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Project/File: 123222665

**Attention: Mark Phillips, Director of Protective Services**

Squamish – Lillooet Regional District  
Box 219, 1350 Aster Street  
Pemberton, BC V0N 2L0

Dear Mark,

**Reference: Gun Lake Water Quality Sampling – March 14, 2024**

## 1 Introduction

Stantec Consulting Ltd. (Stantec) conducted water quality sampling on March 14, 2024, at Gun Lake on behalf of the Squamish-Lillooet Regional District (SLRD). Gun Lake is located in the Bridge River Valley in the West-Central interior of British Columbia (BC) and is a source of drinking water for Gun Lake community residents. In 2023, the community of Gun Lake was impacted by the Downton Lake wildfire, which burned along the steep, northern shoreline of the lake. Gun Lake community residents have concerns regarding the water quality of the lake as a source of drinking water. Stantec understands that water quality sampling was conducted by a SLRD subcontractor in September 2023, which indicated a slight exceedance of benzene. As a precautionary measure, the SLRD contracted Stantec to complete additional water quality sampling at Gun Lake.

This letter presents the March 14, 2024, Gun Lake water quality results, a comparison of the results with the BC Ministry of Environment and Climate Change Strategy (ENV) Water Quality Guidelines, and quality assurance and quality control (QA/QC) results.

## 2 Executive Summary

Water quality samples were collected from five locations on Gun Lake on March 14, 2024. Results were compared to the BC Source Drinking Water Quality Guidelines (BC SDWQG), BC Water Quality Guidelines for Recreation (BC WQG-R) and BC Water Quality Guidelines for Freshwater Aquatic Life (BC WQG-FAL).

- BC Source Drinking Water Quality Guidelines (BC SDWQG) are guidelines that apply to ambient water before it is treated and distributed for domestic use.
- BC Water Quality Guidelines for Recreation (BC WQG-R) are guidelines apply to primary contact to the water related to recreational activity, where face or body may be immersed in the water (i.e., swimming, water skiing, etc...).
- BC Water Quality Guidelines for Freshwater Aquatic Life (BC WQG-FAL) guidelines apply to the health of freshwater aquatic life and are either “short-term” or “long-term”. The short-term BC WQG-FAL refers to acute concentrations that may be harmful to freshwater aquatic life. The long-term BC WQG-FAL are typically applied to an average concentration (e.g., 5 samples collected over a 30-

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day period) to account for natural variability in the water. The long-term guidelines are applied to each sample individually in this report and therefore do not consider natural variability in the water.

Measurements for temperature, turbidity, dissolved oxygen, specific conductivity, and pH were recorded in the field and water quality samples were analyzed against the applicable water quality guidelines for physical parameters, anions, nutrients, microbiological parameters (total coliforms, fecal coliforms, and *E. coli*), total and dissolved metals, volatile organic carbons (VOCs) (including benzene, ethylbenzene, toluene, and xylene (BTEX)), and polycyclic aromatic hydrocarbons (PAHs).

Results for the water quality sampling at Gun Lake on March 14, 2024, showed that samples collected at the five Gun Lake sampling sites did not exceed BC Source Drinking Water Quality Guidelines for any parameter (anions and nutrients, total and dissolved metals, microbial tests, volatile organic compounds (VOCs), or polycyclic aromatic hydrocarbons (PAHs). This includes benzene which was highlighted as a concern due to an exceedance detected in water quality samples collected in September 2023.

Total phosphorous concentrations were above the BC WQG-R and the long-term BC WQG-FAL in four of six lake samples (67%), and above the short-term BC WQG-FAL (0.015 mg/L) in two of six samples (33%). Phosphorous itself is not a toxic to aquatic life; however, elevated phosphorus concentrations can lead to increased algal growth, and can eventually result in decreased DO levels from microbial decomposition of the algae, and degradation of habitat for fish and other aquatic life.

Total aluminum was above the long-term BC WQG-FAL in two of six samples (33%). Dissolved zinc was above the long-term BC WQG-FAL in four of six samples (67%). Dissolved copper was above the short-term and long-term BC WQG-FAL in five of six samples (83%).

Microbiological tests showed that there were no exceedances of the BC WQG-R for fecal coliforms or *E. coli* and there are no BC WQG-FAL for fecal coliforms or *E. coli*. There were no exceedances of VOCs and PAHs for the BC WQG-R or BC WQG-FAL.

### 3 Methods

Water quality sampling was conducted by Stantec at five priority sampling sites provided by the SLRD (Attachment A: Figure 1). Water quality samples were collected from each sampling location from the ice-covered lake following the methods described in the *British Columbia Field Sampling Manual*<sup>1</sup>. At each sampling site, an ice auger was used to drill holes; ice and debris were removed using a strainer prior to sample collection to limit influence of surface disturbance. In situ water quality measurements were collected at ~1 m below surface using a YSI DSS Pro Multimeter Sonde. Measurements for temperature, turbidity, dissolved oxygen, specific conductivity, and pH were recorded in the field. Water quality samples were analyzed for physical parameters, anions, nutrients, microbiological parameters (total coliforms, fecal coliforms, and *E. coli*), total and dissolved metals, volatile organic carbons (VOCs) (including benzene, ethylbenzene, toluene, and xylene (BTEX)), and polycyclic aromatic hydrocarbons (PAHs)<sup>2,3,4</sup>. At each site, water quality grab samples were collected in clean, laboratory-provided bottles, while wearing nitrile gloves to reduce the possibility of contamination.

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<sup>1</sup> British Columbia Field Sampling Manual BC FSM Part E1 Surface Water ([gov.bc.ca](http://gov.bc.ca)).

<sup>2</sup> British Columbia Ministry of Environment and Climate Change Strategy. 2020. B.C. Source Drinking Water Quality Guidelines: Guideline Summary. Water Quality Guideline Series, WQG-01. Prov. B.C., Victoria, BC.

<sup>3</sup> British Columbia Ministry of Environment and Climate Change Strategy. 2019. B.C. Recreational Water Quality Guidelines: Guideline Summary. Water Quality Guideline Series, WQG-02. Prov. B.C., Victoria BC.

<sup>4</sup> British Columbia Ministry of Environment and Climate Change Strategy 2021. Working Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Water Quality Guideline Series, WQG-08. Prov. B.C., Victoria, BC.

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Water samples were preserved in the field using laboratory-supplied preservatives (where required) packed with ice in a light-proof cooler. Samples were delivered by Stantec to ALS Environmental Laboratory in Burnaby, BC for analysis on the same day as they were collected to meet the 30 hour hold times for microbiological tests (fecal coliform, total coliform, and *Escherichia coli* [*E. coli*]). A field duplicate was collected at the GL-05 sample location to assess reproducibility of the results and sample collection methods. A field blank was collected to identify potential contamination during sample collection and to assess the purity of laboratory-supplied preservatives.

A travel blank was provided in sealed bottles from the laboratory to assess potential contamination during the transport of samples.

The water quality results were compared to BC Source Drinking Water Quality Guidelines (BC SDWQG) which are conservative estimates of low-risk levels for water quality parameters and receptors. The BC SDWQG are benchmarks and apply to ambient water before it is treated and distributed for domestic use. They are a screening tool used to characterize raw drinking water sources. In addition, the results were compared to the BC Water Quality Guidelines for Recreation (BC WQG-R) and Freshwater Aquatic Life (BC WQG-FAL) to further characterize lake water quality. The long-term BC WQG-FAL are typically applied to an average concentration (e.g. 5 samples collected over a 30-day period) to account for natural variability in the water. However, in this report, the long-term guidelines are applied to each sample individually and therefore, do not consider natural variability. The BC WQG-FAL calculations for dissolved copper, total aluminum and dissolved zinc require a measurement of dissolved organic carbon (DOC). DOC concentrations were not measured and the lower limits for DOC of 0.5 mg/L for dissolved copper, 0.08 mg/L for total aluminum and 0.3 mg/L for dissolved zinc were applied. The dissolved copper BC WQG-FAL was calculated using the Bio Ligand Model (BLM).

## 4 Results

Water quality results are summarized below and compared to the BC Water Quality Guidelines in Attachment B. Attachment C contains the Laboratory Certificate of Analysis.

### In Situ Parameters

In situ water quality parameters including temperature, dissolved oxygen (DO), conductivity, pH, oxygen reduction potential (ORP) and turbidity (NTU) are presented in Table 1. Field pH ranged from 6.5 to 7.5, DO ranged from 10.6 to 13.4 mg/L, and turbidity ranged from -0.1 to 4.4 NTU (Table 1). Field DO, pH, and turbidity were within applicable BC WQG-R and BC WQG-FAL; there are no BC SDWQG for these parameters (Attachment B).

**Table 1 In Situ Water Quality Parameters at Gun Lake Sampling Locations**

Site ID	Latitude	Longitude	Temperature (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	pH	ORP (mV)	Turbidity (NTU)
GL-01	50.85559	-122.895	2.8	11.5	89.9	7.5	116.5	-0.1
GL-03	50.86322	-122.883	-0.1	13.4	102.7	7.4	135.5	4.6
GL-04	50.87999	-122.852	2.2	11.0	90.6	7.5	119.3	-0.1
GL-05	50.8794	-122.88	0.4	10.7	91.9	6.5	148.9	0
GL-06	50.86491	-122.895	-0.1	13.5	93.6	7.2	136.5	0.5

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## Anions and Nutrients

- Ammonia, fluoride, chloride, nitrate, nitrite, and sulphate concentrations did not exceed applicable BC SDWQG (Attachment B).
- Ammonia, fluoride, chloride, nitrate, nitrite, and sulphate concentrations were also below the applicable BC WQG-R, or BC WQG-FAL guidelines (Attachment B).
- Total phosphorous ranged from below the detection limit of <0.0020 mg/L to 0.0243 mg/L and was above the BC WQG-R (0.01 mg/L) and the long-term BC WQG-FAL (0.005 mg/L) at sites GL-03, GL-05, and GL-06 and the duplicate sample. Total phosphorous was above the short-term BC WQG-FAL (0.015 mg/L) at sites GL-03 and GL-06. Phosphorous itself is not a toxic to aquatic life; however, elevated phosphorus concentrations can lead to increased algal growth, potentially resulting in decreased DO levels from microbial decomposition of the algae, and degradation of habitat for fish and other aquatic life.

## Total and Dissolved Metals

- Total metal concentrations were below respective BC SDWQG (Attachment B) and there are no dissolved metal BC SDWQG.
- Total metal concentrations for antimony, arsenic, barium, boron, cadmium, chromium, mercury, selenium, uranium, and zinc were also below respective BC WQG-R and BC WQG-FAL. Results were also below their respective detection limits for each of these parameters except for arsenic.
- Total aluminum was above the calculated pH, DOC, and hardness dependent long-term BC WQG-FAL of 0.028 and 0.029 mg/L mg/L at sites GL-01 and GL-03, respectively.
- Dissolved copper ranged from 0.002 to 0.005 mg/L and concentrations were above the calculated long-term and short-term BC WQG-FALs at sites GL-01, GL-03, GL-05, GL-06, and in the duplicate sample.
- Dissolved zinc was below the calculated pH, DOC, and hardness short-term BC WQG-FAL at all sites and was above the long-term BC WQG-FAL at sites GL-01, GL-03, GL-06 and the duplicate sample.
- Dissolved metal concentrations of cadmium, iron, and lead were below respective BC WQG-FAL. There are no dissolved metal BC WQG-R.

## Microbiological Tests

- The BC SDWQG for fecal coliforms and *E. coli* are  $\leq 10$  CFU/100 mL and there is no BC SDWQG for total coliforms. There were no exceedances of the BC SDWQG for fecal coliforms or *E. coli*.
- The BC WQG-R for *E. coli* is  $\leq 200$  CFU/100 mL and there is no BC WQG-R or BC WQG-FAL for total coliforms. There were no exceedances of BC WQG-R or BC WQG-FAL for fecal coliforms or *E. coli*.

## VOCs and PAHs

- There were no exceedances of the BC SDWQG for the VOC or PAHs analysed. This includes benzene which was highlighted as a concern due to an exceedance detected in water quality samples collected in September 2023.

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- There were also no exceedances of the BC WQG-R or BC WQG-FAL for the VOCs or PAHs. Concentrations of PAHs and VOCs in the March 2024 concentrations were below the detection limits (0.20 to 5 µg/L).
- There were no exceedances of PAH BC SDWQG or BC WQG-FAL. PAH concentrations were below the detection limits (0.0050 to 0.010 µg/L).

## 5 Quality Assurance Quality Control

The QA/QC program followed protocols outlined in the *British Columbia Field Sampling Manual* (ENV 2024)<sup>5</sup> and *British Columbia Environmental Laboratory Manual* (ENV 2020)<sup>6</sup> for both the field and laboratory activities. QA/QC procedures include using standardized sampling sheets, completing chain of custody forms, collecting a blind field duplicate (BFD) sample, field and trip blank samples, and the laboratory following QA/QC measures. Samples for dissolved nutrients and metals were field filtered.

Field QA/QC duplicate, field blank, and trip blank sample results are summarized below and are included in Attachment B and Attachment C. Laboratory QA/QC results are included in the Attachment C.

One BFD sample was collected to meet the minimum frequency objective of at least 10% of the samples collected. The BFD is a replicate sample collected at the same location, at the same time, by the same person utilizing the same equipment during field activities. The relative percent difference (RPD) between the original 'parent sample' and the BFD was used to assess field sampling procedures and natural variability.

Calculated RPDs were compared to data quality objectives (DQO) outlined in the *BC Field Sampling Manual*<sup>6</sup>, where if one of a set of duplicate values at or greater than five times the method detection limits (MDL), then RPD values >20% indicate a possible issue and >50% indicate a definite problem, most likely either contamination or lack of sample representativeness.

The parent water sample (GL-05) and the BFD sample (DUP-1) were submitted for analysis. The RPD were less than the DQO of 20%, except for the total copper, where the RPD was 37%.

One field blank sample was collected to determine effectiveness of sampling procedures, to assess potential contamination during sample collection and to assess the purity of laboratory-supplied preservatives. The field blank sample was collected by pouring laboratory supplied distilled water into laboratory provided sampling containers and submitted for laboratory analysis. The field blank sample contained concentrations less than detection limits for all parameters, with the exception of the VOC chloroform which had a concentration of 1.21 mg/L (Attachment B).

Travel blanks were used to identify sources of cross-contamination due to transport and storage of samples. Travel blanks were in a sealed bag, located in a cooler, during transport. The parameters analyzed had concentrations below the analytical detection limits.

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<sup>5</sup> British Columbia Field Sampling Manual BC FSM Part E1 Surface Water ([gov.bc.ca](http://gov.bc.ca))

<sup>6</sup> British Columbia Field Sampling Manual BC FSM QA/QC Part A ([gov.bc.ca](http://gov.bc.ca))

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Overall, the results obtained through the implementation of these field quality assurance measures indicate that the water quality data obtained during this sampling program are considered reproducible and representative of water quality in the sampled area.

## 6 Summary

Results from March 14, 2024, water quality sampling at Gun Lake showed that samples collected at the five Gun Lake sampling sites did not exceed BC SDWQG. This includes benzene which was highlighted as a concern due to an exceedance detected in water quality samples collected in September 2023.

Total phosphorous concentrations were above the BCWQG-R and the long-term BC WQG-FAL in four of six lake samples (67%), including the duplicate sample and were above the short-term BC WQG-FAL (0.015 mg/L) in two of six samples (33%).

An analysis of total and dissolved metals showed that dissolved copper concentrations were above the long-term and short-term BC WQG-FAL in five of six samples (83%), including the duplicate sample and total aluminum concentrations were above the calculated long-term BC WQG-FAL in one of six lake samples (17%) including the duplicate sample. Dissolved zinc was above the long-term BC WQG-FAL in four of six samples (67%), including the duplicate sample.

Microbiological tests showed that there were no exceedances of the BC WQG-R for fecal coliforms or E. coli. VOCs and PAHs did not exceed the BC WQG-R or BC WQG-FAL.

## 7 Limitations

The conclusions in the report entitled Gun Lake Winter Water Quality Sampling – April 22, 2024 are Stantec's professional opinion, as of the time of the Report and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not consider any subsequent changes.

The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from Squamish-Lillooet Regional District and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

## 8 Closing

We trust this letter satisfies the current requirements. If you have any questions or require further information, please do not hesitate to contact Amy Nielsen ([amy.nielsen@stantec.com](mailto:amy.nielsen@stantec.com)).

Reference: **Gun Lake Water Quality Sampling – March 14, 2024**

Regards,

**Stantec Consulting Ltd.**

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Attachments: A – Attachment A Figure 1—Gun Lake Water Quality Sampling Locations  
B – Water Quality Guidelines Comparison  
C – ALS Certificate of Analysis

Reference: Gun Lake Water Quality Sampling – March 14, 2024

## **Attachment A      Figure 1—Gun Lake Water Quality Sampling Locations**

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## **Attachment B      Water Quality Guidelines Comparison Table**

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## **Attachment C      ALS Certificate of Analysis**