Summary of Columbia Lake Stewardship Society's 2024-25 Water Quantity Monitoring Program

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January 2026

Executive Summary

Since fall 2014, the Columbia Lake Stewardship Society (CLSS) has continuously operated its Water Quantity Monitoring Program. This initiative supports the Society's goal of protecting Columbia Lake's ecological health and water supply for current and future generations. The program aims to better understand what affects lake levels, with the intention of providing useful guidance to those responsible for managing the lake over time.

The 2045-25 season experienced minimal snow accumulation, resulting in the lake reaching near-record low levels despite unusually high temperatures in late May. Subsequent rainfall during late June, July, and August offset the reduced meltwater input and moderated the rate of decline, such that by the end of the season, the lake level was comparable to that of typical years.

All loggers operated satisfactorily though the shuttle, the device used to download data in the field, developed a timing error that erased data causing lengthy gaps in the records of some stations. The ongoing failure of the RX2103 automated station to yield correct measurements continued. The station was removed in October and disassembled for inspection. Water was found to have entered the waterproof case, and a means of repair has been taken up with the supplier.

Data from the rain gauge at Spur Lake was lost from May onward, also because of the timing error in the shuttle. In contrast, the record from the Canal Flats rain gauge was not affected and was complete.

1. Introduction

The Columbia Lake Stewardship Society's (CLSS) mission is "to preserve the ecological health and water supply of Columbia Lake for present and future generations …". This implies management and management in turn implies creating and implementing a plan to sustain the water resource. Components of most water resource management plans include the water source, water rights, development demands, water quality, policy, regulation, education and public awareness, conservation efforts, impact assessments, and, more recently, climate change. The CLSS is engaged in all these areas (see www.columbialakess.com for further details), but the focus of this document is on the source, sometimes more broadly known as water supply or water quantity.

The CLSS started water quantity monitoring activities in the Lake Columbia Watershed in the fall of 2014. This is the eleventh in a series of annual reports and summarizes activities conducted during the 2024-25 water year, extending from November 1, 2024, to October 31, 2025.

The amount of water in the lake at any given time is in balance with the water that enters and leaves the lake. The water held in storage serves many functions. It maintains the water quality at a healthy level, provides drinking water for residents, irrigates crops, and supports the local tourism industry. It also provides a habitat that sustains wildlife and aquatic species. The demands for water to meet such a variety of needs are growing and are in conflict. Understanding the balance and its change during the year is fundamental to resolving those demands.

The original intent of the Water Quantity program was to balance the water in the lake with the inflow and outflow, considering local contributions of surface runoff, precipitation, and groundwater to inflow and the counteracting losses due to evapotranspiration and consumptive use. The results would serve as guidance to those charged with managing the lake.

Once underway, the monitoring revealed that Columbia Lake does not lie in a confined watershed but is subject to inflow from the adjacent Dutch Creek. This meant that attempts to establish a water balance had to be reevaluated.

2. The Watershed

The only long-term source of local water flow information is the Water Survey of Canada (WSC) hydrometric station on the Columbia River at the Highway 93/95 crossing near Fairmont Hot Springs. The Columbia Lake Management Strategy (RDEK, 1997) cites the drainage area upstream of that station to be 881 square kilometres and to consist mainly of two separate basins, the 696 square kilometre Dutch Creek sub-basin and the 171 square kilometre Columbia Lake sub-basin. A series of small creeks made up the remaining 9 square kilometres.

The description is not completely accurate. During the spring runoff, water from Dutch Creek flows into Columbia Lake, causing the lake to rise and expand beyond its normal shoreline, mainly northward over part of the Dutch Creek delta. During that period, the two major sub-basins are inseparable, and Columbia Lake is, in effect, a reservoir holding excess water flowing out of Dutch Creek until it can be dispersed downstream in the Columbia River. That inflow is not likely confined to the runoff period. Field observations have shown that a small amount of seepage exists at other times of the year. Thus, instead of two sub-basins, for investigative purposes, the area above the WSC station must be treated as one large watershed.

Figure 1 – Map showing station locations. The integrated watershed boundary is shown in the inset. Site abbreviations are provided in Section 4.1.

The situation is made more complicated by the braided configuration of channels on the delta. That configuration has undergone and is continuing to undergo change as some channels became blocked with deposited material and new ones form. In the present channel configuration, and when flow rates are low and unimpeded, the main channel flows directly across the delta to enter the Columbia River, a few tens of metres below the lake outlet. Aerial photos and satellite images show that the channel has been stable since at least 1975. However, it is known that in earlier years, the channel directly entered the lake near the Columere Marina. (see Jamieson, 2011).

At the present-day junction with the Columbia River, the level of Dutch Creek is only a few tens of centimetres below lake level. Only a slight increase in the level of Dutch Creek creates a hydraulic head that accounts for the flow into the lake.

3. Antecedent and Concurrent Conditions

There are no weather stations within the entire watershed having a continuous long-term record. The closest is the Cranbrook Weather Station (Cranbrook A), located at the Cranbrook - Kimberley Airport, some 60 km south of Canal Flats.

The mean monthly temperatures at that location for the 2024-25 water year are shown in Figure 2. The corresponding long-term normal values based on records accumulated over the 30-year period 1981-2010 are superimposed for comparison. Of significance is the reversal of temperature during March, following a very cold January and February.

Precipitation-wise, the overall summer rainfall accumulation turned out to be near normal, but the rain was not uniformly distributed. Figure 3 shows that the spring started dry and remained so into June, raising concerns about drought. Rain returned in late June, but it was not until mid-July that accumulated amounts reached normal values.

As for snow, 2024-25 was a low-yield snow season. Snow depths recorded at the Little Dragon avalanche monitoring station (elevation 2250 m) operated by the BC Ministry of Transport and Infrastructure's Avalanche and Weather Program (see Appendix B for location) are shown with those of the previous seven seasons in Figure 4. Snow depths were abnormally low from the beginning of the season until January and then fell below all previously recorded values. Melt got underway a bit earlier than usual in mid-April and proceeded quickly until interrupted by a brief period of cold weather and new snow near mid-May.

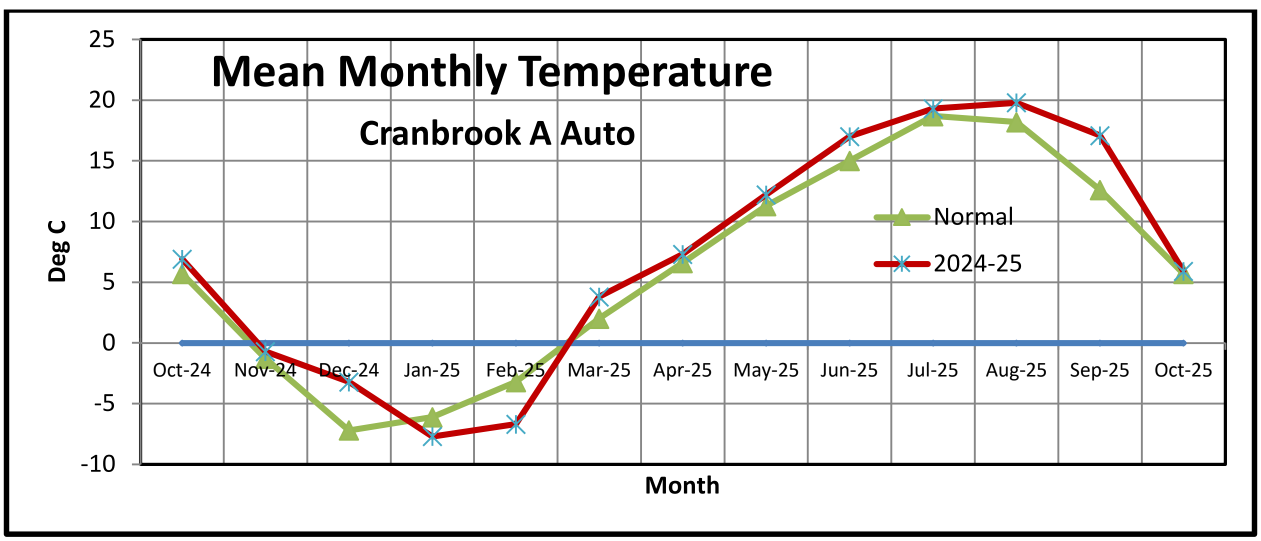

Figure 2 – Mean monthly temperatures at the Cranbrook- Kimberley Airport during the 2024-25 water year and the corresponding 1981-2010 long-term normal values.

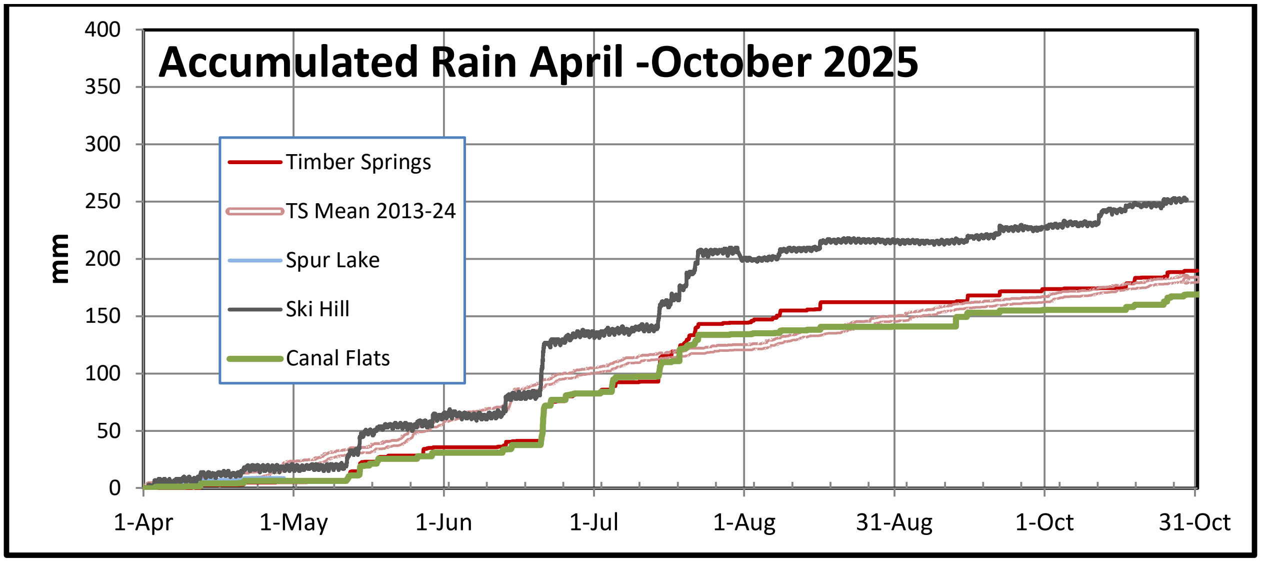

Figure 3 – Accumulated precipitation measured at Timber Springs (elevation 850 m asl), Fairmont Ski Hill (1480) and Canal Flats (820) during 2025. The Spur Lake station (1175) is also shown but stopped operating in late April. The thirteen-year mean for Timber Springs is superimposed.

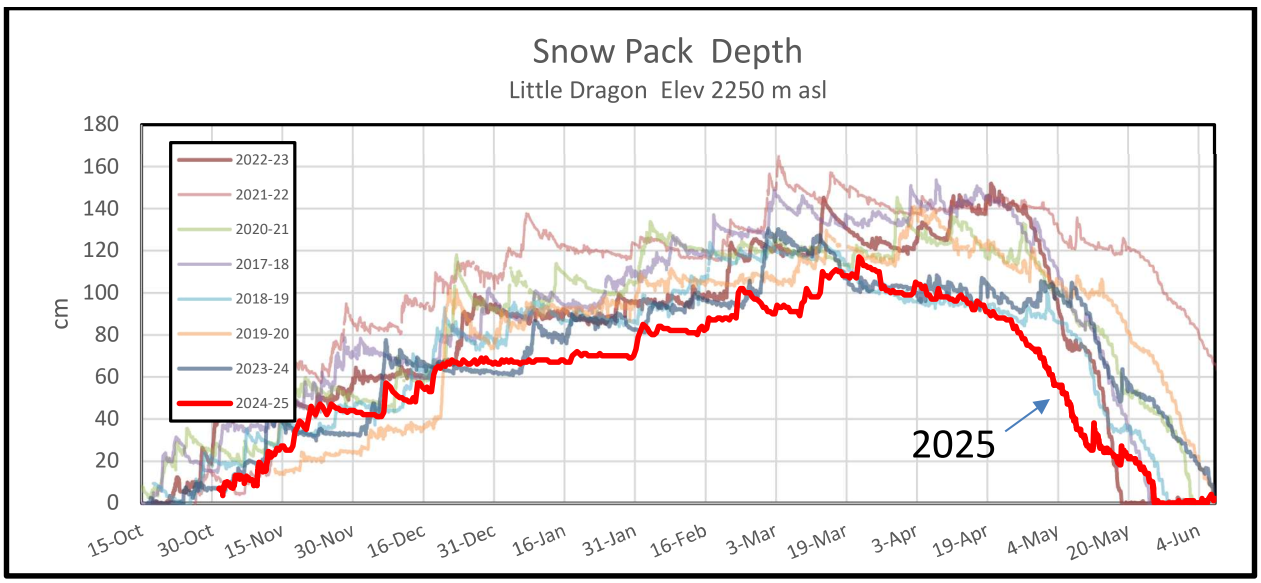

Figure 4 – Snow Depths recorded at the Ministry of Transportation and Infrastructure's Little Dragon Snow weather station located near Panorama during the 2024-25 and preceding seven seasons.

4. 2024-25 Activities

4.1. Stations

The water level monitoring stations in operation were: Columere Marina (COL), Columbia River near Fairmont Hot Springs (WSC), Dutch Creek at the Highway 93/95 Bridge (DC), and at the lake outlet (Outlet). The locations are shown in Figure 1. DC only operated during the open water season. COL recorded the lake level. Backup sensors were installed at the COL, WSC, and Outlet sites, although not all were operational for the entire year. The HOBO RX2103 automated station installed in Columere Marina in 2023 remained in operation but only measured atmospheric pressure accurately. The water level logger rendered incorrect values for reasons noted below. The atmospheric pressure served as the pressure standard against which all loggers in the network were evaluated.

No flow measurements were made.

The Timber Springs weather station remained in operation and recorded wind speed and direction, temperature, relative humidity, and precipitation at hourly intervals.

The Canal Flats tipping bucket rain gauge operated throughout the year. Data from the Spur Lake HOBO tipping bucket collected after late April was destroyed by the shuttle during a download attempt on September 7. Data collected after September 7 could not be retrieved owing to a lack of access to the site.

Three independently operated stations contributed valuable information. The Little Dragon avalanche monitoring station (elevation 2250 m), operated by the BC Ministry of Transport and Infrastructure's Avalanche and Weather Program (see Appendix B for location), provided snow depths. The weather station located on the Ski Hill at Fairmont Resort provided snow water equivalent, temperature, and precipitation data, and the weather station located on the Fairmont Hot Springs Airport provided altimeter settings that, when converted, provided the atmospheric pressure required to verify logger accuracy. The Airport station underwent an upgrade during mid-season and was out of service from early spring until late November 2025. Pressure information is only required periodically, and the lack of data during that period did not significantly affect the Water Quantity operations.

A "shuttle" is used to read out the stored logger information during periodic field visits and transfer it to a temporary onboard memory bank. The data stored in the bank is downloaded to a host computer upon return to the office. A recurring timing issue arose that caused the shuttle to erase stored data. The erased data could not be recovered. In some instances, it was possible to reconstruct missing data from the records recorded by backup or nearby loggers. However, extended periods of missing data do exist, most notably from DC.

4.2 Equipment Purchases

Two HOBO water level loggers were sent to a local distributor for battery replacement. One (H326) exhibited a significant bias on return but was otherwise operational. The second (H325) stopped recording before the season ended.

A replacement shuttle was purchased late in the season.

4.3. Data Collection and Management Issues

There were two significant instrumentation issues during the year.

One was the failure of the RX2103 water level logger to record data accurately. The RX2103 is a self-monitoring water level station containing two sensors, one submerged to measure total pressure and a second to measure atmospheric pressure. The difference between the two reflects the water depth. The station was purchased in 2023 because it could be adapted for remote monitoring and thereby minimize the number of field trips required to download data and ensure equipment operation. It was intended as a replacement for the existing COL station. The station was removed in October 2025, and a detailed examination was conducted. Water was found to have penetrated the waterproof logger case and is believed to be the cause of the malfunction. Enquiries to the supplier were made, but a response had not yet been received at season's end. The planned transition of this station as the primary Columere Marina station remains on hold, and the original COL continues as the primary station. There was no issue with the barometric pressure sensor.

The second was with the shuttle. The shuttle is used in the field to download data from the loggers. It developed a timing issue that caused it destroy data stored on the loggers during some downloads. In some instances, data could be reconstructed from backup or nearby loggers, but not all. The most significant losses were at Outlet from April 26 to June 2 and from September 12 to October 31, and at Dutch Creek from April 26 to May 15. Another casualty was the tipping bucket rain gauge at Spur Lake. Its data was erased during data retrieval in September.

The batteries in the RX2103 station died on October 26, 2025, and were not replaced until November 2, just prior to the beginning of the fall calibration. Atmospheric data for the missing period were reconstructed by regression on out of service logger H326 stored nearby.

The performance of the loggers is evaluated twice a year, with offsets recalculated as detailed in Appendix A.

5. Water Temperature and Level

5.3. Winter 2024-25

The winter water temperatures recorded at four stations, COL, WSC, DC, and Outlet, are shown in Figure 5. The DC logger is not operated in winter due to the threat of ice damage and was not reinstalled until late March. Outlet was also not placed in operation until after the spring calibration. The mean daily air temperatures recorded at Timber Springs are superimposed for comparison and show the first period of subzero weather beginning in late November. Outbreaks of much colder air followed in late January and early February.

The water levels recorded at COL and WSC are shown in Figure 6. A sudden drop in water level at WSC and a corresponding rise in lake level coinciding with the November subzero air temperatures are suggestive of an ice jam upstream on the Columbia River blocking flow on the river and diverting water into the lake. There were no eyewitness accounts to verify.

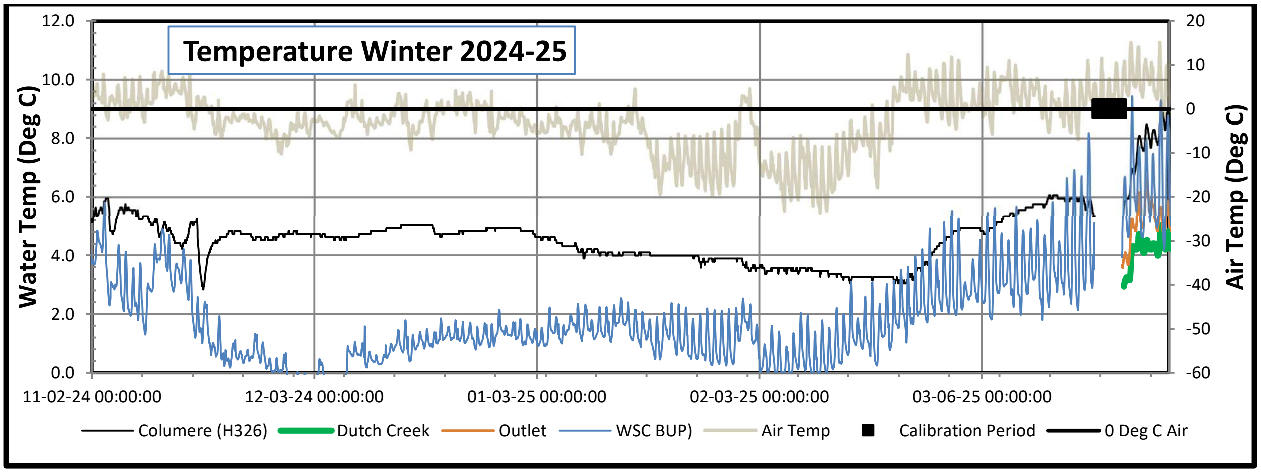

Figure 5 – Winter water temperatures. Air temperatures recorded at Timber Springs are superimposed.

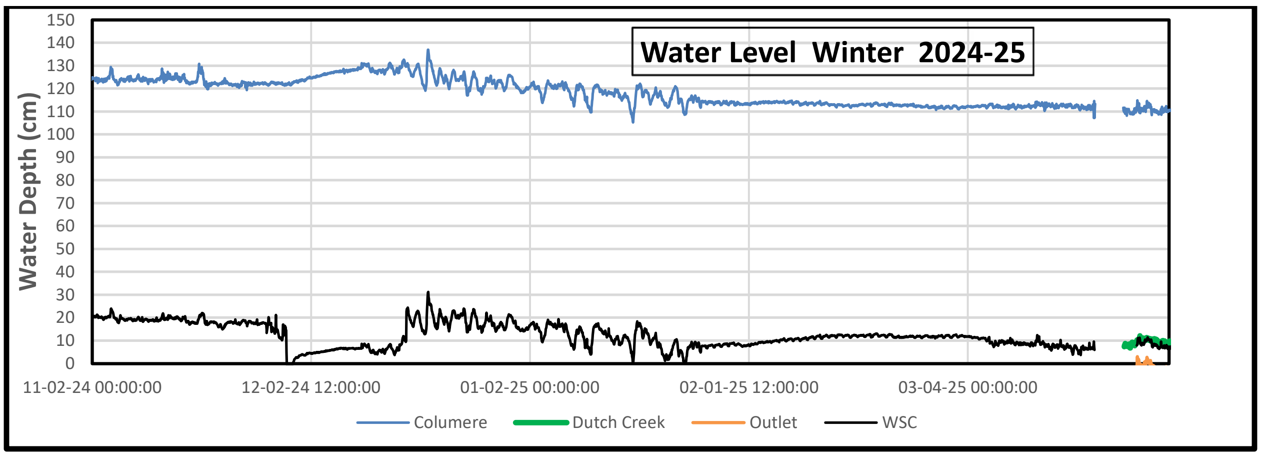

Figure 6 – Winter water depths recorded by loggers.

5.2 Open Water Season 2025

5.2.1 Water Temperature

The water temperatures recorded during the open water season at the COL, WSC, Dutch Creek, and Outlet stations are shown in Figure 7. Despite the large gaps in the record, the direction of flow in the lake outlet channel during much of the runoff period can be inferred from the Outlet water temperatures. Temperatures like those of Dutch Creek indicate inflow to the lake; those like COL indicate outflow. June 7-14 was a period of inflow. Two brief inflow periods occurred in July. They coincided in time with significant rainfall events (see Figure 8) and seem likely to have been triggered by high flows in Dutch Creek.

Air temperatures recorded at Timber Springs are also shown for reference.

5.2.2 Water Level

The recorded water levels at the DC, Outlet, WSC, and COL stations are shown in Figure 8. The levels represent the depth of water above a local reference and are not related to any known elevation standard.

The levels in the streams rose and fell in unison with the melt rates (see Figure 4) and eventually peaked on May 30. The rise in lake level was slower to take place but continued beyond May 30, owing to an imbalance created by more water entering the delta than leaving. After the lake crested on June 15, drawdown commenced, and the level decreased accordingly until it was interrupted by rain events near July 14 and August 16 that increased inflow and slowed the decline.

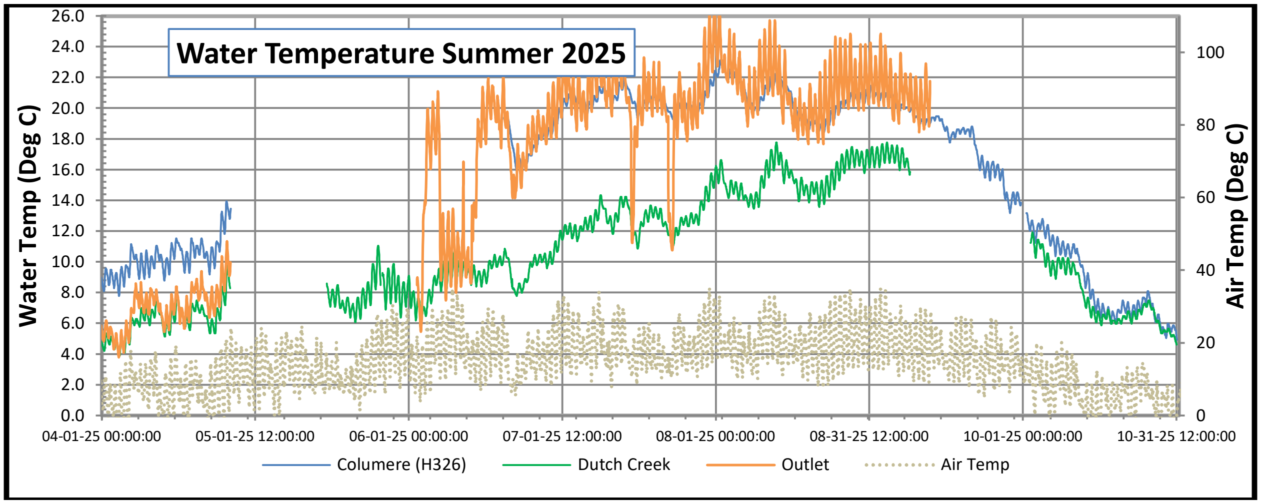

Figure 7 – 2024 water temperatures. Gaps in the record were due to a malfunctioning download device. Note the major fluctuations in the Outlet water temperatures during June and July. When temperatures were like those of Dutch Creek, water was flowing into the lake.

5.2.3 Comparison with Previous Seasons

Figure 9 compares the lake water levels during the summer of 2025 with those of previous summers. The time of the crest fell within the range of those previously experienced, but the level of the crest was well below the norm. It is worthy of note that the infusion of water following the July 14 and August 16 rain events compensated for the lack of inflow from snowmelt and added sufficient volume to bring the water level back to near normal at season's end.

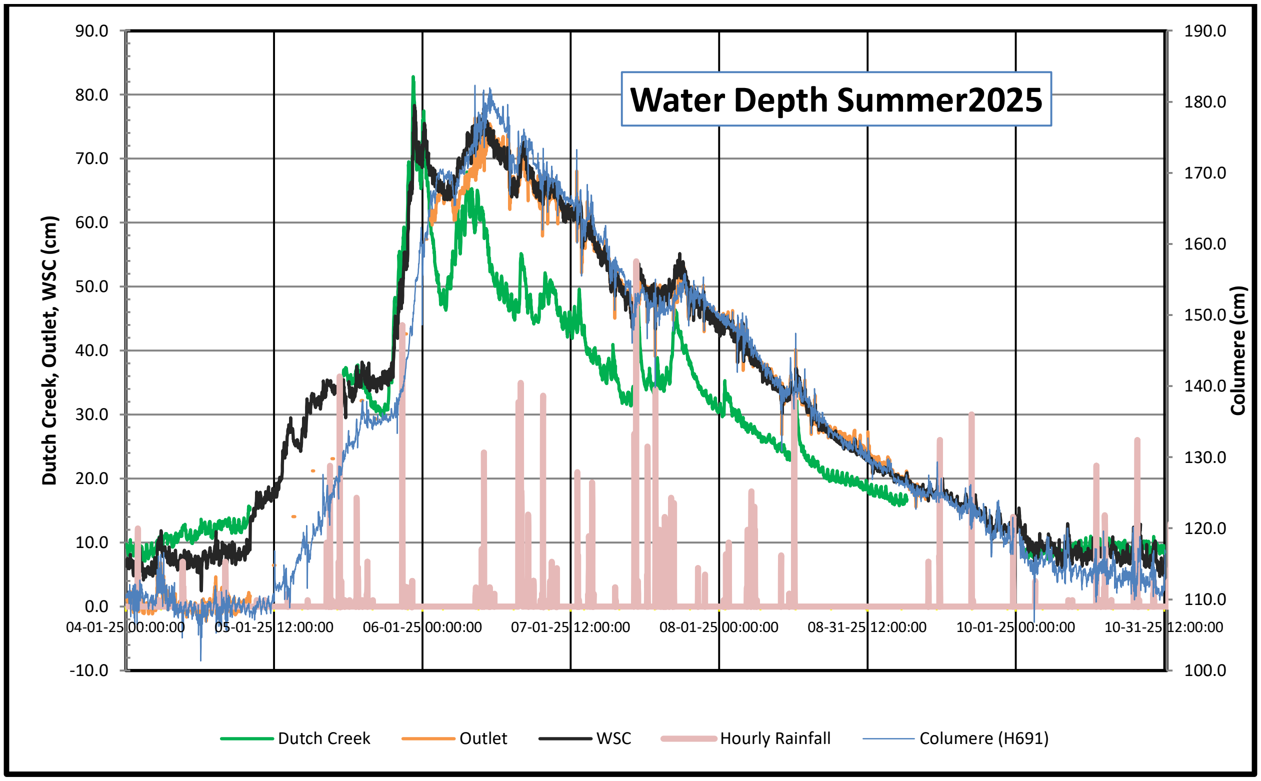

Figure 8 – Hourly water depths in centimetres. Depths are as recorded by loggers and do not relate to a common reference level. The Outlet water levels shown during May were manually recorded from the onsite staff gauge. Hourly rainfall amounts are also shown and are in tenths of millimetres.

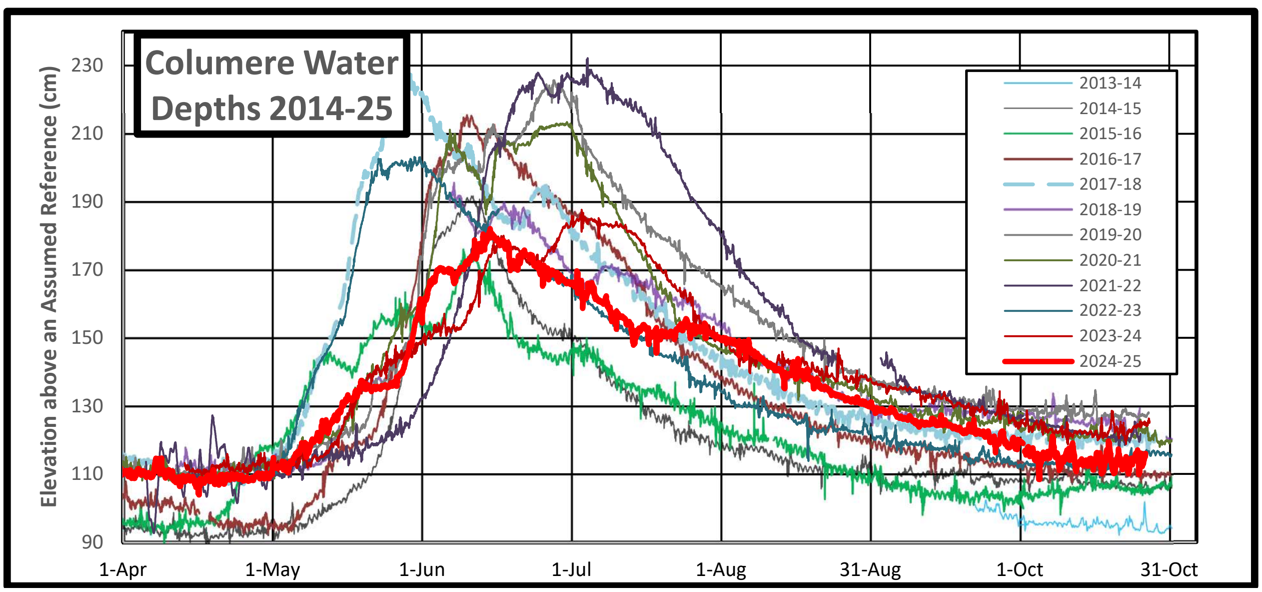

Figure 9 – 2025 Columbia Lake water levels compared with water levels recorded during the 2014 to 2024 open water seasons.

6. Local Water Exchanges

6.1 Rating Curves

No flow measurements were made during the year.

6.2 Water Balance

No progress was made in improving estimates of the lake water balance owing to the inability to calculate the volume of water held in storage in the lake during the flood period

7. Discussion

Calculating the water balance is an accounting process in which volume is measured at various points as water passes downstream through a watershed. For the CLSS, the water level in Columbia Lake is the final measuring point in that trajectory, and the foregoing has demonstrated that the contribution from Dutch Creek is significant. However, it is not possible to calculate the contribution with the information currently available. Two options exist. One is to assume that the excess between the water entering the delta via Dutch Creek and that leaving via the Columbia River enters the lake. This option requires flow measurements on Dutch Creek, which currently do not exist. The second is to calculate changes in lake volume from lake depth and surface area. However, the only source of depth and area information is The Columbia Lake Management Strategy (RDEK, 1997), and that information applies only when the lake is at low level; it does not apply when the lake rises above its low-level shoreline. A surface area – depth relationship is required. Neither option is simple to implement.

No advancements were made in the water balance calculations during the current year. However, findings from this and previous year's monitoring programs have begun to elucidate several factors that influence lake behavior. The volume of water retained in the high-mountain snowpack is a primary determinant of the seasonal outflow from Dutch Creek. Additionally, the timing of warm air periods and rainfall events significantly impacts both the timing and magnitude of crests, as well as the subsequent rate of decline in lake levels. These dynamics are illustrated in Figures 7 and 8 above.

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9. Acknowledgements

Thanks to Rachel Milner for invaluable assistance in maintaining stations and collecting data.

Data used to compile this document came from a variety of sources. In addition, several organizations, communities, and individuals made valuable contributions. The input of the following is gratefully acknowledged:

Avalanche Canada
BC Ministry of Transport and Infrastructure
BC Hydro
Environment and Climate Change Canada
Columbia Valley Airport Society
Columbia Valley Local Conservation Fund
Regional District of East Kootenay
Lake Windermere Ambassadors
Living Lakes Canada
Columere Marina
Fairmont Hot Springs Resort Ltd.
Panorama Mountain Resort
Village of Canal Flats
Columbia Ridge Community Association
Columere Park Community Association
Spirits Reach Strata
BC Lake Stewardship Society
Nature Conservancy of Canada
Fairmont Creek Debris Flow Mitigation Project
All donors whose contributions made the purchase of monitoring equipment possible.

Appendix A

Appendix A - Accuracy of Measurements

The integrity of an analysis depends on accurate measurements. The following describes the steps taken to evaluate equipment performance and minimize errors.

A1 -Water Level

Water information is collected using data loggers. The loggers measure pressure and temperature and record them in internal memory. The loggers are programmed to record every hour on the hour. Loggers from two different manufacturers, Van Essen (Diver) and Onset (HOBO), are in use.

All loggers are non-vented. This means that the sensor measures the pressure exerted by the column of water above the logger, including that of the atmosphere. The atmospheric pressure must be removed to obtain the pressure exerted by the water alone. Once removed, the water depth can be calculated from the water pressure (a water density of one was assumed). Atmospheric pressure is measured using a separate logger mounted at lake level. Most stations are located at lake level (808.5 metres asl), so an elevation adjustment is not required. An exception is the Dutch Creek station, which is twenty-four metres above lake level. Two cm of water pressure was added to the recorded pressure to bring it into alignment.

The atmospheric pressure standard was the barometer contained in the HOBOlink RX2103 water level station mounted in the Columere Marina. Its accuracy was periodically verified against the barometer located on the nearby Fairmont Hot Springs Airport (CYCZ) used to broadcast altimeter settings to incoming and outgoing aircraft. Close agreement exists, as shown in Figure A1.

All loggers are taken out of service twice during the year, once at the beginning and again at the end of the open water season, and collocated on a test bench located at an elevation of 40 metres above lake level. Their comparison generally lasts from 2 to 4 days. The pressures recorded during the Fall, 2024, and Spring and Fall 2025 comparisons are shown in Figures A2, A4 and A6, respectively. The pressure sensors are subject to drift, so an offset adjustment is often required. The mean offsets from the RX2103 barometer were calculated and are shown in Table A1. The offsets were applied to data collected during the six months following the comparison tests.

No correction was made for the effects of temperature on water density or on logger performance.

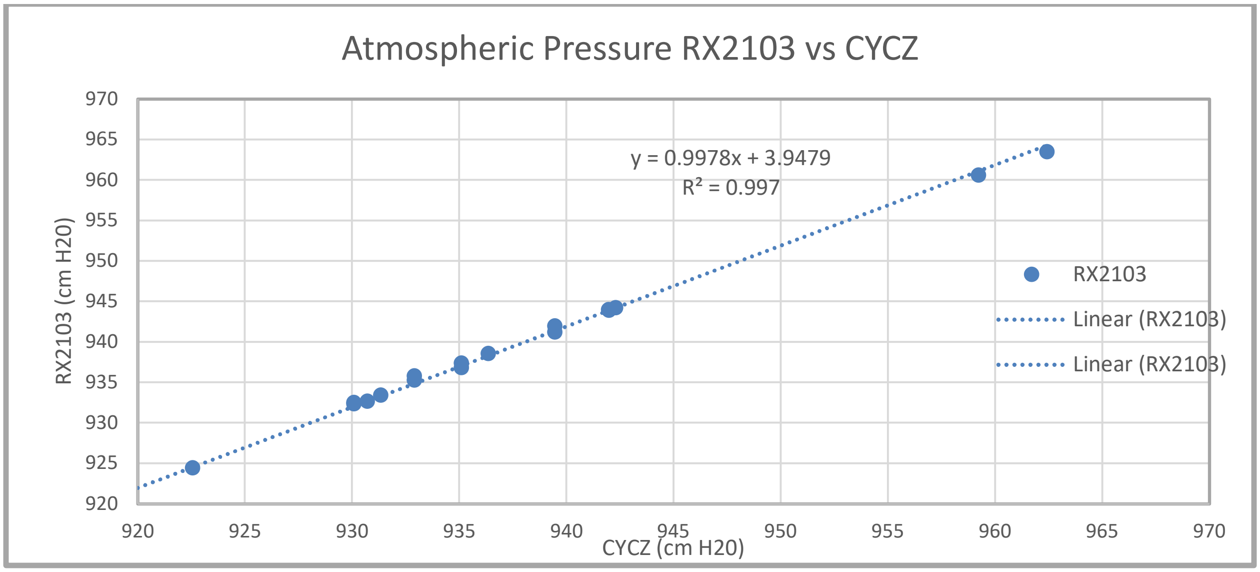


Figure A1 – XY plot showing the relationship between atmospheric pressures recorded by the RX2103 station and the barometer at the Fairmont Hot Springs Airport during December 2025. The line of best fit is superimposed.

A2- Water Temperature

Beginning and end-of-season comparisons of the temperature sensors were made in a similar fashion. The records are displayed in Figures A3, A5, and A7, respectively.

In general, the loggers measure temperature accurately, but they are sensitive to solar radiation. The exposure of the loggers to sunlight on the test bench was not well controlled, so occasional spikes appeared in the records. Otherwise, good agreement is shown.

The loggers are mounted in stilling wells, but the wells do not completely block out solar radiation, and diurnal temperature changes are not uncommon.

A3- Other

Other steps were taken to ensure the integrity of the data. Manual measurements of water level were made at each location periodically during the season to verify the accuracy of the recorded pressure measurements. The stilling wells and intake pipes at each of the stream sites were back flushed twice per year, once before and again after the freshet.

Table A1 – Measured Offsets during comparison trials

Oct - 24			Apr-25			Oct -25		
Logger	**cm H2O**	**Diff fm RX2103**	**Logger**	**cm H2O**	**Diff fm H012**	**Logger**	**cm H2O**	**Diff from RX2103**
RX2103A	932.8	0.0	RX2103	939.3	5.1	RX2103A	936.1	0
AV083	N/A		AV083	933.9	-0.3	AV083	935.4	-0.7
H012	931.8	-1.0	H012	934.2	0	H012	935.5	-0.6
H013	933.8	1.0	H013	936.3	2.1	H013	937.4	1.3
H325	933.2	-1.7	H325		N/A	H325	U/S	N/A
H326	926.5	-7.9	H326	927.5	-6.7	H326	928.6	-7.5
H109	932.8	0	H109		N/A	H109	938.0	1.9
H691	933.5	0.7	H691	935.7	1.5	H691	938.0	1.9
RX2103 W	985.6	52.8						

[1] APR-25 – RX2103 and H109 were not removed from respective stations and, therefore not representative. H012 used as reference

Table A2– Logger Deployment 2024-2025 Water Year

H325 - Out of service Nov 1, 2024, to May 26. U/S after May 26
H326 - Out of service various locations. DC Oct 1 to Oct 31, 2025
H013 - Out of service at various locations. Dutch Creek Mar 22 to Oct 1
H012 - WSC Nov 1, 2024- Oct 25, 2025
H109 - Out of service at various locations. Outlet Mar 24 to Oct 31 except for several interruptions due shuttle failure.
H691 - Columere Nov 1, 2024, to Oct 31, 2025
RX2103 - Columere Marina Nov 1, 2024, to Oct 31, 25. Water component U/S throughout period.
AV083 - WSC backup Nov 1, 24 to Oct 31, 25
1601 - (AKA BARO) - spare, not in service. Temperature only.

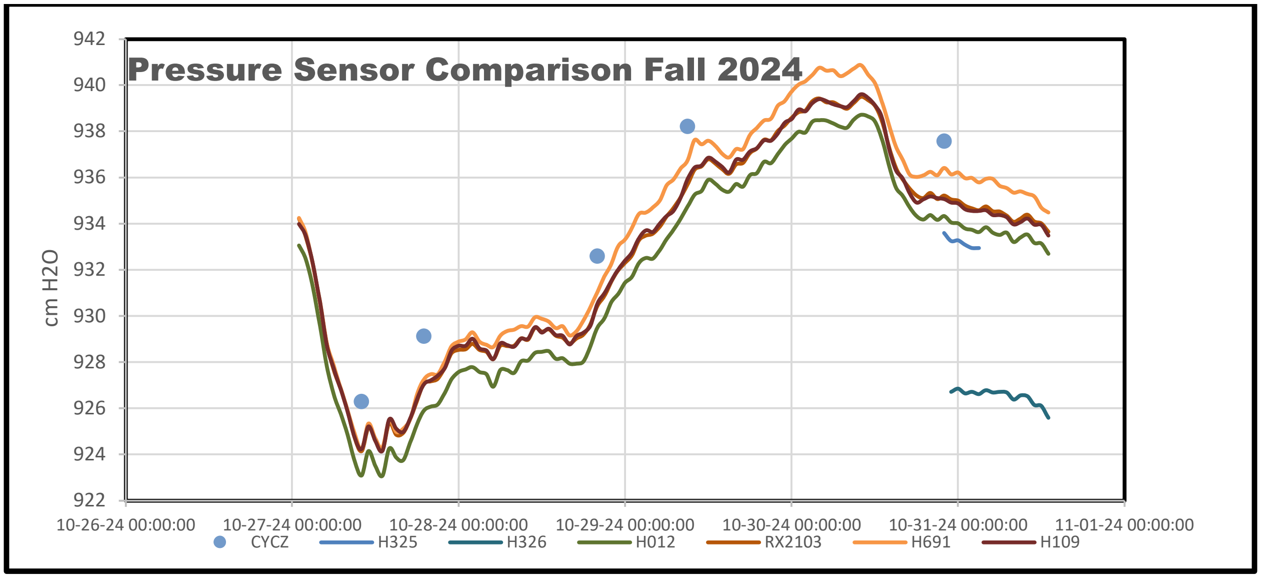


Figure A2 – Pressure readings from all loggers in relation to RX2103 during October 2024. The elevation of the Fairmont Hot Springs Airport (CYCZ) is 811 metres asl and roughly 40 metres below the evaluation site. About 4 cm H2O should be subtracted from its values to be comparable. The batteries in loggers H325 and H326 were being replaced so that the loggers were not available at the beginning of the evaluation.

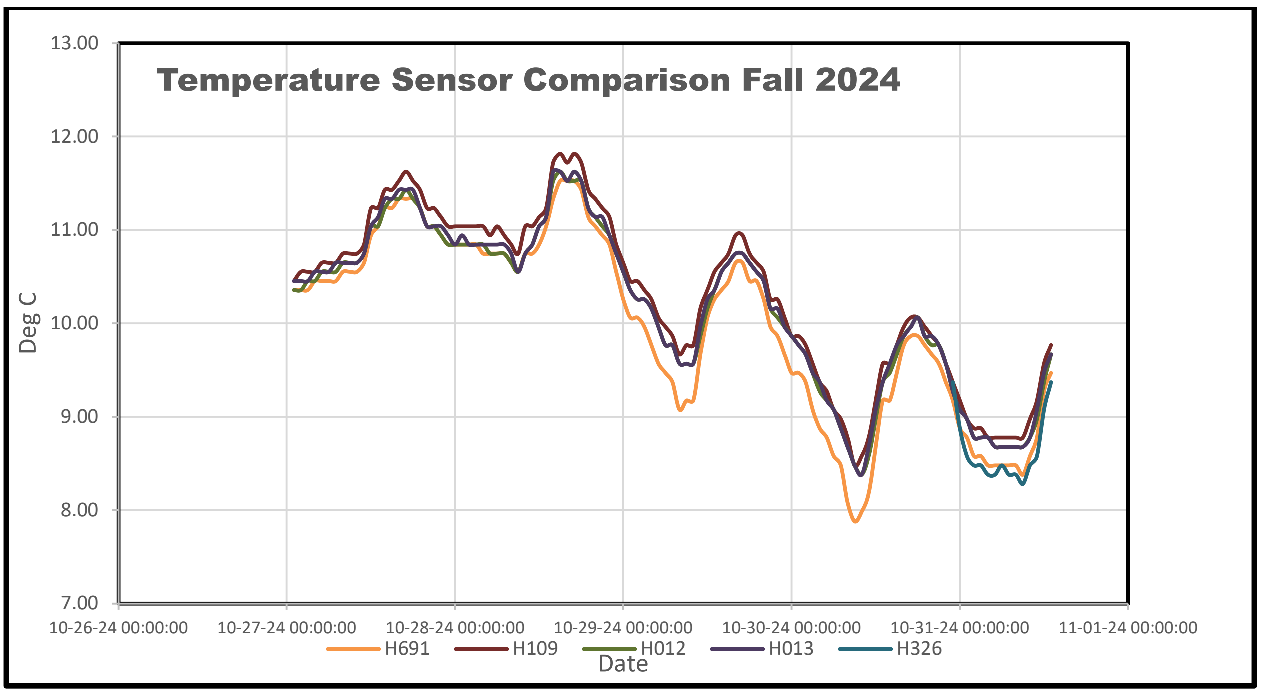


Figure A3 – Logger temperature comparison Fall 2024

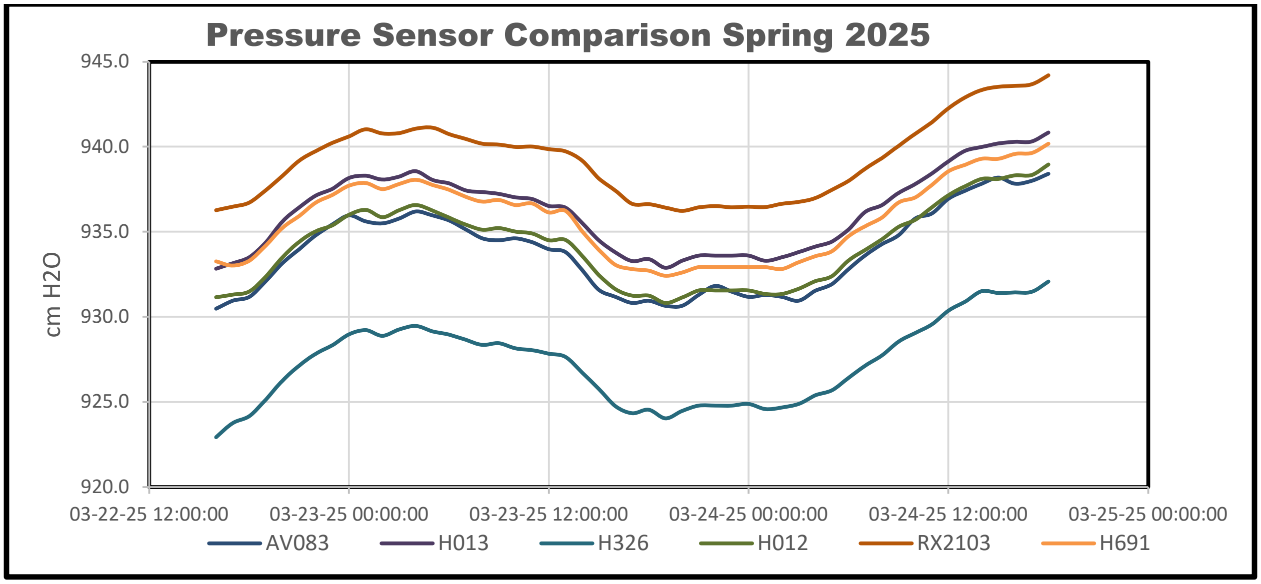


Figure A4 – Logger pressure comparison Spring 2025.

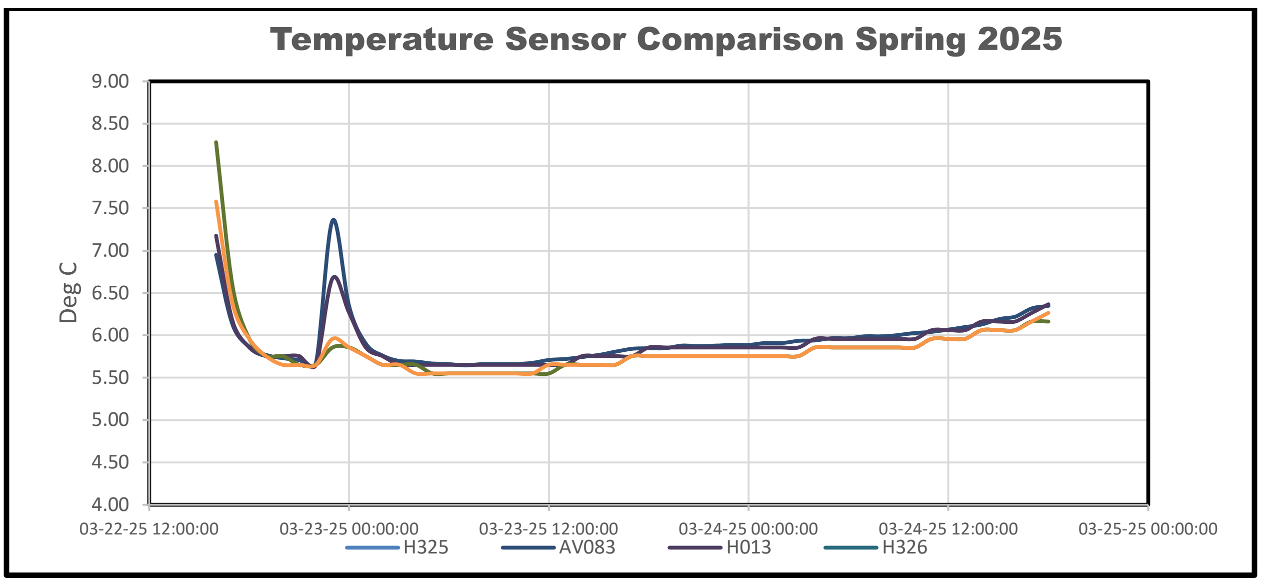


Figure A5 – Logger temperature comparison Spring 2025.

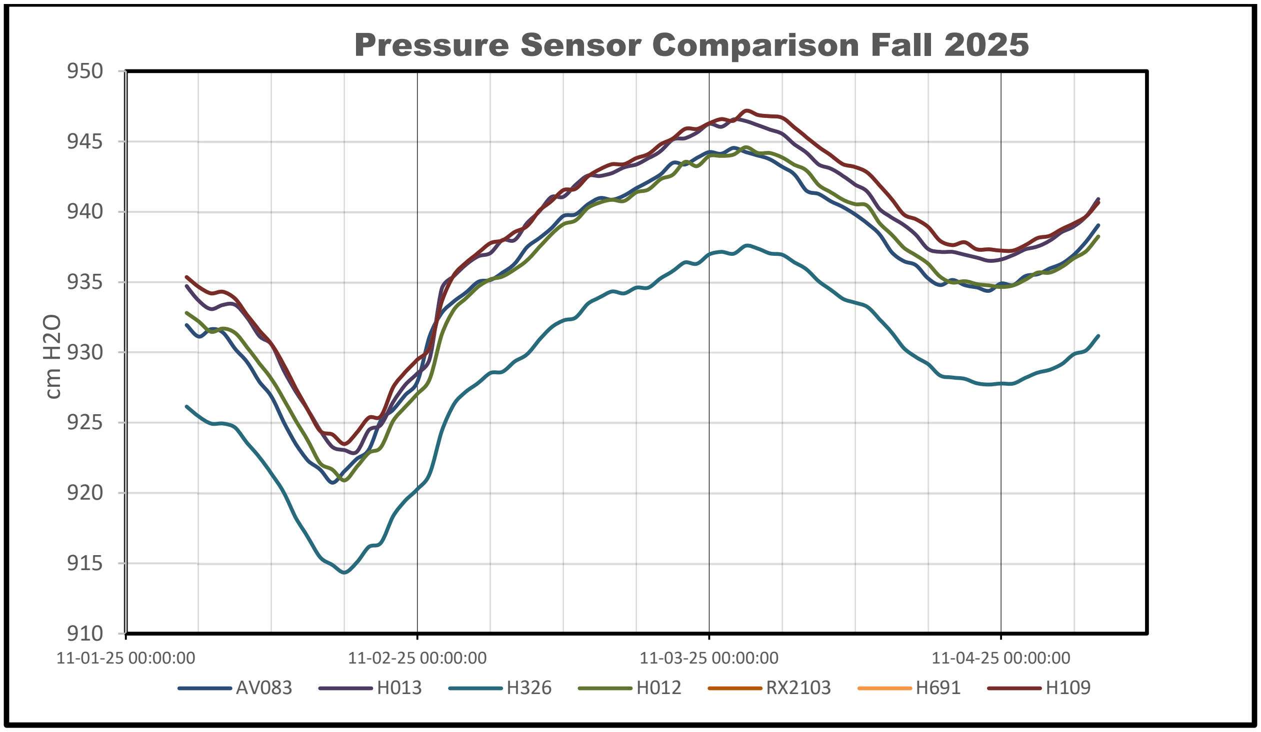


Figure A6 – Logger pressure comparison Fall 2025.

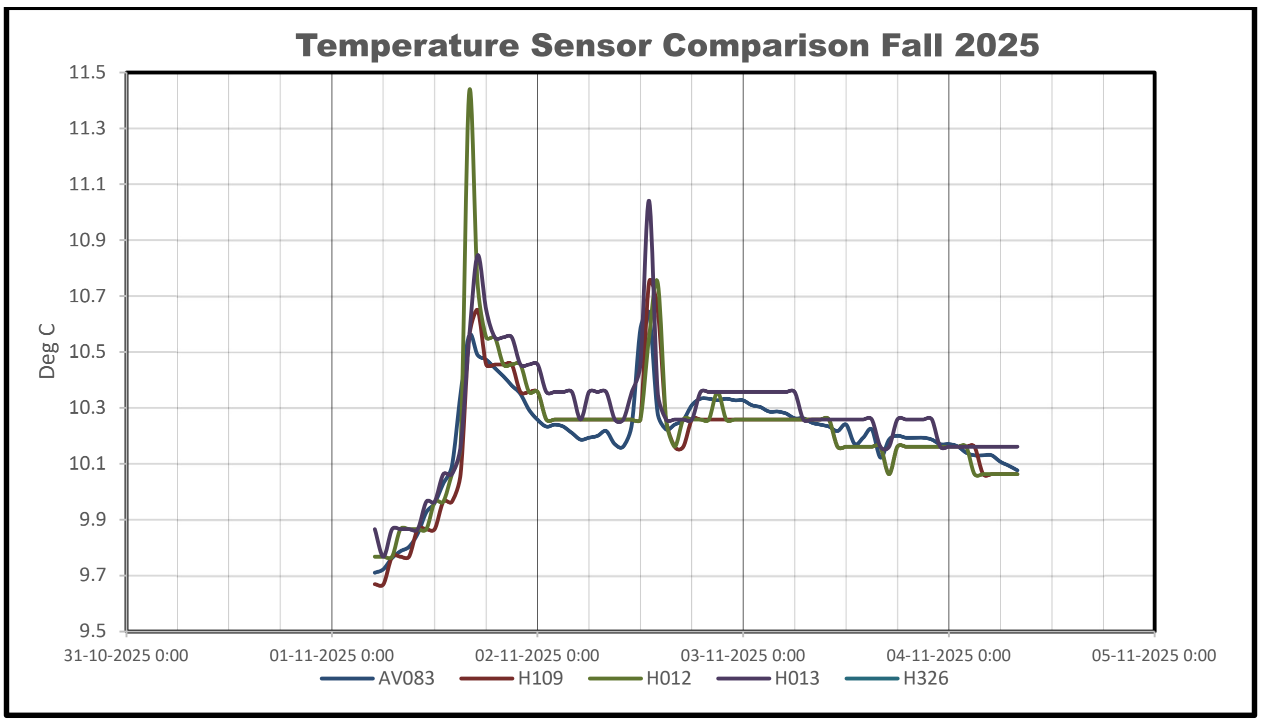
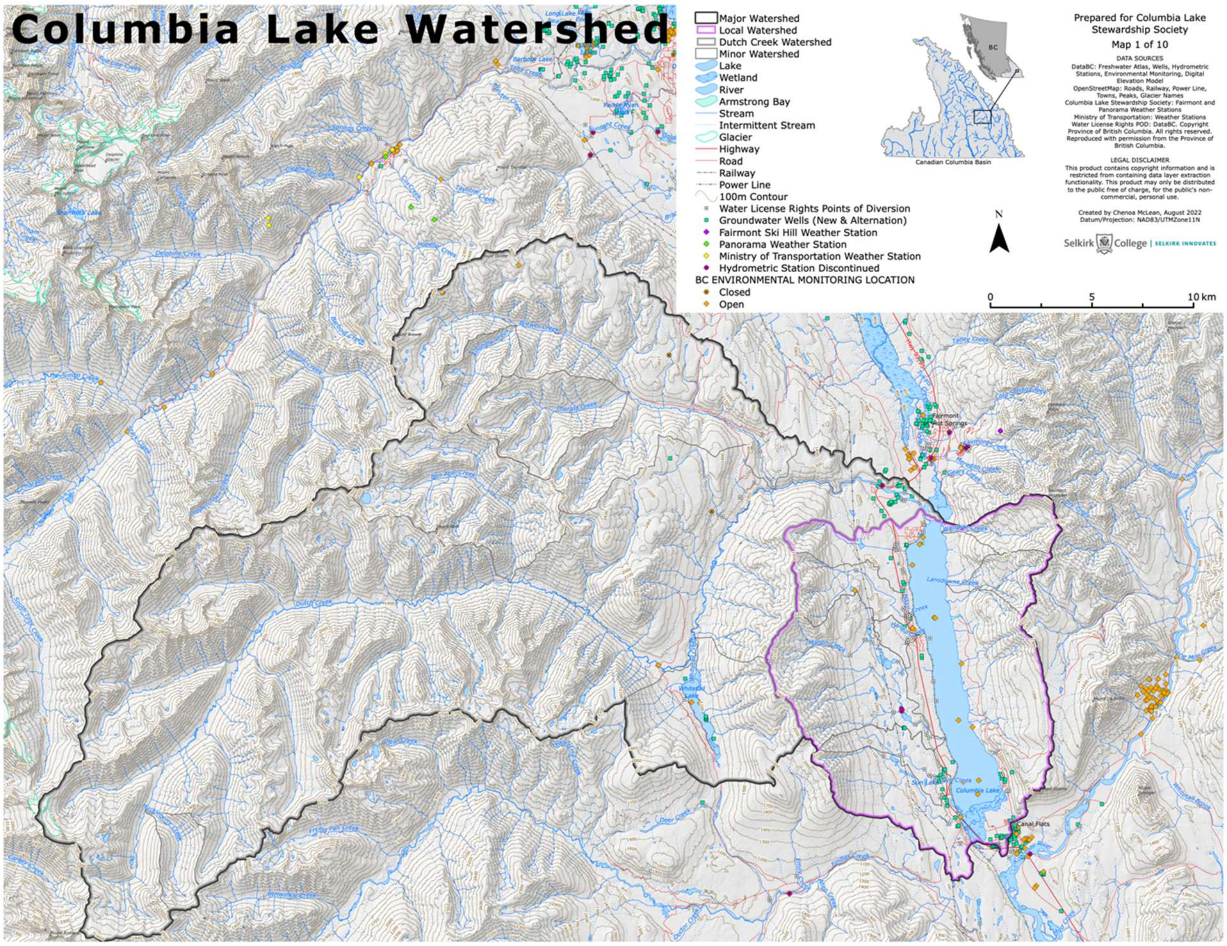


Figure A7 – Logger temperature comparison Fall 2025.

APPENDIX B


Columbia Lake Watershed
Major Watershed
Local Watershed
Dutch Creek Watershed
Minor Watershed
Lake
Wetland
River
Armstrong Bay
Stream
Intermittent Stream
Glacier
Highway
Road
Railway
Power Line
100m Contour
Water License Rights Points of Diversion
Groundwater Wells (New & Alternation)
Fairmont Ski Hill Weather Station
Panorama Weather Station
Ministry of Transportation Weather Station
Hydrometric Station Discontinued
BC ENVIRONMENTAL MONITORING LOCATION
Closed
Open
BC
Canadian Columbia Basin
Prepared for Columbia Lake Stewardship Society
Map 1 of 10
DATA SOURCES
DataBC: Freshwater Atlas, Wells, Hydrometric Stations, Environmental Monitoring, Digital Elevation Model
OpenStreetMap: Roads, Railway, Power Line, Towns, Peaks, Glacier Names
Columbia Lake Stewardship Society: Fairmont and Panorama Weather Stations
Ministry of Transportation: Weather Stations
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Created by Chenoa McLean, August 2022
Datum/Projection: NAD83/UTMZone11N
N
Selkirk College | SELKIRK INNOVATES
0
5
10 km
Columbia Lake
Canal Flats