Roddy Creek and Avola Creek Watershed Source Protection

Direct Impacts from Forestry Practices on Licensed Water Sources

William Shulba, P.Geo
Watershed Geoscientist

TECHNICAL LETTER
Independent Assessment
July 2022

The Issue

As of 2021 there has been impacts on drinking water license number F043942 near Avola, BC. William Shulba, P.Geo was made aware of direct impacts from forestry operations on this water source in September 2021.

On October 18, 2021, William Shulba made a site visit to the subject property that was guided by the landowner, Nels Olson. At that time, there were active impacts from forestry operations, mainly road building, that was transporting visible sediment to the licensed water works and generating significant drinking water impacts in the point of diversion and licensed linear works, (line ID: 556501469). At that time, the main crossing of Roddy Creek was not completed and the culvert was not installed. Attached is a photo log demonstrating visual impacts on the landowners water system.

The License

The water license is on a private domestic property near the town of Avola, BC an unincorporated community located in the Thompson-Nicola Regional District of British Columbia. The civic address is 4137 Messiter Station Rd, legal description DISTRICT LOT 4043 KAMLOOPS DIVISION YALE DISTRICT, parcel ID 013-222-449 approximately 18 acres, RL-1 zoning, with primary use of domestic homesteading that includes small scale agriculture.

The water license F043942, with a date of precedent of August 17, 1959, approximately 63 years on Roddy Creek for 4,546 Litres per day at latitude 51.8018, longitude -119.3231 within the Kamloops / North Branch district precinct in the water license watershed "UNTH-Avola".

Geology

The geology of the area is dominated by metamorphic fractured bedrock of the Shuswap Assemblage of Proterozoic to Paleozoic age. The original description *"undivided quartzofeldspathic gneiss, biotite-quartz schist (commonly with sillimanite, kyanite, garnet or staurolite), amphibolite, quartzite, marble, calc-silicate rock and skarn; abundant and locally dominant pegmatite, muscovite granite."* The specific unit associated with the water license area is Malton Complex.

There are no mapped aquifers in the area, although the fractured bedrock hosts significant amounts of groundwater resources that is exploited throughout the region. In the vicinity of the license parcel are many springs that manifest on topographic benches that source positive head boundary (source) the creeks in the area including, but not limited to, Roddy Creek.

Climate Data

The current operating weather station in the area is at BLUE RIVER operated by ECCC – MSC, Latitude:52°07'44.400" N Longitude:119°17'23.700" W Elevation:682.80 m Climate ID:1160H99 WMO ID:71883. The climatic averages are presented below. Although these climate normal are from 1981-2010, Pacific Climate Impacts Consortium have estimated that winters will be milder and wetter and summers will be hotter and drier and spring flooding will be increased.

Table 1. Historic Canadian Climate Normals, Blue River, BC 1981-2010

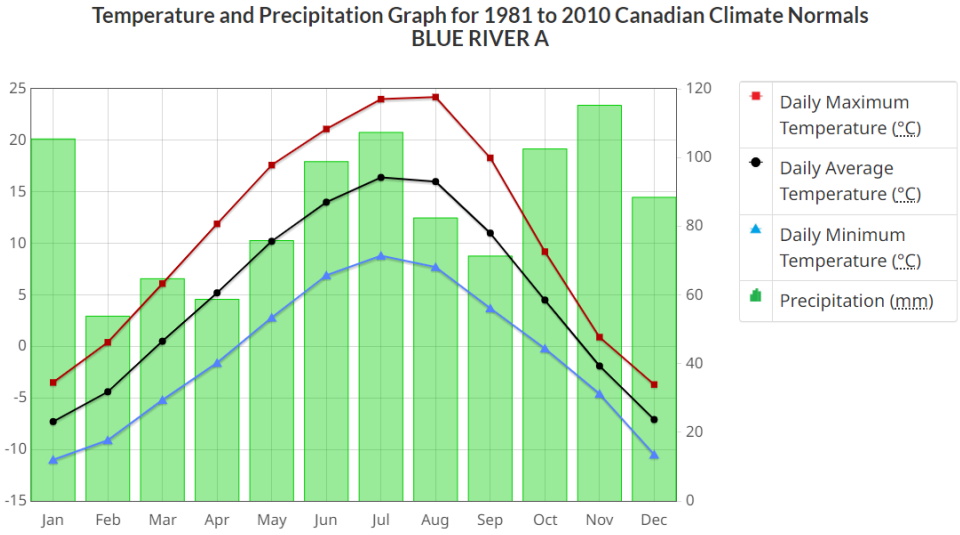
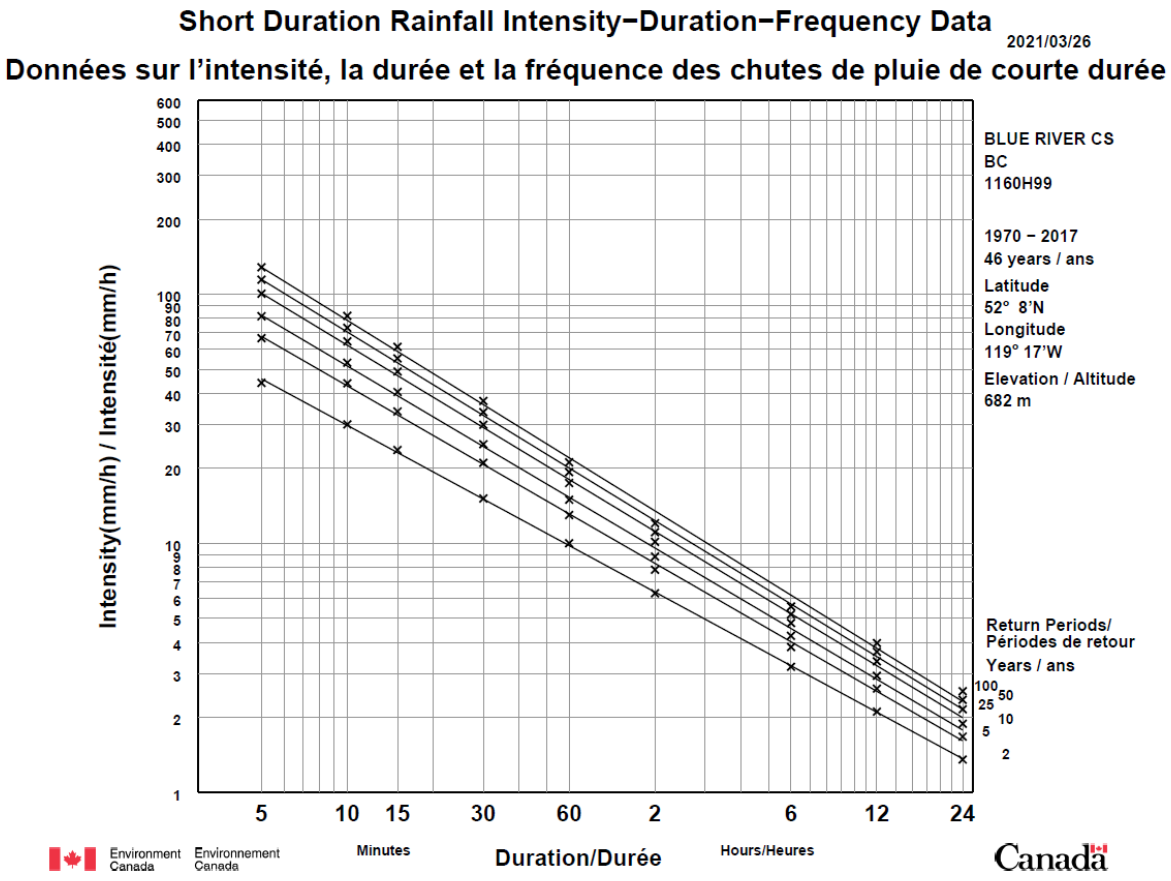


Table 2. Canadian Climate Normals Precipitation, Blue River, BC 1981 -2010

1981 to 2010 Canadian Climate Normals station data

Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	21.3	17.6	35.8	52.7	75.6	98.8	107.3	82.4	71.3	94.0	49.5	13.5	719.7
Snowfall (cm)	113.5	49.5	38.3	7.0	0.4	0.0	0.0	0.0	0.0	10.0	82.4	103.4	404.4
Precipitation (mm)	105.4	53.8	64.7	58.7	75.8	98.8	107.3	82.4	71.3	102.5	115.2	88.4	1024.4
Average Snow Depth (cm)	72	78	62	13	0	0	0	0	0	0	14	43	24
Median Snow Depth (cm)	71	77	64	9	0	0	0	0	0	0	13	44	23
Snow Depth at Month-end (cm)	81	76	40	1	0	0	0	0	0	2	26	53	23
Extreme Daily Rainfall (mm)	30.6	17.8	22.0	31.6	29.2	44.4	44.9	35.1	40.4	**47.4**	38.8	35.8	
Date (yyyy/dd)	1992/ 31	1971/ 14	1993/ 06	2003/ 25	2002/ 20	1999/ 09	2006/ 09	1975/ 21	1978/ 02	**2003/ 16**	1983/ 15	1980/ 14	
Extreme Daily Snowfall (cm)	**56.1**	29.7	33.2	10.8	3.0	0.0	0.0	0.0	3.8	34.8	33.3	51.8	
Date (yyyy/dd)	**1972/ 21**	1975/ 10	1993/ 14	2003/ 03	1999/ 07	1970/ 01	1970/ 01	1970/ 01	1972/ 23	1975/ 29	1972/ 30	2000/ 16	
Extreme Daily Precipitation (mm)	41.8	22.9	26.2	32.0	29.2	44.4	44.9	35.1	40.4	**47.4**	42.4	45.6	
Date (yyyy/dd)	1986/ 18	1972/ 27	1993/ 14	2003/ 25	2002/ 20	1999/ 09	2006/ 09	1975/ 21	1978/ 02	**2003/ 16**	1998/ 12	1980/ 14	
Extreme Snow Depth (cm)	**175**	155	157	107	15	0	0	0	3	21	69	115	
Date (yyyy/dd)	**1972/ 22**	1974/ 04	1972/ 05	1975/ 03	1982/ 01	1970/ 01	1970/ 01	1970/ 01	1972/ 28	2004/ 23	1973/ 28	1984/ 21	



License Watershed Hydrology

The license is sourced from Roddy Creek within the North Thompson River watershed.

Table 3. Creek Watershed Source, Roddy Creek and Avola Creek, BC

Creek Watershed	Sub-Catchment Area (Ha)	Gradient length (m)	Headwater Elevation (m asl)	Crossing Elevation (m asl)	Slope (m/m)
Roddy Creek	424.5	3405	1767	600	0.343
Avola Creek	305.5	3754	1876	637	0.330

Time of Concentration Estimation

Time of concentration (t_{ch}) for a watershed is a widely used time parameter to estimate peak discharges in hydrologic designs. The time of concentration of a watershed is the time required for runoff to travel from the hydraulically most distant point to the outlet of a watershed.

Time of concentration was determined for each catchment and combined to produce a fundamental watershed parameter that determines the peak discharge for the crossing. The Kirpich method was appropriate to determine time of concentration.

Where;

$$t_{ch} = KL^{0.770}S^{-0.385}$$

t_{ch} time of concentration
K unit conversion coefficient (0,195 SI units)
L Travel Length (m)
S slope (unitless)

Table 1.*Rational Method Stream Hydraulics for the Kirpich Method*

Creek Watershed	Slope (m/m)	Travel length (m)	Time of Concentration (min)
Roddy Creek	0.343	21124	63
Avola Creek	0.330	12017	41

Rational Method Watershed Forecasting

The estimated discharge of overland flow draining from each sub-catchment contributing to the water licenses crossing was estimated using the rational method using the equation and then summed:

$$Q = 0.278\ (CiA)$$

Where;

Q *the volume of overland flow draining off the sub-catchment in (m^3/s)*
C *runoff coefficient (typically in forest environments this ranges from 0.05 – 0.25*
i *rainfall intensity for each return period or flood year (in mm/hr)*
A *area of the sub-catchment (km^2)*
0.278 *standard unit conversion factor*

The runoff coefficient for forested environments is typically 0.05 – 0.25. From vegetation surveys and other basin analysis; a runoff coefficient of 0.2 was selected for each catchment. Rainfall intensity was derived from the IDF values from Blue River CDA climate station. Peak discharge at selected

return-periods of 5-year, 10-year, 25-year, 50-year, and 100-year were determined for the sub-catchment area and it is conservatively assumed that all of the overland flow entering the streams during flooding conditions exists the sub-catchment through the crossing.

It is assumed that groundwater infiltration and evapotranspiration net change is minimal within the watershed and therefore not factored into flood hydrology analysis. Snowpack influence has also not been factored into flood hydrology analysis and therefore rain-on-snow events may produce flood volumes that are higher than those estimated by this method. For return periods a 10% conservative safety factor was applied to the discharge rates to address landscape variability and climate change.

Table 2. *Rational Method Peak Stream Discharge*

Crossing ID	Return-Period (year)	Rainfall Intensity (mm/hr)	Peak Discharge (m^3/s)	Adj. Peak Discharge (m^3/s)
Roddy Creek Watershed (62 min)	100	20	4.4	**5.1**
	50	19	4.2	**4.8**
	25	18	4.0	**4.6**
	10	15	3.3	**3.8**
	5	12	2.6	**3.0**
	2	10	2.2	**2.5**
Avola Creek Watershed (41 min)	100	30	6.1	**7.0**
	50	28	6.2	**7.1**
	25	25	5.5	**6.3**
	10	20	4.4	**5.1**
	5	18	4.0	**4.6**
	2	12	2.6	**3.0**

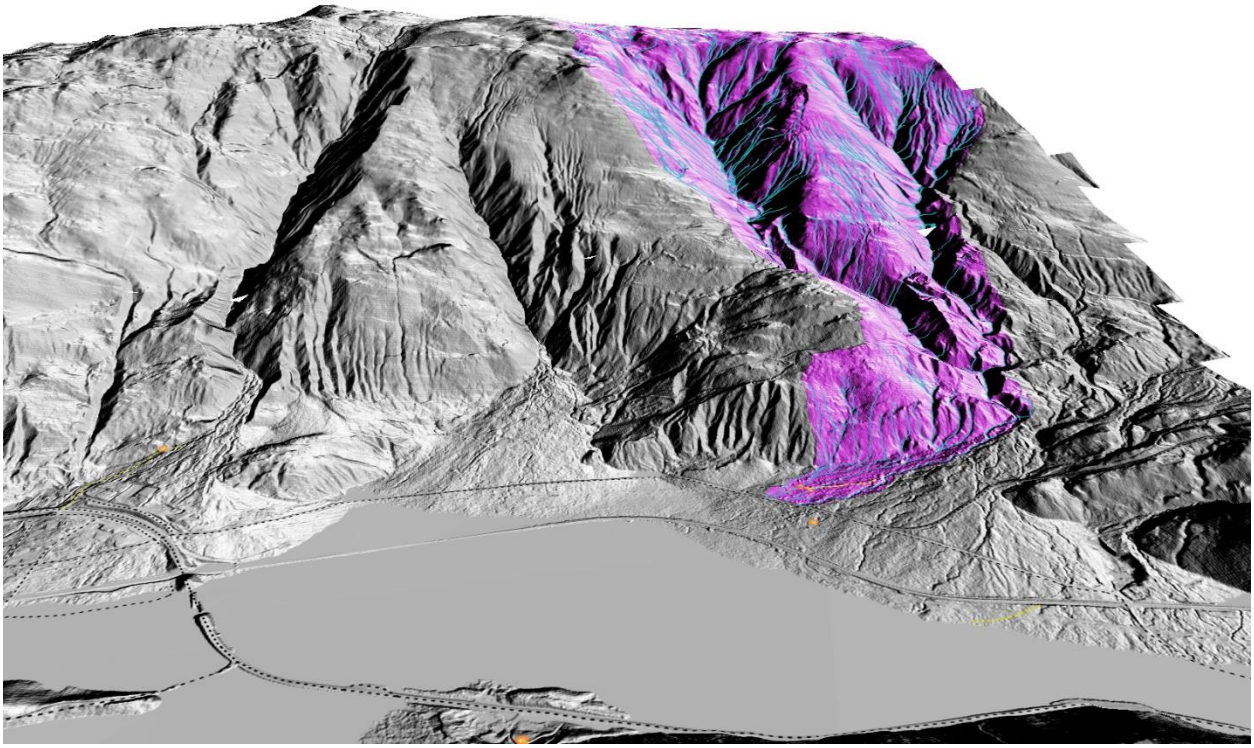


Figure 1. *3D View of Roddy Creek Watershed*

Forestry Operations Impacts to Water License

Through personal communications with the landowners, it is known that Avola area watersheds have a legacy of preservation and protection by community efforts and through sensible forestry management. Older second growth forests in sensitive watersheds were not traditionally included in forestry operations. The mature forests of the Avola and Roddy Creeks are likely the main contributing factor to sustainable licensed water resources on those creeks.

However, over the past years, sensitive watershed areas have been considered for intensive logging. Due to the significant topographic slope of the Avola Creek and Roddy Creek watersheds and the unique fractured/weathered bedrock that underlay the forest floor; intensive forestry operations in these watersheds like significant road cutting in the vicinity of the riparian areas and Streamside Protection and Enhancement Area (SPEA) is likely to cause significant and ongoing sediment transport into the receiving creeks. Sediment transport from erosion of forest floors and weathered bedrock can carry other bacteriological and chemical contaminants including but not limited to coliforms, heavy metals, and compounds that impacts pH and salinity of source water.

The recent road building extending from Avola Mountain Forestry Road and into the Roddy Creek is a significant industrial operation in a serene watershed. The approach angle of the road to the main creek crossing has outcropped many vertical metres of fractured bedrock by tens of meters in length. This has exposed water-saturated fractures that were actively springing into the road ditch. The downslope of the road is very steep and the vegetation has been removed down the slope to the creek. There were no natural or unnatural erosion mitigation measures to discourage sediment movement from the road and associated construction to the creek. It is likely that the groundwater discharge from the exposed rock-cut will not subside and that it will provide persistent

groundwater flow into the road ditch and eventually into the creek. Although the quantity of the groundwater discharge may be less significant compared to the surface water discharge, the concentration of solute that is carried by weathered bedrock can have significant impact to the water quality of the creek.

Water Quality Monitoring to Assess Impacts

On November 4, 2021 after noticing a visual spike in turbidity in their water system, the landowners collected water samples under the direct supervision of an Environmental Scientist competent and experienced in water quality monitoring and sample collection. Samples were submitted to ALS Laboratory in Kamloops, BC. Samples were analysed for routine chemistry, total metals, and coliform matter. On November 22, 2021 BCTS collected several water samples located upstream of their logging activities which were analysed for total metals and coliform matter. A review of the results show significant increase of select metals, coliform matter, and turbidity in the landowners water system when compared to results from upstream sample results. In particular analytical results from the landowner's samples exceeded Canadian Drinking Water Quality Guidelines for Maximum Acceptable Concentrations for coliform, aluminum, lead, manganese, and uranium.

Conclusions

Impacts to those licenses with a date of precedent of over half a century must be considered and are likely irreplaceable. The forestry operations in the headwaters of Roddy Creek have caused significant impact to the drinking water license F043942 with a date of precedent of August 17, 1959. It was identified by William Shulba, P.Geo in October 2021, that drinking water was directly disrupted by forestry practices in the Roddy Creek watershed specifically road building in the area. Further investigation included water samples collected from within the landowners potable water supply, results have which show several exceedances of Canadian Drinking Water Guidelines for Aesthetic Objective/Operational Guideline as well as exceedances of select metals and coliform matter for Maximum Acceptable Concentrations. Although some attention was given to this from the operators and BCTS, there was little compensation or alteration to the forestry practice to mitigate these issues or improve the landowners water system to meet code.

Recommendations

It is recommended that:

- The forestry operations in the Roddy Creek watershed be suspended and investigated by Ministry of Forests staff to ensure that the road building will not cause continued impacts to Roddy Creek, including but not limited to impacts to drinking water licenses and salmon habitat.

- Mitigation measures be established immediately to stop erosion and road cut groundwater from directly entering Roddy Creek and that those mitigation measures be implemented under the direct supervision of a Qualified Environmental Professional (QEP).

- Intensive forestry operations not continue in the Avola and Roddy Creek Watersheds for the protection of the drinking water licenses that source from those waterbodies.

- Water quality monitoring should be continued at the expense of the contractor, and under direct supervision of an engineer or geoscientist with competency in water quality monitoring.

Closure

This technical letter was written by William Shulba, P.Geo without compensation nor contract and provided a general watershed analysis and stream crossing hydrology for the purposes of recommendation for the protection of water license F043942 with a date of precedent of August 17, 1959 . This analysis and report was a desktop study that utilized basic survey elevation provided by LiDARBC, open-source data from the Regional District of Thompson-Nicola and the Province and laboratory test results collected by landowners from within their water system, and BCTS from up steam of logging and road building operations.

This technical letter pertains to a specific area, a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation of the site or development of the water license resource would necessitate a supplementary investigation and assessment.

This technical letter and the assessments and recommendations contained in it are intended for the sole use of educating the landowner of the parcel that contains water license F043942 with a date of precedent of August 17, 1959. The undersigned does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than educational purposes of the landowner unless otherwise authorized in writing by the undersigned.

This technical letter is based solely on the conditions which existed within the study area or on site at the time of investigation. The landowner and any other parties reviewing this letter with the express written consent of the undersigned, acknowledge that conditions affecting the environmental assessment of the site can vary with time and that the conclusions and recommendations set out in this report are time and subject sensitive.

Any party using this technical letter with the express written consent of the undersigned, acknowledge that the conclusions and recommendations set out in this technical letter are based on limited observations on the area and subject site and that conditions may vary across the site which, in turn, could affect the conclusions and recommendations made. The reviewer of this letter acknowledges that the undersigned is neither qualified to, nor is it making, any recommendations with respect to the maintenance, mitigation, purchase, sale, investment or development of the water license and property, the decisions on which are the sole responsibility of landowner.

During the performance of the work and the preparation of this letter, the undersigned may have relied on information provided by persons other than the landowner, including information from the Province and BCTS. While the undersigned endeavours to verify the accuracy of such information the undersigned accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

Services performed by the undersigned for this report have been conducted in a manner consistent with the level of skill ordinarily exercised by members of

the Engineering and Geoscience profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Engineering and geoscience judgement has been applied in developing the conclusions and/or recommendations provided in this report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of this report.

The undersigned professional, William Shulba, P.Geo is a professional geoscientist in good standing with the Engineers and Geoscientists of BC and has strived to utilize the most up to date guidance documentation and software packages for the analysis of this project and that there was no monetary exchange nor contract for this letter. This letter was hand delivered to the landowner for their educational purposes
Thank you for your consideration of these limitation and hope that they are received in good faith. If you have any questions please contact William Shulba, P.Geo to have your questions or concerns addressed appropriately.

Thank you for your time and consideration,
William Shulba, P.Geo

Appendix A. Photo Log

Photo 1. Erosion on Logging Road Above Landowners Water Supply November, 2021

Photo 2. Steep Road Construction and Erosion November, 2021

Photo 3. Road Construction Eroding into Roddy Creek November, 2021

Photo 4. Sediment Control Structures Requiring Maintenance with Extremely Turbid Water, November, 2021

Photo 5. Sediment Build Up in Landowner’s Water System Intake

Photo 6. Sediment Build Up on the Water Intake of the Landowner’s Water System

Photo 7. Turbid Water in Spring Near Landowners Water System Intake

Photo 8. Turbid Water in Landowners Water System Intake, November 2021

Photo 9. Highly Turbid Water in Landowners Water System with Plume of Sediment Visible, September 2021

Photo 10. Extremely Turbid Water in Landowners Water System, August 2021

Appendix B. Tabulated Water Quality Analytical Results

Appendix B Water Quality Analytical Results, 4317 Messiter Stn Rd Avola, BC

Sample Information									
Sampling ID	Sampling Date	Dissolved Nitrite (N)	Dissolved Nitrate (N)	Turbidity	Colour, true	Chloride	Fluoride	Sulfate (SO4)	Coliforms, Thermotolerant (Fe
	(dd-mmm-yyyy)	mg/L	mg/L	NTU	CU	mg/L	mg/L	mg/L	CFU/100ml
Groundwater Samples									
Seepage	22-Nov-2021	NA	NA	***26.3***	***41.9***	NA	NA	NA	<1
Bridge Upstream	22-Nov-2021	NA	NA	***0.54***	<5.0	NA	NA	NA	<1
Bridge Downstream	22-Nov-2021	NA	NA	***1.69***	5	NA	NA	NA	<1
Hydro Upstream	22-Nov-2021	NA	NA	***0.6***	<5.0	NA	NA	NA	<1
2800 CMP Upstream	22-Nov-2021	NA	NA	***0.25***	<5.0	NA	NA	NA	<1
2800 CMP Downstream	22-Nov-2021	NA	NA	***0.41***	<5.0	NA	NA	NA	<1
POD	22-Nov-2021	NA	NA	***0.6***	<5.0	NA	NA	NA	1
Pond (Collected by Owner)	4-Nov-2021	0.0011	0.0492	***192***	9.9	<0.50	0.092	4.71	NA
Canadian Drinking Water Quality, Aesthetic Objective/Operational Guideline		**NG**	**NG**	**0.1**	**15**	**250**	**NG**	**NG**	
Canadian Drinking Water Quality, Maximum Acceptable Concentrations		**1**	**10**	**NG**	**NG**	**NG**	**1.5**	**NG**	

Notes:

Analytical results greater than the referenced Canadian Drinking Water Maximum Acceptable Concentration shown in **red highlighted font**

Analytical results greater than the referenced Canadian Drinking Water Maximum Acceptable Concentration shown in ***italicized font***

NA - not analyzed

NG - no guideline

mg/L - milligrams per litre

µg/L - micrograms per litre

Table 1

Water Quality Sample Analytical Results - Routine Parameters
2021 Water Quality Test Results 314 Messiter Station Rd, Avola BC

							Laboratory Analytical Results											
Total Coliforms	Coliforms, E. Coli	Hardness (CaCO3)	Total Dissolved Solids	Conductivity	pH	Alkalinity (Total as CaCO3)	Total Aluminum (Al)	Total Antimony (Sb)	Total Arsenic (As)	Total Barium (Ba)	Total Beryllium (Be)	Total Bismuth (Bi)	Total Boron (B)	Total Cadmium (Cd)	Total Calcium (Ca)	Total Cesium	Total Chromium (Cr)	Total Cobalt (Co)
MPN/100ml		mg/L	mg/L	uS/cm	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NA	NA	9.43	NA	NA	NA	NA	***2.75***	<0.00010	0.00024	0.0297	0.000135	0.000065	<0.010	0.0000131	2.06	0.000359	0.0022	0.00078
NA	NA	45.3	NA	NA	NA	NA	0.0516	<0.00010	<0.00010	0.00496	<0.00010	<0.000050	<0.010	<0.0000050	14.7	0.000015	<0.00050	<0.00010
NA	NA	44.1	NA	NA	NA	NA	***0.14***	<0.00010	<0.00010	0.00604	<0.00010	<0.000050	<0.010	<0.0000050	14.2	0.00003	<0.00050	<0.00010
NA	NA	45.1	NA	NA	NA	NA	0.0519	<0.00010	<0.00010	0.00485	<0.00010	<0.000050	<0.010	<0.0000050	14.7	0.000018	<0.00050	<0.00010
NA	NA	48	NA	NA	NA	NA	0.0292	<0.00010	<0.00010	0.00392	<0.00010	<0.000050	<0.010	<0.0000050	15.9	0.000016	<0.00050	<0.00010
NA	NA	46.8	NA	NA	NA	NA	0.0439	<0.00010	<0.00010	0.00399	<0.00010	<0.000050	<0.010	<0.0000050	15.6	0.000021	<0.00050	<0.00010
NA	NA	46	NA	NA	NA	NA	0.0631	<0.00010	<0.00010	0.00473	<0.00010	<0.000050	<0.010	<0.0000050	15.1	0.000018	<0.00050	<0.00010
727	5	78.8	65	112	7.69	63.5	*8.85*	<0.0050	0.00112	0.0798	NA	NA	<0.100	0.000244	24.3	NA	0.0108	NA
NG	**NG**	**NG**	**500**	**NG**	**7.0-10.5**	**NG**	**0.1**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**
1	**1**	**NG**	**NG**	**NG**	**NG**	**NG**	**2.9**	**0.006**	**0.01**	**2**	**NG**	**NG**	**5**	**0.007**	**NG**	**NG**	**0.05**	**NG**

Total Copper (Cu)	Total Iron (Fe)	Total Lead (Pb)	Total Lithium (Li)	Total Magnesium (Mg)	Total Manganese (Mn)	Total Molybdenum (Mo)	Total Mercury (Hg)	Total Nickel (Ni)	Total Phosphorous (P)	Total Potassium (K)	Rubidium (Rb)	Total Selenium (Se)	Total Silicon (Si)	Total Silver (Ag)	Total Strontium (Sr)	Total Sodium (Na)	Total Uranium (U)	Total Zinc
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.00314	***2.07***	0.00111	0.0032	1.04	***0.0716***	0.000393	<0.0000050	0.0018	0.073	1.46	0.00709	0.00019	10.6	0.000022	0.0198	1.85	0.000622	0.0067
<0.00050	0.036	<0.000050	0.0023	2.08	0.00178	0.00192	<0.0000050	<0.00050	<0.050	0.657	0.00089	<0.000050	4.91	<0.000010	0.138	1.85	0.00737	<0.0030
0.00103	0.118	0.000096	0.0023	2.1	0.00362	0.00181	<0.0000050	0.00053	<0.050	0.728	0.00121	<0.000050	5.28	<0.000010	0.132	1.94	0.00753	<0.0030
<0.00050	0.036	<0.000050	0.0023	2.04	0.00167	0.0019	<0.0000050	<0.00050	<0.050	0.656	0.00092	<0.000050	5.04	<0.000010	0.144	1.84	0.00768	<0.0030
<0.00050	0.022	<0.000050	0.0024	2.01	0.00091	0.00153	<0.0000050	<0.00050	<0.050	0.693	0.0008	<0.000050	5.03	<0.000010	0.121	1.86	0.00476	<0.0030
<0.00050	0.038	<0.000050	0.0024	1.9	0.00156	0.00143	<0.0000050	<0.00050	<0.050	0.68	0.00084	0.000074	4.83	<0.000010	0.115	1.78	0.00479	<0.0030
<0.00050	0.046	<0.000050	0.0022	2.01	0.00152	0.0016	<0.0000050	<0.00050	<0.050	0.71	0.00094	<0.000050	5.05	<0.000010	0.121	1.92	0.00526	<0.0030
0.0264	***9.91***	0.0101	NA	4.4	***0.33***	NA	0.0000504	NA	NA	2.12	NA	0.00162	NA	NA	NA	2.33	0.106	<0.0500
1	**0.3**	**NG**	**NG**	**NG**	**0.02**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**	**NG**		**200**	**NG**	**5**
2	**NG**	**0.005**	**NG**	**NG**	**0.12**	**NG**	**0.001**	**NG**	**NG**	**NG**	**NG**	**0.05**	**NG**	**NG**		**NG**	**0.02**	**NG**

Appendix C. ALS Laboratory Reports

CERTIFICATE OF ANALYSIS (GUIDELINE EVALUATION)

Work Order	: **KS2103651**	Page	: 1 of 6
Client	: **Cash Clients Canada**	Laboratory	: Kamloops - Environmental
Contact	: Kris Olson	Account Manager	: Caitlin Fountain
Address	: BC Canada	Address	: 1445 McGill Road, Unit 2B Kamloops, British Columbia Canada V2C 6K7
Telephone	: 778-208-4781	Telephone	: 250 372 3588
Project	: 4137 Messiter Stn Rd, Avola BC	Date Samples Received	: 04-Nov-2021 13:15
PO	: ----	Date Analysis Commenced	: 04-Nov-2021
C-O-C number	: 20-933883	Issue Date	: 09-Nov-2021 13:28
Sampler	: ----		
Site	: ----		
Quote number	: Kamloops Cash Client Pricing		
No. of samples received	: 1		
No. of samples analysed	: 1		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Guideline Comparison

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Lampreau	Laboratory _ Supervisor	Microbiology, Kamloops, British Columbia
Angela Ren	Team Leader - Metals	Metals, Burnaby, British Columbia
Caleb Deroche	Lab Analyst	Metals, Burnaby, British Columbia
Miles Gropen	Department Manager - Inorganics	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.
Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guidelines are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

Key : LOR: Limit of Reporting (detection limit).

Unit	*Description*
µS/cm	Microsiemens per centimetre
CU	colour units (1 CU = 1 mg/L Pt)
mg/L	milligrams per litre
MPN/100mL	most probable number per 100 mL
NTU	nephelometric turbidity units
pH units	pH units

>: greater than.
<: less than.
Red shading is applied where the result is greater than the Guideline Upper Limit or the result is lower than the Guideline Lower Limit.
For drinking water samples, Red shading is applied where the result for E.coli, fecal or total coliforms is greater than or equal to the Guideline Upper Limit.

Analytical Results

Sub-Matrix: Water (Matrix: Water)			Client sample ID	4137 Messiter Stn Rd Avola BC						
			Sampling date/time	03-Nov-2021 20:25						
Analyte	*Method*	*LOR*	*Unit*	KS2103651-001	**CDWG AO/OG**	**CDWG MAC**				
Physical Tests										
alkalinity, total (as CaCO3)	E290	1.0	mg/L	63.5	--	--				
colour, true	E329	5.0	CU	9.9	**15**	--				
conductivity	E100	2.0	µS/cm	112	--	--				
pH	E108	0.10	pH units	7.69	**7 - 10.5**	--				
solids, total dissolved [TDS]	E162	10	mg/L	65	**500**	--				
turbidity	E121	0.10	NTU	192	**0.1**	--				
hardness (as CaCO3), from total Ca/Mg	EC100A	0.60	mg/L	78.8	--	--				
Anions and Nutrients										
chloride	E235.Cl	0.50	mg/L	<0.50	**250**	--				
fluoride	E235.F	0.020	mg/L	0.092	--	**1.5**				
nitrate (as N)	E235.NO3-L	0.0050	mg/L	0.0492	--	**10**				
nitrite (as N)	E235.NO2-L	0.0010	mg/L	0.0011	--	**1**				
sulfate (as SO4)	E235.SO4	0.30	mg/L	4.71	--	--				
Bacteriological Tests										
coliforms, total	E010	1	MPN/100mL	727	--	**1**				
coliforms, Escherichia coli [E. coli]	E010	1	MPN/100mL	5	--	**1**				
Total Metals										
aluminum, total	E420	0.0100	mg/L	8.85	**0.1**	**2.9**				
antimony, total	E420	0.00050	mg/L	<0.00050	--	**0.006**				
arsenic, total	E420	0.00010	mg/L	0.00112	--	**0.01**				
barium, total	E420	0.0200	mg/L	0.0798	--	**2**				
boron, total	E420	0.100	mg/L	<0.100	--	**5**				
cadmium, total	E420	0.000200	mg/L	0.000244	--	**0.007**				
calcium, total	E420	0.100	mg/L	24.3	--	--				
chromium, total	E420	0.00200	mg/L	0.0108	--	**0.05**				
copper, total	E420	0.00100	mg/L	0.0264	**1**	**2**				
iron, total	E420	0.030	mg/L	9.91	**0.3**	--				
lead, total	E420	0.000500	mg/L	0.0101	--	**0.005**				
magnesium, total	E420	0.100	mg/L	4.40	--	--				

Analyte	Method	LOR	Unit	KS2103651-001 (Continued)	CDWG AO/OG	CDWG MAC				
Total Metals - Continued										
manganese, total	E420	0.00200	mg/L	0.330	**0.02**	**0.12**				
mercury, total	E508	0.0000050	mg/L	0.0000504	--	**0.001**				
potassium, total	E420	0.100	mg/L	2.12	--	--				
selenium, total	E420	0.00100	mg/L	0.00162	--	**0.05**				
sodium, total	E420	2.00	mg/L	2.33	**200**	--				
uranium, total	E420	0.000100	mg/L	0.106	--	**0.02**				
zinc, total	E420	0.0500	mg/L	<0.0500	**5**	--				

Please refer to the General Comments section for an explanation of any qualifiers detected.

Summary of Guideline Breaches by Sample

SampleID/Client ID	Matrix	Analyte	Analyte Summary	Guideline	Category	Result	Limit
4137 Messiter Stn Rd Avola BC	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	192 NTU	0.1 NTU
	Water	aluminum, total	There is no consistent, convincing evidence that aluminum in drinking water causes adverse health effects in humans. The operational guideline applies to treatment plants using aluminum-based coagulants; it does not apply to naturally occurring aluminum found in groundwater. For treatment plants using aluminum-based coagulants, monthly samples should be taken of the water leaving the plant; the OGs are based on a running annual average of monthly samples.	CDWG	AO/OG	8.85 mg/L	0.1 mg/L
	Water	iron, total	Based on taste and staining of laundry and plumbing fixtures; no evidence exists of dietary iron toxicity in the general population.	CDWG	AO/OG	9.91 mg/L	0.3 mg/L
	Water	manganese, total	Based on taste and staining of laundry and plumbing fixtures.	CDWG	AO/OG	0.330 mg/L	0.02 mg/L
	Water	coliforms, Escherichia coli [E. coli]	The presence of E. coli indicates recent faecal contamination and the potential presence of microorganisms capable of causing gastrointestinal illnesses; pathogens in human and animal faeces pose the most immediate danger to public health.	CDWG	MAC	5 MPN/100mL	1 MPN/100mL
	Water	coliforms, total	Total coliforms are not used as indicators of potential health effects from pathogenic microorganisms; they are used as a tool to determine how well the drinking water treatment system is operating and to indicate water quality changes in the distribution system. Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.	CDWG	MAC	727 MPN/100mL	1 MPN/100mL
	Water	aluminum, total	Aluminum is not an essential element. Studies in humans have found possible associations between aluminum ingestion and diseases of the nervous system. However, these studies have a number of design limitations and do not provide strong evidence that aluminum can cause these diseases. Studies in animals have consistently observed adverse effects on the nervous system following ingestion of high levels of aluminum, which supports effects seen in human studies.	CDWG	MAC	8.85 mg/L	2.9 mg/L

SampleID/Client ID	Matrix	Analyte	Analyte Summary	Guideline	Category	Result	Limit
	Water	lead, total	Health basis of MAC: Biochemical and neurobehavioural effects (intellectual development, behaviour) in infants and young children (under 6 years). Other: Anaemia, central nervous system effects; in pregnant women, can affect the unborn child; in infants and children under 6 years, can affect intellectual development, behaviour, size and hearing; classified as probably carcinogenic to humans. MAC is based on chronic effects, it is intended to apply to average concentrations in water consumed for extended periods. Exposure to lead should nevertheless be kept to a minimum; plumbing should be thoroughly flushed before water is used for consumption; most significant contribution is generally from lead service line entering the building.	CDWG	MAC	0.0101 mg/L	0.005 mg/L
	Water	manganese, total	Health Basis of MAC: Effects on neurological development and behaviour; deficits in memory, attention, and motor skills. Other: Formula-fed infants (where water containing manganese at levels above the MAC is used to prepare formula) may be especially at risk.	CDWG	MAC	0.330 mg/L	0.12 mg/L
	Water	uranium, total	Health basis of MAC: Kidney effects (various lesions); may be rapidly reversible after exposure ceases	CDWG	MAC	0.106 mg/L	0.02 mg/L

Key:

CDWG — Canada Guidelines for Canadian Drinking Water Quality (MAR, 2021)

AO/OG — Aesthetic Objective/Operational Guideline

MAC — Maximum Acceptable Concentrations

CERTIFICATE OF ANALYSIS (GUIDELINE EVALUATION)

Work Order	: **KS2103836**	Page	: 1 of 9
Client	: **Cash Clients Canada**	Laboratory	: Kamloops - Environmental
Contact	: BC Timber Sales - Daniel Arcand	Account Manager	: Caitlin Fountain
Address	: BC Canada	Address	: 1445 McGill Road, Unit 2B Kamloops, British Columbia Canada V2C 6K7
Telephone	: ----	Telephone	: 250 372 3588
Project	: BC Timber Sales, 687 Yellowhead Hwy, Clearwater BC, V0E 1N2	Date Samples Received	: 23-Nov-2021 13:25
PO	: ----	Date Analysis Commenced	: 23-Nov-2021
C-O-C number	: ----	Issue Date	: 06-Dec-2021 15:55
Sampler	: ----		
Site	: ----		
Quote number	: Kamloops Cash Client Pricing		
No. of samples received	: 7		
No. of samples analysed	: 7		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Guideline Comparison

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Amanda Lampreau	Laboratory _ Supervisor	Microbiology, Kamloops, British Columbia
Kim Jensen	Department Manager - Metals	Metals, Burnaby, British Columbia
Lindsay Gung	Supervisor - Water Chemistry	Inorganics, Burnaby, British Columbia
Owen Cheng		Metals, Burnaby, British Columbia
Tracy Harley	Supervisor - Water Quality Instrumentation	Inorganics, Burnaby, British Columbia

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.
Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guidelines are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

Key : LOR: Limit of Reporting (detection limit).

Unit	*Description*
CFU/100mL	colony forming units per 100 mL
CU	colour units (1 CU = 1 mg/L Pt)
mg/L	milligrams per litre
NTU	nephelometric turbidity units

>: greater than.
<: less than.
Red shading is applied where the result is greater than the Guideline Upper Limit or the result is lower than the Guideline Lower Limit.
For drinking water samples, Red shading is applied where the result for E.coli, fecal or total coliforms is greater than or equal to the Guideline Upper Limit.

Analytical Results Evaluation

Matrix: **Water**

Analyte	CAS Number	Unit	Client sample ID	Seepage	Bridge Upstream	Bridge Downstream	Hydro Upstream	2800 CMP Upstream	2800 CMP Downstream	POD
			Sampling date/time	22-Nov-2021 13:22	22-Nov-2021 13:34	22-Nov-2021 13:45	22-Nov-2021 13:27	22-Nov-2021 13:59	22-Nov-2021 14:01	22-Nov-2021 14:44
			Sub-Matrix	Water	Water	Water	Water	Water	Water	Water
				KS2103836-001	KS2103836-002	KS2103836-003	KS2103836-004	KS2103836-005	KS2103836-006	KS2103836-007
Physical Tests										
colour, true	----	CU		41.9	<5.0	5.0	<5.0	<5.0	<5.0	<5.0
hardness (as CaCO3), from total Ca/Mg	----	mg/L		9.43	45.3	44.1	45.1	48.0	46.8	46.0
turbidity	----	NTU		26.3	0.54	1.69	0.60	0.25	0.41	0.60
Bacteriological Tests										
coliforms, thermotolerant [fecal]	----	CFU/100mL		<1	<1	<1	<1	<1	<1	1
Total Metals										
aluminum, total	7429-90-5	mg/L		2.75	0.0516	0.140	0.0519	0.0292	0.0439	0.0631
antimony, total	7440-36-0	mg/L		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
arsenic, total	7440-38-2	mg/L		0.00024	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
barium, total	7440-39-3	mg/L		0.0297	0.00496	0.00604	0.00485	0.00392	0.00399	0.00473
beryllium, total	7440-41-7	mg/L		0.000135	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100	<0.000100
bismuth, total	7440-69-9	mg/L		0.000065	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
boron, total	7440-42-8	mg/L		<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
cadmium, total	7440-43-9	mg/L		0.0000131	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
calcium, total	7440-70-2	mg/L		2.06	14.7	14.2	14.7	15.9	15.6	15.1
cesium, total	7440-46-2	mg/L		0.000359	0.000015	0.000030	0.000018	0.000016	0.000021	0.000018
chromium, total	7440-47-3	mg/L		0.00220	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
cobalt, total	7440-48-4	mg/L		0.00078	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
copper, total	7440-50-8	mg/L		0.00314	<0.00050	0.00103	<0.00050	<0.00050	<0.00050	<0.00050
iron, total	7439-89-6	mg/L		2.07	0.036	0.118	0.036	0.022	0.038	0.046
lead, total	7439-92-1	mg/L		0.00111	<0.000050	0.000096	<0.000050	<0.000050	<0.000050	<0.000050
lithium, total	7439-93-2	mg/L		0.0032	0.0023	0.0023	0.0023	0.0024	0.0024	0.0022
magnesium, total	7439-95-4	mg/L		1.04	2.08	2.10	2.04	2.01	1.90	2.01
manganese, total	7439-96-5	mg/L		0.0716	0.00178	0.00362	0.00167	0.00091	0.00156	0.00152
mercury, total	7439-97-6	mg/L		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
molybdenum, total	7439-98-7	mg/L		0.000393	0.00192	0.00181	0.00190	0.00153	0.00143	0.00160
nickel, total	7440-02-0	mg/L		0.00180	<0.00050	0.00053	<0.00050	<0.00050	<0.00050	<0.00050

Analytical Results Evaluation

Matrix: **Water**

Analyte	CAS Number	Unit	Client sample ID	Seepage	Bridge Upstream	Bridge Downstream	Hydro Upstream	2800 CMP Upstream	2800 CMP Downstream	POD
			Sampling date/time	22-Nov-2021 13:22	22-Nov-2021 13:34	22-Nov-2021 13:45	22-Nov-2021 13:27	22-Nov-2021 13:59	22-Nov-2021 14:01	22-Nov-2021 14:44
			Sub-Matrix	Water	Water	Water	Water	Water	Water	Water
				KS2103836-001	KS2103836-002	KS2103836-003	KS2103836-004	KS2103836-005	KS2103836-006	KS2103836-007
Total Metals										
phosphorus, total	7723-14-0	mg/L		0.073	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
potassium, total	7440-09-7	mg/L		1.46	0.657	0.728	0.656	0.693	0.680	0.710
rubidium, total	7440-17-7	mg/L		0.00709	0.00089	0.00121	0.00092	0.00080	0.00084	0.00094
selenium, total	7782-49-2	mg/L		0.000119	<0.000050	<0.000050	<0.000050	<0.000050	0.000074	<0.000050
silicon, total	7440-21-3	mg/L		10.6	4.91	5.28	5.04	5.03	4.83	5.05
silver, total	7440-22-4	mg/L		0.000022	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
sodium, total	17341-25-2	mg/L		1.85	1.85	1.94	1.84	1.86	1.78	1.92
strontium, total	7440-24-6	mg/L		0.0198	0.138	0.132	0.144	0.121	0.115	0.121
sulfur, total	7704-34-9	mg/L		<0.50	1.79	1.88	1.58	2.08	1.98	1.89
tellurium, total	13494-80-9	mg/L		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
thallium, total	7440-28-0	mg/L		0.000036	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
thorium, total	7440-29-1	mg/L		0.00017	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010
tin, total	7440-31-5	mg/L		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
titanium, total	7440-32-6	mg/L		0.0678	0.00114	0.00358	0.00111	0.00059	0.00123	0.00149
tungsten, total	7440-33-7	mg/L		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
uranium, total	7440-61-1	mg/L		0.000622	0.00737	0.00753	0.00768	0.00476	0.00479	0.00526
vanadium, total	7440-62-2	mg/L		0.00360	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
zinc, total	7440-66-6	mg/L		0.0067	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
zirconium, total	7440-67-7	mg/L		0.00038	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020

Please refer to the General Comments section for an explanation of any qualifiers detected.

Summary of Guideline Breaches by Sample

SampleID/Client ID	Matrix	Analyte	Analyte Summary	Guideline	Category	Result	Limit
2800 CMP Downstream	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	0.41 NTU	0.1 NTU
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	0.41 NTU	0.1 NTU
2800 CMP Upstream	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	0.25 NTU	0.1 NTU
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	0.25 NTU	0.1 NTU
Bridge Downstream	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	1.69 NTU	0.1 NTU
	Water	aluminum, total	There is no consistent, convincing evidence that aluminum in drinking water causes adverse health effects in humans. The operational guideline applies to treatment plants using aluminum-based coagulants; it does not apply to naturally occurring aluminum found in groundwater. For treatment plants using aluminum-based coagulants, monthly samples should be taken of the water leaving the plant; the OGs are based on a running annual average of monthly samples.	CDWG	AO/OG	0.140 mg/L	0.1 mg/L
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	1.69 NTU	0.1 NTU

SampleID/Client ID	Matrix	Analyte	Analyte Summary	Guideline	Category	Result	Limit
Bridge Upstream	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	0.54 NTU	0.1 NTU
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	0.54 NTU	0.1 NTU
Hydro Upstream	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	0.60 NTU	0.1 NTU
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	0.60 NTU	0.1 NTU
POD	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	0.60 NTU	0.1 NTU
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	0.60 NTU	0.1 NTU
	Water	coliforms, thermotolerant [fecal]	The presence of E. coli indicates recent faecal contamination and the potential presence of microorganisms capable of causing gastrointestinal illnesses; pathogens in human and animal faeces pose the most immediate danger to public health.	CDWG	MAC	1 CFU/100mL	1 CFU/100mL
Seepage	Water	colour, true	May interfere with disinfection; removal is important to ensure effective treatment.	CDWG	AO/OG	41.9 CU	15 CU

SampleID/Client ID	Matrix	Analyte	Analyte Summary	Guideline	Category	Result	Limit
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	AO/OG	26.3 NTU	0.1 NTU
	Water	aluminum, total	There is no consistent, convincing evidence that aluminum in drinking water causes adverse health effects in humans. The operational guideline applies to treatment plants using aluminum-based coagulants; it does not apply to naturally occurring aluminum found in groundwater. For treatment plants using aluminum-based coagulants, monthly samples should be taken of the water leaving the plant; the OGs are based on a running annual average of monthly samples.	CDWG	AO/OG	2.75 mg/L	0.1 mg/L
	Water	iron, total	Based on taste and staining of laundry and plumbing fixtures; no evidence exists of dietary iron toxicity in the general population.	CDWG	AO/OG	2.07 mg/L	0.3 mg/L
	Water	manganese, total	Based on taste and staining of laundry and plumbing fixtures.	CDWG	AO/OG	0.0716 mg/L	0.02 mg/L
	Water	turbidity	For systems that use groundwater, turbidity should generally be below 1.0 NTU. Filtration systems should be designed and operated to reduce turbidity levels as low as reasonably achievable and strive to achieve a treated water turbidity target from individual filters of less than 0.1 NTU.	CDWG	MAC	26.3 NTU	0.1 NTU

Summary of Guideline Limits

Analyte	CAS Number	Unit	CDWG AO/OG	CDWG MAC					
Physical Tests									
colour, true	----	CU	**15 CU**						
hardness (as CaCO3), from total Ca/Mg	----	mg/L							
turbidity	----	NTU	**0.1 NTU**	**0.1 NTU**					
Bacteriological Tests									
coliforms, thermotolerant [fecal]	----	CFU/100mL		**1 CFU/100mL**					
Total Metals									
aluminum, total	7429-90-5	mg/L	**0.1 mg/L**	**2.9 mg/L**					
antimony, total	7440-36-0	mg/L		**0.006 mg/L**					
arsenic, total	7440-38-2	mg/L		**0.01 mg/L**					
barium, total	7440-39-3	mg/L		**2 mg/L**					
beryllium, total	7440-41-7	mg/L							
bismuth, total	7440-69-9	mg/L							
boron, total	7440-42-8	mg/L		**5 mg/L**					
cadmium, total	7440-43-9	mg/L		**0.007 mg/L**					
calcium, total	7440-70-2	mg/L							
cesium, total	7440-46-2	mg/L							
chromium, total	7440-47-3	mg/L		**0.05 mg/L**					
cobalt, total	7440-48-4	mg/L							
copper, total	7440-50-8	mg/L	**1 mg/L**	**2 mg/L**					
iron, total	7439-89-6	mg/L	**0.3 mg/L**						
lead, total	7439-92-1	mg/L		**0.005 mg/L**					
lithium, total	7439-93-2	mg/L							
magnesium, total	7439-95-4	mg/L							
manganese, total	7439-96-5	mg/L	**0.02 mg/L**	**0.12 mg/L**					
mercury, total	7439-97-6	mg/L		**0.001 mg/L**					
molybdenum, total	7439-98-7	mg/L							
nickel, total	7440-02-0	mg/L							
phosphorus, total	7723-14-0	mg/L							
potassium, total	7440-09-7	mg/L							
rubidium, total	7440-17-7	mg/L							
selenium, total	7782-49-2	mg/L		**0.05 mg/L**					
silicon, total	7440-21-3	mg/L							
silver, total	7440-22-4	mg/L							
sodium, total	17341-25-2	mg/L	**200 mg/L**						
strontium, total	7440-24-6	mg/L		**7 mg/L**					
sulfur, total	7704-34-9	mg/L							
tellurium, total	13494-80-9	mg/L							

Analyte	CAS Number	Unit	CDWG AO/OG	CDWG MAC					
Total Metals - Continued									
thallium, total	7440-28-0	mg/L							
thorium, total	7440-29-1	mg/L							
tin, total	7440-31-5	mg/L							
titanium, total	7440-32-6	mg/L							
tungsten, total	7440-33-7	mg/L							
uranium, total	7440-61-1	mg/L		**0.02 mg/L**					
vanadium, total	7440-62-2	mg/L							
zinc, total	7440-66-6	mg/L	**5 mg/L**						
zirconium, total	7440-67-7	mg/L							

Please refer to the General Comments section for an explanation of any qualifiers detected.

Key:

CDWG — Canada Guidelines for Canadian Drinking Water Quality (MAR, 2021)

AO/OG — Aesthetic Objective/Operational Guideline

MAC — Maximum Acceptable Concentrations

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 - 933926

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Page of

Environmental Division
Kamloops
Work Order Reference
KS2103836

Telephone : +1 250 372 3588

White Paper Co. 604 951-3900

Report To	Contact and company name below will appear on the final report
Company:	BC Timber Sales
Contact:	Daniel Arcand
Phone:	250-819-7635
	Company address below will appear on the final report
Street:	687 Yellowhead Hwy
City/Province:	Clearwater, BC
Postal Code:	V0E 1N2
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	BCTS
Contact:	Daniel Arcand

Reports / Recipients

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☐ NO ☐ N/A

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: daniel.arcand@gov.bc.ca

Email 2:

Email 3:

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: daniel.arcand@gov.bc.ca

Email 2:

Turnaround Time (TAT) Requested

☑ Routine [R] if received by 3pm M-F - no surcharges apply

☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum

☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimu

☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimu

☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimu

☐ Same day [E2] if received by 10am M-S - 200% rush surcharge. Addl may apply to rush requests on weekends, statutory holidays and non-r

Date and Time Required for all E&P TATs:

For all tests with rush TATs requested, please

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#:

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (ALS use only): KS2103836

ALS Contact: Sampler:

Analysis R

Indicate Filtered (F), Preserved (P) or Filtered a

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Metals	Fecal Coliform	Color	Turbidity	SAMPLES ON HOLD	EXTENDED STORAGE REQ	SUSPECTED HAZARD (see
1	Seepage	22-Nov-21	13:22		4	X	X	X	X			
2	Bridge Upstream		13:34		4							
3	Bridge Downstream		13:45		4							
4	Hydro Upstream		13:27		4							
5	2800 CMP Upstream		13:59		4							
6	2800 CMP Downstream		14:01		4							
7	POD		14:44		4							

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human consumption/ use? ☑ YES ☐ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
3							

SHIPMENT RELEASE (client use)

Released by:	Date:	Time:

INITIAL SHIPMENT RECEPTION (ALS use only)

Received by:	Date:	Time:
	NOV 23 2021	1325

FINAL SHIPMENT RECEPTION (ALS use only)

Received by:	Date:	Time:

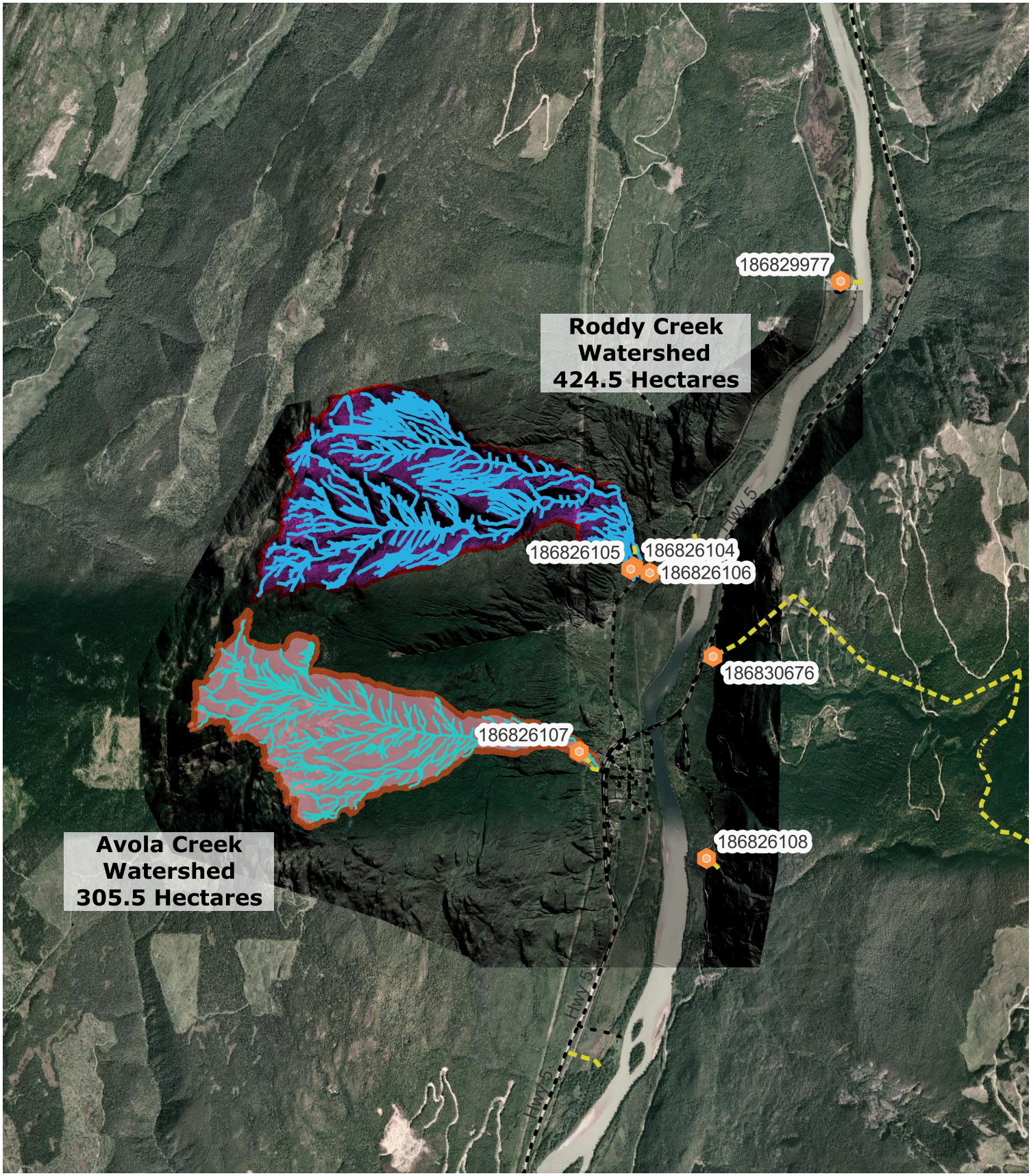
REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

AUG 2020 FRONT



Channel Network
Water License
Licensed Works
Roddy Watershed
Avola Watershed
Digital Elevation Model
1,955.697144
574.08429

0 1 2 3 km

1:50,000

N

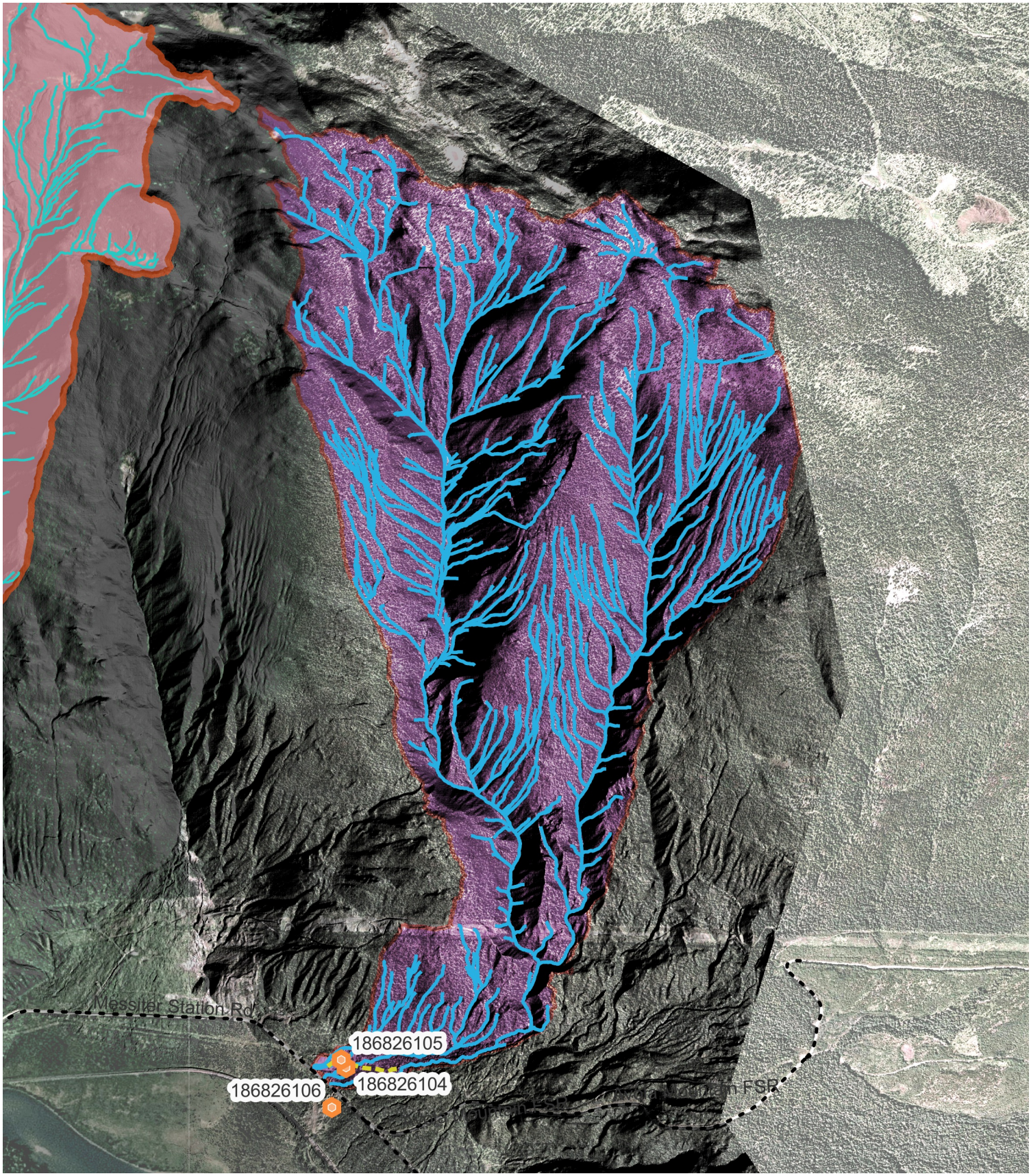
Roddy Creek and Avola Creek Watershed Source Protection Study

Catchment Basins

NOTES:
LIDARBC LiDAR-1m ASCII Digital Elevation Grids processed into a terrain geotiffUsed to delineate regional watershed catchment basins

Drawn By: William Shulba, P.Geo
Date: July 2022

FIGURE 1



Channel Network
Water License
Licensed Works
Roddy Watershed
Avola Watershed

Digital Elevation Model
1,955.697144
574.08429

0 250 500 750 1,000 m

1:20,000

N

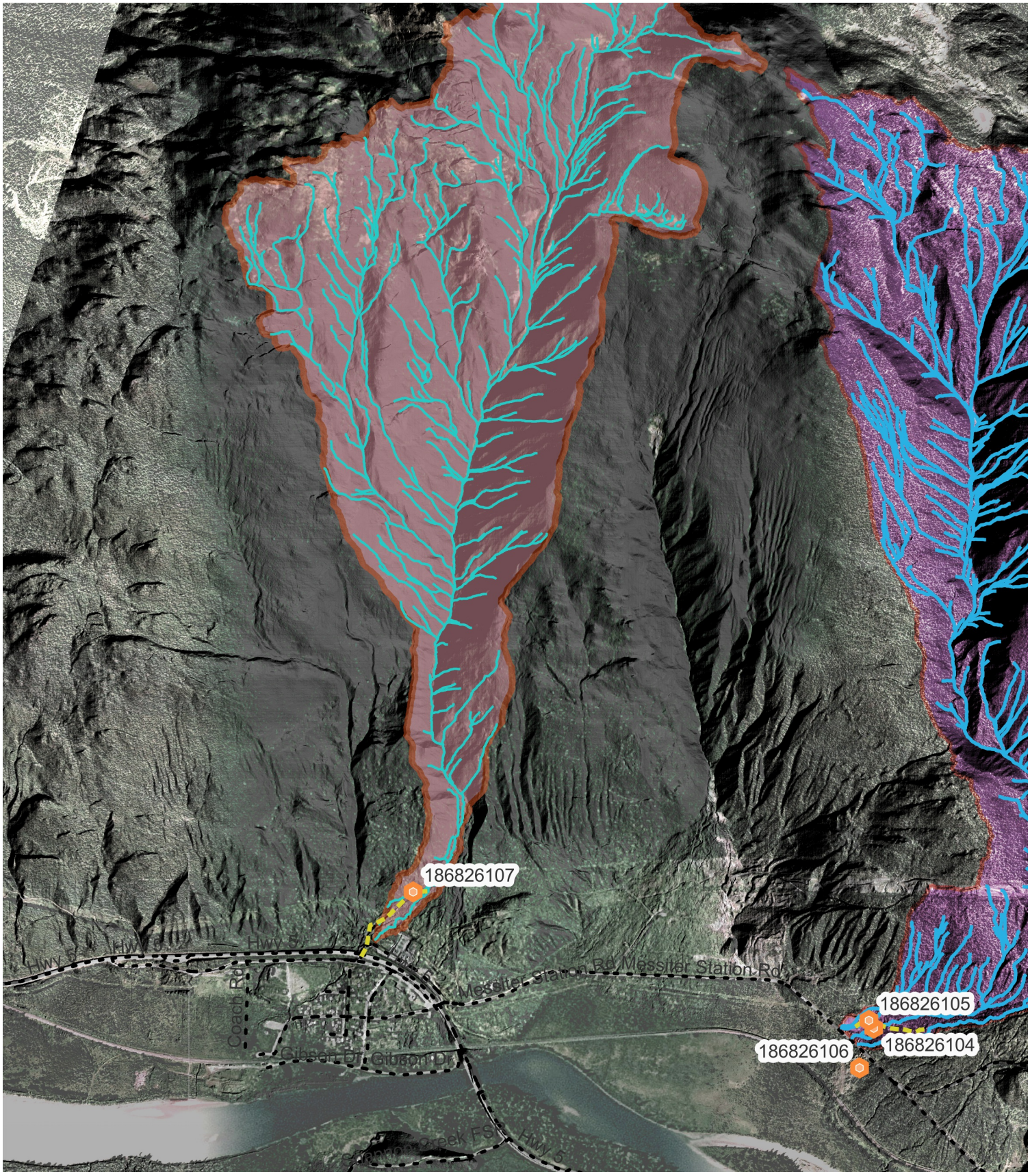
Roddy Creek and Avola Creek Watershed Source Protection Study

Roddy Watershed Catchment

NOTES:
LIDARBC LiDAR-1m ASCII Digital Elevation Grids processed into a terrain geotiffUsed to delineate regional watershed catchment basins

Drawn By: William Shulba, P.Geo
Date: July 2022

FIGURE 2



Channel Network
Water License
Licensed Works
Roddy Watershed
Avola Watershed

Digital Elevation Model
1,955.697144
574.08429

0 250 500 750 1,000 m

1:20,000

N

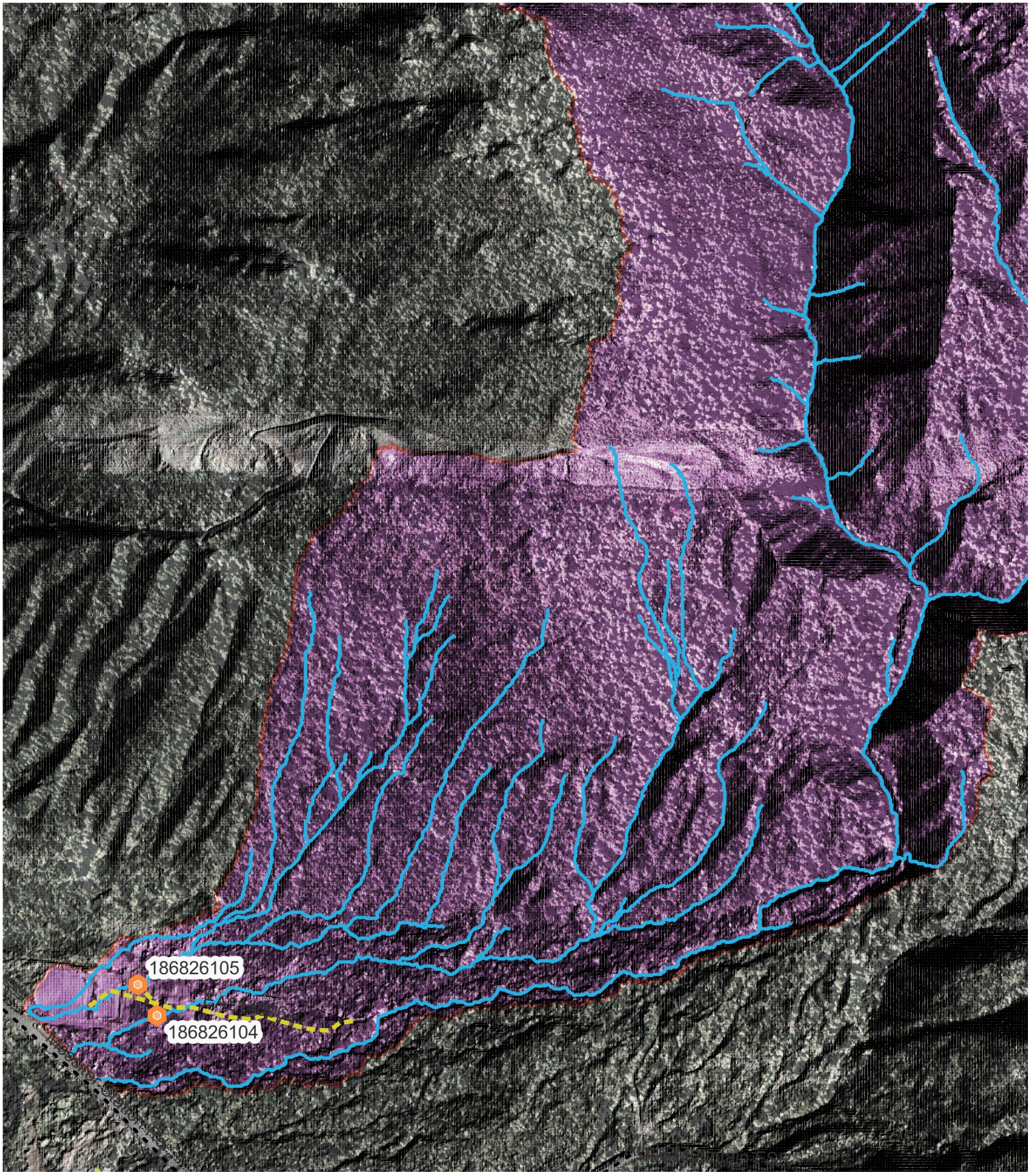
Roddy Creek and Avola Creek Watershed Source Protection Study

Avola Creek Watershed Catchment

NOTES:
LIDARBC LiDAR-1m ASCII Digital Elevation Grids processed into a terrain geotiffUsed to delineate regional watershed catchment basins

Drawn By: William Shulba, P.Geo
Date: July 2022

FIGURE 3



Channel Network
Water License
Licensed Works
Roddy Watershed
Avola Watershed

Digital Elevation Model
1,955.697144
574.08429

0 50 100 150 200 m

1:5,000

N

Roddy Creek and Avola Creek Watershed Source Protection Study

Water License F043942

NOTES:
LIDARBC LiDAR-1m ASCII Digital Elevation Grids processed into a terrain geotiffUsed to delineate regional watershed catchment basins

Drawn By: William Shulba, P.Geo
Date: July 2022

FIGURE 4