in Wells #1, #2 and #3 was lower than previous years. Notably, Wells #1 and #2 maximum level (meters below top of casing) values were the greatest in the corresponding data set, and the Well #3 value was the second greatest value in that data set.

The 2023 water quality in these wells were generally within the expected values for the parameters measured. Below is a summary of 2023 water quality observations.

- Chloride:
  - Chloride concentrations in Well #1 increased during each sampling event from April 2021 to April 2023, but remained stable in 2023 and are below 25 mg/L.
  - Well #2 chloride concentrations were elevated compared to the past 5 years, but were within the historic chloride concentration range and below 25 mg/L.
  - Chloride concentrations in Well #3 were consistent with past concentrations and below 25 mg/L.
- Ammonia:
  - Ammonia concentrations at all monitored wells except for MW-5 have been relatively stable and low since 2011.
  - Ammonia concentration in Well #3 for the April sampling event were consistent with historic values. The concentration for the September sampling event was elevated by an order of magnitude compared to historic data set range. This level of change is considered anomalous.
  - Ammonia in the other wells were consistent with historic concentrations.
- Nitrate and Nitrite
  - Nitrate concentrations at Well #1 were just below the BC CSR DW standard during both sampling events in 2023. The concentration of nitrate at Well #1 is anomalous and suggests there may be another point source of nitre being added to the aquifer near this location.
  - Nitrate and nitrite concentrations at Well #2 and #3 are relatively stable and largely below 1 mg/L.
  - Nitrate concentrations at Well #2 were elevated above 3 mg/L during both sampling events.
- Total Hardness:
  - Values for Well #1 and #2 were consistent with historic trends.
  - An elevated total hardness concentration of 8,470 mg/L was measured in Well #3 on April 18, 2023. This is the largest recorded value, which is similar to the September 19, 2007 value. The 2007 value was noted as possible error.
- Sodium:
  - The 2023 sodium concentration for the Well #3 April sampling event was elevated compared to the past five years, but it is within the historic data set range. The September concentration is consistent with the historic data set.
  - Values for Well #1 and #2 are consistent with historic values.

TABLE 2-3: 10-YEAR HISTORICAL SUMMARY OF GROUNDWATER DEPTHS FOR AIRPORT MONITORING WELLS

Monitoring Well	Year	Minimum Level (mbtoc)	Maximum Level (mbtoc)	Average Level* (mbtoc)	Level Range (m)
Well #1 Air Cadet	2013	9.78	10.44	10.11	0.66
	2014	9.98	10.58	10.33	0.60
	2015	10.01	10.51	10.28	0.50
	2016	10.21	10.5	10.36	0.29
	2017	9.9	10.59	10.32	0.69
	2018	9.65	10.29	10.03	0.64
	2019	9.72	10.62	10.26	0.9
	2020	9.62	10.51	10.22	0.89
	2021	9.24	10.4	9.8	1.16
	2022	10.16	10.85	10.51	0.69
	2023	10.59	10.96	10.76	0.37
Well #2 Rodeo Grounds	2013	5.62	6.24	5.91	0.62
	2014	5.84	6.27	6.08	0.43
	2015	5.69	6.66	6.08	0.97
	2016	5.66	5.97	5.82	0.31
	2017	5.98	6.3	6.16	0.32
	2018	5.81	6.24	5.99	0.43
	2019	6.18	6.96	6.61	0.78
	2020	7.07	7.46	7.27	0.39
	2021	7.48	7.78	7.62	0.3
	2022	7.79	8.10	7.94	0.31
	2023	8.02	8.26	8.1725	0.24
Well #3 91A Street	2013	1.20	1.39	1.27	0.19
	2014	1.11	1.65	1.37	0.54
	2015	1.21	1.66	1.41	0.45
	2016	1.13	1.43	1.28	0.30
	2017	1.06	1.38	1.23	0.32
	2018	0.87	1.51	1.2	0.64
	2019	1.24	1.78	1.45	0.54
	2020	1.18	1.72	1.44	0.54
	2021	1.2	2.1	1.7	0.9
	2022	1.51	2.16	1.73	0.65
	2023	1.49	2.27	1.865	0.78

TABLE 2-4: 10-YEAR HISTORICAL WATER QUALITY DATA FOR AIRPORT MONITORING WELLS

Monitoring Well	Sample Date	Chloride	Ammonia	Nitrate + Nitrite	Total Hardness	Sodium
Well #1 Air Cadet	9-Apr-2013		0.034	10.1	384	18.5
	9-Sep-2013		< 0.020	20.2	383	17
	16-Apr-2014		0.027	21.6	542	18.1
	4-Sep-2014	19.8	< 0.020	23.9	402	19.5
	14-Apr-2015	20.7	0.102	24.4	485	20.5
	16-Sep-2015	15.9	0.079	20.5	590	23.5
	-	-	-	-	-	-
	13-Sep-2016	13.7	0.032	15	386	19.1
	10-Apr-2017	14.2	0.033	12	388	19.5
	11-Sep-2017	10.4	<0.020	6.97	392	18
	14-May-2018	11.9	0.025	6.75	363	19.1
	10-Sep-2018	9.92	<0.020	7.97	344	16.8
	28-Oct-2019	9.77	0.023	12.6	388	19.6
	6-Apr-2020	10.3	<0.050	13	331	18.8
	1-Sep-2020	9.31	<0.050	11.1	378	19.4
	22-Apr-2021	8.83	<0.050	11	316	17.1
	13-Sep-2021	12.1	0.094	9.67	303	17.6
	11-Apr-2022	16.9	<0.050	9027*	319	17.6
	7-Sep-2022	22.2	<0.050	8.3	320	18.6
	18-Apr-2023	24.6	<0.050	9.72	319	19.1
	25-Sep-2023	24.7	<0.050	8.64	318	201
Well #2 Rodeo Grounds	9-Apr-2013		0.047	0.121	384	18.4
	9-Sep-2013		0.023	0.115	889	18
	16-Apr-2014		0.024	0.123	392	15.9
	4-Sep-2014	8.47	0.02	0.584	370	15.9
	14-Apr-2015	9.05	0.094	0.865	494	18.5
	16-Sep-2015	6.56	0.037	0.3	1120	31.6
	-	-	-	-	-	-
	13-Sep-2016	6.54	0.032	0.628	1110	19.2
	10-Apr-2017	7.6	0.072	0.343	914	20.4
	11-Sep-2017	6.1	0.02	0.124	959	17.1
	14-May-2018	7.2	0.1	0.122	2550	20.3
	10-Sep-2018	7.07	0.037	0.138	2090	18.9
	28-Oct-2019	6.55	0.103	0.385	2440	20.8
	6-Apr-2020	6.44	0.101	0.212	394	17.2
	1-Sep-2020	6.86	0.081	0.173	1540	18.9
	22-Apr-2021	6.78	0.102	0.312	1410	17.5
	21-Sep-2021	9.24	0.081	0.045	1740	20.4
	11-Apr-2022	7.14	0.068	0.324	1970	20.5
	7-Sep-2022	7.51	<0.050	0.872	2980	23.6
	18-Apr-2023	10.1	0.065	3.42	2150	18.2
	25-Sep-2023	10.7	<0.050	3.59	1220	15.7

Well #3 91A Street	9-Apr-2013		0.049	0.074	834	23.9
	9-Sep-2013		0.07	0.101	1430	24.6
	16-Apr-2014		0.028	0.058	399	16.9
	4-Sep-2014	125	0.023	0.032	438	21.8
	14-Apr-2015	8.99	0.086	0.106	631	18.9
	16-Sep-2015	7.59	0.047	0.035	496	18.5
	-	-	-	-	-	-
	13-Sep-2016	8.01	0.032	0.214	389	17.2
	10-Apr-2017	8.07	0.059	0.334	366	16.7
	11-Sep-2017	7.64	<0.020	0.042	346	15.2
	14-May-2018	8.31	0.024	0.0507	381	15.4
	10-Sep-2018	8.05	0.031	0.739	355	14.4
	28-Oct-2019	7.87	0.121	0.349	360	16
	6-Apr-2020	8.03	0.095	0.315	371	16.3
	1-Sep-2020	8.47	<0.050	0.0929	443	16.5
	22-Apr-2021	8.68	<0.050	0.25	356	15.2
	21-Sep-2021	7.77	0.15	0.307	1120	15.1
	11-Apr-2022	8.48	0.191	<0.0200	559	15.7
	7-Sep-2022	9.04	0.141	0.0886	1260	19
	18-Apr-2023	8.11	0.079	0.0705	8470	33.5
	25-Sep-2023	9.65	3.37	<0.0100	1100	18.5

2.5.3 Fairview Monitoring Wells

The Town of Oliver has seven groundwater monitoring wells downgradient of the Fairview area. Refer to Figure 2-1 and Figure 2-2 for their locations. Notes specific to well sampling in this area are as follows:

- MW-1, MW-2, and MW-3 were not included in the 2023 data collection. These wells were installed in 1997 as part of hydrogeological investigation supporting the design and commissioning of a rapid infiltration basin (RIB), which is no longer in use. As such, these wells are no longer monitored.

Ten years of historical data for groundwater level monitoring is presented in Table 2-5. The depths of all wells were comparable to previous years. For complete historic data sets and trends, see Appendix I.

Ten years of historical data for groundwater quality analysis is presented in Table 2-6. The 2023 water quality in these wells was generally within the expected concentrations for the parameters measured. For complete historic data sets and trends, see Appendix G.

Below is a list summarizing water quality observation for the 2023 sampling period. A detailed review was completed by WWA and is included in Appendix J.

- Chloride:
  - 2023 chloride concentrations at MW-4 are consistent with historic trends. Historically high chloride at this location is associated with its proximity to the RIB and surrounding agricultural activity.
  - Chloride concentrations at MW-6 and MW-11 are slightly below those at MW-4. These concentrations are influenced by reclaimed water infiltration at the Fairview Gulf Course.
  - MW-5 had the lowest chloride values which is expected given its further proximity from an irrigation source. This is used as a background well.
  - In 2023, MW-8 and MW-10 remained below applicable standards, while concentrations at MW-6 were just above irrigation standards in April 2023.
  - MW-11 concentrations remained above irrigation standards during both sampling events in 2023.
- Ammonia:
  - Ammonia concentrations were below detection limits at MW-6 and MW-11 for both sampling events.
  - All other sampling events for MW-4, MW-5, MW-8 and MW.10 were not detected or detected at low concentrations.
- Nitrate and Nitrite:
  - Nitrate concentrations at MW-6 and MW-8 were slightly lower than MW-10 and MW-11.
  - Concentrations at MW-6 were higher in September than in April 2023, similar to 2022.
  - Nitrate concentrations at MW-5 have stabilized in recent years and are typically at or below 2 mg/L. The cause is unknown but may be associated with changes in agricultural or irrigation practices upgradient.
- Total Hardness:
  - Elevated total hardness was measured at MW-4 with the April sampling event concentration being the second highest value in the data set.
  - MW-10 and MW-11 had slightly elevated Total hardness being approximately 200 mg/L above MW-5 concentrations.
  - Concentrations at MW-6 and MW-8 are similar to those at MW-5.

TABLE 2-5: HISTORICAL SUMMARY OF GROUNDWATER DEPTHS FOR FAIRVIEW MONITORING WELLS

Monitoring Well	Year	Minimum Level (mbtoc)	Maximum Level (mbtoc)	Average Level* (mbtoc)	Level Range (m)
Monitoring Well #4 Sand Pit	2013	8.21	10.64	8.89	2.43
	2014	7.43	9.62	8.57	2.19
	2015	8.08	10.20	8.92	2.12
	2016	7.79	8.98	8.38	1.19
	2017	6.24	8.33	7.71	2.09
	2018	1.99	8.13	6.75	6.14
	2019	7.81	9.4	8.47	1.59
	2020	7.8	10.43	9.03	2.63
	2021	8.35	10.75	9.30	2.40
	2022	8.65	10.62	9.51	1.59
	2023	8.41	10.61	9.34	2.2
Monitoring Well #5 125th Street	2013	5.59	9.23	7.95	3.64
	2014	8.13	9.77	9.04	1.64
	2015	-	-	-	-
	2016	4.57	9.90	7.70	5.33
	2017	4.56	10.57	7.93	6.01
	2018	5.28	9.09	7.78	3.81
	2019	7.89	9.66	9.01	1.77
	2020	7.36	10.1	9	2.74
	2021	7.1	9.6	8.8	2.5
	2022	7.61	10.13	8.96	2.52
	2023	8.03	9.61	8.98	1.58
Monitoring Well #6 Fairview Golf Course	2012-2019	*13.92 (Dry)*			
	2021	12.38	12.75	12.58	0.37
	2022	12.87	13.21	13.12	0.34
	2023	13.15	13.75	13.40	0.6
Test Well # 7 (Road No. 5) ABANDONED	2012-2019	*25.91 (Dry)*			
	2021	Abandoned			
	2022	Abandoned			
		Abandoned			
Monitoring Well #8 Public Works Yard	2021	2.76	3.01	2.91	0.25
	2022	2.00	3.35	2.79	1.35
	2023	2.22	3.02	2.85	0.80
Monitoring Well #9 Cemetery	2021	21.50	21.1 (dry)	21.20	0.40
	2022	21.05	21.44	21.10	0.39
	2023	21.10	21.11	21.10	0.01
Monitoring Well #10 Gala Linear Park	2021	25.80	27.70	26.40	1.90
	2022	25.69	26.59	26.10	0.90
	2023	25.81	26.84	26.34	1.03
Monitoring Well #11 Road No. 5	2021	24.40	30.50	27.00	6.10
	2022	24.55	24.84	24.73	0.29
	2023	24.86	25.11	25.01	0.25

TABLE 2-6: HISTORICAL WATER QUALITY FOR FAIRVIEW MONITORING WELLS

Monitoring Well	Sample Date	Chloride	Ammonia	Nitrate + Nitrite	Total Hardness	Sodium
Monitoring Well #4 Sand Pit	9-Apr-2013		0.091	1.78	1070	118
	9-Sep-2013		0.156	2.06	1350	146
	16-Apr-2014		0.073	3.02	1050	115
	4-Sep-2014	125		1.68		127
	Apr. 14, 2015	141		3.56		120
	16-Sep-2015	135	0.023	1.53	1440	127
	-	-	-	-	-	-
	13-Sep-2016	129	0.021	1.63	1700	19.2
	10-Apr-2017	121	0.084	10.2	820	108
	11-Sep-2017	110	<0.020	3.05	387	11.5
	14-May-2018	111	0.035	4.12	725	100
	10-Sep-2018	96	0.043	2.99	838	87.1
	28-Oct-2019	103	0.222	16.9	704	93
	6-Apr-2020	119	0.091	8.03	659	92.2
	1-Sep-2020	101	0.072	1.11	1120	86.9
	22-Apr-2021	125	<0.050	4.19	782	81.7
	21-Sep-2021	101	0.073	0.967	2020	97.1
	11-Apr-2022	119	<0.050	3.51	991	81.2
	7-Sep-2022	121	<0.050	1.35	1610	92
	18-Apr-23	152	0.081	3.56	3750	108
	25-Sep-23	128	<0.050	1.26	1810	107
Monitoring Well #5 125th Street	9-Apr-2013		0.036	1.11	381	15.9
	9-Sep-2013		0.071	0.652	398	12.4
	16-Apr-2014		0.022	0.577	465	13.1
	4-Sep-2014	14.7		0.683		14
	14-Apr-2015	16.7		1.31		14.7
	16-Sep-2015	27.7	< 0.020	0.794	456	31.6
	-	-	-	-	-	-
	13-Sep-2016	23.9	0.022	1.11	960	20.4
	10-Apr-2017	17	0.052	1.21	481	14.1
	11-Sep-2017	16.5	0.089	1.11	917	88.4
	14-May-2018	16	0.058	0.569	400	12.8
	10-Sep-2018	15.6	0.066	1.59	348	10.3
	28-Oct-2019	16.1	0.774	2.18	415	13.6
	6-Apr-2020	16.7	<0.050	1.6	409	14
	1-Sep-2020	17.7	<0.050	2.28	419	17.7
	22-Apr-2021	17.5	<0.050	1.69	386	16.5
	21-Sep-2021	16.4	0.073	1.6	374	15.1
	11-Apr-2022	13.5	<0.050	0.796	292	9.87
	7-Sep-2022	16.1	<0.050	1.17	442	15.9
	18-Apr-23	15.7	0.101	1.19	372	13
	25-Sep-23	13.9	<0.050	1.31	329	11.2

Monitoring Well #6 Fairview Golf Course	21-Sep-2021	95.6	<0.050	2.33	396	96.9
	11-Apr-2022	95.2	<0.050	2.76	369	94.5
	7-Sep-2022	95.7	<0.050	2.81	395	102
	18-Apr-23	102	<0.050	3.62	417	101
	25-Sep-23	92.7	<0.050	3.02	408	112
Monitoring Well #8 Public Works Yard	21-Sep-2021	45.5	<0.050	2.28	311	35.7
	11-Apr-2022	48.7	<0.050	2.58	278	30.4
	7-Sep-2022	87.8	0.737	1.47	353	48.2
	18-Apr-23	81.8	0.07	1.07	392	42.6
	25-Sep-23	63.3	<0.050	1.34	334	45.2
Monitoring Well #10 Gala Linear Park	21-Sep-2021	165	<0.050	5.89	317	67.1
	11-Apr-2022	37.9	<0.050	3.18	312	22.4
	7-Sep-2022	85.1	<0.050	3.94	674	62.8
	25-Sep-23	191	0.089	3.58	580	86
Monitoring Well #11 Road No. 5	21-Sep-2021	97.7	<0.050	3.21	493	18.4
	11-Apr-2022	114	<0.050	4.13	470	17.8
	7-Sep-2022	115	<0.050	4.34	498	18.3
	18-Apr-23	132	<0.050	5.86	573	24.8
	25-Sep-23	134	<0.050	5.84	592	24.5

2.5.4 Groundwater Monitoring Plan Recommendations

To improve the groundwater monitoring program, the following recommendations are made by WWAL:

- WWAL recommends continued monitoring of the water levels monthly and semi-annual sampling at the wells currently being monitored. They further recommend that a water level transducer be installed at MW-4 to better characterize the effects on water levels when the RIB is in use and for one full year, groundwater quality samples from MW-4 should be collected monthly to better characterize water quality impacts related to the RIB discharge.
- Recent water level measurements at Wells #1 and #2 exceed the believed depths of those wells. Depths of these monitoring wells, referenced from the top of the PVC casing, should be reconfirmed at the next water level measurement, and communicated to the consultant.
- As the only monitoring location total nitrogen concentrations near or exceed the CSR DW guideline of 10 mg/L, the source of the elevated nitrogen at Well #1 should be investigated. Possible sources for include the near by vineyard and orchards, BC Tree Fruits facility, possible septic field for the Air Cadet building, or leaking wastewater or reclaimed irrigation water mains. Depending on the results of this investigation, additional monitoring wells in the area may be required to further investigate the source of the nitrate+nitrite in groundwater at that location. WWAL further recommends adding pH to the list of water quality parameters assessed in each well to be able to assess exceedances for ammonia in the future.

- A review of land use in the vicinity of background well MW-5 should be completed, including collecting information on fertilizer application to assess potential sources of ammonia. For the time being, MW-5 should continue to be monitored.
- The well installed at the cemetery grounds in 2021 (MW-9) has been dry since installation and was likely completed above the aquifer at that location. This well should be abandoned and replaced with a deeper monitoring well.
- Recommended changes to the sampling program parameters:
    - WWAL recommend assessing the pH for monitoring well samples to determine applicable ammonia guideline criteria.
    - For reclaimed water, add the parameters sodium, chloride, nitrate, nitrite and ammonia.

Additional commentary and analysis of 2023 hydrogeological data is provided by WWA in their Hydrogeological Review in Appendix J.

2.6 Soils Assessment (OC 5.4, 5.5, and 6.9)

In accordance with Section 6.9 of the OC, a soils assessment of the irrigated areas was completed in June 2020 and is summarized herein. Soils were identified using a detailed soil survey of the central and southern Okanagan and Lower Similkameen Valley. This information was published in the *MOE Technical Report 18 Soils of the Okanagan and Similkameen Valleys, 1986.*

The conclusions found in the 2020 report prepared by Hamilton & Associates are as follows.

- The schoolyard, cemetery, and park sites are all suitable for irrigation with reclaimed wastewater subject to the regulatory water quality requirements for reclaimed water.
- The airport lands east of the existing irrigated area will require special management.
    - This area has a limited irrigation season (June 15 to September 10).
    - Apply approximately ½ the rate outlined in the BC Agriculture Water Calculator.
    - Once vegetative cover improves and a layer of organic litter develops, the irrigation rates may be re-evaluated.
- Overall, the irrigation areas are capable of accepting reclaimed water for irrigation purposes.

For full report details please refer to Appendix H.

A summary of the soil classifications, characteristics, physical properties, and drainage for the reclaimed water irrigation areas is presented in Table 2-7. Detailed individual profile descriptions and an overview map of the soil parent materials is provided in Appendix H. As seen, all irrigated areas are well to rapidly drained except for the Public Works Yard. At this location, reclaimed water is used for compost operations and landscape irrigation, therefore it does not present an issue with respect to surface runoff or surfacing of reclaimed water.

TABLE 2-7: SOILS OVERVIEW – RECLAIMED WATER IRRIGATION AREAS

Irrigation Location	Soil Name	Soil Texture	Drainage	Coarse Fragment	Parent Material
Cemetery[1,2]	Ponderosa	Sandy Loam	Well-drained	65	FLUV
Oliver Secondary School[1,2]	Rutland	Sandy Loam	Rapidly-drained	63	GLFL
High School Park[1]	Rutland	Sandy Loam	Rapidly-drained	63	GLFL
Public Works Yard[1,2]	Cawston	Silt Loam	Rapidly-drained	15	FLUV
Airport[1]	Rutland	Sandy Loam	Rapidly-drained	63	GLFL
Oliver Community Park[3]	Kinney	Sandy Loam	Imperfect	-	FLUV
Alonso	Approved in Operational Certificate PE-13717				
Huggins	Approved in Operational Certificate PE-13717				
Fairview Mountain Golf Course	Approved in Operational Certificate PE-13717				

[1]Approved in Principle by the Ministry in August 2022
[2]Previously irrigated with freshwater, simple replacement
[3]Area considered for future reclaimed water irrigation

2.6.1 Soil Descriptions (OC 6.9)

Soil descriptions for each soil type are as follows:

Ponderosa Soils

Ponderosa soils only occur in the vicinity of Oliver. They have developed in a gravelly, moderately coarse textured fluvial veneer between 10 to 50 cm thick, overlying gravelly coarse textured fluvial fan deposits. Surface and subsurface textured are gravelly or very gravelly sandy loam or gravelly loam. Subsoils are very gravelly loamy sand. The soil drainage class is well to rapid.

Rutland Soils

Rutland soils occupy significant areas throughout the Okanagan Valley. The parent material is a moderately coarse textured veneer between 10 and 25 cm thick, which overlies gravelly and stony, very coarse textured glaciofluvial deposits. Surface soil textures are dominantly sandy loam or loamy sand. Subsurface materials are gravelly sand or gravelly loamy sand. The soil drainage class is rapid.

Cawston Soils

Cawston soils occur on the Okanagan River floodplain. They have developed in medium textured recent fluvial deposits generally between 50 to 100 cm thick, overlying moderately coarse textured materials. Surface and subsurface textures are silt loam or loam. Subsoil textures are gravelly sandy loam or gravelly loamy sand. They are moderately pervious, have a high water holding capacity and slow surface runoff. The soil drainage class is dominantly poor, ranging to imperfect.

Kinney Soils

Kinney soils occur on the Okanagan River floodplain between Penticton and Osoyoos Lake. They have developed in a loamy fluvial veneer, usually between 30 and 80 cm thick, that overlies sandy floodplain deposits. Surface and subsurface textures are loam or sandy loam with a subsoil that is loamy sand or sand, occasionally containing thin silty lenses. They are imperfectly drained, moderately pervious and have moderate to low water holding capacity.

2.6.2 Surface Runoff (OC 5.4)

To date, the Town has not observed surface water runoff generated from reclaimed water irrigation use. As outlined in the soil profiles, the parent material at each irrigation area is generally well-drained. Runoff has also not been an operational issue due to the arid climate.

2.6.3 Surfacing Reclaimed Wastewater (OC 5.5)

The irrigation system is designed and managed to ensure that there is no surfacing of irrigation tail water downslope of the point of irrigation. A hydrogeological study of the rapid infiltration basin was completed by Golder Associated in 1998. The system capacity of 355 m^3/day was derived on the basis of the natural discharge capacity of the subsurface soils such that surfacing of effluent will not occur within 150m of the site.

3.0 Analytic Recommendations

As per OC Section 6.6, Sampling and Analytical Requirements, 6.6.5 “The permittee is required to follow the terms of the Quality Assurance Regulation (EQDA). Ten percent of the samples collected shall be duplicated to provide data quality assurance.” Currently, duplicate sampling is not being conducted. For this reason, it is recommended that duplicate testing be carried out in 2024. Furthermore, it is recommended that duplicates be distributed throughout the monitoring programs to improve the quality of this analysis.

APPENDIX A

Operational Certificate for PE 13717

Province of
British Columbia

MINISTRY OF
ENVIRONMENT,
LANDS AND PARKS

BC Environment

Environmental Protection
#201-3547 Skaha Lake Rd.
Penticton, British Columbia
V2A 7K2
Telephone: (604) 490-8200
Fax: (604) 492-1314

Date: December 14, 1995 File: 76750-40/PE-13717 (01)

REGISTERED MAIL

The Corporation of the Town of Oliver
PO Box 638
Oliver BC VOH 1TO

Attention: Tom Szalay, Administrator

Enclosed is a copy of the Operational Certificate No. PE-13717 issued under the provisions of the Waste Management Act. This Operational Certificate supersedes Permit PE-00102 which is cancelled in accordance with Section 16(13) of the Waste Management Act. Your attention is respectfully directed to the terms and conditions outlined in the Operational Certificate. An annual Permit fee will be determined according to the Waste Management Permit Fee Regulation.

This Operational Certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority shall rest with the Operational Certificate holder.

This Operational Certificate is issued pursuant to the provisions of the Waste Management Act to ensure compliance with Section 34(3) of that statute, which makes it an offence to discharge waste without proper authorization. It remains the responsibility of the Operational Certificate holder to ensure that all activities conducted under this authorization comply with any other applicable legislation which may be in force from time to time.

The administration of this Operational Certificate will be carried out by staff from our Regional Office located in Penticton, (telephone 490-8200). Plans, data and reports pertinent to the Operational Certificate are to be submitted to the Environmental Protection office, Suite 201, 3547 Skaha Lake Road, Penticton, British Columbia, V2A 7K2. - 30th Street, Vernon, British Columbia, V1T 9G3.

This decision may be appealed by any person(s) who considers themselves aggrieved by this decision, in accordance with Part 5 of the Waste Management Act. Written notice of intent to appeal must be received by the Regional Waste Manager within twenty-one (21) days of the date of notification of this decision.

Yours truly,

T.R. Forty, P.Eng.
Assistant Regional Waste Manager
Okanagan Sub-Region

Enclosure

PROVINCE OF
BRITISH COLUMBIA

Environmental Protection
#201 - 3547 Skaha Lake Road
Penticton
British Columbia, V2A 7K2
Telephone: (604) 490-8200

MINISTRY OF ENVIRONMENT,
LANDS AND PARKS

OPERATIONAL CERTIFICATE

PE 13717

Under the Provisions of the Waste Management Act

TOWN OF OLIVER

P.O. Box 638

Oliver, British Columbia

V0E 1T0

is authorized to discharge reclaimed wastewater to the ground by irrigation, from a municipal sewage collection and aerated lagoon sewage treatment facility located at Oliver, British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the Waste Management Act and may result in prosecution.

1. SPECIFIC AUTHORIZED DISCHARGES AND RELATED REQUIREMENTS

The discharge of effluent to which this sub-section is applicable is from a municipal sewage treatment facility located approximately as shown on the attached Site Plan A and Site Plan B. The reference number (S.E.A.M. site number) for this discharge is E222150.

1.1 Discharge Quantity

1.1.1 The maximum authorized rate of effluent to be discharged from the aerated lagoon sewage treatment system to the reclaimed wastewater storage reservoir, averaged on a monthly basis:

1995 - 1950 m^3 per day
1996 - 2000 m^3 per day
1997 - 2050 m^3 per day
1998 - 2100 m^3 per day
1999 - 2150 m^3 per day
2000 - 2200 m^3 per day

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1.1.2 There is no maximum authorized rate of reclaimed wastewater to be discharged from the storage reservoir for beneficial use as irrigation water.

1.2 Discharge Quality

1.2.1 It is recommended that to ensure reclaimed wastewater is adequately renovated prior to irrigation, the characteristics of the effluent discharged from the aerated lagoon treatment system to the reclaimed wastewater storage reservoir not exceed:

5 Day Biochemical Oxygen Demand, 45 mg/L; and

Total Suspended Solids - 60 mg/L.

1.3 Permit Fee Calculations for Reclaimed Wastewater Discharge to Land

1.3.1 The characteristics of the reclaimed wastewater discharged from the storage reservoir and beneficially used for irrigation, for the purposes of permit fee calculations, the following discharge factors have been assumed:

5 Day Biochemical Oxygen Demand, 10 mg/L; and

Total Suspended Solids - 10 mg/L.

1.4 Authorized Works

The works authorized are: sewage collection system, sewage treatment plant concrete tankage for emergency containment, influent screen, flow equalization basin, pumping station, pressure forcemain to aerated lagoons, aerated lagoon treatment system, reclaimed wastewater storage reservoir sized to provide a minimum retention time of 60 days prior to spray irrigation, post storage chlorination, pressure forcemain to the golf course and related irrigation supply mains and sprinkler irrigation equipment, infiltration basin, and other related appurtenances, approximately as shown on the attached Site Plan A.

1.5 Source of Discharge

The source of discharge and sewage collection system services the Town of Oliver and surrounding area.

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1.6 Location of Works

The location of the sewage collection, flow equalization basin and effluent pumping station is: Block 47 of District Lot 2450s, Similkameen Division of Yale District.

The location of the effluent aerated lagoon treatment facilities, reclaimed wastewater storage reservoir, chlorination and withdrawal facilities is: District Lot 763s, and Block B, District Lot 682s, Similkameen Division of Yale District. The location of the potential infiltration basin sites: Block K, Plan 1789 (Town Sand Pit) and Lot 2, Plan 5881 (Town Gravel Pit).

1.7 Location of Discharge

The location where reclaimed wastewater may be irrigated is described generally as Oliver and the surrounding area.

1.8 Irrigation Plan

Submit for review, and obtain written authorization from the Regional Waste Manager, an "Irrigation Plan" of all new areas of land to be irrigated prior to commencement of irrigation with reclaimed wastewater. Areas for effluent irrigation are as indicated in the Oliver Waste Management Plan and as indicated on Site Plan A.

2. GENERAL REQUIREMENTS

2.1 Maintenance of Works, Emergency Procedures and Noncompliance Reporting

Inspect the pollution control works regularly and maintain them in good working order. In the event of an emergency or any condition which prevents continuing operation of the approved method of pollution control or results in noncompliance with the terms and conditions of this Operational Certificate, immediately notify the Regional Waste Manager and take appropriate remedial action.

2.2 Bypasses

The discharge of effluent which has bypassed the designated treatment works is prohibited, unless the consent of the Regional Waste Manager is obtained and confirmed in writing.

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2.3 Process Modifications

Notify the Regional Waste Manager, and his written consent obtained, prior to implementing changes to any process that may affect the quality and/or quantity of the discharge.

2.4 Alternate Water Supply

Provide alternate water supplies if any privately owned well is adversely affected by the land disposal scheme as determined by the Regional Waste Manager.

2.5 Plans - New Works

2.5.1 Plans of modifications and/or extensions to the existing works shall be signed and sealed by a Professional Engineer licensed to practise in the Province of British Columbia.

2.5.2 Copies of all "as-built" plans and drawings for the effluent treatment system, signed and sealed by a Professional Engineer licensed to practise in the Province of British Columbia, shall be submitted to the Regional Waste Manager on completion of construction.

2.5.3 Plans and specifications of any proposed new works, modifications or additions to the works authorized in this Operational Certificate, including the infiltration basin plans, and with the exception of the sewage collection system, shall be submitted to the Regional Waste Manager, and his written consent obtained before construction commences. The works shall be constructed in accordance with such plans.

2.5.4 Retain a copy of all "as-built", plans of modifications and/or extensions to the sewage collection system for perusal by the Regional Waste Manager, or his designate, upon request.

2.5.5 Plans for modifications of, and/or extensions to, the existing reclaimed wastewater irrigation system shall be approved by a person qualified in the design of irrigation systems.

2.5.6 Design and construct the irrigation works in accordance with best current agricultural practice and:

The "Pollution Control Guidelines for Municipal Effluent Application to Land", dated January 1983, and any amendments thereto, issued by the Ministry of Environment of British Columbia.

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The "B.C. Sprinkler Irrigation Manual" 1989 issue, prepared by the B.C. Ministry of Agriculture and Fisheries.

The "Health and Safety Criteria for the Use of Reclaimed Wastewater", 1991, developed by the Ministry of Health and the Ministry of Environment.

3. GENERAL REQUIREMENTS - ALL DISCHARGES

3.1 Operation and Maintenance

Develop and maintain both an Operational and Maintenance Manual for the sewage collection, sewage treatment and reclaimed wastewater utilization. A copy of the Operational and Maintenance Manuals shall be retained at the treatment facility for inspection by the Regional Waste Manager or their designate.

3.2 Facility Classification

Maintain the wastewater treatment facility classification as authorized in Section 1.4 with the "British Columbia Water and Wastewater Operators Certification Program Society" (BCWWOCPS). The new aerated lagoon treatment facility is presently classified as a Level II facility.

3.3 Operator Certification

3.3.1 All operators in training (OIT) working at this Level II facility classified by the BCWWOCPS shall be required to successfully pass an OIT examination within three (3) months of commencement of employment at the facility. The OIT certificate shall be valid for fifteen (15) months from the date of issue. Prior to the expiry date of the OIT certificate, but not sooner than twelve (12) months from the date when the OIT commenced facility operation, the OIT shall successfully complete a Class I certification examination in order to continue to operate at the facility.

3.3.2 The facility is currently classified by the BCWWOCPS at Level II. Designate at least one operator to be the "Chief Operator" of the facility by **December 1, 1996**. The "Chief Operator" shall be certified at a Class II level, at a minimum.

After **December 1, 1996**, no person shall have "Direct Responsible Charge", as defined by the BCWWOCPS, of a municipal wastewater

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Assistant Regional Waste Manager

treatment facility classified at Level II or higher unless they possess a valid operator's certificate not more than one level below the classification level of the facility. **"Direct Responsible Charge" is the "Chief Operator" of the facility, the identifiable senior person who is in charge of the plant.**

3.3.3 Should the facility be reclassified by the BCWWOCPS at Level III, designate a "Chief Operator", certified at a Class III level by **December 1, 1998.**

3.3.4 Should the facility be reclassified by the BCWWOCPS at Level IV, designate a "Chief Operator", certified at a Class IV level by **December 1, 1998.**

3.4 Water Conservation

Establish a water conservation program to encourage a reduction in the volume of domestic and industrial wastewaters discharged to the sewage collection system.

3.5 Sewage Collection System - Groundwater Infiltration, Inflow and Cross Connections

Inspect and maintain the sewage collection system works so as to minimize the possibility of cross connections between the storm sewer and the sanitary sewer systems, to minimize infiltration of groundwater, to minimize inflow of water from basement sump pumps and roof drains, and minimize exfiltration of the collected sewage from the sewage collection system to the ground.

3.6 Influent Wastes Bylaw

Subject to being declared a Sewage Control Area under Section 17 of the Waste Management Act, and in order to minimize the potential effect of heavy metals or other toxic materials in the effluent and/or sludge, prepare, implement and/or amend an Influent Wastes Bylaw, Building Bylaw, or other similar bylaws, to regulate the input of such wastes to the sewage collection system. Devices to process household putrescible waste for disposal to the sewage collection system shall be prohibited.

3.7 Contingency Plan

Prepare a Contingency Plan that will address the appropriate course of action to be taken in any particular preconceived emergency situation. The Contingency Plan shall include chlorine leaks and any potential point of concern in the collection, treatment and disposal systems. Attention is to be given to public

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Assistant Regional Waste Manager

safety and the protection of the environment. The Contingency Plan is to be continually updated as necessary to reflect the current operation. A copy of the Contingency Plan shall be forwarded to the Regional Waste Manager on or before December 31, 1997.

3.8 Sludge Management Plan

The rationale of sludge management, including frequency of withdrawal of sludge from the sewage treatment plant and the location(s) used for disposal and/or utilization shall be developed into a Sludge Management Plan. The Sludge Management Plan shall be prepared and submitted to the Regional Waste Manager for approval on or before December 31, 1996.

3.9 Odours

Should odours become objectionable, additional works shall be provided when so directed in writing by the Regional Waste Manager.

3.10 Fencing

Erect a fence around the sewage treatment facility, storage reservoir and such other areas as required by the Regional Waste Manager. The height and type of fencing shall meet the approval of the Regional Waste Manager.

3.11 Surface Water Diversionary Works

Surface water shall be intercepted and diverted away from the effluent treatment facilities to the greatest extent possible.

3.12 Signage

3.12.1 A suitable sign erected at the main entrance to the site shall have the appropriate emergency phone numbers for use by the general public and others.

3.12.2 Prominent "NO TRESPASSING", signs shall be erected around agricultural and silvicultural sites irrigated with reclaimed wastewater, warning persons of the possible health hazard during the irrigation season and advising that the water used for irrigation is NOT POTABLE. The wording shall be in language or symbols readily comprehensible by the general public. eg. "NO TRESPASSING - RECLAIMED WASTEWATER - DO NOT DRINK"

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4. GENERAL REQUIREMENTS - EFFLUENT STORAGE RESERVOIR

4.1 Leakage

Operate and maintain the reclaimed wastewater storage reservoir to minimize fluid leakage. Leakage shall not aggravate or produce soil or bedrock instability or erosion elsewhere or contaminate ground or surface water.

5. GENERAL REQUIREMENTS - EFFLUENT IRRIGATION

5.1 Disinfection - Chlorination

5.1.1 Adequate chlorination shall be maintained and provide not less than one hour's contact time at average flow rates in the reclaimed wastewater discharging from the chlorination facility to the irrigation system.

5.1.2 Reclaimed wastewater utilized for irrigation shall conform to the effluent irrigation guidelines developed by the B.C. Ministry of Health. Fecal coliforms shall not exceed 200 MPN per 100 mL for agricultural, silvicultural and low public use lands, or exceed 2.2 MPN per 100 mL for high public use lands.

5.2 Annual Irrigation

5.2.1 The authorized discharge period for irrigation is during the period March 15 to October 31, inclusive.

5.2.2 With the written authorization of the Regional Waste Manager, the irrigation schedule may be extended on a weekly basis beyond these limits. Any extension will be considered only upon receipt of a substantiated written request.

5.3 Buffer Zones

5.3.1 The requirement for formal buffer zones surrounding lands irrigated with reclaimed wastewater is no longer in effect, however, a buffer zone may be specified by the Regional Waste Manager.

5.3.2 Reclaimed wastewater applied by irrigation shall not be applied to the ground any closer than 15 metres from the edge of flowing streams or bodies of water.

5.3.3 There shall be no reclaimed wastewater irrigated within 30 metres of any well or inground reservoir for domestic supply.

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Assistant Regional Waste Manager

5.4 Surface Runoff

There shall be no surface runoff of irrigated reclaimed wastewater from the irrigated lands.

5.5 Surfacing Reclaimed Wastewater

Irrigation shall be managed in such a fashion as to preclude surfacing of irrigation tail water down slope of the point of irrigation.

5.6 Spray Irrigation Drift

The reclaimed wastewater irrigation system shall be managed in such a fashion as to preclude aerosol drift from leaving the irrigated lands.

5.7 Irrigation Rates

5.7.1 Irrigation rates shall not exceed the rates given in "B.C. Sprinkler Irrigation Manual", dated 1989, prepared by the B.C. Ministry of Agriculture and Fisheries.

5.7.2 Soils of the irrigated lands shall be monitored to prevent saturation, erosion, and instability.

5.8 Agricultural Products Lag Time

5.8.1 A three day lag time is required before uninspected livestock intended for human consumption are permitted on areas irrigated with reclaimed wastewater. No lag time is required if livestock are subjected to the federal meat inspection program.

5.8.2 A six day lag time is required before dairy cattle are permitted in areas irrigated with reclaimed wastewater.

5.8.3 A three day lag time, after irrigation has ceased, is required before a crop intended for animal feed is harvested.

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Assistant Regional Waste Manager

6. MONITORING REQUIREMENTS

6.1 Influent Sampling Program - (Equalization Basin)

6.1.1 Install and maintain a suitable sampling facility at the equalization basin outlet, (S.E.A.M. site number E222152), and obtain a grab sample of the plant influent **semi-annually** (a proportional continuous sampler may be used).

6.1.2 Obtain analyses of the influent sample for the following:

total phosphorus and ortho phosphorus, expressed as P in mg/L;

6.2 Effluent Sampling Program - (Cell #3, prior to storage reservoir)

6.2.1 Install and maintain a suitable sampling facility on the outlet of the aerated treatment lagoon, Cell #3, (S.E.A.M. site number E222151), and obtain a grab sample of the effluent before it is discharged to the storage reservoir, for analysis by a suitably accredited laboratory, a proportional continuous sampler may be used, provided that prior written approval has been obtained from the Regional Waste Manager.

6.2.2 Obtain analyses of the effluent sample for the following:

total suspended solids (non-filterable residue), (**monthly** analysis), mg/L;

5-day biochemical oxygen demand, (**monthly** analysis), mg/L;

total phosphorus, ortho phosphorus and total dissolved phosphorus, (**quarterly analysis during 1996, and semi-annually** analysis, thereafter), all expressed as mg/L P; and

total nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, and organic nitrogen, (**quarterly analysis during 1996, and semi-annually analysis thereafter**), all expressed as mg/L N.

6.2.3 Occasional full chemical analysis of the main cations and anions and other characteristics may be required at the discretion of the Regional Waste Manager.

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6.3 Effluent Irrigation Sampling Program - (Chlorine Contact Chamber, prior to Irrigation)

6.3.1 Install a suitable sampling facility after the chlorine contact chamber, prior to irrigating, (S.E.A.M. site number E222150) and obtain a grab sample of the reclaimed wastewater **during the irrigation season.**

6.3.2 Obtain analyses of the sample, parameters and frequency as follows:

faecal coliforms, M.P.N./100ml, on a **monthly** basis;

total coliforms, M.P.N./100ml, on a **monthly** basis;

total phosphorus, mg/L, on a **monthly** basis;

total nitrogen, mg/L, on a **monthly** basis; and

chlorine residual, mg/L, on a **weekly** basis.

6.3.3 Occasional full chemical analysis of the main cations and anions and other characteristics may be required at the discretion of the Regional Waste Manager.

6.4 Effluent Irrigation Monitoring Program

6.4.1 Provide and maintain a suitable flow measuring device to measure total volume of reclaimed wastewater irrigated annually and record the areas where it is utilized.

6.4.2 Provide and maintain a suitable flow measuring device to measure the amount of fresh water make-up from Okanagan River to the equalization basin in m^3/day, and totalize this make up water volume on an annual basis in m^3/year.

6.4.3 Provide and maintain a suitable flow measuring device and record once per day the reclaimed wastewater volume irrigated over a 24-hour period. Record the flows for each calendar month and for each calendar year.

6.5 Storage Reservoir Level Monitoring Program

6.5.1 Provide a suitable staff gauge or other similar device as approved by the Regional Waste Manager in the storage reservoir and take weekly measurements of the water level in the storage reservoir on a year round basis.

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Assistant Regional Waste Manager

6.6 Sampling and Analytical Requirements

6.6.1 Proper care should be taken in sampling, storing and transporting the samples to adequately control temperature and avoid contamination, breakage, etc.

6.6.2 Occasional full chemical analysis of the main cations and anions and other characteristics may be required at the discretion of the Regional Waste Manager.

6.6.3 Analyses are to be carried out in accordance with procedures described in the second edition of "A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments and Biological Materials, (March 1994 Permittee Edition)", or by suitable alternative procedures as authorized by the Regional Waste Manager.

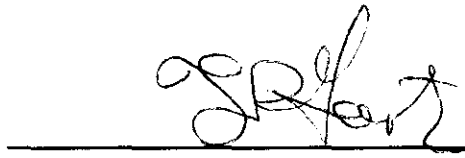
The above manual may be purchased from Queens Printer Publications Centre, 2nd Floor, 563 Superior Street, Victoria, B.C., V8V 4R6, 1-800-663-6105. The manual may also be reviewed at any Environmental Protection Program Office.

6.6.4 Sampling and flow measurement shall be carried out in accordance with the procedures described in "Field Criteria for Sampling Effluents and Receiving Waters", April 1989, 17 pp., or by other suitable alternative procedures as authorized by the Regional Waste Manager.

6.6.5 The Permittee is required to follow the terms and conditions of the Quality Assurance Regulation (EQDA). Ten percent of the samples collected shall be duplicated to provide data quality assurance. Quality control information generated by the Permittee lab while analyzing parameters required by this Permit shall also be provided with the data required to be reported.

6.7 Sludge Sampling and Monitoring Program

Develop and maintain a record keeping system for measuring and recording the depth of sludge collecting in the lagoons and volume of sludge removed from the treatment lagoons during desludging operations, the location where the sludge was discharged, and the amount of sludge discharged at each location. The Regional Waste Manager is to be notified in writing at least two weeks prior to the commencement of desludging operations. Analysis of the sludge may be required by the Regional Waste Manager.



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6.8 Groundwater Monitoring Program

A Groundwater Monitoring Program, shall be submitted to the Regional Waste Manager. The Groundwater Monitoring Program shall be designed by a Professional Engineer or a Hydrogeological Technologist licensed to practice in the Province of British Columbia, to establish with acceptable scientific accuracy, the groundwater flow pattern and nutrient removal capability of the soil to ensure reasonable notice of impending high phosphorus or nitrate levels that may adversely affect surface water, groundwater or domestic waterwells. The sampling, measurement frequency and analyses shall be conducted in accordance with the Groundwater Monitoring Program upon its written authorization by the Regional Waste Manager. The Groundwater Monitoring Program to be submitted to the Regional Waste Manager by December 31, 1997.

6.9 Soils Assessment Program

A ground assessment of any new areas to be irrigated, as shown in the "Irrigation Plan", shall be performed by a suitably qualified professional, using best current climate and soils data to substantiate that the land is capable of accepting reclaimed wastewater for irrigation purposes. This assessment is to include any suggested restrictions or recommendations that the suitably qualified professional deems necessary. This Soils Assessment shall be submitted to the Regional Waste Manager for review prior to the initial commencement of irrigation annually. Further review and ongoing soils assessments may be required by the Regional Waste Manager.

7. REPORTING

7.1 General Reporting

7.1.1 Maintain the monitoring data required in Section 6 for inspection.

7.1.2 The influent/effluent water quality analyses and flow data is to be submitted to the Regional Waste Manager such that they are received by the Regional Waste Manager within 30 days of the results being sent out by the testing agency.

7.1.3 Monitoring data shall be submitted in an electronic and/or printed format satisfactory to the Regional Waste Manager.

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Assistant Regional Waste Manager

7.2 Annual Reporting

7.2.1 Submit an Annual Report which includes a summary of the results of all sampling and monitoring programs as specified in this permit, data interpretation and trend analyses by a suitably qualified professional.

7.2.2 This report is to be in a format which is suitable for review by the public and/or other government agencies.

7.2.3 The first report is due on or before 60 days of the end of a calendar year for that year's monitoring. Raw data are to be attached as appendices to the report.

7.2.4 Maintain and submit records of the following as a part of the annual report:

7.2.4.1 Records of reclaimed wastewater balance, that is, the flows to and from the storage reservoir. This balance, must also include the freshwater make-up.

7.2.4.2 Records of the duration, intensity, property owner, acreage, location, and type of reclaimed wastewater irrigation.

7.2.4.3 Records of efforts to reduce infiltration, inflow and cross connections for inspection by the Regional Waste Manager or his designate.

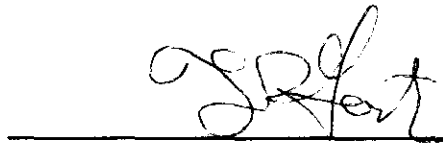
7.2.4.4 Records of efforts to administer the Influent Wastes By-law(s) for inspection by the Regional Waste Manager or his designate. Include as an attachment, any amendments to the Influent Wastes By-law(s) that have been made during the past year.

7.2.4.5 Copy of the Contingency Plan.

7.2.4.6 Copy of the Sludge Management Plan.

7.2.4.7 Copy of the Annual Flow Summaries.

7.2.4.8 Copy of the Annual Irrigation Summaries.



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Assistant Regional Waste Manager

APPENDIX A

Requirements of Reclaimed Wastewater Users

The holder of this Operational Certificate (The reclaimed wastewater supplier) shall be responsible for ensuring that the contractual agreement with the Reclaimed Wastewater User is in accordance with the Operational Certificate. A copy of this Appendix is to be provided to each user prior to the commencement of irrigation EACH YEAR.

1 GENERAL REQUIREMENTS

1.1 Plans - New Works

1.1.1 Plans for modifications and/or extensions to the existing reclaimed wastewater irrigation system shall be approved by a person qualified in the design of irrigation systems.

1.1.2 Design and construct the irrigation works in accordance with best current agricultural practice and the "Pollution Control Guidelines for Municipal Effluent Application to Land", dated January 1983, and any amendments thereto, issued by the Ministry of Environment of British Columbia, and also in accordance with the "B.C. Sprinkler Irrigation Manual", dated 1989, prepared by the B.C. Ministry of Agriculture and Fisheries.

1.2 Construction Criteria

1.2.1 All reclaimed water user valves, shall be of a type or secured in a manner that permits operation by only personnel authorized by each wastewater user. All piping, valves and outlets should be marked to differentiate reclaimed wastewater from domestic water. All reclaimed wastewater controllers, valves, etc., shall be affixed with reclaimed wastewater warning signs.

1.2.2 Use or installation of hose-bibbs on any irrigation system presently operating, or designated to operate with reclaimed wastewater, regardless of the hose-bibb construction or identification, is not permitted.

1.2.3 There shall be at least a 3 metre horizontal and a 0.3 metre vertical separation (with domestic water pipeline above the reclaimed water pipeline) between all pipelines transporting reclaimed water and those transporting domestic water.

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Assistant Regional Waste Manager

1.2.4 There shall be no connection between a potable water supply, irrigation water or industrial well, and piping containing reclaimed wastewater, except through an air gap separation or reduced pressure principle device.

1.3 Fencing

The Reclaimed Wastewater User MAY be required by the Regional Waste Manager to erect a fence around the disposal area to restrict public access. The height and type of fencing shall meet the approval of the Regional Waste Manager.

1.4 Signage

1.4.1 Prominent "NO TRESPASSING", signs shall be erected around agricultural and silvicultural sites irrigated with reclaimed wastewater, warning persons of the possible health hazard during the irrigation season and advising that the water used for irrigation is NOT POTABLE. The wording shall be in language or symbols readily comprehensible by the general public. eg. "NO TRESPASSING - RECLAIMED WASTEWATER - DO NOT DRINK"

1.4.2 Warning signs shall be posted in sufficient numbers and size and at strategic locations to advise the public that reclaimed water is being used. Additional signage may be required as directed by the Regional Waste Manager.

2 GENERAL REQUIREMENTS - RECLAIMED WASTEWATER IRRIGATION

2.1 Buffer Zones

2.1.1 The requirement for formal buffer zones surrounding lands irrigated with reclaimed wastewater is no longer in effect, however, a buffer zone may be specified by the Regional Waste Manager.

2.1.2 Reclaimed wastewater applied by irrigation shall not be applied to the ground any closer than 15 metres from the edge of flowing streams or bodies of water.

2.1.3 There shall be no reclaimed wastewater irrigated within 30 metres of any well or inground reservoir for domestic supply.

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Assistant Regional Waste Manager

2.2 Surface Runoff

2.2.1 There shall be no surface runoff of irrigated reclaimed wastewater from the irrigated lands.

2.2.2 The maximum ground slope shall not exceed 20% without the written consent of the Regional Waste Manager.

2.3 Surfacing Reclaimed Wastewater

2.3.1 Irrigation shall be managed in such a fashion as to preclude surfacing of irrigation tail water down slope of the point of irrigation.

2.3.2 Irrigation shall be managed as to prevent ponding.

2.4 Spray Irrigation Drift

2.4.1 Reclaimed wastewater shall be confined to the area designated and approved for reclamation. The reclaimed wastewater irrigation system shall be managed in such a fashion as to prevent aerosol drift from leaving the irrigated lands.

2.4.2 Precautions shall be taken to ensure that reclaimed water will not have contact with any facility or area not designated for reclamation, such as passing vehicles, buildings, domestic water facilities, fruit and vegetable gardens, or food handling facilities.

2.4.3 Drinking water facilities shall be protected from direct or wind blown reclaimed wastewater spray.

2.5 Irrigation Rates

2.5.1 Irrigation rates shall not exceed the rates given in "B.C. Sprinkler Irrigation Manual", dated 1989, prepared by the B.C. Ministry of Agriculture and Fisheries.

2.5.2 Soils of the irrigated lands shall be monitored periodically or as otherwise directed by the Regional Waste Manager or the Town of Oliver, to prevent saturation, erosion, and instability .

T.R. Forty, P.Eng.
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2.6 Agricultural Products Lag Time

2.6.1 A three day lag time is required before uninspected livestock intended for human consumption are permitted on areas irrigated with reclaimed wastewater. No lag time is required if livestock are subjected to the federal meat inspection program.

2.6.2 A six day lag time is required before dairy cattle are permitted in areas irrigated with reclaimed wastewater.

2.6.3 A three day lag time, after irrigation has ceased, is required before a crop intended for animal feed is harvested.

2.7 Insect and Vector Control

Adequate measures shall be taken to prevent the breeding of insects and other vectors of health significance, and the creation of odors, slimes or unsightly deposits.

2.8 Irrigation of Public Areas

2.8.1 Irrigation on golf courses or cemeteries shall only be practised when the public are not present.

2.8.2 Golf score cards shall indicate that reclaimed wastewater is used for irrigation on the golf course lands.

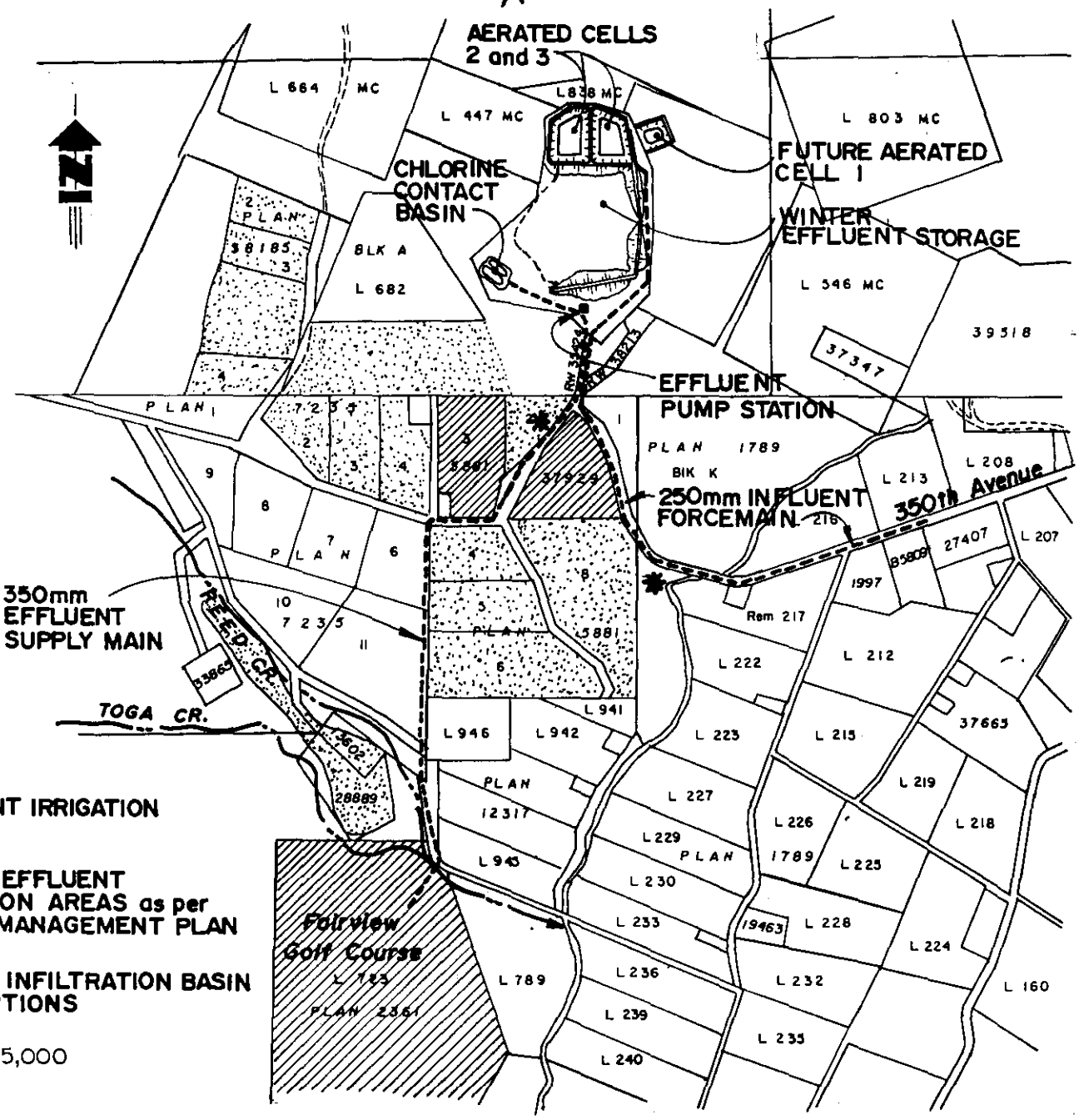
T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Province of British Columbia
Ministry of Environment, Lands and Parks

BC Environment

ENVIRONMENTAL PROTECTION DIVISION

SITE PLAN A



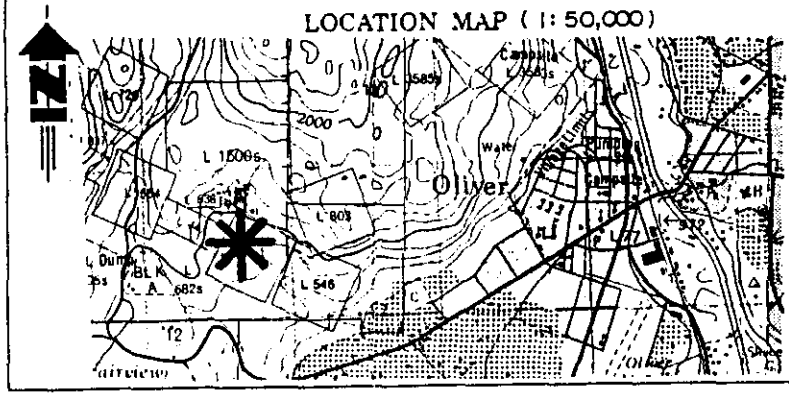
EFFLUENT IRRIGATION AREAS

FUTURE EFFLUENT IRRIGATION AREAS as per WASTE MANAGEMENT PLAN

FUTURE INFILTRATION BASIN SITE OPTIONS

Scale 1: 15,000

LOCATION MAP (1: 50,000)



(FOR OFFICE USE ONLY)

December 14, 1995
Date Issued

Date Amended

T.R. Forty, P.Eng.
Assistant Regional Waste Manager

Page

Permit No./Approval No. PE 13717

ENV 1987

APPENDIX B

Influent and Effluent Sampling Data

Table 1-2: Influent Sampling Analysis

Year	Date	Total Phosphorus (mg/L)	Ortho Phosphate (mg/L)
1996	Mar. 22	5.44	
	Sep. 12	5.18	
1997	Mar. 19	5.87	
1998	Mar. 18	5.6	
	Sep. 9	5.89	
1999	Mar. 11	6.66	
	Sep. 23	4.89	
2000	Mar. 23	6.48	4.69
	Sep. 28	8.67	3.04
2001	Mar. 22	4.57	2.3
	Sep. 19	4.13	1.88
2002	Mar. 19	4.53	3.84
	Sep. 10	4.52	2.55
2003	Mar. 10	3.78	3.78
	Sep. 30	4.48	4.38
2004	Mar. 16	5.23	4.76
	Sep. 14	5.15	3.75
2005	Mar. 22	5.24	4.63
	Oct. 5	6.74	5.58
2006	Sep. 14	7.05	5.96
2007	Mar. 13	5.03	6.43*
	Sep. 11	6.03	5.03
2008	Sep. 3	7.44	3.3
2009	Mar. 5	8.18	3.84
	Sep. 1	5.31	1.38
2010	Mar. 9	4.26	0.558
	Sep. 2	3.36	2.16
2011	Mar. 8	4.9	0.316
	Sep. 8	11.00	0.859
2012	Mar. 1	6.16	2.23
	Sep. 11	7.76	3.72
2013	Mar. 7	5.75	2.57
	Sep. 11	4.62	1.89
2014	Mar. 5	4.28	0.82
	Sep. 17	3.82	not tested
2015	Mar. 11	5.36	2.66
	Sep. 16	4.55	2.96
2016	Mar. 7	4.17	1.21
	Sep. 6	2.35	0.36*
2017	Mar. 7	3.77	2.42
	Sep. 6	4.69	2.13
2018	Mar. 7	5.37	1.95
	Sep. 4	5.89	1.83
2019	Mar. 11	5.34	1.97
	Sep. 3	5.42	2.32
2020	Mar. 2	4.97	1.89
	Sep. 1	5.45	2.09
2021	Mar. 15	6.76	1.7
	Sep.14	5.59	2.28
2022	Mar. 1	6.88	2.12
	Sept 6.	Not Tested	1.26
2023	Mar. 16	5.32	2.00
	Sept . 12	5.32	2.27
Average for Period of Record		**5.48**	**2.70**

* Suspected error

phosphate as P, not orthophosphate, not included in average

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
January	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1917.00							
2	1370.80							
3	1634.50							
4	1515.80							
5	1614.90							
6	1456.80							
7	1612.20							
8	1722.00							
9	1536.60							
10	1618.50							
11	1672.90							
12	1518.00							
13	1708.30							
14	1476.00							
15	1672.80							
16	1511.90							
17	1540.40							
18	1637.90							
19	1606.30							
20	1552.00							
21	1902.40							
22	1339.40							
23	1476.10							
24	1640.80							
25	1524.00							
26	1605.20							
27	1536.50							
28	1706.70							
29	1346.00							
30	1470.50							
31								
		47443	1581	0.0	0		0.0	#DIV/0!
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2 & 3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Missing January 31, 2023

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
February	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	3,197							
2	1,512							
3	1,486							
4	1,618							
5	1,378							
6	1,491							
7	1,465							
8	1,651							
9	1,637							
10	1,572							
11	1,591							
12	1,354							
13	1,466							
14	1,660							
15	1,553							
16	1,540							
17	1,582							
18	1,499							
19	1,319							
20	1,395							
21	1,649							
22	1,462							
23	1,580							
24	1,569							
25	1,269							
26	2,525							
27	1,447							
28	1,503							
29								
30								
31								
		44969	1606	0	0		0.0	#DIV/0!
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
March	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1640.8					0.0		
2	1625.1					0.0		
3	1468.8					0.0		
4	1807.8					0.0		
5	1322.6					0.0		
6						0.0		
7	3106.2					0.0		
8	1524.6					0.0		
9	1601.0					0.0		
10	1580.3					0.0		
11	1854.3					0.0		
12	1305.6					0.0		
13	1501.5					0.0		
14	1515.3					0.0		
15	1606					0.0		
16	1796.3					0.0		
17	1560.5					0.0		
18	1314.7					0.0		
19	2188.4					0.0		
20	1513.6					0.0		
21	1524.8					707.9		
22	1596					2070.2		
23	1560.5					105.1		
24	1542.2					0.0		
25	1857.4					0.0		
26	1404.5					0.0		
27	1154.9					331.7		
28	1818.1					0.0		
29	1545.2					434.4		
30	1659.2					400.0		
31	1671.9					375.9		
		49168	1639	0	0		4425.6	143
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
April	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1916					335.0		
2	1374					554.5		
3	1529.8					571.3		
4	1640.5					541.7		
5	1563.7					0.0		
6	1480.4					334.8		
7	1607					767.2		
8	1757					1046.9		
9	1037.0					2476.9		
10	1450					3009.9		
11	1487.6					1048.4		
12	1564.2					1077.7		
13	1663.4					1108.2		
14	1573.2					833.3		
15	1997					1616.3		
16	1033.5					824.2		
17	1920.0					1683.8		
18	1597.8					1777.8		
19	1486					1087.7		
20	1270					781.4		
21	1684					598.5		
22	1147.5					354.9		
23	2376.6					932.6		
24	1596.5					1193.1		
25	1568.4					821.9		
26	1550.4					1415.0		
27	1442.3					386.6		
28	1518.9					1416.4		
29	1921.3					1617.2		
30	1783.3					1155.6		
31								
		47537	1585	0	0		31368.9	1046
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
May	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1550.8					768.9		
2	1561.3					1208.5		
3	1592.9					1199.8		
4	1107.4					1561.7		
5	2050.5					1279.3		
6	2005.9					0.0		
7	2092					756.7		
8	1575.8					734.5		
9	1589.7					1312.7		
10	1501.6					1759.4		
11	1255.8					1709.4		
12	2447.3					1638.9		
13	1224.2					878.5		
14	1513.6					1183.0		
15	1548.6					382.0		
16	1632.7					0.0		
17	1657.4					1038.0		
18	1751.3					967.3		
19	1918.5					1581.4		
20	1435.2					1318.7		
21	2385					743.8		
22	1845					961.2		
23	1634.5					1539.3		
24	1609.3					1603.0		
25	1886.3					2098.5		
26	1697.8					2501.0		
27	1981					2479.0		
28	2056.8					3024.3		
29	1695.5					2354.5		
30	1755.2					3294.7		
31	1242.1					3423.0		
		52801	1703	0	0		45300.9	1461
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
June	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	2457.3					3567.9		
2	2006.3					2816.4		
3	1730					798.5		
4	2895.7					354.3		
5	1985.8					1096.6		
6	1434.1					1352.4		
7	1892.2					1016.7		
8	1853.2					2641.9		
9	1936.8					2112.3		
10	2092.4					1099.1		
11	1476.7					1115.7		
12	2162.2					2071.9		
13	1508.9					1864.7		
14	1992.1					896.6		
15	1546					1233.9		
16	1990.7					1097.1		
17	1593					357.8		
18	2479					805.6		
19	1778					849.9		
20	1228.9					828.1		
21	1934.4					1179.4		
22	1596					2213.1		
23	1396.6					2418.5		
24	2368.7					2488.8		
25	2262.2					3047.8		
26	1753.3					3244.6		
27	1501.7					3918.2		
28	1790.6					4179.2		
29	1868.8					3509.1		
30	1966.7					3920.2		
31								
		56478	1883	0	0		58096.0	1937
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
July	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	2294.0					3377.8		
2	1620.0					3842.9		
3	1840					3607.2		
4	1422.0					3031.2		
5	1626.7					1125.9		
6	2226.1					1662.8		
7	1804					2732.0		
8	1638					1052.6		
9	2531.0					1348.2		
10	1882					3099.3		
11	1435.4					2952.8		
12	1541.1					3066.3		
13	2009					3190.0		
14	1203.1					3385.3		
15	2160.5					3513.1		
16	2337.6					3684.2		
17	1935.1					3539.7		
18	1365.6					4271.7		
19	1917.3					4408.4		
20	1941.4					4703.0		
21	1791.0					3960.3		
22	1975.5					4460.3		
23	2301.6					3895.9		
24	1801.5					4750.7		
25	1315.8					4475.7		
26	1551.9					4706.0		
27	2134.0					4796.9		
28	1483					3625.6		
29	1802.1					5016.2		
30	2339.6					3760.0		
31	1757.0					4500.7		
		56983	1838	0	0		109542.7	3534
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

August	High Lift Station			Chlorine Booster Station				
	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1485.6					4399.1		
2	1768.6					4411.8		
3	1114.2					3612.6		
4	2191					3855.2		
5	2168.2					4594.9		
6	2212.5					3857.3		
7	1684.2					3722.2		
8	1314					4111.3		
9	1780.7					3532.3		
10	1802					2916.7		
11	1880.8					2666.7		
12	1520.4					2755.5		
13	2607.0					2737.6		
14	1574.2					2774.7		
15	987.3					2885.6		
16	2257.9					3508.5		
17	1357.3					2896.3		
18	2129.8					3577.6		
19	1491.9					3418.4		
20	2331					2536.6		
21	1602.5					2770.0		
22	1372.9					2526.5		
23	1766.9					2550.9		
24	1299.4					1275.6		
25	1213.7					1950.6		
26	2245					2586.3		
27	2100.0					2305.9		
28	1823.5					2847.7		
29	1355.7					3510.1		
30	1556					2654.6		
31	1762.3					3863.2		
		53757	1734	0	0		97612.3	3149
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
September	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1706.7					2595.8		
2	1808.3					2744.3		
3	2461.5					2682.4		
4	1541.3					2480.5		
5	1522.8					3205.5		
6	1789.1					2868.4		
7	1445.4					3762.6		
8	1978.3					2465.1		
9	1895.8					3155.6		
10	1886					3863.5		
11	1695.3					2942.7		
12	1663					3003.1		
13	1561.5					3111.0		
14	1521.7					1896.9		
15	1692.6					577.5		
16	1621.4					883.2		
17	2028.0					1119.2		
18	1646.5					630.1		
19	1549.3					560.1		
20	1550.7					1151.8		
21	1509.2					2240.3		
22	1669.1					1674.0		
23	1737.3					2119.4		
24	1896.8					2585.5		
25	1595					1148.6		
26	1514.4					202.5		
27	1570.0					1262.6		
28	1975.7					2524.1		
29	1490.4					2297.1		
30	1764					1835.2		
31	1850							
		53137	1714	0	0		63588.6	2120
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
October	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1493.7					2472.3		
2	1850					541.7		
3	1657.5					181.3		
4	1478.3					900.8		
5	1520.4					2005.6		
6	1681.7					1896.5		
7	1471.7					2154.9		
8	1711.8					1523.7		
9	1397					650.8		
10	1638.8					186.4		
11	1677.5					927.2		
12	1499.1					2071.2		
13	1518.3					1968.6		
14	2077.8					2172.1		
15	1381.4					2134.2		
16	1568.5					1534.7		
17	1439.2					896.8		
18	1487.5					181.9		
19	1616.2					0.0		
20	1484.9					188.4		
21	1894.7					0.0		
22	1401.1					176.8		
23	1443.7					0.0		
24	1553.3					180.0		
25	1480.5					0.0		
26	1438.7					181.2		
27	1576.6					248.5		
28	1720					3.3		
29	1489.7					0.0		
30	1429.7					0.0		
31	1512.7					0.0		
		48592	1567	0	0		25378.9	819
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
November	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1532.8							
2	1490.1							
3	1712							
4	1533							
5	1533.9							
6	1156.7							
7	1557.4							
8	1399.3							
9	1617.2							
10	1328.2							
11	1304.2							
12	1847.6							
13	1402.9							
14	1569.1							
15	1346.5							
16	1429.2							
17	1478.8							
18	1681.5							
19	1667							
20	1383							
21	1411.6							
22	1539.4							
23	1366.9							
24	1492.1							
25	1788.3							
26	1317.6							
27	1403.8							
28	1541.3							
29	1548.3							
30	1528.9							
31								
		44909	1497	0	0		0.0	#DIV/0!
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2 & 3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Originally report as 18476 and corrected to 1847.6.

Originally report as 14029 and corrected to 1402.9.

Town of Oliver Sewer Flows - PE - 13717

	High Lift Station			Chlorine Booster Station				
December	Daily Flow m3/day	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Total Monthly m3/day	Monthly Average m3/day
1	1480							
2	1441.7							
3	1343.3							
4	1397.7							
5	1599.6							
6	900.1							
7	1447.3							
8	1934.5							
9	12459							
10	1974.9							
11	1445.4							
12	1532.7							
13	1533							
14	1458.9							
15	1502.7							
16	1600.6							
17	1325.8							
18	1434.8							
19	1477.5							
20	1485.0							
21	1512.1							
22	1507.5							
23	1100							
24	1817.5							
25	1417.3							
26	1522.9							
27	1352.5							
28	1499.3							
29	1484.4							
30	1392							
31	1447.9							
		56828	1833	0	0		0.0	#DIV/0!
	OC Limit	n/a	2050m3/day				n/a	n/a

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2 & 3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

TOWN OF OLIVER
Summary of Monthly Sewer Flows

	High Lift Station		Chlorine Booster Station			
	Total Monthly m3/day	Monthly Average m3/day	Irrigation m3/day (1)	Rapid Infiltration m3/day (2)	Total Daily m3/day (3)	Monthly Average m3/day
Jan	47443	1581	0	0	0	#DIV/0!
Feb	44969	1606	0	0	0	#DIV/0!
Mar	49168	1639	0	0	0	#DIV/0!
Apr	47537	1585	0	0	13061.085	933
May	52801	1703	0	0	47098.042	1519
Jun	56478	1883	0	0	91850.26	3062
Jul	56983	1838	0	0	103176.04	3328
Aug	53757	1734	0	0	91772.44	2960
Sep	53137	1714	0	0	51665.388	1722
Oct	48592	1567	0	0	17620.126	568
Nov	45870	1480	0	0	1744.6512	218
Dec	56828	1833	0	0	0	#DIV/0!
Total	613563		0	0	417988.04	
Average	1681				1145	

Notes:

(1) These readings have been calculated by subtracting the flows read at the rapid infiltration site, from the flows read on the main meter in the Chlorine Booster Station. Both the irrigation flows and the rapid infiltration flows travel through this meter.

(2) These flows are read at two, 2 inch water meters located at the rapid infiltration site except during the non-irrigation season when the rapid infiltration readings are read from the meter located in the Chlorine Booster Station.

(3) These are the flows that have been read at the main meter located in the Chlorine Booster Station.

Confirmed by Town via email on 2024-02-09

TOWN OF OLIVER

PE-13717 - Effluent Sampling - Cell #3, prior to storage reservoir - EMS ID E222151

	Date	BOD5 Carbonaceous	TSS	Nitrate	Nitrite	Phosphate	Nitrate & Nitrite	Nitrogen	Nitrogen	Ammonia	Kjeldahl	Phosphorus	Phosphorus
OC Limit			60 mg/L	(as N)	(as N)	(as P)	(as N)	(Total)	(Organic)	Total (as N)		Total (as P)	Total Dissolved
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Frequency		monthly	monthly	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually	semi-annually
January	3	16.8	12.8										
February	6	15.6	31										
March	6	16	26.4										
March	6			0.067	0.029	3.65	0.0953	37.70	4.21	33.40	37.60	5.4	4.77
March	6					2.00						5.32	
April	24	15.7	36.4										
May	1	15.4	33										
June	5	9.9	18										
July	4	12	26.4										
July	10	7.8	39										
August	8	<6.9	16.2										
September	5			1.24	2	4.02	3.24	25.4	1.55	20.6	22.2	7.3	6.82
September	5					2.27						5.32	
September	5	15.9	10										
October	3	3.7	6.7										
November	6	4.1	10										
December	4	10.4	13.2										

PE - 13717 - Influent Sampling - Equalization Basin - EMS ID E222152
Influent Sampling

Semi- Annual

*March 9, 2022 Sample has been preserved for TP in the laboratory and the holding time has been extended.
*March 12, 2022 The sample was prepared and /or analyzed past the recommended holding time.

APPENDIX C

Reclaimed Water Storage Reservoir Level, Flow and Volume Calibration Curve

TOWN OF OLIVER

RECLAIMED WATER USE BY CUSTOMER
(Readings in m3)

LOCATION	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AIRPORT	221400.0	238400.0	203100.0	161600.0	131800.0	201050.0	147688.3	153841.2	185686.70	124891.7	115743.3	98510.9	101779.8	99601.3	69142.8	19567.0	32276.3	28254.4	39423.6
CEMETERY	14015	14125	17325	17000	18215	13311.2	16338.73	14607.36	19159.94	15996.1	14354.03	14843.27	13399.67	12651.17	16986.46	17498.75	18291.44	18335.58	20577.27
PUBLIC WORKS YARD	7720	12535	7580	5575	5795	6155.8	5163.96	6408.64	7085.72	7393.22	7380.1	8094.8	8340.74	6260.65	5939.63	8319.96	5387.7	6103.28	4488.44
103 STREET PARK	4555	9255	7090	5280	6345	5377.24	6232.1	6621.86	8051.37	8749.04	7647.12	8359.52	**1030.6***	5927.68	8858.46	1244.97	11676.42	8089.04	7393.94
SOSS										48457	4873.58	0	1.55	0	25743.75	27419.66	24693.89	8545.39	24002.73
ALONSO						3495.31	1670.9	7014.59	6714.65	3892.74	3850.51	2364.03	2498.39	1794.43	9240	6012.39	0	0	0
HUGGINS						15536.5	3787.05	2872.33	1290.33	meter off	8554.16	0	0	0	4614.7	0	0	0	0

Other Users Not Metered:

- Fairview Mountain Golf Course
- Fairview Park (new 2015)

*103 STREET PARK 2021 value amended from 8576.02 to 11676.42

TOWN OF OLIVER
STORAGE RESERVOIR
LEVEL DATA

	JANUARY		FEBRUARY		MARCH		APRIL	
DAY	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*
1			444.86	306,000				
2	444.17	256,000						
3							446.06	373,000
4								
5								
6					445.69	354,000		
7			444.98	315,000				
8								
9								
10	444.36	271,000					446.12	376,000
11								
12								
13					445.80	360,000		
14			445.17	327,000				
15								
16								
17								
18	444.58	286,000					446.16	378,000
19								
20					445.91	365,000		
21			445.38	339,000				
22								
23								
24								
25	444.73	298,000					446.06	373,000
26								
27					446	370,000		
28			445.52	346,000				
29								
30								
31								

* Volume in Storage above Elevation 439.00
Elevation 439.00 is minimum 60 day average operating level

DAY	MAY		JUNE		JULY		AUGUST	
	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*
1	445.97	368,000						
2					444.70	293,000		
3								
4								
5			445.68	354,000				
6							443.48	212,000
7								
8	446.00	370,000			444.50	280,000		
9								
10								
11								
12			445.42	346,000			443.26	198,000
13								
14								
15	445.95	367,000			444.36	271,000		
16								
17								
18								
19			445.20	330,000			442.91	176,000
20								
21								
22	445.87	363,000			444.1	252,000		
23								
24								
25								
26			444.98	315,000			442.83	172,000
27								
28								
29	445.8	360,000			443.84	234,000		
30								
31								

* Volume in Storage above Elevation 439.00
Elevation 439.00 is minimum 60 day average operating level

DAY	SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*	ELEVATION	VOLUME IN STORAGE*
1								
2	442.82	172,000						
3								
4								
5							443.99	246,000
6			442.69	164,000				
7					443.29	200,000		
8								
9	442.73	166,000						
10			442.72	166,000				
11								
12							444.12	253,000
13								
14								
15					443.74	228,000		
16	442.53	156,000						
17			442.85	173,000				
18								
19							444.27	264,000
20								
21								
22					443.77	230,000		
23	442.49	154,000						
24			443.00	182,000				
25								
26							444.43	275,000
27								
28								
29					443.88	237,000		
30	442.6	160,000						
31			443.14	191,000				

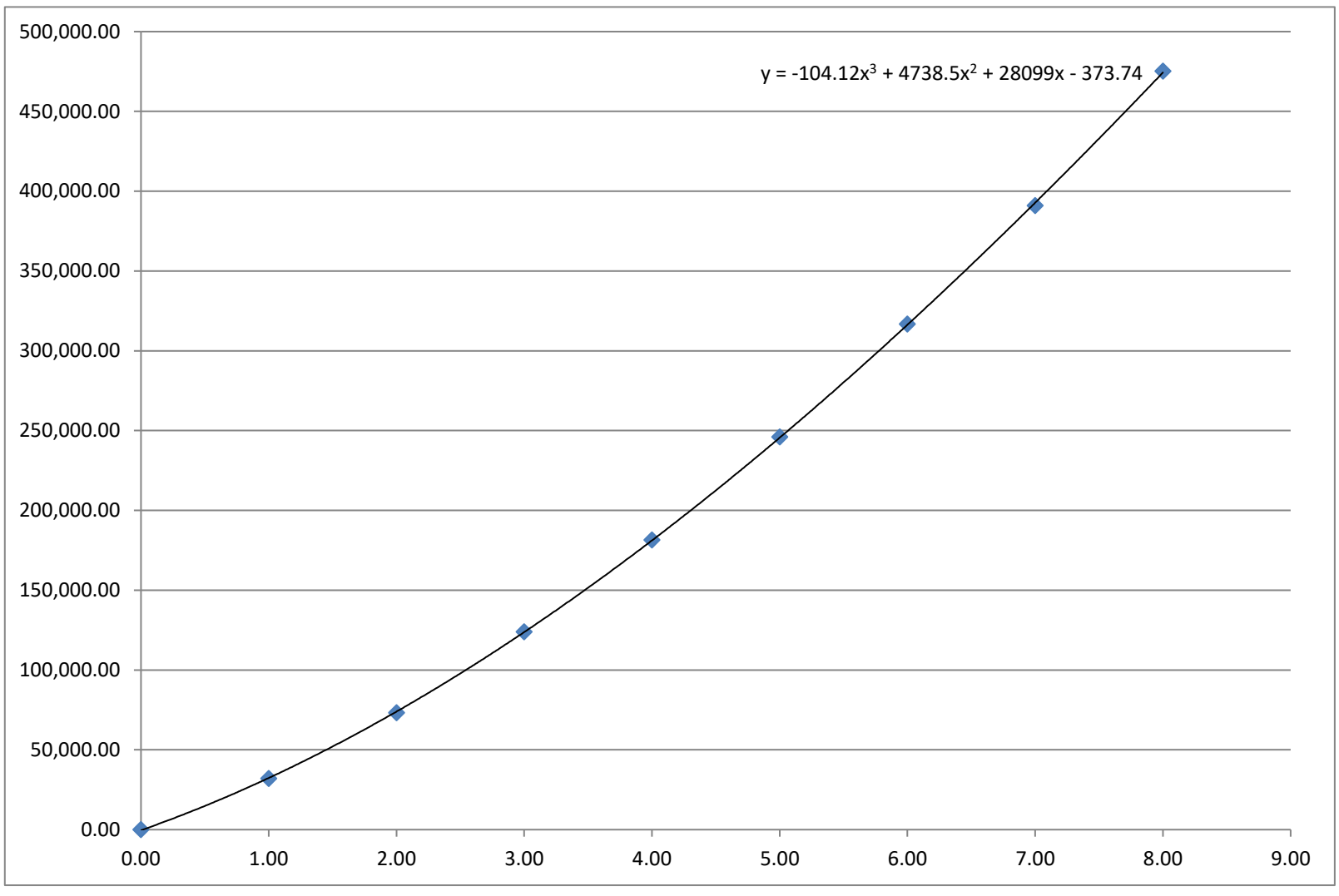
* Volume in Storage above Elevation 439.00
Elevation 439.00 is minimum 60 day average operating level

Topping Lake Elevation

	max	min
elev	446.16	442.49
stor.	378,000	154,000

Town of Oliver - Effluent Storage Reservoir - Volume Capacity

Reservoir Elevation (m)	Elevation above 439.0m	Total Operating Storage (cu. m.)	Calculated Volume (m^3)	% Difference from Measured
439.00	0.00	0.00	-373.74	N/A
440.00	1.00	32,000.00	32359.6	1%
441.00	2.00	73,300.00	73945.14	1%
442.00	3.00	124,000.00	123758.16	0%
443.00	4.00	181,600.00	181173.94	0%
444.00	5.00	246,000.00	245567.76	0%
445.00	6.00	316,800.00	316314.9	0%
446.00	7.00	391,000.00	392790.64	0%
447.00	8.00	475,200.00	474370.26	0%



APPENDIX D

Irrigation Plan

May 4, 2020 Authorization Number: 13717

VIA EMAIL: sgoodsell@oliver.ca; JTrottier@oliver.ca; NAlteen@true.bc.ca; sunderwood@true.bc.ca

The Corporation of the Village of Oliver
PO Box 638
Oliver, BC V0H 1T0

Dear Authorization Holder:

Re: Clause 1.8 of OC 13717 - Authorizaton of Irrigation Plan for All New Areas

This letter is in response to a letter dated February 25, 2020 from TRUE Consulting, sent on behalf of the Corporation of the Village of Oliver with Operational Certificate (OC) 13717, that requested authorization of an irrigation plan of all new areas of land to be irrigated. An updated site plan was included to support the request. The Ministry of Environment and Climate Change Strategy acknowledges receipt and has found the submission of the irrigation plan adequate.

In accordance with Clause 1.8 of OC 13717, the director authorizes the irrigation plan of all new areas of land identified in the letter from February of 2020.

If there are any questions about this letter, please contact Kristina Moseley at 250.490.2239 or email kristina.moseley@gov.bc.ca.

Yours truly,

Bryan Vroom
for director, *Environmental Management Act*

BRITISH COLUMBIA

Reference: 66483

AUG 06 2002

Her Worship Mayor Linda Larson
and Councillors
Town of Oliver
PO Box 638
Oliver BC V0H 1T0

Dear Mayor Larson and Councillors:

I am pleased to inform you that the update to the Town of Oliver's Liquid Waste Management Plan (LWMP) is hereby approved in principle in accordance with section 18 of the *Waste Management Act*.

I recognize that your LWMP update was rather complicated and required the concerted efforts of your staff and your consultant to complete. I commend your efforts and those of your consultant and wish you well in the continued implementation of your LWMP.

The implementation and administration of the LWMP will require resolution of details involving financial, engineering, operational and administrative elements, and I request that you continue to work closely with ministry staff on plan implementation details. I am sending a copy of this letter to my colleague, the Minister of Community, Aboriginal and Women's Services (formerly Municipal Affairs), the Honourable George Abbott so that he is aware of my support for your funding request for the continued implementation of this plan.

Best regards,

Joyce Murray
Minister

cc: The Honourable George Abbott, Minister of Community, Aboriginal and Women's Services

FILE:
ROUTING: Vault file w/ WMP.
COMMENTS:

COPIES: TRU, BH
Reg Aug 26

Ministry of
Water, Land
and Air Protection

Office of the Minister

Mailing Address:
Parliament Buildings
Victoria BC V8V 1X4

December 13, 2018 Our File: 306-088-005

Ministry of Environment & Climate Change Strategy
102 Industrial Place
Penticton, B.C.
V2A 7C8

Attn: Regional Waste Manager

Dear Sir/Madam:

RE: *Town of Oliver – Update to Reclaimed Water Irrigation Plan - OC PE-13717*

The Town of Oliver requests approval from the Ministry for expansion of their reclaimed water irrigation system as authorized in Operational Certificate PE-13717. The current works authorized within this Operational Certificate are outlined in Site Plan A, dated December 14, 1995. The areas include:

Location	Legal Description
Fairview Mountain Golf Course	Lot 1, Plan KAP62023, DL2450S, SDYD
Alonso	Lot A, Plan KAP37929, Sec 12, Township 54, SDYD
Huggins	Lot 3, Plan KAP5881, Sec 12, Township 54, SDYD

The Town requests authorization for expansion of the irrigation system. The expansion areas are shown in Figure 1 enclosed herein. They are identified as Reclaimed Water Irrigation Expansion Areas (2006). Their location and legal descriptions of the expansion areas are as follows.

Location	Legal Description
High School Park	- Lot 2H, DL 2450S, SDYD, Townsite of Oliver - Southern portion of Block C, DL 2450S, SDYD, Irrigation Lateral SRW shown on PL 330, Lot 2G BLF52 on Oliver Townsite map
Fairview Park	- Lot 2J, DL 2450S, SDYD, Townsite of Oliver - Block 34, DL 2450S, SDYD, Townsite of Oliver, Incl Closed Rd PL B7567
Oliver Secondary School	Block 32, Plan KAP4297, DL 2450S, SDYD
Public Works	Lot 2, Plan KAP54258, DL 2450S, SDYD
Airstrip	Lot 2, Plan KAP38137, DL 2450S, SDYD
Cemetery	Lot 1, Plan KAP 24065, DL 2450S, SDYD, Portion L 203A

.../2

Total reclaimed water use is measured by a flow meter located at the booster station, adjacent to the reclaimed water storage reservoir. Meters have also been installed at the Cemetery, Airport, Public Works Yard, Alonso Property, Southern Okanagan Secondary School, High School Park and Huggins Property for the purposes of measuring total reclaimed water use at each location. There is no flow meter on the irrigation service to the Fairview Mountain Gold Course. Usage is calculated as the total annual irrigation, less all other metered usage. Annual reporting of the irrigated areas will be consistent with the reporting requirements as outlined in PE-13717 and include the total usage, crop type, irrigated area, irrigation application rate, and irrigation period.

Groundwater monitoring plans are established for the airport and Fairview Mountain Gold Course sites, the two largest users of reclaimed water. Sampling data is included in annual reporting.

As per the operational certificate, no reclaimed wastewater will be applied to the ground any closer than 15 metres from the edge of flowing streams or bodies of water. Additionally, no reclaimed wastewater is irrigated within 30 metres of any well or inground reservoir for domestic supply.

Should questions arise or for additional information, please do not hesitate to contact the undersigned.

Yours truly,

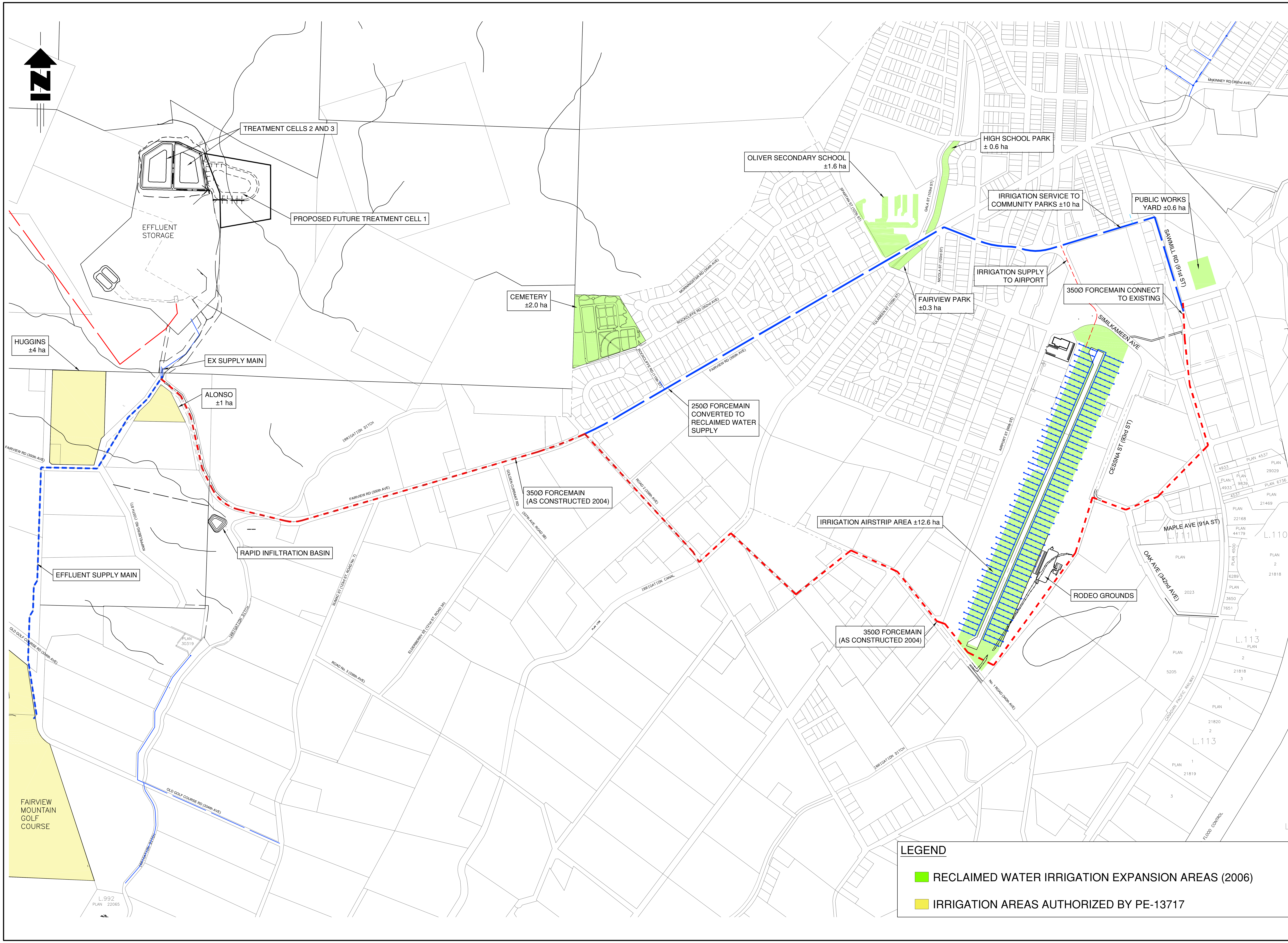
TRUE CONSULTING

Steve Underwood, P. Eng.

Enclosures

NA/

R:\Clients\300-399\306\306-088-005\02 Correspondence\Outgoing\To MoE\306-088-005-MoE-Oliver Treated Effluent Irrigation Area Expansion Notification-2018 12 13.docx



No.	DATE	DESCRIPTION	BY	APP'D

ISSUES / REVISIONS

CONSULTANT SEAL

TRUE CONSULTING
201 - 2079 Falcon Road ▪ Kamloops BC ▪ V2C 4J2
tel 250.828.0881 ▪ fax 250.828.0717
info@TRUE.bc.ca

BRITISH COLUMBIA Town of Oliver

SANITARY SEWER SYSTEM

OVERALL PLAN RECLAIMED WATER SYPPLY SYSTEM AND IRRIGATION AREAS

SCALE N.T.S. (11x17)

PROJECT REFERENCE No. 306-088-005

DRAWING No.

FIG 1

SHEET 1 OF 1

ISSUE/REV.

January 17, 2019 Our File: 306-088-005

Ministry of Environment & Climate Change Strategy
102 Industrial Place
Penticton, B.C.
V2A 7C8

Attn: Jen Pape, Environmental Protection Officer, Municipal Liquid Waste

Dear Ms. Pape:

RE: *Town of Oliver – Irrigation Area Expansion Notification - OC PE-13717*

In response to your email dated January 10, 2018, the following supplemental information is provided to support the Update to Reclaimed Water Irrigation Plan submitted to the Ministry on December 13, 2018.

1. The Town currently provides treated reclaimed water to the Alonso and Huggins vineyards for irrigation purposes. The Huggins service is turned off, but this service provides a backup source to the user in the event of a drought period. Both vineyards use drip irrigation to water crops. There are no supplemental food crops in the irrigation area.

2. The following drawings of the Town of Oliver Effluent Infiltration Basin are enclosed herein:
    a. General Location Map (Dwg. No. 306-1201-05)
    b. Effluent Infiltration Basin Plan and Profile (Dwg. No. 306-1322-03)

Should questions arise or for additional information, please do not hesitate to contact the undersigned.

Yours truly,

TRUE CONSULTING

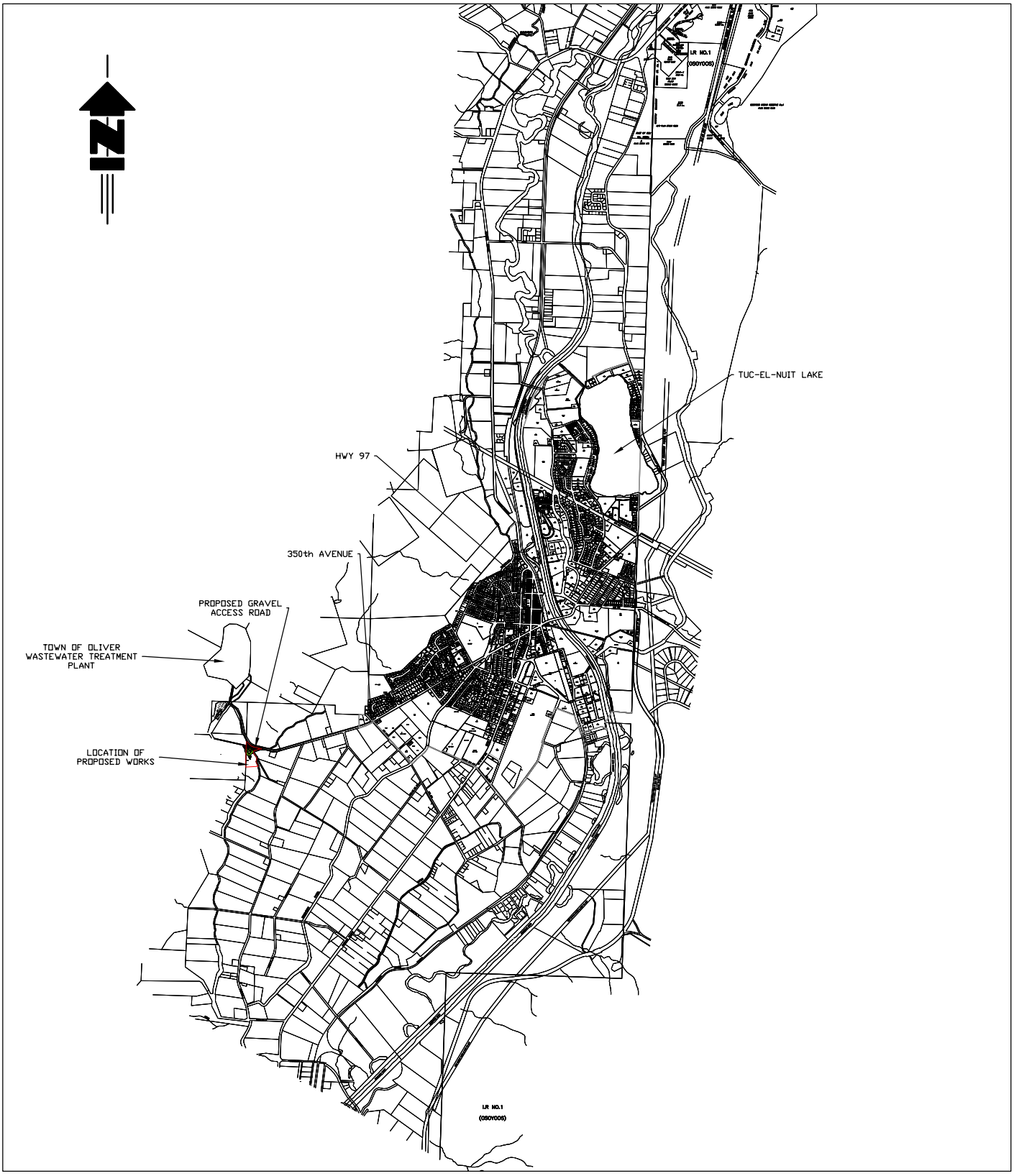
Natalie Alteen

Natalie Alteen, EIT

Enclosures

NA

R:\Clients\300-399\306\306-088-005\02 Correspondence\Outgoing\To MoE\Irrigation Area Expansion Notification\306-088-005-MoE-Oliver Treated Effluent Irrigation Area Expansion Notification-2019 01 17.docx



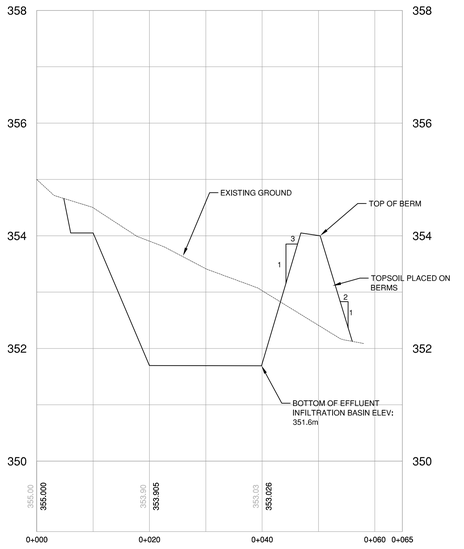
TOWN OF OLIVER

GENERAL LOCATION MAP

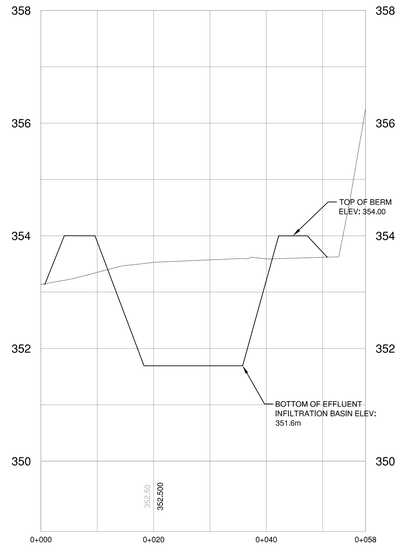
TRUE CONSULTING

DSGN. BY:	
SCALE:	1:50,000
DWG. NO.:	306-1201-05
REV.:	
DWN. BY:	KK
DATE:	NOV 2011

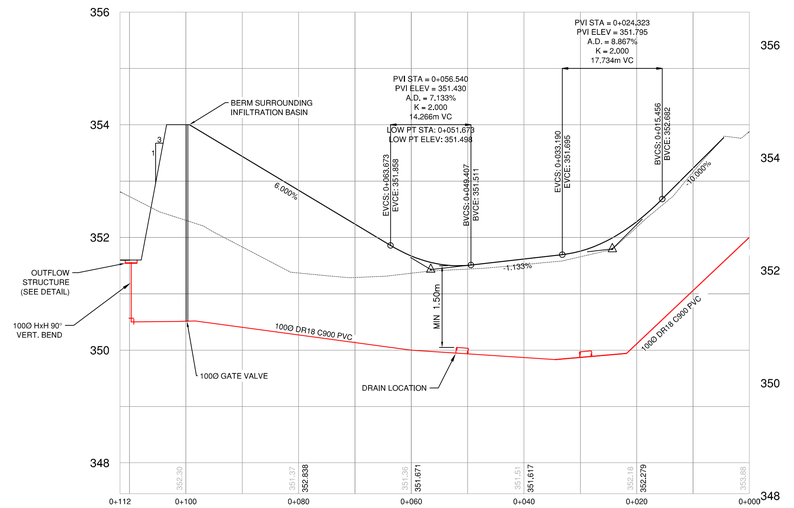
FILE: x:\landprojects2007\306-1201p\dwg\306-1201.dwg

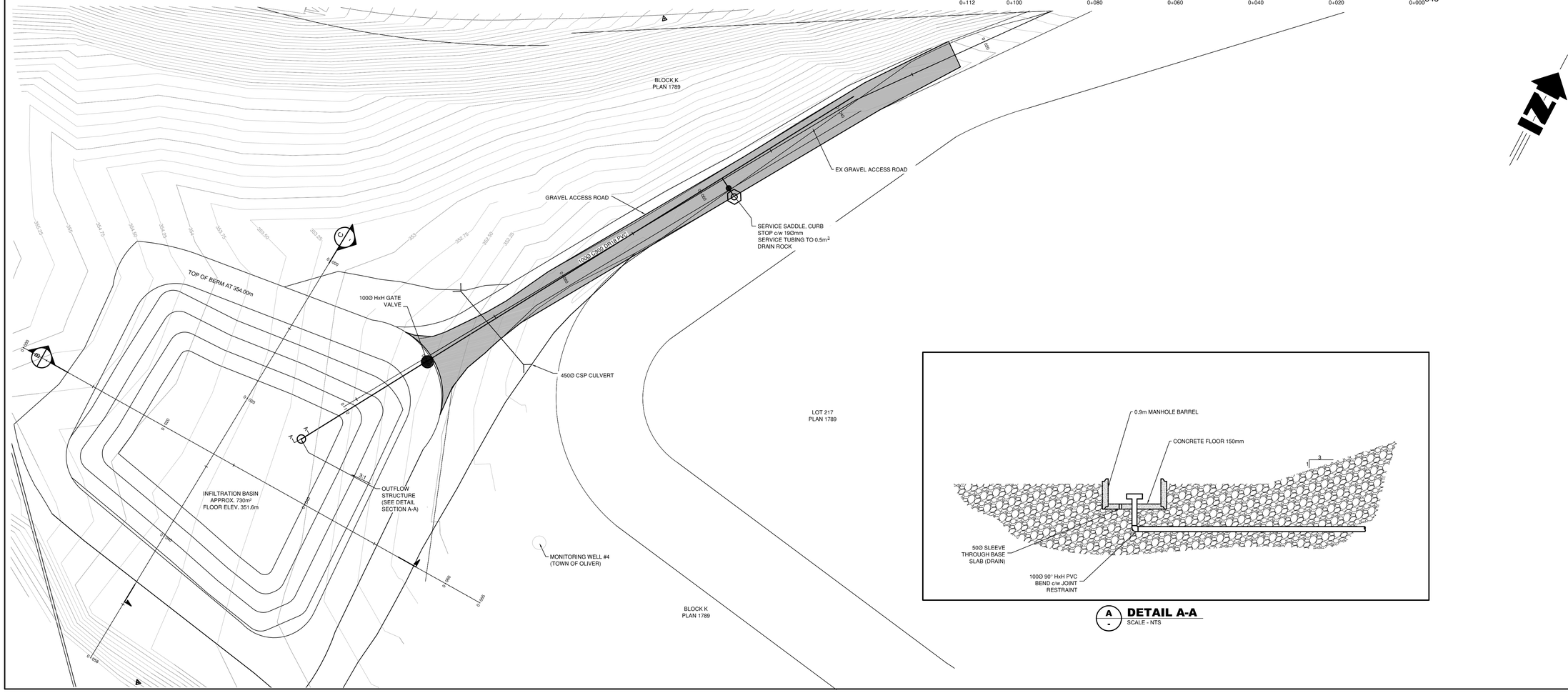


B - **EFFLUENT INFILTRATION BASIN SECTION B-B**
SCALE - 1:50



C - **EFFLUENT INFILTRATION BASIN SECTION C-C**
SCALE - 1:50





A - **DETAIL A-A**
SCALE - NTS

No.	DATE	DESCRIPTION	BY	APPD
2	SEPT 25/14	RECORD DRAWING	SP	SU
1	SEPT 25/13	ISSUED FOR TENDER	SP	SU

ISSUES / REVISIONS

CONSULTANT SEAL

TRUE CONSULTING
201 - 2079 Falcon Road ≡ Kamloops BC ≡ V2C 4J2
tel 250.828.0881 ≡ fax 250.828.0717
info@TRUE.bc.ca

TOWN OF OLIVER

EFFLUENT INFILTRATION BASIN

PLAN AND PROFILE

SCALE	1:250 1:50
DESIGN BY	TRU/SU
DRAWN BY	WF/SP
DATE	SEPTEMBER 2013
PROJECT REFERENCE No.	306-1201
DRAWING No.	306-1322 **03**
SHEET	03 OF 03
REVISION	02

February 25, 2020 Our File: 306-088-007

Ministry of Environment and Climate Change Strategy
102 Industrial Place
Penticton, B.C.
V2A 7C8

Attn: Jen Pape, Environmental Protection Officer, Municipal Liquid Waste

Dear Ms. Pape:

RE: *Town of Oliver – Update to Reclaimed Water Irrigation Plan – OC-PE-13717*

The Town of Oliver submitted an approval request to the Ministry for expansion of their reclaimed water irrigation system as authorized in Operational Certificate ("OC") PE-13717 on December 13, 2018 (please see attached). This letter serves as a notification for additional expansion.

CURRENT WORK AUTHORIZED WITHIN PE-13717 (ISSUED: DECEMBER 14, 1995)

Works authorized within the OC, as described in Site Plan A of the permit, are outlined in the Table 1.

TABLE 1 AUTHORIZED WORKS WITHIN OC PE-13717 SITE PLAN A (DATED DECEMBER 14, 1995)

Location	Legal Description
Fairview Mountain Golf Course	Lot 1, Plan KAP62023, DL2450S, SDYD
Alonso	Lot A, Plan KAP37929, Sec 12, Township 54, SDYD
Huggins	Lot 3, Plan KAP5881, Sec 12, Township 54, SDYD

As described in the response letter submission to the Ministry on January 17, 2019 (please see attached), the Alonso and Huggins properties utilize reclaimed water irrigation for their vineyards. The Huggins service is turned off but provides a backup source to the user in the event of a drought period. Both vineyards utilize drip irrigation to water crops and there are no supplemental food crops in the irrigation area.

EXPANSION AREA NOTIFICATION (DECEMBER 13, 2018)

On December 13, 2018, the Town requested authorization for expansion of the irrigation system as described in Table 2. These areas are currently being irrigated.

…/2

TABLE 2 PROPSED EXPANSION AREA BY TOWN IN NOTIFICATION TO MINISTRY (DATED DECEMBER 13, 2018)

Location	Legal Description;
Gala Street Linear Park	Lot 2H, DL 2450S, SDYD, Townsite of Oliver; Southern portion of Block C, DL 2450S, SDYD, Irrigation Lateral SRW shown on PL 330, Lot 2G BLF52 on Oliver Townsite map
Fairview Park	Lot 2J, DL 2450S, SDYD, Townsite of Oliver; Block 34, DL 2450S, SDYD, Townsite of Oliver, Incl Closed Rd PL B7567
South Okanagan Secondary School	Block 32, Plan KAP4297, DL 2450S, SDYD; Block 48, Plan KAP2507, DL2450S, SDYD
Public Works	Lot 2, Plan KAP54258, DL 2450S, SDYD
Oliver Municipal Airport	Lot 2, Plan KAP38137, DL 2450S, SDYD
Cemetery	Lot 1, Plan KAP 24065, DL 2450S, SDYD, Portion L 203A

EXPANSION AREA NOTIFICATION

The Town wishes to notify the Ministry of an expansion to the South Okanagan Secondary School irrigation area. This irrigated area has increased from ± 1.6 ha to ± 5.4 ha as show on Figure 1-1 enclosed herein.

SYSTEM METERING

To date, total reclaimed water use is measured by a flow meter located at the booster station, adjacent to the reclaimed water storage reservoir. To measure total reclaimed water use at each location meters have been installed at the Cemetery, Oliver Municipal Airport, Public Works Yard, Alonso Property, Southern Okanagan Secondary School, Gala Street Linear Park, Huggins Property and most recently at Fairview Park.

There is no flow meter on the irrigation service to the Fairview Mountain Golf Course therefor usage is calculated as the total annual irrigation, less all other metered usage. Annual reporting of the irrigated areas is consistent with the reporting requirements as outlined in PE-13717 and include the total usage, crop type, irrigated area, irrigation application rate, and irrigation period.

GROUNDWATER MONITORING

Groundwater monitoring plans are established for the airport and Fairview Mountain Golf Course sites, the two largest users of reclaimed water. Sampling data is included in annual reporting.

As per the operational certificate, no reclaimed wastewater will be applied to the ground any closer than 15 metres from the edge of flowing streams or bodies of water. Additionally, no reclaimed wastewater is irrigated within 30 metres of any well or inground reservoir for domestic supply.

Should questions arise or for additional information, please do not hesitate to contact the undersigned.

Yours truly,

TRUE CONSULTING

Natalie Alteen

Natalie Alteen, EIT

Enclosures
NA/slf
R:\Clients\300-399\306\306-088-005\02 Correspondence\Outgoing\To MoE\Irrigation Area Expansion Notification\306-088-007-MoE-Oliver Treated Effluent Irrigation Area Expansion Notification-2020 02 25.docx

TREATMENT CELLS 2 AND 3

EFFLUENT STORAGE

PROPOSED FUTURE TREATMENT CELL 1

HUGGINS ±4 ha

EX SUPPLY MAIN

ALONSO ±1 ha

CEMETERY ±2.0 ha

OLIVER SECONDARY SCHOOL EXPANSION AREA 2019 ±3.4 ha

OLIVER SECONDARY SCHOOL ±1.6 ha

KIWANIS PARK ±0.6 ha

PARK ±0.6 ha

HIGH SCHOOL PARK ± 0.6 ha

OLIVER PARKS &RECREATION BALL DIAMONDS ±8.6 ha

IRRIGATION SERVICE TO COMMUNITY PARKS ±10 ha

PUBLIC WORKS YARD ±0.6 ha

IRRIGATION SUPPLY TO AIRPORT

350Ø FORCEMAIN CONNECT TO EXISTING

FAIRVIEW PARK ±0.3 ha

2500 FORCEMAIN CONVERTED TO RECLAIMED WATER SUPPLY

350Ø FORCEMAIN (AS CONSTRUCTED 2004)

IRRIGATION AIRSTRIP AREA ±12.6 ha
FUTURE LEASE AREA ±9.8 ha

RAPID INFILTRATION BASIN

EFFLUENT SUPPLY MAIN

350Ø FORCEMAIN (AS CONSTRUCTED 2004)

RODEO GROUNDS

FAIRVIEW MOUNTAIN GOLF COURSE

L.992 PLAN 22065

LEGEND

- EXISTING RECLAIMED WATER IRRIGATION AREAS *AUTHORIZED BY PE-13717
- RECLAIMED WATER IRRIGATION EXPANSION AREAS (DEC 2018)
- RECLAIMED WATER IRRIGATION EXPANSION AREA (2019)
- FUTURE RECLAIMED WATER IRRIGATION EXPANSION AREAS

No.	DATE	DESCRIPTION	BY	YYYY

ISSUES / REVISIONS

CONSULTANT SEAL

TRUE CONSULTING
201 - 2079 Falcon Road ≈ Kamloops BC ≈ V2C 4J2
tel 250.828.0881 ≈ fax 250.828.0717
info@TRUE.bc.ca

Town of Oliver
CANADA'S WINE CAPITAL

SANITARY SEWER ANNUAL REPORT

OVERALL PLAN RECLAIMED WATER SYPPLY SYSTEM AND IRRIGATION AREAS

SCALE	N.T.S. (11x17)
DESIGN BY	TRU
DRAWN BY	NA
DATE	JANUARY 2018
PROJECT REFERENCE No.	306-088-005
DRAWING No.	FIG 1-1
SHEET	1 OF 1
ISSUE/REV.	

APPENDIX E

Yearly Precipitation Data

Seasonal Precipitation Summary

Oliver STP

YEAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	SEASON TOTAL (mm)
1992	41.4	8.0	64.8	62.0	9.8	2.2	11.8	200.0
1993	50.6	34.5	48.0	67.9	39.5	18.4	14.8	273.7
1994	42.4	30.8	37.8	12.2	33.9	17.4	24.8	199.3
1995	17.5	17.9	37.6	10.2	22.6	7.5	10.6	123.9
1996	15.8	62.2	27.9	24.2	5.2	52.3	28.2	215.8
1997	35.3	41.8	87.9	47.6	18.5	63.4	29.0	323.5
1998	29.4	79.1	31.2	25.1	12.3	2.9	33.7	213.7
1999	20.1	28.9	40.3	15.5	44.1	1.2	11.7	161.8
2000	10.4	24.8	25.8	26.7	4.5	14.4	19.6	126.2
2001	37.6	16.4	39.4	32.2	15.0	13.6	24.1	178.3
2002	8.7	43.0	4.8	9.8	0.3	9.4	7.3	83.3
2003	29.4	18.4	12.9	0	0.0	11.4	21.7	93.8
2004	27.9	30.7	56.0	7.8	27.7	32.3	48.9	231.3
2005	12.4	41.1	48.4	2.9	1.3	2.9	22.4	131.4
2006	20.8	52.0	36.0	14.2	0.1	8.7	12.4	144.2
2007	4.9	3.2	24.1	29.0	2.8	12.2	11.6	87.8
2008	5.0	3.65	27.5	5.0	19.9	2.7	9.9	73.7
2009	4.8	26.8	13.4	28.6	27.8	20.2	39.5	161.1
2010	20.0	55.9	68.3	14.6	9.1	38.9	13.7	220.5
2011	12.5	69.6	24.4	18.7	0.0	3.4	22.4	151.0
2012	39.9	14.8	78.7	46	0.3	2	40.8	222.5
2013	16.5	30.5	35.0	8.6	36.6	47.5	5.6	180.3
2014	15.3	24.4	42.8	25	12.2	19.3	35.9	174.9
2015	2.2	54.4	13.2	17	19.9	3	26.3	136.0
2016	5.8	14.9	38.5	25.9	1.2	16.4	62.8	165.5
2017	40.5	61.2	21.2	0	0.0	4.8	5.3	133.0
2018	50.4	31.3	53.2	31.4	1.5	9.4	33.1	210.3
2019	8.0	3.7	6.9	10.4	6.1	80.9	11.1	127.1
2020	20.5	57.6	61.3	7.9	2.8	5.8	30.2	186.1
2021	1.8	2.0	17.6	4.6	2.9	7	32	67.9
2022	5.3	29.1	45.8	29.3	10.0	5.4	2.6	127.5
2023	13.5	42.1	5.1	14.2	13.6	14.7	13.6	116.8
Avg.	20.8	33.0	36.7	21.1	12.5	17.2	22.4	163.8

1992 to 1996 data from Environment Canada
1997 - present data compiled from Town of Oliver daily records

APPENDIX F

Sludge Monitoring (Quality) Data and Management Plan

TOWN OF OLIVER
PE-13717 - Effluent Sludge - Cell #2

ANALYTICAL REPORT - Sampled on November 29, 2023

			WALP Guidelines			
Parameter	***Unit***	**CELL 2 EFF SLUDGE-1**	**Agricultural Low Grade**	**Agricultural High Grade**	**Retail Low Grade**	**Retail High Grade**
Aluminum	ug/g					
Antimony	ug/g					
Arsenic	ug/g	6.5	75	75	75	75
Barium	ug/g					
Beryllium	ug/g					
Bismuth	ug/g					
Cadmium	ug/g	1.8	25	20	20	5-20
Calcium	ug/g					
Chromium	ug/g	49.2				
Cobalt	ug/g	4.12	150	150	150	150
Copper	ug/g	1,210				
Iron	ug/g					
Lead	ug/g	17.0	1000	500	500	500
Magnesium	ug/g					
Manganese	ug/g					
Mercury	ug/g	1.38	10	5	5	5
Molybdenum	ug/g	14.6	20	20	20	20
Nickel	ug/g	21.6	200	180	180	180
Phosphorus	ug/g					
Potassium	ug/g					
Selenium	ug/g	12.3	14	14	14	14
Silver	ug/g					
Sodium	ug/g					
Strontium	ug/g					
Tellurium	ug/g					
Thallium	ug/g					
Tin	ug/g					
Titanium	ug/g					
Vanadium	ug/g					
Zinc	ug/g	1,170	2500	1850	1850	1850
Zirconium	ug/g					

Total Solids	%	4.7
Volatile Solids	%	71.9

Sludge Management Plan

Town of Oliver

March 2019

Project No. 306-088-006

TRUE

ENGINEERING ■ PLANNING ■ URBAN DESIGN ■ LAND SURVEYING

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1	1	Town of Oliver
	1	Ministry of Environment
1	1	TRUE Consulting

Revision Log

Revision #	Revised by	Date	Issue / Revision Description

Report Submission

Report Prepared By:

Natalie Alteen, EIT
Project Engineer

Report Reviewed By:

PROFESSIONAL ENGINEER PROVINCE OF BRITISH COLUMBIA T. R. UNDERWOOD

Terry Underwood, P. Eng.
Project Engineer
Mar 13 / 2019

R:\Clients\300-399\306\306-088-006\05 Reports\2019 Sludge Management Plan\306-088-006-Oliver Sludge Management Plan-March 2019.docx

Table of Contents

APPENDICES

List of Figures

List of Acronyms

BC MOE	British Columbia Ministry of Environment,
OC	Operational Certificate
OCP	Official Community Plan
OMRR	Organic Matter Recycling Regulation
TRUE	TRUE Consulting

Units of Measure

ft	feet
km	kilometre
L/d	Litres per day
L/m	Litres per minute
L/s	Litres per second
lpcd	Litres per capita per day
m	metre
mg/L	milligrams per Litre
mm	millimetre
NTU	Nephelometric Turbidity Units
psi	pounds per square inch
USgpm	US gallons per minute

Referenced Reports

Lambourne Environmental	“Lagoon Survey Report for Town of Oliver Cells 1 & 2,” December 2011
Canadian Council of Ministers of the Environment	“Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage,” 2012
TRUE Consulting	“Sanitary Sewer System 2017 Annual Report,” February 2018

1.0 Background

The wastewater treatment facility for the Town of Oliver has been in operation since 1965. From 1965 to 1984, the Town operated a treatment plant for municipal wastewater and discharged treated effluent to the Okanagan River. In response to regulatory agency requirements for reduced phosphorus loadings to surface water courses in the Okanagan River Basin, the Town constructed effluent storage and land disposal systems in the Fairview area in 1983 and 1984. Since 1985, the Town has utilized treated effluent in the Fairview area with the principle end user of treated effluent being the Fairview Mountain Golf Course. In 1995, a two-cell aerated lagoon system was constructed in the Fairview area (see Figure 1).

The existing treatment facility is comprised of influent screening, equalization storage, a two-cell aerated lagoon treatment system, winter effluent storage, chlorination contact chamber and reclaimed water irrigation.

In accordance with the Town of Oliver's Operation Certificate (OC) No. PE-13717 issued under the provisions of the Waste Management Act, the Town has prepared a Sludge Management Plan as it relates to the wastewater treatment facility. This document outlines the monitoring, management and beneficial use of the Town's municipal biosolids.

2.0 Characterization of Sludge

The Town of Oliver's wastewater collection system is generated primarily from residential and commercial buildings. The sludge is comprised of a mixture of fecal matter, organic and inorganic materials. Trace amounts of heavy metals, solvents, and petroleum products may enter the system as a result of municipal activities.

Source control initiative are imperative as they ensure the wastewater treatment facility functions properly, operator health and safety are protected, and the quality of treated effluent/biosolids is maintained. This mandate is included in the Town's Official Community Plan (OCP) Bylaw 1370, which prioritizes public awareness for potential groundwater contamination and health hazards related to the discharge of toxic substances into the municipal drainage system.

3.0 Sludge Sampling and Monitoring Program

3.1 System Design

Effluent is pumped from the equalization basins to the aerated lagoon Cells No. 2 and No.3 via the High Lift Station. Biological degradation and sedimentation of suspended solids is a primary function of the aerated lagoons system. Treatment is accomplished through the stabilization of organic wastes by bacteria and algae. Waste products include carbon dioxide (CO_2), ammonia and phosphates.

The aerated lagoon treatment system is comprised of two treatment cells, with aeration allowing for microbial degradation of organic material. Effluent enters Cell No.2 and then proceeds to secondary treatment in Cell No.3.

Cell No.2 provides primary digestion of influent. As such, sludge accumulates around the perimeter of the cell in the low current areas. This material sinks to the bottom of the cell, forming a sludge blanket. The capacity of Cells No.2 and No.3 are as follows. Each lagoon has a maximum operating depth of 5.3 m.

Cell No.2

Surface Area at FWL 11,000 m^2
Storage Volume 37,600 m^3

Cell No.3

Surface Area at FWL 10,100 m^2
Storage Volume 38,200 m^3

Anaerobic degradation occurs in areas with low dissolved oxygen and sunlight. Anaerobic bacteria produce water, carbon dioxide, nutrients, ammonia, alkalinity, hydrogen sulfide and methane as waste products.

On this basis, solids accumulations will occur in the aerated lagoons and require removal from the system. Excessive solids accumulations in the cells may result in odours, visible masses of floating solids on the lagoon surface, reduced detention time and degraded effluent quality.

The rate at which solids accumulate in the aerated cells and the point at which accumulations may significantly impair the operation of the system varies. Piping and other design provisions have been made for a future third cell construction east of the existing lagoons (see Figure 2).

Overall, the Operational Certificate for the system required the Town of Oliver to develop a strategy or plan to ultimately deal with sludge accumulations in the aerated cells. The OC specifies the following limits:

- Discharge rate – 2,200 m^3/day
- 5 Day Biochemical Oxygen Demand – 45 mg/L
- Total Suspended Solids – 60 mg/L

3.2 Theoretical Sludge Production Rates

Sludge accumulation rates within the system are dependent on the following variables:

- Amount of suspended solids entering the system in the raw sewage. Influent suspended solids to the treatment system are reduced as the influent is screened prior to entering the aerated lagoons.
- Operating temperature. As sludge accumulates on the floor of each cell, anaerobic digestion processes occur. This results in volatile solids removal and corresponding reductions in accumulated solids volume and mass. The digestion process is temperature dependent. Recognizing the geographic location of Oliver and generally "hot" summer weather conditions, anaerobic digestion processes on the floor of the cells represent a mechanism for significant sludge volume and mass reductions.
- Hydraulic load to the system and residence time.
- Sludge characteristics and compression. As sludge accumulates on the bottom of the lagoons, compression of the actual sludge mass will occur. This results in higher solids concentrations expressed as a % solids. Literature suggests that compression mechanisms are time and characteristic dependent.

Recognizing that influent is screened, there are favorable conditions for in-pond anaerobic digestion. The cells are adequately sized to allow for associated compression processes and there is no chemical addition to the system. Therefore, sludge accumulation within the lagoon cells is expected to be lower that other systems within the region.

A theoretical sludge accumulation rate calculation is presented herein. This rate is based on an assumed sludge production rate of 0.2 kg/kg of BOD removal. This sludge production rate is typical of extended aeration treatment plants in which digestion processes represent a mechanism for internal sludge quantity reductions:

	Influent BOD Loading	180 mg/L
	Average Influent Flow	2000 m^3/d
	Total BOD Daily Loading	360 kg/d
Cell No. 2	Average BOD removal Cell #2- 70% of influent	250 kg/d
	Theoretical Sludge Production- 250 x 0.2	50 kg/d
	Sludge Volume/day= 50 kg @ 10% solids	0.50 m^3/d
	Sludge Volume/year	182 m^3/yr
Cell No. 3	Average BOD removal Cell #3- 70% of Cell #2 effluent	80 kg/d
	Theoretical Sludge Production- 80 x 0.2	16 kg/d
	Sludge Volume/day= 16 kg @ 10% solids	0.16 m^3/d
	Sludge Volume/year	60 m^3/yr

The preceding calculations suggest that the sludge accumulation rate in Cell No.2 will occur at a rate at least three times greater than Cell No.3. This has been shown in accumulation surveys and described in Section 4.0.

3.3 Monitoring Methods

Sludge accumulation are to be measured by direct and indirect monitoring as described herein.

3.3.1 Direct Monitoring

Direct sludge monitoring should be undertaken every two years. It is important that sampling is completed at the same time each year. In this manner, inaccuracies related to temperature dependent digestion process will be eliminated. September or October are suggested as the most appropriate periods to undertake a sludge accumulation survey.

The primary objective is to define the amount of sludge accumulation by probing the cell bottom and recording the apparent sludge thickness and location on a plan of the lagoon system. Each successive monitoring activity should attempt to probe approximately the same locations to assist in the determination of the accumulation rate.

Anticipated primary areas of sludge accumulation will be in the general vicinity of the inlet piping in the relatively quiescent areas between air diffusers. Sludge will generally not accumulate in the vicinity of the aerators.

The design depth of the lagoons (5.3m) will make in-cell measurements of sludge accumulation less than straightforward. Sludge accumulation measurements may be simplified to some extent by lowering the operating levels of Cells No.2 and No.3 by lowering the slide gate in hydraulic structure S-3. Lowering of operating levels should be undertaken on a gradual basis.

Any deviation from normal operation (i.e. lowering of operating levels) will require notification and approval of the Ministry of Environment.

3.3.2 Indirect Monitoring

Indirect Monitoring of sludge accumulation can be accomplished via analysis of treated effluent water quality. If treated effluent water quality exceeds the permitted discharge concentration limits, assessment of the sludge accumulation depth is triggered.

3.4 Sludge Sampling

Which final disposal method for sludge removed from the lagoons will be dependent on the characteristics of the sludge and require approval from the MOE. To enable evaluation of sludge disposal options and to support a proposal/plan submission for approval to the MOE, it is recommended that a minimum of two sludge samples be taken during accumulation surveys for physical and chemical analysis.

Samples may be obtained by a pipe-type probe or at depth samplers. Analysis of the sludge samples should include the following parameters:

% solids	
% volatile solids	
Fecal Coliform*	MPN/g*
Arsenic	(mg/kg)*
Cadmium	(mg/kg)
Chromium	
Cobalt	
Copper	(mg/kg)
Mercury	(mg/kg)
Molybdenum	(mg/kg)
Nickel	(mg/kg)
Lead	(mg/kg)
Selenium	(mg/kg)
Zinc	(mg/kg)

*On a dried weight basis

All parameters listed above should be analyzed during the initial phases of the sludge monitoring program. As data is compiled some parameters may be identified as not representing a concern, and in consultation with the MOE, the scope of the analysis accordingly reduced.

The chemical and physical characteristics of the final sludge product will be a major factor in determining the disposal method which will be acceptable to the MOE. The Town must follow the Organic Matter Recycle Regulation (OMRR) process and quality criteria for the desired end use of the bioldoids.

3.5 Sludge Removal

Sludge accumulation monitoring will provide data on when scheduling of sludge removal should be undertaken. Excessive sludge accumulations have the potential to significantly impact the performance of the system. Conditions that suggest accumulated sludge may be negatively impacting the system will be evident in the south-east corner area of Cell No 2, in the vicinity of the influent pipe. Indicators of excessive sludge accumulations in the area may include:

- Black color of wastewater
- Low dissolved oxygen concentrations
- Floating sludge masses
- Localized odours
- What appears to be “air bubbles” covering the lagoon surface during warm weather periods.

Sludge removal options which may be considered by the Town include the use of specialized equipment while the system is in operation, or alternatively draining of the cell for removal using excavation equipment. Equipment that can be utilized include: a float or barge mounted “dredge” type pump, floating discharge line, and on-shore portable sludge dewatering system.

The second approach involves cell draining and removal using excavation equipment. Utilization of this approach related to Cell No.2 is described herein.

3.5.1 Cell No.2 Draining Procedure

The procedure to drain Cell No.2 for sludge removal with a reduced water content is described as follows:

i. Lower the operating level of Cells No.2 and No.3 by gradually lowering the overflow weir gate in hydraulic structure S-3. This procedure should be undertaken over a 3 to 5 week period. When complete, the adjustable slide gate in hydraulic structure S-3 will be in the fully down position.

   IMPORTANT NOTE: Lowering of the operating level of the system is required to reduce the hydraulic head difference across the common berm between the cell to be drained and the cell remaining in operation. Failure to reduce the system operating level as described herein may result in localized instability and soil slumping at the toe of the slope of the common berm in the drained cell.

ii. The system should then be operated in the Cell No.2 bypass mode.

iii. The air supply to the aeration system in Cell No.2 should be shut off by closing isolation valves on the air header. Cautionary aspects related to the aeration system include:

   - Ensure air flow to diffuser units remining in service do not exceed the manufacturer’s recommended maximum per unit flow.
   - Confirm blower operation remains within the accepted operation range specified by the manufacturer.

   Operation of the aeration system with partial flow release to the pressure relief valve on the blower discharge piping may be necessary to maintain operation of the aeration system in Cell No.3 within ranges specified by both the blower and aeration system manufacturer.

iv. Reduce the operating level in Cell No.2 by opening valve V-5. Opening of valve V-5 will enable partial draining of Cell No.2, by gravity**,** to the winter effluent storage reservoir. Valve V-5 should be gradually opened such that the drop in liquid level in Cell No.2 does not exceed 150 mm per day.

v. Set up portable pumping equipment and completed draining of Cell No.2. Ideally, the discharge from the drainage pump will be directed into the Cell No.3 side chamber of hydraulic structure S-2. In this manner, contents from Cell No.2 will be provided treatment in Cell No.3 prior to discharge into the storage reservoir. Care

should be given to ensure the discharge piping is securely fastened to hydraulic structure S-2.

CAUTION: During draining operation of Cell No.*2, simply pumping the contents across the common berm with the discharge piping laid on the berm is not recommended. The pump discharge, in this case, could result in serious erosion and localized instability of the exposed and/or submerged berm slope in Cell* No.*3.*

Locating the pump at the north end of Cell No.2 is recommended to minimize operational problems associated with sludge plugging the pump suction and/or sludge being drawn into the pump and simply relocated to Cell No.3.

vi. Upon completion of draining, allow the exposed sludge accumulation to air dry. The period necessary for air drying is difficult to estimate. An air-drying period of at least one month should be anticipated in the schedule planning of the desludging operation. The objective of the drying period is to reduce the water content of accumulated sludge, thereby making removal by excavation equipment more straightforward.

vii. Disconnect air feeder lines from laterals and remove from the lagoon. Temporary caps should be placed on cell lateral outlets to prevent sludge or other foreign material from entering the lateral piping.

CAUTION: Care is essential to ensure foreign material does not enter the lateral piping when the air feeder lines are removed. If foreign material ends up in the lateral piping, it will be carried after reassembly by air flowing into the diffusers, leading to clogging.

While the lagoon cell is drained, the aeration system should be thoroughly inspected and any corroded or "suspect" components replaced. Replacement of the air diffuser membranes and ropers to the retrieval floats is straightforward with the cell drained and should be scheduled to be done concurrent with the desludging operation.

viii. Remove accumulated sludge from Cell No.2. The most appropriate equipment required for the removal operation will be determined on-site based on the apparent water content of the material and the actual amount and location of the accumulations in the cell.

The preceding procedure would be followed in reverse to return the cell to service after de-sludging. In reassembling the aeration system, the manufacturer's design details should be complied with in terms of connection fittings and anchor locations. It is important that the actual diffuser units be installed at the same level within tolerances recommended in the manufacturer's Operation and Maintenance Manual. The lagoon cell should be filled to "just submerge" all aeration components at which time all laterals should be air tested by carefully partially opening ("cracking") isolation valves on the air supply header.

CAUTION: The aeration system in Cell No.2 should not be returned to normal operation by opening of the isolation valve on the air header until the wastewater elevations in Cells No.2 and No.3 are equal.

3.6 Sludge Disposal

In British Columbia, the quality and beneficial use of biosolids for land application and composting is regulated under the Organic Matter Recycling Regulation (OMRR). This regulation applies to the construction and operation of composting facilities, as well as the production, distribution, storage, sale and use or land application of biosolids and compost.

When planning sludge removal operations, a written notification is to be provided to the Regional Waste Manager at least two weeks prior to the commencement of de-sludging operations. The notification should include the following requirements as outlined in the OMRR:

- An estimate of the total sludge volume based on monitoring data.
- Classification of the biosolids and an overview of the proposed treatment process.
- Analytical characterization derived from sampling data.
- A description of the proposed disposal method.

To a major extent, the analytical characterization of the sludge will determine what disposal options and sites will be acceptable to the Ministry. Compliance with pathogen and metal testing treatment objectives will be required. If the intended use is land application, a Land Application Plan (LAP) must be developed and signed by a Qualified Professional prior to any land application. Information required in this plan is set out in Schedule 7 of the OMRR.

Consistent with the strategy of the Town's wastewater treatment and disposal system, the objective of the sludge disposal method evaluation should be to provide the greatest flexibility possible for beneficial use. Options which may be considered consistent with this objective include:

3.6.1 Class A Biosolid

Composting to result in a Class A biosolid. These biolsolids must meet all of the following requirements:

- Schedule 1, Pathogen Reduction Processes;
- Schedule 2, Vector Attraction Reduction;
- Schedule 3, Pathogen Reduction Limits;
- Section 3 of Schedule 4, Quality Criteria;
- Schedule 5, Sampling and Analyses-Protocols and Frequency;
- Schedule 6, Record Keeping.

Class A biosolids can be applied in quantities greater than 5 cubic meters per year per parcel of land in accordance with the LAP and the soil substance concentrations specified in Schedule 10.1

of the OMRR. They must only be distributed in volumes that do not exceed 5 cubic meters per vehicle per day. If they are distributed in sealed bags for retail purposes, they are not to exceed 5 cubic meters, with no restrictions on the number of bags distributed per vehicle per day. They may be distributed in volumes greater than 5 cubic metres to composting facilities or biosolids growing medium facilities.

3.6.2 Class B Biosolids

Composting to result in a Class B biosolid. These biosolids must meet all of the following requirements:

- Schedule 1, Pathogen Reduction Processes;
- Schedule 2, Vector Attraction Reduction;
- Schedule 3, Pathogen Reduction Limits;
- Column 3 of Schedule 4, Quality Criteria;
- Schedule 5, Sampling and Analyses-Protocols and Frequency;
- Schedule 6, Record Keeping.

Class B biosolids must be applied to land in accordance with the LAP, the methodology specified in Schedule 8 and the soil substance concentrations specified in Schedule 10.1 of the OMRR. Class B biosolids may be distributed to composting facilities with no volume restrictions. They may be distributed to a biosolids growing medium facility with no volume restrictions if they meet the pathogen reduction and vector attraction requirements for Class A biosolids. They must not be applied to land in a watershed used as a permitted water supply under the Drinking Water Protection.

3.6.3 Biosolids Growing Medium

Biosolids that meet the requirements of all the following are biosolids growing medium:

- Column 2 of Schedule 4, Quality Criteria;
- Schedule 5, Sampling and Analyses-Protocols and Frequency;
- Schedule 6, Record-keeping;
- Schedule 11, Requirements for Biosolids Growing Medium.

Biosolids growing medium may be distributed with no volume restriction.

3.6.4 Disposal at the Sanitary Landfill

Sludge can be landfilled with other solid waste or used as a soil conditioner in final cover areas to enhance vegetation growth. Disposal at the landfill with sold waste should be considered as the least preferred option as no benefit is achieved and landfill “air space” is consumed. However, it should be recognized that the quality of the sludge may, in the final analysis, leave the landfill as the only feasible disposal option.

4.0 Recent Sampling

A sludge survey was completed by Lambourne Environmental in 2011 using a digital GPS and gridded sampling programme (see Appendix A). The dry down tell results for Cell No.2 range from 2.97 to 24.13 % solids, whereas Cell No.3 ranges from 3.82 to 7.12 % solids. As derived in theoretical calculations, Cell No.2 has an increased rate of sludge production due to the treatment system design.

The Town completed sludge sampling in 2017. Following sampling, Cell No.2 was lowered, and sludge was removed around the perimeter of the cell. Sludge accumulation sampling was again completed in 2018.

5.0 Recommendations

As the Town continues to advance their Sludge Management Plan, a reserve fund should be maintained for sludge removal and upgrading of the lagoons as required. Sludge sampling for thickness and density in Cell No.2 and No. 3 is to be completed every 2 years (at a minimum). Ongoing monitoring and maintenance will allow the Town to adapt to increases in population growth and reductions of water resources in a sustainable manner. Options for beneficial reuse of sludge should continue to be explored in the future.

Blk A
LOT 682s

LOT 682s

LOT 447 MC

CROWN LAND
OLIVER
MOUNTAIN
PARK

EXISTING
AERATED
CELL No. 3

EXISTING
AERATED CELL No. 2

CHLORINE
CONTACT
CHAMBERS

Blk B
LOT 682s

EFFLUENT STORAGE
RESERVOIR

LOT 838

LOT 682s

Lot 3
5881

LOT 763s

BLOWER BUILDING

UNSURVEYED
CROWN LAND
PID 015-086-721

Lot 2
5881

EFFLUENT
BOOSTER
STATION

TOP OF BERM

ACCESS ROAD

FAIRVIEW ROAD

R/W 35424

R/W 38213

EXISTING SANITARY
FORCEMAIN

UNSURVEYED
CROWN LAND
PID 014-879-361

Lot A
37929

Lot 2
5881

LOT 682s

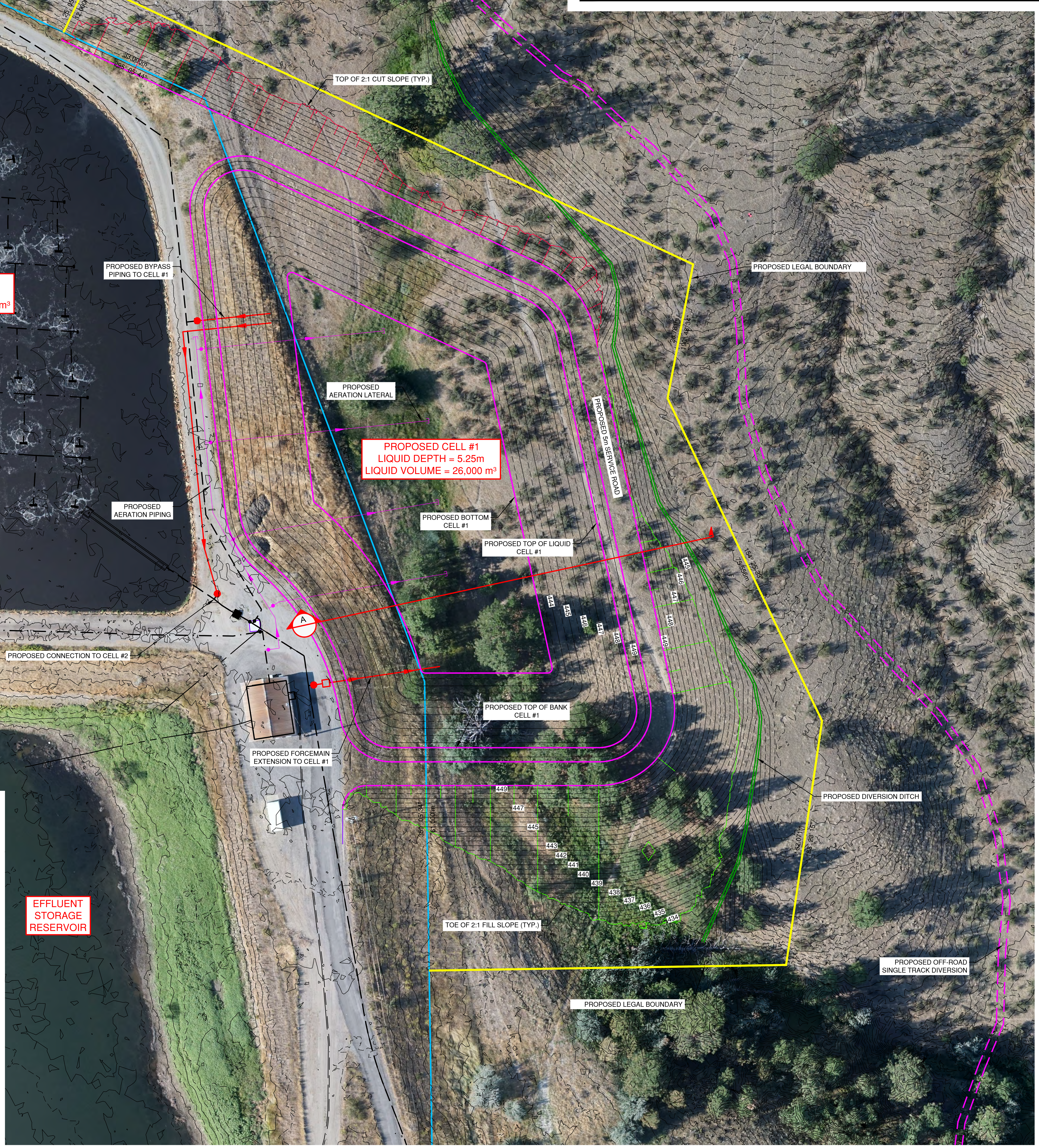
Blk K
1789

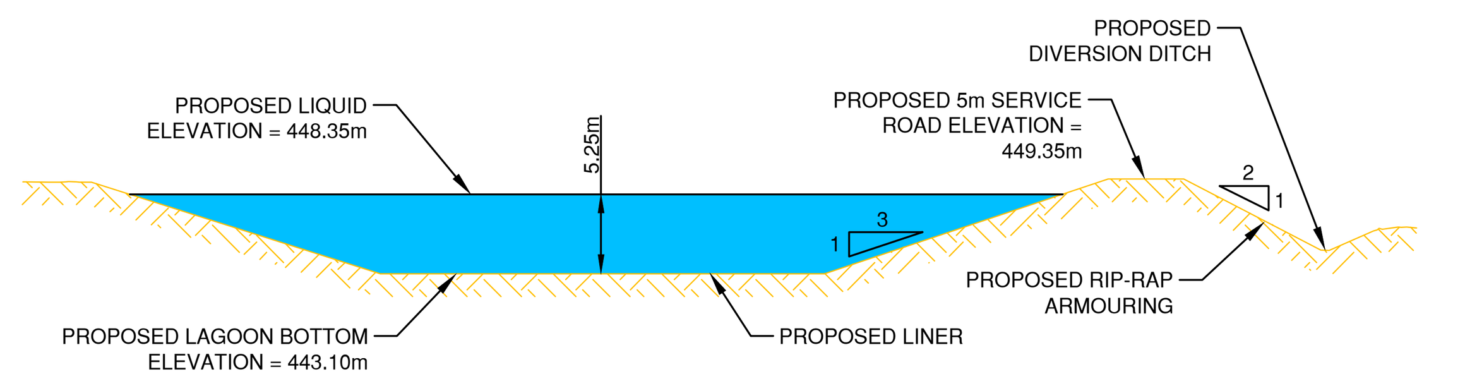
TOWN OF OLIVER
AERATED LAGOON TREATMENT SYSTEM
OVERALL SITE PLAN

TRUE CONSULTING

DESIGN BY: SAC
SCALE: 1 : 2,500
DWG NO.: Fig. 1 306-088-005
REV: 0
DRAWN BY: SAC/DL
DATE: JAN 2019

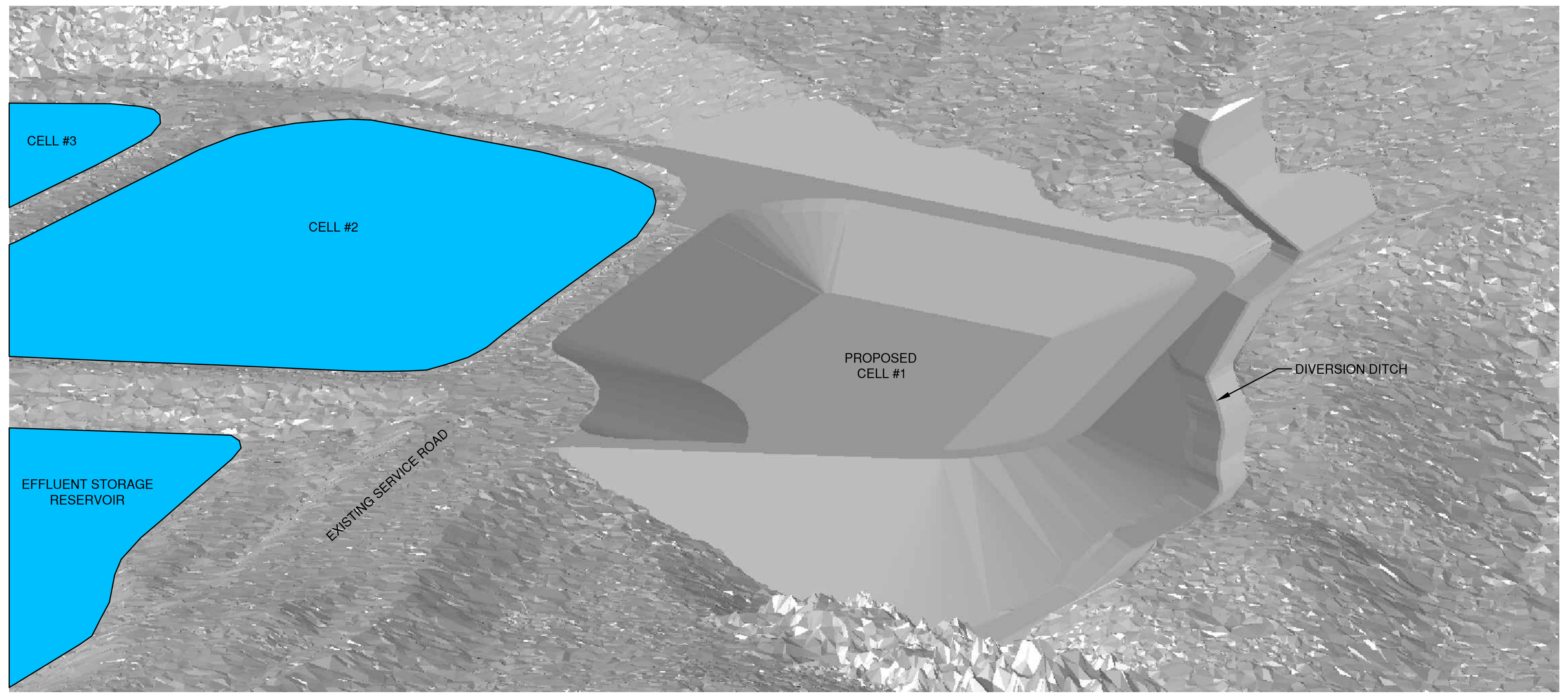
FILE:n:\clients\300-399\306\306-175\2\03 drawings\cad\02 design drawings\dwg-306-1752.dwg



SECTION A - PROPOSED CELL #1 & DIVERSION DITCH

HORIZONTAL & VERTICAL
SCALE 1:500



CUT/FILL QUANTITIES

PROPOSED CELL #1 EARTHWORKS

24,000 m³ (CUT)
19,500 m³ (FILL)
NET 4,500 m³ (CUT)

NOT INCLUDING STRIPPING
APPROXIMATE VOLUME 3,900 m³ (CUT)

PROPOSED CELL #1 CAPACITY
26,000 m³

DRAFT

No.	DATE	DESCRIPTION	BY	APP'D
0	SEPT 07/2017	ISSUED FOR DISCUSSION	DF	SC

ISSUES / REVISIONS

CONSULTANT SEAL

TRUE CONSULTING
201 - 2079 Falcon Road • Kamloops BC • V2C 4J2
tel 250.828.0881 • fax 250.828.0717
info@TRUE.bc.ca

BRITISH COLUMBIA Town of Oliver

AERATED LAGOON TREATMENT SYSTEM

PROPOSED CELL #1

SCALE	0 1:500 25
DESIGN BY	SU/SC
DRAWN BY	DF
DATE	SEPTEMBER, 2017
PROJECT REFERENCE No.	306-083 & 306-291

DRAWING No. **306-088-005**

Fig. 2

SHEET 1 OF 1

ISSUE/REV. **0**

FILE: r:\clients\300-399\306\306-985\03 drawings\cad\02 design drawings\dn-306-985-oliver treatment

APPENDIX A

Referenced Report

LAMBOURNE ENVIRONMENTAL Ltd.
51, 37337 Burnt Lake Trail, Red Deer County, AB T4S 2K5 Ph. (403)348-8298 Fax (403) 348-8290

December 15, 2011

Town of Oliver
35016 - 97 St.
PO Box 638
Oliver, BC
V0H 1T0
Attn: Shawn Goodsell

Re: Lagoon Survey Report for Town of Oliver, Cells 1 & 2

Dear Shawn,

Lambourne Environmental was contracted to conduct a sludge survey of cells 1 and 2 in Oliver. This survey was completed on November 17, 2011 and was conducted using a digital GPS system, with a boat being used to take the depth measurements and to gather samples from the lagoons. At the time of the survey, the lagoons were ice free and the aeration system had been turned off.

The calculation of volumes for the cells is shown in Table 1 below. The volume calculations were done using Carlson Civil 3D software. While collecting the samples for dry matter testing, it was difficult to find sludge in the second cell. The material in cell 2 was of low density and was found mostly along the east side of the cell. Several attempts to obtain samples in other areas of cell 2 yielded only gravel or stones and dark water. Cell 1 did contain some areas of accumulation and the sludge density varied considerably as seen in the dry down results obtained using our in-house single sample ovens. The majority of the sludge in cell 1 was around the perimeter of the cell indicating the aeration system is moving the material around and it is settling out in the low current area around the perimeter.

When calculating the dry tonnes, we typically see fairly consistent solids results. We take the average of the dry downs and multiply by the sludge volume to arrive at the dry tonnes. In this case, there were a few samples that showed significantly higher solids than the rest of the samples. We retested these samples on different dry down ovens to ensure consistent results. The average number used may skew the calculation of dry tonnes present, particularly in cell 1. The extent of the higher density material was not determined, but it may correspond to the location of the inlets to the cell or it could be material that has not been removed for some time. In the higher density samples, the biosolids did seem to contain a significant inorganic content of sand and grit.

Table 1

Cell #	Total Volume (m^3)	Biosolids Volume (m^3)	Average % solids	Calculated Dry Tonnes	Cell Depth (m)	Biosolids Height (m)
1	36,229	5,000	9.20%	460	5.6	0.1 – 1.95
2	36,278	3,000	5.13%	154	5.5	0 – 2.52
Total	72,507	8,000				

The following are the dry down test results from each cell.

Cell 1	
Sample #	% Solids
1-1	11.13
1-2	3.93
1-3	2.97
1-4	6.52
1-5	6.51
1-6	24.13

Cell 2	
Sample #	% Solids
2-1	7.12
2-2	3.82
2-3	4.99
2-4	4.59

I have also included the following drawing and data exhibits:

1. Cell 1 - Carlson drawing indicating the lagoon shape and points from where the depth measurements were taken.
2. Cell 1 - Table indicating the total depth measurements as well as the height of sludge in each location.
3. Cell 2 - Carlson drawing indicating the lagoon shape and points from where the depth measurements were taken.
4. Cell 2 - Table indicating the total depth measurements as well as the height of sludge in each location.
5. Cell 1 and 2 – Drawing indicating where the samples used for determining percent solids were collected from.

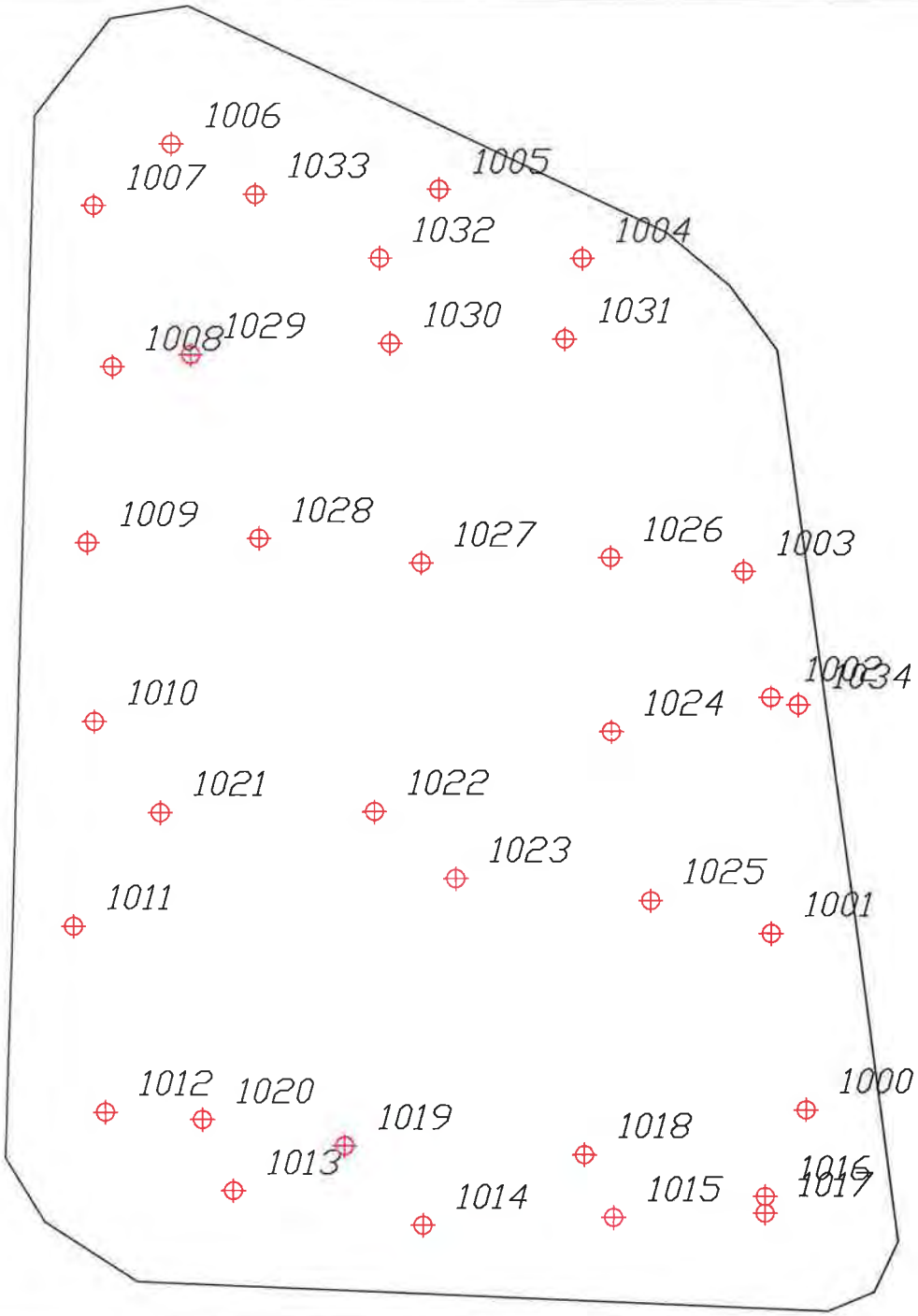
We appreciate the opportunity to work with you on this project. If there is any additional information you require, please let me know.

Yours truly,
Lambourne Environmental Ltd.

Blair Benn, P. Ag.
Vice-President

Encl.

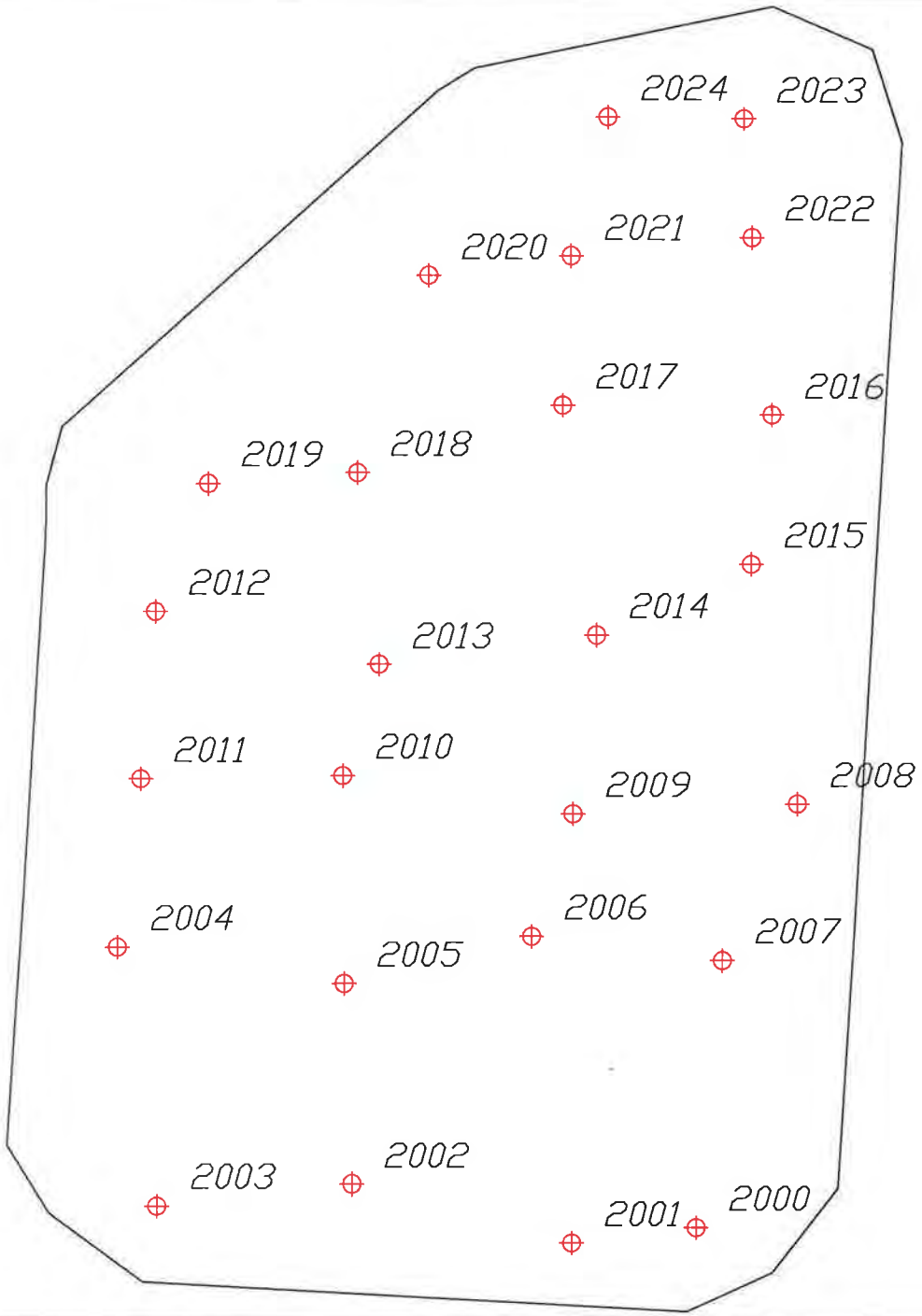
Cc: True Consulting Group Ltd. – Kaitlin Klamut



Survey Points

DRAWN BB	DATE 12/14/11	Lambourne Environmental
APPROVED	DATE	
SCALE	SHEET Cell 1	PROJECT NO. Oliver

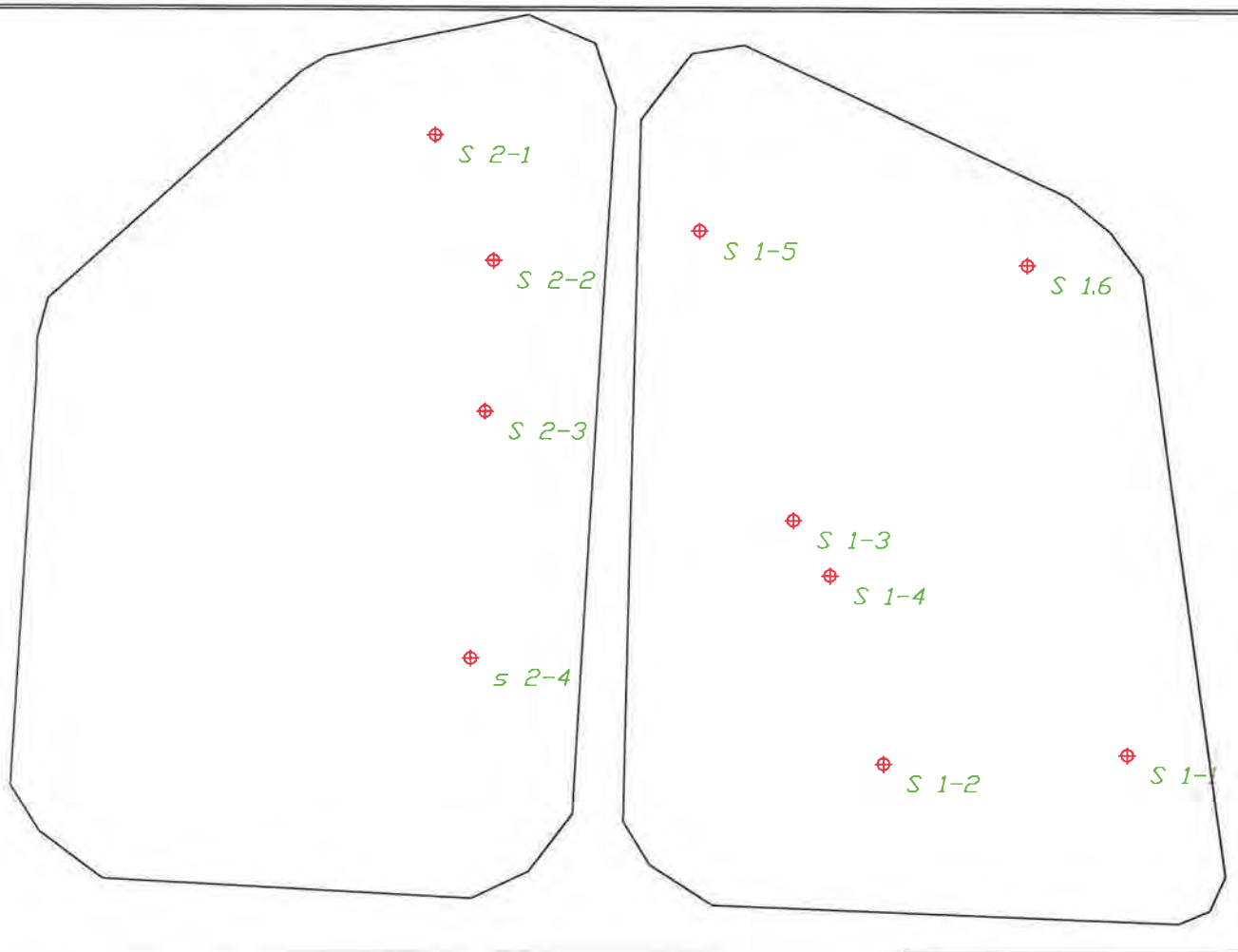
Oliver Cell 1		
Point #	**Total Depth**	**Sludge Height**
1000	2.64	1.54
1001	2.86	1.76
1002	1.87	0.67
1003	2.00	1.00
1004	1.60	0.60
1005	1.72	0.52
1006	2.76	1.86
1007	1.53	0.43
1008	2.18	0.88
1009	1.54	0.04
1010	2.06	1.36
1011	1.46	0.06
1012	2.12	0.12
1013	2.54	0.34
1014	1.71	0.01
1015	2.22	0.02
1016	2.72	0.62
1017	2.46	1.86
1018	4.18	0.18
1019	4.35	1.15
1020	4.37	0.87
1021	4.58	1.08
1022	5.50	0.00
1023	5.50	0.40
1024	5.67	0.67
1025	5.43	0.03
1026	5.61	0.01
1027	5.46	0.06
1028	5.42	0.02
1029	4.55	1.15
1030	5.45	0.05
1031	4.75	1.95
1032	5.13	0.03
1033	4.91	1.71
1034	0.97	0.47



Survey Points

DRAWN BB	DATE 12/15/11	Lambourne Environmental
APPROVED	DATE	
SCALE	SHEET Cell 2	PROJECT NO. Oliver

Oliver Cell 2		
Point #	**Total Depth**	**Sludge Height**
2000	1.53	0
2001	1.84	0
2002	3.78	0.68
2003	1.91	0
2004	3.23	0.03
2005	5.45	0.55
2006	5.53	0.63
2007	4.64	1.34
2008	2.08	0.00
2009	5.68	0.08
2010	5.54	0.04
2011	3.67	0.00
2012	3.58	0.58
2013	5.64	0.04
2014	5.67	0.37
2015	4.84	1.84
2016	3.64	0.54
2017	5.55	0.05
2018	4.81	0.00
2019	3.14	1.14
2020	1.70	0.00
2021	5.75	0.25
2022	4.72	2.52
2023	3.17	1.17
2024	3.32	0.42



Sample Points

DRAWN BB	DATE 12/15/11	Lambourne Environmental
APPROVED	DATE	
SCALE	SHEET Cell 1 & 2	PROJECT NO. Oliver

APPENDIX G

Groundwater Monitoring Data – CARO Analytical

Monitoring Well	Year	Minimum Level (mbtoc)	Maximum Level (mbtoc)	Average Level* (mbtoc)	Level Range (m)
Well #1 Air Cadet	2007	9.59	10.68	10.18	1.09
	2008	10.52	10.79	10.69	0.27
	2009	10.77	11.40	10.93	0.63
	2010	10.31	11.03	10.76	0.72
	2011	10.33	10.80	10.55	0.47
	2012	9.84	10.78	10.50	0.94
	2013	9.78	10.44	10.11	0.66
	2014	9.98	10.58	10.33	0.60
	2015	10.01	10.51	10.28	0.50
	2016	10.21	10.5	10.36	0.29
	2017	9.9	10.59	10.32	0.69
	2018	9.65	10.29	10.03	0.64
	2019	9.72	10.62	10.26	0.9
	2020	9.62	10.51	10.22	0.89
	2021	9.24	10.4	9.8	1.16
	2022	10.16	10.85	10.51	0.69
	2023	10.59	10.96	10.76	0.37
Well #2 Rodeo Grounds	2007	5.89	6.40	6.10	0.51
	2008	6.11	6.38	6.25	0.27
	2009	5.83	6.54	6.20	0.71
	2010	5.69	6.35	6.04	0.66
	2011	5.84	6.34	6.09	0.50
	2012	5.84	6.54	6.20	0.70
	2013	5.62	6.24	5.91	0.62
	2014	5.84	6.27	6.08	0.43
	2015	5.69	6.66	6.08	0.97
	2016	5.66	5.97	5.82	0.31
	2017	5.98	6.3	6.16	0.32
	2018	5.81	6.24	5.99	0.43
	2019	6.18	6.96	6.61	0.78
	2020	7.07	7.46	7.27	0.39
	2021	7.48	7.78	7.62	0.3
	2022	7.79	8.10	7.94	0.31
	2023	8.02	8.26	8.1725	0.24
Well #3 91A Street	2007	1.52	2.19	1.81	0.67
	2008	1.50	2.34	1.78	0.84
	2009	1.47	2.05	1.77	0.58
	2010	1.45	1.64	1.54	0.19
	2011	1.31	1.55	1.46	0.24
	2012	1.38	1.54	1.46	0.16
	2013	1.20	1.39	1.27	0.19
	2014	1.11	1.65	1.37	0.54
	2015	1.21	1.66	1.41	0.45
	2016	1.13	1.43	1.28	0.30
	2017	1.06	1.38	1.23	0.32
	2018	0.87	1.51	1.2	0.64
	2019	1.24	1.78	1.45	0.54
	2020	1.18	1.72	1.44	0.54
	2021	1.2	2.1	1.7	0.9
	2022	1.51	2.16	1.73	0.65
	2023	1.49	2.27	1.865	0.78

**Depth indicates the measurement from the top of casing to the water level.*

TOWN OF OLIVER
GROUNDWATER MONITORING WELL #1 (AIR CADET)

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	24.60	9.7	<0.010	319	9.7	<0.050	<6.4	707	0.105	0.0888	101	16.4	19.1
25-Sep	24.7	8.64	<0.010	318	8.64	<0.050	<7.0	652	0.0836	0.0681	101	16.1	201

GROUND WATER MONITORING WELL #2 (RODEO GROUNDS)

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	10.10	3.420	<0.010	2150	3.420	0.065	<6.4	617	0.08	0.0058	707	92.7	18.2
25-Sep	10.7	3.59	<0.010	1220	3.59	<0.050	<7.0	614	35	<0.0050	453	22.0	15.7

GROUND WATER MONITORING WELL #3 (MAPLE AVENUE)

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	8.11	0.07	<0.010	8470	0.0705	0.079	<6.4	815	0.029	0.0061	2650	445	33.5
25-Sep	9.65	<0.010	<0.010	1100	<0.0100	3.37	248	878	69.2	0.03	344	58.2	18.5

GROUND WATER MONITORING WELL #4 (SAND PIT)

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	152	3.56	<0.010	3750	3.56	0.081	<6.4	1990	0.211	0.156	1130	225	108
25-Sep	128	1.26	<0.010	1810	1.26	<0.050	<7.0	1870	37	0.213	578	87.3	107

*** Test results high due to draining effluent water two weeks before testing into the infiltration to lower Topping Lake

GROUND WATER MONITORING WELL #5 (Choke Cherry)

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	15.7	1.19	<0.010	372	1.19	0.101	<6.4	683	0.0179	0.0111	110	23.5	13
25-Sep	13.9	1.31	<0.010	329	1.31	<0.050	<7.0	605	0.581	0.019	97.5	20.7	11.2

Fairview Gold Course

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	102	3.62	<0.010	417	3.62	<0.050	<6.4	1220	0.101	0.097	83.7	48.5	101
25-Sep	92.7	3.02	<0.010	408	3.02	<0.050	<7.0	1160	0.109	0.106	85.3	47.3	112

Public Works Yard

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	81.8	1.07	<0.010	392	1.07	0.07	<6.4	960	0.146	0.136	109	28.9	42.6
25-Sep	63.3	1.34	<0.010	334	1.34	<0.050	<7.0	764	0.133	0.0594	90.2	26.3	45.2

Linear Park

	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
25-Sep	191	3.58	<0.010	580	3.58	0.089	<7.0	1040	8.36	0.0174	170	37.6	86

End of Road 5

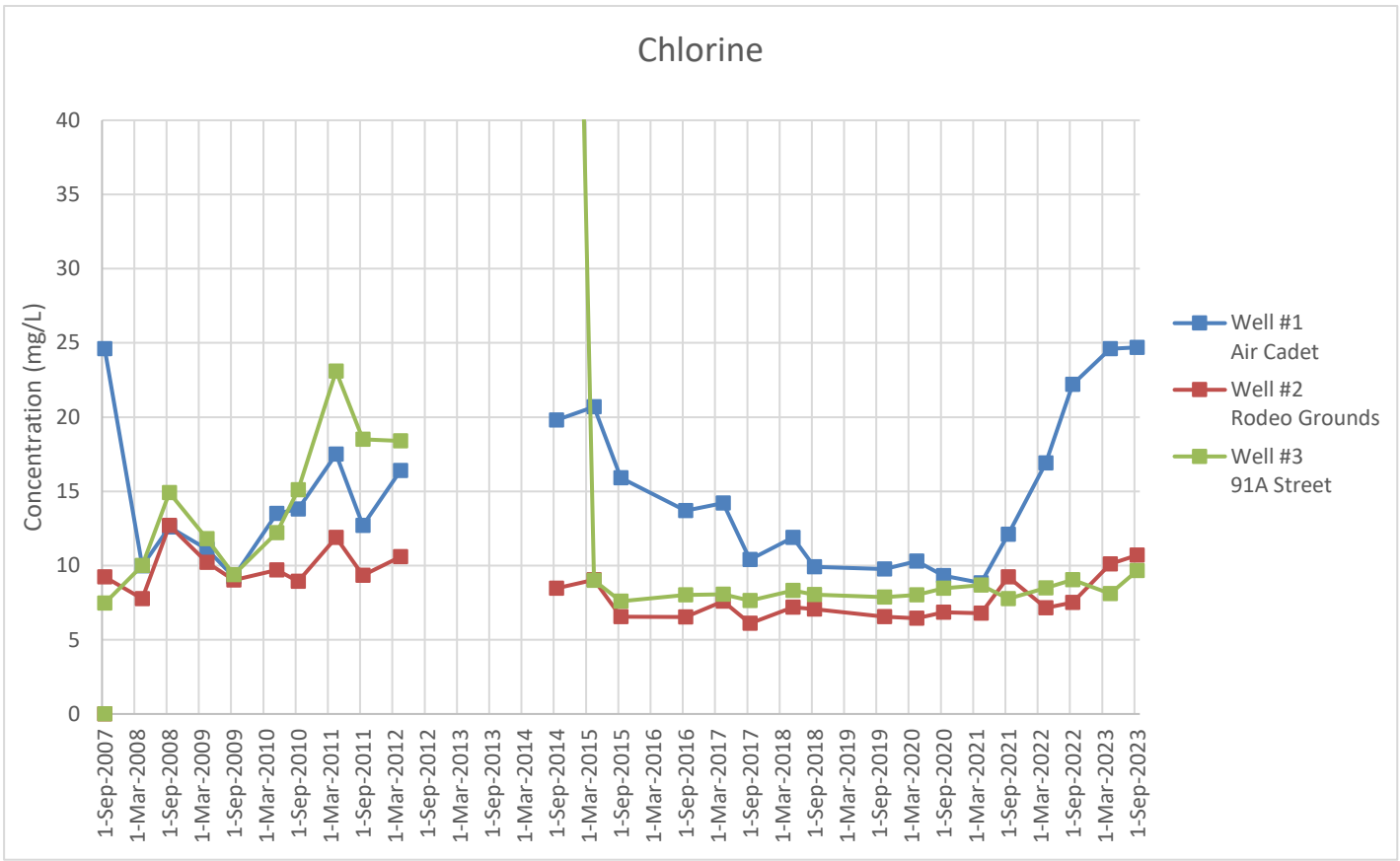
	Anions			Calculated Parameters		General Parameters					Total Metals		
Sample Date	Chloride	Nitrate (as N)	Nitrite (as N)	Hardness Total (as CaCO3)	Nitrate+Nitrite (as N)	Ammonia Total (as N)	BOD 5-day Carbonaceous	Conductivity (EC)	Phosphorus Total (as P)	Phosphorus Total Dissolved	Calcium Total	Magnesium Total	Sodium Total
18-Apr	132	5.86	<0.010	573	5.86	<0.050	<6.4	1160	0.0147	0.0136	129	60.6	24.8
25-Sep	134	5.84	<0.010	592	5.84	<0.050	<7.0	1140	0.0343	<0.0050	131	64.2	24.5

TABLE 2-2: HISTORICAL SUMMARY OF WATER QUALITY ANALYSIS FOR THE AIRPORT MONITORING WELLS

Monitoring Well	Sample Date	Chloride	Ammonia	Nitrate + Nitrite	Total Hardness	Sodium
Well #1 Air Cadet	19-Sep-2007	24.6	< 0.02	7.71	535	13.9
	9-Apr-2008	9.97	0.09	2.84	773	24.1
	11-Sep-2008	12.6	0.04	1.3	817	21.7
	7-Apr-2009	11.1	0.02	0.7	1220	27.3
	18-Sep-2009	9.23	0.02	2.3	437	17.7
	19-May-2010	13.5	0.06	12.7		
	7-Sep-2010	13.8	< 0.02	12	383	22.1
	28-Apr-2011	17.5	0.15	12.1	217	9.33
	28-Sep-2011	12.7	0.12	7.87	400	18.4
	24-Apr-2012	16.4	0.04	7.59	464	20.0
	16-Oct-2012		0.034	9.7	481	19.8
	9-Apr-2013		0.034	10.1	384	18.5
	9-Sep-2013		< 0.020	20.2	383	17
	16-Apr-2014		0.027	21.6	542	18.1
	4-Sep-2014	19.8	< 0.020	23.9	402	19.5
	14-Apr-2015	20.7	0.102	24.4	485	20.5
	16-Sep-2015	15.9	0.079	20.5	590	23.5
	13-Sep-2016	13.7	0.032	15	386	19.1
	10-Apr-2017	14.2	0.033	12	388	19.5
	11-Sep-2017	10.4	<0.020	6.97	392	18
	14-May-2018	11.9	0.025	6.75	363	19.1
	10-Sep-2018	9.92	<0.020	7.97	344	16.8
	28-Oct-2019	9.77	0.023	12.6	388	19.6
	6-Apr-2020	10.3	<0.050	13	331	18.8
	1-Sep-2020	9.31	<0.050	11.1	378	19.4
	22-Apr-2021	8.83	<0.050	11	316	17.1
	13-Sep-2021	12.1	0.094	9.67	303	17.6
	11-Apr-2022	16.9	<0.050	9027	319	17.6
	7-Sep-2022	22.2	<0.050	8.3	320	18.6
	18-Apr-2023	24.6	<0.050	9.72	319	19.1
	25-Sep-2023	24.7	<0.050	8.64	318	201
Well #2 Rodeo Grounds	19-Sep-2007	9.24	< 0.02	0.25	2330	
	9-Apr-2008	7.76	0.03	0.5	1690	23.7
	11-Sep-2008	12.7	0.08	1.14	890	21.7
	7-Apr-2009	10.2	< 0.02	1.28	346	15.2
	18-Sep-2009	9.01	< 0.02	0.36	677	19.1
	19-May-2010	9.69	0.04	0.08		
	7-Sep-2010	8.93	< 0.02	0.26	686	22.3
	28-Apr-2011	11.9	0.05	0.05	531	9.13
	28-Sep-2011	9.33	0.02	2.18	491	16.1
	24-Apr-2012	10.6	0.01	0.749	572	17.4
	16-Oct-2012		0.021	0.263	661	17.8
	9-Apr-2013		0.047	0.121	384	18.4
	9-Sep-2013		0.023	0.115	889	18
	16-Apr-2014		0.024	0.123	392	15.9
	4-Sep-2014	8.47	0.02	0.584	370	15.9
	14-Apr-2015	9.05	0.094	0.865	494	18.5
	16-Sep-2015	6.56	0.037	0.3	1120	31.6
	-	-	-	-	-	-
	13-Sep-2016	6.54	0.032	0.628	1110	19.2
	10-Apr-2017	7.6	0.072	0.343	914	20.4
	11-Sep-2017	6.1	0.02	0.124	959	17.1
	14-May-2018	7.2	0.1	0.122	2550	20.3
	10-Sep-2018	7.07	0.037	0.138	2090	18.9
	28-Oct-2019	6.55	0.103	0.385	2440	20.8
	6-Apr-2020	6.44	0.101	0.212	394	17.2
	1-Sep-2020	6.86	0.081	0.173	1540	18.9
	22-Apr-2021	6.78	0.102	0.312	1410	17.5
	21-Sep-2021	9.24	0.081	0.045	1740	20.4
	11-Apr-2022	7.14	0.068	0.324	1970	20.5
	7-Sep-2022	7.51	<0.050	0.872	2980	23.6
	18-Apr-2023	10.1	0.065	3.42	2150	18.2
	25-Sep-2023	10.7	<0.050	3.59	1220	15.7
	19-Sep-2007	7.46	0.06	0.05	7340*	15.1
	9-Apr-2008	10	0.03	0.05	972	27.5
	11-Sep-2008	14.9	0.12	0.04	5010	38.4
	7-Apr-2009	11.8	0.02	0.026	1270	31.6
	18-Sep-2009	9.39	0.11	< 0.02	1070	24.6
	19-May-2010	12.2	0.06	< 0.02		
	7-Sep-2010	15.1	0.35	0.35	2300	37.7
	28-Apr-2011	23.1	0.04	0.44	633	15.3
	28-Sep-2011	18.5	0.1	0.32	1160	36.8
	24-Apr-2012	18.4	0.09	0.270	1470	36.9
	16-Oct-2012		0.04	0.033	924	31.6
	9-Apr-2013		0.049	0.074	834	23.9
	9-Sep-2013		0.07	0.101	1430	24.6

Well #3 91A Street	16-Apr-2014		0.028	0.058	399	16.9
	4-Sep-2014	125	0.023	0.032	438	21.8
	14-Apr-2015	8.99	0.086	0.106	631	18.9
	16-Sep-2015	7.59	0.047	0.035	496	18.5
	-	-	-	-	-	-
	13-Sep-2016	8.01	0.032	0.214	389	17.2
	10-Apr-2017	8.07	0.059	0.334	366	16.7
	11-Sep-2017	7.64	<0.020	0.042	346	15.2
	14-May-2018	8.31	0.024	0.0507	381	15.4
	10-Sep-2018	8.05	0.031	0.739	355	14.4
	28-Oct-2019	7.87	0.121	0.349	360	16
	6-Apr-2020	8.03	0.095	0.315	371	16.3
	1-Sep-2020	8.47	<0.050	0.0929	443	16.5
	22-Apr-2021	8.68	<0.050	0.25	356	15.2
	21-Sep-2021	7.77	0.15	0.307	1120	15.1
	11-Apr-2022	8.48	0.191	<0.0200	559	15.7
	7-Sep-2022	9.04	0.141	0.0886	1260	19
	18-Apr-2023	8.11	0.079	0.0705	8470	33.5
	25-Sep-2023	9.65	3.37	<0.0100	1100	18.5

* Suspected error.


Chlorine
Concentration (mg/L)
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20
15
10
5
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1-Sep-2019
1-Mar-2020
1-Sep-2020
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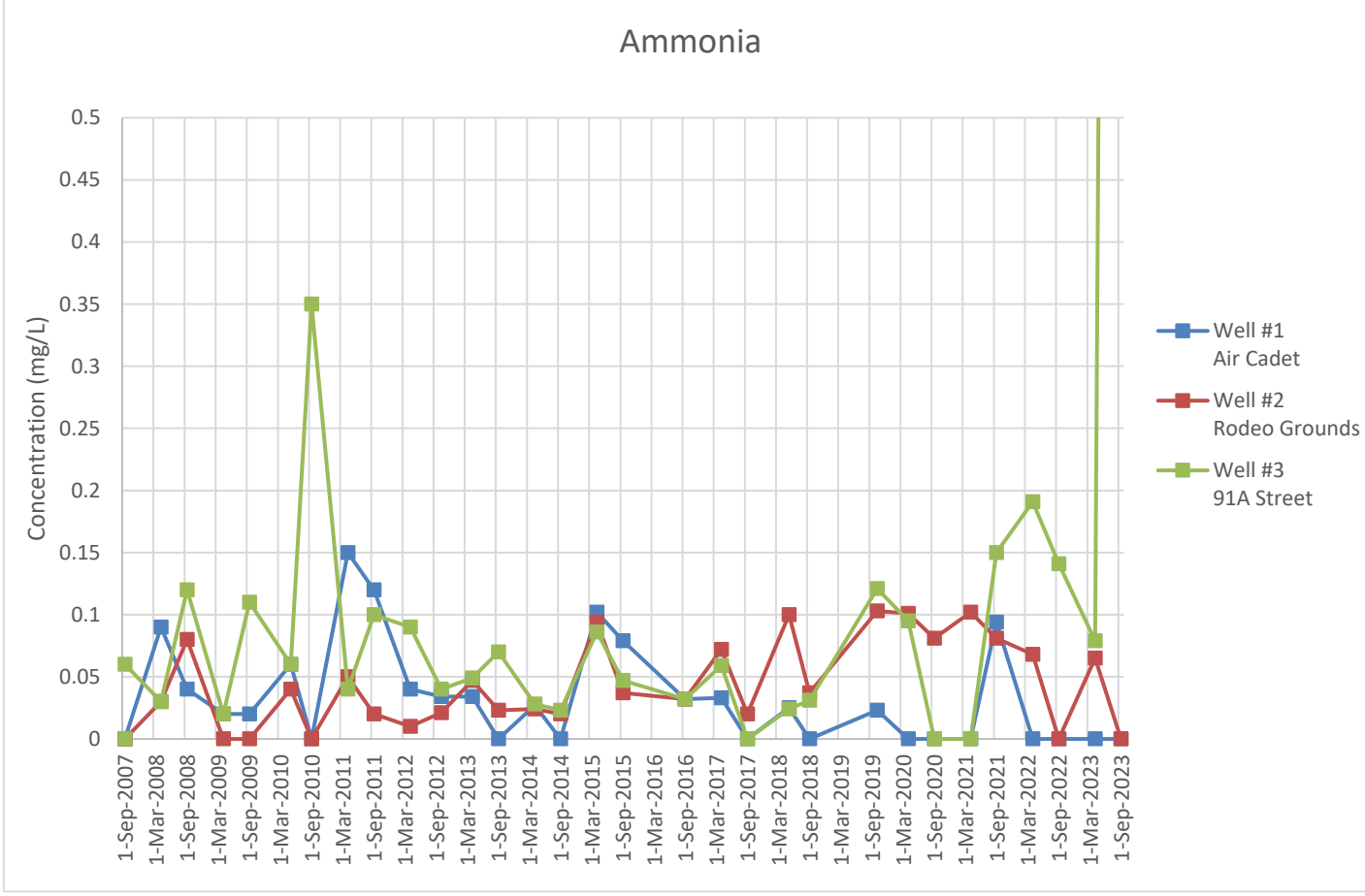
Well #1
Air Cadet
Well #2
Rodeo Grounds
Well #3
91A Street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Concentration (mg/L)
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0.3
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0.05
0
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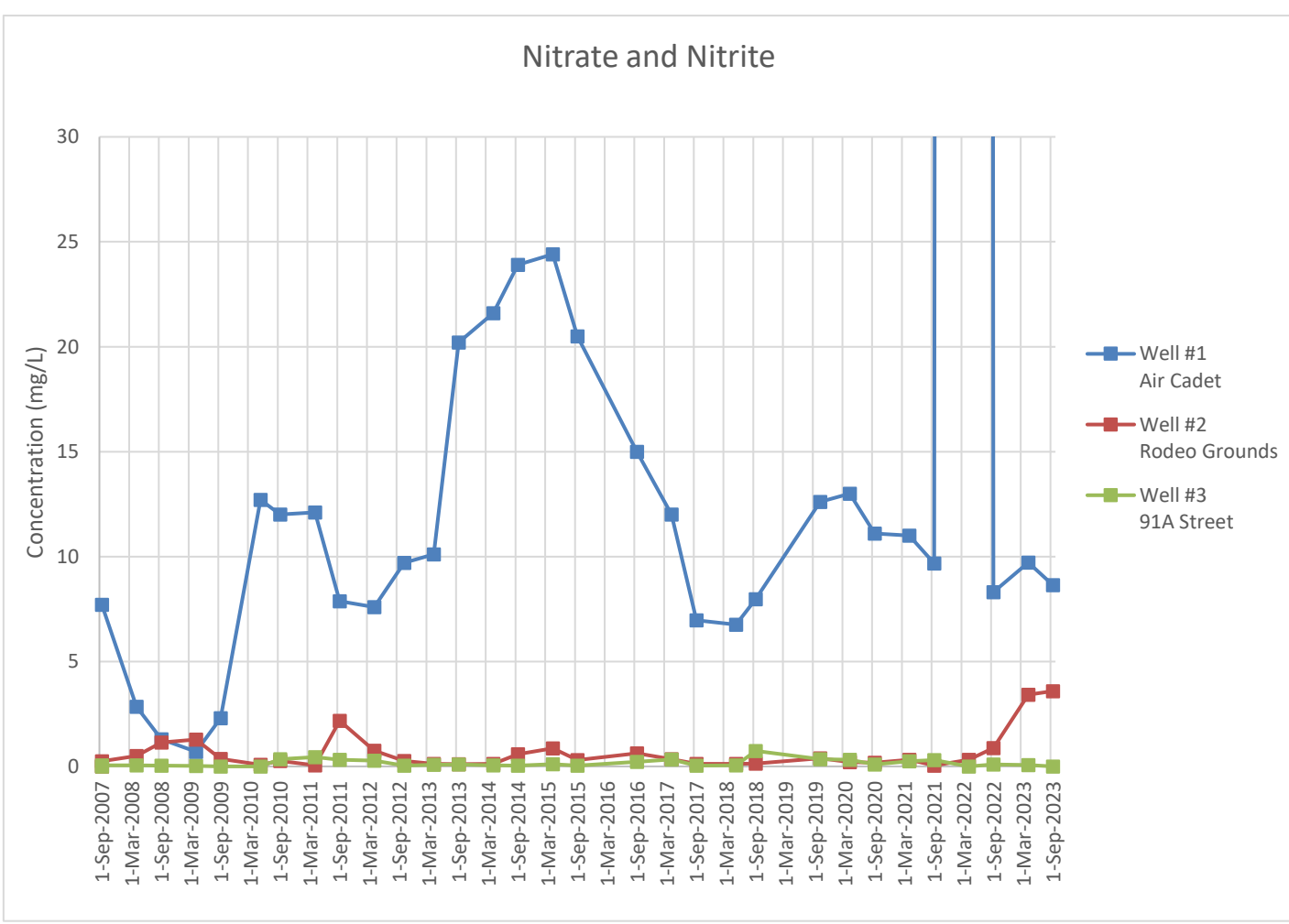
Well #1
Air Cadet
Well #2
Rodeo Grounds
Well #3
91A Street


Nitrate and Nitrite
Concentration (mg/L)
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15
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0
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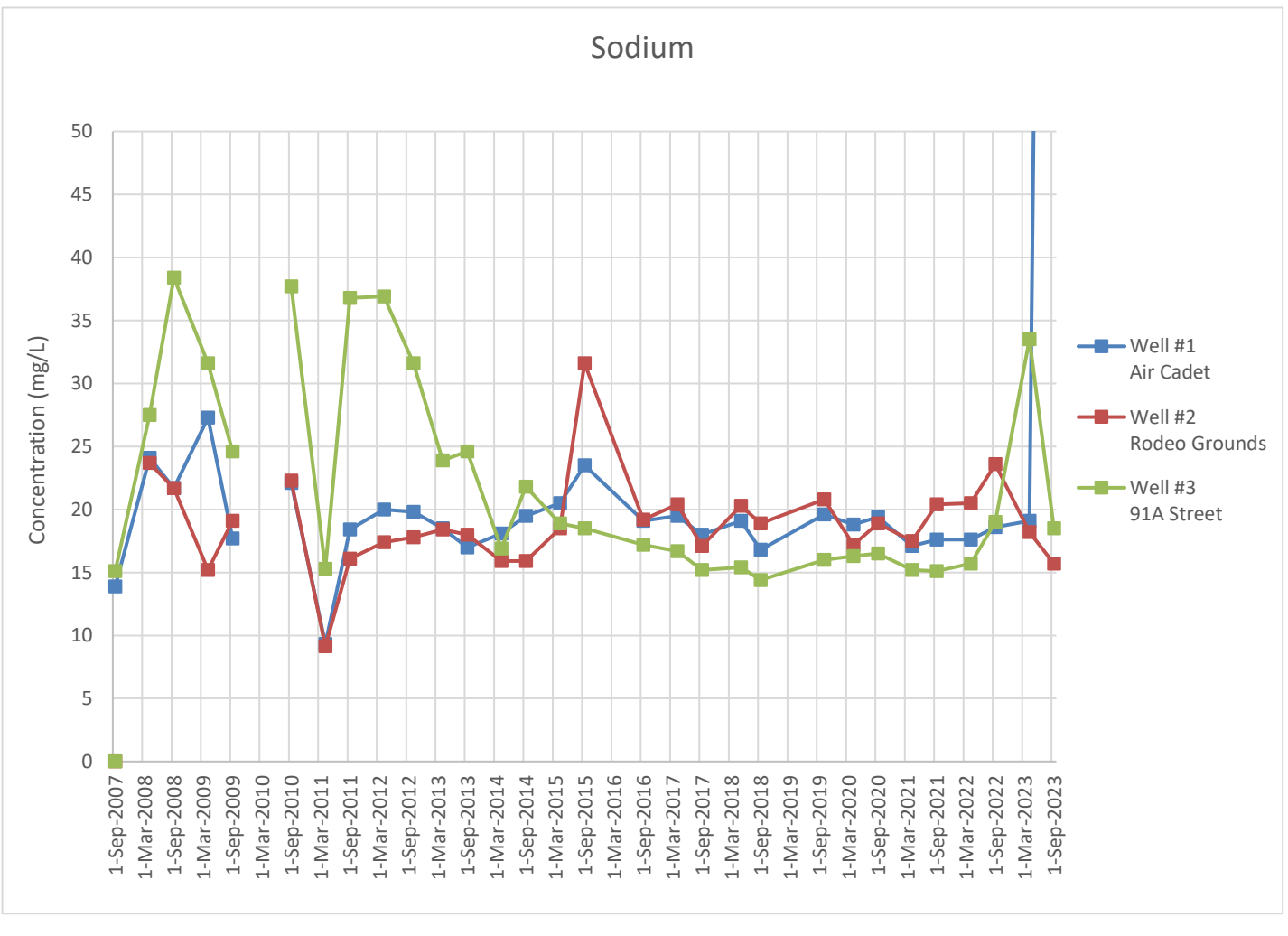
1-Mar-2022
1-Sep-2022
1-Mar-2023
1-Sep-2023
Well #1
Air Cadet
Well #2
Rodeo Grounds
Well #3
91A Street

Total Hardness
Concentration (mg/L)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1-Sep-2007
1-Mar-2008
1-Sep-2008
1-Mar-2009
1-Sep-2009
1-Mar-2010
1-Sep-2010
1-Mar-2011
1-Sep-2011
1-Mar-2012
1-Sep-2012
1-Mar-2013
1-Sep-2013
1-Mar-2014
1-Sep-2014
1-Mar-2015
1-Sep-2015
1-Mar-2016
1-Sep-2016
1-Mar-2017
1-Sep-2017
1-Mar-2018
1-Sep-2018
1-Mar-2019
1-Sep-2019
1-Mar-2020
1-Sep-2020
1-Mar-2021
1-Sep-2021
1-Mar-2022
1-Sep-2022
1-Mar-2023
1-Sep-2023
Well #1
Air Cadet
Well #2
Rodeo Grounds
Well #3
91A Street


Sodium
Concentration (mg/L)
50
45
40
35
30
25
20
15
10
5
0
1-Sep-2007
1-Mar-2008
1-Sep-2008
1-Mar-2009
1-Sep-2009
1-Mar-2010
1-Sep-2010
1-Mar-2011
1-Sep-2011
1-Mar-2012
1-Sep-2012
1-Mar-2013
1-Sep-2013
1-Mar-2014
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1-Mar-2019
1-Sep-2019
1-Mar-2020
1-Sep-2020
1-Mar-2021
1-Sep-2021
1-Mar-2022
1-Sep-2022
1-Mar-2023
1-Sep-2023
Well #1
Air Cadet
Well #2
Rodeo Grounds
Well #3
91A Street

TOWN OF OLIVER

GROUND WATER MONITORING WELL READINGS
(Note: The value recorded indicates the measurement from the top of casing to the water level expressed in meters.)

Month	Day	Air Cadet (Well #1)	Rodeo Grounds (Well #2)	Maple Ave (Well #3)	Test Well #2 (Corner 350th/T.L.)	Test Well #4 (Sand Pit)	Test Well #5	Test Well #6 (Golf Course)	Test Well #7 (Road #5 West)	Test Well #8 Cemetery	Test Well #9 Linear Park	Test Well #10 End of Road 5
January		10.59	8.12	1.63	fenced off	9.56	9.26	13.21	2.950	21.1	26.22	24.86
February	3	10.62	8.17	1.67	fenced off	8.43	9.46	13.21	2.95	21.1	25.98	24.88
March	14	10.71	8.02	1.49	fenced off	8.61	9.61	13.34	2.65	21.11	25.91	24.95
April	18	10.88	8.1	1.49	fenced off	8.41	9.57	13.35	2.91	21.11	25.81	24.99
May	25	10.96	8.15	1.66	fenced off	8.54	8.07	13.49	2.22	21.11	26.17	25.02
June	28/29	10.71	8.17	1.87	fenced off	9.34	8.03	13.55	2.77	21.1	26.41	25.02
July	20/21	10.76	8.17	2.02	fenced off	9.94	8.34	13.75	2.91	21.1	26.72	25.03
August	14	10.75	8.19	2.22	fenced off	10.42	8.46	13.52	2.96	21.1	26.78	25.05
September	21/22	10.64	8.23	2.25	fenced off	10.61	8.88	13.26	2.96	21.1	26.84	25.06
October	10/11	10.69	8.24	2.27	fenced off	10.17	9.04	13.15	2.93	21.1	26.64	25.08
November	21	10.87	8.25	1.94	fenced off	8.84	9.44	13.46	3.02	21.11	26.32	25.1
December	13	10.93	8.26	1.87	fenced off	9.23	9.57	13.47	3.01	21.11	26.32	25.11

TABLE 2-3: SUMMARY OF GROUNDWATER DEPTHS FOR FAIRVIEW MONITORING WELLS

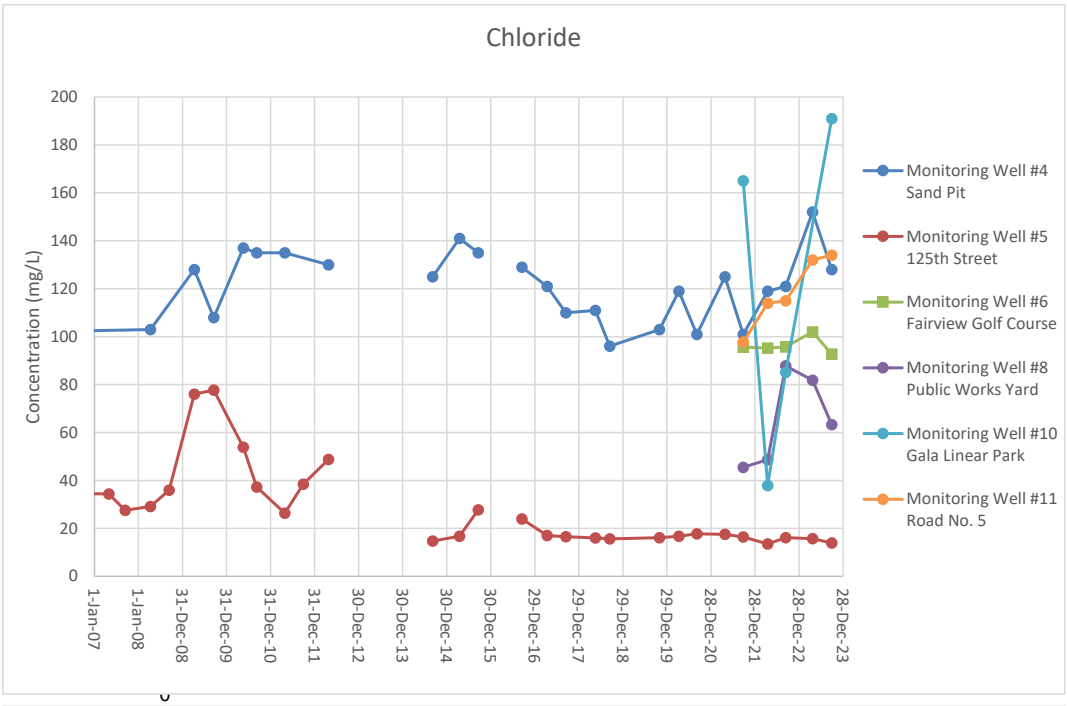
Monitoring Well	Year	Minimum Level (mbtoc)	Maximum Level (mbtoc)	Average Level* (mbtoc)	Level Range (m)
Monitoring Well #4 Sand Pit	2003	9.24	11.13	9.76	1.89
	2004	8.16	9.56	8.77	1.40
	2005	8.12	10.33	8.91	2.21
	2006	8.35	11.16	9.45	2.82
	2007	8.55	11.36	10.06	2.81
	2008	8.70	11.34	10.06	2.64
	2009	8.80	11.30	10.15	2.50
	2010	8.28	10.61	9.32	2.33
	2011	8.36	11.24	9.74	2.88
	2012	8.48	10.85	9.79	2.37
	2013	8.21	10.64	8.89	2.43
	2014	7.43	9.62	8.57	2.19
	2015	8.08	10.20	8.92	2.12
	2016	7.79	8.98	8.38	1.19
	2017	6.24	8.33	7.71	2.09
	2018	1.99	8.13	6.75	6.14
	2019	7.81	9.4	8.47	1.59
	2020	7.8	10.43	9.03	2.63
	2021	8.35	10.75	9.30	2.40
	2022	8.65	10.62	9.51	1.97
	2023	8.41	10.61	9.34	2.2
Monitoring Well #5 125th Street	2003	7.30	9.48	8.68	2.18
	2004	7.95	10.59	9.57	2.64
	2005	7.77	10.22	9.25	2.45
	2006	7.44	9.74	8.83	2.30
	2007	7.64	9.92	8.99	2.28
	2008	9.57	11.32	10.41	1.75
	2009	10.17	10.81	10.47	0.64
	2010	8.26	11.97	10.20	3.71
	2011	5.38	9.69	8.12	4.31
	2012	6.41	9.54	8.48	3.13
	2013	5.59	9.23	7.95	3.64
	2014	8.13	9.77	9.04	1.64
	2015	-	-	-	-
	2016	4.57	9.90	7.70	5.33
	2017	4.56	10.57	7.93	6.01
	2018	5.28	9.09	7.78	3.81
	2019	7.89	9.66	9.01	1.77
	2020	7.36	10.1	9	2.74
	2021	7.1	9.6	8.8	2.5
	2022	7.61	10.13	8.96	2.52
	2023	8.03	9.61	8.9775	1.58
Monitoring Well #6 Fairview Golf Course	2003-2019	*13.92 (Dry)*			
	2021	12.38	12.75	12.58	0.37
	2022	12.87	13.40	13.12	0.53
	2023	13.15	13.75	13.40	0.6
Test Well # 7 (Road No. 5) ABANDONED	2003	25.87	25.89	25.88	0.02
	2004	25.89	25.89	25.89	0.00
	2005	25.44	25.89	25.86	0.45
	2006	25.00	*25.91 (Dry)*	25.56	0.91
	2007-2019	*25.91 (Dry)*			
	2021	Abandoned			
	2022	Abandoned			
	2023	Abandoned			
Monitoring Well #8 Public Works Yard	2021	2.76	3.01	2.91	0.25
	2022	2.00	3.35	2.79	1.35
	2023	2.22	3.02	2.85	0.80
Monitoring Well #9 Cemetery	2021	21.50	21.1 (dry)	21.20	0.40
	2022	21.05	21.44 (dry)	21.13	0.39
	2023	21.10	21.11	21.10	0.01
Monitoring Well #10 Gala Linear Park	2021	25.80	27.70	26.40	1.90
	2022	25.69	26.59	26.10	0.90
	2023	25.81	26.84	26.34	1.03
Monitoting Well #11 Road No. 5	2021	24.40	30.50	27.00	6.10
	2022	24.55	24.84	24.73	0.29
	2023	24.86	25.11	25.01	0.25

corrected 2022 values

TABLE 2-4: HISTORICAL SUMMARY OF WATER QUALITY ANALYSIS FOR FAIRVIEW MONITORING WELLS

Monitoring Well	Sample Date	Chloride	Ammonia	Nitrate + Nitrite	Total Hardness	Sodium
Monitoring Well #4 Sand Pit	22-Apr-03	72	0.05	0.52	1060	55.8
	30-Sep-03	94	0.08	0.39	1370	80.3
	20-Apr-04	111	0.04	0.97	1130	73.1
	4-Sep-04	123	0.02	0.35	3280	108
	12-Apr-05	102	<0.01	1.44	1060	85.1
	9-Apr-08	103	<0.02	2.46	1170	104
	7-Apr-09	128	<0.02	2.21	1030	103
	16-Sep-09	108	0.09	0.74	4980	125
	19-May-10	137	0.02	2.43		
	7-Sep-10	135	0.03	1.02	1310	128
	28-Apr-11	135	0.08	2.95	1020	108
	24-Apr-12	130	0.04	2.39	1110	101
	16-Oct-12		0.034	0.691	1420	119
	9-Apr-13		0.091	1.78	1070	118
	9-Sep-13		0.156	2.06	1350	146
	16-Apr-14		0.073	3.02	1050	115
	4-Sep-14	125		1.68		127
	14-Apr-15	141		3.56		120
	16-Sep-15	135	0.023	1.53	1440	127
	13-Sep-16	129	0.021	1.63	1700	19.2
	10-Apr-17	121	0.084	10.2	820	108
	11-Sep-17	110	<0.020	3.05	387	11.5
	14-May-18	111	0.035	4.12	725	100
	10-Sep-18	96	0.043	2.99	838	87.1
	28-Oct-19	103	0.222	16.9	704	93
	6-Apr-20	119	0.091	8.03	659	92.2
	1-Sep-20	101	0.072	1.11	1120	86.9
	22-Apr-21	125	<0.050	4.19	782	81.7
	21-Sep-21	101	0.073	0.967	2020	97.1
	11-Apr-22	119	<0.050	3.51	991	81.2
	7-Sep-22	121	<0.050	1.35	1610	92
	18-Apr-23	152	0.081	3.56	3750	108
	25-Sep-23	128	<0.050	1.26	1810	107
Monitoring Well #5 125th Street	22-Apr-03	36.1	<0.01	3.9	367	29.5
	30-Sep-03	29.2	0.02	3.9	391	29
	20-Apr-04	30.4	0.03	3.6	395	23.8
	4-Sep-04	22.3	0.02	6.52	447	32.4
	12-Apr-05	34.2	<0.01	5.81	409	25.5
	7-Sep-05	46.5	<0.01	12.4	537	25.7
	15-Jun-06	34.8	<0.01	8.62	543	27
	21-Sep-06	34.6	1.65	6.05	399	28
	1-May-07	34.4	0.41	2.15	355	26
	13-Sep-07	27.5	0.03	2.95	388	30.2
	9-Apr-08	29.1	0.08	3.62	399	35.9
	11-Sep-08	36	0.13	2.8	512	33.7
	7-Apr-09	76	<0.02	6.1	407	35.1
	16-Sep-09	77.7	<0.02	5.72	480	21.6
	19-May-10	53.9	0.03	3.03		
	7-Sep-10	37.3	0.03	1.03	467	29.2
	28-Apr-11	26.3	0.04	2.1	639	41
	28-Sep-11	38.5	0.35	2.75	423	48.7
	24-Apr-12	48.8	1.9	3.19	460	22.4
	16-Oct-12		0.025	2.94	446	19.3
	9-Apr-13		0.036	1.11	381	15.9
	9-Sep-13		0.071	0.652	398	12.4
	16-Apr-14		0.022	0.577	465	13.1
	4-Sep-14	14.7		0.683		14
	14-Apr-15	16.7		1.31		14.7
	16-Sep-15	27.7	< 0.020	0.794	456	31.6

		-	-	-	-	-
	13-Sep-16	23.9	0.022	1.11	960	20.4
	10-Apr-17	17	0.052	1.21	481	14.1
	11-Sep-17	16.5	0.089	1.11	917	88.4
	14-May-18	16	0.058	0.569	400	12.8
	10-Sep-18	15.6	0.066	1.59	348	10.3
	28-Oct-19	16.1	0.774	2.18	415	13.6
	6-Apr-20	16.7	<0.050	1.6	409	14
	1-Sep-20	17.7	<0.050	2.28	419	17.7
	22-Apr-21	17.5	<0.050	1.69	386	16.5
	21-Sep-21	16.4	0.073	1.6	374	15.1
	11-Apr-22	13.5	<0.050	0.796	292	9.87
	7-Sep-22	16.1	<0.050	1.17	442	15.9
	18-Apr-23	15.7	0.101	1.19	372	13
	25-Sep-23	13.9	<0.050	1.31	329	11.2
Monitoring Well #6 Fairview Golf Course	21-Sep-21	95.6	<0.050	2.33	396	96.9
	11-Apr-22	95.2	<0.050	2.76	369	94.5
	7-Sep-22	95.7	<0.050	2.81	395	102
	18-Apr-23	102	<0.050	3.62	417	101
	25-Sep-23	92.7	<0.050	3.02	408	112
Monitoring Well #8 Public Works Yard	21-Sep-21	45.5	<0.050	2.28	311	35.7
	11-Apr-22	48.7	<0.050	2.58	278	30.4
	7-Sep-22	87.8	0.737	1.47	353	48.2
	18-Apr-23	81.8	0.07	1.07	392	42.6
	25-Sep-23	63.3	<0.050	1.34	334	45.2
Monitoring Well #10 Gala Linear Park	21-Sep-21	165	<0.050	5.89	317	67.1
	11-Apr-22	37.9	<0.050	3.18	312	22.4
	7-Sep-22	85.1	<0.050	3.94	674	62.8
	25-Sep-23	191	0.089	3.58	580	86
Monitoring Well #11 Road No. 5	21-Sep-21	97.7	<0.050	3.21	493	18.4
	11-Apr-22	114	<0.050	4.13	470	17.8
	7-Sep-22	115	<0.050	4.34	498	18.3
	18-Apr-23	132	<0.050	5.86	573	24.8
	25-Sep-23	134	<0.050	5.84	592	24.5


Chloride
Concentration (mg/L)
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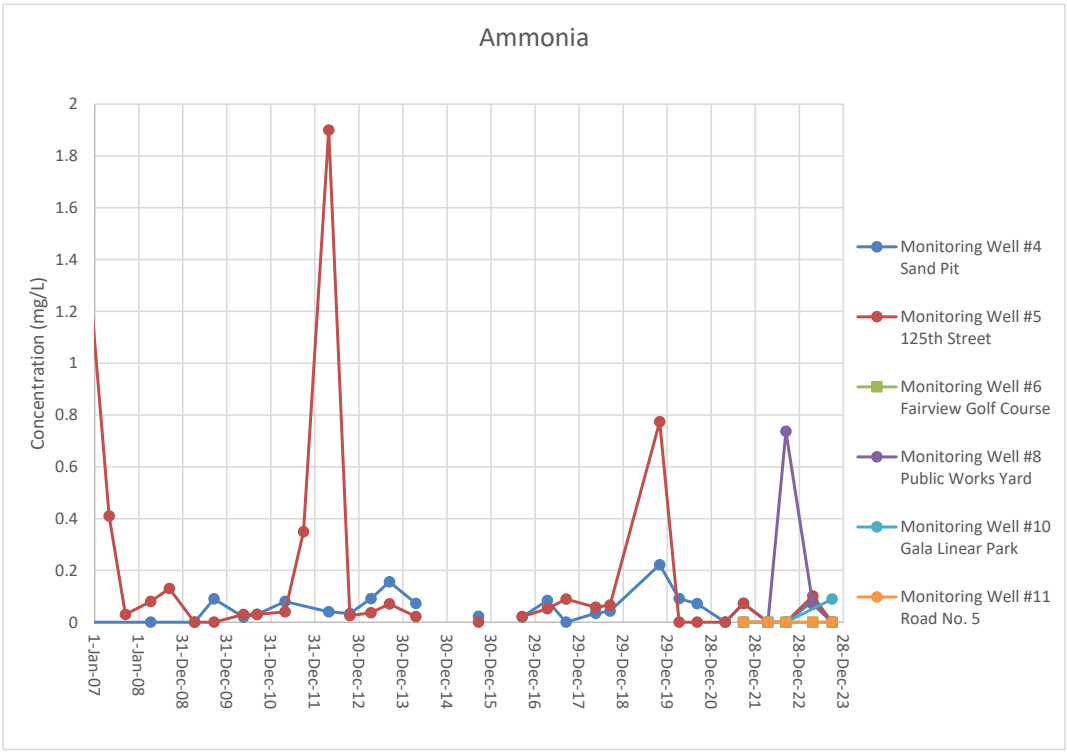
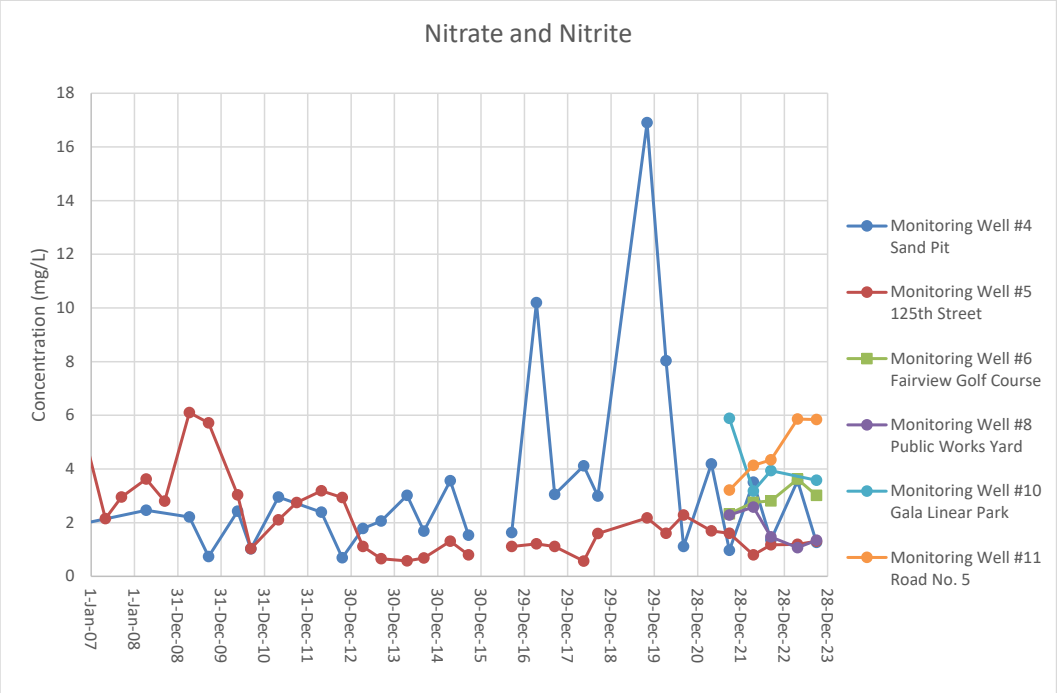
180
160
140
120
100
80
60
40
20
0
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
30-Dec-14
30-Dec-15
29-Dec-16
29-Dec-17
29-Dec-18
29-Dec-19
28-Dec-20
28-Dec-21
28-Dec-22
28-Dec-23
Monitoring Well #4 Sand Pit
Monitoring Well #5 125th Street
Monitoring Well #6 Fairview Golf Course
Monitoring Well #8 Public Works Yard
Monitoring Well #10 Gala Linear Park
Monitoring Well #11 Road No. 5


Ammonia
Concentration (mg/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
30-Dec-14
30-Dec-15
29-Dec-16
29-Dec-17
29-Dec-18
29-Dec-19
28-Dec-20
28-Dec-21
28-Dec-22
28-Dec-23
Monitoring Well #4 Sand Pit
Monitoring Well #5 125th Street
Monitoring Well #6 Fairview Golf Course
Monitoring Well #8 Public Works Yard
Monitoring Well #10 Gala Linear Park
Monitoring Well #11 Road No. 5


Nitrate and Nitrite
Concentration (mg/L)
18
16
14
12
10
8
6
4
2
0
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
30-Dec-14
30-Dec-15
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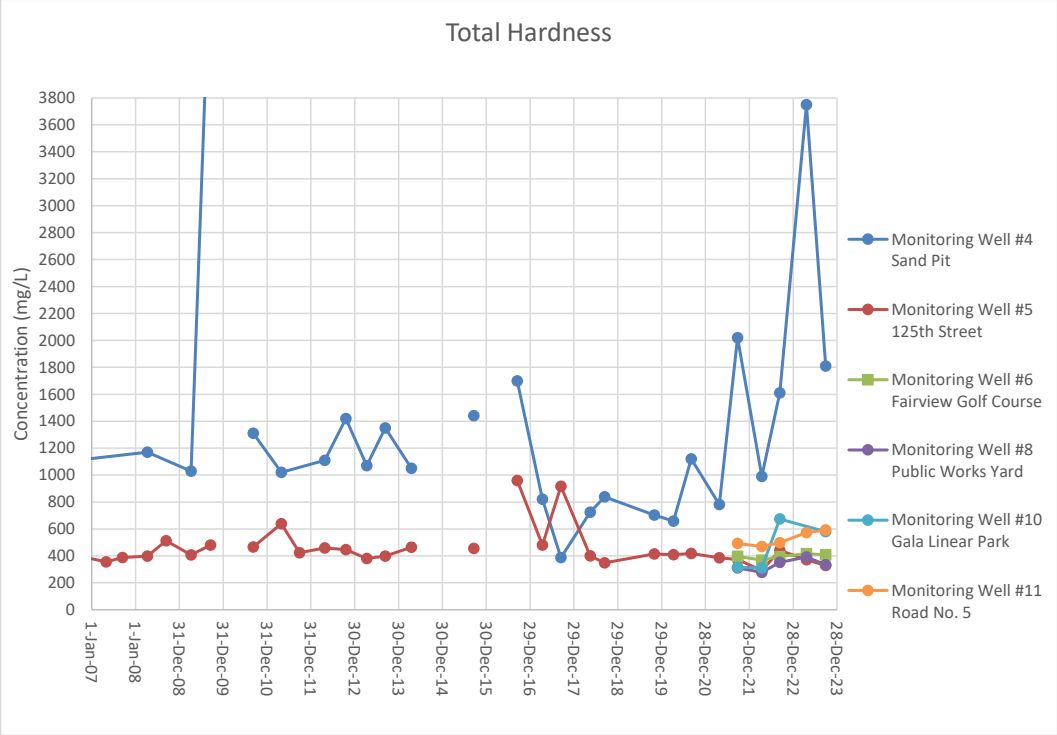
29-Dec-18
29-Dec-19
28-Dec-20
28-Dec-21
28-Dec-22
28-Dec-23
Monitoring Well #4 Sand Pit
Monitoring Well #5 125th Street
Monitoring Well #6 Fairview Golf Course
Monitoring Well #8 Public Works Yard
Monitoring Well #10 Gala Linear Park
Monitoring Well #11 Road No. 5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Concentration (mg/L)
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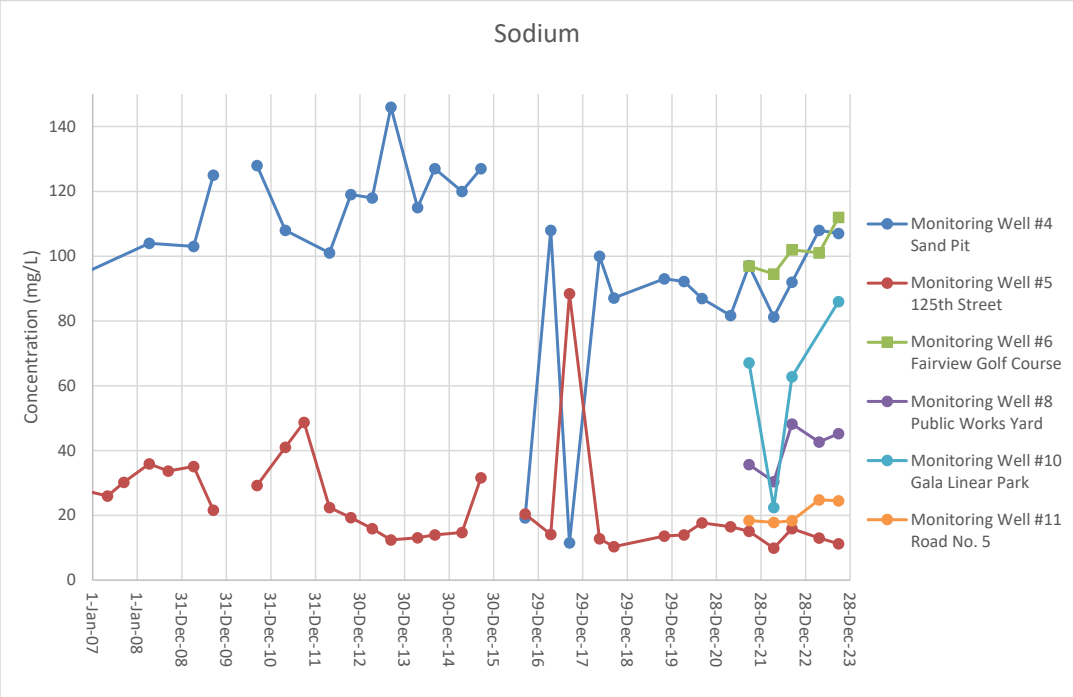
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1-Jan-07
1-Jan-08
31-Dec-08
31-Dec-09
31-Dec-10
31-Dec-11
30-Dec-12
30-Dec-13
30-Dec-14
30-Dec-15
29-Dec-16
29-Dec-17
29-Dec-18
29-Dec-19
28-Dec-20
28-Dec-21
28-Dec-22
28-Dec-23
Monitoring Well #4 Sand Pit
Monitoring Well #5 125th Street
Monitoring Well #6 Fairview Golf Course
Monitoring Well #8 Public Works Yard
Monitoring Well #10 Gala Linear Park
Monitoring Well #11 Road No. 5


Sodium
Concentration (mg/L)
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20
40
60
80
100
120
140
1-Jan-07
1-Jan-08
31-Dec-08
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31-Dec-10
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30-Dec-12
30-Dec-13
30-Dec-14
30-Dec-15
29-Dec-16
29-Dec-17
29-Dec-18
29-Dec-19
28-Dec-20
28-Dec-21
28-Dec-22
28-Dec-23
Monitoring Well #4 Sand Pit
Monitoring Well #5 125th Street
Monitoring Well #6 Fairview Golf Course
Monitoring Well #8 Public Works Yard
Monitoring Well #10 Gala Linear Park
Monitoring Well #11 Road No. 5

CERTIFICATE OF ANALYSIS

REPORTED TO	Oliver, Town of 5971 Sawmill Road, PO Box 638 Oliver, BC V0H 1T0		
ATTENTION	Shannon Grata	**WORK ORDER**	23D2161
PO NUMBER		**RECEIVED / TEMP**	2023-04-20 09:45 / 9.5°C
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02
PROJECT INFO	B.6.	**COC NUMBER**	No Number

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

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23D2161
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02

Analyte	Result	RL	Units	Analyzed	Qualifier
MW1 - Air Cadet (23D2161-01) | Matrix: Water | Sampled: 2023-04-18 09:40					FILTa, PRESa
Anions					
Chloride	**24.6**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**9.72**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**319**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**9.72**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**707**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.105**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.0888**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**101**	0.20	mg/L	2023-04-26	
Magnesium, total	**16.4**	0.010	mg/L	2023-04-26	
Sodium, total	**19.1**	0.10	mg/L	2023-04-26	
MW2 - Rodeo Grounds (23D2161-02) | Matrix: Water | Sampled: 2023-04-18 09:50					FILTa, PRESa
Anions					
Chloride	**10.1**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**3.42**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**2150**	2.50	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.42**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**0.065**	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**617**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.0834**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.0058**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**707**	0.20	mg/L	2023-04-27	RS1
Magnesium, total	**92.7**	0.010	mg/L	2023-04-27	RS1
Sodium, total	**18.2**	0.10	mg/L	2023-04-27	RS1

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23D2161
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02

Analyte	Result	RL	Units	Analyzed	Qualifier
MW3 - Maple Grounds (23D2161-03) | Matrix: Water | Sampled: 2023-04-18 10:05					FILTa, PRESa
Anions					
Chloride	**8.11**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**0.070**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**8470**	2.50	mg/L	N/A	
Nitrate+Nitrite (as N)	**0.0705**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**0.079**	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**815**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.0290**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.0061**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**2650**	0.20	mg/L	2023-04-27	RS1
Magnesium, total	**445**	0.010	mg/L	2023-04-27	RS1
Sodium, total	**33.5**	0.10	mg/L	2023-04-27	RS1
MW4 - Test Well #4 - Sand Pit (23D2161-04) | Matrix: Water | Sampled: 2023-04-18 08:55					FILTa, PRESa
Anions					
Chloride	**152**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**3.56**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**3750**	2.50	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.56**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**0.081**	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**1990**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.211**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.156**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**1130**	0.20	mg/L	2023-04-27	RS1
Magnesium, total	**225**	0.010	mg/L	2023-04-27	RS1
Sodium, total	**108**	0.10	mg/L	2023-04-27	RS1

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23D2161
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02

Analyte	Result	RL	Units	Analyzed	Qualifier
MW5 - Test Well #5 - Chokecherry (23D2161-05) | Matrix: Water | Sampled: 2023-04-18 08:35					FILT, PRESb
Anions					
Chloride	**15.7**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**1.19**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**372**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**1.19**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**0.101**	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**683**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.0179**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.0111**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**110**	0.20	mg/L	2023-04-27	
Magnesium, total	**23.5**	0.010	mg/L	2023-04-27	
Sodium, total	**13.0**	0.10	mg/L	2023-04-27	
MW6 - Fairview Golf Course (23D2161-06) | Matrix: Water | Sampled: 2023-04-18 08:20					FILTa, PRES
Anions					
Chloride	**102**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**3.62**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**417**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.62**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**1220**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.101**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.0970**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**86.7**	0.20	mg/L	2023-04-26	
Magnesium, total	**48.5**	0.010	mg/L	2023-04-26	
Sodium, total	**101**	0.10	mg/L	2023-04-26	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23D2161
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02

Analyte	Result	RL	Units	Analyzed	Qualifier
MW7 - Public Works Yard (23D2161-07) | Matrix: Water | Sampled: 2023-04-18 10:10					FILTa, PRESa
Anions					
Chloride	**81.8**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**1.07**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**392**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**1.07**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**0.070**	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**960**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.146**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.136**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**109**	0.20	mg/L	2023-04-26	
Magnesium, total	**28.9**	0.010	mg/L	2023-04-26	
Sodium, total	**42.6**	0.10	mg/L	2023-04-26	
MW10 - End of Road 5 (23D2161-08) | Matrix: Water | Sampled: 2023-04-18 08:15					FILTa, PRESb
Anions					
Chloride	**132**	0.10	mg/L	2023-04-22	
Nitrate (as N)	**5.86**	0.010	mg/L	2023-04-21	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-04-21	
Calculated Parameters					
Hardness, Total (as CaCO3)	**573**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**5.86**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-04-23	
BOD, 5-day Carbonaceous	< 6.4	2.0	mg/L	2023-04-26	
Conductivity (EC)	**1160**	2.0	µS/cm	2023-04-21	
Phosphorus, Total (as P)	**0.0147**	0.0050	mg/L	2023-04-24	
Phosphorus, Total Dissolved	**0.0136**	0.0050	mg/L	2023-04-24	
Total Metals					
Calcium, total	**129**	0.20	mg/L	2023-04-26	
Magnesium, total	**60.6**	0.010	mg/L	2023-04-26	
Sodium, total	**24.8**	0.10	mg/L	2023-04-26	

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23D2161
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02

Sample Qualifiers:

FILT	The sample has been filtered for NH3 in the laboratory. Results may not reflect conditions at the time of sampling.
FILTa	The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
PRES	Sample has been preserved for NH3, TP, TDP in the laboratory and the holding time has been extended.
PRESa	Sample has been preserved for TDP, TP, NH3 in the laboratory and the holding time has been extended.
PRESb	Sample has been preserved for TP, TDP, NH3 in the laboratory and the holding time has been extended.
RS1	The Reporting Limits for this sample have been raised due to high analyte concentration and/or matrix interference.

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Oliver, Town of	**WORK ORDER**	23D2161
PROJECT	Ground Water Monitoring	**REPORTED**	2023-04-27 13:02

Analysis Description	Method Ref.	Technique	Accredited	Location
Ammonia, Total in Water	SM 4500-NH3 G* (2021)	Automated Colorimetry (Phenate)	✓	Kelowna
Anions in Water	SM 4110 B (2020)	Ion Chromatography	✓	Kelowna
Biochemical Oxygen Demand, Carbonaceous in Water	SM 5210 B (2019)	Dissolved Oxygen Meter	✓	Kelowna
Conductivity in Water	SM 2510 B (2021)	Conductivity Meter	✓	Kelowna
Hardness in Water	SM 2340 B* (2021)	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Est)	✓	N/A
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
Total Metals in Water	EPA 200.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond

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
mg/L	Milligrams per litre
µS/cm	Microsiemens per centimetre
EPA	United States Environmental Protection Agency Test Methods
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

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.

CERTIFICATE OF ANALYSIS

REPORTED TO	Oliver, Town of 5971 Sawmill Road, PO Box 638 Oliver, BC V0H 1T0		
ATTENTION	Shannon Grata	**WORK ORDER**	23I3324
PO NUMBER		**RECEIVED / TEMP**	2023-09-26 09:25 / 12.4°C
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01
PROJECT INFO	B.6.	**COC NUMBER**	No Number

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

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23I3324
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01

Analyte	Result	RL	Units	Analyzed	Qualifier
MW1 - Air Cadet (23I3324-01) | Matrix: Water | Sampled: 2023-09-25 10:05					FILT, PRES
Anions					
Chloride	**24.7**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**8.64**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**318**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**8.64**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**652**	2.0	µS/cm	2023-09-28	
Phosphorus, Total (as P)	**0.0836**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.0681**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**101**	0.20	mg/L	2023-10-01	
Magnesium, total	**16.1**	0.010	mg/L	2023-10-01	
Sodium, total	**20.1**	0.10	mg/L	2023-10-01	
MW2 - Rodeo Grounds (23I3324-02) | Matrix: Water | Sampled: 2023-09-25 10:12					FILT, PRES
Anions					
Chloride	**10.7**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**3.59**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**1220**	1.00	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.59**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**614**	2.0	µS/cm	2023-09-28	
Phosphorus, Total (as P)	**35.0**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	< 0.0050	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**453**	0.20	mg/L	2023-10-01	RS1
Magnesium, total	**22.0**	0.010	mg/L	2023-10-01	RS1
Sodium, total	**15.7**	0.10	mg/L	2023-10-01	RS1

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23I3324
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01

Analyte	Result	RL	Units	Analyzed	Qualifier
MW3 - Maple Avenue (23I3324-03) | Matrix: Water | Sampled: 2023-09-25 10:28					FILT, PRES
Anions					
Chloride	**9.65**	0.10	mg/L	2023-09-28	
Nitrate (as N)	< 0.010	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**1100**	2.50	mg/L	N/A	
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**3.37**	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	**248**	2.0	mg/L	2023-10-03	
Conductivity (EC)	**878**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**69.2**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.0300**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**344**	0.20	mg/L	2023-10-01	RS1
Magnesium, total	**58.2**	0.010	mg/L	2023-10-01	RS1
Sodium, total	**18.5**	0.10	mg/L	2023-10-01	RS1
MW4 - Infiltration Basin (Sandpit) (23I3324-04) | Matrix: Water | Sampled: 2023-09-25 08:40					FILT, PRES
Anions					
Chloride	**128**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**1.26**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**1810**	1.00	mg/L	N/A	
Nitrate+Nitrite (as N)	**1.26**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**1870**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**37.0**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.213**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**578**	0.20	mg/L	2023-10-01	RS1
Magnesium, total	**87.3**	0.010	mg/L	2023-10-01	RS1
Sodium, total	**107**	0.10	mg/L	2023-10-01	RS1

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23I3324
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01

Analyte	Result	RL	Units	Analyzed	Qualifier
MW5 - Chokecherry Street (23I3324-05) | Matrix: Water | Sampled: 2023-09-25 08:20					FILT, PRES
Anions					
Chloride	**13.9**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**1.31**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**329**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**1.31**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**605**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**0.581**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.0190**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**97.5**	0.20	mg/L	2023-10-01	
Magnesium, total	**20.7**	0.010	mg/L	2023-10-01	
Sodium, total	**11.2**	0.10	mg/L	2023-10-01	
MW6 - Fairview Gold Course (23I3324-06) | Matrix: Water | Sampled: 2023-09-25 08:15					FILT, PRES
Anions					
Chloride	**92.7**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**3.02**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**408**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.02**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**1160**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**0.109**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.106**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**85.3**	0.20	mg/L	2023-10-01	
Magnesium, total	**47.3**	0.010	mg/L	2023-10-01	
Sodium, total	**112**	0.10	mg/L	2023-10-01	

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23I3324
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01

Analyte	Result	RL	Units	Analyzed	Qualifier
MW7 - Public Works Yard (23I3324-07) | Matrix: Water | Sampled: 2023-09-25 10:40					FILT, PRES
Anions					
Chloride	**63.3**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**1.34**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**334**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**1.34**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**764**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**0.133**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.0594**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**90.2**	0.20	mg/L	2023-10-01	
Magnesium, total	**26.3**	0.010	mg/L	2023-10-01	
Sodium, total	**45.2**	0.10	mg/L	2023-10-01	
MW9 - Linear Park (by High School) (23I3324-08) | Matrix: Water | Sampled: 2023-09-25 09:15					FILT, PRES
Anions					
Chloride	**191**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**3.58**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**580**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.58**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	**0.089**	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**1040**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**8.36**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	**0.0174**	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**170**	0.20	mg/L	2023-10-01	
Magnesium, total	**37.6**	0.010	mg/L	2023-10-01	
Sodium, total	**86.0**	0.10	mg/L	2023-10-01	

TEST RESULTS

REPORTED TO	Oliver, Town of	**WORK ORDER**	23I3324
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01

Analyte	Result	RL	Units	Analyzed	Qualifier
MW10 - End of Road 5 (23I3324-09) | Matrix: Water | Sampled: 2023-09-25 07:55					FILT, PRES
Anions					
Chloride	**134**	0.10	mg/L	2023-09-28	
Nitrate (as N)	**5.84**	0.010	mg/L	2023-09-28	
Nitrite (as N)	< 0.010	0.010	mg/L	2023-09-28	
Calculated Parameters					
Hardness, Total (as CaCO3)	**592**	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**5.84**	0.0100	mg/L	N/A	
General Parameters					
Ammonia, Total (as N)	< 0.050	0.050	mg/L	2023-09-28	
BOD, 5-day Carbonaceous	< 7.0	2.0	mg/L	2023-10-03	
Conductivity (EC)	**1140**	2.0	µS/cm	2023-09-30	
Phosphorus, Total (as P)	**0.0343**	0.0050	mg/L	2023-09-29	
Phosphorus, Total Dissolved	< 0.0050	0.0050	mg/L	2023-09-29	
Total Metals					
Calcium, total	**131**	0.20	mg/L	2023-10-01	
Magnesium, total	**64.2**	0.010	mg/L	2023-10-01	
Sodium, total	**24.5**	0.10	mg/L	2023-10-01	

Sample Qualifiers:

FILT	The sample has been filtered for TDP in the laboratory. Results may not reflect conditions at the time of sampling.
PRES	Sample has been preserved for NH3, TP, TDP in the laboratory and the holding time has been extended.
RS1	The Reporting Limits for this sample have been raised due to high analyte concentration.

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Oliver, Town of	**WORK ORDER**	23I3324
PROJECT	Ground Water Monitoring	**REPORTED**	2023-10-04 14:01

Analysis Description	Method Ref.	Technique	Accredited	Location
Ammonia, Total in Water	SM 4500-NH3 G* (2021)	Automated Colorimetry (Phenate)	✓	Kelowna
Anions in Water	SM 4110 B (2020)	Ion Chromatography	✓	Kelowna
Biochemical Oxygen Demand, Carbonaceous in Water	SM 5210 B (2019)	Dissolved Oxygen Meter	✓	Kelowna
Conductivity in Water	SM 2510 B (2021)	Conductivity Meter	✓	Kelowna
Hardness in Water	SM 2340 B* (2021)	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Est)	✓	N/A
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
Total Metals in Water	EPA 200.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond

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
mg/L	Milligrams per litre
µS/cm	Microsiemens per centimetre
EPA	United States Environmental Protection Agency Test Methods
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

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 H

Soils Classification and Description

Hamilton & Associates
3909 16th Street
Vernon, BC, V1T 7N5

June 23, 2020

Town of Oliver
c/o Western Water Associates Ltd.
#106-5145 26 Street,
Vernon, BC V1T 8G4

RE: OPERATIONAL CERTIFICATE NUMBER PE-13717
SOIL ASSESSMENT PROGRAM – NEW RECLAIMED WATER IRRIGATION AREAS

Attention: Ryan Rhodes, P.Geo.

1. INTRODUCTION

The Town of Oliver (the Town) currently discharges the reclaimed municipal wastewater from its wastewater treatment facility (WWTF) to ground by irrigation under the authorization of Operational Certificate (OC) PE-13717. The Town wishes to expand the area that is authorized for irrigation with reclaimed municipal wastewater and will therefore require an amendment to the OC. Hugh Hamilton, P.Ag., of Hamilton and Associates was retained by Western Water Associates Ltd., on behalf of the Town, to complete a soil assessment to determine whether the lands on planned new irrigation areas are capable of accepting reclaimed wastewater for irrigation purpose. The requirements for the soils assessment are specified in Section 6.9 of the OC.

The assessment was completed through a combination of a review of background information (including soil maps and reports, climate data, land use zoning maps, and aerial photographs), a field reconnaissance completed on June 3, 2020, and data analyses and interpretation. Additional information on methods is contained in Section 4.

2. DESCRIPTION OF THE PLANNED NEW IRRIGATION AREAS

Four irrigation areas are to be added to the approved land base for reclaimed water irrigation:

- The playing fields and park land located between Oliver Elementary School and South Okanagan High School (Figure 1 – maps and photos are at end of report). All of this parcel is currently covered with turfgrass and is irrigated with an underground sprinkler system (Photo 1). There are mature trees around the edges of the fields.
- Oliver Cemetery (Figure 2). The cemetery grounds are primarily vegetated with turfgrass (Photos 3 and 4) and are irrigated with underground sprinklers. Trees (mostly cedar) are planted around the property boundary, and there are some deciduous tree among the monuments.
- Oliver Community Park located immediately east of the Okanagan River on Fairview Road (Figure 3). The park includes three baseball/softball fields, a lawn bowling green, and areas for walking and sitting. The ground cover is turfgrass and there are a number of mature trees in the

areas outside the ball fields and on the small area on the north side of Fairview Road (Photo 5). The park is irrigated with an underground sprinkler system.

- Oliver Municipal Airport (Map 4). The new irrigation area is the strip of industrial-zoned land on the east side of the runway (Photo 7). The fields surrounding the runway to the west are already authorized for reclaimed water irrigation. The new irrigation area is mostly unoccupied although some parts are used for storage and there is one building. It appears that the topsoil was stripped from parts of the site and transported off-site. Vegetation cover is limited (about 25-50% on average) and includes alfalfa, agronomic and native grasses, and invasive species (see Section 4). It is not currently irrigated.

3. EXISTING SOILS, LAND USE AND EXPOSURE POTENTIAL

Soil information for the subject property was obtained from the BC Soil Information Finder Tool (SIFT). Figures 1 to 4 show the spatial distribution of soil types on the planned irrigation sites, and the soil properties are summarized in Table 1. Soils at the school and airport sites are mapped by BC as 100% Rutland soils, which are classified as Orthic Dark Brown Chernozems, developed on glacio-fluvial deposits. They typically are gravelly with a sandy or sandy loam surface texture (Photo 2). Soils at the cemetery are Ponderosa soils developed on alluvial fan deposits with a fluvial veneer. They are classified as Rego Dark Brown Chernozems and are also gravelly within sandy loam. The soils in the park have been developed on fluvial and floodplain deposits. About 90% of the irrigated area is classified as Kinney soils and are Gleyed Regosols (signifying that they are relatively young and that the soil profile is routinely saturated for an extended period). The northwest part of the park as mapped as Cawston soils, a Rego Gleysol (indicating somewhat greater soil profile development but also routinely saturated). The Kinney soils have a sandy loam or loam texture with some silt lenses, while the Cawston soil is a silt loam (Photo 6).

Because the sites are all located within the municipal boundaries, there are no published agricultural capability maps. All of the sites are located outside of the BC Agricultural Land Reserve.

The school grounds are used by the school students of sports and general play when school is in session, and by the public for recreation without restriction at all other times. The cemetery is open to the public and family visits every day during specified hours. Oliver Community Park is always open to public use. The airport lands are located behind a locked gate, so public access is unlikely. Based on the definitions in the BC Reclaimed Water Guidelines (BC Ministry of Environment 2013), the school grounds, park and cemetery would be considered “High Exposure Potential” while the airport is “Low Exposure Potential”. The school, park and cemetery also would be considered “high public use lands” as per Section 5.1.2 of the OC, while the airport is “low public use lands”. The treatment standard for use of reclaimed water on these sites varies slightly between the regulatory documents (Table 2). The OC requirements are understood to take precedence over the other documents, although Section 5.1.2 says that irrigation shall conform to guidelines developed by BC, so the Reclaimed Water guidelines should also apply (note that it sets limits for *E. coli*, not fecal coliforms).

Table 1 – Soils on the Planned Irrigation Sites

Soil Name	**Rutland**	**Kinney**	**Cawston**	**Ponderosa**
Sites where present	**Airport** (AP), **Schools** (SC)	**Oliver Community Park** (PK)	**Oliver Community Park**	**Cemetery** (CM)
Approximate coverage on sites	AP-100%, SC-100%	PK – 90%	PK- 10%	CM - 100%
Classification	Orthic Dark Brown Chernozem	Gleyed Regosol	Rego Humic Gleysol	Rego Dark Brown Chernozem
Parent material	Sandy veneer over glacial-fluvial deposits	Loamy fluvial veneer over sandy floodplain deposits	Fluvial deposits	Fluvial veneer over fluvial fan deposits
Texture	Sandy loam, loamy sand	Sandy loam/loam with some silt lenses	Silt loam or loam	Gravelly/very gravelly sandy loam or gravelly loam
Drainage	Rapid	Imperfect	Poor to imperfect	Well to rapid
Water holding capacity	Low	Moderate to low	High	Low
Major soil limitations for crops	Stoniness, low available moisture holding capacity, low natural fertility	High water tables near Okanagan River; moderate salinity	Short duration fluctuating groundwater table in sandy & gravelly subsoils during spring freshet	Stoniness; susceptible to soil acidification after several years or irrigation & fertilization

Sources: Government of British Columbia. (2019); Wittneben (1986); Gough et al. (1994).

Table 2
Standards for bacteriological quality of reclaimed water for irrigation

Regulatory Document	School grounds, cemetery & park	Airport
Operational Certificate PE-13717	Maximum 2.2 MPN/100 mL fecal coliforms	Maximum 200 MPN/100 mL fecal coliforms
Reclaimed Water Guideline (BC MoE 2013)	1 CFU/100 mL or 2 MPN/ 100 mL *E. coli*	Not specified
Municipal Wastewater Regulation	Median <1 CFU/100 mL or <2.2 MPN fecal coliforms; maximum 14 CFU/100 mL	Median <200 CFU/100 mL fecal coliforms; maximum 1,000 CFU/100 mL

4. RESULTS OF THE ASSESSMENT

4.1 Soil Properties

The field assessment took place on June 3, 2020. The weather was clear and sunny although there had been some rainfall over the previous several days. The field work was completed by Hugh Hamilton, P.Ag. with the assistance of Ryan Rhodes, P.Geo., of Western Water. At each site, several boreholes were completed with a hand auger to a depth of between approximately 0.3 and 0.7 metres. The characteristics of the soil at each location were noted including the thickness of the upper (A or Ap) horizon, presence/depth of roots, soil texture (by hand), soil colour, presence/absence of mottles (iron staining), and the amount of gravel (based on the Soil Classification Working Group, 1998). In most cases it was not possible to auger beyond about 0.5 m depth because of the amount of gravel in the soil. In addition to the boreholes, we noted the vegetation cover and general drainage patterns, and looked for evidence of water ponding or running off the sites from previous irrigation or rainfall.

The soil properties observed in the field were consistent with the existing BC mapping, indicating that the published soil information (SIFT) can be relied upon for irrigation planning. The key exception is the land on the airport site where the topsoil (likely the Ap horizon[1] or the combined A and B horizons appear to have been stripped off in places, exposing the underlying gravelly BC or C horizon that is characteristic of the Rutland soil (Wittneben 1986). This was confirmed by digging a soil pit or the west side of the fence in the alfalfa field that surrounds the runway, where a dark brown Ap horizon (~0.3 m thick) was present (Photo 8). At the airport site there is considerable gravel exposed on the surface among pockets of thin sandy soil. The vegetation cover is sparse (Photos 7, 9 and 10).

The soils in Oliver Community Park were moist but not saturated at the time of the site visit, and no free water was encountered in any of the auger holes. At depths beyond about 0.15 m the soils were grey-brown in colour with faint mottling, indicating periodic saturation and reducing conditions. These properties may reflect conditions prior to creation of the park and construction of the dike along the Okanagan River. However, a high water table is likely during spring freshet when the river level is high.

[1] The “p” in the Ap soil horizon descriptor represent the plow layer, where previous cultivation has typically blended the natural A and part of the natural B horizons.

4.2 Capability for Irrigation

Table 3 shows the monthly average irrigation demand for the soils on the planned irrigation sites. These estimates were generated using the BC Irrigation Calculator[2] for the soil textures confirmed in the field. At the school, cemetery, and park sites the crop is grass, while the crop at the airport was assumed to be alfalfa, like the neighbouring field (alfalfa is currently sporadically present on the new fields – Photo 10). Sprinkler was selected as the irrigation method except at the airport, where a solid set gun was assumed (consistent with the method used on the fields around the runway). The irrigation demand values in Table 3 are presented as cubic metres per hectare per day for the specified month as well as a total volume per hectare for the core May 1 to September 30 irrigation season.

Based on the soil assessment and the irrigation capacity calculations, the school, cemetery, and park sites are all suitable for irrigation with reclaimed water, subject to the regulatory requirements for reclaimed water and assuming best practices are followed for irrigation on public lands (Section 4.3).

It is important to note that the irrigation demand values shown are estimates of average rates based on modelling data and should be used for guidance only. Specific sites may be capable of using more or less water in any specific year depending on the weather. Except for the new areas at the airport, the other sites are currently irrigated, and the Town of Oliver and School Board operators have considerable experience managing the irrigation regime on their sites. In general, the irrigation volumes should be managed to optimize crop growth while meeting the regulations and best practices for the use of reclaimed water. Additional guidance on irrigation operations is provided in the next section.

[2] On-line at: http://bcwatercalculator.ca/agriculture/irrigation

Table 3
Estimated Average Irrigation Rate by land parcel

Site	**Community Park – N. Part**	**Community Park – Middle Part**	**Community Park – S. Part**	**Airport***	**Cemetery**	**Schools – N. Side**	**Schools – S. Side**
PID	001486683	006278159	026967201	007629583	n/a	001486683	010562401
Dominant Soil	Cawston	Kinney	Kinney	Rutland	Ponderosa	Rutland	Rutland
Irrigation Period**	Apr 27 – Oct 1	Apr 27 – Oct 1	Apr 27 – Oct 1	Apr 26 – Oct 1	Apr 27 – Oct 1	Apr 29 – Oct 1	Apr 29 – Oct 1
VOLUME PER HECTARE	**m^3/ha/day**	**m^3/ha/day**	**m^3/ha/day**	**m^3/ha/day**	**m^3/ha/day**	**m^3/ha/day**	**m^3/ha/day**
April	0.68	0.88	0.85	*0.88*	zero	1.75	0.00
May	32	42	42	*56*	35	42	37
June	56	72	72	*96*	77	72	71
July	71	91	91	*121*	99	91	90
August	59	75	75	*100*	82	75	75
September	37	48	48	*64*	52	48	48
October	53	67	68	*90*	75	67	67
TOTAL MAY-SEPT (m^3/ha)	**7,833**	**10,042**	**10,042**	***13,407***	**10,575**	**10,043**	**9,822**

*Airport values in Italics would apply if the topsoil were intact. Values shown are not appropriate under current conditions and should not be used. See text Section 4.3 for recommendations.

**Irrigation period is from the BC Agriculture Water Calculator. Note that irrigation typically occurs on few days in both April and October. The total volume per hectare for the core May 1 to September 30 irrigation season is intended to provide guidance for irrigation planning purposes.

4.3 Operational Considerations

Irrigation must follow the conditions specified in the OC. Following are the key clauses that apply to new reclaimed water irrigation on the four sites:

- Section 5.1.2 - Disinfection must meet the requirements of the OC (≤2.2 MPN/100 mL fecal coliforms) and the Reclaimed Water Guideline ≤1 CFU/100 mL or ≤2 MPN/ 100 mL *E. coli)*.
- Section 5.2 – The irrigation period is March 15 to October 31.
- Section 5.3 – No reclaimed water shall be applied within 15 m of a stream (e.g. Okanagan River at the park site) or waterbody, or within 30 m of a well used for domestic supply.
- Sections 5.4 and 5.5 – No surface runoff of irrigated runoff shall occur, and no water should emerge from slopes located downgradient of the irrigated areas (known as tail water).
- Section 4.5 – Spray irrigation water must not drift in the air off-site, e.g. as an aerosol.
- Section 5.7.2 – Irrigation should not cause the soils to become saturated or cause soil erosion or instability.

Section 5.7.1 of the OC states that the irrigation rates should follow the 1989 BC Sprinkler Irrigation Manual. That manual was published before the province developed its current irrigation demand models or the BC Agriculture Water Calculator. The irrigation rates shown above in Table 3 are preferred over the single value given for Oliver in the 1989 manual because they are customized for each soil polygon.

In addition, the following practices from the BC Reclaimed Water Guideline (p. 20) should be followed at the **school, cemetery, and park sites**.

- No direct contact shall occur between the reclaimed water and any person while irrigation is underway.
- Residual chlorine should be present in the reclaimed water at the point of use at a concentration of at least 0.5 mg/L.
- There should be signs indicating that reclaimed water is used for irrigation (as per OC Section 3.12.1).
- The movement of irrigation water below the rooting zone to groundwater must be minimized.
- Periodic sampling (i.e. annually) and testing of the reclaimed water for metals and ions (specifically sodium and chloride) should take place, with the results compared to the applicable BC and Canadian water quality guidelines. This is in addition to the testing for BOD, TSS and nutrients under the OC.

At the **airport**, special irrigation management is necessary because of the lack of topsoil and the sparse vegetative cover on the site, which could result in excessive volumes of reclaimed water moving to groundwater rather than being evapotranspired. Irrigation of this site should begin in a limited fashion until it can be demonstrated that irrigation can meet the same guidelines and standards for the other sites, as listed above. The recommended approach is as follows:

- Irrigation of the site should not start before June 15 and should finish by September 10.

- Start with about one-half the prescribed monthly rate from the BC calculator (Table 3; e.g. maximum 60 m^3/ha/day in July). Monitor the to see if the alfalfa and grasses on-site respond with increased growth and expanded surface coverage.
- If feasible, apply a layer (approximately 10 cm) of soil, compost or biosolids before beginning irrigation in the first year. This is to improve water and nutrient retention and to promote vegetative growth. This could begin with a pilot test program on several plots (e.g. three 20 m × 20 m plots) to fine-tune the methodology.
- All other conditions in the OC and the Reclaimed Water Guideline must also apply.

If the vegetation cover becomes better established and an organic litter layer builds up on the surface, the length of the irrigation season and the irrigation rate may be increased at the new airport site until they approach the guidelines for a Rutland soil.

5. CONCLUSIONS AND RECOMMENDATIONS

To conclude, the schoolyard, cemetery, and park sites are all suitable for irrigation with reclaimed water, subject to the regulatory requirements for reclaimed water and assuming best practices are followed for irrigation on public lands (as listed in Section 4.3). The airport lands located east of the existing irrigated lands will require special management if they are to be irrigated with reclaimed water, due to the lack of topsoil and the sparse vegetation. Irrigation can proceed within a limited season only (June 15 to September 10), initially using rates that are about one-half of the BC Agriculture Water Calculator. If the vegetative cover improves and a layer of organic litter develops on the surface, then the schedule and irrigation rates may be re-evaluated. If possible, a layer of soil, biosolids or compost should be applied prior to irrigation to improve water and nutrient retention.

6. CLOSURE

This report was prepared exercising the standard of care, skill and diligence which is reasonably expected within the agrology profession involved in the assignment, in the location of the assignment, as measured by professional standards applicable during the performance of the services. No other warranty or guarantee, expressed, implied or statutory, is made or intended by this report.

I trust this completes this assignment to your satisfaction. Please contact the undersigned at (250) 938-3408 if you have any questions or require additional information.

Sincerely,
Hamilton and Associates

Hugh Hamilton, Ph.D., P.Ag.
Senior Scientist

Attachments: Figures 1-4 and Photographs.

REFERENCES

BC Ministry of Environment 2013. Reclaimed Water Guideline: A companion document to the Municipal Wastewater Regulation. Victoria. 44 pp.

Gough, N., G. Hughes-Games, and D. Nikkel. 1994. Soil Management Handbook for the Okanagan and Similkameen Valleys. 1st Edition. B.C. Ministry of Agriculture, Fisheries and Food.

Government of British Columbia. 2019. Soil Information Finder Tool (SIFT). On-line at: https://www2.gov.bc.ca/gov/content/environment/air-land-water/land/soil/soil-information-finder

Soil Classification Working Group. 1998. The Canadian System of Soil Classification. 3rd Edition. Agriculture and Agri-Food Canada. Ottawa.

Wittneben, U. 1986. Soils of the Okanagan and Similkameen Valley. Report no. 52, BC Soil Survey. Ministry of Environment. Victoria. 229 pp.

PHOTOGRAPHS

Photo 1. Sports field with turfgrass cover between elementary and high schools.

Photo 2: Typical surface soil (~4-20 cm below surface) at school site.

Photo 3: Lawn area along cemetery boundary, currently irrigated.

Photo 4: Cemetery overview showing unirrigated and irrigated (background) areas.

Photo 5: Oliver Community Park from dike looking northeast.

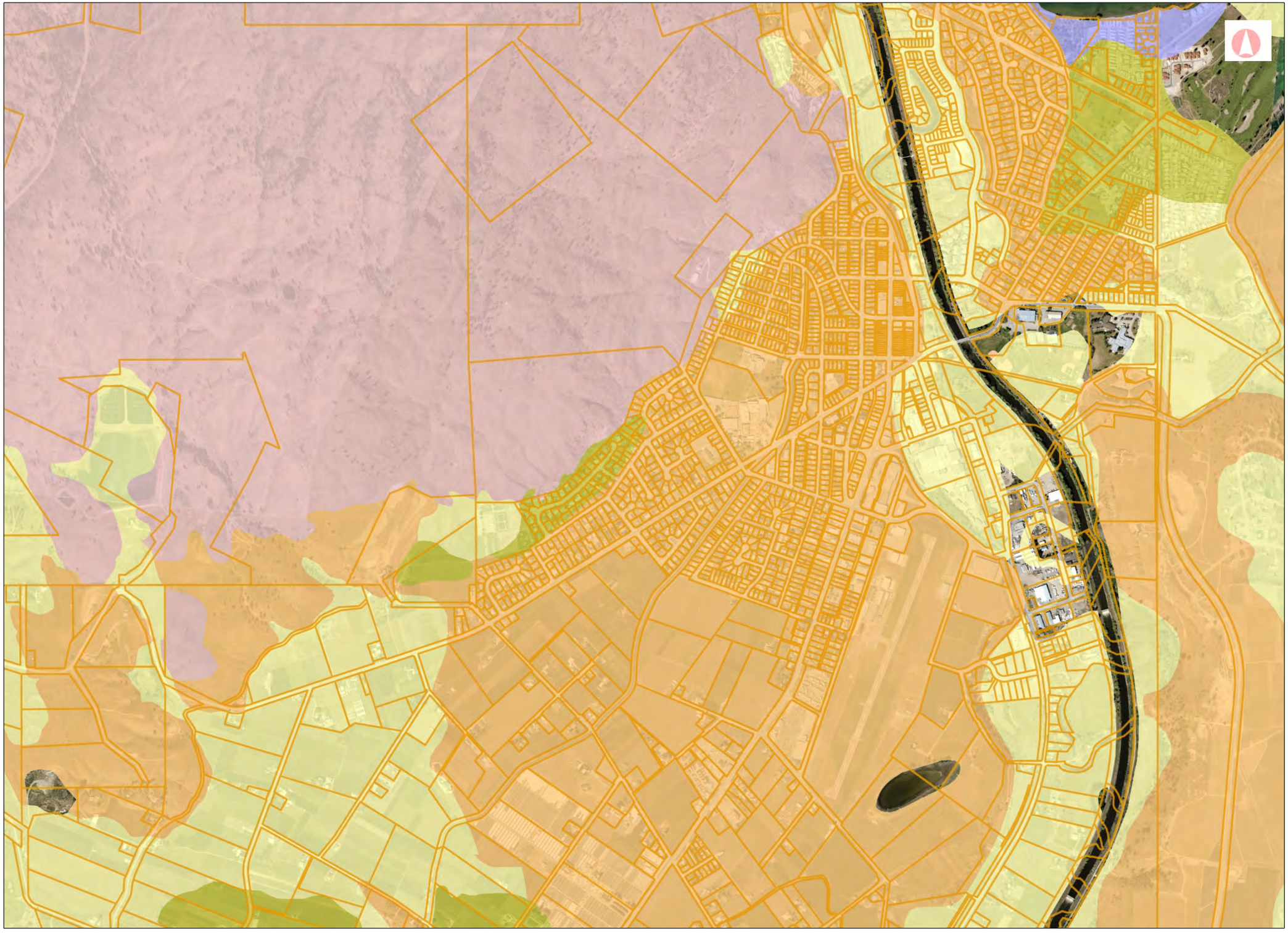
Photo 6: Example of silty soil in north part of Oliver Community Park

Photo 7: Proposed new irrigation area at airport. Note exposed sub-soil and relatively spare vegetative cover [Land on right side of photo may receive some irrigation water from fields near runway (yellow flowers)].

Photo 8: Surface soil in irrigated fields. Note intact dark upper horizon and presence of gravel throughout.

Photo 9: Soil pit on proposed irrigation area at airport. At this location, a residual A/Ap horizon is present. Note fine roots in upper 10 cm.

Photo 10: Ground surface at new airport irrigation area where topsoil may have been partially removed. Note how alfalfa plants are green as their roots obtain moisture from deep within soil.



BRITISH COLUMBIA

iMapBC Mapping

Legend

PMBC Parcel Cadastre - Ou

Soil Polygons - Parent Mate

- MDEP_1
- <Null>
- -
- Anthropogenic
- Colluvial
- Eolian
- Fluvial
- Organic - Fen Peat
- Organic - Forest Peat
- Glaciofluvial
- Glaciolacustrine
- Glaciomarine
- Lacustrine
- Marine
- Organic - Spaghnum Peat
- Till
- Undifferentiated Mineral
- Organic - Undifferentiated
- Volcanic

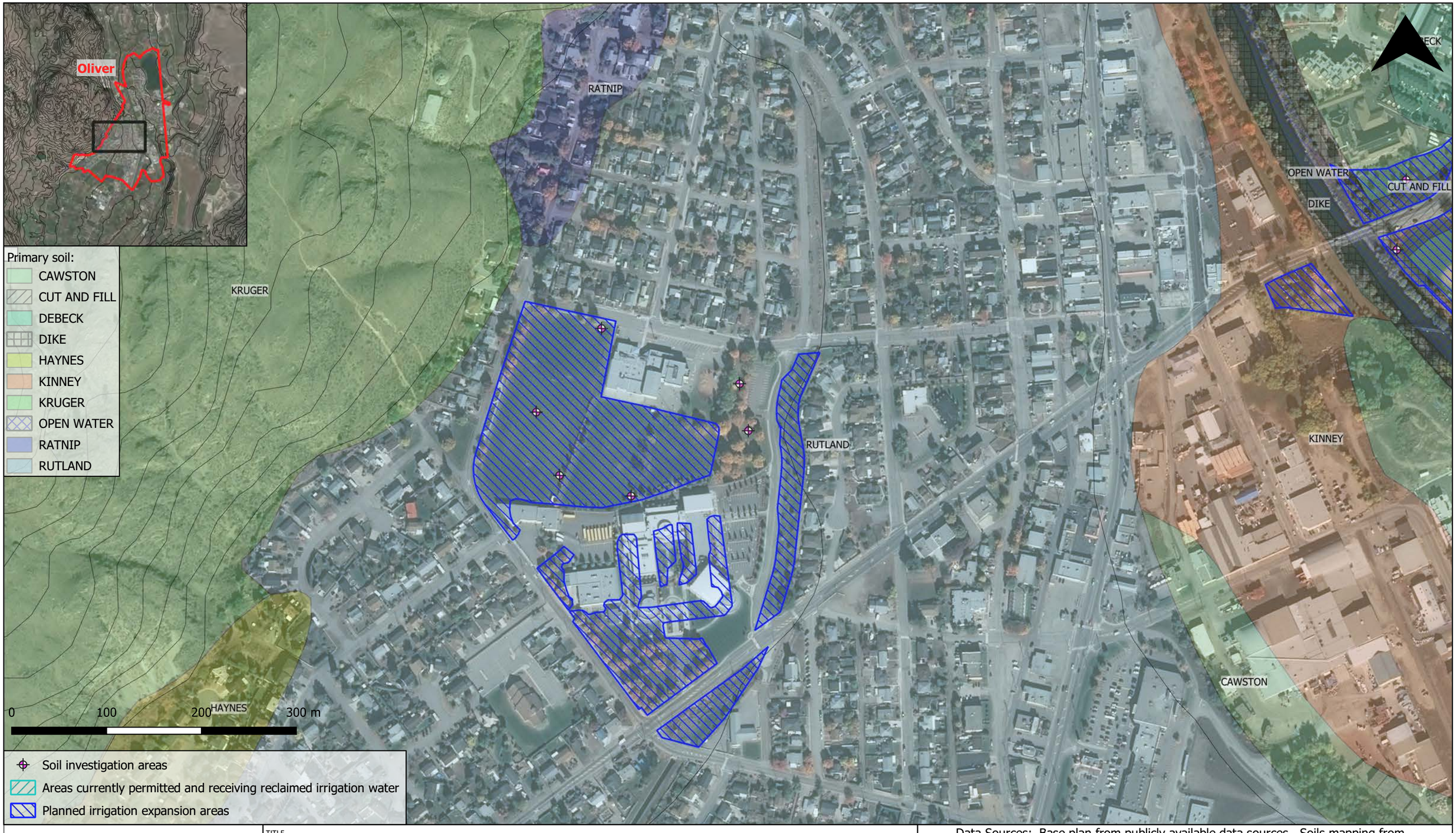
0 0.41 0.8 km

1: 20,000

Copyright/Disclaimer

Datum:	NAD83
Projection:	WGS_1984_Web_Mercator_Auxiliary_Sphere

Key Map of British Columbia



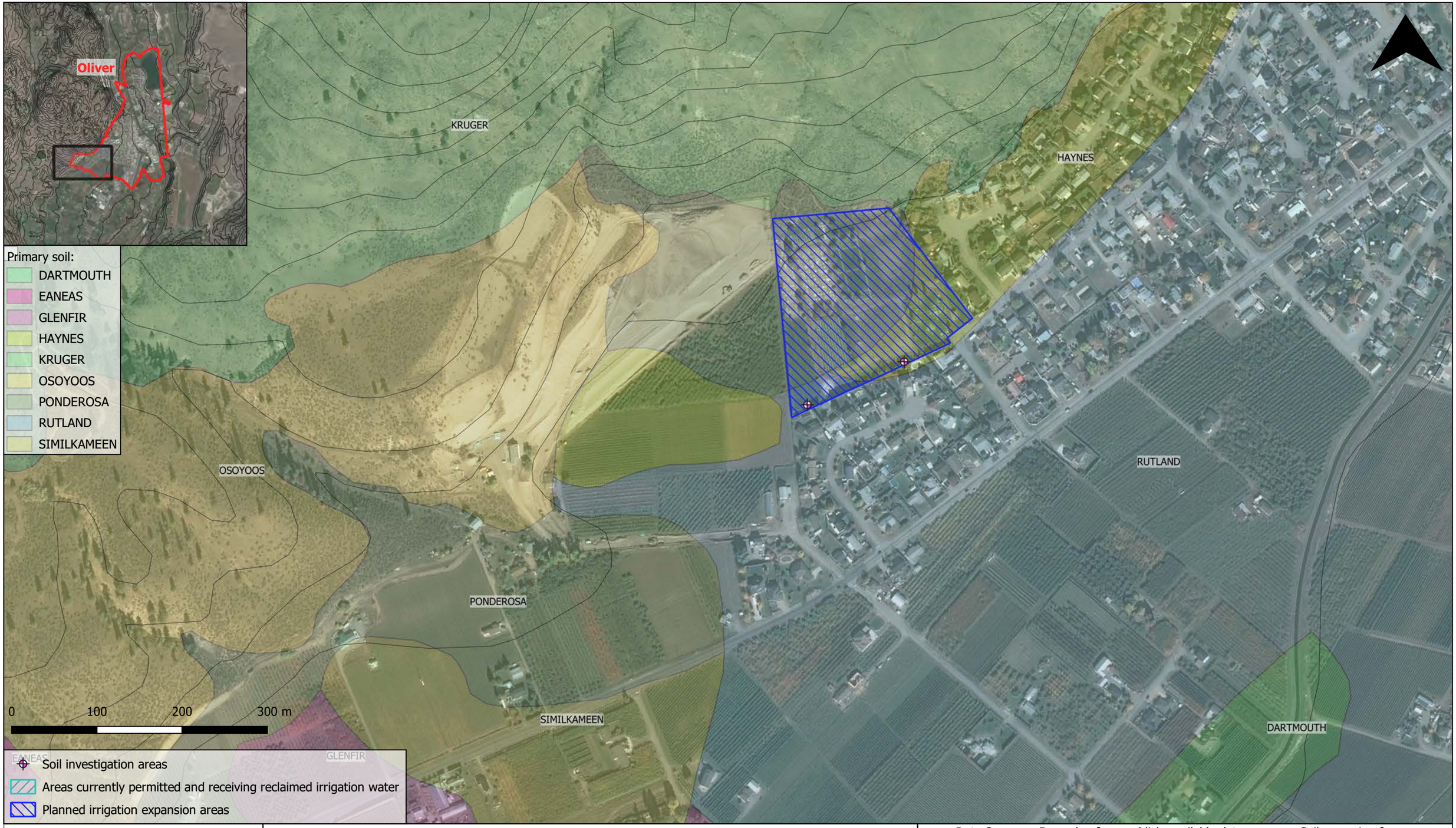
Oliver Spray Irrigation Review

TITLE **Figure 1:** School Area

western water ASSOCIATES LTD

DRAWN	Tim Sivak	DATE June 29, 2020	CLIENT TRUE Consulting Ltd.
REVIEWED	Ryan Rhodes	PROJECT NO. 20-046-01VR	REVISION NO. C

Data Sources: Base plan from publicly available data sources. Soils mapping from National Soils Database.
Contour interval: 20 m
Map Projection: NAD83 BC Albers (ESPG 3005)
Other notes: Soil investigation areas recorded with handheld GPS. Current and future spray irrigation areas from TRUE Consulting Ltd.



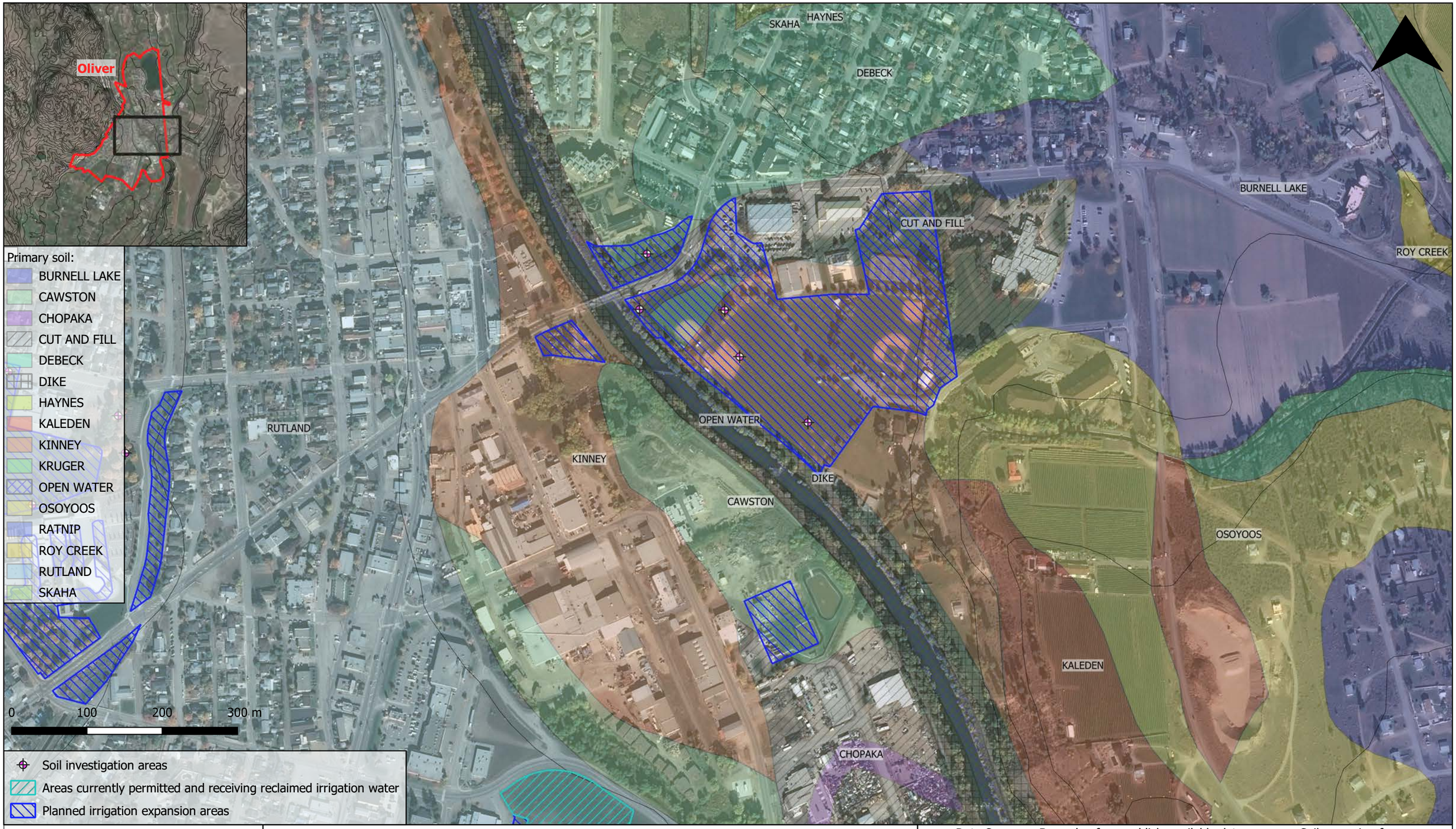
Oliver Spray Irrigation Review

western water ASSOCIATES LTD

TITLE **Figure 2:** Oliver Cemetery Area

DRAWN	DATE	CLIENT
Tim Sivak	June 29, 2020	TRUE Consulting Ltd.
REVIEWED	PROJECT NO.	REVISION NO.
Ryan Rhodes	20-046-01VR	C

Data Sources: Base plan from publicly available data sources. Soils mapping from National Soils Database.
Contour interval: 20 m
Map Projection: NAD83 BC Albers (ESPG 3005)
Other notes: Soil investigation areas recorded with handheld GPS. Current and future spray irrigation areas from TRUE Consulting Ltd.



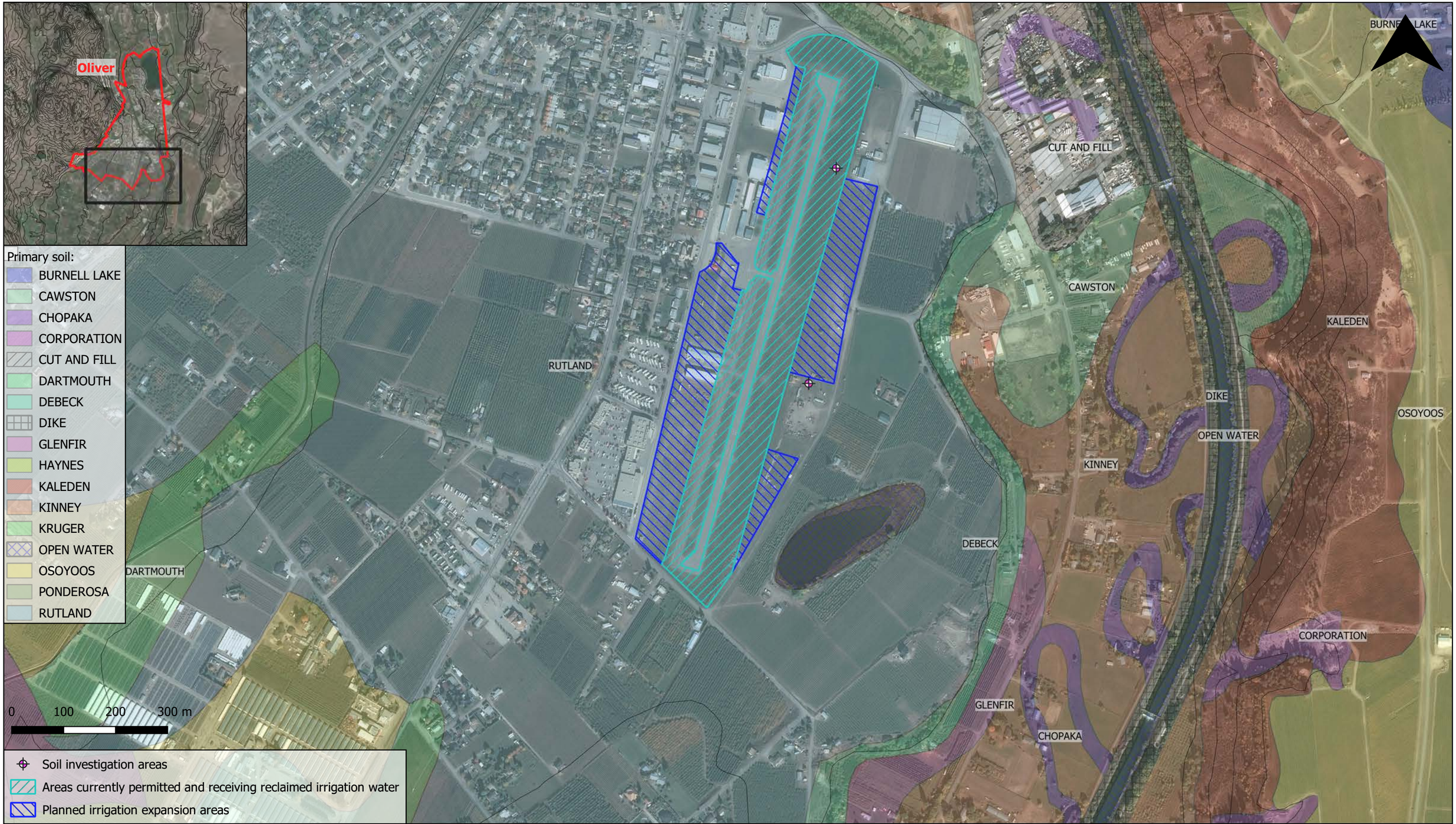
Oliver Spray Irrigation Review

western water ASSOCIATES LTD

TITLE **Figure 3:** Oliver Community Park & Area

DRAWN	Tim Sivak	DATE	June 29, 2020	CLIENT	TRUE Consulting Ltd.
REVIEWED	Ryan Rhodes	PROJECT NO.	20-046-01VR	REVISION NO.	C

Data Sources: Base plan from publicly available data sources. Soils mapping from National Soils Database.
Contour interval: 20 m
Map Projection: NAD83 BC Albers (ESPG 3005)
Other notes: Soil investigation areas recorded with handheld GPS. Current and future spray irrigation areas from TRUE Consulting Ltd.



Oliver Spray Irrigation Review

western water ASSOCIATES LTD

TITLE **Figure 4:** Aiport Area

DRAWN	DATE	CLIENT
Tim Sivak	June 29, 2020	TRUE Consulting Ltd.
REVIEWED	PROJECT NO.	REVISION NO.
Ryan Rhodes	20-046-01VR	C

Data Sources: Base plan from publicly available data sources. Soils mapping from National Soils Database.
Contour interval: 20 m
Map Projection: NAD83 BC Albers (ESPG 3005)
Other notes: Soil investigation areas recorded with handheld GPS. Current and future spray irrigation areas from TRUE Consulting Ltd.

RUTLAND SOILS (R)

GENERAL COMMENTS

Rutland soils occupy significant areas throughout the Okanagan Valley portion of the map area and also near Keremeos in the Similkameen Valley. Topography is usually level to gently sloping although some terrace scarps are extremely sloping. Soils commonly associated with Rutland soils include Faulder, Dartmouth, Keremos, Oyama and Skaha.

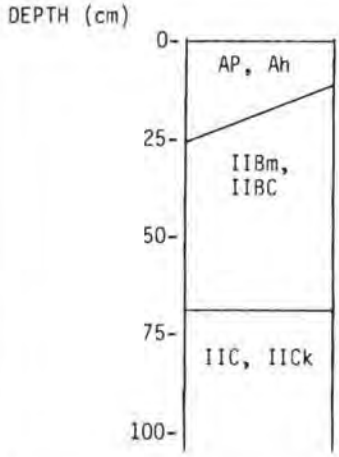
The parent material of Rutland soils is a moderately coarse textured veneer between 10 and 25 cm thick which overlies gravelly and stony, very coarse textured glaciofluvial deposits. Surface soil textures are dominantly sandy loam or loamy sand while subsurface and subsoil textures are gravelly sand or gravelly loamy sand. Stones and cobbles are also common. Rutland soils are classifed as Orthic Dark Brown. They are rapidly drained, rapidly pervious, have slow surface runoff and low water holding capacity.

A very gently sloping area of undeveloped Rutland soils northeast of Oliver.

The main agricultural limitations are gravelly and stony textures, rapid permeability and low water holding capacity. Tree fruits and grapes are presently grown in most cultivated and irrigated areas. Typical native vegetation consists of a variety of grasses, sagebrush, rabbitbrush and scattered Ponderosa pine.

Rutland soils are well suited for urban and related uses. They are rapidly drained, have high bearing capacity and generally level topography. The depth of topsoil is shallow. Effluent from septic field installations may be incompletely filtered by the very gravelly, coarse-textured subsoil.

GENERALIZED RUTLAND SOIL PROFILE



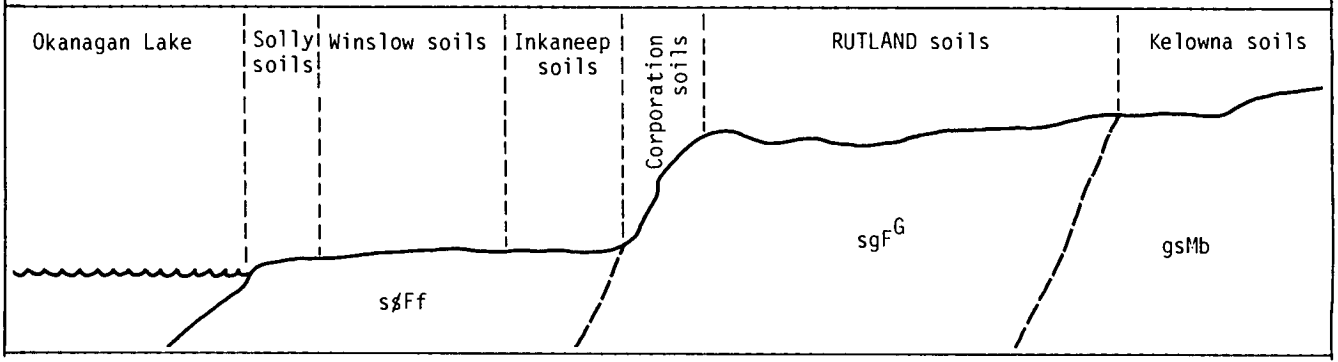
AP, Ah — Dark grayish brown or brown (10YR 4/2.5), sandy loam or loamy sand; weak, fine subangular blocky structure; soft consistence.

IIBm, IIBC — Brown (10YR 5/3), very gravelly sand or very gravelly loamy sand; weak, very fine subangular blocky structure; soft consistence.

IIC, IICk — Light gray to brownish-yellow (10YR 7/1-6/6), very gravelly sand; single-grain; loose consistence; weakly calcareous in upper part, grading to moderately calcareous at depth.

TAXONOMIC SOIL CLASSIFICATION: Orthic Dark Brown

RUTLAND SOIL LANDSCAPE CROSS SECTION



SOIL CHARACTERISTICS

DEPTH TO BEDROCK (m)	:	>2
PARENT MATERIAL	:	fluvioglacial deposits
DEPTH TO FREE LIME (cm)	:	>80
SURFACE STONINESS CLASS	:	1-4
DEPTH TO WATERTABLE (m)	:	>2
PERVIOUSNESS CLASS	:	rapid
SOIL DRAINAGE CLASS	:	rapid
DEPTH TO ROOT RESTRICTION (cm)	:	none, other than that due to gravelly and strong subsurface textures
TOPOGRAPHY	:	mostly nearly level to gentle slopes; some terrace scarps may be extremely sloping

PHYSICAL SOIL PROPERTIES	SOIL DEPTH	
	0-20 cm	>20 cm
UNIFIED TEXTURE SYMBOL	SM	GW-GP
AASHO TEXTURE SYMBOL	A-2-4	A-1
LIQUID LIMIT	NP	NP
PLASTICITY INDEX	NP	NP
SHEAR STRENGTH	medium	high
SOIL TEXTURE	sandy loam, loamy sand	gravelly loamy sand, very gravelly sand
PERMEABILITY	rapid	very rapid
AWSC	low	very low
COARSE >7.5 cm (%)	0-5	10-30
FRAGMENTS <7.5 cm (%)	0-10	30-80
PASSING # 4	60-100	50-80
SIEVES (%) # 40	40-80	1-5
#200	10-40	<4

CHEMICAL SOIL PROPERTIES	SOIL DEPTH	
	0-20 cm	>20 cm
SOIL REACTION (pH) 1:1 H_2O	6.6-7.4	7.2-8.0
1:2 0.01M $CaCl_2$	6.1-6.8	6.8-7.5
SALINITY CLASS	non-saline	non-saline
ORGANIC CARBON	moderate	very low
NITROGEN	low	very low
EXCHANGE CAPACITY	medium	low to very low
EXCHANGEABLE CATIONS - Ca	high	high
- Mg	high	high
- Na	very low	medium
- K	high	low
BASE SATURATION (%)	90-100	100
PHOSPHOROUS	medium	variable
SULFUR	low	low

KINNEY SOILS (KY)

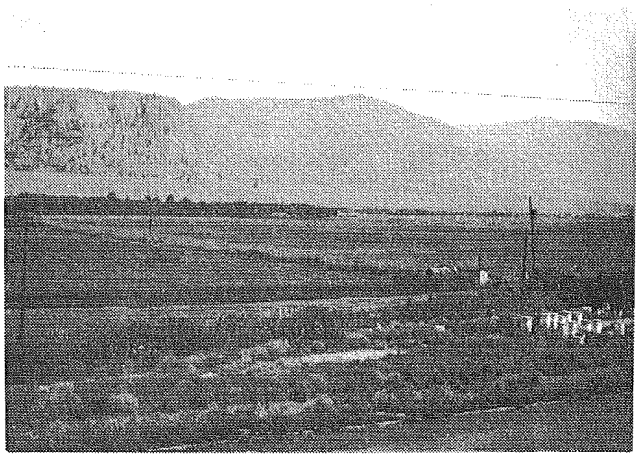
GENERAL COMMENTS

Kinney soils occur on the Okanagan River floodplain between Penticton and Osoyoos Lake. They occupy the slightly higher-lying, nearly level to very gently slopes in association with Chopaka, Cawston and Strutt soils.

Kinney soils have developed in a loamy fluvial veneer, usually between 30 and 80 cm thick, that overlies sandy floodplain deposits. Surface and subsurface textures are sandy loam or loam; the subsoil is loamy sand or sand and sometimes contains thin silty lenses. These Gleyed Regosol soils are imperfectly drained, moderately pervious and have moderate to low water holding capacity. Periodic water tables fluctuate with the level of the Okanagan River.

The main agricultural limitations of Kinney soils are moderately high water tables in late spring and in some areas, moderate salinity in the surface and potential for flooding. Cultivated areas are used for pasture and hay production. Natural vegetation occurs in a few areas and consists of black cottonwood, aspen, willow and scattered Ponderosa pine on slightly elevated dryer sites.

Urban uses of Kinney soils are restricted by periodic high water tables and potential for flooding.



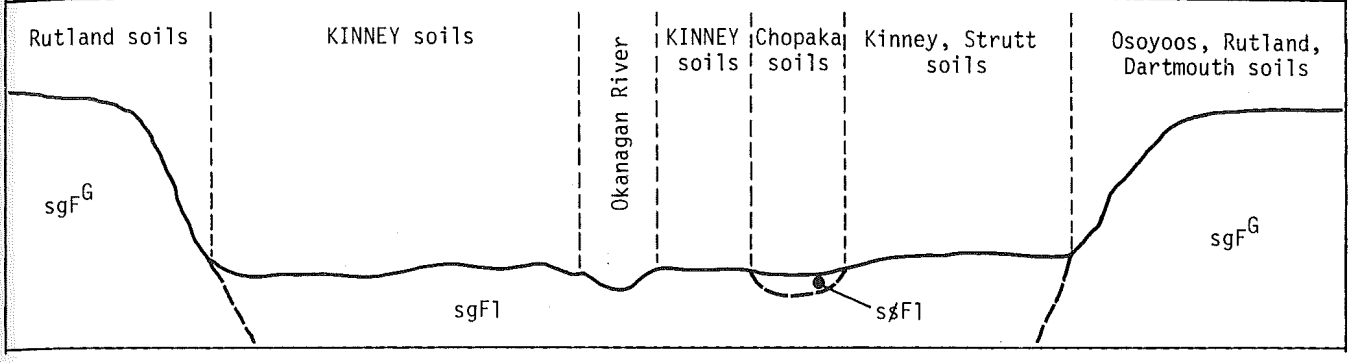
Kinney soils occupy the higher areas on the gently undulating central portion of the photo.

GENERALIZED KINNEY SOIL PROFILE

DEPTH (cm)		
0-	Ap,AC	Dark gray or gray (10YR 4.5/1.5), loam or sandy loam; moderate to strong, fine, pseudo-platy structure breaking to moderate to strong, very fine, angular blocky peds; slightly hard consistence; lower part weakly calcareous; sometimes slightly to moderately saline.
25-		
50-	Cgj	Pale brown (10YR 6/3), sandy loam; massive, breaking to moderate to strong, medium, angular blocky peds; slightly hard to hard consistence; common, fine, distinct, brownish-yellow (10YR 6/6) mottles.
75-		
100-	IICg	Light gray (10YR 6/1), loamy sand or sand; very weak, very fine, subangular blocky structure; very friable consistence; many, medium, distinct, strong brown (7.5YR 5/6) mottles.

TAXONOMIC SOIL CLASSIFICATION: Gleyed Regosol

KINNEY SOIL LANDSCAPE CROSS SECTION



SOIL CHARACTERISTICS

DEPTH TO BEDROCK (m)	:	>2
PARENT MATERIAL	:	recent fluvial floodplain deposits
DEPTH TO FREE LIME (cm)	:	surface is sometimes weakly calcareous, subsoil is generally lime free
SURFACE STONINESS CLASS	:	0
DEPTH TO WATERTABLE (m)	:	fluctuates from about 25 cm to over 1.5 m
PERVIOUSNESS CLASS	:	moderate
SOIL DRAINAGE CLASS	:	imperfect
DEPTH TO ROOT RESTRICTION (cm)	:	100; water table
TOPOGRAPHY	:	nearly level and very gentle slopes

PHYSICAL SOIL PROPERTIES	SOIL DEPTH	
	0-100 cm	>100 cm
UNIFIED TEXTURE SYMBOL	ML	SM-SP
AASHO TEXTURE SYMBOL	A-4	A-2-4; A-2
LIQUID LIMIT	10-25 or NP	10-25 or NP
PLASTICITY INDEX	0.1-5 or NP	0.1-5 or NP
SHEAR STRENGTH	medium	medium
SOIL TEXTURE	sandy loam, loam	loamy sand or sand
PERMEABILITY	moderate	rapid
AWSC	moderate	low
COARSE >7.5 cm (%)	0	0
FRAGMENTS <7.5 cm (%)	0	0-5
PASSING # 4	100	100
SIEVES (%) # 40	70-100	60-70
#200	40-70	30-40

CHEMICAL SOIL PROPERTIES	SOIL DEPTH	
	0-100 cm	>100 cm
SOIL REACTION (pH) 1:1 H_2O	7.5-8.4	7.0-7.5
1:2 0.01M $CaCl_2$	7.1-8.0	6.6-7.0
SALINITY CLASS	non to moderately saline	non-saline
ORGANIC CARBON	moderate to low	very low
NITROGEN	low	very low
EXCHANGE CAPACITY	medium	low to very low
EXCHANGEABLE CATIONS - Ca	high	high
- Mg	high	low to medium
- Na	high	low
- K	high	low
BASE SATURATION (%)	100	100
PHOSPHOROUS	variable	very low
SULFUR	high	low to medium

CAWSTON SOILS (CA)

GENERAL COMMENTS

Cawston soils occur on the floodplain of the Similkameen River near Keremeos and Cawston and on the Okanagan River floodplain between Osoyoos Lake and Penticton. These Rego Humic Gleysol soils occupy slightly depressional to very gently sloping lower fluvial terraces, usually in association with Kinney, Chopaka, Gillanders and Keremeos soils.

Cawston soils have developed in medium textured recent fluvial deposits generally between 50 and 100 cm thick overlying moderately coarse textured materials. Surface and subsurface textures are silt loam or loam. Subsoil texture are usually gravelly sandy loam or gravelly loamy sand. The soils are poorly to imperfectly drained. They are moderately pervious, have a high water holding capacity and slow surface runoff.

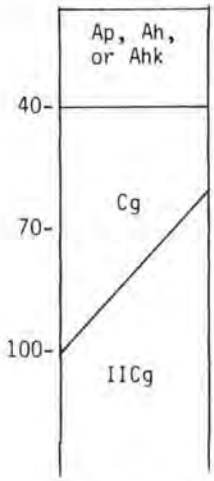
Cawston soils in association with Chopaka and Keremeos soils occupy the gently undulating middle portion of the photo.

Cawston soils are suited for most agricultural crops, particularly if artificial drainage is installed. Most areas are now cleared and cultivated. The more poorly drained areas are mostly used for forage production while the somewhat higher-lying, imperfectly drained areas are used for tree fruits, forages and vegetables. The few, uncleared areas support grasses, cattails, reeds and black cottonwood.

Cawston soils are constrained for urban and similar uses by moderately high water tables which impede basement and other excavations and restrict the operation of septic tank disposal fields.

GENERALIZED CAWSTON SOIL PROFILE

DEPTH (cm)



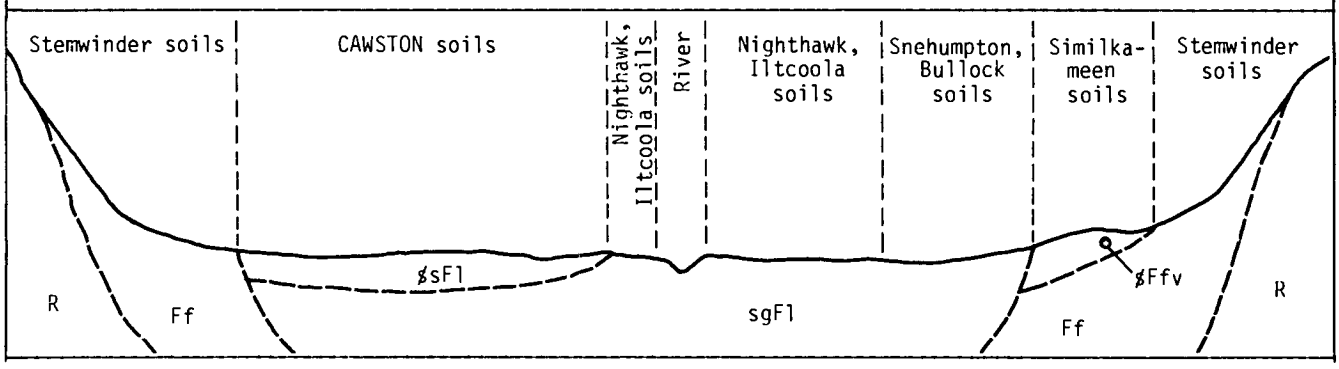
Dark grayish brown (10YR 4/2) to very dark grayish brown (10YR 3/2), silt loam or loam; weak to moderate, very fine subangular blocky structure; very friable consistence; weakly to moderately calcareous; none or few, fine, faint mottles.

Dark grayish brown or very dark grayish brown (10YR 3.5/2), sandy loam to silt loam; weak, fine pseudo-subangular blocky structure; very friable consistence; few, fine, faint mottles.

Dark brown (10YR 3/3) or brown (10YR 4/3), gravelly sandy loam to very gravelly loamy sand; weak, medium, pseudo-angular blocky structure or single-grain; loose or very friable consistence; few, coarse, prominent mottles.

TAXONOMIC SOIL CLASSIFICATION: Rego Humic Gleysol

CAWSTON SOIL LANDSCAPE CROSS SECTION



SOIL CHARACTERISTICS

DEPTH TO BEDROCK (m)	: >2
PARENT MATERIAL	: recent fluvial floodplain deposits
DEPTH TO FREE LIME (cm)	: weakly to moderately calcareous in surface layer
SURFACE STONINESS CLASS	: 0
DEPTH TO WATERTABLE (m)	: fluctuating, ranges from 50 cm to >1 m.
PERVIOUSNESS CLASS	: moderate
SOIL DRAINAGE CLASS	: dominantly poor, ranging to imperfect
DEPTH TO ROOT RESTRICTION (cm)	: 80; water table
TOPOGRAPHY	: nearly level and very gentle slopes

PHYSICAL SOIL PROPERTIES	SOIL DEPTH		
	0-40 cm	40-80 cm	>80 cm
UNIFIED TEXTURE SYMBOL	ML-CL	SM-ML	GP, GM
AASHO TEXTURE SYMBOL	A-6; A-4	A-6; A-4; A-2-4	A-1
LIQUID LIMIT	30-35	25-35	NP
PLASTICITY INDEX	1-15	1-12	NP
SHEAR STRENGTH	medium to low	low to medium	high
SOIL TEXTURE	loam, silt loam	silt loam to sandy loam	very gravelly loamy sand, gravelly sandy loam
PERMEABILITY	moderate	moderate	rapid
AWSC	moderate	moderate to low	very low
COARSE >7.5 cm (%)	0	0	5-10
FRAGMENTS <7.5 cm (%)	0	0-5	35-60
PASSING # 4	100	100	5-10
SIEVES # 40	60-80	60-80	<5
#200	40-60	50-70	<2

CHEMICAL SOIL PROPERTIES	SOIL DEPTH		
	0-40 cm	40-80 cm	>80 cm
SOIL REACTION (pH) 1:1 H_2O	7.9-8.0	7.7-8.0	7.8-8.4
1:2 0.01M $CaCl_2$	7.6-8.0	7.4-7.6	7.6-8.0
SALINITY CLASS	non to very weakly saline	non-saline	non-saline
ORGANIC CARBON	moderate	very low	very low
NITROGEN	medium to high	very low	very low
EXCHANGE CAPACITY	high	medium	low to very low
EXCHANGEABLE CATIONS - Ca	high	high	high
- Mg	high	medium to high	low
- Na	low	low	low
- K	high	moderately high	low
BASE SATURATION (%)	100	100	100
PHOSPHOROUS	very low	very low	very low
SULFUR	moderately high	moderately high	moderately high

PONDEROSA SOILS (PO)

GENERAL COMMENTS

Ponderosa soils occur only in the vicinity of Oliver. They occupy nearly level to moderately sloping areas in association with Rutland, Glenfir, Ratnip and Burnell Lake soils.

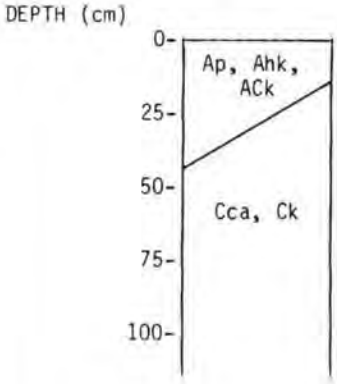
Ponderosa soils have developed in a gravelly, moderately coarse textured fluvial veneer between 10 and 50 cm thick, overlying gravelly coarse textured fluvial fan deposits. Surface and subsurface textures are gravelly or very gravelly sandy loam or gravelly loam; subsoils are very gravelly loamy sand. These Rego Dark Brown: calcareous phase soils are well to rapidly drained, rapidly pervious and have low water holding capacity.

Almost all areas of Ponderosa soils are cleared, cultivated and planted to tree fruits and vineyards. Small, scattered, uncleared areas located on steep slopes support scattered Ponderosa pine, sagebrush and grass in the understory.

Except for a few steeply sloping areas, Ponderosa soils are moderately well suited for most urban and related uses. Incomplete septic tank effluent filtration may occur in the coarse-textured subsoils.

A typical view of moderately sloping Ponderosa soils near Oliver.

GENERALIZED PONDEROSA SOIL PROFILE

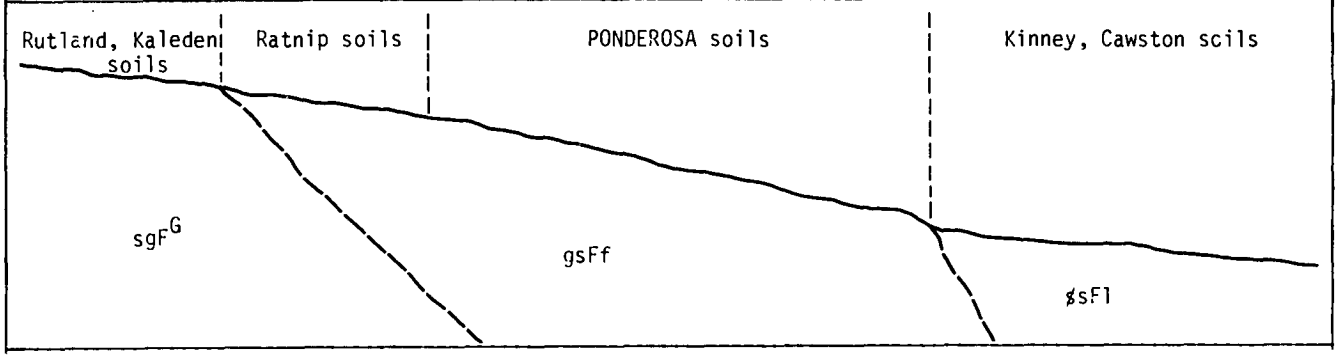


Dark grayish brown (10YR 4.5/2.5), gravelly sandy loam; weak, fine to very fine, granular structure; very friable consistence; moderately calcareous.

Pale brown (10YR 5.5/3 - 6/3.5), very gravelly loamy sand; weak, fine subangular blocky structure; very friable to firm consistence; strongly calcareous.

TAXONOMIC SOIL CLASSIFICATION: Rego Dark Brown: calcareous phase

PONDEROSA SOIL LANDSCAPE CROSS SECTION



SOIL CHARACTERISTICS

DEPTH TO BEDROCK (m)	:	>2
PARENT MATERIAL	:	fluvial fan deposits
DEPTH TO FREE LIME (cm)	:	calcareous to surface
SURFACE STONINESS CLASS	:	0-3
DEPTH TO WATERTABLE (m)	:	>2
PERVIOUSNESS CLASS	:	rapid
SOIL DRAINAGE CLASS	:	well to rapid
DEPTH TO ROOT RESTRICTION (cm)	:	none
TOPOGRAPHY	:	nearly level to moderate slopes

PHYSICAL SOIL PROPERTIES	SOIL DEPTH	
	0-50 cm	>50 cm
UNIFIED TEXTURE SYMBOL	GM-GC	GM-GP
AASHO TEXTURE SYMBOL	A-1	A-1
LIQUID LIMIT	15-25 or NP	NP
PLASTICITY INDEX	0.1-5 or NP	NP
SHEAR STRENGTH	high to medium	high to medium
SOIL TEXTURE	very gravelly sandy loam to gravelly loam	very gravelly loamy sand
PERMEABILITY	rapid	very rapid
AWSC	moderate to low	low
COARSE FRAGMENTS >7.5 cm (%)	5-15	20-40
<7.5 cm (%)	20-75	30-60
PASSING # 4	50-80	30-50
SIEVES (%) # 40	20-30	5-20
#200	5-10	<2

CHEMICAL SOIL PROPERTIES	SOIL DEPTH	
	0-50 cm	>50 cm
SOIL REACTION (pH) 1:1 H_2O	7.8-8.1	8.0-8.5
1:2 0.01M $CaCl_2$	7.4-7.6	7.5-7.8
SALINITY CLASS	non-saline	non-saline
ORGANIC CARBON	moderate	low
NITROGEN	low to very low	very low
EXCHANGE CAPACITY	low	low to very low
EXCHANGEABLE CATIONS - Ca	high	high
- Mg	low	medium to high
- Na	very low	very low
- K	medium	moderately high
BASE SATURATION (%)	100	100
PHOSPHOROUS	very low	very low
SULFUR	low	medium

APPENDIX I

2021 Western Water Associates Well Installation Report and Hydrogeological Review

Town of Oliver Monitoring Well Installation

TECHNICAL MEMORANDUM

TO:	Shawn Goodsell (Town of Oliver), Natalie Alteen, P.Eng. (TRUE)	**DATE:**	26-Aug-2021
FR:	Morgan Jackson, B.Sc. and Ryan Rhodes, P.Geo, (WWAL)	**REFERENCE:**	20-046-02VR

RE: MONITORING WELL INTALLATION, DEVELOPMENT AND SAMPLING – TOWN OF OLIVER RECLAIMED WASTEWATER IRRIGATION SYSTEM ENVIRONMENTAL MONITORING PROGRAM, OLIVER, B.C.

INTRODUCTION

Western Water Associates Ltd. (WWAL) is pleased to provide this brief Technical Memorandum to the Town of Oliver (the Town) and TRUE Consulting Ltd. documenting the installation of new and replacement monitoring wells for the Town's reclaimed wastewater environmental monitoring program.

In 2020, WWAL completed a review of the Town's environmental monitoring program (WWAL 2021), which is a requirement of the Town's reclaimed wastewater system Operational Certificate PE-13717. Over time, the Town of Oliver has expanded the areas receiving reclaimed wastewater for irrigation, but the monitoring network had not been updated in concert so new monitoring wells to increase coverage of irrigated areas was recommended. In addition, two wells in the existing network were reportedly dry for the past decade, and we recommended those be replaced.

In total, four wells were completed in 2021. Drilling was completed in early May 2021. After drilling and installation, monitoring wells were developed, purged and sampled by WWAL for wastewater indicator parameters. In addition, WWAL was able to rehabilitate one of the original monitoring wells (Town MW6) to make it suitable for continued sampling.

MONITORING WELL DRILLING PROGRAM

WWAL installed four monitoring wells between May 4 and 7, 2021. Three of the monitoring wells were installed to provide coverage to newer areas receiving reclaimed water for irrigation that were not being monitored:

- MW8 – south side of the Town Public Works Yard
- MW9 - south end of the Oliver Cemetery
- MW10 – Gala Street linear park, east of the South Okanagan Secondary School.

The fourth monitoring well (MW-11) is located near the west end of 332nd Avenue, and was installed as a replacement for pre-existing monitoring well Town MW7, which has been dry since at least 2006.

All four monitoring wells were drilled by Mud Bay Drilling of Surrey, B.C. with a rubber tracked Sonic DB320 drill rig. The wells were completed to depths of between 6.6 m to 29.7 m (22 ft to 97.5 ft) below ground surface (bgs) into unconsolidated sediments. The wells are 50 mm (2 inches) in diameter and are equipped with a J-Plug cap and a 10 slot screen of 1.5 m or 3 m (5 ft or 10 ft) in length. A 10-20 filter sand pack was installed in the annulus surrounding the well screens and a bentonite seal was installed as appropriate within the annular space, above the screened interval, and at surface. Three wells are completed flush with ground surface and one well (MW-11) was completed with an above ground steel protector. The well covers or monuments for all four wells were cemented

in place. All four monitoring wells comply with the requirements of the *B.C. Groundwater Protection Regulation*. Well logs are provided as an attachment and Table 1 summarizes select well details. Figure 1 depicts the location of all new and existing monitoring wells included in the groundwater monitoring program.

Table 1 – Summary of Select Monitoring Well Details

Well Identification	Completion Date	Well Completion Depth (mbtoc)	Well Surface Completion	Screened Interval (mbgs)	Aquifer Lithology	Water Level May 19, 2021 (mbtoc)
MW-8	May 4, 2021	6.52	Flush Mount	5.2 – 6.7	Sand & Gravel	2.35
MW-9	May 5, 2021	21.1	Flush Mount	18.2 – 21.2	Sand & Gravel some fines at depth	dry
MW-10	May 6, 2021	27.1	Flush Mount	25.7 – 27.2	Sand & Gravel some fines at depth	24.54
MW-11	May 7, 2021	30.6	Above Ground Monument	27.1 – 29.7	Sand and Silt	24.32

Note: mbtoc- meters below top of casing; mbgs- meters below ground surface.

Well lithology was logged by WWAL field staff during drilling. Lithology observed in monitoring wells was relatively similar, consisting of sand, gravel or sand and gravel. At wells MW-9, MW-10 and MW-11 some finer sediments (silt and/or clay seams) were observed at depths ranging from 15 m to 26 m (48 ft to 88 ft). Lithology in the new monitoring wells is similar to reported lithology in existing monitoring wells included the program. Detailed well logs with lithology are included as an attachment.

MONITORING WELL DEVELOPMENT AND SAMPLING METHODS

The monitoring wells were developed by surging with a Waterra surge block, tubing and foot valve until approximately ten times the well volume was removed and water removed was relatively clear. The monitoring wells were disinfected with chlorine bleach approximately 4 to 7 hours prior to sample collection. The bleach was agitated using a bailer dedicated to that well and water was purged into a bucket away from the well head. Groundwater quality samples were collected within 3 to 5 hours of well development when the water ran relatively clear and no longer smelled of chlorine. WWAL field staff noted slight turbidity in water samples collected at the wells, which is common in newly installed wells and is expected to dimmish over time with additional sampling. The samples were labelled and stored in an ice-filled cooler, then transported to CARO Analytical, in Kelowna B.C. for chemical analyses within 24-hours of sample collection.

Monitoring well MW-9 has remained dry since installation and could not be developed or sampled at this time.

During an initial site visit in March 2021, WWAL staff found approximately 1 m of water in pre-existing monitoring well Town MW-6, which had previously been considered dry. Further, the well depth was measured to be approximately 4 m (13 ft) shallower than reported on the well log; we interpreted this to mean that fine sediments had accumulated in the bottom of the well over time. WWAL field staff attempted to bail out and re-develop MW-6 on two occasions using a small pump and waterra tubing/foot valve. This resulted in the removal of 0.4 m of sediment from the well.

WATER QUALITY SAMPLING RESULTS

Table 2 below summarizes the water quality results from monitoring wells MW-8, MW-10, and MW-11 collected on May 19, 2021. Water quality samples were also collected from pre-existing monitoring well Town MW-6 on May 19, 2021 as this well had recently been re-developed and had not been sampled since it was reported dry in 2003. A copy of the laboratory water quality results are attached to this report.

Reclaimed wastewater associated parameters chloride, nitrate, and sodium are slightly at all sampled locations, however, all below applicable Canadian Drinking Water Quality Guidelines (GCDWQ). Nitrate is elevated at MW-10 and MW-11 and to a lesser extent at MW-6 at 4.63 mg/L, 3.13 mg/L and 1.99 mg/L, respectively. Total coliform bacteria was not detected at any of the newly installed monitoring well but was detected a 5 MPN/100 mL at MW-6. *E.coli* bacteria were not detected at any of the sampled locations.

A duplicate sample was collected at monitoring well MW-11 during the sampling event on May 19, 2021 for QA/QC purposes. The Relative Percent Difference (RPD) of each of the sampled parameters with results above detection limits was calculated. Most parameters indicated RPD values lower than 10%, with the majority of the parameters falling below 5%. The RPD for total dissolved phosphorus was 28% and total kjeldahl nitrogen (TKN) was above 50%. WWAL asked the laboratory to re-analyze the samples for dissolved phosphorus and TKN to establish if there was laboratory error introduced during the previous analysis. The RPD for the re-run samples were 21.6 % (dissolved phosphorus) and 49.1 % (TKN). Caro Laboratory staff indicated that one of the samples was slightly more turbid, which likely caused the discrepancy between sample concentration values. Overall, we deem the sampling methodology used and results obtained to be acceptable. In the future, best efforts should be made to collect samples with as low turbidity as possible.

Table 2 – Summary of Water Quality Results

Field Parameter	Units	GCDWQ	MW-6 (pre-existing well)	MW-8	MW-10	MW-11
pH	pH units	7.0 - 10.5	7.8	7.83	8.11	7.0
Electrical Conductivity	µS/cm	None	980	849	788	1031
Temperature	°C	AO≤ 15°C	13.1	11.9	12.4	14.0
Oxidation Reduction Potential	RmV	None	710	74	151	719
Laboratory Parameter						
Chloride	mg/L	AO≤250	91.6	83.3	90.9	157
Total Dissolved Phosphorus	mg/L	None	0.0557	0.117	0.0239	0.0264
Total Phosphorus (as P)	mg/L	None	0.251	0.185	0.0497	0.088
Ammonia	mg/L	None	0.067	<0.050	<0.050	<0.050
Nitrate as N	mg/L	MAC=10	1.99	0.945	4.63	3.13
Nitrite as N	mg/L	MAC=1	<0.010	<0.010	<0.010	<0.010
Nitrate as N + Nitrite as N	mg/L	None	1.99	0.945	4.63	3.14
Total Nitrogen	mg/L	None	2.62	1.24	4.91	3.38
Total Kjeldahl Nitrogen	mg/L	None	0.625	0.292	0.282	0.241
Conductivity	µS/cm	None	1060	905	978	1220
pH	pH units	7.0 - 10.5	7.02	6.94	7.31	7.04
Hardness	mg/L	None	345	312	343	470
Calcium (total)	mg/L	None	80.7	89.4	82.5	111
Magnesium (total)	mg/L	None	34.7	21.4	33.2	46.7
Sodium (total)	mg/L	AO≤200	109	83.2	36.7	78.7
Total Coliform	MPN /100 mL	MAC = None Detected	**5**	<1	<1	<1
E. coli	MPN/100 mL	MAC = None Detected	<1	<1	<1	<1

Note: bolded orange values indicated exceedance of health based MAC guidelines;

CONCLUSIONS AND RECOMMENDATIONS

WWAL oversaw the installation of four monitoring wells for inclusion in the Oliver reclaimed wastewater irrigation system groundwater monitoring program. After installation, WWAL developed the wells to make them suitable for ongoing sampling, and collected initial water quality samples from three of the monitoring wells (MW-8, MW-10, MW11) and one pre-existing monitoring well MW-6 (not sampled since at least 2003). Monitoring well MW-9 has been dry since installation and could not be developed and sampled at this time.

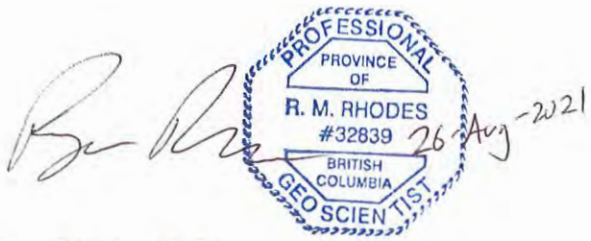
We recommend the following:

R1 Incorporate the four new monitoring wells into the environmental monitoring program. Continue to complete monthly water level measurements of all wells and biannual sampling.

R2 Rehabilitated monitoring well Town MW-6 has a fairly limited water column and was observed to recharge slowly after being purged. Much of the screened interval of the well is filled with sediment, making this well more prone to producing turbid water during sampling. While most of the program monitoring wells are purged and sampled with waterra tubing and foot valves, we recommend Town MW-6 be purged and sampled with a bailer. This well should be first purged and

then sampled on the following day. Care should be taken to lower and remove the bailer slowly when sampling to obtain the clearest samples possible.

Further, MW-6 should be disinfected with bleach approximately 24 hours prior to purging and collecting water samples during the next sampling event to eliminate total coliform bacteria found to be present after the recent sampling.



Morgan Jackson, B.Sc.
Environmental Scientist

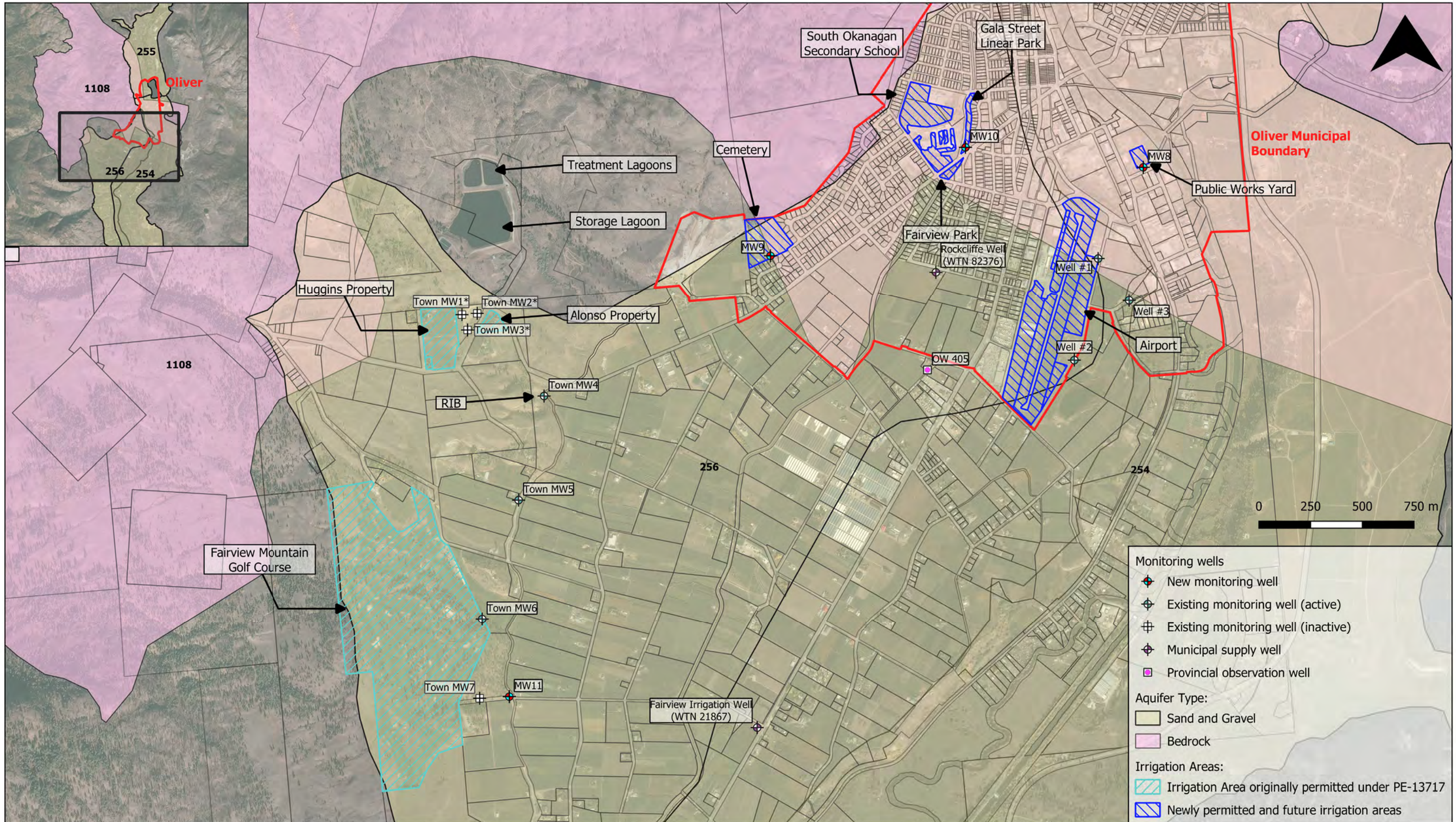
Ryan Rhodes, P.Geo.
Hydrogeologist

Attachments:

Figure 1 – Location of Oliver Reclaimed Water Environmental Monitoring Wells
Well Logs
Laboratory Analytical Reports

REFERENCES

Western Water Associates Ltd. 2021. Hydrogeological Review of the Town of Oliver Reclaimed Wastewater Irrigation Groundwater Monitoring Program. Report prepared for the Town of Oliver and TRUE Consulting Ltd., January 28, 2021.



Oliver Reclaimed Water Irrigation Review

western water ASSOCIATES LTD

TITLE **Figure 1** Town of Oliver Reclaimed Wastewater Irrigation Monitoring Wells

DRAWN	DATE	CLIENT
Tim Sivak	August 25, 2021	TRUE Consulting Ltd.
REVIEWED	PROJECT NO. 20-046-02VR	REVISION NO. A

Data Sources: Base plan from publicly available data sources.
Contour interval: -
Map Projection: NAD83 BC Albers (EPSG 3005)
Other notes: Current and future spray irrigation areas from TRUE Consulting Ltd.
*location is approximate.

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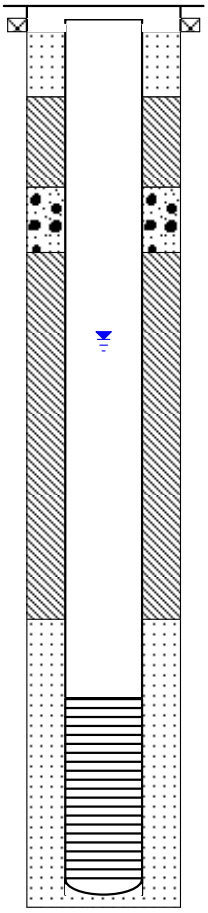
Consultants in Hydrogeology and Water Resources Management

MONITORING WELL LOG MW-8

MONITORING WELL ID: MW-8
DATE DRILLED: May 4, 2021
PROJECT: Town of Oliver Monitoring Well Installation
SITE LOCATION: Public Works Yard
CLIENT: Town of Oliver
PROJECT NUMBER: 20-046-02VR

DEPTH (m)	LITHOLOGY DESCRIPTION	WELL CONSTUCTION	WELL COMPLETION DETAILS
	Ground Surface		**Flushmount box, cemented in place**
0	SAND and GRAVEL, with some cobbles, coarse grained sand, small to large sub-rounded gravel, loose, poorly sorted, dry, brown.		**0.1 m - 5.2 m below ground surface (bgs) Blank 2 inch diameter PVC with J-plug cap**
1			**0.2 m - 0.3 m bgs 10-20 Filter sand**
			0.3 m - 1.2 m Surface seal, Enviroplug medium bentonite chips
2	SAND with some silt, minor clay, fine grained sand, loose, poorly sorted, dry, brown to grey. Organics (wood flecks) and mottling 2.3 m to 3 m.		**1.2 m - 1.8 m bgs Sand and Crush**
			Water level 2.45 m (8.0 ft) below top of casing (btoc)
3			
	SAND and SILT, fine grained sand, loose, poorly sorted, moist to wet at 5.2 m, dark grey		**1.8 m - 4.6 m bgs Bentonite chips**
4			
5			**4.6 m - 5.2 m bgs 10- 20 Filter sand**
	SAND and GRAVEL coarse and medium grained sand, small to large rounded gravel, loose, wet, brown.		
6			**5.2 m - 6.7 m bgs 2 inch diameter 10 slot PVC screen 1.5 m (5 ft) length with bottom plug**
	SANDY SILT, with clay seams, loose, wet, dark grey. Clay seams at approximately 6.7 m and 8.2 m, hard, dry, 1 -2.5 inches in thickness.		**Total Well Depth 6.52 m (21.4 ft) btoc**
7			
8			
9			

COORDINATES: 11U 314598.0 m E 5450466.0 m N
ELEVATION: 298 m asl **(gps)**

STATIC WATER LEVEL: 2.45 m btoc
DRILLING CONTRACTOR: Mud Bay Drilling Ltd.

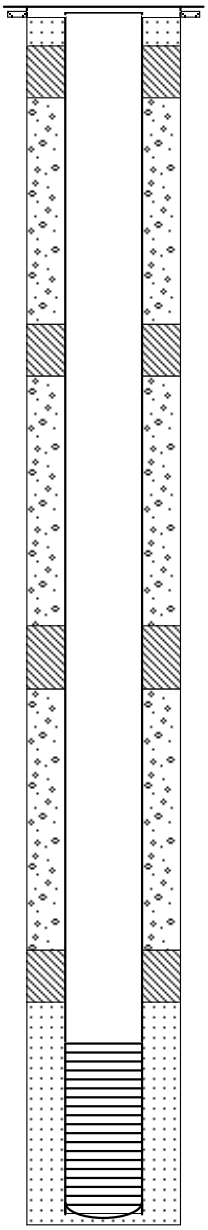
TOTAL DEPTH: 6.52 m btoc
DRILLING METHOD: Sonic rubber track rig

Drawn By: MJ | Reviewed By: RR | Logged By: MJ

western water ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

MONITORING WELL LOG MW-9

MONITORING WELL ID: MW-9
DATE DRILLED: May 5, 2021
PROJECT: Town of Oliver Monitoring Well Installation
SITE LOCATION: Cemetary
CLIENT: Town of Oliver
PROJECT NUMBER: 20-046-02VR

DEPTH (m)	LITHOLOGY DESCRIPTION	WELL CONSTUCTION	WELL COMPLETION DETAILS
0	**Ground Surface**		**Flushmount box, cemented in place**
0 – 8	SAND and GRAVEL, medium and coarse grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown.		**0.1 m - 18.1 m below ground surface (bgs) Blank 2 inch diameter PVC with J-plug cap** **0.2 m - 0.6 m bgs 10-20 Filter sand** **0.6 m - 1.5 m bgs Surface seal, Enviroplug medium bentonite chips**
9 – 12	GRAVEL with some SAND, fine grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown.		**1.5 m - 17.4 m bgs Alternating layers of 1 m bentonite seal with 4.5 m of natural sluff**
13 – 19	SAND with GRAVEL coarse and medium grained sand, small to large rounded to sub-rounded gravel, loose, wet, brown. Mottling at 13.7 m (45 ft), approximately 1 cm thick.		**17.4 m - 21.2 m bgs 10-20 Filter sand** **18.1 m -21.2 m bgs 2 inch diameter 10 slot PVC screen 3 m (10 ft) length with bottom plug**
20 – 22	SAND, with some silty clay chunks, fine and medium grained sand, loose, wet, brown.		**Total Well Depth 21.1 m (69.2 ft) below top of casing (btoc)**

COORDINATES: 11U 3142761.6 m E 5450263.7 m N
ELEVATION: 336 m asl **(gps)**

STATIC WATER LEVEL: Dry
DRILLING CONTRACTOR: Mud Bay Drilling Ltd.

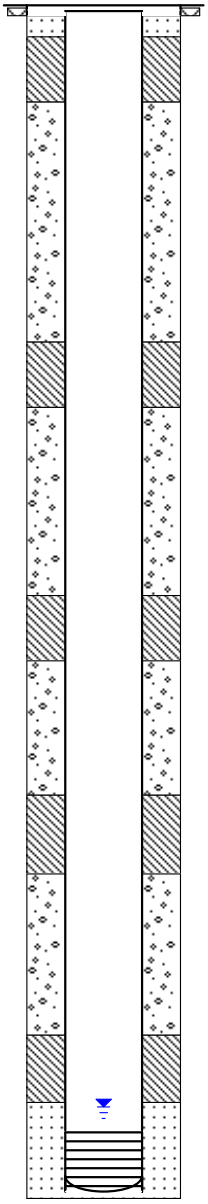
TOTAL DEPTH: 21.1 m btoc
DRILLING METHOD: Sonic rubber track rig

Drawn By: MJ	Reviewed By: RR	Logged By: MJ

western water ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

MONITORING WELL LOG MW-10

MONITORING WELL ID: MW-10
DATE DRILLED: May 6, 2021
PROJECT: Town of Oliver Monitoring Well Installation
SITE LOCATION: Gala St. Linear Park
CLIENT: Town of Oliver
PROJECT NUMBER: 20-046-02VR

DEPTH (m)	LITHOLOGY DESCRIPTION	WELL CONSTUCTION	WELL COMPLETION DETAILS
0	Ground Surface		**Flushmount box, cemented in place**
0	TOPSOIL		**0.1 m - 25.7 m bgs Blank 2 inch diameter PVC with J-plug cap**
2	GRAVEL with SAND, medium and coarse grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown. Mottling approximately 14.3 m and 21 m (47 ft and 68 ft) below ground surface.		**0.2 m - 0.6 m bgs 10-20 Filter sand**
			0.6 m - 2.1 m bgs Suface seal, Enviroplug medium bentonite chips
			2.1 m - 25 m bgs Alternating layers of appoximately 1 m bentonite seal with 4.5 m of natural sluff
21	GRAVEL, small to large rounded to sub-rounded gravel, loose, wet, brown.		**Water level 25.1 m (82.3 ft) below top of casing (btoc) (May 6, 2021)**
			25 m - 27.2 m bgs 10-20 Filter sand
			25.7 m - 27.2 m bgs 2 inch diameter 10 slot PVC screen 1.5 m (5 ft) length with bottom plug
27	SAND with some SILT, fine with some medium grained sand, loose, wet, brown.		**Total Well Depth 27.1 m btoc**
29			

COORDINATES: 11U 313762.5 m E 5450678.4 m N
ELEVATION: 326 m asl **(gps)**

STATIC WATER LEVEL: 25.1 m btoc
DRILLING CONTRACTOR: Mud Bay Drilling Ltd.

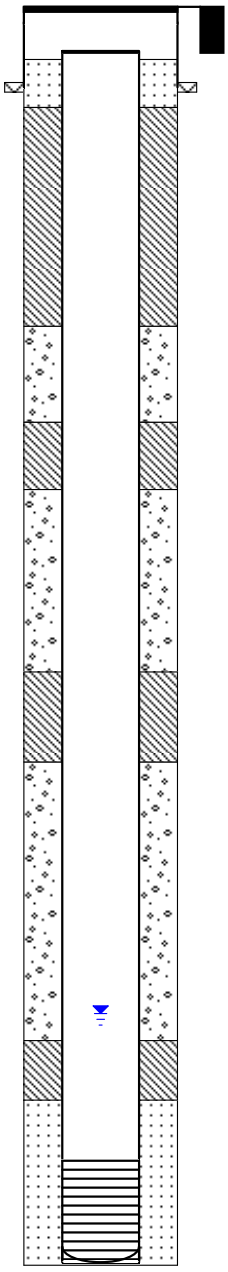
TOTAL DEPTH: 27.1 m btoc
DRILLING METHOD: Sonic rubber track rig

Drawn By: MJ | Reviewed By: RR | Logged By: MJ

western water ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

MONITORING WELL LOG MW-11

MONITORING WELL ID: MW-11
DATE DRILLED: May 6-7, 2021
PROJECT: Town of Oliver Monitoring Well Installation
SITE LOCATION: West end 332 Ave
CLIENT: Town of Oliver
PROJECT NUMBER: 20-046-02VR

DEPTH (m)	LITHOLOGY DESCRIPTION	WELL CONSTUCTION	WELL COMPLETION DETAILS
0	Ground Surface		**Well stick-up 0.86 m above ground surface (ags)**
1	SAND with GRAVEL, fine and medium grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown.		**0.86 m ags - 27.1 m below ground surface (bgs) Blank 2 inch diameter PVC with J-plug cap. Above ground lockabel monument casing, cemented in place**
2			**0.7 m ags - 0.6 m bgs 10-20 Filter sand**
3			
4	SAND, with Silt lenses, fine and medium grained sand, loose, poorly sorted, dry, grey.		**0.6 m - 6.1 m bgs Surface seal, Enviroplug medium bentonite chips**
5			
6			
7			
8			
9	SAND with GRAVEL, fine and medium grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown.		
10			
11			
12	SAND, fine grained, loose, well sorted, dry, brown.		**6.1 m - 25.6 m bgs Alternating layers of approximately 1 m bentonite seal with 4.5 m of natural sluff**
13			
14	SAND with GRAVEL, fine and medium grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown.		
15			
16			
17	SAND, with compact Silt and Clay lenses, fine and medium grained sand, loose, poorly sorted, dry, grey.		
18			
19			
20	SAND with GRAVEL, fine and medium grained sand, small to large rounded to sub-rounded gravel, loose, poorly sorted, dry, brown.		
21			
22			
23	SAND, with compact Silt and Clay lenses, fine and medium grained sand, loose, poorly sorted, dry, grey.		**Water level 25.1 m (82.3 ft) below top of casing (btoc) (May 6, 2021)**
24			
25	SAND and SILT, fine grained sand, loose, poorly sorted, moist, brown. Increased moisture at 19.2 m, 20.7 m and21 m (63 ft, 68 ft and 69 ft) bgs. Mottling throughout.		**25.6 m - 29.7 m bgs 10-20 Filter Sand**
26			
27			**27.1 m - 29.7 m bgs 2 inch diameter 10 slot PVC screen 3 m (10 ft) length with bottom plug**
28			
29			
30			**Total Well Depth 30.6 m btoc**
31			

COORDINATES: 11U 311235.0 m E 5448302.0 m N
ELEVATION: 356 m asl **(gps)**

STATIC WATER LEVEL: 24.3 m btoc
DRILLING CONTRACTOR: Mud Bay Drilling Ltd.

TOTAL DEPTH: 30.6 m btoc
DRILLING METHOD: Sonic rubber track rig

Drawn By: MJ | Reviewed By: RR | Logged By: MJ

CERTIFICATE OF ANALYSIS

REPORTED TO	Western Water Associates Ltd 106 - 5145 26th Street Vernon, BC V1T 8G4		
ATTENTION	Morgan Jackson	**WORK ORDER**	21E2339
PO NUMBER		**RECEIVED / TEMP**	2021-05-20 09:52 / 11.0°C
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49
PROJECT INFO		**COC NUMBER**	B099390

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.

Note: Sample ID "duplicate" is a duplicate for MW11. Samples with Laboratory ID's ending in "RE1" were rerun at the request of WWAL to evaluate QA/QC.

If you have any questions or concerns, please contact me at bwhitehead@caro.ca

Authorized By:

Brent Whitehead
Client Scientist - Team Lead

TEST RESULTS

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
MW-8 (21E2339-01) | Matrix: Water | Sampled: 2021-05-19 07:30						
Anions						
Chloride	**83.3**	AO ≤ 250	0.10	mg/L	2021-05-21	
Nitrate (as N)	**0.945**	MAC = 10	0.010	mg/L	2021-05-21	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2021-05-21	
Calculated Parameters						
Hardness, Total (as CaCO3)	**312**	None Required	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**0.945**	10	0.0100	mg/L	N/A	
Nitrogen, Total	**1.24**	N/A	0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2021-05-25	
Conductivity (EC)	**905**	N/A	2.0	µS/cm	2021-05-26	
Nitrogen, Total Kjeldahl	**0.292**	N/A	0.050	mg/L	2021-05-28	
pH	**6.94**	7.0-10.5	0.10	pH units	2021-05-26	HT2
Phosphorus, Total (as P)	**0.185**	N/A	0.0050	mg/L	2021-05-27	
Phosphorus, Total Dissolved	**0.117**	N/A	0.0050	mg/L	2021-05-27	
Microbiological Parameters						
Coliforms, Total	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
E. coli	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
Total Metals						
Calcium, total	**89.4**	None Required	0.20	mg/L	2021-05-27	
Magnesium, total	**21.4**	None Required	0.010	mg/L	2021-05-27	
Sodium, total	**83.2**	AO ≤ 200	0.10	mg/L	2021-05-27	
MW-10 (21E2339-02) | Matrix: Water | Sampled: 2021-05-19 08:00						
Anions						
Chloride	**90.9**	AO ≤ 250	0.10	mg/L	2021-05-21	
Nitrate (as N)	**4.63**	MAC = 10	0.010	mg/L	2021-05-21	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2021-05-21	
Calculated Parameters						
Hardness, Total (as CaCO3)	**343**	None Required	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**4.63**	10	0.0100	mg/L	N/A	
Nitrogen, Total	**4.91**	N/A	0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2021-05-25	
Conductivity (EC)	**978**	N/A	2.0	µS/cm	2021-05-26	
Nitrogen, Total Kjeldahl	**0.282**	N/A	0.050	mg/L	2021-05-28	
pH	**7.31**	7.0-10.5	0.10	pH units	2021-05-26	HT2
Phosphorus, Total (as P)	**0.0497**	N/A	0.0050	mg/L	2021-05-27	
Phosphorus, Total Dissolved	**0.0239**	N/A	0.0050	mg/L	2021-05-27	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
MW-10 (21E2339-02) | Matrix: Water | Sampled: 2021-05-19 08:00, Continued						
Microbiological Parameters						
Coliforms, Total	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
E. coli	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
Total Metals						
Calcium, total	**82.5**	None Required	0.20	mg/L	2021-05-27	
Magnesium, total	**33.2**	None Required	0.010	mg/L	2021-05-27	
Sodium, total	**36.7**	AO ≤ 200	0.10	mg/L	2021-05-27	
MW-11 (21E2339-03) | Matrix: Water | Sampled: 2021-05-19 08:50						
Anions						
Chloride	**157**	AO ≤ 250	0.10	mg/L	2021-05-21	
Nitrate (as N)	**3.13**	MAC = 10	0.010	mg/L	2021-05-21	
Nitrite (as N)	**0.010**	MAC = 1	0.010	mg/L	2021-05-21	
Calculated Parameters						
Hardness, Total (as CaCO3)	**470**	None Required	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.14**	10	0.0100	mg/L	N/A	
Nitrogen, Total	**3.38**	N/A	0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2021-05-25	
Conductivity (EC)	**1220**	N/A	2.0	µS/cm	2021-05-26	
Nitrogen, Total Kjeldahl	**0.241**	N/A	0.050	mg/L	2021-05-28	
pH	**7.04**	7.0-10.5	0.10	pH units	2021-05-26	HT2
Phosphorus, Total (as P)	**0.0880**	N/A	0.0050	mg/L	2021-05-27	
Phosphorus, Total Dissolved	**0.0264**	N/A	0.0050	mg/L	2021-05-27	
Microbiological Parameters						
Coliforms, Total	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
E. coli	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
Total Metals						
Calcium, total	**111**	None Required	0.20	mg/L	2021-05-27	
Magnesium, total	**46.7**	None Required	0.010	mg/L	2021-05-27	
Sodium, total	**78.7**	AO ≤ 200	0.10	mg/L	2021-05-27	
MW-11 (21E2339-03RE1) | Matrix: Water | Sampled: 2021-05-19 08:50						
General Parameters						
Nitrogen, Total Kjeldahl	**0.267**	N/A	0.050	mg/L	2021-06-21	HT1
Phosphorus, Total Dissolved	**0.0273**	N/A	0.0050	mg/L	2021-06-18	HT1

TEST RESULTS

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
Duplicate (21E2339-04) | Matrix: Water | Sampled: 2021-05-19						
Anions						
Chloride	**150**	AO ≤ 250	0.10	mg/L	2021-05-21	
Nitrate (as N)	**3.04**	MAC = 10	0.010	mg/L	2021-05-21	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2021-05-21	
Calculated Parameters						
Hardness, Total (as CaCO3)	**493**	None Required	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**3.04**	10	0.0100	mg/L	N/A	
Nitrogen, Total	**3.50**	N/A	0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2021-05-25	
Conductivity (EC)	**1200**	N/A	2.0	µS/cm	2021-05-26	
Nitrogen, Total Kjeldahl	**0.454**	N/A	0.050	mg/L	2021-05-28	
pH	**7.10**	7.0-10.5	0.10	pH units	2021-05-26	HT2
Phosphorus, Total (as P)	**0.0861**	N/A	0.0050	mg/L	2021-05-27	
Phosphorus, Total Dissolved	**0.0338**	N/A	0.0050	mg/L	2021-05-27	
Total Metals						
Calcium, total	**114**	None Required	0.20	mg/L	2021-05-27	
Magnesium, total	**50.3**	None Required	0.010	mg/L	2021-05-27	
Sodium, total	**83.8**	AO ≤ 200	0.10	mg/L	2021-05-27	
Duplicate (21E2339-04RE1) | Matrix: Water | Sampled: 2021-05-19						
General Parameters						
Nitrogen, Total Kjeldahl	**0.398**	N/A	0.050	mg/L	2021-06-21	HT1
Phosphorus, Total Dissolved	**0.0332**	N/A	0.0050	mg/L	2021-06-18	HT1
MW-6 (21E2339-05) | Matrix: Water | Sampled: 2021-05-19 07:00						
Anions						
Chloride	**91.6**	AO ≤ 250	0.10	mg/L	2021-05-21	
Nitrate (as N)	**1.99**	MAC = 10	0.010	mg/L	2021-05-21	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2021-05-21	
Calculated Parameters						
Hardness, Total (as CaCO3)	**345**	None Required	0.500	mg/L	N/A	
Nitrate+Nitrite (as N)	**1.99**	10	0.0100	mg/L	N/A	
Nitrogen, Total	**2.62**	N/A	0.0500	mg/L	N/A	
General Parameters						
Ammonia, Total (as N)	**0.067**	None Required	0.050	mg/L	2021-05-25	
Conductivity (EC)	**1060**	N/A	2.0	µS/cm	2021-05-26	
Nitrogen, Total Kjeldahl	**0.625**	N/A	0.050	mg/L	2021-05-28	

TEST RESULTS

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
MW-6 (21E2339-05) | Matrix: Water | Sampled: 2021-05-19 07:00, Continued						
General Parameters, Continued						
pH	**7.02**	7.0-10.5	0.10	pH units	2021-05-26	HT2
Phosphorus, Total (as P)	**0.251**	N/A	0.0050	mg/L	2021-05-27	
Phosphorus, Total Dissolved	**0.0557**	N/A	0.0050	mg/L	2021-05-27	
Microbiological Parameters						
Coliforms, Total	**5**	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
E. coli	< 1	MAC = 0	1	MPN/100 mL	2021-05-20	HT1
Total Metals						
Calcium, total	**80.7**	None Required	0.20	mg/L	2021-05-27	
Magnesium, total	**34.7**	None Required	0.010	mg/L	2021-05-27	
Sodium, total	**109**	AO ≤ 200	0.10	mg/L	2021-05-27	

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.

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analysis Description	Method Ref.	Technique	Accredited	Location
Ammonia, Total in Water	SM 4500-NH3 G* (2017)	Automated Colorimetry (Phenate)	✓	Kelowna
Anions in Water	SM 4110 B (2017)	Ion Chromatography	✓	Kelowna
Coliforms, Total in Water	NA / SM 9223 (2017)	Quanti-Tray / Enzyme Substrate Endo Agar	✓	Kelowna
Conductivity in Water	SM 2510 B (2017)	Conductivity Meter	✓	Kelowna
E. coli in Water	NA / SM 9223 (2017)	Quanti-Tray / Enzyme Substrate Endo Agar	✓	Kelowna
Hardness in Water	SM 2340 B* (2017)	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Est)	✓	N/A
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2017)	Block Digestion and Flow Injection Analysis	✓	Kelowna
pH in Water	SM 4500-H+ B (2017)	Electrometry	✓	Kelowna
Phosphorus, Total Dissolved in Water	SM 4500-P B.5* (2011) / SM 4500-P F (2017)	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	✓	Kelowna
Phosphorus, Total in Water	SM 4500-P B.5* (2011) / SM 4500-P F (2017)	Persulfate Digestion / Automated Colorimetry (Ascorbic Acid)	✓	Kelowna
Total Metals in Water	EPA 200.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond

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
MPN/100 mL	Most Probable Number per 100 millilitres
pH units	pH < 7 = acidic, ph > 7 = basic
µS/cm	Microsiemens per centimetre
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:

BC CSR Schedule 3.2 Drinking Water

Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019)

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	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

General Comments:

The results in this report apply to the 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. Samples will be disposed of 30 days after the test report has been issued or once samples expire, whichever comes first. Longer hold is possible if agreed to in writing.

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	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

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 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 B1E2150										
Blank (B1E2150-BLK1)				Prepared: 2021-05-21, Analyzed: 2021-05-21						
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
Blank (B1E2150-BLK2)				Prepared: 2021-05-21, Analyzed: 2021-05-21						
Chloride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
LCS (B1E2150-BS1)				Prepared: 2021-05-21, Analyzed: 2021-05-21						
Chloride	15.8	0.10	mg/L	16.0		99	90-110			
Nitrate (as N)	4.00	0.010	mg/L	4.00		100	90-110			
Nitrite (as N)	2.00	0.010	mg/L	2.00		100	85-115			
LCS (B1E2150-BS2)				Prepared: 2021-05-21, Analyzed: 2021-05-21						
Chloride	16.1	0.10	mg/L	16.0		100	90-110			
Nitrate (as N)	4.01	0.010	mg/L	4.00		100	90-110			
Nitrite (as N)	2.11	0.010	mg/L	2.00		106	85-115			
General Parameters, Batch B1E2319										
Blank (B1E2319-BLK1)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B1E2319-BLK2)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B1E2319-BLK3)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B1E2319-BLK4)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B1E2319-BLK5)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B1E2319, Continued										
LCS (B1E2319-BS1)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	1.04	0.050	mg/L	1.00		104	90-115			
LCS (B1E2319-BS2)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	0.980	0.050	mg/L	1.00		98	90-115			
LCS (B1E2319-BS3)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	0.943	0.050	mg/L	1.00		94	90-115			
LCS (B1E2319-BS4)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	0.963	0.050	mg/L	1.00		96	90-115			
LCS (B1E2319-BS5)				Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	1.08	0.050	mg/L	1.00		108	90-115			
Duplicate (B1E2319-DUP4)	**Source: 21E2339-01**			Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	< 0.050	0.050	mg/L		< 0.050				15	
Matrix Spike (B1E2319-MS4)	**Source: 21E2339-01**			Prepared: 2021-05-25, Analyzed: 2021-05-25						
Ammonia, Total (as N)	0.204	0.050	mg/L	0.250	< 0.050	82	75-125			
General Parameters, Batch B1E2448										
Blank (B1E2448-BLK1)				Prepared: 2021-05-26, Analyzed: 2021-05-26						
Conductivity (EC)	< 2.0	2.0	µS/cm							
LCS (B1E2448-BS1)				Prepared: 2021-05-26, Analyzed: 2021-05-26						
Conductivity (EC)	1410	2.0	µS/cm	1410		100	95-105			
Reference (B1E2448-SRM1)				Prepared: 2021-05-26, Analyzed: 2021-05-26						
pH	7.00	0.10	pH units	7.01		100	98-102			
General Parameters, Batch B1E2546										
Blank (B1E2546-BLK1)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Phosphorus, Total (as P)	< 0.0050	0.0050	mg/L							
Phosphorus, Total Dissolved	< 0.0050	0.0050	mg/L							
Blank (B1E2546-BLK2)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Phosphorus, Total (as P)	< 0.0050	0.0050	mg/L							
Phosphorus, Total Dissolved	< 0.0050	0.0050	mg/L							
LCS (B1E2546-BS1)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Phosphorus, Total (as P)	0.100	0.0050	mg/L	0.100		100	85-115			
Phosphorus, Total Dissolved	0.100	0.0050	mg/L	0.100		100	85-115			
LCS (B1E2546-BS2)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Phosphorus, Total (as P)	0.0967	0.0050	mg/L	0.100		97	85-115			
Phosphorus, Total Dissolved	0.0967	0.0050	mg/L	0.100		97	85-115			
General Parameters, Batch B1E2548										
Blank (B1E2548-BLK1)				Prepared: 2021-05-26, Analyzed: 2021-05-28						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
Blank (B1E2548-BLK2)				Prepared: 2021-05-26, Analyzed: 2021-05-28						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	21E2339
PROJECT	20-046-02VR	**REPORTED**	2021-06-23 08:49

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B1E2548, Continued										
LCS (B1E2548-BS1)				Prepared: 2021-05-26, Analyzed: 2021-05-28						
Nitrogen, Total Kjeldahl	1.01	0.050	mg/L	1.00		101	85-115			
LCS (B1E2548-BS2)				Prepared: 2021-05-26, Analyzed: 2021-05-28						
Nitrogen, Total Kjeldahl	0.998	0.050	mg/L	1.00		100	85-115			
General Parameters, Batch B1F2166										
Blank (B1F2166-BLK1)				Prepared: 2021-06-18, Analyzed: 2021-06-21						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
Blank (B1F2166-BLK2)				Prepared: 2021-06-18, Analyzed: 2021-06-21						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
LCS (B1F2166-BS1)				Prepared: 2021-06-18, Analyzed: 2021-06-21						
Nitrogen, Total Kjeldahl	1.03	0.050	mg/L	1.00		103	85-115			
LCS (B1F2166-BS2)				Prepared: 2021-06-18, Analyzed: 2021-06-21						
Nitrogen, Total Kjeldahl	1.03	0.050	mg/L	1.00		103	85-115			
Microbiological Parameters, Batch B1E2012										
Blank (B1E2012-BLK1)				Prepared: 2021-05-20, Analyzed: 2021-05-20						
Coliforms, Total	< 1	1	MPN/100 mL							
E. coli	< 1	1	MPN/100 mL							
Blank (B1E2012-BLK2)				Prepared: 2021-05-20, Analyzed: 2021-05-20						
E. coli	< 1	1	MPN/100 mL							
Blank (B1E2012-BLK3)				Prepared: 2021-05-20, Analyzed: 2021-05-20						
Coliforms, Total	< 1	1	MPN/100 mL							
E. coli	< 1	1	MPN/100 mL							
Blank (B1E2012-BLK4)				Prepared: 2021-05-20, Analyzed: 2021-05-20						
E. coli	< 1	1	MPN/100 mL							
Total Metals, Batch B1E2552										
Blank (B1E2552-BLK1)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Calcium, total	< 0.20	0.20	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
LCS (B1E2552-BS1)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Calcium, total	2.06	0.20	mg/L	2.02		102	80-120			
Magnesium, total	2.22	0.010	mg/L	2.02		110	80-120			
Sodium, total	2.22	0.10	mg/L	2.02		110	80-120			
Reference (B1E2552-SRM1)				Prepared: 2021-05-26, Analyzed: 2021-05-27						
Calcium, total	9.98	0.20	mg/L	10.7		93	70-130			
Magnesium, total	3.65	0.010	mg/L	3.59		102	70-130			
Sodium, total	8.88	0.10	mg/L	8.71		102	70-130			

CARO Analytical Services | **Client** Western Water Associates Ltd
FINAL Analytical Testing Report | **Attention** Morgan Jackson
Work Order: 21E2339 | **Project** 20-046-02VR
Report Date: 2021-06-23 08:49:58 | **Project Info** [none]

Note: This is not the original data. Please refer to PDF / Hardcopy report.

												Sample Re-Analysis		
LAB ID						21E2339-05	21E2339-01	21E2339-02	21E2339-03	21E2339-04		21E2339-03RE1	21E2339-04RE1	
CLIENT ID						MW-6	MW-8	MW-10	MW-11	Duplicate (MW11)	Relative Percent Difference (%)	MW-11	Duplicate (MW11)	Relative Percent Difference (%)
DATE SAMPLED						2021-05-19	2021-05-19	2021-05-19	2021-05-19	2021-05-19		2021-05-19	2021-05-19	
DATE RECEIVED						2021-05-20	2021-05-20	2021-05-20	2021-05-20	2021-05-20				
MATRIX						Water	Water	Water	Water	Water		Water	Water	
General Method	**Analyte**	**Units**	**RL**	**Std (CDWQG)**	**Std (CSR2DW)**									
Anions	Chloride	mg/L	1	AO<=250	250	91.6	83.3	90.9	157	150	4.5%			
Anions	Nitrate (as N)	mg/L	0.01	MAC=10	10	1.99	0.945	4.63	3.13	3.04	2.9%			
Anions	Nitrite (as N)	mg/L	0.01	MAC=1	10	<0.010	<0.010	<0.010	0.01	<0.010	NA			
Calculated Parameters	Hardness, Total (as CaCO3)	mg/L	0.5	None Required	N/A	345	312	343	470	493	4.9%			
Calculated Parameters	Nitrate+Nitrite (as N)	mg/L	0.01	N/A	10	1.99	0.945	4.63	3.14	3.04	3.2%			
Calculated Parameters	Nitrogen, Total	mg/L	0.05	N/A	N/A	2.62	1.24	4.91	3.38	3.5	3.6%			
General Parameters	Ammonia, Total (as N)	mg/L	0.05	None Required	N/A	0.067	<0.050	<0.050	<0.050	<0.050	NA			
General Parameters	Nitrogen, Total Kjeldahl	mg/L	0.05	N/A	N/A	0.625	0.292	0.282	0.241	0.454	88.4%	0.267	0.398	49.1%
General Parameters	Phosphorus, Total (as P)	mg/L	0.005	N/A	N/A	0.251	0.185	0.0497	0.088	0.0861	2.2%			
General Parameters	Phosphorus, Total Dissolved	mg/L	0.005	N/A	N/A	0.0557	0.117	0.0239	0.0264	0.0338	28.0%	0.0273	0.0332	21.6%
General Parameters	pH	pH units	0.1	7.0-10.5	N/A	7.02	6.94	7.31	7.04	7.1	0.9%			
General Parameters	Conductivity (EC)	uS/cm	2	N/A	N/A	1060	905	978	1220	1200	1.6%			
Microbiological Parameters	Coliforms, Total	MPN/100 mL	1	MAC = 0	N/A	5	<1	<1	<1		NA			
Microbiological Parameters	E. coli	MPN/100 mL	1	MAC = 0	N/A	<1	<1	<1	<1		NA			
Total Metals	Calcium, total	mg/L	0.2	None Required	N/A	80.7	89.4	82.5	111	114	2.7%			
Total Metals	Magnesium, total	mg/L	0.01	None Required	N/A	34.7	21.4	33.2	46.7	50.3	7.7%			
Total Metals	Sodium, total	mg/L	0.1	AO<=200	200	109	83.2	36.7	78.7	83.8	6.5%			

CDWQG - Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019)
CSR2DW - BC CSR Schedule 3.2 Drinking Water

RPD values >25% flagged.

APPENDIX J

WWA Hydrogeological Review of the Town of Oliver Reclaimed Wastewater Irrigation System Environmental Monitoring Program – Supplement to TRUE Consulting's 2023 Annual Report

western water
ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

February 26, 2024 WWAL Project: 20-046-05VR

Town of Oliver
c/o TRUE Consulting Ltd.
201-2079 Falcon Road,
Kamloops, B.C.
V2C 4J2

Attn: Natalie Alteen, P.Eng.

Re: Hydrogeological Review of the Town of Oliver Reclaimed Wastewater Irrigation System Environmental Monitoring Program – Supplement to TRUE Consulting's 2023 Annual Report

Western Water Associates Ltd. (WWAL) is pleased to provide this hydrogeological review of the Town of Oliver's (the Town's) reclaimed wastewater irrigation system environmental monitoring program. The Town municipal wastewater system operates under the Ministry of Environment (ENV) Operational Certificate (OC) PE-13717 (last amended 1995) which outlines requirements for operations, monitoring and annual reporting as approved by the ENV.

TRUE Consulting has prepared the annual reports on behalf of the Town in recent years. Condition 6.8 and 7.2 of the OC outline the requirements for a groundwater monitoring plan and annual reporting, to be completed annually by an Engineer or Hydrogeologist licensed to practice in the Province of British Columbia. Input from a hydrogeologist on the annual monitoring commenced in 2020, when WWAL compiled all available data from 2003 onward and prepared a comprehensive hydrogeological report (WWAL 2021a).

In 2021, WWAL implemented recommendations from our assessment and oversaw the installation of four monitoring wells to provide coverage to newer areas receiving reclaimed water, and replacement of a well that had gone dry (WWAL 2021b). The reader is referred to our previous reports for detailed information on site geology, derivation of groundwater flow direction, hydrogeologic setting and monitoring well logs.

This letter report updates our previous assessments and interprets annual monitoring data collected in 2023.

1.0 BACKGROUND

The Town of Oliver has been collecting municipal wastewater, treating it to reclaimed water reuse standards and using the reclaimed wastewater for irrigation on several properties since the mid 1980's. The current wastewater treatment system includes influent screening, two-cell aerated lagoon treatment system, winter effluent storage, chlorine contact system and reclaimed water irrigation (TRUE 2019).

During winter months (October to April), the treated municipal wastewater is stored in the two storage ponds with a total capacity of 470,000 m^3. In the summer months, the reclaimed wastewater is disinfected with chlorine and used to spray irrigate several properties including: Fairview Park, Gala Street Linear Park, grounds at South Okanagan Secondary School, the Town's Public Works Yard, lands surrounding the Oliver Municipal Airport, and the Cemetery. The total irrigation area in 2023 is approximately 79.4 Ha (TRUE 2023). Annual monitoring reports prepared by TRUE on behalf of the Town are detailed and contain information on the wastewater storage and annual balancing, irrigation volumes and effluent/reclaimed water quality.

The groundwater monitoring program consists of bi-annual (April and September) monitoring of groundwater quality and monthly monitoring of water levels at ten monitoring wells. Monitored wells Well #1, Well #2 and Well #3 have been consistently sampled since 2007, MW-4 since 2008 and MW-5 since 2003. Monitoring wells MW-8, MW-9, MW-10, and MW-11 were installed in 2021 and have been sampled ever since; except for MW-10 in April 2023 and at MW-9, which has been dry since installation. Monitoring well MW-6 was thought to have been dry since 2003, however, WWAL field staff re-developed a small portion of the well screen in May 2021 and water level measurements and water quality samples have been collected ever since.

Monitoring well MW-5 is intended as a background well as reclaimed water irrigation is no longer practiced upgradient of this location.

The water quality parameters assessed in each well in 2023 included the following:

- Nitrogen species (nitrate, nitrite, ammonia)
- Total and dissolved phosphorous
- Chloride
- Total sodium, total calcium, and total magnesium
- Total hardness
- Conductivity
- Carbonaceous Biological Oxygen Demand 5-day ($CBOD_{5\text{-}day}$)

The irrigation areas for the Town and the location of all groundwater monitoring wells included in the groundwater sampling program are outlined in TRUE's Sanitary Sewer System 2023 Annual Report for the Town of Oliver. Table 1.1 summarizes the well construction details and their locations relative to irrigated area for the current program monitoring wells.

Town of Oliver staff complete water level monitoring monthly and water quality sampling biannually. Sampling involves purging each well of at least three well volumes with Waterra tubing/foot valve or with a bailer and collecting water samples. Oliver staff have noted that some wells are slow to recharge, and those are purged until dry and sampled the following day.

Table 1.1 Summary of Monitoring Well Construction Details

Well ID	Well Depth m	Screened Interval m bgs	Diameter mm (in)	Top of Casing Elevation m asl	Location
Well #1 (Air Cadet)	10.52 btoc	unknown	50 (2)	308.52	East (downgradient) of Airport
Well #2 (Rodeo Grounds)	8.08 btoc	unknown	50 (2)	306.56	East (downgradient) of Airport
Well #3 (91A Street)	4.1 btoc	unknown	50 (2)	295	East (downgradient) of Airport
Town MW-4 (Sand Pit)	10.98 btoc	7.25 – 12.25	50 (2)	351.906	Downgradient of RIB
Town MW-5 (125th Street)	13.25 btoc	5.75 – 10.75	50 (2)	363.361	Assumed Background
Town MW-6 (Fairview Golf Course)	18.29 bgs	13.29 - 18.29	50 (2)	362.702	Downgradient of Golf Course
Town MW-8 (Public Works Yard)	6.52 btoc	5.2 - 6.7	50 (2)	298	Downgradient of Golf Course
Town MW-9 (Cemetery)	21.1 btoc	18.2 - 21.2	50 (2)	336	East Side of Cemetery grounds
Town MW-10 (Gala St. Linear Park)	27.1 btoc	25.7 - 27.2	50 (2)	326	East (downgradient) of South Okanagan Secondary School
Town MW-11 (Road No. 5)	30.6 btoc	27.1 - 29.7	50 (2)	356	Downgradient of Golf Course

Notes: mbtoc- meters below top of casing; mbgs- meters below ground surface. The top casing elevations for MW-8, MW-9, MW-10 and MW-11 are approximate as the wells have not been surveyed.

2.0 HISTORICAL GROUNDWATER LEVELS

Groundwater level measurements have been collected by Town staff at all of the monitored well locations since January 2014, with the exception of the new wells installed in 2021. As noted, monitoring well MW-6 was thought to have been dry. Water levels have been collected at MW-6 since re-development in May 2021. MW-9 has been dry since installation (2021). Groundwater flow direction in the Fairview area where the bulk of the irrigation occurs is inferred to be eastward towards the Okanagan River. In lower elevation areas closer to the Okanagan River (airport, public works yard) groundwater flow direction is inferred to follow the Okanagan River southward. Figure 2.1 below depicts the 2014-2023 water elevation hydrograph.

Water levels collected at Well #1 and Well #2 in 2023 (except March 2023) and partially in 2022 were below the measured well depths. As water quality samples were collected in both April and September 2023 (and 2022), when water levels were measured below the well depth, the depth of both Well #1 and Well #2 should be reconfirmed by Town staff at the next monitoring event, referenced from top of PVC casing.

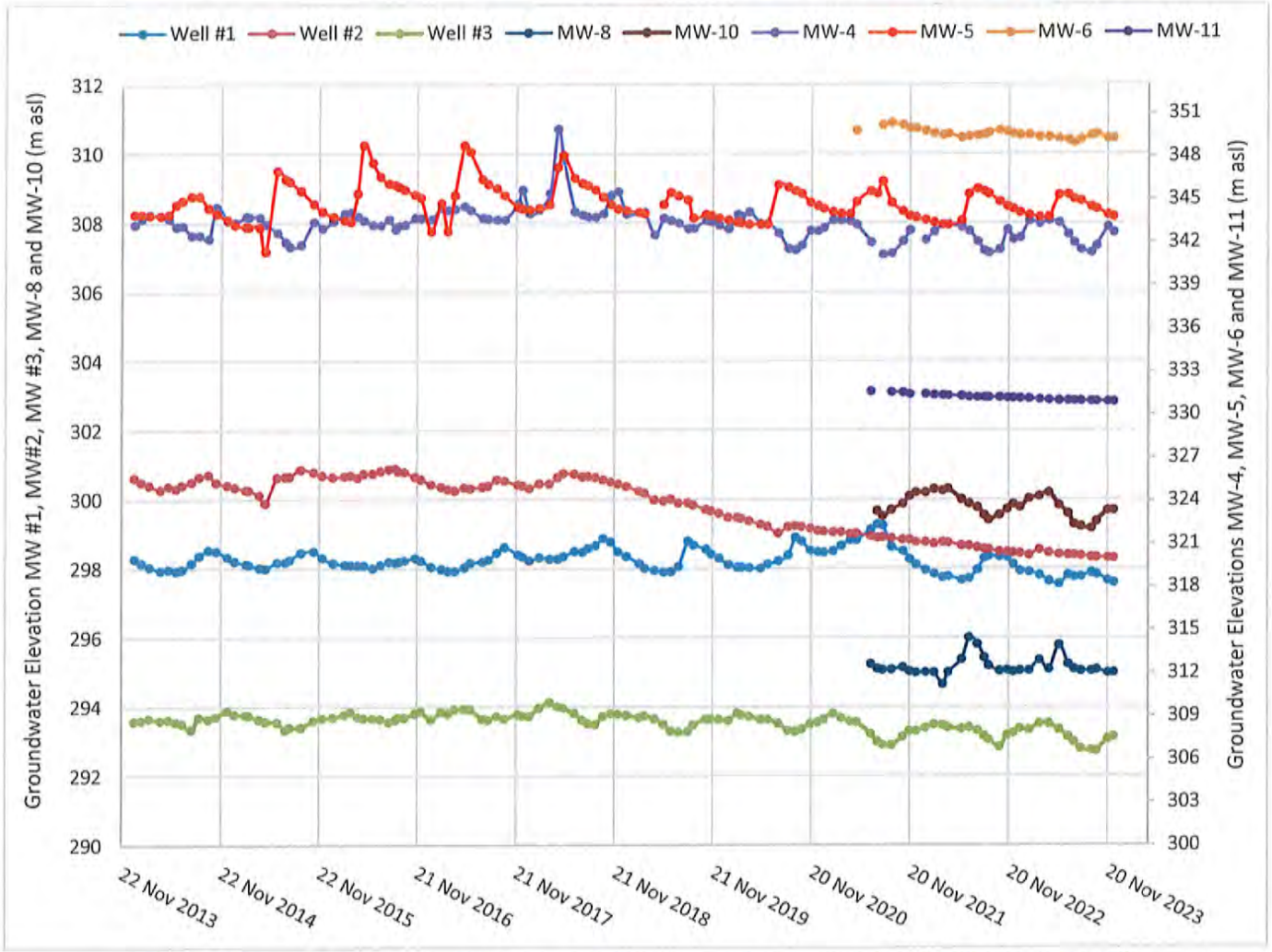


Figure 2.1 Groundwater Elevation Hydrograph of Oliver Groundwater Monitoring Wells

Water table elevations have remained relatively similar throughout the 10-year period of record. Annual fluctuations in the monitoring wells located at the airport and public works yard (Wells #1, #2, #3, and MW-8, completed in Aquifer 254) are on the order 0.2 to 1.4 m and monitored wells MW-4, MW-5, and MW-10 (completed in Aquifer 256), typically fluctuate by approximately 1 m to 3 m annually. Monitoring wells MW-6 and MW-11 fluctuate less than 0.7 m since monitoring began (2021).

Monitoring well MW-5 is located hydraulically upgradient of most of the irrigated areas and has seasonal highs typically occurring in May or June. This is the expected response for an aquifer with a recharge regime dominated by freshet and snowmelt. However, since 2020, groundwater elevation at MW-5 have peaked slightly later in season, in July or August. MW-5 is located near orchards and vineyards and could be influenced by irrigation practices on surrounding agricultural land.

Water levels at MW-4 typically begin decreasing in April and are lowest in August and September. The pattern of water level elevations at MW-4 is assumed to be affected by the use of the nearby RIB. Water

level measurements are only collected monthly, the full impact of use of the RIB (which typically only occurs for a short period) is likely not captured.

The pattern of water level fluctuation at the three airport wells differs from the expected freshet dominated seasonal response. Well #3 water level elevations appear at their lowest in the summer months, rising in fall (October/November) and are typically at their highest in early spring (March/April). Rising groundwater elevation in the fall suggests recharge to the well is influenced by irrigation return flows. Elevations at Well # 1 appear higher near the end of the irrigation season suggesting that irrigation return flows are also contributing recharge to the aquifer. Well #2 showed a similar trend until late 2018 when water level elevations began to steadily decrease with very little seasonal variability. Water level elevations also show a slight decrease at Well #1 and Well #3 since 2020. These changes coincide with decreased volume of spray irrigation discharged to the airport lands since 2019 (TRUE 2023) and are likely a contributing cause of lower groundwater elevations measured in this area. Google Earth imagery of agricultural land to the east also suggests a transition from fruit tree orchards to vineyards, which may have resulted in less irrigation recharge of the underlying aquifers.

The remaining monitoring wells are new, installed in 2021, or historical data does not exist (MW-6). Based on available data, MW-6 shows a similar pattern of seasonal fluctuations as Well #1 and Well #3 with elevated groundwater in the fall near the end of the irrigation season. Groundwater elevations at MW-10, like MW-4, are elevated in the early spring (April) and lowest late summer and early fall (September). Groundwater at MW-8 (public works) is similar in elevation to Well #3 and shows a similar pattern to MW-5 with elevated groundwater levels in May, June, and July. Groundwater elevations at MW-11 are relatively stable with little seasonal variation over the 3-year period of record.

3.0 HISTORICAL GROUNDWATER QUALITY DATA

Assessing potential impact on the receiving environment from reclaimed water spray irrigation is the main objective of the current groundwater monitoring program. The receptors of concern are aquifers beneath and downgradient of the irrigation areas and RIB where wells may be used, downgradient aquatic receiving environments, mainly the Okanagan River, and irrigation and livestock watering with wells in the agricultural areas just south of Oliver (WWAL 2021a).

Based on the above receptors of concern, the water quality data were compared to the following applicable guidelines and standards:

- The B.C. Contaminated Sites Regulation, Schedule 3.2, Generic Numerical Water Standards for Drinking Water (CSR DW), Aquatic Life (CSR AW), Livestock Watering (LW) and Irrigation (IW) (ENV, 1997).

Water quality data for selected parameters sampled at the monitored wells are discussed in the sections below and illustrated with time series-plots.

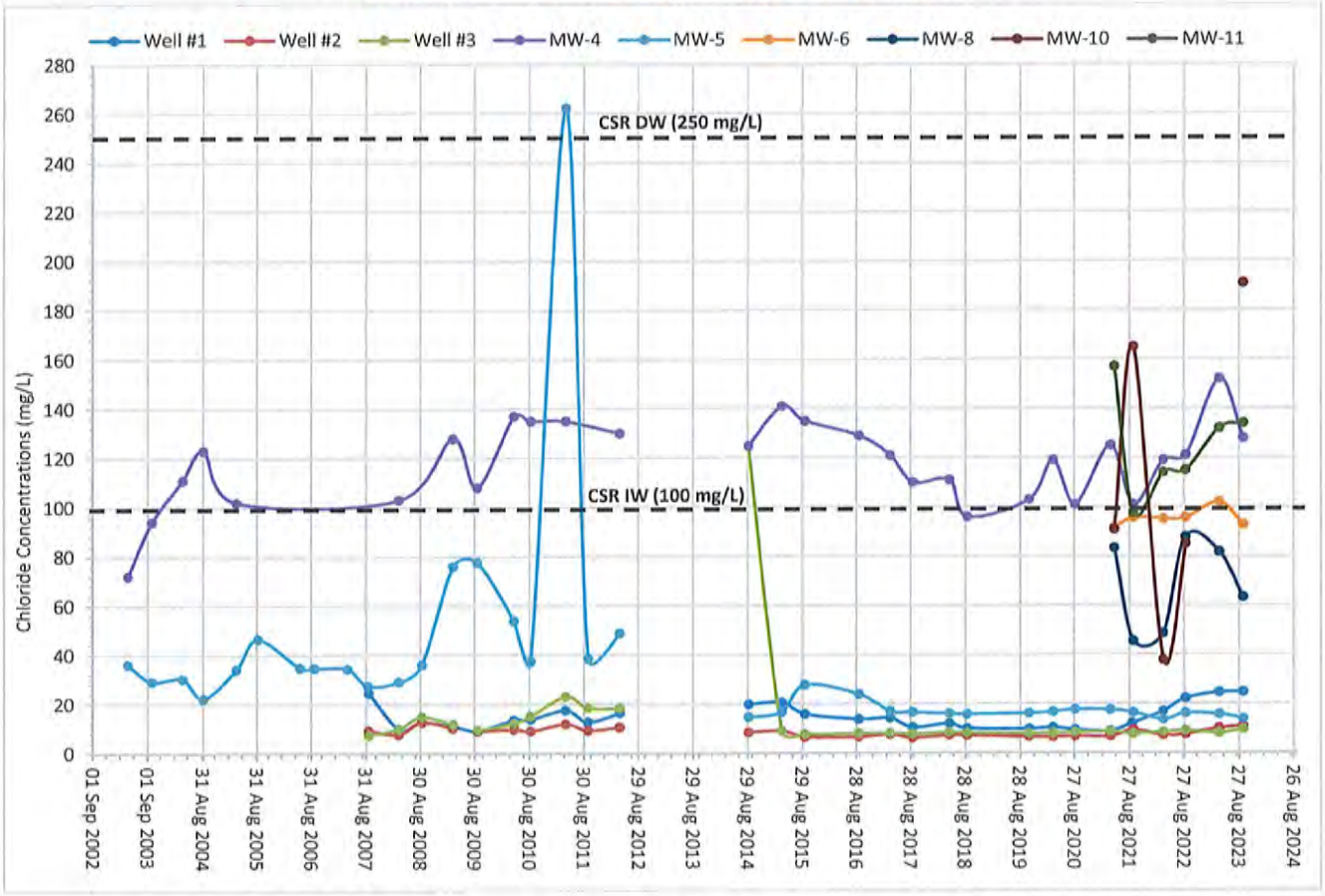
3.1 Chloride

The presence of chloride is not of direct concern to human health; however, concentrations above background levels can indicate the magnitude of impact on groundwater from the reclaimed water spray

irrigation. Chloride is a conservative ion, meaning it does not sorb to soil or degrade in the environment. While chloride is naturally present in small concentrations in groundwater, elevated chloride can be due to anthropogenic activities such as road salting, industrial processes, wastewater effluent disposal to ground, and agricultural activity. Chloride concentrations over time in samples from the monitoring wells are outlined in Figure 3.1 below.

Overall chloride levels at Wells #1, #2 and #3 (airport wells) are relatively stable and are typically below 25 mg/L. Chloride concentrations at Well #1 increased during each sampling event from the April 2021 to April 2023 but remained stable in 2023 and are below 25 mg/L. Monitoring well MW-4 typically displays the highest chloride concentrations out of all monitored wells with concentrations consistently above the CSR irrigation standards (100 mg/L). The elevated chloride at MW-4 is likely due to its downgradient location with respect to the RIB. Monitoring wells MW-6, MW-8, MW-10 and MW-11 have chloride concentrations elevated above the airport wells and background well MW-5. In 2023, MW-8 and MW-10 remained below applicable standards, while concentrations at MW-6 were just above irrigation standards in April 2023. Chloride at MW-11 remained above irrigation standards during both sampling events in 2023 (Figure 3.1).

Figure 3.1 Chloride Concentrations Over Time



Chloride concentrations at MW-5 have been relatively stable and similar to concentrations at Wells #1, #2 and #3 since 2014.

3.2 Total Sodium

The presence of sodium above background concentrations can indicate wastewater impacts on groundwater. Sodium can also be present naturally due to weathering of bedrock containing natural sources of sodium or due to anthropogenic activities such as road salting, sewage and industrial effluents, home water softener use, and agricultural activity. Total sodium concentrations over time in samples from the monitoring wells are displayed on Figure 3.2.

Sodium concentrations at Wells #1, #2 and #3 remained relatively stable since 2014, ranging between 14.4 mg/L to 33.5 mg/L. Monitoring well MW-4 displays the highest sodium concentrations and sizeable fluctuations in sodium concentrations with a range of approximately 134 mg/L. Sodium concentrations at MW-4 are typically elevated at the end of the irrigation season (September) relative to the start (April); however, concentrations were elevated and relatively similar during both sampling events in 2023. This is likely due to the operation of the RIB upgradient of MW-4. Both MW-4 and the upgradient RIB are also located within a draw, which could convey impacted water from upgradient agricultural activities towards the area.

Although trends are not yet discernable in recently installed monitoring wells, in 2023, sodium at MW-6 and MW-8 were elevated in September and lower in April and concentrations at MW-11 were similar during both sampling events in 2023. Concentrations at MW-10 (only sampled in September 2023) and MW-11 were above historical results during the 2023 sampling events. Concentrations at these new wells are above background, with concentrations at MW-6 elevated above all other sample locations including MW-4 in September 2023.

Historically MW-5 showed relatively large variations in sodium concentrations (2011 and 2017); however, since 2018 concentrations are relatively stable and similar to the airport wells at approximately 14 mg/L.

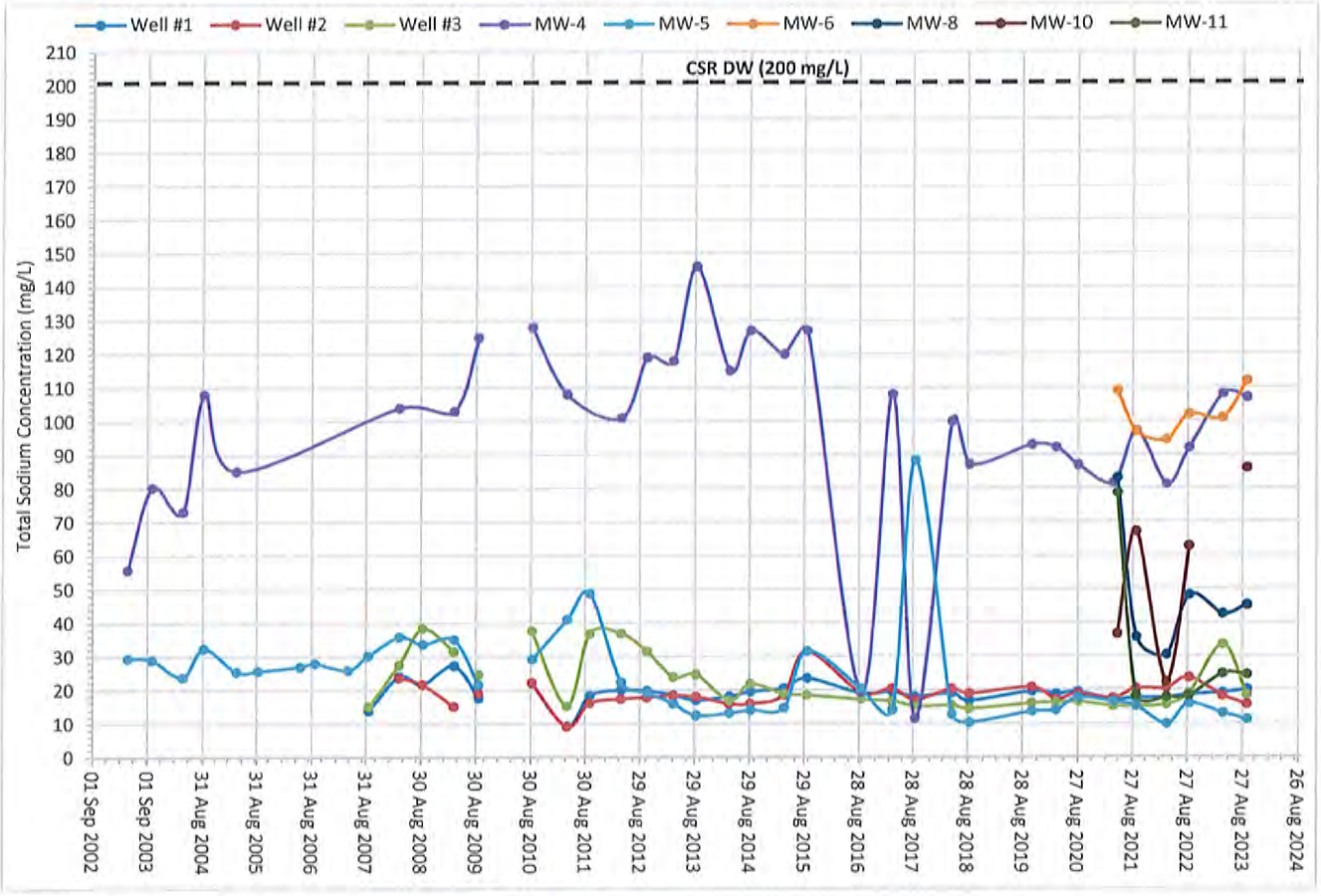


Figure 3.2 Sodium Concentrations Over Time

3.3 Nitrate

Nitrate is of direct concern for its potential effects on human health and the environment. Nitrate concentrations greater than 3 mg/L are considered by the province to reflect human impacts (ENV 2007), but typically nitrate is not present or only present at low concentrations (i.e. < 0.3 mg/L) in pristine environments. The most common anthropogenic sources of nitrates include agricultural activities, wastewater disposal to ground, and discharge from industrial processes and mining (blast residuals from ammonium-nitrate or other explosives). Nitrite is an unstable form of nitrogen that rapidly oxidizes to nitrate or reduces to nitrogen gas, as such nitrite is typically found at low concentrations in the environment (ENV, 1998). Nitrate (as N) concentrations over time is displayed on Figure 3.3.

Monitored location Well #1 typically displays the highest nitrate levels with concentrations frequently exceeding the BC CSR DW standard (10 mg/L). Concentrations at Well #1 were just below BC CSR DW standards during both sampling events in 2023. The concentration of nitrate at Well #1 is anomalous and suggests there may be another point source of nitrate being added to the aquifer near this location. Nitrate+nitrite concentrations at Well #2 and Well #3 are relatively stable and largely below 1 mg/L, despite their proximity to Well #1 and completion in the same aquifer. Concentrations at Well #2 were elevated above 3 mg/L during both sampling events in 2023. This is the highest recorded concentration

of nitrate at this location since sampling began (2007) and could be a result of point source of nitrate near this location or declining water levels, which can increase the concentration of contaminants.

Nitrate concentrations at monitoring wells MW-6, MW-8 are slightly lower (1 to 3.6 mg/L) than concentrations measured at MW-10, and MW-11 (3 to 6 mg/L). Similar to 2022, concentrations at MW-6 were higher in September than in April 2023.

Concentrations of nitrate at monitoring well MW-4 typically range between 1 mg/L to 4 mg/L with the exception of sampling events in April 2017, October 2019, and April 2020 when concentrations were above or near the CSR DW standard. These spikes are attributed to use of the nearby RIB. Nitrate is typically elevated in April relative to September at MW-4 and this trend continued in 2023. Nitrate concentrations at MW-5 have been relatively stable since 2013 and are typically at or below 2 mg/L. Historically nitrate concentrations at MW-5 were elevated and variable but have declined and become more stable in recent years. The cause of this is not known but may be linked to changes in agricultural or irrigation practices upgradient.

Interpretation of nitrate concentrations in the Oliver area, and in the south Okanagan as a whole, need to consider widespread, pre-existing nitrate contamination. Several studies have documented elevated nitrate in the area up to and above the CSR DW guideline of 10 mg/L (Hodge 1992, Athanasopoulos 2009). For the Oliver monitoring wells, background nitrate concentration appears to be in the 1-4 mg/L range. Wells with nitrate concentrations above that range and those wells where nitrogen concentrations fluctuate significantly, may be impacted by the reclaimed wastewater irrigation or other land uses.

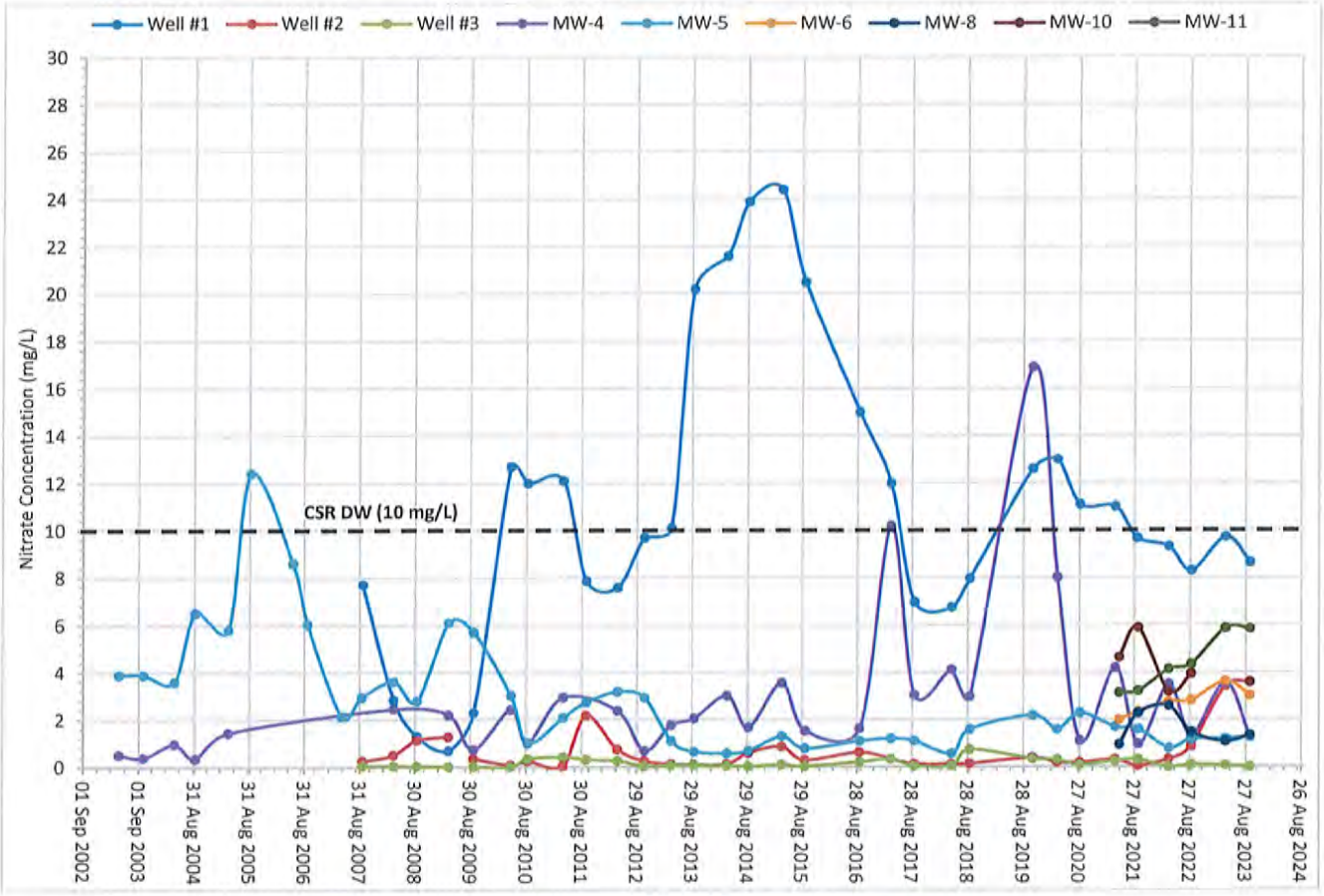


Figure 3.3 Nitrate (as N) Concentrations Over Time

3.4 Ammonia

Ammonia and nitrite are early forms of nitrogen in the nitrification process. Ammonia is preferentially used by nitrifying bacteria in the wastewater treatment process, with excess ammonia oxidized to nitrite and eventually to nitrate typically occurring prior to discharge to the receiving environment (Grady et al 1980). When ammonia or nitrite are present in groundwater, it can indicate that the source of nitrogen is close by. Similar to nitrate, anthropogenic sources of ammonia include wastewater effluent, agriculture and urban development, industrial effluents, and mining (blast residuals). Figure 3.4 displays ammonia concentrations over time for the monitored locations.

Ammonia concentrations at all monitored wells except MW-5 have been relatively stable and low since 2011. Ammonia at MW-8 spiked in September 2022 and in September 2023 ammonia spiked at Well #3. While there are too few data (3-years) to establish a trend in water quality at MW-8, at Well #3 (15-years of data), the measured concentration of ammonia in September 2023 was almost 50 times the average concentration for this location. This level of change is considered anomalous, especially when the measured concentration of ammonia in April 2023 at Well #3 were low (0.079 mg/L) and typical for this location.

Several spikes in ammonia concentration at MW-5 have occurred which do not correspond to spikes at other locations and are also considered anomalous. The ammonia data indicates a source other than the reclaimed irrigation water could be impacting MW-5. Ammonia was below detection limits at Well #1, MW-6, and MW-11 during both sampling events in 2023. Ammonia was either not detected or detected at low concentrations at Well #2, MW-4, MW-5, MW-8, and MW-10 in 2023.

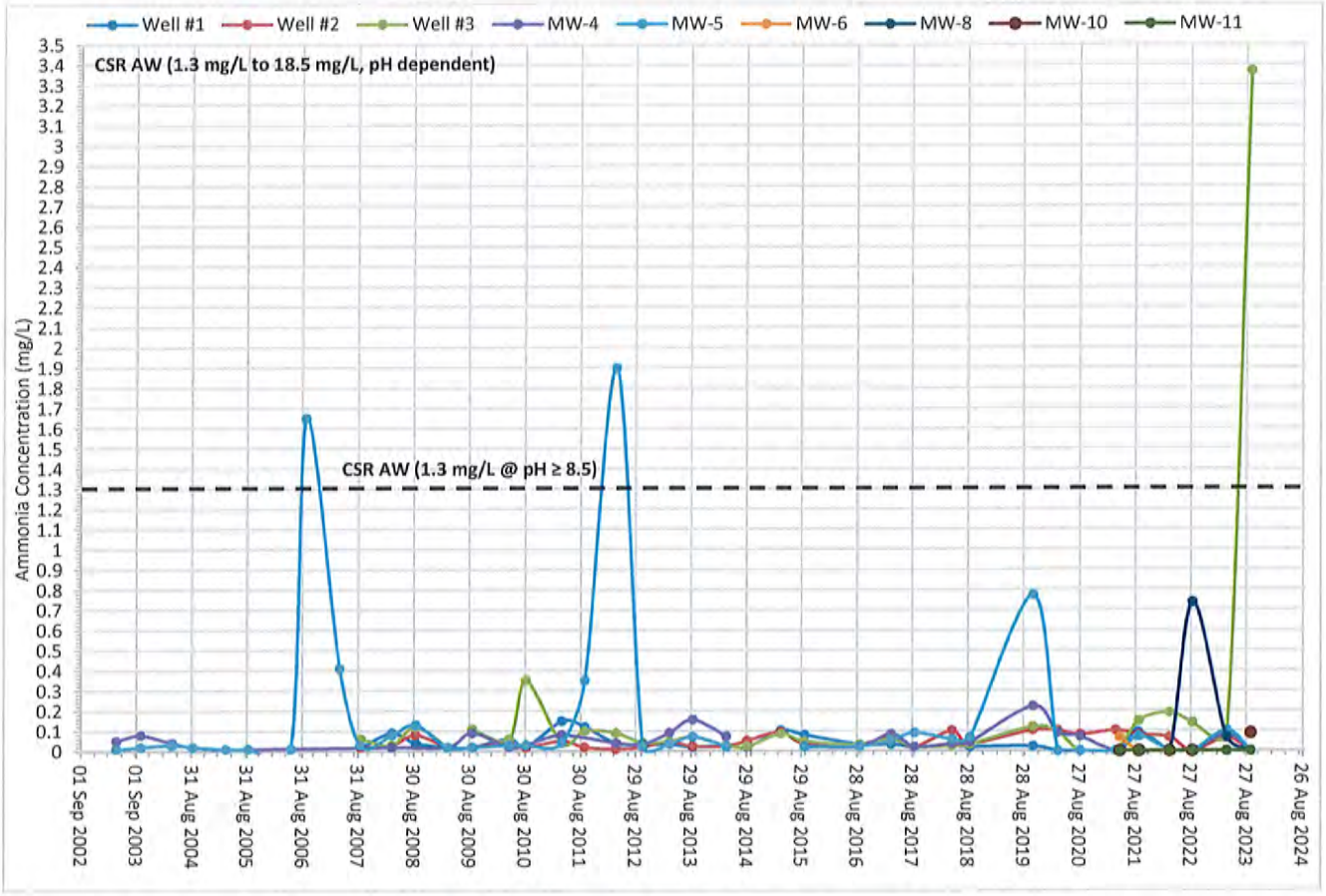


Figure 3.4 Ammonia Concentrations Over Time

3.5 Nitrate vs. Chloride

To highlight differences in water quality, to fingerprint water from different aquifers and to discern factors affecting water quality, a graph of nitrate+nitrite vs. chloride was created and updated to include 2023 data (Figure 3.5).

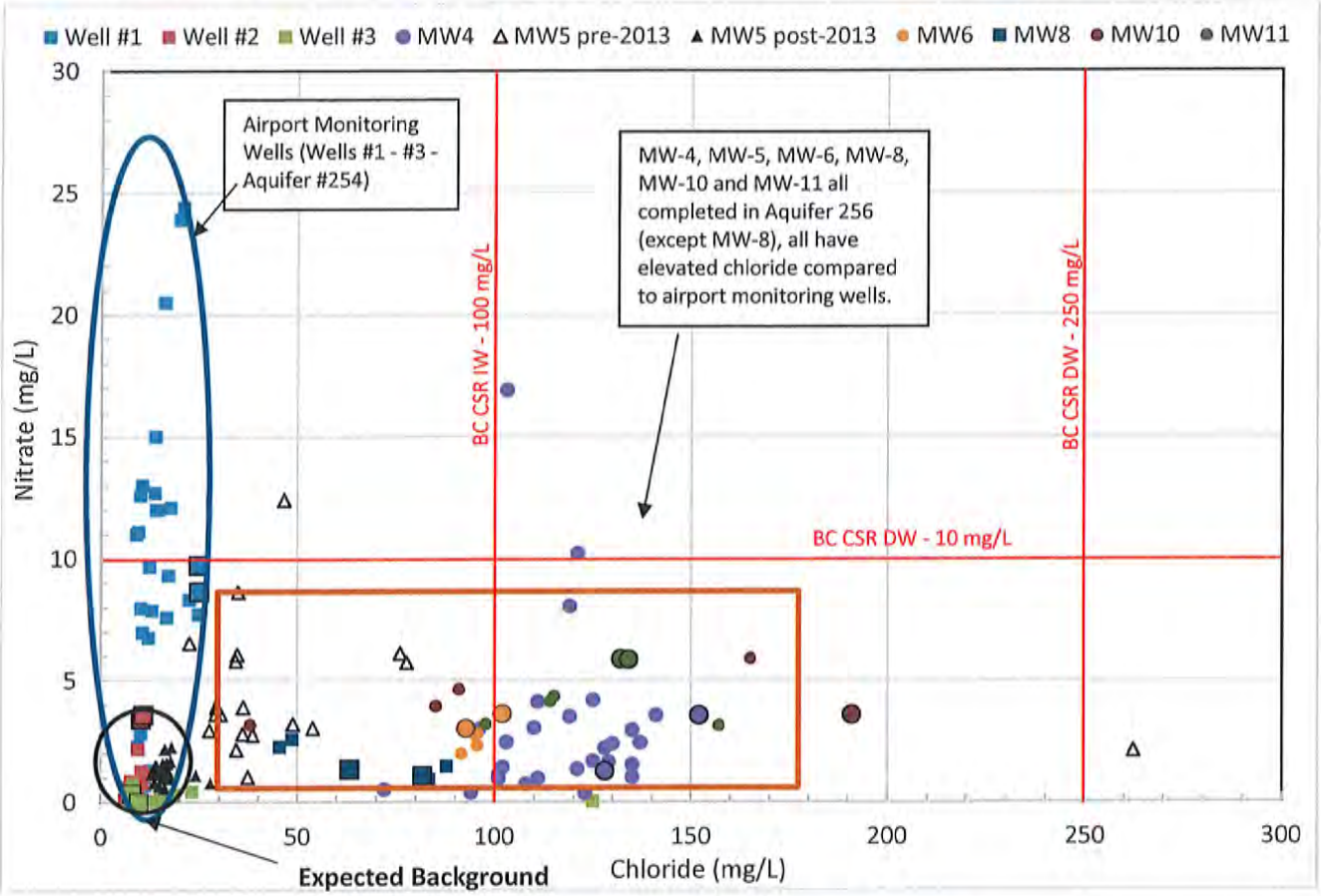


Figure 3.5 Nitrate vs. Chloride in Monitoring Wells

The 2023 data are identified by an outline and larger symbol size in Figure 3.5.

The graph provided visually highlights several key points:

- The Airport monitoring wells (Wells #1 through #3) are typified by low chloride concentrations. Well #1 stands out with its elevated and variable nitrate concentration, often above the BC CSR DW guideline of 10 mg/L.
- Wells located west and upslope of the valley bottom completed in Aquifer 256 have elevated chloride concentrations in comparison to the airport wells. Nitrate is variable in these wells, typically in the 1 to 5 mg/L range and below the 10 mg/L BC CSR DW guideline.
- Data for MW-5, the intended program background well show a clear difference before and after 2013. Prior to 2013, both chloride and nitrogen concentrations were elevated and variable, while after 2013, concentrations are lower for both parameters and stable. This suggests a change in land use or farming practices in the area occurred.
- Expected background concentrations for these parameters in the Oliver area are indicated in the lower left corner of the graph. Airport Wells #2 and #3, and MW-5 post-2013 fall in this range.

This indicates most of the program monitoring wells show some degree of anthropogenic impact, from the reclaimed wastewater irrigation or other land uses such as agriculture or road salting.

5.0 CONCLUSIONS

Based on this year's assessment, and building on our previous assessments, we provide the following conclusions:

C1 As part of its annual environmental monitoring program, the Town of Oliver monitors ten wells located downgradient of the areas that are irrigated with reclaimed wastewater and RIB site. Water levels are collected monthly and water quality sampling is completed semi-annually, in spring and fall.

C2 The monitoring wells near the airport (Well #1, #2 and #3) and monitoring well MW-8 are completed in valley bottom Aquifer 254, while the remaining wells which are completed at higher elevation in the Fairview area are completed in Aquifer 256. Groundwater elevation fluctuates on the order of 0.2 to 1.4 m at the lower lying (valley bottom) monitoring wells and at the higher elevation wells groundwater elevations fluctuate on the order of 1 to 3 m. MW-6 and MW-11 fluctuate less than 0.7 m.

Groundwater elevations at Well #1 appear higher near the end of the irrigation season suggesting that irrigation return flows are contributing recharge to the aquifer at this location. Well #2 has shown a consistent decline in water level elevation since late 2018 and less seasonal fluctuation. Additionally, Wells #1 and #3 have shown a slight decline in water level since 2020. These changes in water level coincide with decreases in volume of spray irrigation water discharged to the airport lands. In 2023, water levels at MW-5 peaked in the spring presumably in response to freshet induced recharge, which is typical for this location. This pattern diverged from 2020 to 2022 when groundwater levels at MW-5 peaked in July and August, suggesting water levels at this location could be influenced by irrigation practices on surrounding agricultural land. MW-4, located immediately downgradient of the RIB, shows groundwater levels highest in the early spring and again in November. This may be in response to loading of the RIB, or a result of freshet and fall storms, as the RIB and well are located in a draw that likely receives stormwater runoff.

C3 Water quality results from the groundwater monitoring program indicate the following:

- Water quality at MW-4 shows elevated sodium, chloride and nitrate+nitrite concentrations. MW-4 is located immediately downgradient of the RIB, and in a draw leading from agricultural land located upslope and is likely impacted by these sources. It is likely that the current monitoring program does not capture the full range of impacts from use of the RIB, as the RIB is typically loaded continuously for a period of weeks while water levels are measured monthly and water quality samples are only collected biannually.
- Monitoring well MW-5, the intended program background well, shows some water quality impacts. Of note, recurring spikes in ammonia concentrations at levels not seen in other monitoring wells. As lands near MW-5 are not currently irrigated with reclaimed water the observed water quality impacts are likely due to other unknown sources. Since

2013, concentrations of parameters of interest in MW-5 have stabilized and dropped close to background levels, suggesting land use in the area has changed.

- Well #2 and Well #3 located downgradient of the airport generally display the lowest impacts on groundwater quality, with concentrations of chloride, sodium, nitrate+nitrite and ammonia at what are likely background levels for Aquifer 254. Ammonia concentrations at Well #3 were uncharacteristically elevated (almost 50 times the average) during the September 2023 sampling event. This level of change is considered anomalous and should be confirmed with the next sampling event before drawing conclusions. Well #1 shows low chloride, sodium and ammonia concentrations; however, it is characterized by high nitrate concentrations often above 10 mg/L. When compared to other monitoring wells in the area, the results are anomalous and indicate a possible unknown source of nitrate. The Air Cadet building is located very close to Well #1, and a vineyard and BC Tree Fruits facility is located across the street to the east.
- Chloride concentrations at MW-6, MW-8, MW-10 and MW-11 are above levels observed at the airport wells, and background well MW-5. Sodium at MW-6, MW-10 and MW-8 is also elevated above background while concentrations at MW-11 were similar to the airport wells. Nitrate+nitrite concentrations at MW-8 are lower (~1 mg/L) than those measured at MW-6, MW-10 and MW-11 (> 3 mg/L) in 2023. Ammonia was below detection limits during all sampling events at MW-6 and MW-11 but was detected at low concentrations at MW-8 during the April 2023 sampling event and at MW-10 during the September 2023 sampling event.

C4 In terms of water quality exceedances, all receiving environment monitoring samples were within the standards considered in 2023 with the exception of:

- Chloride at MW-4 and MW-11 frequently exceeds the BC CSR IW standard of 100 mg/L and in April 2023, MW-6 was just above the BC CSR IW standard. The drinking water quality standard for chloride is rarely exceeded.
- At Well #3, ammonia was uncharacteristically elevated (3.37 mg/L) in September 2023; however, it is not certain if the standard was exceeded at this location. The BC CSR AW standards for ammonia are pH dependent and pH is not measured in the groundwater monitoring program. The aquatic life standards for groundwater with pH greater than or equal to 8.5 is 1.3 mg/L, which would put Well #3 in exceedance of the standard; however, for pH between 8.0 and 8.5 the standard is 3.7 mg/L, which is above the measured concentration at Well #3 in September 2023. The anomalously high ammonia result for Well #3 should be confirmed by the next sampling event prior to drawing conclusions as to possible sources.

6.0 RECOMMENDATIONS

Based on conclusions for the 2023 annual environmental monitoring program we make the following recommendations. Note that some recommendations are carried forward from previous reports were deemed still relevant.

R1 WWAL recommends continued monitoring of water levels monthly and semi-annual sampling at the wells currently being monitored. We further recommend that a water level transducer be installed in MW-4 to better characterize the effect on water levels when the RIB is in use and for one full year, groundwater quality samples from MW-4 should be collected monthly to better characterize water quality impacts related to the RIB discharge.

R2 Recent water level measurements at Wells #1 and #2 exceed the believed depth of those wells. Depths of these monitored wells, referenced from the top of the PVC casing, should be reconfirmed at the next water level measurement and communicated to us.

R3 As the only monitoring location total nitrogen concentrations near or exceeding the CSR DW guideline of 10 mg/L, the source of the elevated nitrogen at Well #1 should be investigated. Possible sources for include the nearby vineyard and orchards, BC Tree Fruits facility, possible septic field for the Air Cadet building, or leaking wastewater or reclaimed irrigation water mains. Depending on the results of this investigation, additional monitoring wells in the area may be required to further investigate the source of the nitrate+nitrite in groundwater at that location. WWAL further recommends adding pH to the list of water quality parameters assessed in each well to be able to assess exceedances of BC CSR AW exceedances for ammonia in the future.

R4 A review of land use in the vicinity of background well MW-5 should be completed, including collecting information on fertilizer application to assess potential sources of ammonia. For the time being, MW-5 should continue to be monitored.

R5 The well installed at the cemetery grounds in 2021 (MW9) has been dry since installation and was likely completed above the aquifer at that location. This well should be abandoned and replaced with a deeper monitoring well.

R6 Recommended changes to sampling program parameters:

a. We recommend assessing the pH for monitoring well samples to determine applicable ammonia guideline criteria.

b. For reclaimed water, add the parameters sodium, chloride, nitrate, nitrite and ammonia.

CLOSURE

We trust that the professional opinions and advice presented in this document are sufficient for your needs. Please note that there are restrictions and limitations that apply to the scope of our services and conclusions provided herein, as outlined on the Standard Report Limitations page. Should you have any questions, or if we can be of further assistance in this matter, please contact the undersigned.

WESTERN WATER ASSOCIATES LTD.

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Ryan Rhodes, P.Geo.
Senior Hydrogeologist

REFERENCES

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Western Water Associates Ltd.
Standard Report Limitations

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Applied Research

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Contaminated Sites

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