2023

Greater Vernon Water
Water Quality Monitoring Program

Prepared for: Interior Health

Regional District of North Okanagan

9848 Aberdeen Road, Coldstream, BC

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1. INTRODUCTION

1.1 Acronyms and Definitions

Aesthetic Objectives (AO) – Guidelines for Canadian Drinking Water Quality (GCDWQ) applies these objectives to different substances in water that may affect the acceptance by the customer.

CARO - a full service environmental laboratory that provides analytical services.

Certified Lab – a lab approved in writing by the Provincial Health Officer.

Colilert™ - a product used to detect total coliforms and *E.coli* in water. It is based on IDEXX's patented Defined Substrate Technology (DST). When total coliforms metabolize Colilert's nutrient-indicator, ONPG, the sample turns yellow. When *E.coli* metabolize Colilert's nutrient-indicator MUG, which fluoresces when exposed to UV light.

Colisure™ - a product used to detect Total Coliform and *E.coli* in water. Total Coliform metabolizes Colisure's nutrient – indicator chlorophenol red-beta-D-galactopyranoside (CPRG) that turns the sample from a yellow to red magenta. When *E.coli* metabolizes the Colisure nutrient – indicator MUG (4-methyl-umbelliferyl-β-D-galactopyranoside), which fluoresces when exposed to UV light.

CoV – City of Vernon.

DAF – Dissolved Air Floatation.

DCWTP – Duteau Creek Water Treatment Plant.

DoC – District of Coldstream.

DWPA – *Drinking Water Protection Act*.

DWPR – *Drinking Water Protection Regulation*.

DWTP - Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies

E.coli – *Escherichia coli* is a gram negative rod of the family Enterobacteriaceae. Most strains of *E.coli* do not produce debilitating toxins but there are a few strains that do, one being the *E.coli* O157:H7 strain.

ENKI – internet based data software system with centralized information management.

ERA – Environmental Resource Associates – company who provides Certified Reference Materials (CRMs) and Proficiency Testing (PT) products.

GCDWQ – Guidelines for Canadian Drinking Water Quality.

GVW – Greater Vernon Water.

HPC – Heterotrophic Plate Count.

IMAC – Interim Maximum Concentrations – GCDWQ has established these concentrations which estimates lifetime risks of cancer associated with the guideline.

MAC – Maximum Acceptable Concentrations – GCDWQ has established these concentrations for different substances which may have adverse effects on health.

MF – Membrane Filtration – testing method that theoretically detects a single bacterium in a 100/mL sample.

MHWTP – Mission Hill Water Treatment Plant.

MPN – Most Probable Number – estimate of Coliform density.

P/A – Presence/Absence – procedure used to detect the presence of Total Coliform and *E.coli.*

PHO – Provincial Health Officer.

Quanti-Tray® Enumeration Procedure – used to numerate Colisure™ and Colilert™ procedures by counting the number of positive wells and referring to the MPN table.

RDNO – Regional District of North Okanagan.

RPD - Relative Percent Difference.

SCADA – Supervisory Control and Data Acquisition – is a system for remote monitoring and control that operates with coded signals over communication channels.

Source Water – untreated water before treatment or disinfection.

TC – Total Coliform group is a gram negative, non-spore forming rod-shaped bacteria. A group of specific bacteria called indicator bacteria which indicate a probable presence of pathogenic bacteria.

UV – Ultraviolet.

Water Distribution System – RDNO owned and administrated by GVW. The operations and maintenance is contracted to the CoV and DoC.

WaterTrax® – internet based data software system with centralized information management. Alerts are generated to operations and regulators.

1.2 Background

As guidance for the Greater Vernon Water (GVW) Water Quality (WQ) Program, the Guidelines for Canadian Drinking Water Quality (GCDWQ), the British Columbia *Drinking Water Protection Act and Regulation* (DWPA and DWPR) and the Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies (DWTO); have been drawn on to develop this "Monitoring Plan". The program is designed to monitor weekly and monthly variations in WQ plus long term WQ trends.

GVW WQ uses the multi-barrier approach in the monitoring program. Staff monitor the source water in the watersheds, at the intakes and the wellheads before treatment or disinfection. GVW has two surface water sources used for domestic purposes, two surface water sources and two groundwater wells used for agriculture purposes and one groundwater well as an emergency backup. The source water monitoring program is discussed in section 2.

The treatment facilities are monitored by the Regional District of North Okanagan (RDNO) operators and the WQ staff. This portion of the WQ program is discussed in section 3.

The GVW transmission and distribution system monitoring program incorporates certified operators from the City of Vernon (CoV), District of Coldstream (DoC), and the RDNO to sample at designated sites. WQ staff complete sampling for Trihalomethanes, Haloacetic Acids, distribution projects and more in depth analysis quarterly. During regular operations, there are two distinct potable water systems (Duteau Creek and Kalamalka Lake) where dedicated sample sites are monitored as outlined in section 4. While the distinction is not as clear as in the past and there are more interconnections, the system is still considered distinct. The interconnections within the distribution are used when necessary and the Duteau Creek or the Kalamalka Lake sources can provide water to the whole water system.

There are three distinct irrigation distribution systems Goose Lake, Deer Creek (King Edward) and untreated Duteau Creek water. These systems have limited WQ analysis, outlined in section 2.

1.3 Quality Assurance and Quality Control Program

To ensure good data is collected, a sampling program should include a Quality Assurance (QA) plan. QA is a system of activities designed to make sure the data meets defined standards of quality. It pertains to the overall management of the sampling program, and includes; planning, documentation, training, consistency in collecting and handling samples and analysis, validation and reporting. An important part of QA is *Quality Control* (QC). QC refers to the technical activities used to reduce errors throughout the sampling program. These activities measure the performance of a process against defined standards to verify the data meets the expected quality. Errors can occur in the field, laboratory or while handling the data. QC should include both internal and external measures. Internal QC is a set of measures undertaken by the project's own samplers and analysts. External QC involves people and laboratories outside of the project utility (USEPA 1996).

The following steps have been employed by GVW to ensure reliable information from the WQ Monitoring Program:

1. As directed in the *DWPA and DWPR,* a water supplier is required to have their bacteriological analysis completed by a certified laboratory approved by the Provincial Health Officer (PHO). GVW uses CARO Analytical Services (CARO) to analyze bacteriological samples plus a multitude of other parameters.

2. Due to the nature of the water system there are a number of operators taking WQ samples and performing field measurements. Training through GVW for WQ sampling and emergency response is provided annually to operators to ensure collection and responses are correct. This refresher is used to reduce errors in the sampling program.

3. To assess the quality of the sampling and analytical results, field duplicates are analyzed for the program at a rate of approximately 10% of the total number of samples collected. A duplicate sample is defined as a field sample of water collected from the same location, split into two equal parts, and submitted to the analytical laboratory under a separate label so the laboratory has no knowledge of the samples site location. The collection and analysis of the duplicate samples provide information on the combined (field and analytical) precision of the sampling and analytical program. The individual analytical results in each of the samples of the duplicate pair are compared and the Relative Percent Difference (RPD) is calculated for each analyte pair. RPDs are calculated using the following formula, where *"a" a*nd *"b"* are duplicate pair values in identical units.

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

4. A RPD of 30% or less is generally considered acceptable while a RPD of greater than 30% may indicate a problem in either sampling or analysis (MoE 1998b). This limit may vary somewhat depending on the analysis involved and the concentration of the analyte.

5. The RPD also tends to increase as the result approaches the detection limit. Therefore, use of this threshold is restricted to values five times over their detection limit.

In 2023, GVW WQ staff will take five field blanks, four travel blanks and 37 duplicate samples. Three sites have been selected for field blanks which include, one on Coldstream Creek, one source and one treatment facility. Duplicates will be taken at two sites within the Duteau Creek watershed, one site on Coldstream Creek, two water sources, and two treatment facilities. DoC and CoV operators will each take duplicates at two distribution sites.

Field instruments, including handheld conductivity and pH meters, turbidimeters and colorimeters are brought to the RDNO laboratory for regular maintenance. Handheld conductivity and pH meters are scheduled once a month, turbidimeters are scheduled once every three months and colorimeters are scheduled annually. Operators have been instructed to calibrate pH and conductivity meters before each sampling routine.

In addition to the samples sent to an external lab, the RDNO laboratory uses the Quanti-Tray® Enumeration Procedure to perform Most Probable Number (MPN) and Presence/Absence (P/A) for Total Coliform; and *E.coli.* These analyses are used to supplement the program. There is an associated QC procedure for these tests. The QC procedure is to ensure each package of Colilert™ are providing reliable results.

This is completed by running IDEXX-QC test. The IDEXX-QC meets standards for maintaining accreditation. This is completed by running three sterile vessels with:

- *Escherichia coli*,
- *Klebsiella variicola*, and
- *Pseudomonas aeruginosa*.

All samples are collected and shipped in accordance with the 2005 21st Edition Standard Methods for the Examination of Water and Wastewater (APHA, AWWA, and WEF). A sample confirmation or requisition and chain of custody form accompany all samples sent to the certified laboratory.

GVW WQ staff have developed laboratory procedures that are updated when required.

2. SOURCE WATER

2.1 Source WQ Program

The Source WQ Program is designed to compare source water with guidelines, criteria and regulations that have been set for both health and aesthetic reasons. It is also designed to observe seasonal trends that may affect treatment and chlorine demand, and to monitor for potential threats from watershed land use practices.

Source WQ monitoring is an important component of the multi-barrier approach and drinking water management.

It is important for monitoring programs to be as comprehensive as possible. (Source to Tap: Guidance on the Multi-Barrier Approach to Safe Drinking Water; Canadian Council of Ministers of the Environment, 2004).

The program includes parameters easily tested and linked to WQ changes such as turbidity, temperature, pH, conductivity, and bacteria (Total Coliform and *E.coli*). Some of these parameters are also incorporated in the "GVW Water Quality Deviation Response and Notification Program".

Part of the source monitoring program includes the Duteau Creek Watershed and the Kalamalka Lake / Coldstream Creek Watershed. The results are reported as part of the GVW Annual Report, source WQ information and watershed response plans.

GVW is committed to long-term monitoring for all sources.

2.1.1 Sampling Locations

GVW uses two surface water intakes for domestic/potable purposes; Kalamalka Lake and Duteau Creek which are routinely monitored weekly and monthly. Two ground water sources, Coldstream Ranch Well 3 and Antwerp Springs PH 2 are available for emergency purposes, which are monitored before and when in use.

Non-potable water sources; Deer Creek (King Edward), Coldstream Ranch Well #2, Goose Lake, and untreated Duteau Creek are separated from the domestic water system and are used for irrigation water only. The following tables outline the sources, sampling point location and a descriptor of the site. Sampling location maps are located in Appendix A.

These sites are not monitored extensively, with the exception of Goose Lake. Goose Lake is monitored weekly during the irrigation season due to the chemistry of the lake. A comprehensive water analysis is completed every 5 years on Coldstream Ranch Well 2, Coldstream Ranch Well 3, Goose Lake Intake and Deer Creek Intake Pond.

Table 1 Domestic Potable Water Sources – Raw Water (untreated)

Intake / Source Year Round	Location	Sample Site Comment
Kalamalka Lake Intake	*13204 West Kal Road, Coldstream*	Sample station is located outside on the south side of the Kalamalka Pump Station (PS)
Duteau Creek Intake	*95 Lewis Road, RDNO, Electoral Area "D"*	Sample site inside building at Duteau Creek Intake

Antwerp Springs PH 2	*6282 Highway 6, Coldstream*	Pre-chlorination (emergency Well only)

★ An annual sampling program for Kalamalka Lake is completed by Larratt Aquatic Consulting.

Table 2 Duteau Creek Watershed Sample Sites

Duteau Creek Watershed	Sample Site Comment
Haddo Weir	Sample on south side of weir. Outflow of Haddo Lake
Duteau Creek Bridge	Downstream of bridge at 12km on Haddo main
16 km Aberdeen Road Tributary	Off Aberdeen main – used to monitor impacts of increasing logging in Flyfish subbasin
18 km Aberdeen Road Tributary	Aberdeen main – downstream of culvert – Flyfish Creek

Table 3 Kalamalka Lake Watershed Sample Sites

Kalamalka Lake Watershed★ Coldstream Creek	Sample Site Comment
Coldstream Creek at Howe Drive	Downstream of the bridge
Coldstream Creek at Kirkland Drive	Upstream of the bridge
Coldstream Creek at Brewer Road	Downstream of bridge and the culvert
Coldstream Creek at School Road	Downstream of the bridge

Table 4 Irrigation Water Sources - Watershed and Sample Stations

Intake / Watershed Irrigation	Sample Site Comment
Deer Creek Intake Pond	Intake pond – grab sample in front of screens
King Edward Outflow	Dam structure outlet
Coldstream Ranch Well 3	Well located on Coldstream Ranch
Coldstream Ranch Well 2	Well located on Coldstream Ranch
Goose Lake Intake	Raw water copper line at intake building
Von Keyserlingk PS	Irrigation sample station near Von Keyserlingk PS (not regularly sampled)

2.2 Source Monitoring Schedule

Samples for source water are collected weekly at dedicated copper lines. The 2023 sampling schedule for chemical and physical parameters is outlined in Appendix B. The analysis is completed in the field, the Regional District of North Okanagan laboratory and at CARO Analytical Services.

2.2.1 Bacteriological

Samples of untreated water for domestic/potable purposes are collected weekly at water supply intakes and analyzed for Total Coliform and *E.coli*. Iron related bacteria and Sulfate reducing bacteria are collected monthly at Kalamalka Lake intake and annually at Coldstream Ranch Well 3 or before being brought online and after any operational maintenance work as an indicator of microbial changes in the aquifer.

Bacterial levels at the source are indicators of contamination. Historical data has assisted in developing trends for each source and therefore a deviation from "normal" initiates a response. The response includes a second bacterial sample for confirmation, a site visit to investigate and possibly determine the contamination source. *E.coli* levels that rise above and remain high over an extended period of time will undergo further evaluation.

2.2.2 Turbidity

Kalamalka Lake Intake and Duteau Creek Intake, have online turbidimeters and are monitored by SCADA. Operations have a maintenance schedule for all online analyzers.

The turbidity is reported from the Mission Hill Water Treatment Plant (MHWTP) before chlorination and Ultraviolet (UV) disinfection and at the Duteau Creek Water Treatment Plant (DCWTP) after the Dissolved Air Floatation (DAF), chlorination and UV disinfection. The provincial guidance "Decision Tree for Responding to a Turbidity Event in Unfiltered Drinking Water, April 2013" and the "GVW Water Quality Deviation Response and Notification Plan" which provides details on turbidity events and/or trigger levels used for response and notification.

2.2.3 Chemical, Biological and Physical

Comprehensive samples are taken annually for each water source as well as at two distribution sites; Allenby PS for the Kalamalka distribution and PRV 2 for the Duteau Creek distribution. Allenby PS and PRV 2 are completed biannually to identify seasonal changes in flow and quality. The comprehensive list of parameters is outlined below.

Table 5 Comprehensive Water Analysis

Parameters		
Alkalinity (Total)	Cyanide (Total)	Selenium (Total)
Aluminum (Dissolved)[1]	Dissolved Solids (Total)	Sodium (Total)
Aluminum (Total)	Fluoride	Strontium (Total)
Antimony (Total)	Hardness (Total)	Sulfate
Arsenic (Total)	Iron (Total)	Turbidity
Barium (Total)	Lead (Total)	Temperature
Boron (Total)	Magnesium (Total)	Uranium (Total)
Cadmium (Total)	Manganese (Total)	Zinc (Total)
Calcium (Total)	Mercury (Total)	Dissolved Organic Carbon*
Chloride	Molybdenum (Total)	UV_{254}*
Chromium (Total)	Nickel (Total)	Phosphorus (Total)*
Cobalt (Total)	Nitrate	Total Dissolved Phosphorous*
Color (True)	Nitrite	Total Kjeldahl Nitrogen*
Conductance @ 25 C	pH	Total Organic Carbon*
Copper (Total)	Potassium (Total)	Chlorophyll a*

[1] The Duteau Creek source.
* Sampled at surface water sources only.

Parameters checked routinely at surface sources are in Appendix B with more detail below:

- ***Total Organic and Dissolved Organic Carbon*** relate to Trihalomethane's production and UV disinfection effectiveness. Organic loading is also an indicator of pollutants in the water.

- ***Aluminum*** is monitored at the Duteau Creek source as the natural level is part of the cumulative value after treatment (Poly-Aluminum-Chloride, the flocculants used in the treatment process) in the Duteau Creek system.

- ***Chlorophyll a, Algae density, Total Phosphorous, Total Nitrogen*** is monitored at sources during the "growing" season, algae growth period and during lake turnovers (fall and spring).

- ***Total Phosphorous, Total Nitrogen and Ammonia*** are monitored at the Coldstream Creek locations monthly with increased monitoring during early snow melt, freshet, and flooding. Phosphorous and ammonia loading is an indicator of fertilizers and biological degradation.

- ***Herbicides, pesticides and fuel scans*** are completed every two years for the Kalamalka Lake Intake (scheduled for 2023). E very five years for the groundwater wells: Coldstream Ranch Well 2 and 3, and Antwerp Springs PH 2 (scheduled for 2023).

- **Volatile Organic Compounds (VOC)** are scheduled annually for the Kalamalka Lake Intake.

An emergency sampling kit is available in the RDNO laboratory to be used in the case of a spill, possible cross connection or other emergency testing.

3. TREATMENT AND DISINFECTION FACILITIES

3.1 DCWTP

The DCWTP has flocculation, DAF, chlorine (generated on site) and UV treatment. The DCWTP operators complete the following sampling and analysis:

Table 6 DCWTP Samples and Analysis

Raw	Online – Real Time	Grab Sample Frequency
Turbidity	Online	Daily
Temperature	Online	Daily
pH	Online	Daily
Conductivity	Online	Daily
Alkalinity	N/A	Daily
True Color	N/A	Daily
Apparent Color	N/A	Daily
Dissolved Organic Carbon	Online	N/A
Total Aluminum	N/A	Weekly
Mid-Process	Online – Real Time	Grab Sample Frequency
pH - each train	Online	Monday, Wednesday, Friday
Streaming Current - each train	Online	N/A
Turbidity - each DAF	Online	Daily
DAF Effluent	Online – Real Time	Grab Sample Frequency
Turbidity	Online	Daily

Alkalinity	N/A	Daily
Dissolved Aluminum	N/A	Tuesday, Friday
True Colour	N/A	Daily
UVT	Online	Daily
Pre-UV (Reservoir Outlet)	Online - Real Time	Grab Sample Frequency
Free Chlorine residual	Online	Daily
UVT (2)	Online	Daily
pH	Online	Daily
Post-UV	Online - Real Time	Grab Sample Frequency
Free Chlorine residual	Online	Daily
Alkalinity	N/A	Monday, Wednesday, Friday
Reactive phosphate[1]	N/A	Monday, Wednesday, Friday
Post-UV	Online - Real Time	Grab Sample Frequency
Temperature	N/A	Daily
pH	N/A	Daily
Turbidity	Online	Daily

[1]Reactive phosphate is analyzed from September through April.

WQ staff will also sample and analyze bacteria and conductivity at the UV outlet.

The monthly and quarterly sampling schedules are outlined in the Appendices. The Chlorine Contact Time (CT) is applied at the DCWTP reservoir and dosage can be adjusted if required. Bacteria samples are taken after contact time, on Tuesdays: CARO bacterial and an in-house P/A.

3.2 MHWTP

The MHWTP consists of UV disinfection and chlorination generated on site.

Table 7 MHWTP Samples and Analysis

MHWTP	Online – Real Time	Grab Sample Frequency (excluding holidays)
Free Chlorine residual (before contact chamber)	Online	Monday to Friday
Free Chlorine residual (after contact chamber)	Online	Monday to Friday
Turbidity	Online	Monday to Friday
UVT	Online	Monday to Friday
Conductivity	Online	Monday to Friday
Temperature	Online	Monday to Friday
pH	Online	Monday to Friday
Total Organic Carbon	Online (calculated number using UV254)	N/A
MHWTP	Grab Samples	Grab Sample Frequency (excluding holidays)
Conductivity	Grab Sample	Monday to Friday
Temperature	Grab Sample	Monday to Friday

A chlorine residual analyzer monitors free chlorine levels after 20 minutes of contact time. The UVT is monitored online before the reactors. Both instruments are alarmed for low levels.

WQ staff will also sample at the point where chlorine contact time should be achieved.

The monthly and quarterly sampling schedules are outlined in the Appendices. Bacteria samples are taken after contact time, on Tuesdays: CARO bacterial and an in-house MPN.

3.3 Coldstream Ranch Well 3, Antwerp Springs PH 2

The Coldstream Ranch Well 3 was drilled and brought online in 2021. This well replaced Coldstream Ranch Well 1, which is no longer operational. Coldstream Ranch Well 3 and Antwerp Springs PH 2 are both equipped with sodium hypochlorite tote/tank systems to be used as an emergency potable source. Both are equipped with chlorine residual analyzers and turbidity meters tracked through SCADA.

4. TRANSMISSION / DISTRIBUTION SYSTEM

4.1 Distribution WQ Program

This portion of the WQ program is designed to meet the community water system regulations prescribed by the *DWPA and DWPR,* Schedules A and B. Supporting this design is also in the *Canadian Drinking Water Guidelines* which provide levels set for health reasons, Maximum Acceptable Concentrations (MAC), aesthetic values and Aesthetic Objectives (AO). Other parameters may be monitored if they are known to create problems within water distribution systems.

4.1.1 Sampling Stations – Type, Location and Number

Type - the locations for distribution sampling have been determined by the Manager, WQ, GVW staff operations, and IH. The monitoring regime is designed to capture the changes in WQ as it flows through the pipeline (i.e. flow patterns in the water distribution system). The site locations are broken down into flow ratings of high, medium and low or dead ends. The ideal combination is:

- 10% high flows/ main transmission/ Entry Point (H or EP),
- 40% medium flow (M),
- 40% low flow (L), and
- 10% dead-ends, un-looped lines and stagnant areas (DE).

After the annual review of the sampling sites, the breakdown for each water system is as follows:

Duteau Creek supplied system has a total of 41 sample sites:

- 12 % (5 sites) high flows/ main transmission/ entry point,
- 32% (13 sites) medium flow,
- 34 % (14 sites) low flow, and
- 22 % (9 sites) dead-ends, un-looped lines and stagnant areas.

Kalamalka Lake supplied system has a total of 33 sites:

- 9 % (3 Sites) high flows/ main transmission/ entry point,
- 52 % (17 Sites) medium flow,
- 27 % (9 Sites) low flow, and
- 12 % (4 sites) dead-ends, un-looped lines and stagnant areas.

Number - at this time there are **74** sampling sites regularly sampled throughout the GVW distribution system.

Location - the preferred location for dedicated sampling sites are sites connected directly to a water main. Public buildings or residential are the least preferred sampling sites as they may not be accessible at all times and results may not always be reliable. If a sample line cannot be run continuously, it should be a suitable size to allow water from the main to reach the tap after a brief flushing. Sampling sites are being re-evaluated as the GVW program evolves.

Every year, the RDNO discusses sample site locations with CoV and DoC operators. Some sample stations are moved to better locations and approximately three new sample stations are installed annually. In 2023, the sample station site locations will be reviewed to determine any changes required.

4.2 Distribution Monitoring Schedule for GVW WQ Program

4.2.1 Duteau Creek and Kalamalka Lake Distribution Sampling Sites

During regular operations, GVW has two main water sources with two treatment plants supplying the distribution systems:

- Duteau Creek Water Treatment Plant (DCWTP) - Duteau Creek Water Distribution system (gravity fed system), and
- Mission Hill Water Treatment Plant (MHWTP) - Kalamalka Lake Water Distribution system (pumped system).

As mentioned above, the two water systems have many interconnections which allow some blending of treated water. The water distribution system can also run on one source (treatment plant) if an emergency arises or a planned shutdown is required. There are some obstacles if this happens during peak demand periods (i.e.: summer flows) but GVW could include seasonal source Coldstream Ranch Well 3 and Antwerp Springs PH 2 to provide extra volume.

The distribution monitoring schedule is prepared by management and WQ staff. Operators and staff from the DoC, CoV and the RDNO have routes covered on a rotating four week schedule.

Appendix A has a map of all the distribution sampling sites. This schedule rotates the sampling sites from week to week to assist in a weekly overview of the entire water system. Examples of operations WQ worksheets are located in Appendix C.

The following Tables 8 and 9 are listed by:

- Sample Site Name, Site Description/Location, and
- –Flow Rating:
  - Entry Point (EP): where the water enters the distribution system (treatment plants);
  - High (H): in the distribution system where disinfectant residual is expected to be higher than typical (after entering the distribution system or after re-chlorination);
  - Medium (M): midpoint in the distribution system where disinfectant residual is expected to be typical;
  - Low (L): where disinfectant residual is the lowest; and
  - Dead ends (DE): where disinfectant residual is the lowest.

Table 8 Duteau Water Distribution Sites

ENKI Sample Site Name	Site Description / Location	Flow Rating
43rd Avenue SS	2001 43 Street	DE
6015 Highway 6	6015 Highway 6	L

ENKI Sample Site Name	Site Description / Location	Flow Rating
7900 McClounie Road	7900 McClounie Road – Kalamalka Secondary School	L
Aberdeen Road SS	9007 Aberdeen Road	DE
Boss Creek 1 PS Return	Boss Creek PH 1 (Lower) Return/Inlet	DE
Boss Creek 2 PS Return	Boss Creek PH 2 (Upper) Return/Inlet	DE
Braeburn Drive SS	8835 Braeburn Drive (PRV 270)	L
Brewer Road SS	6815 Brewer Road	L
Coldstream Creek Road SS	12408 Coldstream Creek Road	L
Cosens Bay Road SS	Cosens Bay Road and Grieves Drive	L
Cunliffe Reservoir SS	6910 Cunliffe Road	M
DCWTP Post Treatment	1014 Whitevale Road	EP
East Dedecker Road SS	East Dedecker Road at the park	M
Foothills Booster	6805 Foothills Drive	M
Golfview Place SS	466 Golfview Place	L
Goose Lake Road PS	6604 Goose Lake Road	L
Haney Road SS	located near SPCA	DE
Highway 6 SS	7446 Highway 6	L
Husband Road PS	11701 Husband Road	M
Kosmina Road SS	1701 Kosmina Road	M
Marmot Court SS	364 Marmot Court	DE
McMechan Booster	901 39 Avenue	M
Mt Grady Road SS	corner of Mt. Grady Court and Mt. Grady Road	L
Noble Canyon Road Hydrant	Noble Canyon	DE
North BX 2 PS	6302 Apple Lane	H
Old Kamloops Road SS	Highway 97 and Old Kamloops Road	M
Palfrey Drive SS	Cunliffe Road and Palfrey Drive	M
Pine Road SS	Pine Road and Coldstream Creek Road SS	M
Pleasant Valley Road SS	6522 PV Road	M
Ponderosa Way SS	13900 Ponderosa Way	L
PRV 076	8101 Highland Place	DE
PRV 1	8798 Buchanan Road	H
PRV 2	4714 Pleasant Valley Road	H
Ravine Drive PS	35 Ravine Drive	M
Rugg Road SS	6926 Rugg Road	DE
South BX 1 PS	3600 East Vernon Road	H

ENKI Sample Site Name	Site Description / Location	Flow Rating
South BX 2 PS	5121 Dixon Dam	H
Springfield Road SS	5608 Petworth/Springfield	L
Sunpeaks Reservoir SS	7444 Sun Peaks Drive	L
Upland Drive SS	488 Upland Drive	L
Total Duteau Sites	**EP = 1 / H = 4 / M = 13 / L = 14 / DE = 9**	

Table 9 Kalamalka Lake Distribution Sites

ENKI Sample Site Names	Site Description / Location	Type
15th Street SS	2702 15 Street	M
21st Avenue SS	2101 32 Street	M
25 Street SS	4404 25 St SS	M
30th Street SS	3402 - 30 Street	M
35 Street SS	2806 35 Street	M
43rd Street SS	2001 43rd Street SS	M
4714 Pleasant Valley SS	City Yard fill station at 4714 Pleasant Valley Road	M
Allenby PS	5715 Bella Vista Road	M
Amber Drive SS	7095 Amber Drive	DE
Anderson Way SS	5100 Anderson Way	M
Balsam Reservoir SS	558 Balsam Court	M
Brassy Place SS	803 Brassy Place	DE
College Way SS	Highway 97 and College Way	M
Dunsmuir Road SS	3025 Dunsmuir SS	L
Kidston Road SS	12101 Kidston Road	DE
Kirkland Drive SS	7906 Kirkland Drive	L
Kokanee Booster	9320 Kokanee Road	M
Longacre Drive SS	6532 Longacre Drive	L
Longspoon Court SS	595 Longspoon Court	L
McMechan Reservoir SS	39 Avenue	H
MHWTP Post Treatment	3350 Reservoir Road	EP
Mission Road SS	1400 Mission Road	L
Mt Grady Court SS	Mt Grady Court and Mt Grady Road	L
Okanagan Landing 1 PS	7864 Okanagan Landing Road	M
Okanagan Landing 2 PS	8979 Okanagan Landing Road	M
Okanagan Landing Road SS	5871 Okanagan Landing Road	M

Pottery Road SS	1802 Pottery Road	H
Tavistock Reservoir SS	9033 Tavistock Road	L
Tronson Road SS	Beachcomber Bay Road & Tronson Road	M
Turtle Mountain PS	3600 Turtle Mountain Blvd	M
Upper Commonage Booster	461 Commonage Road	L
Weeks Road SS	7540 Weeks Road	L
West Kal Road SS	7603 West Kal Road	DE
Total Kal Sites	**EP = 1 / H = 2 / M = 17 / L = 9 / DE = 4**	

4.3 Bacteriological

The frequency and number of samples for microbiological control monitoring is based on recommendations from the *DWPA and DWPR.*

Schedule A - WQ Standards for Potable Water Fecal Coliform bacteria – no detectable fecal Coliform bacteria per 100mLs.

Escherichia coli (*E.coli)* – no detectable *E.coli* per 100mLs.

Total Coliform Bacteria:

(a) one sample in a 30 day period - no detectable Total Coliform per 100 mls.

(b) more than one sample in a 30 day period - at least 90% of samples have no detectable total bacteria per 100 mls.

Schedule B – Frequency of Monitoring Samples

Population served by the prescribed water supply system: 5,000 to 90,000.

Number of samples per month: 1 per 1,000 populations.

Other considerations when developing a WQ monitoring program:

- quality of the source water
- number of water sources
- past frequency of unsatisfactory samples
- adequacy of treatment and capacity of the treatment plant
- size and complexity of the distribution system
- practice of disinfection; and
- size of population served.

Tables 10 and 11 summarizes the population sizes and number of sources, which help determine the number of bacterial samples to be completed each month for GVW's WQ program. A minimum of **68** bacteriological samples are sent to CARO for analysis each month for the Kalamalka Lake and Duteau Creek systems. A minimum of **50** bacterial samples are completed at the RDNO laboratory using the Colilert® methods for MPN. A total of **118** bacterial samples are analyzed monthly for the water distribution system. The schedule for the water systems is shown below.

Note: Staff and operators are asked to collect a P/A sample if the free chlorine is lower than 0.20 mg/L and to deliver it to the RDNO laboratory RDNO laboratory for analysis.

Table 10 Distribution Bacteria Sampling Frequency

System	Population (approx.)	Sources/ Intakes	Sample Sites	Samples per month to Caro	Minimum Bacterial Samples per Month
Kalamalka Lake	41,000	1	33	42	41
Duteau Creek	17,000	1	41	26	17
Total 2023	**58,000**	**2**	**74**	**68**	**58**

Table 11 GVW Sampling Schedule

Week	Kal Lake CARO	Kal Lake P/A / MPN	Duteau CARO	Duteau P/A/MPN
1	10	6	7	5
2	12	4	5	8
3	10	7	7	4
4	10	9	7	67
Monthly Total	**42**	**26**	**26**	**24**

4.4 Chlorine Residual and Chlorine Management

Chlorine is used as a disinfectant for the GVW system. As required in the DWPA, Section 6(b) and Section 5.2(a) of the DWPR. All sampling sites are monitored for free and total chlorine by operators or GVW WQ staff.

A more in-depth look at chlorine management will continue in 2023. Additional chlorine checks will be added to provide operators and the WQ team with more data for chlorine residual and optimization. The sites are as follows:

Table 12 Additional Chlorine Sample Sites

Chlorine Sites	Description
Galiano Road BO	water pumped from South BX #1
Brookside Road BO	small road off Dixon Dam Road
Longspoon Court SS	Predator Ridge - chlorination
Golfview Place SS	north west - Swan Lake
Tavistock Reservoir SS	Adventure Bay
Aberdeen Road SS	Aberdeen Road

4.5 Chemical and Physical Parameters

The chemical and physical testing within the distribution system includes conductivity, temperature, turbidity, free and total chlorine and pH. Parameters chosen for the weekly analysis help identify WQ issues before they become problematic or where source blending is occurring in some areas of the distribution system.

Further examination of WQ in the distribution system is completed quarterly at two sampling sites, which are:

1. Allenby PS (Kalamalka Lake supply), and
2. PRV 2 (Duteau Creek supply).

These sites help determine if there are WQ issues due to changes in alkalinity, pH, flow (high/low), chlorine levels or the type of water mains. The schedule and parameters for these sites are located in Appendix B.

Further WQ information on the following parameters:

4.5.1 Aluminum

Dissolved and total Aluminum are monitored monthly before and after treatment on the Duteau water source. Total aluminum values can reflect on the flocculation process carried through to the treated water. Elevated dissolved aluminum can be an indicator of over application of Poly Aluminum Chloride (PAC), the plant's primary coagulant. Aluminum is a treatment related parameter; with an Operational Guideline, developed in 1998, (OG) of < 0.2 mg/L (other treatment type, not conventional). The OG applies to treatment plants using aluminum-based coagulants; it does not apply to naturally occurring aluminum. OGs are based on a running annual average of monthly samples. The naturally occurring Aluminum in the Duteau Creek source averages around 0.12 mg/L.

Currently, Health Canada has developed a technical guideline document to solicit comments on the proposed guideline and OG values. The document proposed a MAC of 2.9 mg/L for total aluminum and a OG value of 0.050 mg/L is proposed for total aluminum to optimize water treatment and distribution systems.

4.5.2 Orthophosphate Corrosion Inhibitor

Orthophosphates are used primarily as a corrosion inhibitor with its ability to create passivity film on the surface of distribution pipes. In this project, WQ staff have investigated the effectiveness of the zinc orthophosphate addition to the water distribution system. Zinc orthophosphate is injected into the treated water at the DCWTP in the fall until spring to reduce issues arising from cast and ductile iron waterlines in the distribution system. The Zinc orthophosphate has the ability to create an inert and resilient protective, microscopic layer on metal surfaces. This film acts as a barrier between the oxygenated and corrosive potable water and the metal pipe surface which minimizes the release of iron, lead, copper, and other metals that indicate corrosion is occurring and can produce harmful effects in the system. If properly applied, all the Zinc orthophosphate reacts with the pipe surface and there is no active residual left in the water.

Monthly samples and analysis will continue at sample sites shown in Table 13.

Table 13 Corrosion Inhibitor Monitoring Sites

Sample Sites	Parameters Apply to All Sample Sites
DCWTP Post Treatment	Reactive Phosphate, Iron
Aberdeen Road SS	
Sunpeaks Reservoir SS	
Golfview Place SS	
Noble Canyon Road Hydrant	

In 2023, the effectiveness of the Zinc orthophosphate will be reviewed through the sampling program. The dosage rate will also be examined with operations to ensure it is optimal for the

system. Samples are routinely collected at the sites listed in Table 13, then brought to the RDNO laboratory for analysis. Operators at the DCWTP grab samples from the reservoir three times per week to analyze reactive phosphate levels.

4.5.3 THM's and HAA's

Disinfection Byproducts (DBP) are monitored as per the GCDWQ. The distribution systems are monitored quarterly for THM's and HAA's have been designed to look at the following conditions:

- first customer or point of entry - water treatment plants,
- at points in the distribution system with the longest disinfectant retention time,
- the worst case scenario (longest contact time), and
- the effect of different sources blending in the distribution system.

The maximum acceptable concentration (MAC) for the distribution system is based on a locational running annual average of the quarterly samples taken at the sample sites with the longest disinfectant retention time. The following sample sites will be monitored in March, June, September and November of 2023.

Table 14 THM and HAA Monitoring Sites

Sample Sites	Location in Distribution	Most Common Source	Parameters
DCWTP Post Treatment	first customer – entry point	Duteau Creek	THM, HAA, P/A,TOC
Palfrey Drive SS	mid-point - after re-chlorination at PRV#1	Duteau Creek	THM, HAA, P/A
Sunpeaks Reservoir SS	longest disinfectant retention time	Duteau Creek	THM, HAA, P/A
Golfview Place SS	longest disinfectant retention time	Duteau Creek	THM, HAA, P/A
MHWTP Post Treatment	first customer - entry point	Kalamalka Lake	THM, HAA, P/A, TOC
Tavistock Reservoir SS	longest disinfectant retention time	Kalamalka Lake	THM, HAA, P/A
Allenby PS	mid-point	Kalamalka Lake	THM, HAA, P/A
Longspoon Reservoir SS	longest disinfectant retention time	Kalamalka Lake	THM, HAA, P/A

5. REPORTING

In 2022, RDNO has switched to a new internet based databased called ENKI. Enki is an internet based data software system with centralized information management. The ENKI database is accessible to all who have been registered as "users" by the administrator (GVW Manager, WQ). Prior to 2022, RDNO used WaterTrax, which is an internet based software program. In 2023, all historical data from WaterTrax was uploaded to ENKI.

At this time, WQ notification and maintenance activities such as flushing can be found on the RDNO website at www.rdno.ca. Customers can subscribe to receive announcements, media releases, and updates by email at https://www.rdno.ca/subscribe.

Weekly reports are generated by GVW WQ staff for Operations Supervisors by Friday of each week. This allows an overview of chlorine residuals, turbidity and bacterial results within the distribution system and some source water information.

Monthly WQ reports are generated by GVW WQ staff for Interior Health each month. All reports are sent to the Drinking Water Officer, Operations Supervisors and the WQ Manager by the 15 day of the following month. Following review, the reports are posted on the RDNO website.

An annual WQ report is due on June 30 for the previous year. The report includes microbiological, inorganic and organic parameters for the sources and the distribution system plus recommendations to improve WQ where standards and aesthetic issues are not met.

6. REFERENCES

Decision Tree for Responding to a Turbidity Event in Unfiltered Drinking Water, Ministry of Health, BC, April 2013.

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Drinking Water Protection Regulation, B.C. Reg. 200/2003 [includes amendments up to B.C. Reg. 87/2011, May 19, 2011].

Guidelines for Canadian Drinking Water Quality, Health Canada, *February 2017.*

WQG-01 Source Drinking Water Quality Guidelines, Ministry of Environment & Climate Change Strategy, Water Protection & Sustainability Branch , *2017*.

APPENDICES

APPENDIX A - WQ Sample Sites

APPENDIX B - Parameters and Schedules

APPENDIX C – Operator Worksheets