2024 Water Quality Monitoring Program Results

Haslam Lang Community Watershed

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EARTH WATER LAND

SUMMARY

Powell River Salmon Society (PRSS) has monitored water quality within the Haslam Lang Community Watershed since 1997. The watershed supplies drinking water to the City of Powell River and the community of Brew Bay. It provides important habitat for salmon species, and the PRSS operates a hatchery on Lang Creek. Maintaining water quality is important for providing healthy drinking water and maintaining clean salmon habitat.

PRSS retained Statlu Environmental Consulting Ltd. (Statlu) to analyze water quality data collected during the 2024 monitoring program and to compare the results with data from previous years. PRSS recorded water temperature, creek stage, turbidity, pH, and salinity twice per month at six locations within the watershed. The measurements were taken at Lang Creek near the Alex Dobler Salmon Centre, the outlet of Duck Lake, Anderson Creek, Blackwater Creek, Haslam Lake, and the weir at the outlet of Haslam Lake named Slough Station. The water quality monitoring program, which began in 1997, documents a long period within the watershed which is a valuable tool for establishing baseline conditions. This allows land managers to detect potential problems and implement solutions to maintain good water quality for fish and water users.

The area received 34% more precipitation in 2024 than the previous year, and 1% more than the 30-year average from 1981 to 2010. The spring and summer were 29% and 21% drier than normal which resulted in relatively low stage and discharge measurements during the warmer months. The minimum biweekly Lang Creek stage measurement of 0.29 m was recorded on September 6, which is 0.04 m higher than the minimum recorded in 2023.

The maximum biweekly water sampling temperatures in 2024 were warmer than 2023 at all stations. Duck Lake had the highest recorded temperature this year at 25.0 °C, which is 0.9 °C warmer than the 2023 maximum which was also recorded at Duck Lake. The maximum water temperature from continuous measurements on Lang Creek in 2024 was 1.7 °C higher than the 2023 maximum.

Turbidity, pH, and salinity generally varied within the normal and acceptable range for 2024. The average turbidity measurements from Lang Creek, Blackwater Creek, and Anderson Creek were 17% to 30% lower than the 2023 values, and the average turbidity measurements from the rest of

the station were 2% to 18% higher. The maximum turbidity on Lang Creek (5.2 NTU) is 49% lower than the 2023 bimonthly maximum of 10.2 NTU and 6% lower than the 2022 maximum of 5.6 NTU. Five readings were above 2 NTU but were well within the range of turbidity measurements recorded since 1997. Average pH measurements were the same or slightly higher (less acidic) than the measurements from 2023. There was one day that had slightly elevated pH measurements recorded at Haslam Lake, however the range remains within normal variability and is much less than pH variation recorded in earlier years. Average salinity at all six stations recorded 13% to 35% higher than average salinities in 2023 and maximum values ranged from a 22% decrease at Lang Creek to a 22% increase at Blackwater Creek in comparison to 2023 maximum readings. These water quality data suggests that forest management strategies intended to protect water quality within the watershed remain successful.

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APPENDICES

1.0 INTRODUCTION

The Powell River Salmon Society (PRSS), with funding from the Powell River Community Forest (PRCF), British Columbia Timber Sales (BCTS), and Thichum Forest Products of the Tla'amin First Nation (Thichum), monitors streams and lakes within the Haslam Lang Community Watershed to identify how development and land use affect water quality and habitat. The watershed provides important habitat for several fish species and PRSS operates a hatchery on Lang Creek. The watershed provides drinking water to the city of Powell River and the community of Brew Bay.

As part of the ongoing water quality monitoring program, PRSS retained Statlu Environmental Consulting Ltd. (Statlu) to analyze water quality data collected during 2024 and to compare the results with previous years of monitoring.

2.0 BACKGROUND

Land managers have prioritized sustainable development within the Haslam Lang Community Watershed for over two decades. Water quality monitoring within the watershed began in 1997 and a watershed management plan was implemented in 1999. Both initiatives aimed to study and maintain water quality to protect the communities and natural ecosystems that depend on the watershed.

The Haslam Lake and Lang Creek Integrated Watershed Management Plan (IWMP) and subsequent watershed assessments, most recently completed in 2020, have guided sustainable development within the watershed by identifying resources at risk and effectively managing public interests. Management planning, watershed assessments, stakeholder involvement, and implementation of best management practices have provided sound scientific and practical guidance for sustainable development in the watershed.

The water quality monitoring program provides important information to the watershed management plan process. The data analysis can identify short-term changes and long-term trends in water quality that can only be identified with active monitoring. If the monitoring identifies potential problems, the data can guide management strategies to reduce risks within the watershed

and to downstream resources. Land managers can use insights from these analyses to prioritize and respond to potential problems before they cause damage to watershed resources.

The monitoring program also ensures that water license operators meet sustainability requirements throughout the year. One requirement is to maintain a minimum flow greater than 15 ft^3/s (0.42 m^3/s) in Slough Creek downstream of the storage dam at all times of the year, and an increased discharge of 25 ft^3/s (0.71 m^3/s) during October and November to meet instream flow requirements for returning salmon runs. Maintaining the minimum flow requirements and good water quality is key for sustainable development within the watershed.

Four watershed assessments have been completed; the first in 1999 (Carson, 2000), the second in 2003 (Carson, 2003), and the third in 2015 (Carson Land Resource Management, 2015). Statlu completed the fourth watershed assessment in 2020 (Statlu, 2020), and conducted another watershed assessment in 2024. The final report for the 2024 assessment is currently in progress and expected to be complete in early 2025. Additionally, Carson (2010) assessed how PRCF operations affect water quality within the Powell River area, including areas within the PRCF but outside the community watershed.

3.0 METHODOLOGY

The water quality monitoring program includes biweekly measurements at six locations in the watershed, continuous water temperature monitoring at several locations, and continuous water temperature and discharge monitoring on Lang Creek at the Alex Dobler Salmon Centre. The biweekly measurements include stream stage, turbidity, pH, water temperature, and salinity. They are taken at Lang Creek near the Alex Dobler Salmon Centre, the outlet of Duck Lake, Blackwater Creek, Anderson Creek, Haslam Lake near the community water intake, and Haslam Lake at Slough Station (Figure 1 in Appendix 1). Continuous water temperature monitoring occurs in Duck Lake and in Lang, Anderson, and Blackwater Creeks. The data, along with general observations and photographs taken during the sampling, were sent to Statlu for analysis.

Statlu first compared monthly precipitation and temperature data recorded during 2024 to the latest average monthly data collected during the 30-year period from 1981 to 2010 (Environment Canada, 2025). Environment Canada has not yet published climate normal data conditions for the

1991 to 2020 interval for Powell River, but they are expected to be released soon[1]. When those data are made publicly available, they will provide a more accurate baseline against which to compare recently measured conditions. The data was recorded at the Powell River A climate station, located 130 m above mean sea level at the Powell River Airport, about 7 km southwest of Haslam Lake. The 30-year average of precipitation and temperature is referenced as normal climate conditions.

Statlu then prepared two graphs for each water quality variable measured during the biweekly sampling (water temperature, stage, turbidity, pH, and salinity). The data for all six sites within the watershed are plotted on each graph. The first graph shows how one of the water quality variables changed at each of the six locations during 2024. The second graph compares the data recorded during 2024 to data recorded from 1997 to present. The long-term graph shows how water quality within the watershed has changed over the history of monitoring and allows anomalous long-term trends to be identified.

Statlu compared the six water quality variables to the continuous hydrograph data recorded on Lang Creek at the Alex Dobler Salmon Centre. We extracted the daily maximum and minimum discharge (water volume) from the continuous stream flow data and compared those values to previous years. We plotted the stream flow data with daily precipitation data collected at the Powell River A climate station, located at Powell River airport. Precipitation data from the Powell River climate station replaces missing Powell River A data on January 23, April 22, October 5, and November 12, 13, 14, 2024. Temperature data from the Powell River climate station replaces missing Powell River A data on November 13, 2024. The comparison of discharge to precipitation shows how Lang Creek responds to short-term weather events. This also provides additional information about how the weather and climate affected water quality during the biweekly sampling, and what may have occurred between sampling dates.

PRSS used to collect precipitation data at the Alex Dobler Salmon Centre, but analysis of several years of data show that the Powell River A and Powell River climate station data closely match the means, range, and variability of the data collected in the watershed. Given the similarity between the climate data from the two locations, the Powell River data reasonably describes climactic

[1] Data were promised "by 2025" in 2024 but have not yet been published as of early March 2025.

conditions in the Lang Creek watershed. Accordingly, the PRSS decided to stop independently collecting climate data. This analysis uses data collected in Powell River (Environment Canada, 2025).

Statlu compared the continuous water temperature data recorded in Duck Lake and Lang, Anderson, and Blackwater Creeks to air temperature data recorded in Powell River. Statlu compared the daily water temperature data to the biweekly water quality data recorded within the watershed.

The PRSS replaced the MX2201 Pendant model Tidbits with the MX2203 TIDBIT 400 models, which worked well during the 2024 collection year. Tidbits are small water temperature data loggers, which continuously monitor temperature data in Anderson, Blackwater, and Lang Creeks, and in Duck Lake. In late December, the turbidity meter used during the biweekly measurements failed, and the final set of biweekly turbidity measurements had to be estimated. The turbidity meter will be replaced for 2025 data collection.

4.0 OBSERVATIONS

The PRSS made field observations and took photographs within the watershed to record conditions that could influence the data. The photographs are shown in Appendix 2.

5.0 RESULTS

5.1 Precipitation and Air Temperature

I compared the total monthly precipitation and mean monthly air temperature, recorded at the Powell River A climate station during 2024, to the monthly 30-year averages (referred to as 'normal') recorded from 1981 to 2010 at the same location (Chart 1). As noted in Section 3, precipitation data from the Powell River climate station replaces missing Powell River A data on January 23, April 22, October 5, and November 12, 13, 14. Temperature data from the Powell River climate station replaces missing Powell River A data on November 13, 2024.

The total precipitation recorded during 2024 was 1222 mm, which is 34% more than the 911 mm recorded in 2023, and 1% more than the 30-year average from 1981 to 2010 of 1206 mm per year

(Environment Canada, 2025). January, May, September, October, and November had more precipitation than the 30-year average with 38%, 22%, 29%, 13%, and 16% increases relative to the long-term monthly averages, respectively. December had the same amount of precipitation as the 30-year average with 158 mm recorded. However, the rest of the year was drier than normal with February to April being 29% drier than the average, and June to August being 21% drier. The summer drought was widespread across the region and affected much of the coast, Vancouver Island, and the Interior Plateau. In particular, the Sunshine Coast and the Lower Mainland reached Stage 3 drought conditions with East Vancouver Island having Stage 4 drought conditions during the summer, reaching Stage 5 drought during the middle of August (BC Government Drought Information Portal, 2025).

Southwest BC had a cool first half and warm second half of the year in 2024. Average air temperature was 0.4°C below normal in January to June, and 1.0°C above normal from July to December, with December having the greatest difference with an average temperature 2.1°C above normal. The warmest month was July, with an average temperature of 19.0°C, which is the same as the warmest average month in 2023, and 1.8°C more than the 30-year average warmest month temperatures of 17.2°C.

The Powell River A climate station recorded five days with temperatures above 30°C in 2024, which is less than 2023, which had eight days above 30°C. The maximum 2024 air temperature was 32.0°C on July 17, 0.2°C cooler than the 2023 maximum of 32.2°C. During the 30-year average from 1981 to 2010, the Powell River A climate station recorded an average 1.6 days above 30°C per year. With five days above 30°C in 2024 and eight days in 2023, that is a 200% to 400% increase from the 30-year average. It is likely that the average number of days above 30°C over the 1991 to 2020 climate interval will be shown to be more than 1.6 when that data is published.

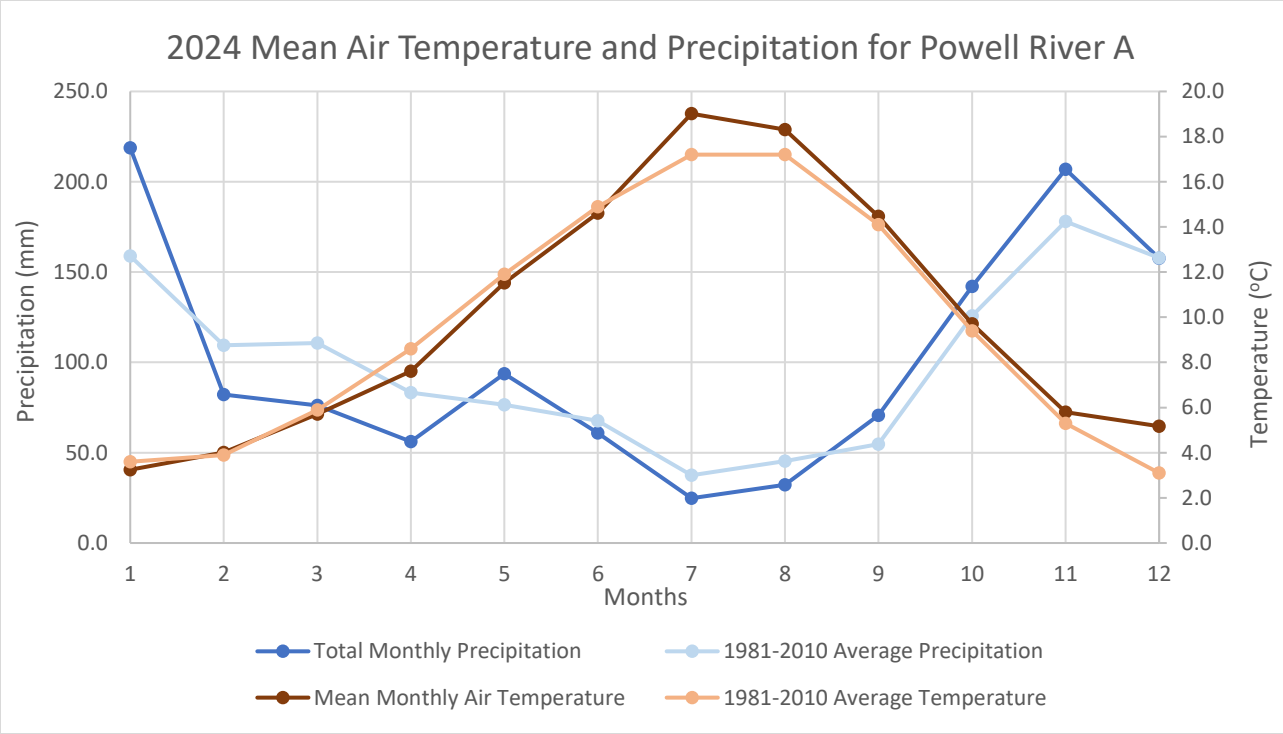

Chart 1: Mean air temperature (°C) and total monthly precipitation (mm) at the Powell River A climate station for 2024 compared to the 30-year average from 1981 to 2010. Precipitation data from the Powell River climate station replaces missing Powell River A data on January 23, April 22, October 5, and November 12, 13, 14. Temperature data from the Powell River climate station replaces missing Powell River A data on November 13.

5.2 Water Temperature

Continuous water temperature monitoring at Lang, Anderson, and Blackwater Creeks, and in Duck Lake, show how water temperature responded to weather events (Chart 2). The continuous water temperature data is compared to air temperature data recorded at the Powell River A climate station (Environment Canada, 2025). The data show that water temperature spikes closely follow air temperature spikes. Lang Creek and Duck Lake have marginally larger temperature increases during summer than Anderson and Blackwater Creek. In spring, Lang Creek stays warmer than the minimum temperatures of the other creeks. In autumn, Duck Lake stays warmer than the minimum temperatures of the creeks. The maximum water temperatures this year occurred between July 17 and 20, with 23.9°C in Duck Lake and 23.5°C in Lang Creek. The maximum water temperatures in Blackwater and Anderson Creeks occurred on August 10, with maximum temperatures recorded as 15.1°C and 17.0°C, respectively. The high temperatures in Duck Lake

and Lang Creek were recorded within the days following the warmest day measured at the Powell River A climate station in 2024. The Anderson and Blackwater temperatures follow a week of high temperatures and are likely not only related to high air temperature but also decreasing flow. The maximum water temperature on Lang Creek in 2024 was 1.7°C higher than the 2023 maximum.

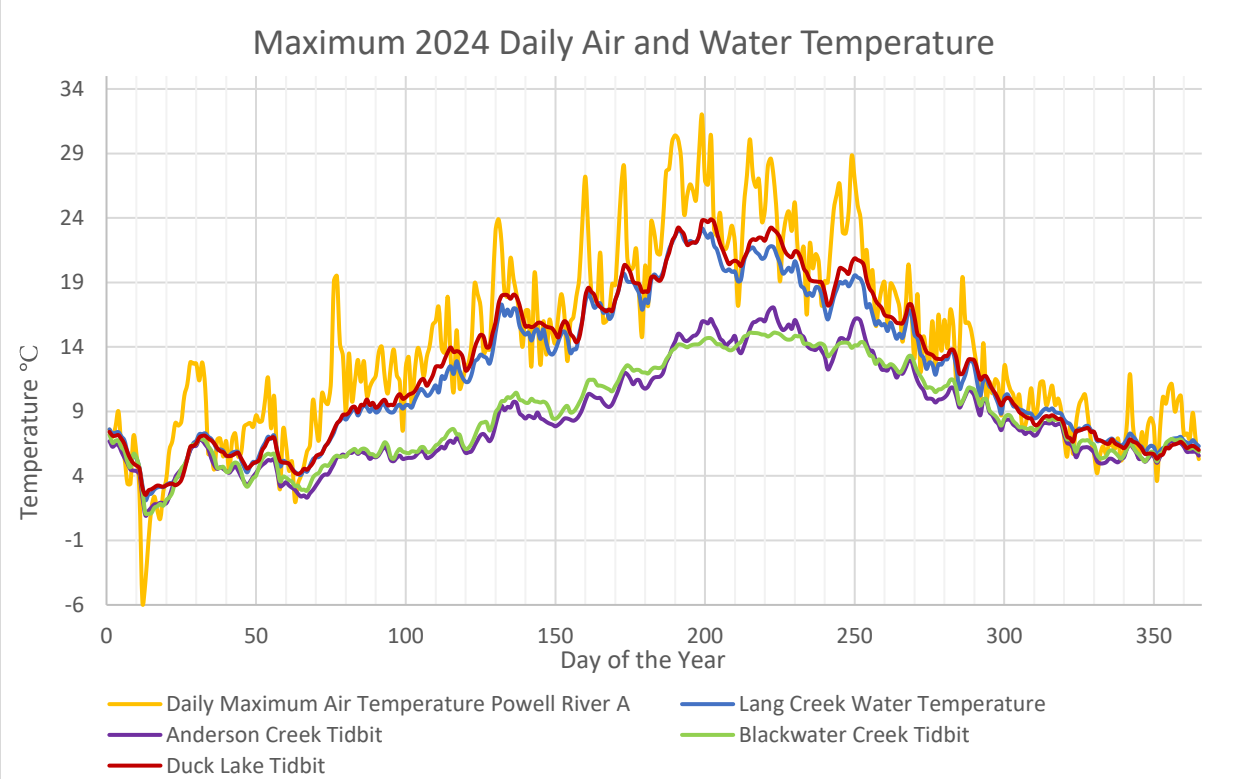

Chart 2: Comparison of maximum air temperature with maximum water temperatures in the watershed. Continuous water temperature data was recorded on Lang Creek at the Alex Dobler Salmon Centre. Air temperature data is from the Powell River and Powell River A climate stations (Environment Canada, 2025).

Biweekly sampling throughout the watershed shows how temperatures at all six sites varied during the year. Average water temperatures measured within the watershed ranged from 8.8°C to 13.3°C, which is warmer than the 2023 averages from 7.9°C to 12.6°C. The temperatures are coldest during the winter and warmest during the summer (Chart 3). The maximum water temperatures recorded were 0.4°C to 2.7°C warmer than in 2023 at all sites. Duck Lake historically has the highest maximum water temperature within the watershed and this year had a maximum temperature of 25.0°C. The 2024 maximum temperature is 0.9°C warmer than the maximum temperature

recorded in Duck Lake in 2023. The maximum biweekly water temperatures in 2024 remain within the normal variability recorded at the six sites from 1997 to present (Chart 4).

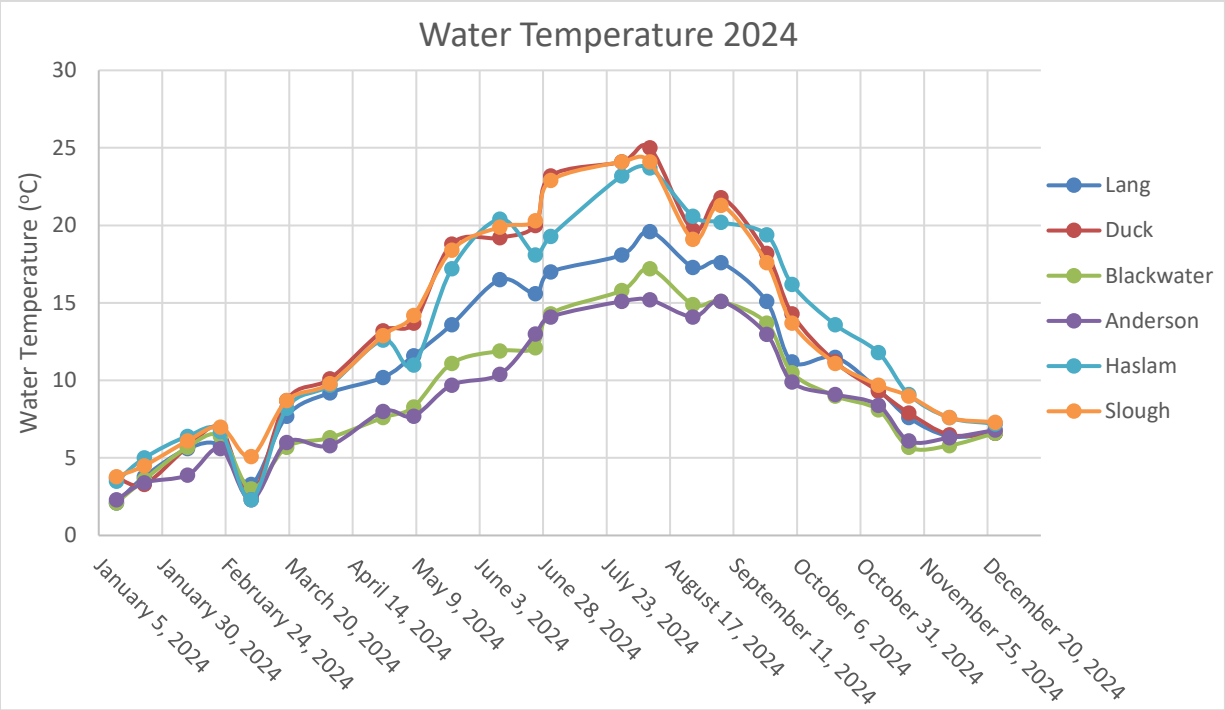

Chart 3: Water temperature measured at six sites within the Haslam Lang Community watershed.

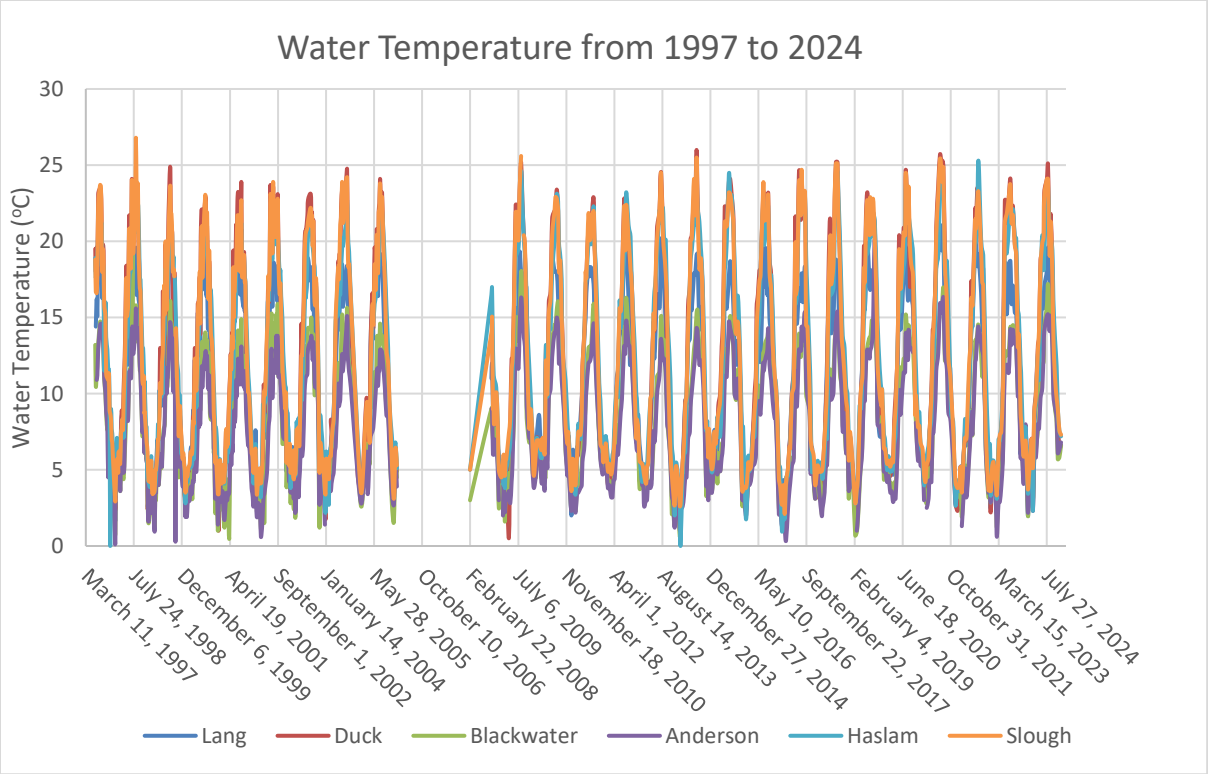

Chart 4: Water temperature at six sites within the Haslam Lang Community watershed between 1997 and present.

5.3 Stage and Hydrograph

Stage measurements record the height of the water surface relative to a known reference elevation (Chart 5). The stage data for Haslam Lake and Slough Station are plotted on a secondary axis as their stage reference points are geodetic elevations, which differ from the other four sampling locations. Despite having two different reference points, the stage data for all six sites shows similar water level variations within the watershed during 2024.

The stage measurements at all six sites started high, reached minimum levels in early fall, and then rose back to meet or exceed the water levels measured at the beginning of the year, in response to precipitation and temperature patterns (Chart 5). The trend of the 2024 stage measurements is similar to the 2023 measurements with higher stage during the winter, spring, and late fall, and lower stage during the summer and early fall. The average stage measurements range from 0 m difference to 0.09 m higher than the 2023 measurements. The minimum stage measurements in 2024 on all creeks based on the biweekly measurements range from 0.01 m higher to 0.19 m higher

than in 2023, while the continuous data from Lang Creek shows slightly lower stage values than in 2023. The minimum stage measurements on Lang Creek were 0.29 m, recorded on September 6. This stage measurement is higher than the previous two years, which recorded 0.25 m in 2023 and 0.27 m in 2022. The stage measurements overall remained within the range of previous measurements in the watershed.

The increased precipitation at the beginning and the end of the year resulted in high stage measurements in January, November, and December. Despite getting more rain this year, the maximum stage was lower than the maximums recorded in 2023, with the exception of the Sloughs, which were 0.05 m higher. All measurements are similar to the normal range of values recorded since 1997 (Chart 6). The biweekly measurements did not capture the extent of the maximum Lang Creek discharge on November 14 (Chart 7), but did roughly capture the high stage days throughout the year that occurred after several days of rain and high discharge.

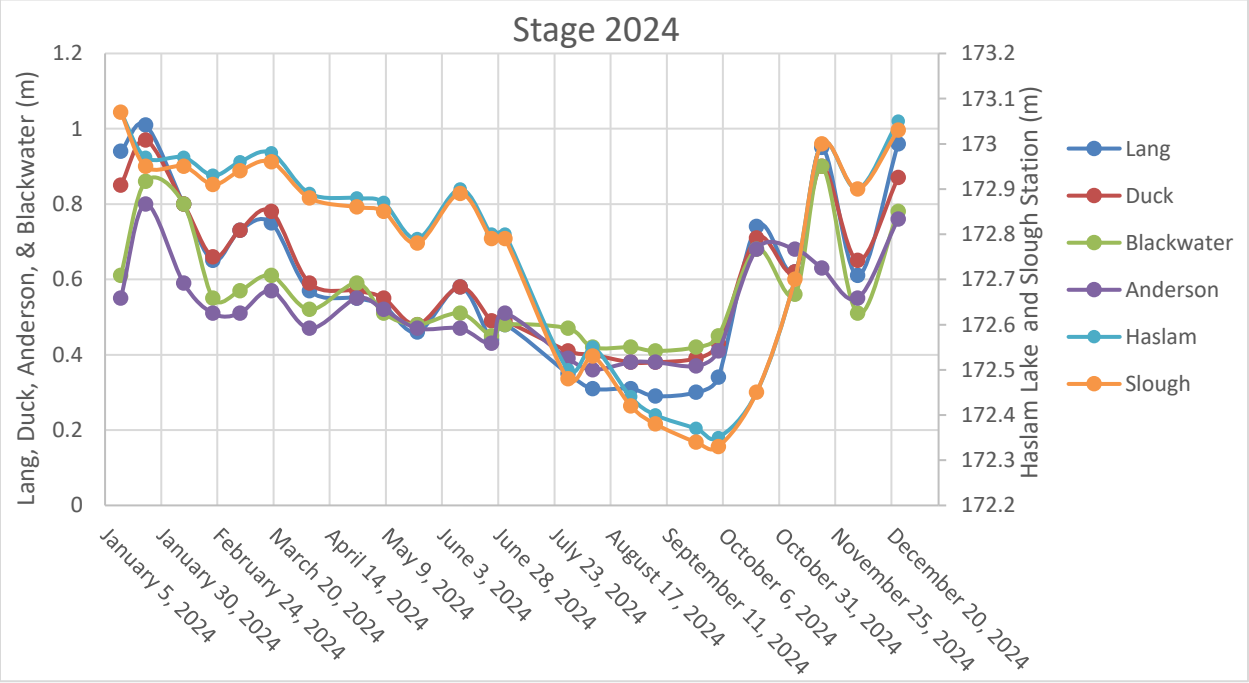

Chart 5: Stage level at six sites within the community watershed during 2024. Stage measurements for Haslam Lake and Slough Station are graphed on the secondary (right) axis.

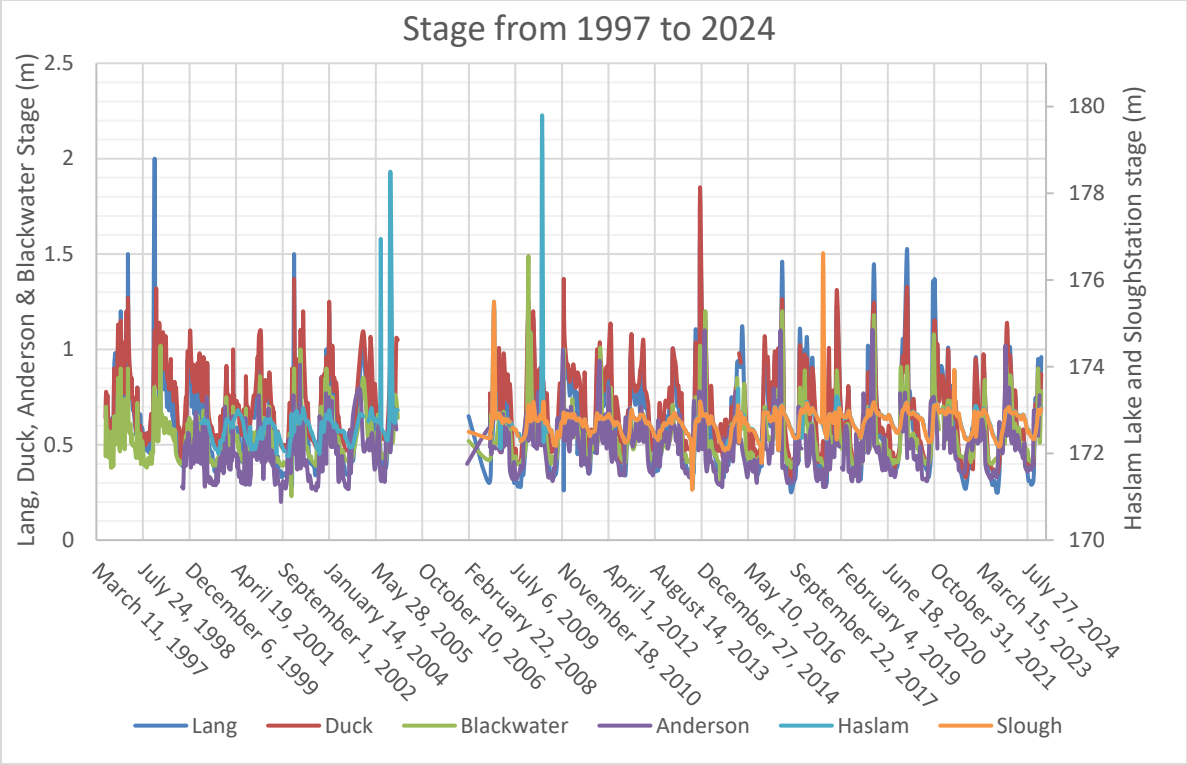

Chart 6: Stage discharge at six sites within the community watershed between 1997 and present. The stage for Haslam Lake and Slough Station is graphed on the secondary (right) axis.

Continuous data recording in Lang Creek measured discharge rates throughout 2024 (Chart 7). The maximum peak discharge in Lang Creek was recorded on November 14 at 36.2 m^3/s, one day after the second highest precipitation event of the year. The lowest discharge was on September 22 at 0.352 m^3/s. The average discharge through 2024 was 4.70 m^3/s and the median discharge was 3.13 m^3/s. The 2024 maximum, minimum, and average discharge values are greater than those recorded in 2023 (Table 1, Chart 8). The maximum discharge is 18% higher, the minimum discharge is 61% higher, and the average discharge is 27% higher than the 2023 values. The median discharge of 2024 is 19% higher than the 2023 median. The 2024 discharge measurements lie within the range of the values recorded in the last 5 years (Table 1, Chart 8).

Haslam Lake was below the level of the outlet weir from about August 1 to about September 22, resulting in consistently low flow in Lang Creek. Several rainstorms beginning around day 266 (September 22) gradually raised the level of Haslam Lake, overtopped the weir, and allowed water

to raise the level of Lang Creek. After this date, smaller single day rain events in October, November, and December resulted in discharge spikes because Haslam Lake's weir was no longer suppressing downstream peak flows. The low flow period in 2023 lasted for approximately 133 days, between May 20 and September 30, however the low flow period in 2024 was only 52 days long due to the rainstorms that occurred in June.

Table 1: Yearly discharge rates of Lang Creek from 2020 to 2024.

Year	Maximum (m^3/s)	Average (m^3/s)	Median (m^3/s)	Minimum (m^3/s)
2020	59.1	6.07	2.70	0.722
2021	70.1	7.56	4.14	0.490
2022	38.1	3.94	2.18	0.282
2023	30.6	3.71	2.63	0.219
2024	**36.2**	**4.70**	**3.13**	**0.352**

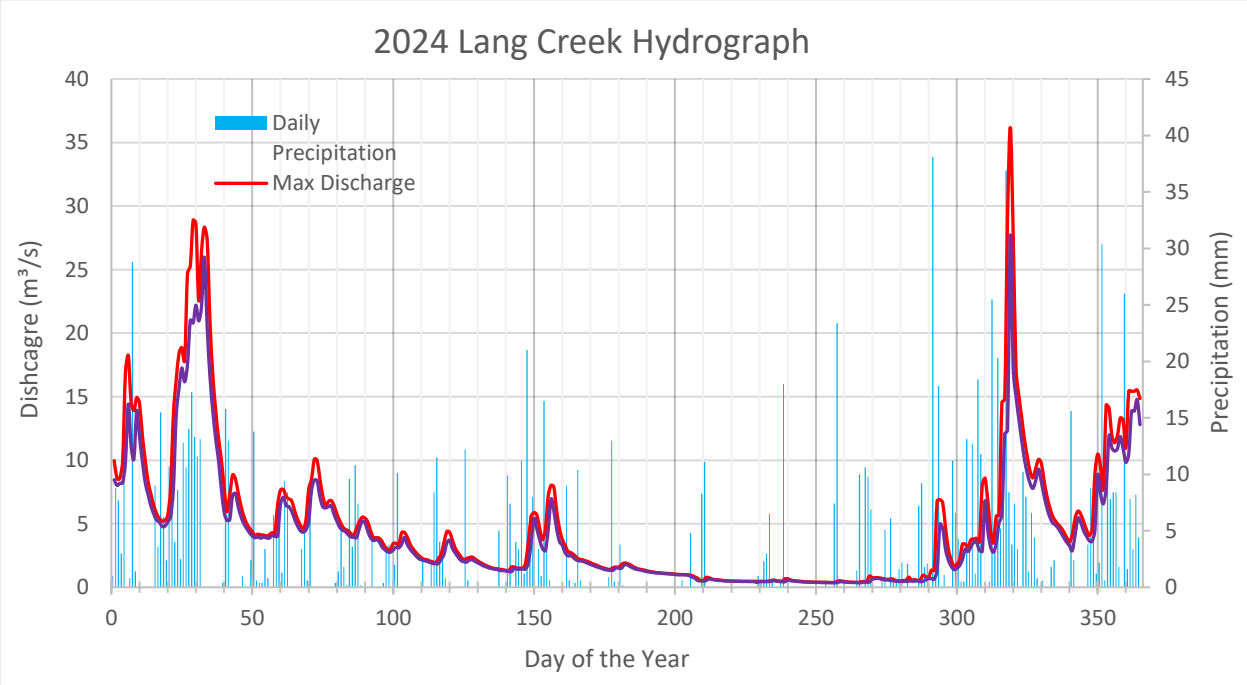

Chart 7: 2024 Hydrograph for Lang Creek. The minimum and maximum daily discharge (m^3/s) for Lang Creek is plotted against the total daily precipitation (mm) recorded at the Powell River A climate station. Precipitation data from the Powell River climate station replaces missing Powell River A data on January 23, April 22, October 5, and November 12, 13, 14.

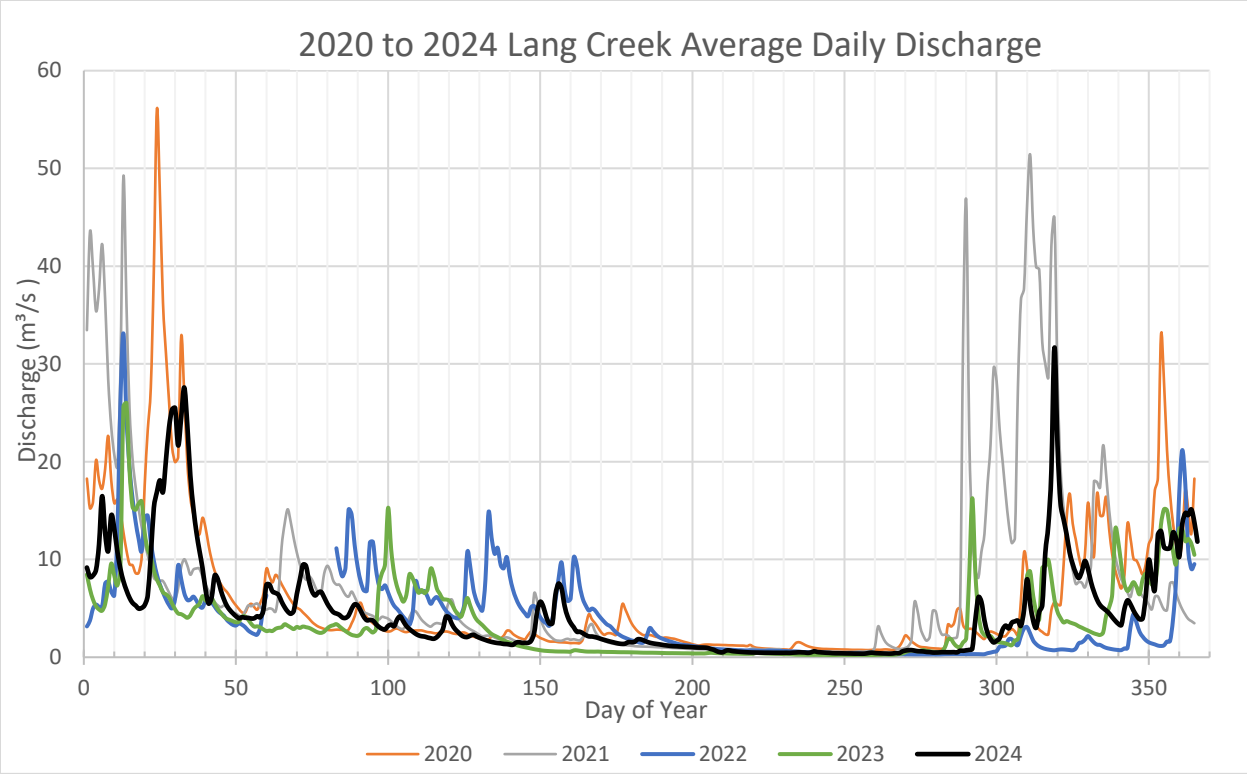

Chart 8: Average daily discharge data for Lang Creek comparing 2020 to 2024 data.

5.4 Turbidity

The bimonthly turbidity measurements in 2024 ranged from 0.25 NTU to 5.2 NTU, with average readings between 0.41 NTU and 1.08 NTU (Chart 9). The highest turbidity reading occurred on November 19 on Lang Creek. Other elevated readings occurred on March 5 on Haslam Lake, May 23 on Haslam Lake and Slough Station, and December 23 on Lang Creek. All other turbidity readings were below 2 NTU. The November Lang Creek high turbidity measurement occurred during a dry part of November, with high winds, so it may be related to something such as blowdown rather than runoff or bank erosion.

The turbidity levels in 2024 are similar to the levels in 2023. The maximum turbidity on Lang Creek (5.2 NTU) is 49% lower than the 2023 bimonthly maximum of 10.2 NTU and 6% lower than the 2022 maximum of 5.6 NTU. The average turbidity measurements from Lang Creek, Blackwater Creek, and Anderson Creek were 17% to 30% lower than the 2023 values, and the average turbidity measurements from the rest of the stations were 2% to 18% higher.

Turbidity data from 1997 to present shows low average turbidity with episodic spikes through the years (Chart 10). The 2024 data shows that average turbidity levels within the watershed are normal and that maximum turbidity levels are well below other turbidity spikes in previous years.

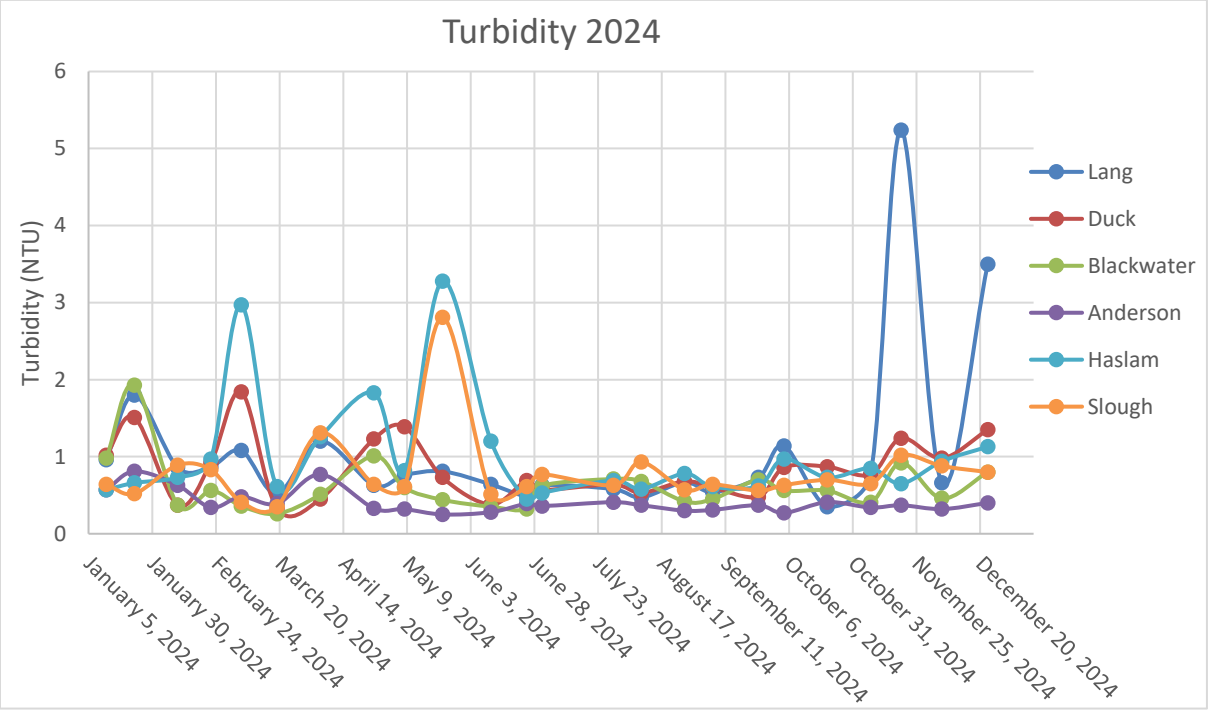

Chart 9: Turbidity measurements through 2024 at six sites within the Haslam Lang Community watershed.

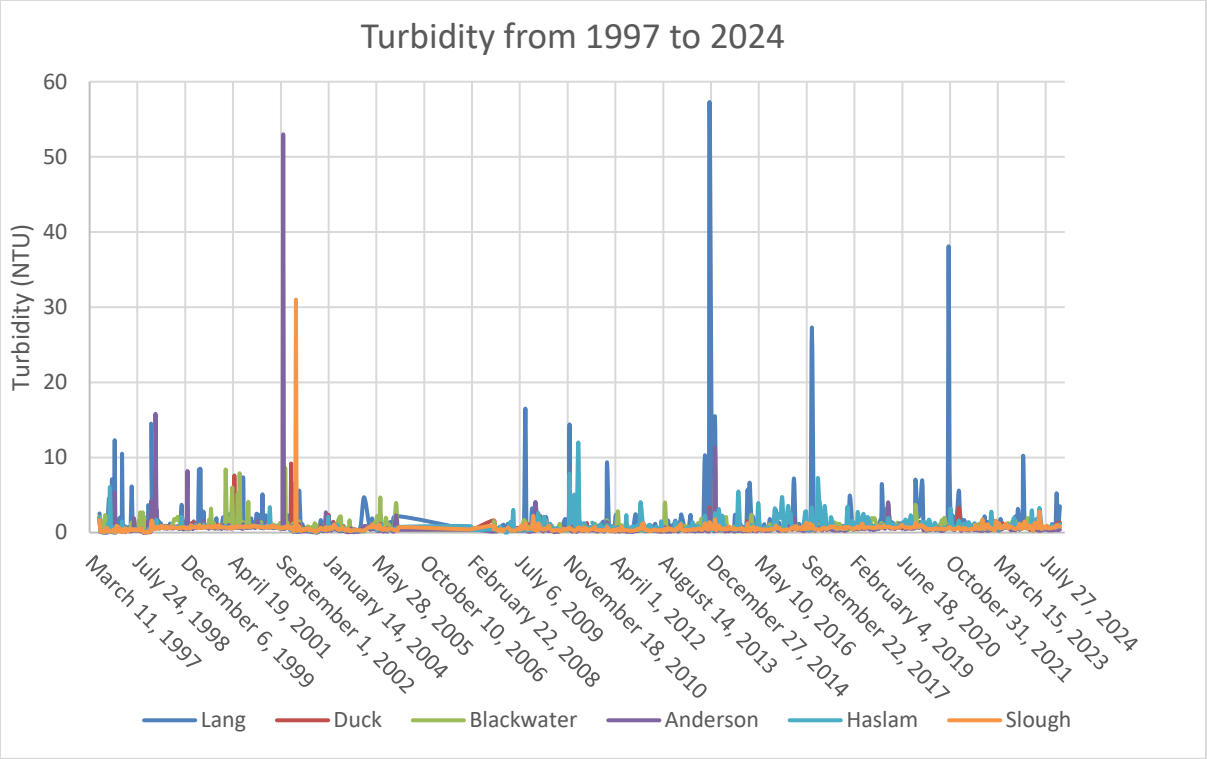

Chart 10: Turbidity at six sites within the Haslam Lang Community watershed between 1997 and present.

5.5 pH

The pH ranged between 6.7 and 7.4 within the watershed during 2024 (Chart 11). Overall, pH varies with a level trend during the year with some lower pH measurements early in the year, a slight increase into the warmer months, and then a more significant decrease in the fall into the winter. Average pH measurements at all sites were the same or slightly higher (less acidic) than recorded in 2023. The 2024 averages were all at 7.0, slightly more basic (less acidic) than the 2023 pH averages of 6.9 to 7.0. The maximum (basic) pH measurement of 7.4 occurred in Haslam Lake on November 7. This reading is 0.3 (3%) less than the maximum pH recorded in 2023 which was in Anderson Creek. The minimum pH measurements of 6.7 occurred in November for Anderson Creek, Duck Lake, and Lang Creek, and additionally in January, October, and December for Anderson Lake. These readings are up to 6% more than the 2023 minimums which were recorded at Haslam Lake and Slough Station.

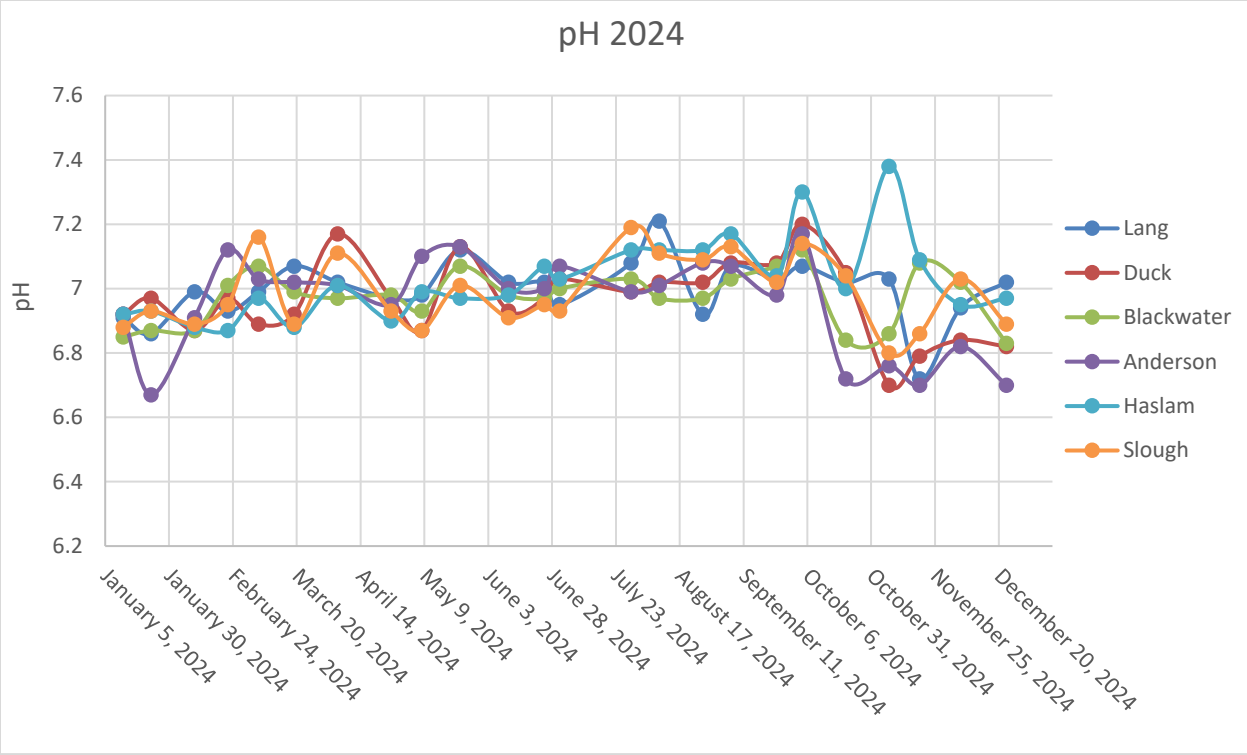

Chart 11: pH at six sites within the Haslam Lang Community watershed.

Variations in pH for the recorded history for all sites are shown in Chart 12. The pH values over the last few years show slightly more variability than between 2016 and 2021, where the pH generally varied between 6.7 and 7.3 (with the exception of one low pH spike in 2019). Despite the increased variability, pH range over the last few years remains within normal variability and is much less than pH variation recorded from 1997 to 2013.

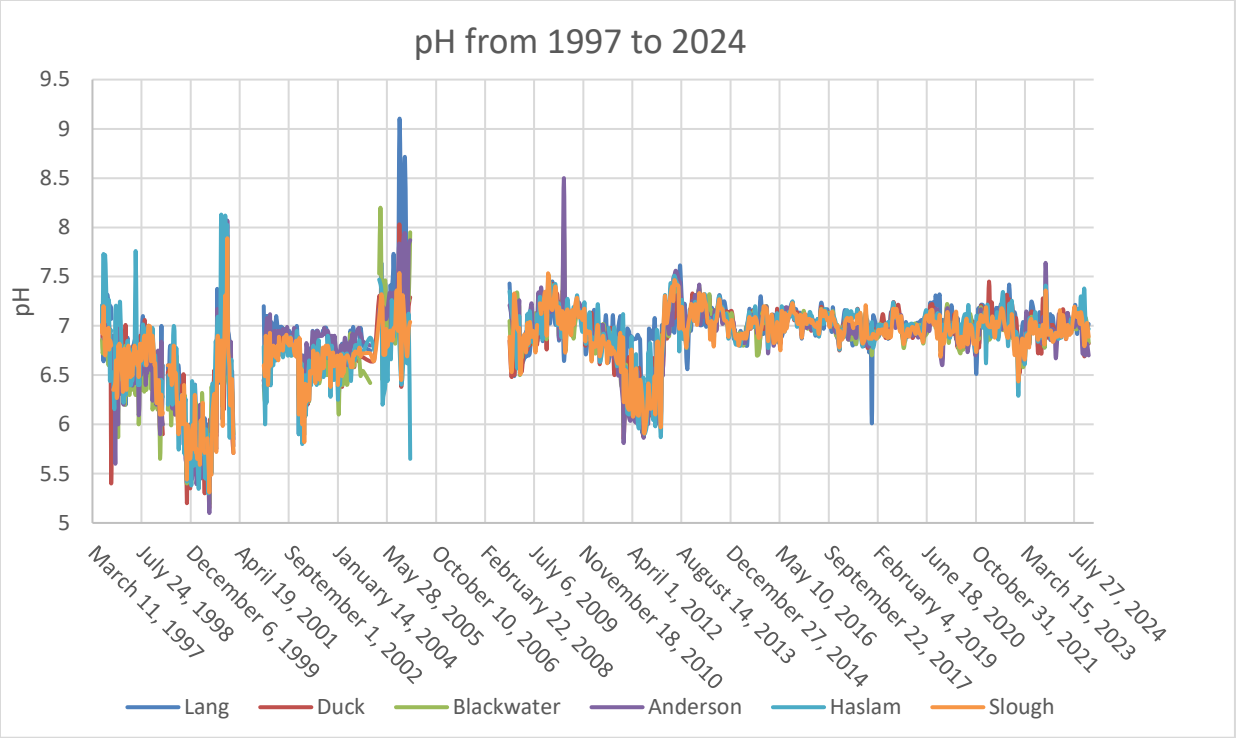

Chart 12: pH at six sites within the Haslam Lang Community watershed between 1997 and 2024.

5.6 Salinity

Salinity varied from about 0 ppm to 22 ppm at the six sites during 2024 (Chart 13). Average 2024 salinity ranged from 9 ppm to 11 ppm, which is more than the 2023 averages that were between 7 ppm and 9 ppm. The average salinity in all six stations recorded 13% to 35% higher average salinities than in 2023.

The maximum 2024 salinity measurement occurred on August 9 on Blackwater Creek at 22 ppm. Blackwater Creek and Anderson Creek also had elevated salinity levels in August and September. Overall, the maximum salinity readings ranged from a 22% decrease at Lang Creek to a 22% increase at Blackwater Creek in comparison to the measurements taken in 2023.

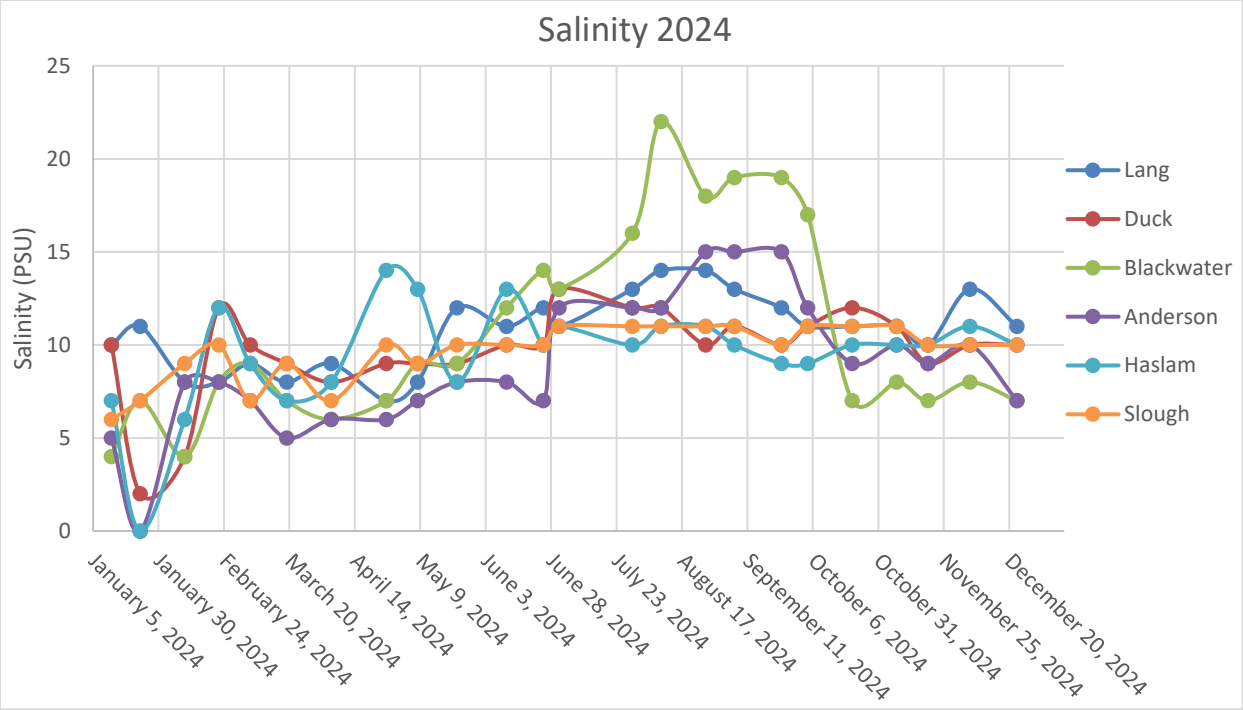

Chart 13: Salinity at six sites within the Haslam Lang Community watershed.

Lang, Blackwater, and Anderson Creeks have variable salinity, that in general, increase from winter to summer and decreases from summer back to winter. Haslam Lake, Duck Lake, and the Slough Station have lower salinity readings early in the year, before increasing and remaining around 10 ppm to 12 ppm on average.

Salinity data from 1997 to present are graphed on Chart 14 with a gap at most stations before 2000 and another gap at all stations between 2006 and 2008 when no monitoring occurred. Salinity data recorded from 2000 to 2006 are greater than salinity data recorded from 2008 to 2019. The abrupt decrease in salinity could result from equipment or measuring differences between the two periods. From 2009 to 2018, the salinity data for all six creeks varies from 0 ppm to 16 ppm and has average values between 4 ppm and 6 ppm. Salinity values started to increase at the end of 2018, and they continued to increase through 2019. The PRSS purchased a new salinity probe in 2020. It recorded similar, but slightly lower salinity levels in 2020 and again in the following years. Despite the elevated salinity in Blackwater Creek in the summer, average salinity levels are similar to previous years and remain within normal salinity levels for the watershed.

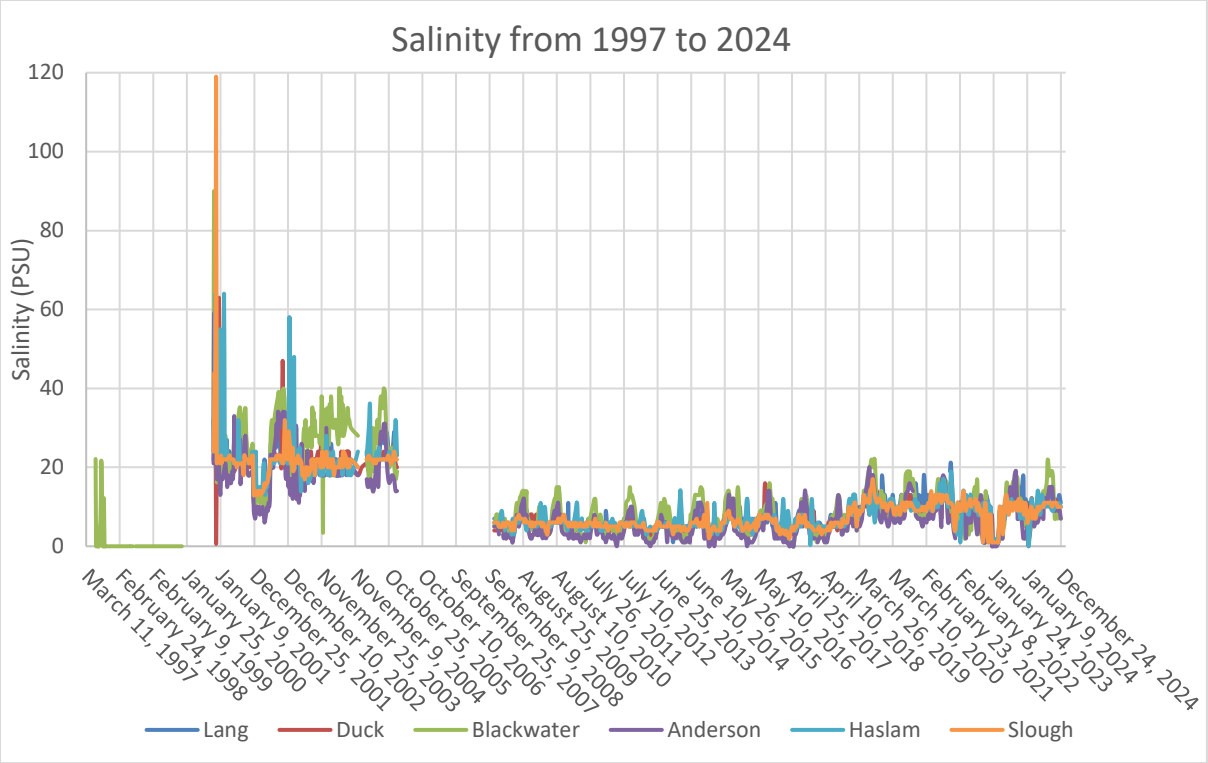

Chart 14: Salinity at six sites within the Haslam Lang Community watershed between 1997 and present.

6.0 DISCUSSION

Climate, weather, and land use affect water quality within the Haslam Lang community watershed. Precipitation controls the volume and timing of water that enters the watershed, which determines how much erosive power streams have and the proportion of stream flow composed by runoff and groundwater. Variances of these properties control the physical and chemical characteristics of the stream such as temperature, discharge, turbidity, pH, and salinity. Land use within the watershed affects the amount of dust and sediment on road surfaces and the amount of potential contaminants within the watershed. Forest harvesting can affect runoff and forest cover near streams, which influences discharge and water temperature. This section compares water quality measurements within the watershed to identify trends between variables and understand how the hydrology of the Haslam Lang Community watershed may vary over time.

Maintaining suitable water temperature is important for maintain healthy habitat within the watershed, as increasing water temperature results in lower water oxygen levels, which can kill aquatic organisms. Water temperatures are closely related to air temperature. The 2024 monthly average air temperatures in Powell River were 0.2°C to 1.0°C below normal from March to June, and up to 2.1°C above normal during the second half of the year, with the largest differences being in July and December. The warmest 2024 Lang Creek water temperature was 1.7°C more than in 2023. Bimonthly sampling also recorded warmer maximum water temperatures in 2024 than in 2023 at all other stations. 2024 did not have either as severe a drought or as high average temperatures as 2023 did, but it appears that the higher maximums in 2024 can be attributed to higher minimum temperatures in 2024 than in 2023. That is, overnight temperatures remained high and reduced the range of diurnal fluctuations.

Continuous water temperature monitoring in Duck Lake and in Lang, Anderson, and Blackwater Creeks show how water temperature varies in the watershed. The highest water temperatures occur on Duck Lake and Lang Creek, while Anderson and Blackwater creeks are much cooler. The larger surface area of Duck Lake and Lang Creek, along with the north-south orientation of Lang Creek, likely allow more solar heating than in Anderson and Blackwater Creeks, which flow roughly east-west and are shaded by forest. Additionally, the storage time of water in Duck Lake allows more solar heating than the flowing water in Anderson and Blackwater Creeks.

The 30-year average from 1981 to 2010 recorded 1.6 days above 30°C in Powell River. The Powell River A climate station recorded five days with temperatures above 30°C in 2024, which is less than 2023, which had eight days above 30°C. The most recent climate normal interval from 1991 to 2020 remains unpublished. We expect the 1991 to 2020 interval will have more annual days above 30°C than from 1981 to 2010. Despite the increased number of warmer days, water temperatures within the watershed remain within normal values recorded since 1997[2], and are even lower than some years between 1997 and 2013. The suitable water temperatures may be helped by effective land management strategies related to riparian retention that help maintain water temperature during the heat waves.

[2] With the exception of the single high biweekly temperature measurement from Haslam from late May, which may be measurement error.

Precipitation and temperature control runoff, groundwater, evaporation, and the intensity of floods and droughts. January, May, and September through November had higher precipitation than the 30-year average with increases from 13% to 38%. The rest of the year was drier than normal with February to April being 29% drier than the average, and June to August being 21% drier. Sunshine Coast and the Lower Mainland reached Stage 3 drought conditions and East Vancouver Island had Stage 4 drought conditions during the summer, reaching Stage 5 drought during the middle of August (BC Government Drought Information Portal, 2025). Stage measurements were low at all sites throughout the summer months of 2024 and increased towards the end of the year with the increased precipitation that fell in October. In 2024, Lang Creek had 91 days of flow below a reference discharge of 1 m^3/s. This is a shorter low flow period than 2023, which had 137 days and is the longest low flow period on record. The second longest low flow period was measured in 2022 with 117 days of flow below the same reference discharge. 2021, 2020, and 2019 each had 73 days, 46 days, and 86 days below 1 m^3/s, respectively.

Peak flow in Lang Creek in 2024 occurred in November, following a day of heavy precipitation. Other rainstorms with similar or higher intensity occurred during the fall and winter of 2024 but did not cause peak discharges as large as in November. With decreased groundwater levels in the spring and summer, as indicated by lower stage measurements in the creeks, the infiltration capacity of the land increased and reduced runoff and floods from similar rainstorms in late spring and early fall. October 18 received the highest amount of rain in a single day in 2024; however, the discharge measured on Lang Creek does not exceed the discharge observed following a smaller rainstorm in November. This is likely due to both soil moisture levels being depleted after the drought, the water level in Haslam Lake being lower than the weir during the drier summer months, and the reservoir being refilled with the increased precipitation throughout the early fall and therefore not providing it transported as streamflow down Lang Creek.

Following May, precipitation was 21% less than normal from June to August. This period was also 0.9°C warmer than normal, resulting in higher evaporation along with minimal precipitation. This resulted in a minimum discharge in Lang Creek of 0.352 m^3/s on September 22, which is 61% higher than the 2023 minimum and is within the range of minimum discharges recorded over the last five years. The average discharge in 2024 was 10% (0.5 m^3/s) lower than the average over the

past 5 years and the average temperature and total precipitation in 2024 was 2% (0.1°C) and 7% (83 mm) higher than the average over the same period. Compared to the previous year, 2024 had higher discharge and more precipitation with slightly lower temperatures.

Similar to discharge, the minimum stage measurements at all sites within the watershed were higher in 2024 than in 2023. The minimum stage and discharge in Lang Creek occurred around the same time in 2023 and 2024. The average stage measurements were the same or slightly higher in 2024, as compared to the previous year, at all six stations.

The minimum flow downstream of the dam that is required by the monitoring program was not met during the drier months of 2023 or in September 2024. This year, 24 days recorded minimum discharge values under 0.42 m^3/s, 23 of these days were in September. The first 18 days of October recorded discharge values under 0.71 m^3/s. In 2023, 78 days had minimum discharges under 0.42 m^3/s and the first 10 days in October had discharges under 0.71 m^3/s. The last time the minimum flow requirements were met was in 2021. The minimum stage measurements at Haslam Lake and Slough Station were slightly higher this year than in 2021 which might suggest that more water could have been released from Haslam Lake to help maintain minimum flow in Lang Creek this year.

Although low flows in Lang Creek were lower than the required minimum flow requirements, PRSS has not requested additional flow during the warmer months as they are concerned that the additional water from the warm lakes would warm all of Lang Creek and create an unfavourable environment for returning salmon and juvenile salmon in the system. Allowing discharges in Lang Creek to be lower than the required low flow through the weir during high temperature events results in Blackwater and Anderson Creeks contributing higher relative inputs of cooler water to lower Lang Creek. This keeps Lang Creek downstream of these two tributaries more hospitable during the spawning period and encourages salmonids in the system to preferentially move into these colder water tributaries to offset warm temperatures in the main creek. The Lang Creek discharge data shows little variability between about August 1 and September 22 suggesting that water levels in Haslam Lake fell below the elevation of the weir that controls water flow into Lang Creek. Water levels likely overtopped the weir after several rainstorms in late September to October, and all subsequent spikes represent the full drainage area of the watershed.

The turbidity levels in 2024 were relatively similar to the levels in 2023, with some stations reporting higher averages and some reporting lower. The turbidity spikes in most creeks are associated with elevated stage and discharge readings. The highest turbidity reading on Lang Creek occurred in mid-November, a few days after the highest discharge event in 2024. However, since this spike in turbidity is mainly observed at the Lang Creek station, which is downstream from the other stations, it is likely that the high turbidity is due to a local disturbance such as a tree falling into the channel or a small bank failure upstream. The peak rainfall on October 18 is not reflected in the bimonthly turbidity measurement recorded on October 21. However, turbidity was elevated in the readings that followed the second and third largest precipitation events in November and December. During the summer months, the absence of large rainstorms maintained low turbidity levels within the watershed in many creeks, until Haslam Lake overtopped the weir and resulted in higher stream flow and higher turbidity in Lang Creek.

Salinity and pH levels are related to the ratio of groundwater to surface runoff comprising stream flow. Groundwater contains dissolved solids that increase pH and salinity while rainstorms can capture air pollution that decreases pH and dilutes salinity. Past salinity and pH measurements are generally greater during the dry season when groundwater comprises a greater portion of stream flow, and lower during the wet season when precipitation runoff is greater. The 2024 salinity and pH measurements are low at the beginning of the year and begin to increase in March to April. At the end of the year, precipitation and streamflow increase resulting in decreasing pH and salinity. Salinity decreases at the end of the year in Duck Lake, Blackwater Creek, and Anderson Creek but stays elevated at Lang Creek, Haslam Lake, and Slough Station. Most of the high salinity and pH measurements occurred from May to October, when groundwater predominantly contributed to streamflow.

The peak (most basic) pH value recorded at Haslam Lake on November 7 does not correspond with peak salinity values at the lake. Precipitation in 2024 was 34% higher than last year, but only 1% higher than the 30-year normal. Precipitation can both increase and decrease pH and salinity results. When the ground is saturated, precipitation runs directly into streams, both diluting groundwater and potentially adding contaminants, thereby decreasing pH and salinity. At lower precipitation rates or immediately after dry conditions, precipitation can recharge ground water

levels and increase the outflow of older ground water entering streams, thereby increasing salinity and pH. Additionally, periods of below average precipitation could have resulted in each rainstorm delivering pulses of water of varying quality to the creeks, resulting in larger decreases and variable data. Overall, both pH and salinity varied throughout the year but are within the normal variability recorded from 1997 to present. The data suggests that management practices within watershed have been effective at maintaining water quality.

The 2019 and 2020 water quality reports by Statlu identified that salinity increased from 2018 to 2019 and remained elevated from 2019 to 2020. PRSS purchased a new salinity probe for the 2021 monitoring program to ensure that the increased salinity measurements were not caused by equipment error. The measured salinity in 2021 was about 10% lower than in 2020 but remained greater than values recorded in early 2018. The salinity measurements in 2024 are similar to the previous three years which have used the new salinity probe. If the increased salinity resulted from equipment error, the salinity would have abruptly returned to early 2018 levels after the probe was replaced. The gradual increase and then decrease of salinity since 2018 indicates the trend is real and not a result of equipment error.

The 2024 data shows that water quality remains within acceptable levels within the watershed. The relatively low levels of turbidity and salinity, along with stable pH values, suggest that watershed management practices have been effective in limiting sediment production and reducing the volume of water that transports sediment and contaminants from roads and ditches directly into streams.

The PRSS has previously noted that the sloughs are popular recreation areas and garbage can be left near the water. Water sampling for general chemistry parameters such as fecal coliform, total metals, and $CaCO_3$ equivalent were last completed in 2010 (Carson, 2018). Additional data collection of these parameters could quantify how human activity affects water quality and would be useful to maintain a robust baseline monitoring program.

7.0 CONCLUSION

The Powell River Salmon Society (PRSS) has monitored water quality within the Haslam Lang Community Watershed since 1997. The watershed supplies drinking water to the City of Powell River and the community of Brew Bay. It provides important habitat for salmon species, and the PRSS operates a hatchery on Lang Creek. Maintaining water quality is important for providing healthy drinking water and maintaining clean salmon habitat.

PRSS retained Statlu Environmental Consulting Ltd. (Statlu) to analyze water quality data collected during the 2024 monitoring program and to compare the results with data from previous years. PRSS recorded water temperature, creek stage, turbidity, pH, and salinity twice per month at six locations within the watershed. The measurements were taken at Lang Creek near the Alex Dobler Salmon Centre, the outlet of Duck Lake, Anderson Creek, Blackwater Creek, Haslam Lake, and the weir at the outlet of Haslam Lake named Slough Station. The water quality monitoring program, which began in 1997, documents a long period within the watershed which is a valuable tool for establishing baseline conditions. This allows land managers to detect potential problems and implement solutions to maintain good water quality for fish and water users.

The watershed received 34% more precipitation in 2024 than the previous year, and 1% more than the 30-year average from 1981 to 2010. The spring and summer were 29% and 21% drier than normal which resulted in relatively low stage and discharge measurements during the warmer months. The minimum biweekly Lang Creek stage measurement of 0.29 m was recorded on September 6, which is 0.04 m higher than the minimum recorded in 2023.

The maximum biweekly water sampling temperatures in 2024 were warmer than 2023 at all stations. Duck Lake had the highest recorded temperature this year at 25.0 °C, which is 0.9 °C warmer than the 2023 maximum which was also recorded at Duck Lake. The maximum water temperature from continuous measurements on Lang Creek in 2024 was 1.7°C higher than the 2023 maximum.

Turbidity, pH, and salinity generally varied within the normal and acceptable range for 2024. The average turbidity measurements from Lang Creek, Blackwater Creek, and Anderson Creek were 17% to 30% lower than the 2023 values, and the average turbidity measurements from the rest of

the station were 2% to 18% higher. The maximum turbidity on Lang Creek (5.2 NTU) is 49% lower than the 2023 bimonthly maximum of 10.2 NTU and 6% lower than the 2022 maximum of 5.6 NTU. Five readings were above 2 NTU but were well within the range of turbidity measurements recorded since 1997. Average pH measurements were the same or slightly higher (less acidic) than the measurements from 2023. There was one day that had slightly elevated pH measurements recorded at Haslam Lake, however the range remains within normal variability and is much less than pH variation recorded in earlier years. Average salinity at all six stations recorded 13% to 35% higher than average salinities in 2023 and maximum values ranged from a 22% decrease at Lang Creek to a 22% increase at Blackwater Creek in comparison to 2023 maximum readings. This water quality data suggests that forest management strategies intended to protect water quality within the watershed remain successful.

8.0 LIMITATIONS

The recommendations provided in this report are based on observations made by Statlu and are supported by information Statlu gathered. Observations are inherently imprecise. Conditions other than those indicated above may exist on the site. If such conditions are observed or if additional information becomes available, Statlu should be contacted so that this report may be reviewed and amended accordingly.

This report was prepared considering circumstances applying specifically to Powell River Salmon Society and the forestry organizations which provide funding for the water quality sampling. It is intended only for internal use by the client for the purposes for which it was commissioned and for use by government agencies regulating the specific activities to which it pertains. It is not reasonable for other parties to rely on the observations or conclusions contained herein.

Statlu prepared the report in a manner consistent with current provincial standards and on par or better than the level of care normally exercised by Professional Geoscientists and Professional Agrologists currently practicing in the area under similar conditions and budgetary constraints. Statlu offers no other warranties, either expressed or implied.

9.0 CLOSURE

Please contact me should you have any questions or if you require further clarification.

Yours truly,

Statlu Environmental Consulting Ltd.

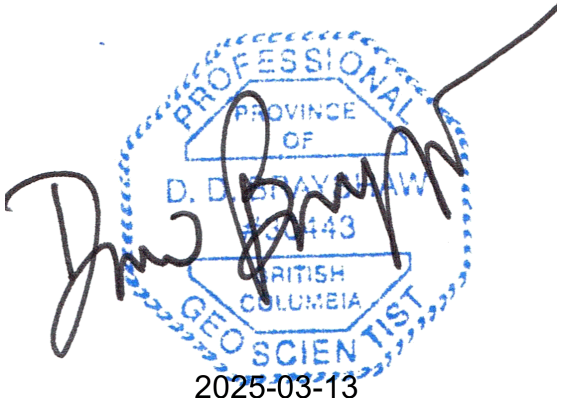

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Figure 1: Monitoring Stations within Haslam Lang Community Watershed

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APPENDIX 2: PHOTOS

Photo 1: Slough Station at the outlet of Haslam Lake.

Photo 2: Fine sediment and clean water in a low-gradient reach of Blackwater Creek.

Photo 3: Tidbit housing maintenance on Anderson Creek.