



Water Quality Monitoring Program Annual Report for 2025

Columbia Lake Stewardship Society
February 22nd, 2026

Executive Summary

The Columbia Lake Stewardship Society (CLSS) began monitoring the water quality of Columbia Lake on April 20, 2014. Since then, monitoring has occurred annually while the lake is ice-free. In 2025, monitoring included measurement of selected water quality indicator parameters on the lake on twelve occasions between late-April and mid-September; measurement of the water quality of Dutch Creek, Hardie Creek, and Canal Flats Creek; and assessment of water quality on the Columbia River between the Columbia Lake Provincial Park and Fairmont Hot Springs.

The monitoring program carried out on Columbia Lake since 2014 has shown that while the lake water is suitable for consumption as drinking water, preservation of aquatic life, and recreational purposes (Table 1), Columbia Lake is an extremely vulnerable lake, highly susceptible to rapid changes in environmental conditions, both natural and man-made. The most recent illustration of this vulnerability was a substantial fish-kill in 2024. The vulnerability of Columbia Lake stems from a variety of factors:

- It is a very shallow lake (with little, if any, water greater than 5.0 m in depth in 2025);
- It has a relatively high pH, which can lead to enhancement of the toxicity of various substances in the water even at 'normal' levels;
- It is very warm in the summer - in 2025 the water temperature was greater than 20°C for the entire of July and August;
- It has a very low flushing rate, with a slow flow (unquantified) of water which enters the lake at the south end (from aquifers under Canal Flats) and exits the lake into Dutch Creek at the north end (Columbia Lake Provincial Park) becoming the Columbia River;
- It has concentrations of total phosphorus which frequently exceed 10 µg/L. This is important because the first response of an aquatic system to increased phosphorus levels is increased plant and algal biomass, which can lead to increased turbidity, increased organic matter, anoxia, and growth of cyanobacteria;
- It has a soft lakebed, which is easily disturbed causing sediment to be stirred into the water;
- Its maximum annual depth is highly dependent on 'reverse' flow of cold water from Dutch Creek into the lake at its north-end during the Spring freshet. The quantity of the redirected water varies, depending on climate conditions and snow-pack in the upper reaches of the Dutch Creek watershed. The lake's direct watershed is very small (Figure 1).

In 2025, CLSS studied water quality of Columbia Lake with a focus on its vulnerability. We made regular measurements of the concentrations of total phosphorus, chlorophyll-a, and manganese and arsenic. These parameters provide information about the trophic state of Columbia Lake and about possible factors that can affect the clarity of the water. We also made regular measurements of chloride concentrations because, while they are not 'high', they are elevated in Columbia Lake compared with local comparator lakes, and they may be increasing over time. Lastly, we monitored water temperature and water levels in the lake (data available in the 2025 Water Quantity report) because shallow water and warm temperatures are known to be physiological stressors for fish.

Our findings in 2025 are presented in this report along with an outline for our planned water quality work in 2026.

Table of Contents

1.0 Introduction	1
2.0 Water Quality Program	3
2.1 Purpose and Acknowledgements	3
2.2 The Monitoring Program Undertaken in 2025	4
2.3 Water Quality Standards	6
2.3.1 Regulatory Guidelines for Water Quality	6
2.3.2 Quality Control Procedures	11
3.0 Water Quality Monitoring 2025	13
3.1 Columbia Lake	13
3.1.1 Lake Depth	14
3.1.2 Temperature	16
3.1.3 Water Clarity: Secchi Depth and Turbidity	19
3.1.4 Specific Conductance	23
3.1.5 pH	24
3.1.6 Dissolved Oxygen	26
3.1.7 Total Phosphorus	28
3.1.8 Chloride	32
3.1.9 Manganese and Arsenic	34
3.1.10 Chlorophyll-a	36
3.1.11 BC Lake Stewards and Monitoring Program	37
3.2 Dutch Creek, Hardie Creek, and Canal Flats Creek	39
3.3 The Columbia River	46
4.0 Comparison of Columbia Lake to Nearby Lakes	51
5.0 Program for 2026	52

1.0 Introduction

Columbia Lake, located in the East Kootenay region of British Columbia between the community of Fairmont Hot Springs and the Village of Canal Flats, is the headwater of the Columbia River drainage system. Columbia Lake is part of the Columbia Wetlands system, which extends from the south end of Columbia Lake near the Village of Canal Flats to the community of Donald on the north side of the Trans-Canada Highway, 28 kilometers northwest of Golden, BC. Columbia Lake drains into the Columbia River at the north end of Columbia Lake. The river then drains into Lake Windermere and from Lake Windermere continues into the Columbia Wetlands north of the Town of Invermere. North of Donald and just beyond the Mica Dam, the Columbia River turns south and drains through the Arrow Lakes system to exit Canada south of Trail, BC.

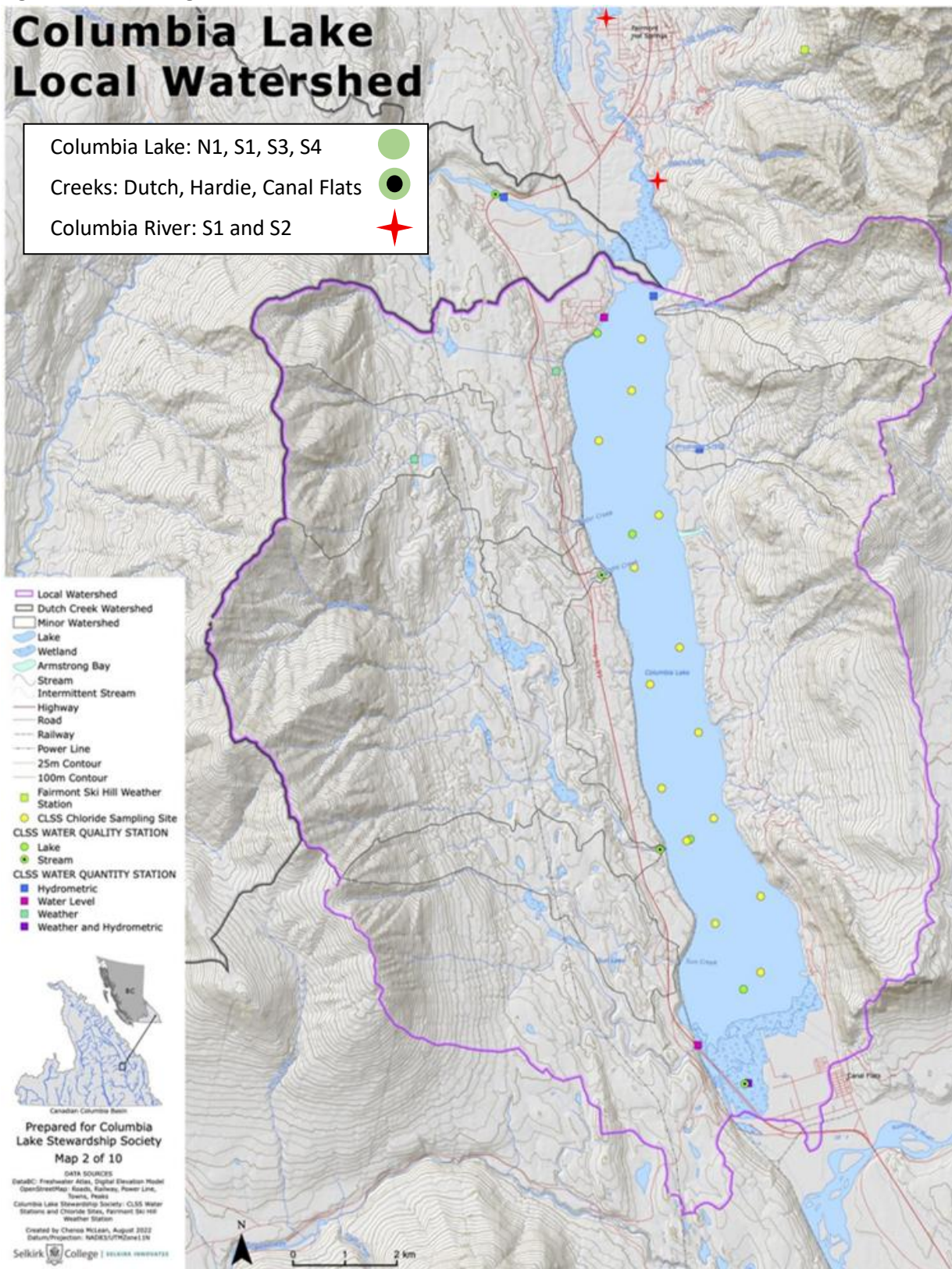
Columbia Lake is a source of drinking water for residents, a source of recreational pleasure for residents and visitors, and an important part of the Pacific Flyway and the Columbia Wetlands ecosystems. Despite its vast surface area and pristine appearance, Columbia Lake is uniquely vulnerable to change because it is very shallow, has an easily-disturbed soft, muddy bottom, is very warm in summer, and has a very low estimated water turn-over rate.

In response to concerns about future development along the lake and the consequent potential for impact on the quality of the lake's water, the Columbia Lake Management Plan was prepared for the Regional District of East Kootenay and the Village of Canal Flats in 2021. The management plan outlines important actions that are required to ensure the safety of Columbia Lake, one of which is to study the lake and monitor its water quality. The plan recommended continuing and expanding the work conducted by CLSS.

The Columbia Lake Stewardship Society (CLSS) began monitoring the lake's water quality in 2014 and has continued the monitoring program while the lake is ice-free every year through to September this year, 2025.

This report presents the data CLSS collected on water quality in 2025 and outlines a proposed plan to continue to assess the lake's water quality in 2026.

Figure 1: Monitoring Locations



2.0 Water Quality Program

2.1 Purpose and Acknowledgements

The water quality monitoring program conducted by CLSS provides baseline water quality information for Columbia Lake from 2014-2025. In the context of this, we can now address more specific questions about water quality conditions in Columbia Lake, including the impacts of current and future activities on the lake, and in the surrounding lands that drain into the lake.

All parameters measured in the CLSS water quality program are standard parameters used broadly to define the quality of water suitable for drinking and to support aquatic life. (See Section 2.3.1.)

The CLSS water quality program is, for the most part, administered, implemented, and interpreted by volunteers. During 2025, many volunteers contributed to the water quality monitoring program. In particular, we would like to acknowledge Diane Jeffers, Kevin Stromquist, David Hubbard, Mark Thomas, Barry Garbett, and Stephen Dykes, who took us out on the lake in their boats (or accompanied us in canoes) and enabled us to complete a full testing season, from late-April to mid-September.

The program receives funding from the following agencies and community groups:

- Columbia Valley Local Conservation Fund
- Columbia Basin Trust
- British Columbia Hydro - Fresh Water Conservation Program
- Regional District of East Kootenay
- Spirits Reach Community Association
- Columere Marina
- Columbia Ridge Community Association
- Columere Park Community Association
- Village of Canal Flats

CLSS collaborates in its work with numerous other groups who work to protect and conserve local lakes and wetland environments, including Lake Windermere Ambassadors, BC Lake Stewardship and Monitoring Program, Living Lakes, Wildsight, and the Columbia Wetlands Stewardship Partners.

The support and participation of these volunteers, individuals, and agencies is gratefully acknowledged.

2.2 The Monitoring Program Undertaken in 2025

In 2025, the water quality monitoring program undertaken by CLSS included data collection on Columbia Lake, at three creeks feeding into Columbia Lake, and at two sites on the upper Columbia River.

2.2.1 Columbia Lake

In 2025, water sampling for Columbia Lake comprised approximately bi-weekly collection of various types of information at four locations (N1, S1, S3, and S4) along the lake (shown in Figure 1.)

The four monitoring sites are at:

Station Location	Northing	Easting	N	W
N1	N50.28769	W115.87126	50°17'15.7	-115°52'16.5
S1	N50.25393	W115.86256	50°15'14.1	-115°51'45.2
S3	N50.20107	W115.84820	50°12'3.9	-115°50'53.5
S4	N50.17533	W115.83442	50°10'31.1	-115°50'3.9

Monitoring occurred on twelve occasions between April 13th and September 16th. (Not all sites were visited on all occasions, depending on weather conditions and availability of boats.)

At each site we made:

- i. Observations about cloud cover, water surface disturbance (waves), and air temperature;
- ii. Measurements of the depth of water, and the depth of clear water using the Secchi disk;
- iii. Measurements of water temperature, turbidity, specific conductance, pH, and concentration of dissolved oxygen; and
- iv. Collected water samples, to measure concentrations of total phosphorous, chloride, metals (manganese and arsenic), and chlorophyll.

BC Lake Stewardship and Monitoring Program Depth Profiles

This year, we also participated in the BC Lake Stewardship and Monitoring Program, Level 2. This was incorporated into our regular testing program. At S1 (the deepest spot on the lake), and sometimes at S3, we recorded depth profiles for concentration of dissolved oxygen, temperature, and specific conductance of the water.

2.2.2 Creeks Feeding into Columbia Lake

The water quality monitoring program undertaken in 2025 included monitoring several creeks which flow into Columbia Lake: Dutch Creek, on the northwest side of the bridge over Highway 93; Hardie Creek, at the outfall to the lake on the Spirits Reach property; and Canal Flats Creek, a small creek draining north from Canal Flats (Fig. 1) These creeks have been chosen because they represent distinct sources of water that enter Columbia Lake.

Dutch Creek enters Columbia Lake at its north end for only a short period of time in the Spring freshet. This water is vital in the seasonal “topping-up” of Columbia Lake with cold water to its maximum depths. It arises from the Dutch Creek and Brewer Creek watersheds.

Canal Flats Creek represents water flowing into Columbia Lake at its south end. This water flows underground from the Kootenay River, fills aquifers under Canal Flats and then re-emerges to flow into Columbia Lake.

Hardie Creek represents small creeks on the west side of the lake which flow into Columbia Lake directly from its small local watershed. These creeks flow through developed, residential, and agricultural land.

In 2025, CLSS worked with a team from the Wildsight Youth Climate Corps, East Kootenay Region.

<https://www.youthclimatecorps.com/yccmap/kimberley-cranbrook>

The YCC team collected data at the three creeks on eleven occasions between May 5th and September 9th. Each outing involved the following:

- i. Measurements of water temperature, specific conductance, turbidity, dissolved oxygen, and pH;
- ii. Water sampling, to measure concentrations of chloride and nitrate.

2.2.3 The Columbia River

In 2023, CLSS began a program to establish baseline measurements along the Columbia River for the major water quality indicator parameters (water temperature, specific conductance, turbidity, dissolved oxygen, and pH) and for chemicals such as chloride and nitrate.

The samples and measurements are taken just upstream of the convenient “put-in” spot on the Columbia River, off Columbia River Drive near the boundary of the Columbia Lake Provincial Park, and at the “take-out,” a downstream location on Wills Road/River Drive in Fairmont Hot Springs. Figure 1 shows these two locations (red stars).

These locations were selected because they are relatively easily accessed. Also, these locations are upstream and downstream of most of the recreational activity occurring along this stretch of the Columbia River, which includes kayaks, canoes, and portable flotation devices on the water, a recreational camping area, and a golf course. This allows us to assess possible impacts of recreational use of that stretch of the Columbia River on the water quality.

In 2025, water quality indicator parameters were measured on eight occasions between 27th May and September 9th. Each outing involved:

- i. Measurements of water temperature, specific conductance, turbidity, dissolved oxygen concentrations, and pH;
- ii. Water sampling, to measure concentrations of chloride and nitrate.

2.3 Water Quality Standards

2.3.1 Regulatory Guidelines for Water Quality

All of our quantitative water quality information is compared to water quality guidelines established by various regulatory agencies. Water quality guidelines apply for two major objectives: i) ensuring clean, safe drinking water for residents; and ii) ensuring that the lake water remains supportive of the aquatic life necessary to sustain the complex ecosystems that depend on it.

In some cases, there can be a substantial difference between the acceptable levels of a substance in water for human consumption compared with the levels acceptable for supporting aquatic life. Given this, CLSS refers to two sets of standards or guidelines, the Guidelines for Canadian Drinking Water Quality (GCDWQ, Health Canada), and the Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for Protection of Aquatic Life (Freshwater).

Table 1 summarizes the standards that CLSS is currently using to guide our sampling program.

The Province of British Columbia has established a variety of guidelines (WQGs) or criteria useful for judging the quality of water used for drinking water and for protection of aquatic life. These guidelines are for broad application on a province-wide basis and do not consider local land uses or ambient lake conditions and thus may be over- or under-protective of a given lake's specific conditions and development pressures. On a site-by-site basis the province allows that WQGs may be established by:

- Direct adoption of WQGs for each monitoring parameter,
- Establishing the upper limit of background concentration for each monitoring parameter, or
- Deriving a site-specific water quality objective (WQO) based upon data collected at the site.

CLSS is currently contributing to determining current background values and/or site-specific data for Columbia Lake, with its database which now encompasses 2014-2025. Some of these ranges are provided in Table 1.

Together, the value ranges given in Table 1 encompass "expected concentrations" for the lake water and provide a relative measure of whether the lake water is changing over time or is maintaining the relatively pristine water quality that residents and users of the lake have been accustomed to.

Table 1: Water Quality Standards

Parameter	Health Canada Drinking Water	CCME Freshwater	BC Aquatic Life	Range Recorded by CLSS on Columbia Lake (2014-2024)
pH	6.5-8.5	6.5-9.0 ¹	6.5-9.0 ¹	7.9-9.1
Dissolved Oxygen (mg/L)		6-9.5 ²	8 (LTC) ³ 5 (STA)	5-12
Sp. Conductance (µS/cm)	700			225-360
Temperature (°C)			± 1 °C ⁴	19-24 (seasonal max.)
Turbidity (NTU)	<=1 ⁶		+8 NTU (STA) +2 NTU (LTC) ⁷	0.5-4
Total Phosphorus (µg/L)		5-15 ⁵	5-15 ⁵	5-15
Chloride (mg/L)	AO<=250	120 LTE 640 STE	150 LTC 600 STA	3.5-6.5
Arsenic (µg/L)	MAC=10	5	5	1.1-1.3 (2023)
Manganese (µg/L)	MAC=120 AO=20	430 ⁸ 260 ⁹		3.5-19.9 (2023) ¹⁰
Iron (µg/L)	AO<=300	300	STA=1000	10-13 (CARO MRL=10)
Molybdenum (µg/L)	88	73 (LTC)		0.57-0.61 (2023)
Uranium (µg/L)	20	15		0.74-0.86 (2023)

NOTES

- 1 pH affects CO₂ concentrations; CO₂ concentrations affect cyanobacteria and fish
- 2 The minimum value is greater for colder water
- 3 Fish buried embryo stages need greater concentrations (11 and 9)
- 4 For lakes, it is recommended that there be only ± 1oC change from ambient background
- 5 10 µg/L is the boundary between an oligo- and mesotrophic lake (see *Trophic Status: page 9*)
- 6 Without treatment for particulates
- 7 STA=24 hrs; LTC=30 days
- 8 Toxicity of manganese is affected by both pH and hardness of water. This value applies to pH 7.5 and 'hardness'=50 mg/L CaCO₃
- 9 If the value is calculated for Columbia Lake (pH 8.4 and hardness 150-174 mg/L) the value for acceptable manganese levels is substantially lower. See Table X, below
- 10 Levels of manganese increase along the lake (S4<S3<S1<N1)

Guidelines for Canadian Drinking Water Quality (GCDWQ, Health Canada)

- AO=aesthetic objective
- MAC=maximum acceptable concentration

CCME Water Quality Guidelines for Protection of Aquatic Life (Freshwater)

<https://ccme.ca/en/summary-table>

- LTE=long-term (chronic) exposure
- STE=short-term (acute) exposure

British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture, Guideline Summary – May 2025 , Ministry of Water, Land and Resource Stewardship , Water Protection & Sustainability Branch

- LTC=average levels acceptable for long term, chronic exposure
- STA=maximum levels tolerable for a short term, acute exposure

CLSS Range

Range for data collected between 2014 and 2024. The values given are the upper and lower values which contain >90% of all collected data.

Water Quality Guidelines and the Protection of Aquatic Life

Some of the water quality factors shown in Table 1 are especially important to protect aquatic life.

Trophic status (levels of phosphorus): Total phosphorus is a limiting factor in the growth of phytoplankton and so the rate at which algae and bacteria grow in a lake depends on the amount of phosphorus available. Increased plant and algal biomass in a lake can lead to increased turbidity of the water, increased organic matter in the water, anoxic conditions in the water, and algal blooms, including growth of toxic cyanobacteria.

Levels of total phosphorus in a lake are used to classify its *trophic status* (the extent to which the growth of algae in the water is supported by the availability of phosphorus).

Trophic Status	Total Phosphorus ($\mu\text{g/L}$)
Ultra-Oligotrophic	<4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hyper-eutrophic	>100

From: Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2004. *Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems*.

Temperature: Lake temperature is important ecologically because the solubility of oxygen in water decreases at higher temperatures, reducing the amount of oxygen available for fish and aquatic invertebrates. Also, higher water temperatures increase the rate of degradation of organic matter, and these processes consume dissolved oxygen in the lake water, further decreasing its concentration. Higher lake temperatures also affect chemical reaction rates, microbial growth patterns, and the toxicity, availability and/or solubility of potential pollutants. In general, warmer waters exacerbate eutrophication processes.

pH: Temperature and pH interact. For example, high pH combined with heat can worsen oxidative stress. The pH “ideal” for aquatic life is considered 6.5-8.5. Some guidelines indicate a range of 6.5-9.0 but note that higher pH increases the solubility of CO_2 which impacts cyanobacteria and fish. Overall, stability in water quality parameters is key for most aquatic organisms.

Stability of conditions: Overall, the most important factor for aquatic organisms is stability of conditions. Rapid changes in water quality conditions can cause severe physiological stress. Rapid or frequent fluctuations in temperature and/or pH and/or levels of metals in the water are more damaging than stable conditions that are at the top or bottom of a range but are still within a species' tolerance.

Toxicity Modifying Factors

Toxicity modifying factors (TMFs) are criteria such as pH and water hardness. These limit the validity of the quality guideline (WQG) to a certain range. In some cases, the toxicity of a substance is affected notably within normal ranges of pH and hardness found in 'healthy' lakes.

For example: The maximum acceptable level for manganese given in Table 1 (430 µg/L, for the protection of aquatic life) applies to pH 7.5 and hardness=50 mg/L CaCO₃. But Columbia Lake has a pH which is frequently measured at 8.4 or greater. Its hardness is also greater than 50mg/L.

We can estimate the hardness of Columbia Lake from previous measurements made by CLSS.

Hardness of Columbia Lake (mg/L CaCO₃)

	14-Aug-2023	28-Aug-2022	27-May-2022	12-Jul-2021	Range
N1	149	141	161	146	141-161
S1	150	144	174	154	144-174
S3	161	161	174	167	161-174
S4	170	167	166	154	154-170

Approx. range=141-174 for Columbia Lake

Using the table below (*from CCME Guidelines for Freshwater Aquatic Life*) we can determine the long-term water quality guideline for manganese that applies to the observed conditions in Columbia Lake, and it is substantially lower than that for a lake at pH 7.5 and hardness 50mg/L.

Long-term CWQGs for dissolved manganese (µg/L).

Water hardness (mg/L as CaCO ₃)	pH										
	5.8	6.0	6.3	6.5	6.7	7.0	7.2	7.5	7.7	8.0	8.4
25–49	290	290	310	330	350	380	380	350	320	270	200
50–74	390	400	430	460	490	500	490	430	390	320	220
75–99	470	480	530	560	590	590	560	490	440	350	240
100–124	530	550	610	640	670	650	610	530	470	370	250
125–149	590	620	670	710	730	710	660	570	500	390	260
150–174	640	670	740	770	790	750	700	600	520	400	260
175–199	690	720	790	830	840	790	730	620	540	420	270
200–299	730	770	840	880	890	830	760	640	560	430	270
300–399	880	940	1000	1000	1000	940	860	710	610	460	290
400–669	1000	1100	1200	1200	1200	1000	930	770	650	480	300
≥670	1300	1400	1500	1400	1400	1200	1100	860	720	520	320

2.3.2 Quality Control Procedures

CLSS endeavors to collect and record all data with the greatest reliability and validity possible. This involves using appropriate equipment to make measurements in the field, ensuring that the equipment is maintained and calibrated properly, and taking duplicate readings as needed to verify outliers.

In 2025 CLSS used the following instruments for field measurements:

Dissolved Oxygen: YSI ProSolo ODO Meter, provided by the BC Lake Stewardship and Monitoring Program. The meter corrects for current barometric pressure, so it was calibrated prior to every testing event. It measures the concentration of dissolved oxygen to 0.01 mg/L. It also measures water temperature, to 0.01°C. Readings were recorded once they had stabilized, which could be as long as one minute.

pH: pHep by Hanna. The pH meter was calibrated before each testing event using pH 7.01 and pH 10.0 standard solutions, purchased from Hanna. This is the appropriate standard range for Columbia Lake, because the pH of its water is typically greater than 7 (8.0-9.0). This pH meter also records water temperature (0.01°C).

Conductivity: YSI Pro30 conductivity meter. The meter was calibrated prior to each outing using Hanna 1413 ($\mu\text{S}/\text{cm}$) conductivity standard. This meter also provides a reading of water temperature (0.01°C). Conductance varies with water temperature, so specific conductance was recorded in all cases (conductance standardized to 25°C).

Temperature: The water temperature recorded at each site was the average of all measurements taken at that site (the pH meter, conductivity meter, and YSI ProSolo DO meter all provide water temperature measurements).

Turbidity: HACH 2100Q Portable Turbidimeter. Calibrated prior to each outing using Hach StablCal Calibration set for 2100Q. Repeated measures of turbidity from a single water sample can be quite different from one another. Given this, in all cases in 2025, we measured the turbidity of three separate water samples at each site, and the turbidity of each of these samples was measured three times in the turbidimeter. Turbidity was determined as the average of these 9 readings.

CARO Water Chemistry: Concentrations of chloride, nitrate, manganese and arsenic, total phosphorus, and chlorophyll a in water samples were determined by CARO Analytical in Kelowna. Samples were collected in appropriate containers provided by CARO and following CARO procedures. Samples were kept cool, and shipped as soon as possible after collection, usually within 24 hrs.

Other measures are in place to ensure validity and reliability of data collection. Each set of volunteers or summer staff is trained in the use of the equipment by our experienced technical advisors. CLSS uses written procedures to guide our volunteers and staff, and these are reviewed annually and updated as new measuring equipment or monitoring methods are applied to the program. In addition, field data are checked as they are recorded, by comparison to expected 'normal' values so they can be measured again, if needed.

Additional quality control for laboratory samples could include:

- Blank samples (distilled water in an appropriate container) which are opened during sampling to collect possible airborne contaminants.
- Duplicate samples (blind) would be a replica of a single sample and collected in the same way as the sample submitted for chemical analysis.

These QC samples are not routinely carried out because they would increase total testing costs but their importance for most parameters is debatable because we already test at four different locations on the lake (N1, S1, S3 and S4). Where the values of a parameter (e.g. pH) do not change substantially across the lake, the four samples act as quality control for one another. Future targeted exploration of parameters such as total phosphorus concentrations will require careful use of control samples, and this will be conducted as recommended by CARO.

3.0 Water Quality Monitoring 2025

3.1 Columbia Lake

The water quality monitoring program undertaken in 2025 is outlined in Section 2.2. The data collected on Columbia Lake in 2025, for each of the parameters we measured, are presented in this section.

The data for each parameter are presented graphically, by normalized date, to illustrate:

- any possible variation across the year (e.g. from May to September); and/or
- any possible differences among sites on the lake (N1, S1, S3, and S4); and/or
- any possible changes over the years (2014-2025)

Normalized Date

Normalized dates have been assigned to all data collected by CLSS (2014-2025) based on the actual date of collection, as follows: Early Month=1st-10th, Mid Month=11th-20th, and Late Month=21st-31st.

Historical Data Ranges

In order to visualize the range of values for each parameter that is 'typical' for Columbia Lake, and to explore possible changes over the years, we have used scatter plots. These plots compare values recorded in 2025 with all values recorded in all other years (2014-2024). In all cases, each value collected by CLSS has been plotted based on its normalized date.

3.1.1 Lake Depth

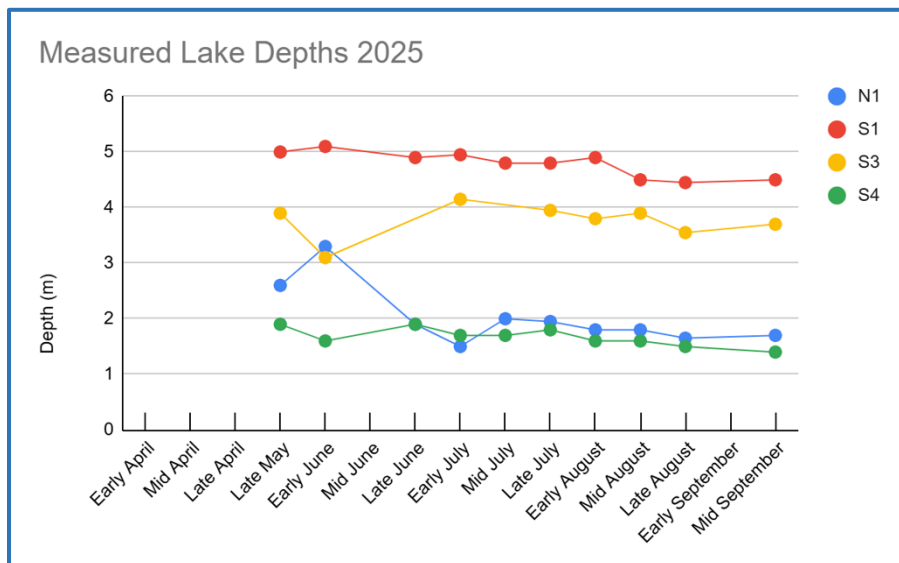
The water quality in a lake is impacted substantially by its volume relative to the rate of water inflow and outflow, and so some brief information concerning the depth of Columbia Lake is reported here for context for the water quality parameters which are measured. (For more detailed information on the depth of Columbia Lake, please consult the *Water Quantity Report 2025*.)

Normally, water enters Columbia Lake at its south end from the Kootenay River via aquifers under Canal Flats, flows northwards (flow/flushing rate unknown), and exits into the Dutch Creek delta at the north end. This slow flow maintains the minimum level of the lake. In Spring, the freshet increases the lake depth to its annual maximum, normally sometime in June, occasionally late May or early July. The maximum water level attained depends on weather and watershed conditions, with the total change in depth of the lake varying from year to year (between approximately 80-130 cm since 2014).

During the freshet, Dutch Creek “tops-up” Columbia Lake at its north end, through a reverse flow into the lake. This inflow is pivotal in determining the maximal water level in Columbia Lake each year because the lake’s local watershed is very limited. (NOTE: The reverse flow also brings cooler water from Dutch Creek into an already warming Columbia Lake. For example, in late May 2025, during reverse flow, the water temperature in Columbia Lake was between 18 and 20°C whereas in Dutch Creek at the same time period it was 9°C.)

Lake Depths Measured in 2025 at N1, S1, S3, and S4

Lake depths were measured by a depth sounder and were corroborated using the tape measure on a Secchi disc. The position of the measurement (N1, S1, S3, and S4) was determined by GPS. The range of depth measurements therefore includes error inherent in using the GPS and also in taking depth measurements in variable weather conditions (wind and waves).

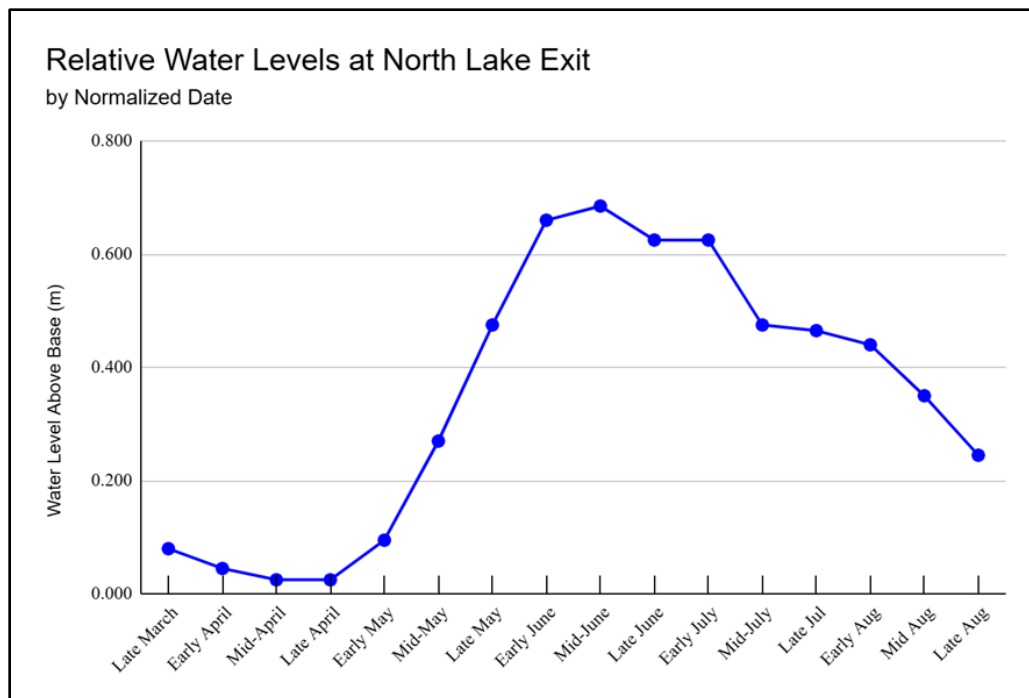


The measurements of depth at N1, S1, S3, and S4 show that in 2025:

- The lake was already at its maximum depth by early June. This is confirmed by other water quantity data, including the relative water levels measured at Columbia Lake North (shown below).
- The maximum depth recorded (S1) was 5.1 m.
- Water depth decreased fairly steadily at all four sites on the lake throughout the summer, as typical.
- By late August, the maximum lake depth (S1) was 4.5 m.

Relative Water Levels at Columbia Lake North 2025

The graph below shows changes in the relative level of water at the north end of Columbia Lake where it exits into the Columbia River. In 2025, the maximum relative depth at this site was noted in early June, around the same time that the maximum depth at S1 was recorded (5.1 m). At this site in 2025, there was an increase in relative depth of approximately 75 cm. This is at the low end of the range recorded since 2014, which is approx. 80-130 cm.



Maximum Recorded Lake Depth at S1: History

The table below shows the maximum depth recorded at S1 each year from 2014-2025. In 2025, we recorded the lowest maximum depth at S1 since 2016.

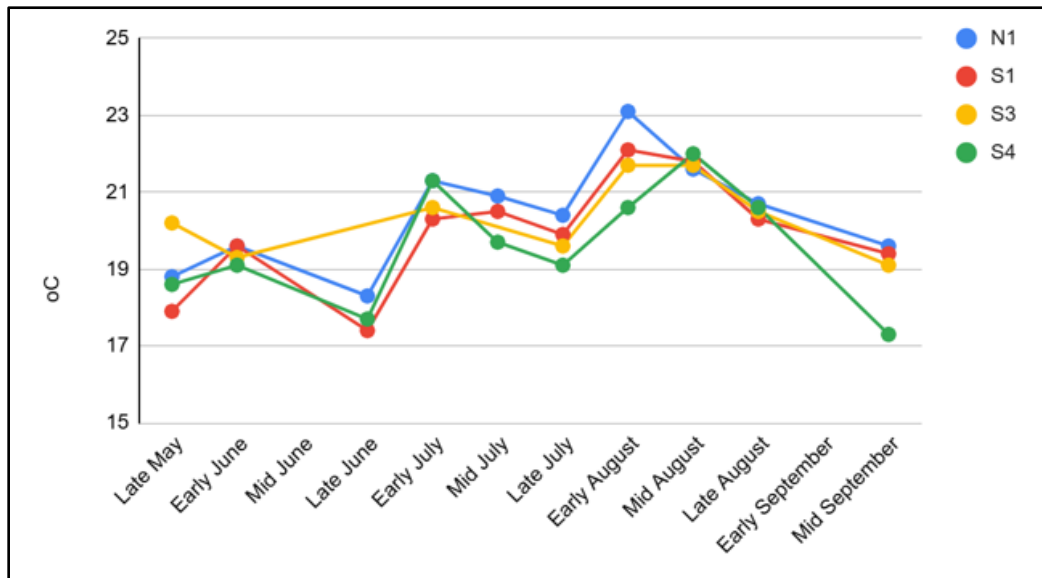
Maximum Depth Recorded at S1 by Year and Normalized Date

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Early May							5.7					
Mid May					5.4							
Late May												
Early June		5.4										5.1
Mid June	5.4			5.6		5.8		6.7	5.8			
Late June			5.1									
Early July												

NOTE: In 2023 and 2024 measurements were not taken early enough in the year at S1 to ensure the maximum was recorded. The first measurement in each of these years was mid-July and the peak is almost invariably reached by late June. See Water Quantity Report 2025 for details

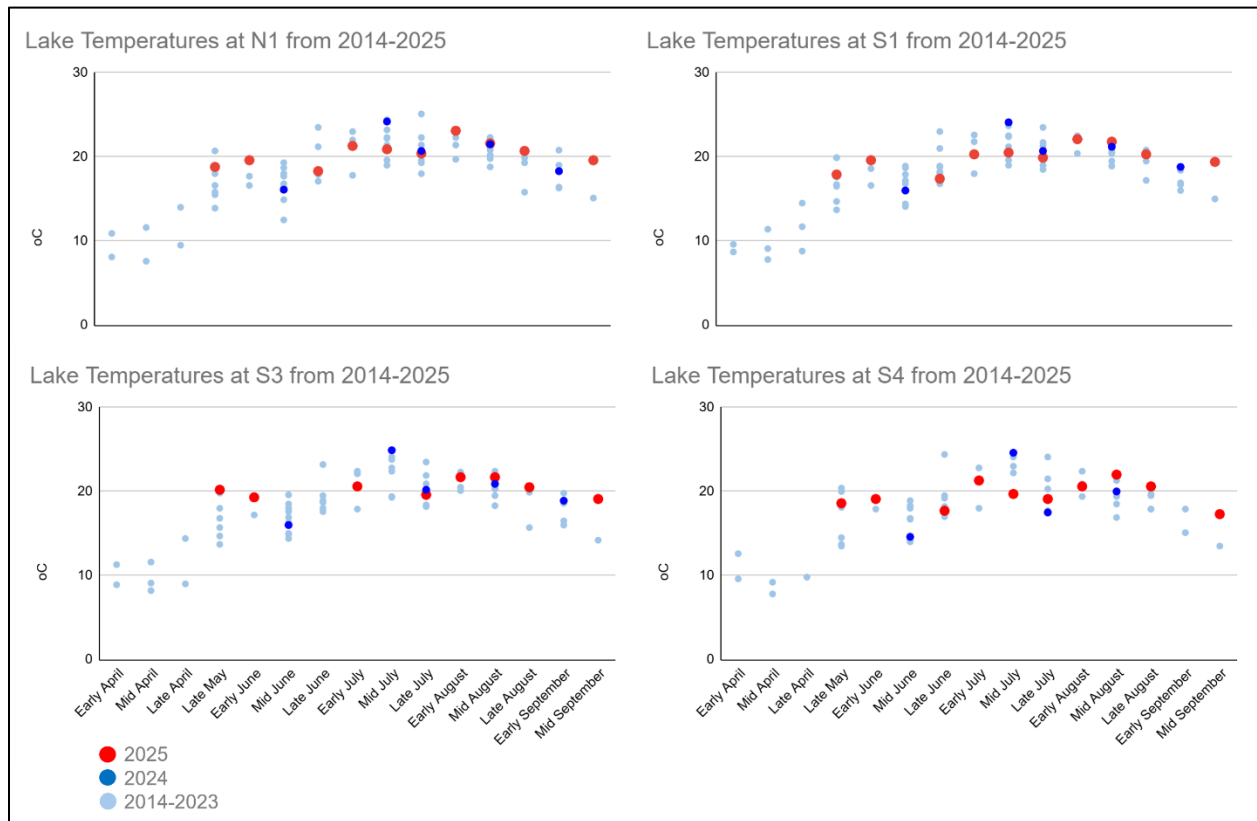
3.1.2 Temperature

Surface Water Temperatures Recorded at N1, S1, S3, and S4 in 2025



- In 2025, the temperature of the lake water reached a maximum in early August at N1, S1, and S3 (23.1°C at N1) and it remained at its highest through mid August at all four sites (21.6-22.0°C).
- Water temperatures were close among the sites, usually within 1.5-2.0°C.

Lake Water Temperature: History 2014-2025

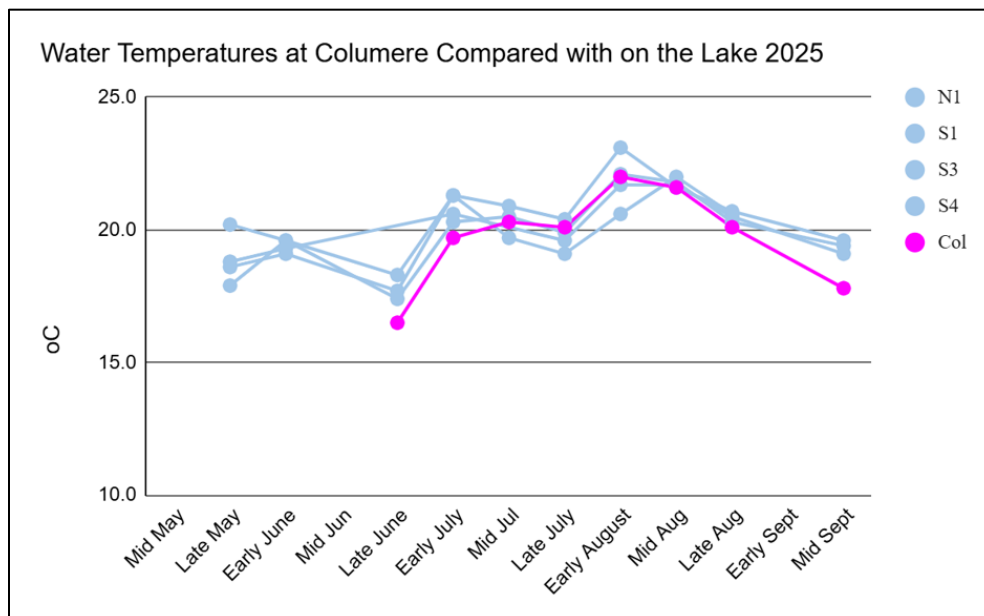


- In 2025, lake water temperatures were at the high end of the range of historical values recorded early in the year (late April and early May).
- Water temperatures then remained steady, so they appear to be in the middle of the historical range later in the year (June through early August).
- The maximum water temperature recorded in 2025 is approximately 2.5°C lower than the maximum average temperature recorded in mid-July in 2024, which was nearly 24.5°C. (This was the highest water temperature recorded in our database since we began monitoring Columbia Lake in 2014). The maximum water temperature recorded in 2025 was also reached almost a month later than in 2024 (early-August).

Exploring Daily Variation in Lake Water Temperature

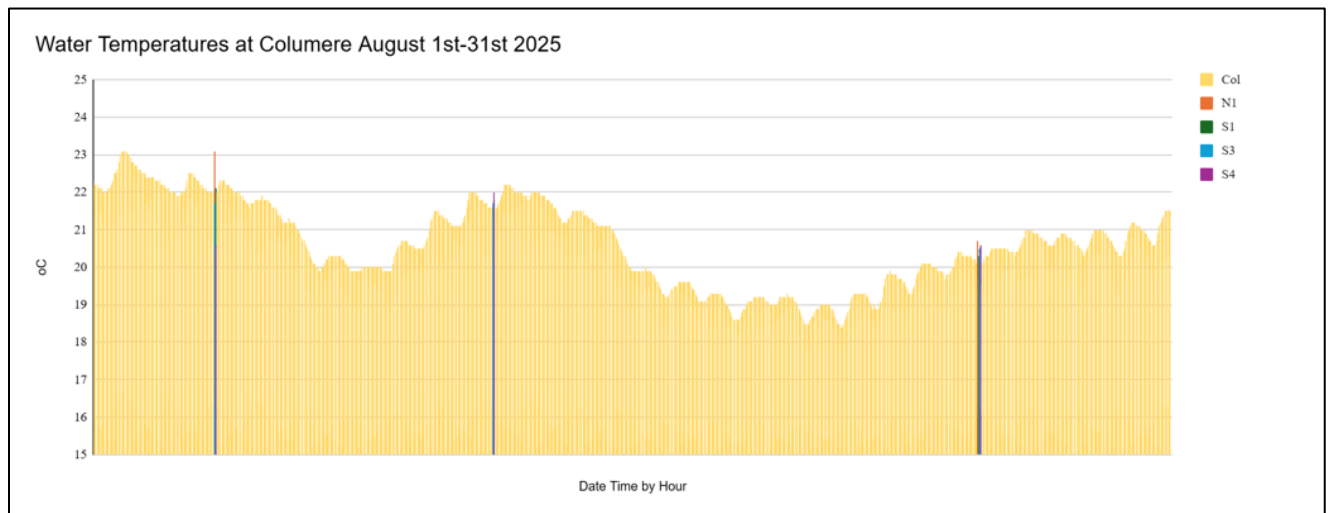
Measurements of lake water temperature at N1, S1, S3, and S4 are taken only once every two weeks at most. They are also normally taken in the morning. Because water quality is so dependent on temperature, we have explored other means to assess changes in lake water temperature which may occur **between** these measurements.

In 2023, 2024, and 2025, measurements of water temperature taken every hour at Columere Marina (HoboLink) agreed closely with the water temperatures recorded out on the lake at N1, S1, S3, and S4. Data are shown below for 2025. Temperatures recorded at the same time and date are shown for Columere Marina (Col) and the lake (N1, S1, S3, and S4). This agreement suggests that we can use changes in the water temperature recorded at Columere Marina to indicate possible changes in water temperature out on the lake between our biweekly monitoring outings.



The temperatures recorded at Columere Marina show that between our biweekly outings on the lake, water temperatures can vary notably. For example, on some occasions in July 2025, water temperatures at Columere Marina were up to 2°C greater than the last recorded value on the lake, whereas on some occasions in August 2025, water temperatures at Columere Marina were up to 3°C lower than the last recorded value on the lake.

This is illustrated in the figure below.



Interestingly, as shown in the figure above, there is also a notable diurnal variation in water temperature in the marina, of approximately 1°C, with the temperature maximum being reached at midnight and the minimum at midday. We do not know if this variation occurs on the lake, but our monitoring outings are usually in the morning.

Water Temperature vs. Depth

We have not reported temperature changes with depth here because our data show that there is not a temperature vs. depth profile for the water in Columbia Lake at N1, S3, or S4 as the water is too shallow. Occasionally, there is a small temperature difference between the surface and the bottom water at the lake's deepest site (S1). Our temperature vs. depth data at S1 for 2025 are shown in the section on the BCLSMP program.

3.1.3 Water Clarity: Secchi Depth and Turbidity

Water clarity is an important consideration for lake water quality since it improves the aesthetic appeal of the lake to recreational users and increases the chance of successful predation by birds, terrestrial animals, and fish. Clear water also promotes the photosynthetic processes needed to maintain the ecological health of the lake.

The turbidity (cloudiness) of lake water is determined mostly by the growth of phytoplankton and by suspended sediments. In deep water, the main cause of turbidity is the growth of phytoplankton. In contrast, in shallow and shoreline water suspended sediments are introduced by surface water draining into the lake, by shoreline erosion, and by wave action and recreational activities which disturb the bottom sediments. Organic matter that decays in the water as it warms up is also a significant contributor to a lake's murkiness. (The decay of organic matter consumes oxygen, and this may limit the oxygen available to support aquatic life.)

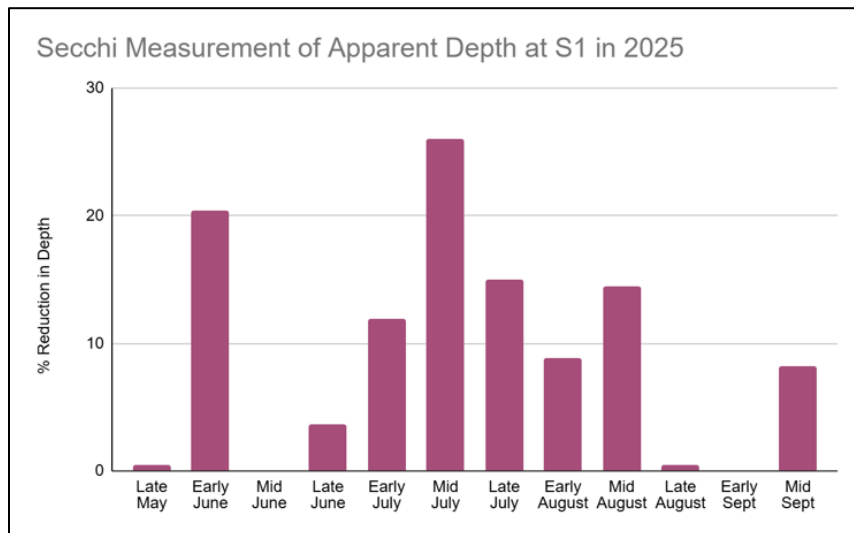
Water clarity or, in contrast, the cloudiness or murkiness of the water, is measured in two ways. The turbidity (cloudiness/murkiness) of the water is measured directly in Nephelometric Turbidity Units (NTUs) and indirectly by measuring the depth at which a Secchi disc can no longer be seen.

Secchi Depth

Secchi depth is the depth of water at which the Secchi disc can no longer be seen from the surface. If the water is clear enough, and the lake shallow enough, the disc will still be visible when it reaches the bottom.

As usual on Columbia Lake, the actual lake depth (measured with a depth sounder) and the Secchi depth did not differ substantially in most cases. At N1 and S4 the Secchi depth and actual depth were the same on all occasions. This is related to the shallowness of the water at these sites (both are typically less than 2 m deep for most of the year). At S3, the measures were the same on all occasions except mid-August, when the apparent depth (Secchi depth) was 15.8% less than the actual depth. Only at S1 (the deepest site on the lake) were differences between actual depth and the Secchi depth (apparent depth) noted regularly throughout the 2025 monitoring season.

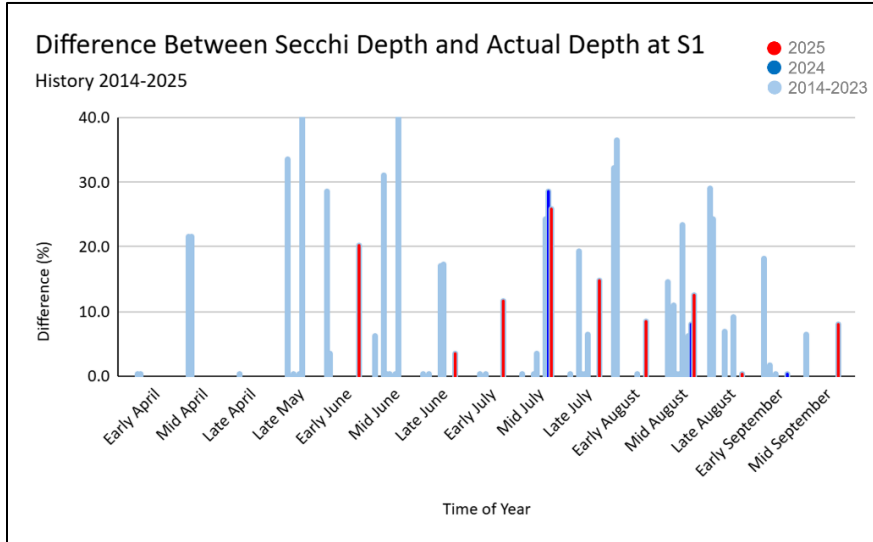
These differences have been plotted below as % reduction in depth (apparent). (*For example, if the actual depth is 5.0 m and the Secchi depth is 4.0 m, the % reduction in depth is $(5.0-4.0)/5.0 \times 100=20\%$.*)



- On five occasions the % reduction in depth was greater than 10%, and on two of these occasions it was greater than 20%.
- Four out of five of these largest % reductions in depth were measured between early July and mid-August.
- The greatest % reduction in depth, and thus the greatest turbidity of the water, occurred in mid-July, with a 26% reduction in apparent depth.

Secchi Depth History at S1: 2014-2025

Secchi depth measurements and actual depth measurements taken at S1 between 2014 and 2025 were used to calculate the % reduction in depth. The values were plotted as a function of normalized date, and are shown in the graph below.

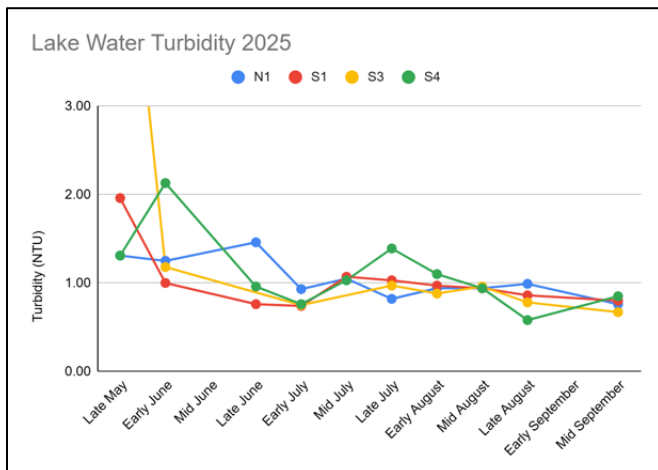


The data show that the clarity of the water in Columbia Lake varies substantially from April through September.

Our data show that there are frequent, notable decreases in water clarity at S1 on Columbia Lake. The causes of the increased turbidity remain to be determined but probably include sediment disturbance caused by wind action and/or recreational use. There may also be contributions from growth of phytoplankton and the decay of organic matter.

Turbidity (NTUs)

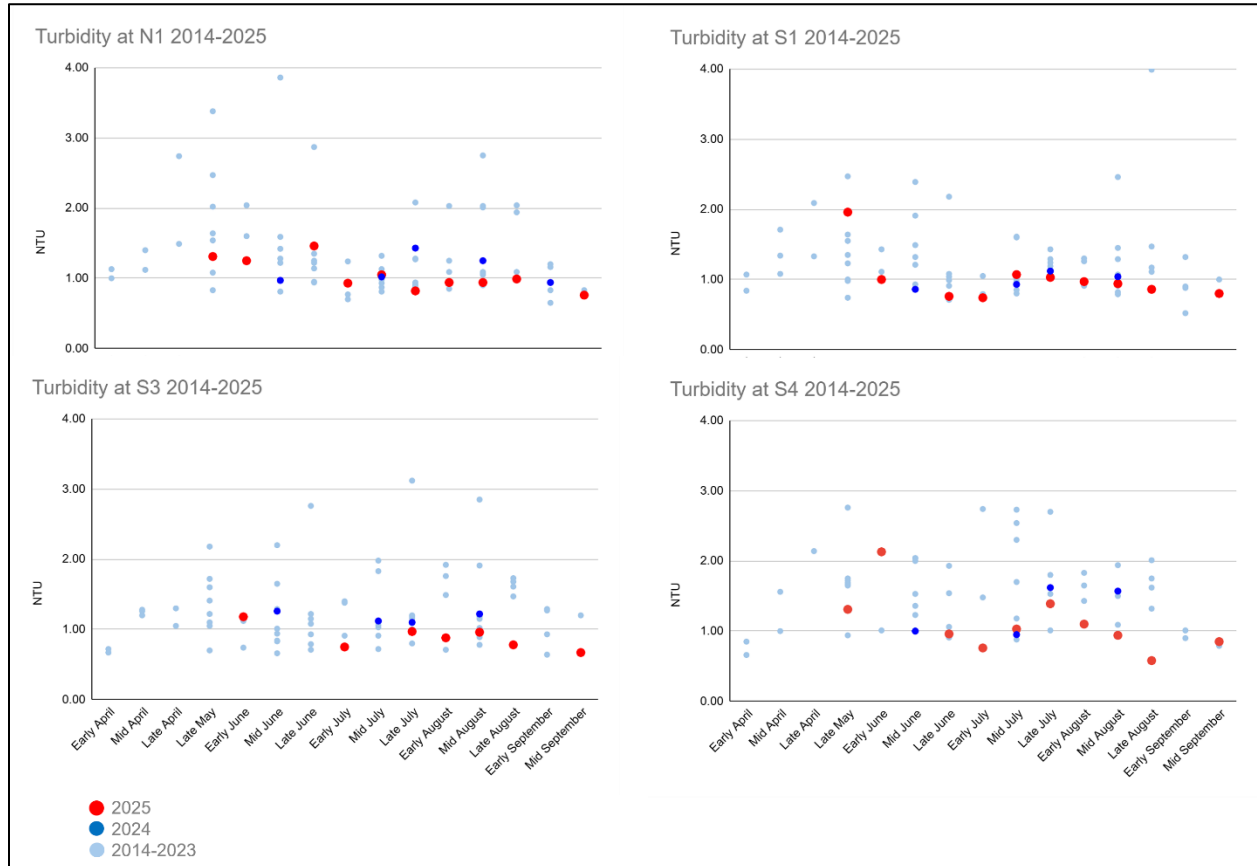
The turbidity of the water in Columbia Lake measured during the 2025 monitoring season is shown in the graph below. All samples were surface water.



- Turbidity at all sites was greatest earlier in the year, and generally decreased over the summer months.
- The turbidity of the water was mostly within the range 0.75 to 2.0.

Lake Water Turbidity: History 2014-2025

This graph compares turbidity of the surface water at each location on the lake in 2024 and 2025 to all measurements collected at the same location on the same normalized dates from 2014-2023.



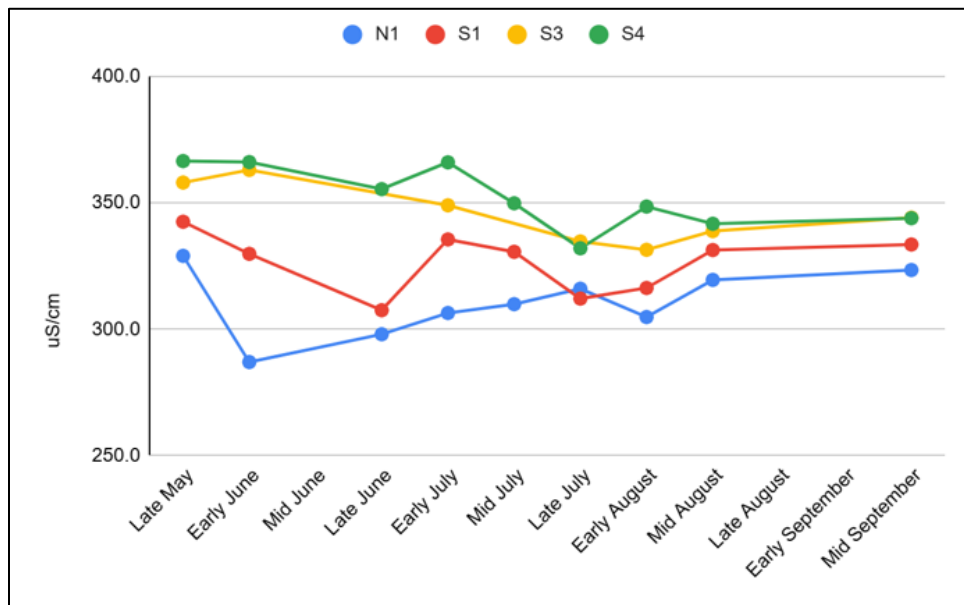
- There have been some measurements of turbidity >2.0 over time, but the majority of measurements fall within 0.5-2.0.
- Measurements of turbidity >2.0 are most frequently observed at N1 and S4. These sites are the shallowest on the lake (1.5-2.0 meters maximum depth) and are most likely to be susceptible to disturbance of sediment.
- In most cases, and at all four sites, turbidity measurements in 2025 fall towards the lower end of the range measured from 2014-2024.

3.1.4 Specific Conductance

Specific conductance is a measure of the electrical conductivity of the lake water; an indicator of the quantity of dissolved salts (ions) the lake water contains. These dissolved salts consist of both mineral salts dissolved from particulate sediments in the lake, and salts that are carried into the lake by groundwater inflows and surface water drainage.

Specific conductance is a temperature-dependent measurement, increasing in warmer water. Because of this, most probes correct automatically for temperature and report the specific conductance, which is the measurement of conductivity standardized to 25°C.

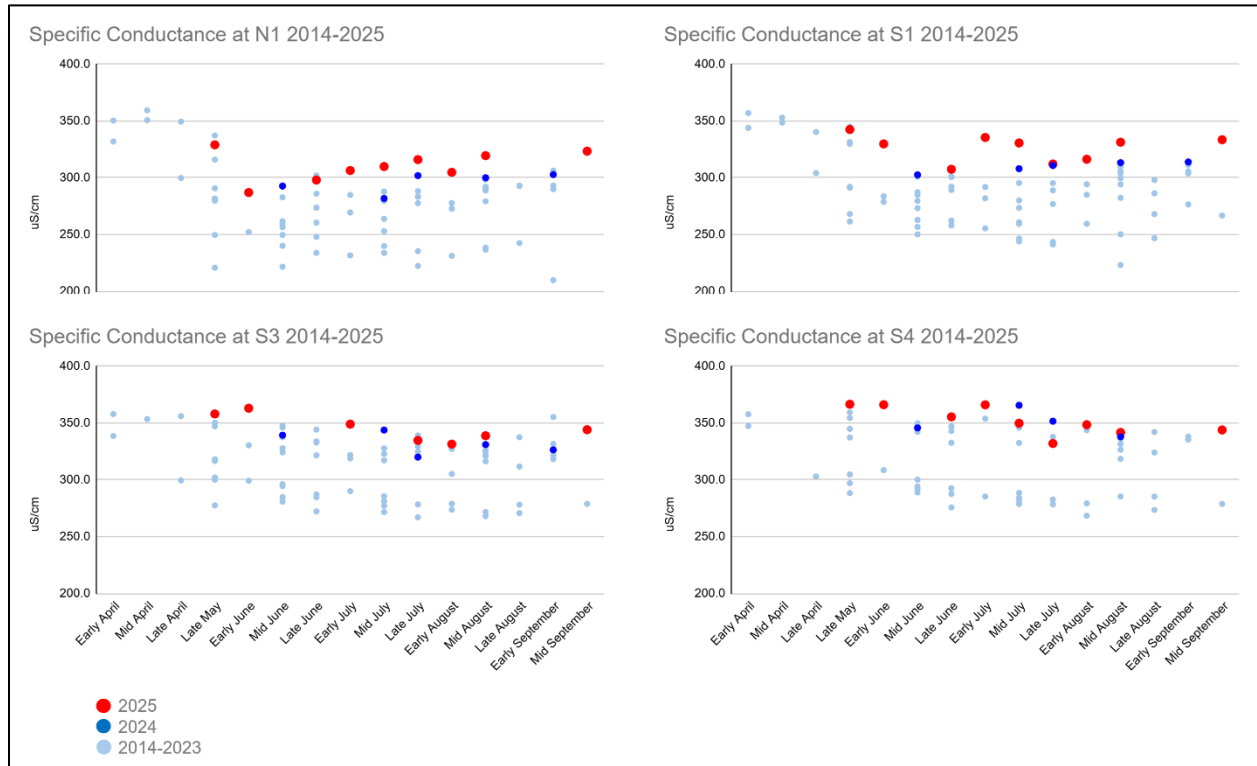
Specific Conductance of Water on Columbia Lake in 2025



On most dates in 2025, the specific conductance at S4 and S3 is highest, while that at N1 is lowest. This is our 'normal' finding for Columbia Lake. CLSS's data (2014-2024) shows that specific conductance of the lake water is consistently lower at N1 and S1 than at S3 and S4. This is related to drainage into the lake at its south, from Canal Flats Creek which itself has a relatively high specific conductance (see the Creeks section of this report). Overall, the lake flows south to north, and so groundwater inflow at the south end of the lake likely contributes to the greater specific conductance at S4. Also, during freshet there is water inflow into the lake at N1 from Dutch Creek. The specific conductance of the water in Dutch Creek (145-200 $\mu\text{S}/\text{cm}$) is notably less than that of the lake water.

In 2025, the lake achieved its maximum depth in early June in 2025. Given that much of the rise in lake level occurs through 'reverse flow' into Columbia Lake at the north end, from Dutch Creek, this may explain the drop in conductivity at N1 at this time.

Lake Water Conductance: History 2014-2025



At all four sites on the lake, and on almost all dates, the specific conductance values in 2025 are the greatest in the historical distribution of values. This may, at least in part, be related to the historically low maximum water levels recorded in Columbia Lake in 2025.

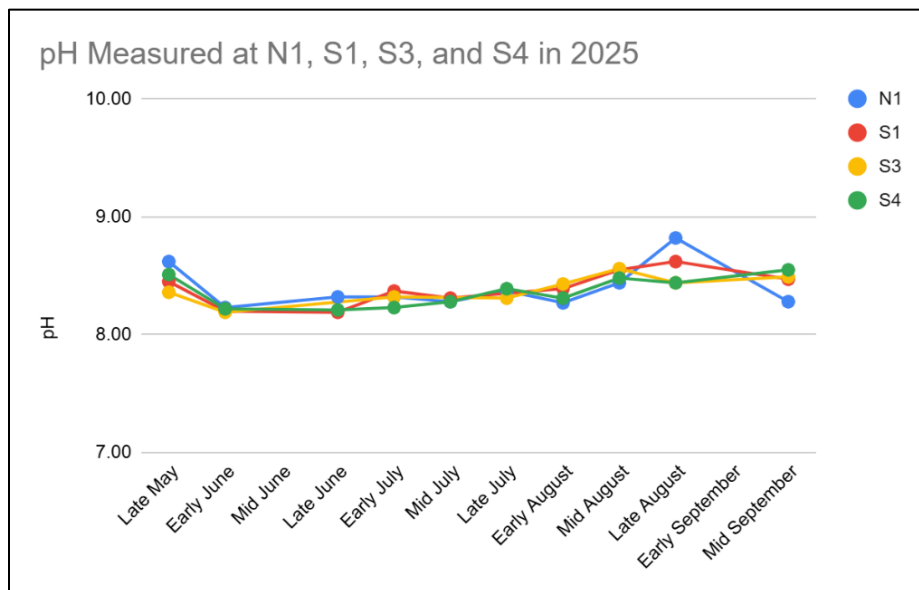
The water quality objective stated in the Columbia Lake Management Plan for specific conductivity is $700\mu\text{S}/\text{cm}$ as established by Health Canada (Table 1). While the specific conductivity of water in Columbia Lake is currently less than this by a factor of two, it appears to be increasing over time. Also, the conductivity is apparently sensitive to the spring rise in lake water levels.

3.1.5 pH

The pH of water affects the survival and growth of aquatic organisms. The pH range for fresh water aquatic life considered acceptable by CCME is 6.5-9.0 (Table 1). Values outside this range have a notable impact on the biochemical processes and metabolism of aquatic organisms. The pH of lake water also affects the availability of dissolved nutrients like carbonates, phosphate, ammonia, iron, and trace metals. Low pH values can cause release of toxic metals such as lead, mercury, arsenic, and copper from lake sediments because these substances are more soluble at lower pH. pH is also an important toxicity modifying factor, where small changes in pH can increase the toxicity of certain metals. For example, the acceptable levels of manganese in water (for aquatic life) are reduced notably by increasing pH: a pH change from 7.5 to 8.5 reduces the acceptable levels of Mn more than twofold (see section 2.3 Water Quality Standards).

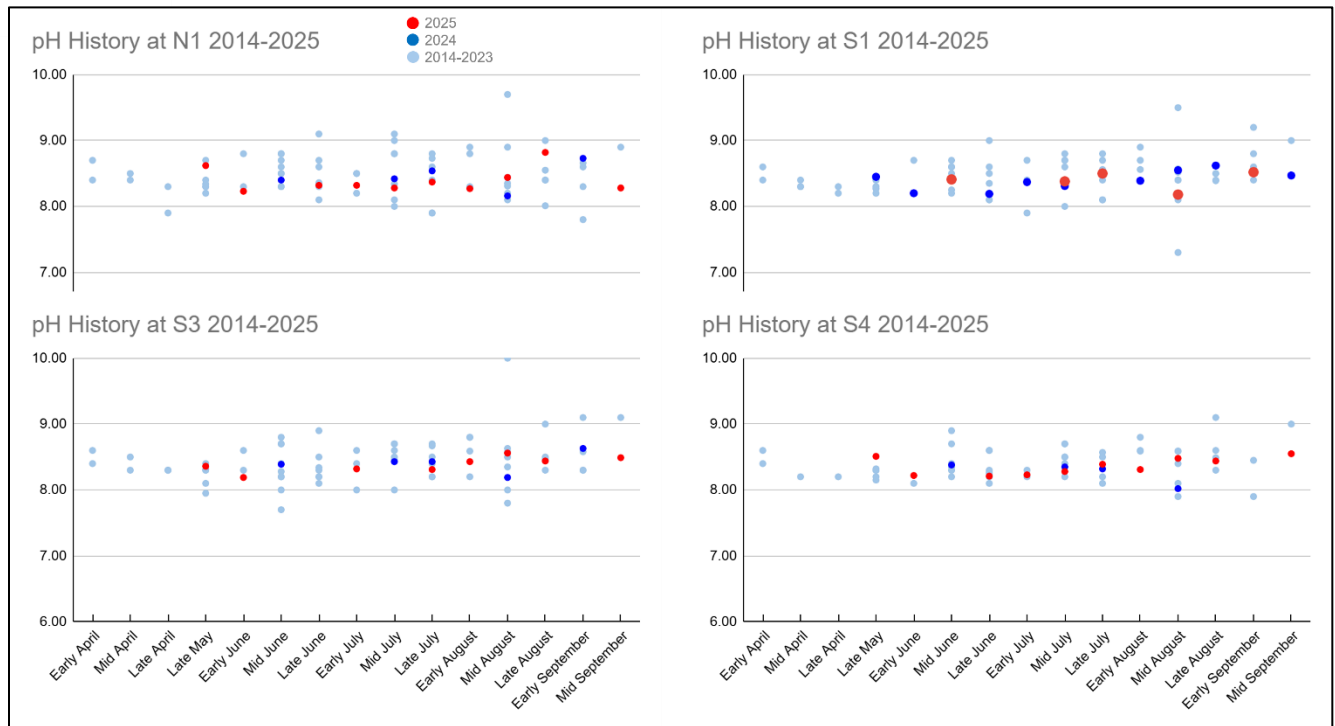
The pH of lake water is determined and affected by a number of variables, including rates of photosynthesis by aquatic organisms (which increases pH during the day by reducing levels of dissolved CO₂), by rain fall (which tends to reduce pH through solubilization of sulphur and nitrogen oxides), and by snow melt (flushing in of accumulated acid deposition). The surrounding geology and soil composition is, of course, a primary determinant of the baseline pH of a lake. Limestones provide a high buffering capacity which can help resist acidification. Granite and sand have a low buffering capacity (low alkalinity). Decomposition of organic matter decreases pH by production of weak organic acids. Anthropogenic changes can result from industrial and agricultural activity.

The pH values measured in 2025 at each monitoring location on Columbia Lake are shown below. Generally, the pH values fall within a narrow range, from 8.1 to 8.5 and are similar among the four monitoring locations.



The plots show that Columbia Lake is a slightly alkaline lake, the pH falling mostly between 8.1 and 8.6.

pH of Columbia Lake: History 2014-2025



The pH values measured at N1, S1, S3, and S4 from 2014-2025 are shown in the graph above. All measurements taken in 2025 are within the historical distribution, which is concentrated between pH 8.0 and pH 9.0.

Columbia Lake is naturally a slightly alkaline lake, with a background pH approaching the maximum end of the range tolerated by aquatic organisms (6.5-9.0). This makes Columbia Lake very sensitive to disturbances in the aquatic environment. In the summer, a high pH combined with warm water temperatures, relatively high conductivity, and variable turbidity, would increase stress on aquatic organisms substantially.

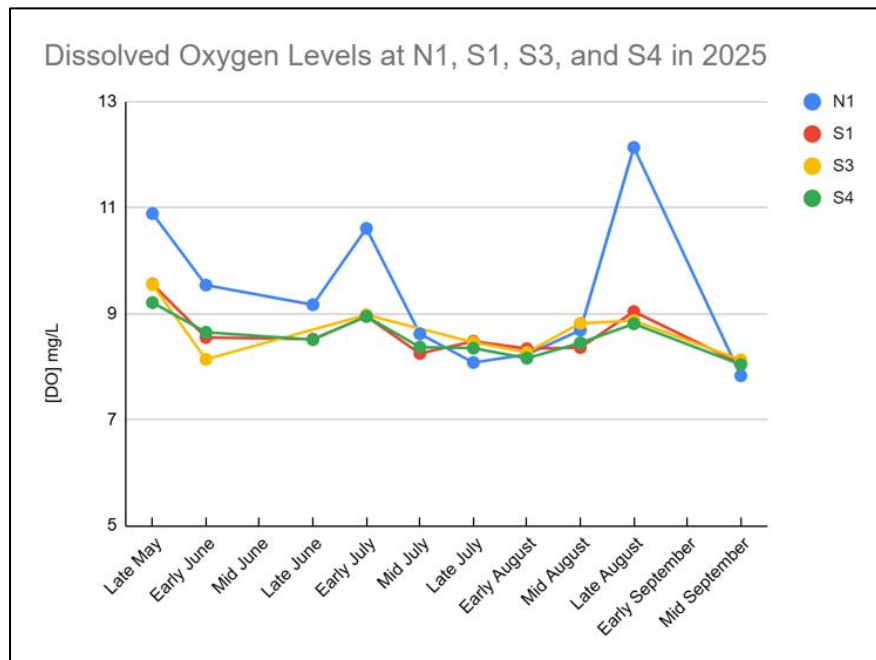
3.1.6 Dissolved Oxygen

Oxygen is produced by photosynthesis and much of the dissolved oxygen in lakes is produced by aquatic plants, algae (phytoplankton and periphyton), and cyanobacteria. The other major sources of dissolved oxygen in lake water are: 1) diffusion from the air, and 2) precipitation falling directly on the lake or introduced as snow melt. Diffusion of oxygen into water from the air (aeration) is enhanced by lake surface disturbances that create turbulence, and by winds which produce waves. Some dissolved oxygen is provided to the lake by the inflow of surface drainage, but groundwater inflow will not contribute substantial amounts of dissolved oxygen.

Dissolved oxygen is required by aquatic species including fish, invertebrates, bacteria, and plants, because all organisms use oxygen in respiration. Even organisms which produce oxygen during photosynthesis consume oxygen during respiration. The amount of dissolved oxygen required varies from organism to organism: bottom feeders such as mussels and worms need minimal amounts (1-6 mg/L), whereas shallow water fish require higher amounts (5-10 mg/L).

The saturation level of oxygen in water is between 8 and 14 mg/L depending upon the water temperature. Oxygen is more readily soluble in cooler water than in warmer water. For example, solubility is 14 mg/L at water temperatures of 1° C compared with 8 mg/L at water temperatures of 25° C.

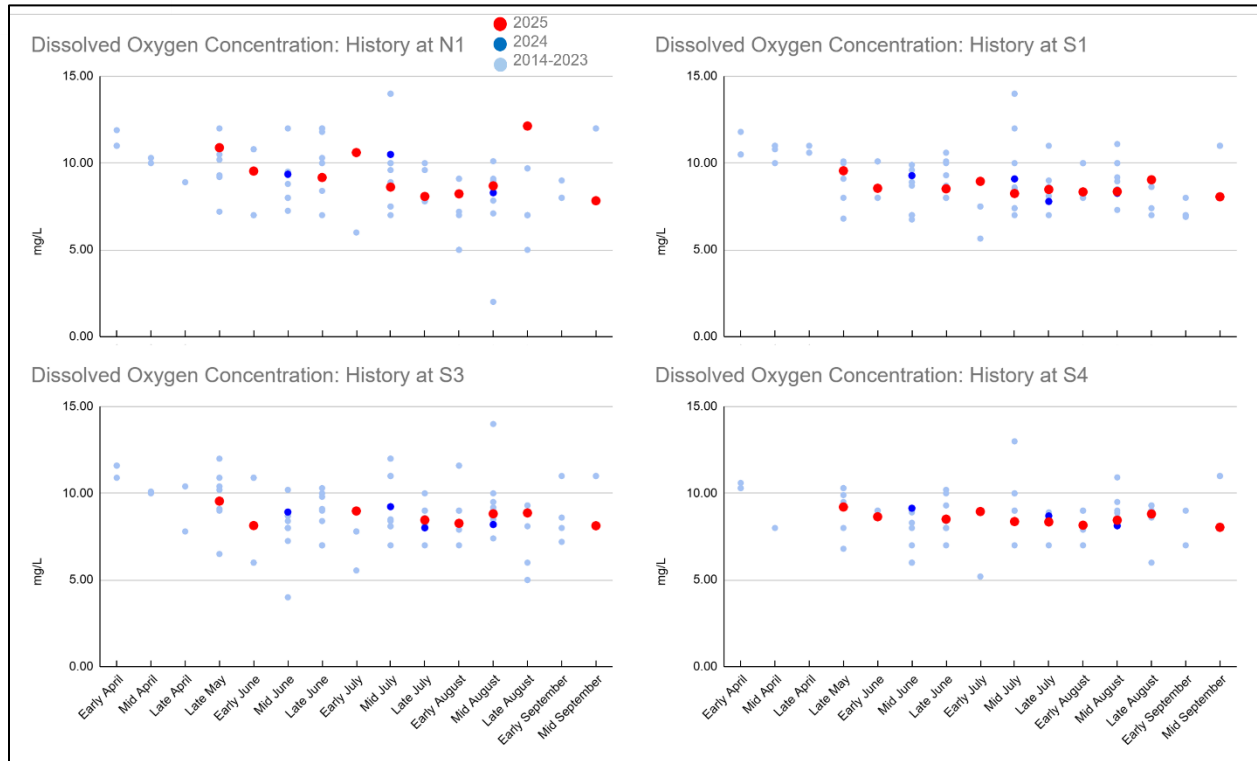
Dissolved Oxygen 2025.



The concentration of dissolved oxygen in Columbia Lake in 2025 was typically between 8.0 and 9.0 mg/L.

The concentrations of dissolved oxygen measured in 2025 at the four monitoring locations along the lake were consistent among the sites S1-S4, with levels at N1 being somewhat greater, especially earlier in the year (late May to early July). In the Spring, water from Dutch Creek flows into Columbia Lake at the usual northeast outflow into the Columbia River. There are likely other access channels from the Dutch Creek delta which allow flow of water from Dutch Creek into Columbia Lake at its north end, and this inflow of water could cause N1 to have greater oxygen concentrations than the rest of the lake (S1-S4 are further south). (Oxygen concentrations measured in Dutch Creek from late May to early July were between 9.0 and 10.0 mg/L whereas those at S1-S4 on the lake were 8.0 to 8.5 in this time period.)

Dissolved Oxygen Concentration: History 2014-2025



In 2025, oxygen concentrations (red) at all four sites on the lake were well within the historical range measured on Columbia Lake from 2014-2024. Almost all values measured at S1-S4 in 2025 were between 8 and 9 mg/L.

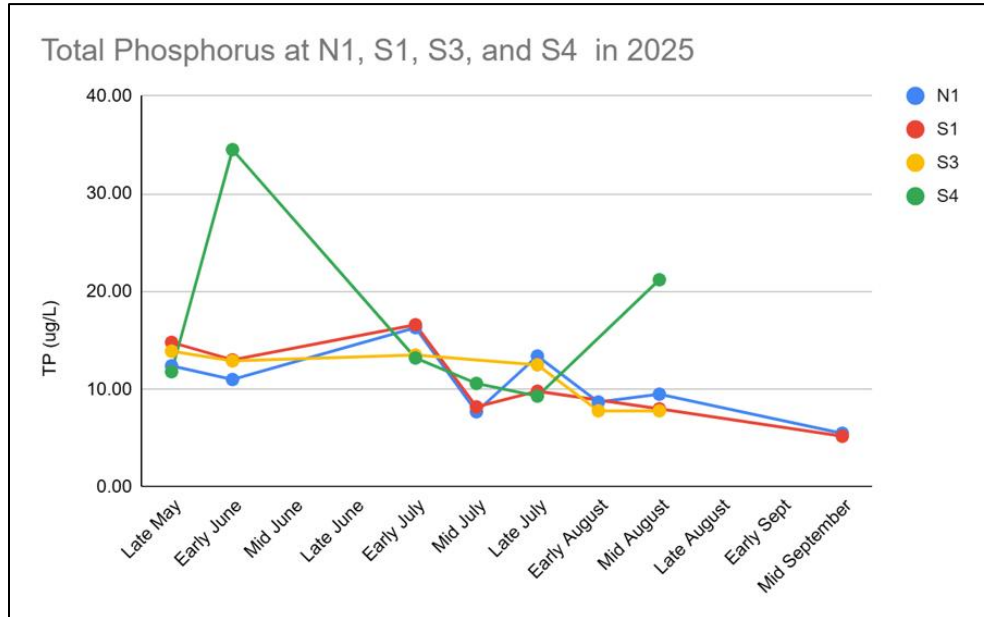
3.1.7 Total Phosphorus

Phosphorus is abundant in the earth's crust and is provided naturally to lake water by drainage into the lake of water courses that contain dissolved mineral salts and organic materials. Phosphorous may also be introduced into lake water by wastewater discharge and drainage of organic wastes from agricultural lands and waters from septic systems. It is a nutrient essential for the growth of plants and other photosynthetic organisms in lakes, such as algae (phytoplankton and periphyton). Photosynthetic algae are the principal feed stock of small fish and invertebrates, which in turn become the feedstock of larger fish and aquatic/amphibious vertebrates. Therefore, healthy lake water must contain phosphorous. Generally, phosphorus is the limiting nutrient in freshwater aquatic systems, and plant and algae growth will cease if phosphorus is unavailable.

However, too much phosphorous is also problematic, because it causes algal blooms, with a subsequent reduction in concentrations of dissolved oxygen, and stagnation of the lake water, an ecological condition not favorable to a healthy lake. (Phytoplankton consume oxygen during respiration at night. Also, when they die and settle to the lake bottom, they stimulate microbial decay processes which consume oxygen. These factors can cause significant fluctuations in oxygen levels in the lake water at night.)

The trophic status of a lake is indicated by the levels of total phosphorus in its water. Under normal conditions, total phosphorus is the most meaningful measure of phosphorus for water (Wetzel, 2001, from *Canadian Water Quality Guidelines: Phosphorus*, 2004). Oligotrophic lakes contain 4-10 µg/L total phosphorus, and mesotrophic lakes contain 10-20 µg/L.

Total Phosphorous Concentrations 2025



From late May through to late July, most of the measurements of total phosphorus indicated concentrations at or greater than 10 µg/L. The concentration of total phosphorus does not seem to differ much by location on the lake, except at S4 which had substantially greater values measured twice in 2025.

Levels of total phosphorus in a lake are used to classify its **trophic status**, which is the extent to which the growth of algae in the water is supported by the availability of phosphorus. (See page 9.)

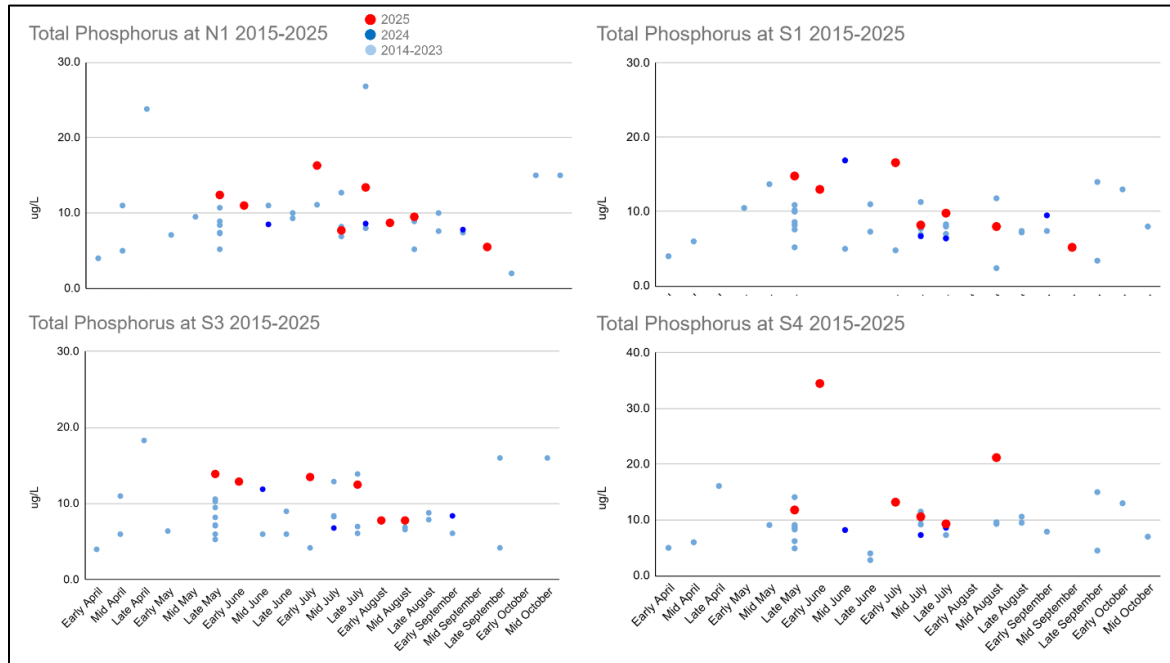
Trophic Status	Total Phosphorus (µg/L)
Ultra-Oligotrophic	<4
Oligotrophic	4-10
Mesotrophic	10-20
Meso-eutrophic	20-35
Eutrophic	35-100
Hyper-eutrophic	>100

From: Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2004. *Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems*.

The measurements of total phosphorus taken in 2025 suggest that the status of Columbia Lake is mesotrophic, or borderline between oligotrophic and mesotrophic at best.

Total Phosphorus Levels on Columbia Lake: History 2014-2025

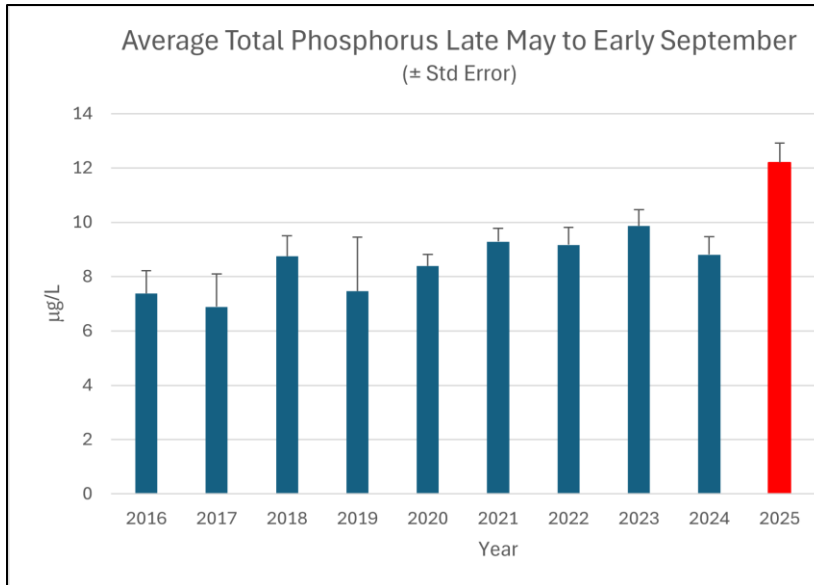
The graphs below show the total phosphorus levels measured at N1, S1, S3, and S4 in 2025 compared with the historical distribution of all levels measured between 2014 and 2024. All values are plotted by normalized date.



These graphs suggest that total phosphorus levels in 2025 (red) are at the high end of the historical range.

To explore this further, we calculated the yearly average total phosphorus concentration of all samples taken between late May and early September, 2014-2025. (Only samples with readings greater than the threshold for the test were included.)

YEAR	Average TP (µg/L)	N	SD	SE
2015	7.5	6	2.07	0.84
2016	7.38	7	3.19	1.2
2017	6.89	12	2.63	0.76
2018	8.75	11	6.64	2
2019	7.46	11	1.43	0.43
2020	8.39	8	1.36	0.48
2021	9.29	12	2.22	0.64
2022	9.17	12	2.08	0.6
2023	9.86	8	1.88	0.66
2024	8.81	14	2.7	0.72
2025	12.19	27	5.73	1.12



These data suggest a possible increase in concentrations of total phosphorus in Columbia Lake over time.

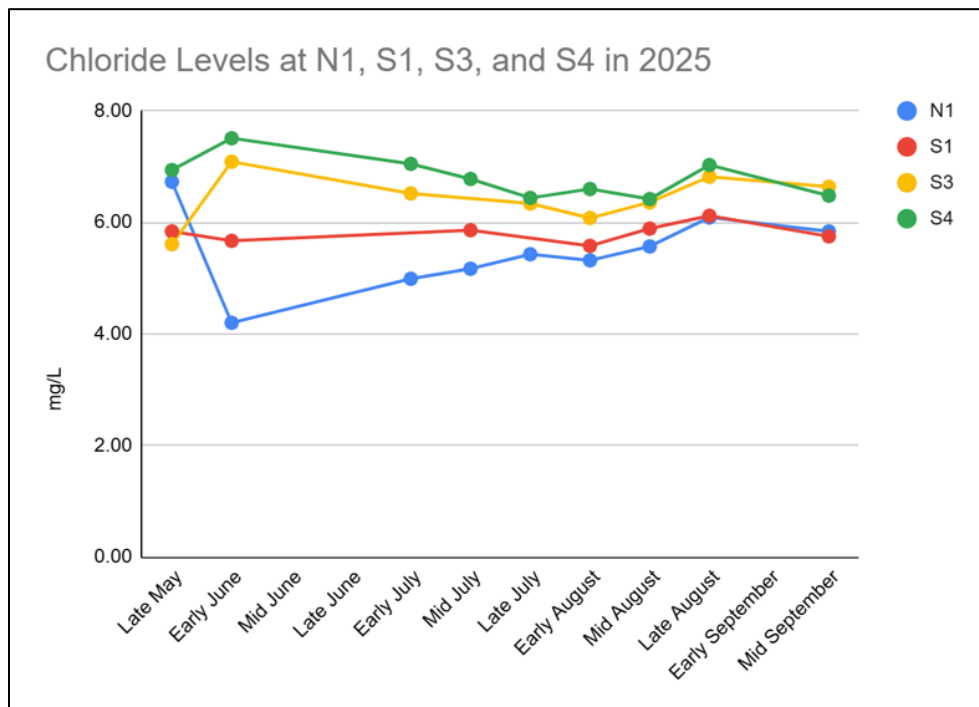
The validity of this observation remains to be determined, since there are many factors which must be taken into consideration when measuring total phosphorus concentrations of a lake. For example, an appropriate number of samples must be collected to accurately reflect total phosphorus concentrations in a system, and specific zones on a large water body like Columbia lake might vary substantially, making a whole-lake approximation invalid. Also, as shown in the table above, in our current data there are substantial differences in the number of samples taken each year, and all sites (N1, S1, S3, and S4) were not always included.

In future years, CLSS will establish a more reliable approach to study the total phosphorus levels in Columbia Lake, taking into account the differences between N1, S1, S3, and S4, and other special sites such as Armstrong Bay (influx), and the westside shallow regions by Spirits Reach.

3.1.8 Chloride

Historically, chloride was added to CLSS's regular chemical analyses because it was noted in the results of BCMOE's sampling program that Columbia Lake contained greater concentrations of chloride than other neighboring lakes. Furthermore, in 2019, analysis of water quality in Canal Flats Creek showed that the creek had chloride concentrations much greater than those measured in either Dutch Creek or Hardie Creek. Our historical data show that the greatest concentrations of chloride are at the south end of the lake, at S4.

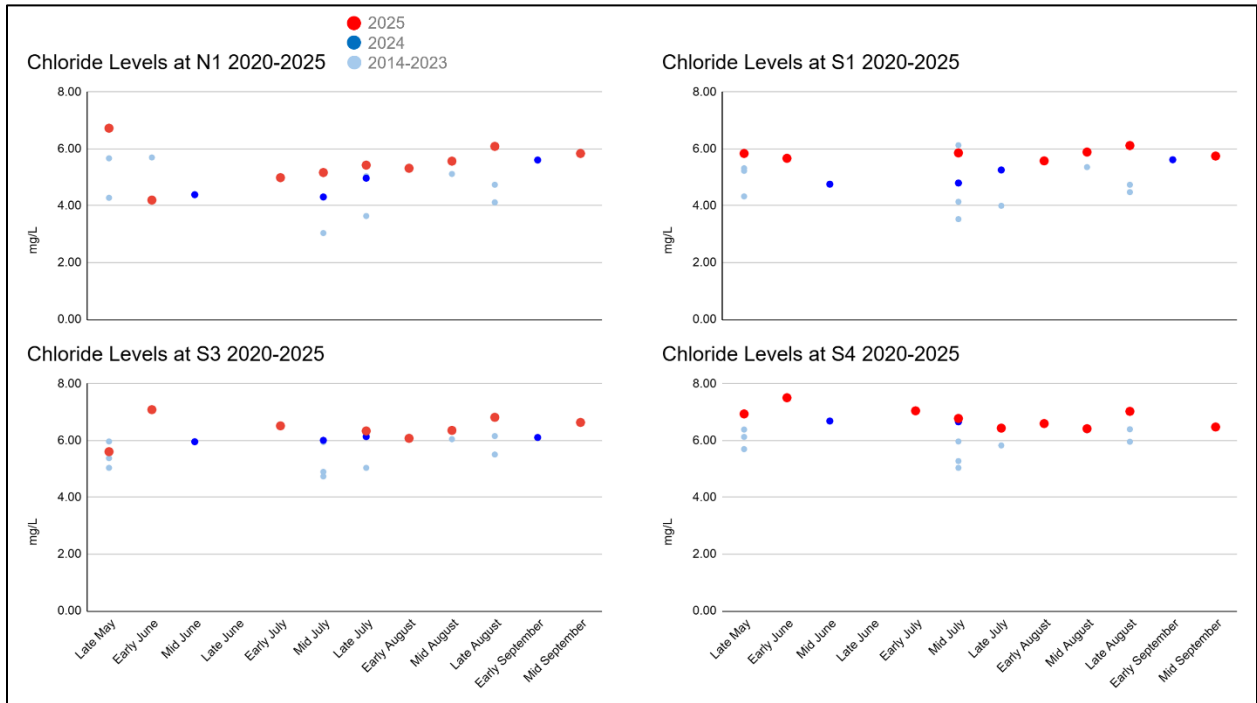
Chloride Concentrations 2025



In 2025, as usual, we observed that chloride concentrations in Columbia Lake are greater at S3 and S4 than at S1 and N1. This supports the suggestion that chloride enters the lake from the south end, flowing in via Canal Flats Creek which emerges from aquifers under Canal Flats.

In early June the concentration of chloride at N1 (the north end of the lake) dropped notably and then increased slowly throughout the year. This is likely a dilution effect, arising from influx of water from Dutch Creek, which has low concentrations of chloride, into Columbia Lake during the freshet as lake levels rise. As the lake levels drop during the summer, and water flows through Columbia Lake from its south end, concentrations of chloride rise again.

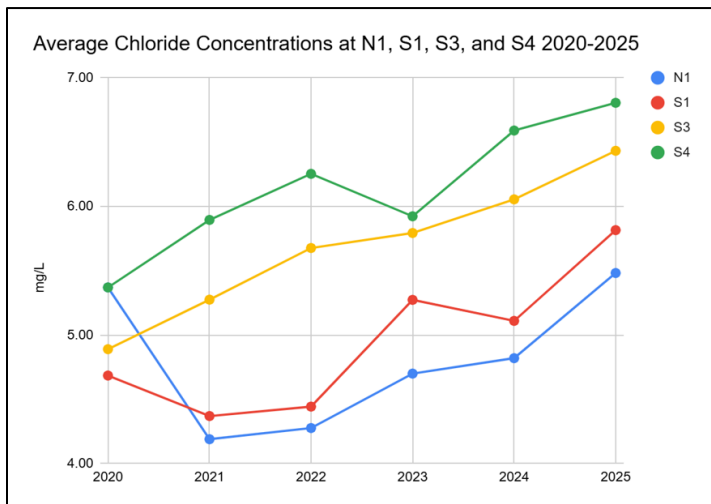
History: Concentrations of Chloride in Columbia Lake 2014-2025



In comparing chloride concentrations in 2025 with previous values (2020-2024) we found that, in almost all cases, chloride concentrations in Columbia Lake were greater than any others measured since 2020. This is true at all locations, N1, S1, S3, and S4. However, the difference is small and might reflect the relatively low levels of water in Columbia Lake in 2025.

Average Chloride Concentrations at N1, S1, S3, and S4: 2020-2025

The graph below shows the average concentration of chloride in all water samples taken each year at each site.



This graph shows that the average concentration of chloride is consistently greatest at the south end of the lake (S4) and decreases progressively to N1 at the north.

This graph also suggests that **average** concentrations of chloride in the lake water have increased since 2021 at all four sites. However, the data have not been collected systematically and all values are impacted by factors such as water flow and lake water level on the date collected. The total volume of the lake varies considerably each year, and in 2025 the lake's maximum water level was at a historical low.

All of these concentrations are much lower than the CCME concentration standard (Table 1, CCME 120 mg/L). However, the apparent increase in concentration of chloride suggests some need for ongoing monitoring.

3.1.9 Manganese and Arsenic

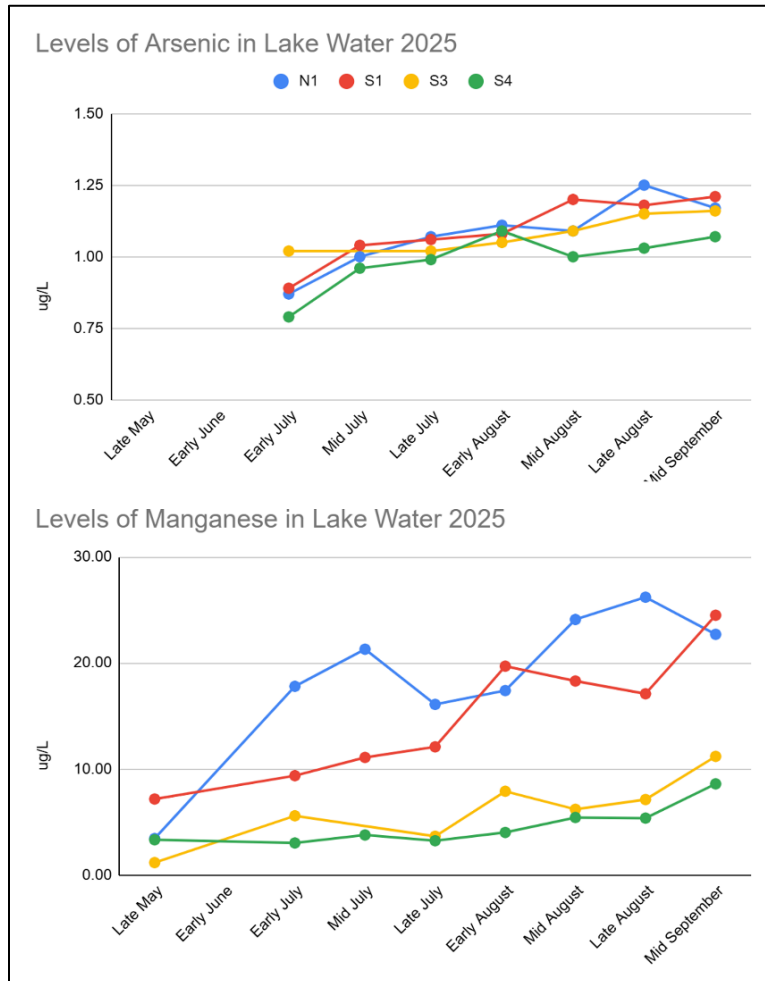
In previous years, iron and manganese were included in the chemical analyses (2020-2024) to explore increases in turbidity noted in the lake water over the summer months in 2019. The increased turbidity could have been due to increases in phytoplankton growth and/or disturbance of bottom sediments. (Bottom sediments can be disturbed through shoreline erosion, sediments from streams draining into the lake, wave action, and recreational activity.)

In 2023 (CARO 2023-09-21) a full metals screen was done for water samples from Columbia Lake (N1, S1, S3, and S4) and for the four creeks (Dutch, Hardie, Marion, and Canal Flats). Sediment/soil samples were also taken at various sites around the lake.

After a review of the concentrations of various metals in both the water and the sediment, we chose to use arsenic (As) and manganese (Mn) as markers in 2025. These were chosen because:

- both are at levels well above the CARO detection limit in both sediment and water samples;
- both are at concentrations less than 10-fold below the MAC (CDWQG) in the lake water.

The graph below shows the concentrations of arsenic and manganese measured in water samples taken at N1-S4 in 2025.



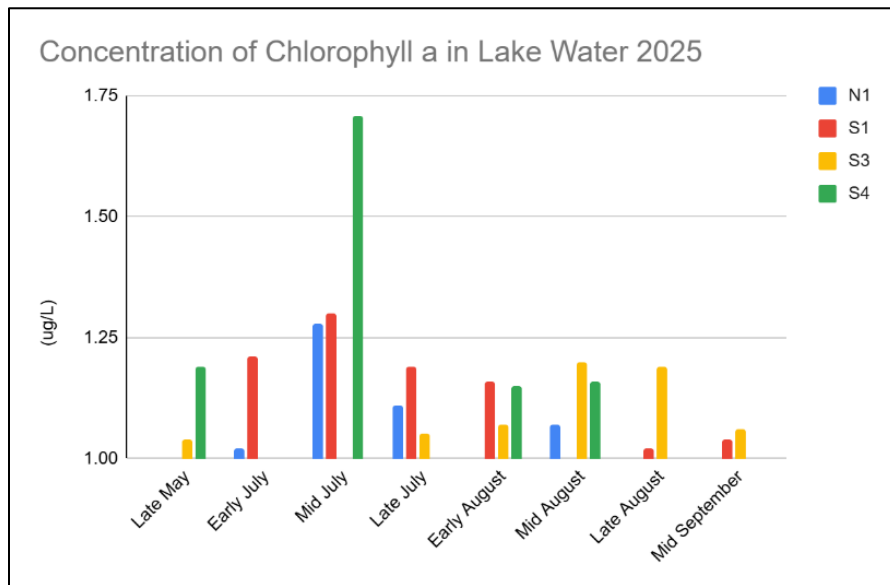
- The data from 2025 are comparable with previous testing for metals in the water (August, 2023), which showed arsenic at 1.1-1.3 $\mu\text{g/L}$ at all sites and manganese at 3-5 $\mu\text{g/L}$ at S4 and S3, and 17-19 $\mu\text{g/L}$ at S1 and N1
- Arsenic levels in the water are approximately the same at all four sites, and appear to increase between early July and late September (by approx. 50%)
- Manganese levels are notably greater at N1 and S1 than at S3 and S4. This fits with sediment analysis (2023) which showed that soils at the north end of the lake contained more than double the concentration of Mn (mg/kg) than at the south end
- Manganese levels in the water also increase between early July and late September, by 300-500%.

3.1.10 Chlorophyll-a

In 2025, CLSS introduced testing for levels of chlorophyll a in Columbia Lake. The intention is to explore levels of phytoplankton in the lake water column, which include green algae and diatoms, and cyanobacteria. Growth of phytoplankton is enhanced when there are elevated levels of phosphorus and in warm, sunny, calm weather conditions.

Chlorophyll a is used as a direct indicator of the biomass in the water column. High levels may indicate eutrophic conditions which can lead to low oxygen concentrations and fish kills. Levels of 3-8 $\mu\text{g/L}$ are considered mesotrophic.

The graph below shows the chlorophyll a concentrations at N1-S4 in 2025. The CARO MRL is 1.0 $\mu\text{g/L}$, so only samples which exceed 1.0 $\mu\text{g/L}$ are shown.



- All sites had low but detectable levels of chlorophyll a on multiple occasions (at least 4) between late May and mid-September
- Amounts detected were between 1.0 and 1.3 $\mu\text{g/L}$. These levels are low, and below the 3-8 $\mu\text{g/L}$ which is considered to be a mesotrophic state.
- At N1, S1, and S4, maximum levels were detected in mid-July, when water temperatures had risen notably in the two weeks since late June.

NOTE: This was the first year CLSS tested for chlorophyll a, and we are exploring changes we might make to improve the reliability of the values. One of the weaknesses of the testing program in 2025 was our inability to ship samples fast enough to ensure that they arrived within the maximum sample holding time. Alternatives will be explored in 2026.

3.1.11 BC Lake Stewards and Monitoring Program

In 2025, CLSS participated in the BCLS&MP, Level 2. This involved measuring water temperature (°C) and concentration of dissolved oxygen (mg/L) vs. water depth, at S1.

Our data from 2014-2024 show that there is not a temperature vs. depth profile for the water in Columbia Lake at N1, S3, or S4 as the water is too shallow. Occasionally, there is a small temperature difference between the surface and the bottom water at the lake's deepest site (S1).

Depth Profile data for 2025 are shown in the Table on the next page.

- In 2025, we were unable to measure temperature and concentration of dissolved oxygen at 5 m depth because the maximum depth at S1 did not exceed 5.0 m.
- The largest difference between the surface temperature (0 m) and the deepest temperature (4 m) was 1.4°C. This was measured in late May. The second largest difference (0.9°C) was measured in late April.
- From mid-July to mid-August, there was no measurable difference in water temperature at the surface and at the bottom.
- The concentration of dissolved oxygen was greatest when the water temperature was lowest, in mid-April to late-May.
- The difference in concentration of dissolved oxygen between the surface of the water and the bottom was a small increase with depth in most cases (3.3-8.5%) and from mid-July to mid-August it was negligible.

Depth Profile for Water Temperature and Concentration of Dissolved Oxygen at S1

		Depth (m)	Water Temp (°C)	Temperature Decrease with Depth (°C)	Dissolved Oxygen (mg/L)	Increase in DO with Depth (mg/L)
Normalized Dates	Mid April	0	9.4		10.27	
Date	13 April, 2025	1	9.2		10.38	
Time (MDT)	12:45 PM	2	9.1		10.48	
Air Temp (°C)	9.5	3	9.1		10.49	
		4	9.1	0.3	10.51	0.24
Normalized Dates	Late April	0	13.1		9.2	
Date	28 April, 2025	1	12.4		9.77	
Time (MDT)	12:00 PM	2	12.3		9.87	
Air Temp (°C)	16	3	12.3		9.92	
		4	12.2	0.9	9.98	0.78
Normalized Dates	Late May	0	17.8		9.56	
Date	27 May, 2025	1	17.8		9.57	
Time (MDT)	5:43 PM	2	16.6		9.69	
Air Temp (°C)	23	3	16.4		9.82	
		4	16.4	1.4	9.88	0.32
Normalized Dates	Early June	0	19.4		8.6	
Date	9 June, 2025	1	19.4		8.69	
Time (MDT)	11:05 AM	2	19.3		8.7	
Air Temp (°C)	26	3	19.2		8.72	
		4	18.7	0.7	8.71	0.11
Normalized Dates	Late June	0	17.5		8.52	
Date	24 June, 2025	1	17.4		8.55	
Time (MDT)	10:00 AM	2	17.4		8.57	
Air Temp (°C)	16	3	17.3		8.6	
		4	17.3	0.2	8.6	0.08
Normalized Dates	Early July	0	20.3		8.95	
Date	1 July, 2025	1	20.2		8.95	
Time (MDT)	11:28 AM	2	19.8		9	
Air Temp (°C)	26.5	3	19.6		9.29	
		4	19.2	1.1	9.38	0.43
Normalized Dates	Mid July	0	20.5		8.25	
Date	15 July, 2025	1	20.5		8.26	
Time (MDT)	1:42 PM	2	20.5		8.25	
Air Temp (°C)	20	3	20.5		8.24	
		4	20.4	0.1	8.24	0.01
Normalized Dates	Late July	0	19.9		8.48	
Date	29 July, 2025	1	19.9		8.5	
Time (MDT)	10:25 AM	2	19.9		8.48	
Air Temp (°C)	20.5	3	19.9		8.48	
		4	19.9	0	8.49	0.01
Normalized Dates	Early August	0	22.1		8.34	
Date	4 August, 2025	1	22.2		8.38	
Time (MDT)	10:54 AM	2	22.1		8.42	
Air Temp (°C)	24.5	3	22.1		8.46	
		4	22	0.1	8.51	0.17
Normalized Dates	Mid August	0	21.8		8.36	
Date	12 August, 2025	1	21.8		8.36	
Time (MDT)	10:54 AM	2	21.8		8.36	
Air Temp (°C)	21.5	3	21.8		8.37	
		4	21.8	0	8.37	0.01
Normalized Dates	Late August	0	20.6		9.04	
Date	26 August, 2025	1	20.6		9.05	
Time (MDT)	10:27 AM	2	20.5		9.1	
Air Temp (°C)	22	3	20.5		9.16	
		4	20.3	0.3	9.4	0.36
Normalized Dates	Mid September	0	19.4		8.06	
Date	16 September, 2025	1	19.4		8.05	
Time (MDT)	12:45 PM	2	19.2		8.12	
Air Temp (°C)	19	3	19.2		8.22	
		4	19.1	0.3	7.89	

3.2 Dutch Creek, Hardie Creek, and Canal Flats Creek

The program conducted by CLSS on streams in 2025 is described in Section 2.2.2. Currently, CLSS monitors three streams:

Dutch Creek – an important seasonal source of fresh water for Columbia Lake, which enters Columbia Lake at its north end only during freshet;

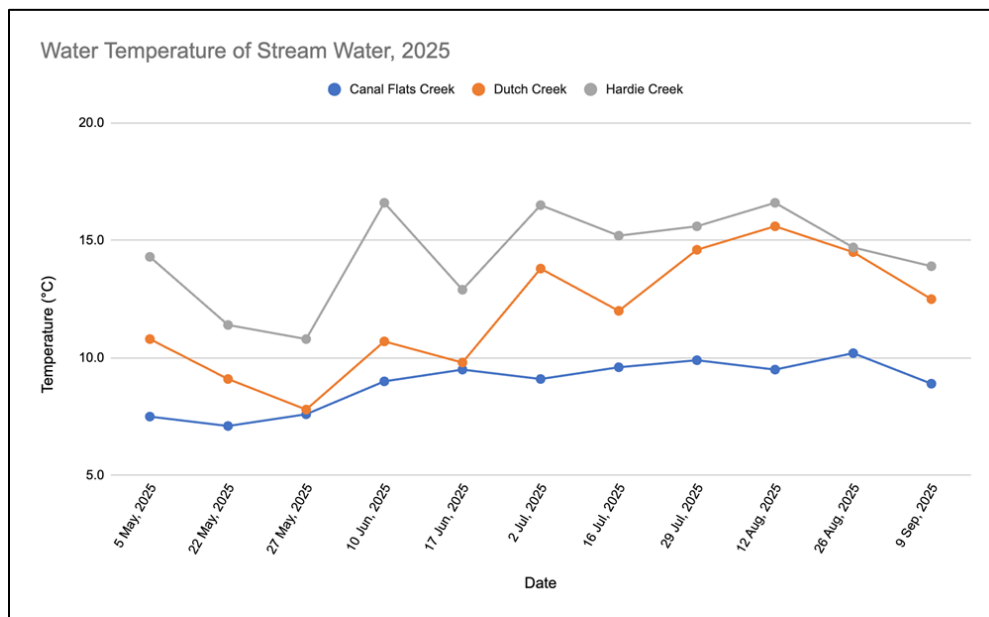
Hardie Creek – a small creek flowing year-round into the west side of the lake, passing near the Columbia Ridge and Spirits Reach communities; and

Canal Flats Creek – a creek which emerges year-round from aquifers under the village of Canal Flats, and which flows into the south end of Columbia Lake.

The water quality measurements made on each stream included: water temperature, specific conductance (conductivity), concentration of dissolved oxygen, pH, and turbidity. In addition, water samples were collected and concentrations of chloride and nitrate were determined by CARO (Kelowna).

CLSS extends thanks to the members of the Youth Climate Corps 2025 for their invaluable contribution to collecting and presenting the following data.

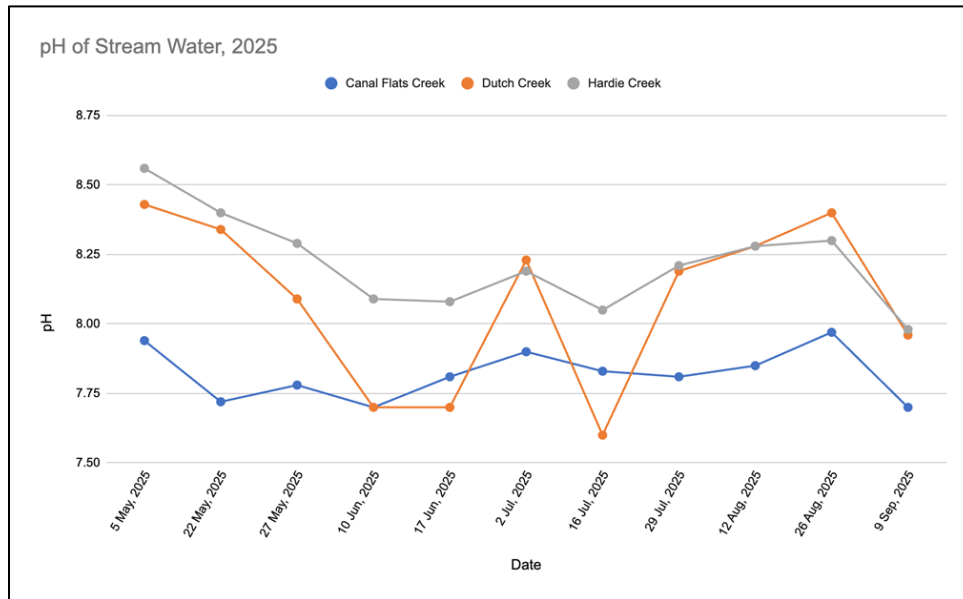
3.2.1 Stream Water Temperature



The temperatures plotted above show that the water temperature in the creeks generally increased over the summer months. The temperature of the water in Canal Flats creek was consistently lowest, peaking at only 10°C, whereas water temperature in both Dutch Creek and Hardie Creek peaked at >15°C.

This observation is in keeping with temperature changes in these creeks measured in previous years (See *Table: History of Stream Water Quality Measurements 2022-2024*). The low and consistent temperature measurements for Canal Flats creek are a consequence of its nearby emergence from aquifers under Canal Flats. The monitoring locations on the other streams are far downstream from their origins and thus the water has a long time to warm up as it runs over the ground.

3.2.2 pH of Stream Water



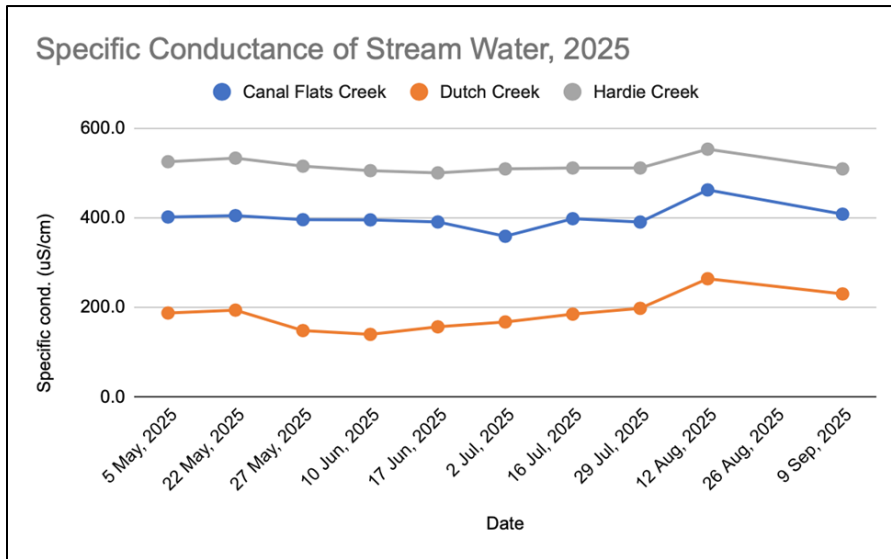
The pH of the stream water ranged from 7.6 to 8.6. The lowest pH values were measured in the Canal Flats creek and the highest pH values were measured in Hardie Creek. This observation is in keeping with the pH measured in these creeks in previous years (See *Table: History of Stream Water Quality Measurements 2022-2024*).

The pH values for Dutch Creek were somewhat variable in 2025. The values were also often closer to those for Hardie Creek than for Canal Flats Creek. In 2024 the range for Canal Flats Creek was 7.5-8.0, for Dutch Creek was 7.7-7.9, and for Hardie Creek was 8.2-8.4. Whether or not this apparent variation is 'real,' all of the pH values measured are within the range of pH for good water quality (Table 2).

Table: History of Stream Water Quality Measurements 2022-2024

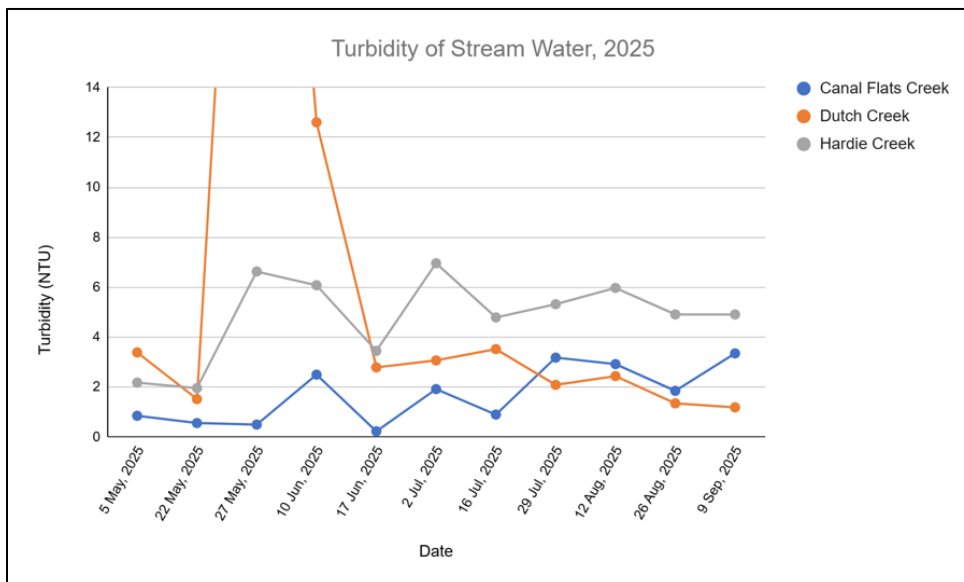
Stream	Date	Time	Water Temp (°C)	Specific Cond. (µS/cm)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
Canal Flats Creek 2022	10-May-22	11:31 AM	6.9	412.7	9.2	7.6	0.7
	22-Jun-22	9:47 AM	8.2	394.0	11.2	7.9	0.4
	12-Jul-22	12:23 PM	11.1	403.3	8.1	8.2	0.6
	17-Aug-22	1:05 PM	9.4	395.5	10.7	8.5	4.0
2023	15-May-23	1:20 PM	8.0	380.6	10.0	7.9	0.2
	29-May-23	12:26 PM	8.2	394.5	12.2	7.8	0.3
	15-Jun-23	9:45 AM	7.1	401.0	9.4	7.9	0.3
	27-Jun-23	9:19 AM	8.3	392.0	9.3	8.0	0.3
	25-Jul-23	11:10 AM	8.4	389.4	14.8	-	1.0
	14-Aug-23	7:55 AM	7.6	407.7	14.2	-	0.7
2024	14-May-24	11:33 AM	8.2	410.9	9.0	7.6	1.5
	29-May-24	10:00 AM	7.2	409.0	-	7.6	0.4
	10-Jun-24	10:06 AM	7.8	393.0	-	7.5	0.6
	10-Jul-24	10:04 AM	8.6	392.3	-	7.8	0.2
	30-Jul-24	1:40 PM	8.0	403.6	8.8	8.0	0.9
Dutch Creek 2022	10-May-22	1:56 PM	6.7	225.7	11.5	8.4	2.5
	10-May-22	1:56 PM	6.7	225.7	11.5	8.4	2.5
	22-Jun-22	11:55 AM	6.9	139.3	13.1	8.7	39.5
	12-Jul-22	10:15 AM	7.6	132.7	10.7	8.3	17.0
	17-Aug-22	10:57 AM	12.3	181.4	10.9	8.8	1.2
	2023	15-May-23	9:30 AM	5.5	134.5	11.5	8.0
29-May-23		7:39 AM	7.0	136.4	12	7.3	15.4
15-Jun-23		8:30 AM	7.5	150.1	10.3	7.8	8.1
27-Jun-23		8:00 AM	10.6	168.9	11.5	8.0	1.6
25-Jul-23		8:46 AM	12.9	201.0	14.2	-	3.0
14-Aug-23		2:12 PM	16.8	214.0	10.2	-	1.9
2024	14-May-24	9:45 AM	6.0	167.8	11.4	7.8	12.2
	29-May-24	8:15 AM	6.6	172.3	-	7.9	7.9
	10-Jun-24	8:30 AM	7.4	148.1	-	7.7	79.3**
	10-Jul-24	8:40 AM	10.5	145.0	-	7.9	8.9
	30-Jul-24	11:50 AM	11.8	200.2	9.9	7.9	1.6
Hardie Creek 2022	10-May-22	1:12 PM	7.9	507.0	13.2	8.5	1.7
	10-May-22	1:12 PM	7.9	507.0	13.2	8.5	1.7
	22-Jun-22	11:20 AM	11.1	507.0	12.5	8.5	1.7
	12-Jul-22	11:03 AM	10.5	492.0	11.7	8.3	4.4
	17-Aug-22	11:42 AM	11.3	474.0	10.6	8.7	2.6
2023	15-May-23	11:15 AM	9.8	503.0	12.8	8.5	1.4
	29-May-23	8:20 AM	9.9	546.0	9.6	8.4	1.4
	15-Jun-23	9:05 AM	10.1	600.0	11.3	8.5	3.3
	27-Jun-23	8:40 AM	11.1	531.0	11.1	8.5	1.4
	25-Jul-23	9:35 AM	12.3	503.0	15.2	-	3.2
	14-Aug-23	1:40 PM	13.4	479.0	9.0	-	2.2
2024	14-May-24	10:37 AM	10.2	497.0	-	8.3	6.7
	29-May-24	9:06 AM	8.7	537.0	-	8.4	4.3
	10-Jun-24	9:18 AM	9.8	502.0	-	8.2	6.2
	10-Jul-24	9:15 AM	11.6	400.9	-	8.4	4.2
	30-Jul-24	12:30 PM	12.3	489.9	9.6	8.3	5.2

3.2.3 Specific Conductance



The lowest values for the specific conductance were measured in Dutch Creek, the stream with the greatest flow rate of the three monitored. In contrast the water in Hardie Creek and the Canal Flats creek had specific conductance values (approx. 400-500 $\mu\text{S}/\text{cm}$) that were more than twice those in Dutch Creek, with Hardie Creek consistently having the greatest specific conductance. The specific conductance values in all three creeks were less than the Health Canada guideline (Table 1) of 700 $\mu\text{S}/\text{cm}$. These values for conductance are all consistent with those measured for the same streams in 2024.

3.2.4 Turbidity

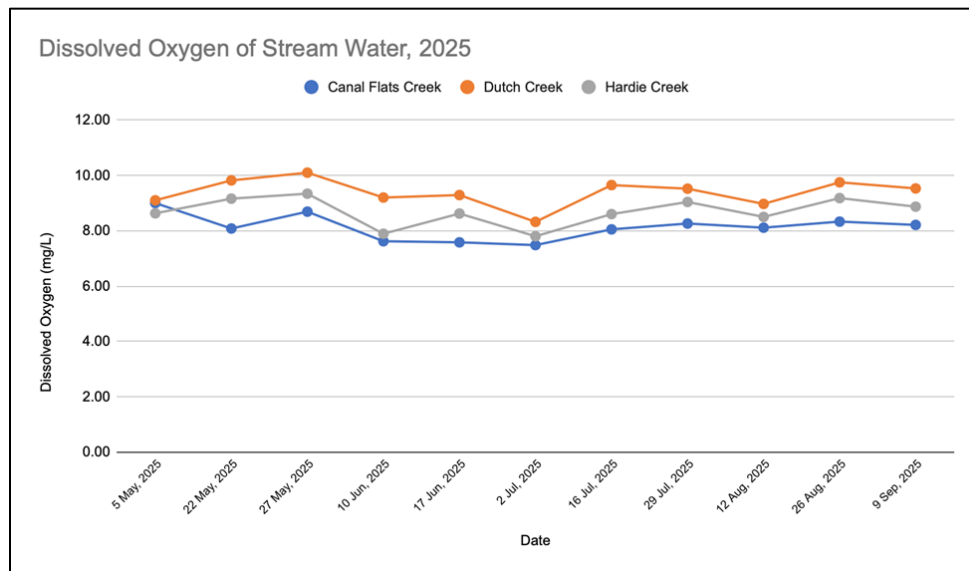


For 2025, the turbidity values measured on the creeks generally ranged between 0.23 and 7 NTUs. An unusually high value of 42 NTUs was measured on Dutch Creek in late May. This is in keeping with data collected in 2024 (see Table) when a value of 79 was recorded on Dutch Creek in late June. Extreme values for turbidity can be observed for streams during freshet, when they have very high flow rates. This value has been excluded from the graph above in order to display all other NTU values on a reasonable scale.

Dutch Creek showed the greatest turbidity from May to early June. This is likely a result of spring run-off, with high water volumes and fast flow rates disturbing sediments on the creek bed. Turbidity then decreased throughout the summer, as typical. After that, the turbidity of Hardie Creek was consistently greatest, between 4 and 6 NTUs, in keeping with measurements made in 2024 (see Table). Data from 2022 and 2023 suggest that the turbidity of water in Hardie Creek has increased somewhat (see Table). All turbidity measurements made on Dutch Creek and Hardie Creek in 2025 were greater than the value used by Health Canada for drinking water quality guidelines (1 NTU).

In 2024 (see Table) Canal Flats Creek had low turbidity (<1 NTU) likely related to its emergence from the aquifer under Canal Flats, which filters the water through sand and gravel. However, in 2025 all values measured for Canal Flats Creek after mid-July were >2.0. The causes of this remain to be explored.

2.3.5 Dissolved oxygen



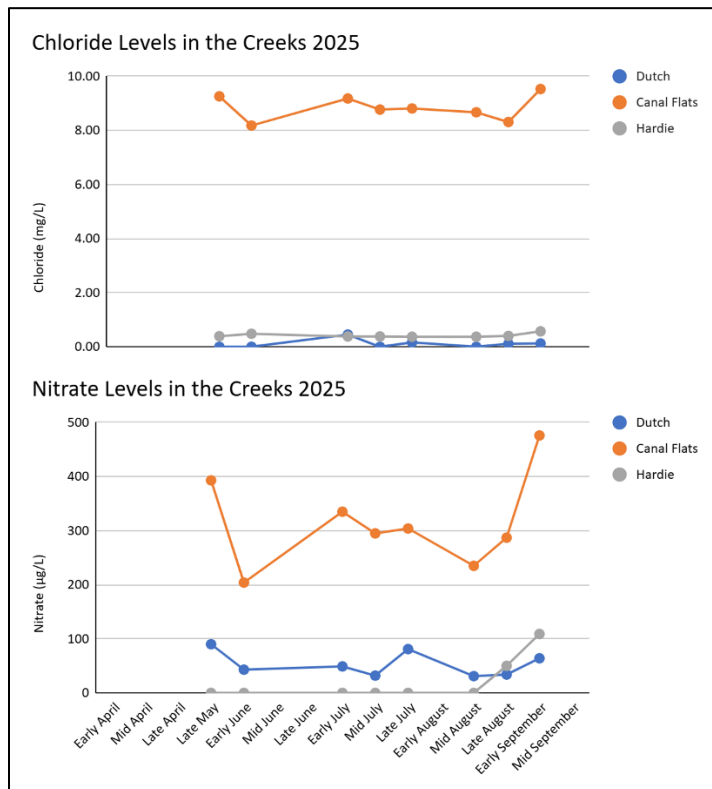
In 2025, dissolved oxygen ranged from 7.5 mg/L to 10.1 mg/L. The solubility of oxygen is affected by water temperature and also by turbulence, which mixes oxygen from the atmosphere into the water.

All values measured in 2025 are normal. The slightly lower concentrations noted in Canal Flats Creek likely reflect its slower flow rate and lack of turbulence compared with the other creeks.

2.3.6 Chloride and Nitrate

As shown above, chloride concentrations were negligible in Dutch Creek and Hardie Creek but were 20- to 90-times greater in Canal Flats Creek. This is in keeping with the relative concentrations of chloride measured on Columbia Lake which are greatest at the south end of the lake, where the Canal Flats Creek enters Columbia Lake.

While the concentrations of chloride are well below CDWQG standards for drinking water, our data suggests that they are increasing at the south end of the lake. This indicates a need for continued monitoring of chloride levels in both the lake and Canal Flats Creek.



Similarly, nitrate levels in Canal Flats Creek are up to 10-times greater than those in Hardie Creek and Dutch Creek. Nitrate levels in water samples from Columbia Lake are frequently below the minimum laboratory detection level, so CLSS is not currently testing the lake for nitrate.

Both chloride and nitrate levels in the creeks have remained consistent since 2019 (see Table: Range for Concentrations of Chloride and Nitrate in the Creeks 2019-2025, below).

Table: History for Concentrations of Chloride and Nitrate in the Creeks 2019-2025

CREEK	YEAR	CHLORIDE (mg/L)	NITRATE ($\mu\text{g/L}$)
CANAL FLATS	2025	8.18-9.53	204-476
	2024	9.58-9.82	271-365
	2023	9.2-10.5	370-456
	2022	9.75-10.5	253-432
	2021	8.45-9.01	294-306
	2020	8.22	346
	2019	9.68	240
DUTCH CREEK	2025	0.0-0.45	31-90
	2024	0.0-0.27	57-95
	2023	0.0-0.14	57-71
	2022	0.0-0.11	37-145
	2021	0	41-45
	2020	0	69
	2019	0.43	21
HARDIE CREEK	2025	0.37-0.57	0-109
	2024	0.37-0.52	26-36
	2023	0.37-0.64	25-56
	2022	0.34-0.48	23-140
	2021	0.31-0.40	18-35
	2020	0.56	23
	2019	0.45	11

3.3 The Columbia River

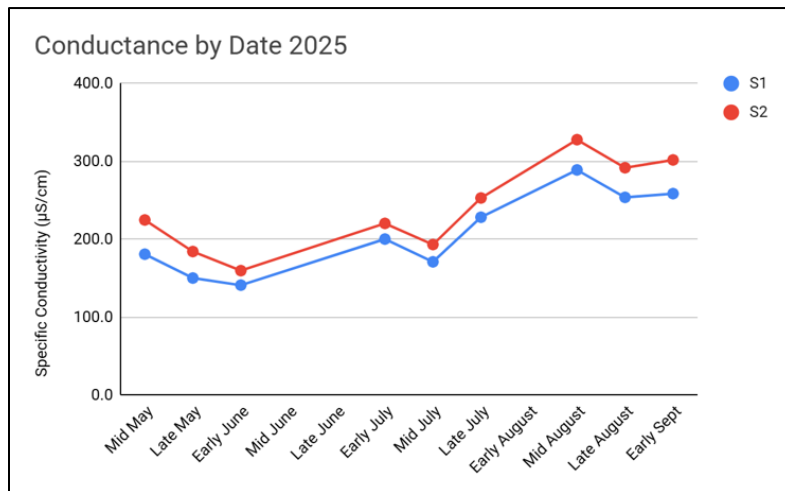
The testing program carried out on the Columbia River in 2025 is described in Section 2.2.3. Figure 1 shows the two locations (red stars) at which testing was carried out. Data collected in 2023 and 2024 are shown in the table below, for comparison.

Table: Water Quality Data for the Columbia River 2023 and 2024

			Water Temp (°C)	Specific Cond. (uS/cm)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
Upstream	Late May	2023					
	June		11.1	186.5	9.9	8.06	3.27
	Mid July		18.8	223.6	6.3		1.99
	Mid Aug		15.1	234.8	9.4		3.42
	Late Sept						
	Late May	2024	7.8	169.9		7.85	12.9
	June		9.4	147.9		7.72	91.13**
	Mid July		17.5	214.5		7.94	2.9
	Mid August						
Late Sept	13.5		248.3		7.79	3.44	
Downstream	Late May	2023					
	June		11.6	197	9.8	8.03	5.17
	Mid July		17.8	249.8	6.1		2.78
	Mid Aug		15.7	272.2	10.2		2.61
	Late Sept						
	Late May	2024	9	203.2		7.9	11.4
	June		10.2	170.2		7.69	102.1**
	Mid July		17.9	229.7		8.19	2.46
	Mid Aug						
Late Sept	13.1		303.2		7.69	3.79	

NOTE: Upstream=S1. Downstream=S2.

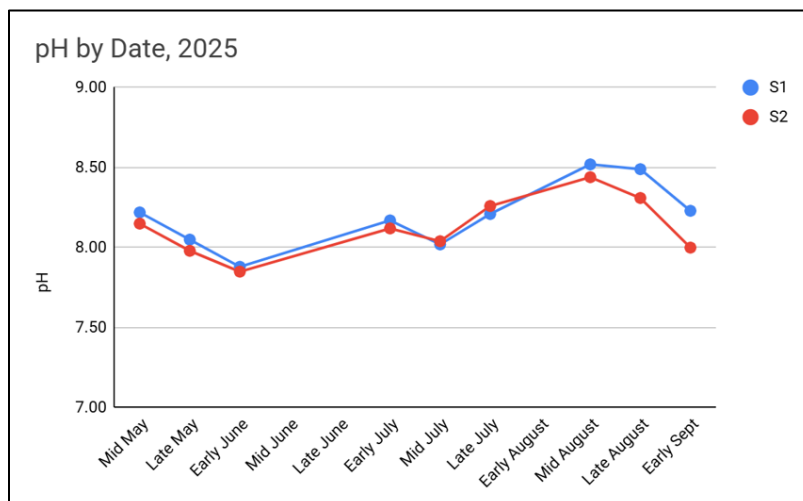
3.3.1 Specific Conductance



In 2025, specific conductivity was greater downstream (S2) than upstream (S1) at all times of the summer. This was also the case in 2023 and 2024. Whether or not the observed differences are substantive remains to be determined. Specific conductance is a measure of the dissolved salt content of the water. The upstream and downstream locations are above and below a golf course, which may impact the salt content of the water. In addition, this stretch of the river is used recreationally during the summer by thousands of people “floating” downstream and this may also have some impact.

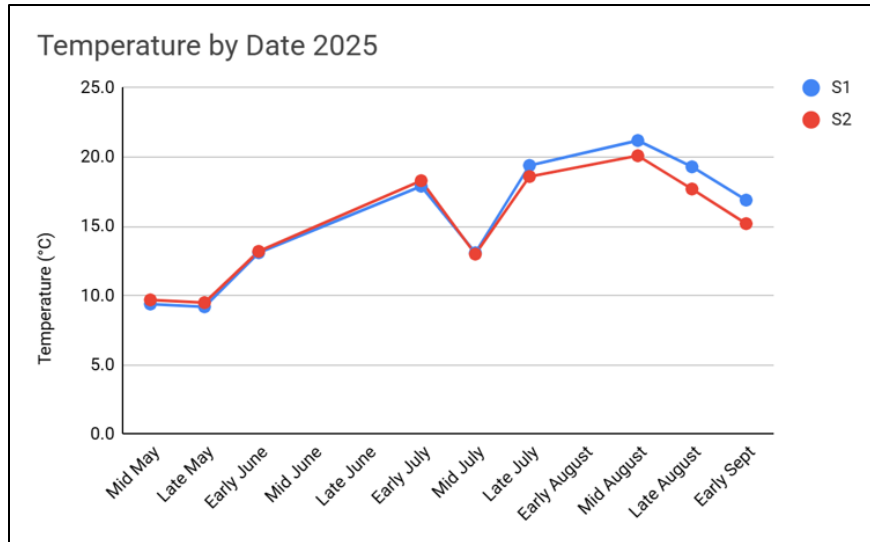
At both sites, specific conductance almost doubled over the summer (approx. 150 to 300 µS/cm). This was also the case in 2023 and 2024. This is likely to reflect the relative decrease over the summer in water volume contributed by Dutch Creek and the relative increase in water volume contributed by outflow from Columbia Lake. The specific conductance of the lake water at N1 is substantially greater than the specific conductance of water in Dutch Creek (approx. 300 vs. <200 µS/cm).

3.3.2 pH



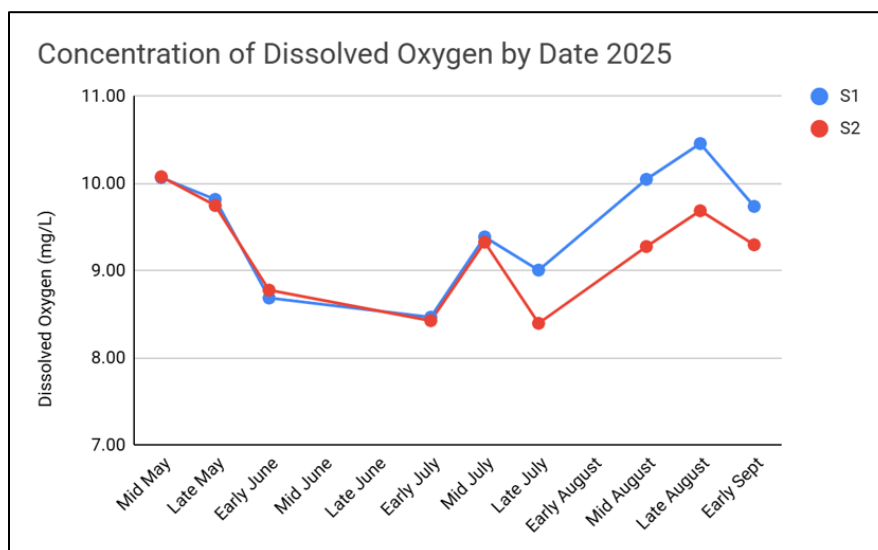
The pH of the water in the Columbia River was the same at both locations for most of the summer, except late August and early September. At this time, the pH of the water downstream (S2) was slightly lower. The pH of the water ranged from 7.8 to 8.5. This is similar to the range observed for water in Dutch Creek and Columbia Lake.

3.3.3 Temperature



The temperature of the water in the Columbia River ranged between approx. 10 and 20°C over the summer. The maximum temperature was somewhat greater than that observed in 2023 and 2024. This is likely related to a combination of factors such as weather and water volume.

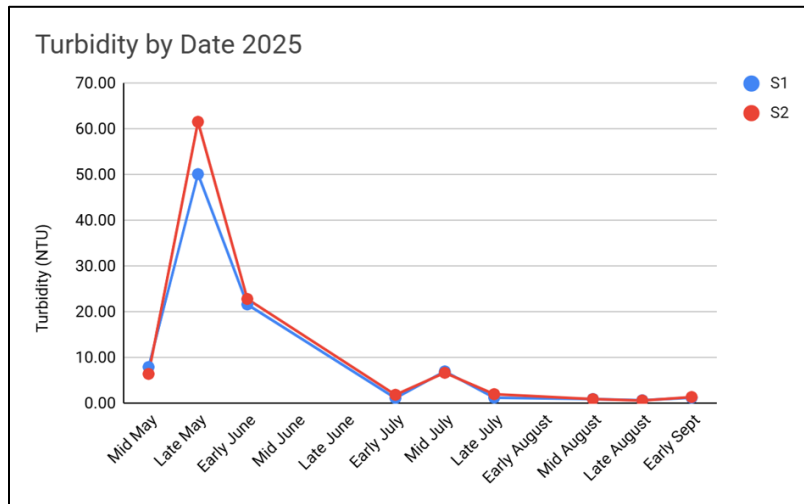
3.3.4 Dissolved Oxygen



The concentration of dissolved oxygen in the water was the same at both sites on the river during the first half of the summer, and it decreased from mid-May to early July as water temperatures increased. Interestingly, in mid-July there was a sudden drop in water temperature and this is matched by a spike in the concentration of dissolved oxygen (the solubility of oxygen is greater in colder water).

Concentrations of dissolved oxygen were slightly greater than those measured in Columbia Lake, and that is likely related to the turbulence of flowing water in the Columbia River.

3.3.5 Turbidity



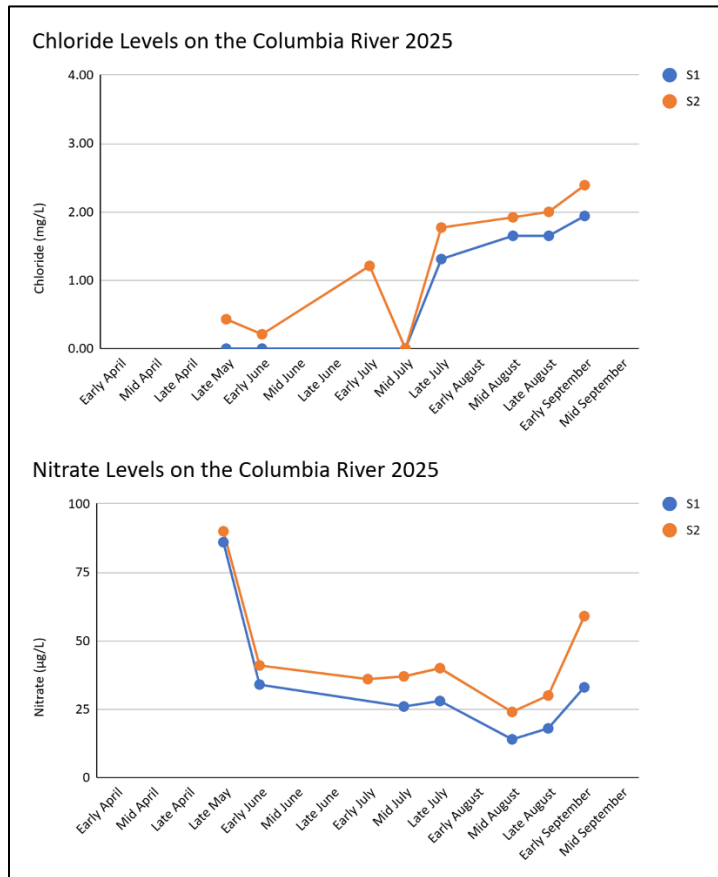
The turbidity of the river water is greatest in the Spring (late May in 2025), reaching its lowest level by late July and remaining at that level. This is typical for the Columbia River during freshet, which becomes extremely murky during high water flow. We also observed very high values for turbidity in Dutch Creek around the same time, and so these high values likely reflect the impact of the turbulent river flow and high-water levels disturbing the riverbed sediments.

The turbidity measured in late July to early September 2025 is shown below.

S1	Date	S2
1.31	Late July	2.09
1.03	Mid August	1.00
0.75	Late August	0.70
1.29	Early Sept	1.46

These values are lower than those found in 2024 and 2023, which were >2 and <4 NTUs.

3.3.6 Chloride and Nitrate



Both chloride and nitrate levels are somewhat greater downstream (S2) than upstream (S1).

Chloride levels seem to increase over the summer. This likely reflects the relative decrease in flow of water from Dutch Creek into the Columbia River and the relative increase in outflow of water from Columbia Lake. Chloride concentrations are more than 10-times greater in Columbia Lake, even at its north end, than they are in Dutch Creek (4-6 mg/L at N1 vs. 0.1-0.45 mg/L in Dutch Creek).

Nitrate levels are greatest in Spring and in the Fall. This may reflect the relatively low volume of water in the Columbia River prior to freshet and at the end of the summer.

4.0 Comparison of Columbia Lake to Nearby Lakes

In the 2024 Water Quality Report, we compared the measurements for the water quality indicator parameters measured in Columbia Lake with those of three nearby lakes: Lake Windermere, Premier Lake, and Whiteswan Lake. The comparison was based on data published by BCMOE (British Columbia Ministry of the Environment) on their website. BCMOE has been monitoring the water quality of these four lakes in the spring and late summer each year since 2016. BCMOE analyses the water samples they collect for an extensive list of parameters (including organic carbon, nutrients, and total and dissolved metals). In general, the values were comparable for all four lakes and all four lakes had excellent water quality.

We have not yet completed this comparison for 2024 and 2025.

Chloride

A notable difference between the lakes was that Columbia Lake has a much higher concentration of chloride than the other lakes. The concentration of chloride reported in Columbia Lake is often more than double that reported in the other lakes. In Premier Lake, the concentration of chloride is typically so low that it is close to the detection limit. Concentrations of chloride in Whiteswan Lake are quite steady, at approx. 3 mg/L, and in Lake Windermere the concentrations of chloride are greatest in Spring (close to levels in Whiteswan Lake) and generally decrease over the summer months.

Chloride is a salt and Columbia Lake has no natural source of salt in its drainage basin. Consequently, chloride can only come to the lake from man-made sources. The most common sources of chloride are wastewater disposal, and road salts used for de-icing and dust control. Although the chloride concentrations in Columbia Lake are much lower than the concentrations that would negatively affect the lake water as an aquatic habitat, wildlife drinking water, or human drinking water, and even recreational uses, the greater concentration in Columbia Lake suggests that lake water quality is affected by the use of the surrounding land. While the absolute levels of chloride are low compared with water quality standards for aquatic life, the levels are important to monitor because Columbia Lake has additional factors which can make aquatic life vulnerable, especially in combination, including relatively high pH and a high water temperature in the summer.

pH

The pH values measured on the four lakes are consistent and comparable. The average pH (2016-2023) in each lake was between 8.27 in Lake Windermere and 8.53 in Premier Lake. In 2025, the pH of Columbia Lake was in the range 8.1-8.5.

5.0 Program for 2026

CLSS has been monitoring water quality on Columbia Lake since 2014. We now have a substantial database of various water quality parameters. These data help us appreciate the current water quality conditions in the lake and give us information about specific parameters which may require some focus or more detailed exploration. Columbia Lake has had multiple substantial fish kills in living memory, most recently in 2024, and we want to explore conditions which might contribute to this.

The susceptibility of Columbia Lake to fish-kill events is likely related to its shallowness, which precludes a depth profile for decreasing temperature and increasing oxygen concentrations. This means that fish have literally nowhere to 'hide' when water temperatures rise and oxygen levels decrease. The shallowness also means that the soft bottom sediments are easily disturbed by wind and waves, and/or recreational use of the lake, and changes in turbidity of the water resulting from this disturbance can have a substantial negative impact of aquatic life. Other factors which may contribute to the vulnerability of Columbia Lake are the pH of the water which, while it is within 'acceptable' ranges, is close to the maximum levels considered tolerable to fish and other aquatic life. This is important because of the effect of pH as a toxicity modifying factor, such as that described for manganese in Section 2.3.1 Water Quality Standards.

In 2025, to explore possible variation in conditions experienced by aquatic organisms in Columbia Lake, we tried to increase the frequency of monitoring. (We monitored water quality on Columbia Lake almost biweekly from late April to mid-September.) We also included regular measurements of the concentration of total phosphorus, chlorophyll-a, and metals in the water column (manganese and arsenic) to explore possible causes of turbidity of the water. Our data show that levels of total phosphorus in Columbia Lake exceed the minimum for the mesotrophic range ($>10 \mu\text{g/L}$). This is important because growth of phytoplankton is enhanced by the availability of phosphorus, and the growth of phytoplankton is known to be a factor in oxygen-deprivation in water.

In 2026, CLSS will continue its regular measurement of various water quality parameters (dissolved oxygen, pH, temperature, conductivity, and turbidity) in Columbia Lake, in some of the streams entering the lake, and on the Columbia River. We will also continue monitoring chloride levels in the lake, and we will expand our exploration of concentrations of total phosphorus, chlorophyll-a, and of metals in the water column. We also plan to try to monitor water temperature and possibly oxygen concentrations more continually, because aquatic organisms are highly susceptible to rapid changes in water conditions and a two-week gap between measurements of these parameters does not tell us enough about acute changes that may occur in Columbia Lake, especially when the water is warmest.

As usual, we will continue to collaborate with other groups such as the BCMoE BC Lake Stewardship and Monitoring Program and Lake Windermere Ambassadors. Our intention is to ensure that our work on Columbia Lake in 2026 complements the work of others to ensure the best scientific outcomes possible for all.

