

Real-Time Water Quality Deployment Report

Flora Creek below TLH

September 8 to
October 19, 2022



Government of Newfoundland & Labrador
Department of Environment & Climate Change
Water Resources Management Division

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General

- The Water Resources Management Division, in partnership with Tacora Resources Inc. – Wabush Mines, maintains one real-time water quality and water quantity station at Flora Creek.
- This station is situated downstream of the former Wabush Mines tailings disposal area in Flora Lake.
- Water Resources Management Division staff monitor the real-time web pages regularly.
- On September 8th, 2022, a real-time water quality monitoring instrument was deployed at the station Flora Creek below TLH. The instrument was deployed for a period of 41 days and was removed on October 19th, 2022. This was the third and final deployment for 2022.
- This station did not transmit data in real time for a portion of the deployment period. The issue was rectified by WSC at the end of September. It was found that there was a faulty port on the data logger and this was causing a transmission issue for the water quality data.

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
 - At deployment and removal, a QA/QC Sonde is temporarily deployed along side the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the degree of difference between parameters recorded by the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

Parameter	Rank				
	Excellent	Good	Fair	Marginal	Poor
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values

may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

- Deployment and removal comparison rankings for the station on Flora Creek deployed between September 8 and October 19, 2022 are summarized in Table 2.

Table 2: Comparison rankings for Flora Creek below TLH station July 20 – September 8, 2022.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Flora Creek below TLH	Sept 8, 2022	Deployment	Excellent	Excellent	Excellent	Excellent	Good
	Oct 19, 2022	Removal	Excellent	Good	Good	Marginal	Fair

- At deployment and removal, all parameters ranked either ‘good’ or ‘excellent’.
- At removal, dissolved oxygen ranked ‘marginal’. The field sonde read a value of 11.71 mg/L, while the QA/QC sonde read a value of 10.85 mg/L. Turbidity ranked ‘fair’. The field sonde read a value of 59.2 NTU, while the QA/QC sonde read a value of 68.0 NTU. All other parameters ranked either ‘excellent’ or ‘good’.
- There are few circumstances which may cause less than ideal QA/QC rankings to be obtained. These include: the placement of the QA/QC sonde in relation to the field sonde, the amount of time each sonde was given to stabilize before readings were recorded; and deteriorating performance of one of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality related events from September 8 to October 19 at the station Flora Creek below TLH.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Flora Creek below TLH

- Water temperature ranged from 4.80 to 17.78°C during this deployment period (Figure 1).
- Water temperature decreased during this deployment period, corresponding with decreasing seasonal ambient air temperature (Figure 1). This is expected due to temperatures decreasing into the fall.

**Water and Air Temperature : Flora Creek below TLH
September 8 to October 19, 2022**

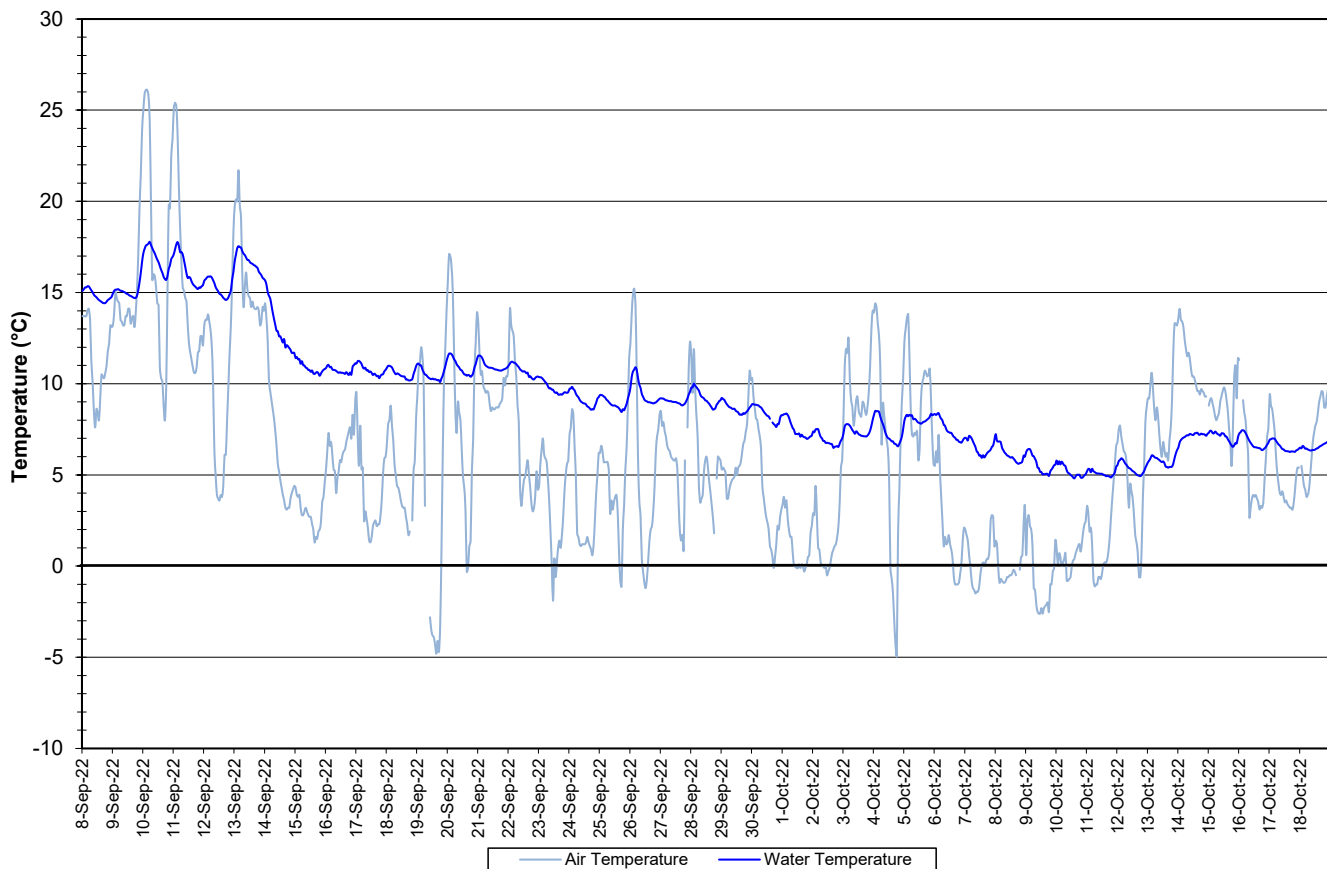


Figure 1: Water and Air Temperature - Flora Creek below TLH

(Weather data collected at Moosehead Lake)

- pH ranged between 7.17 and 7.70 pH units throughout the deployment period, with a median value of 7.36 units (Figure 2).
- pH decreased slightly during the middle of September when stage increased. It then was relatively stable for the remainder of the deployment.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.

Water pH and Stage : Flora Creek below TLH
September 8 to October 19, 2022

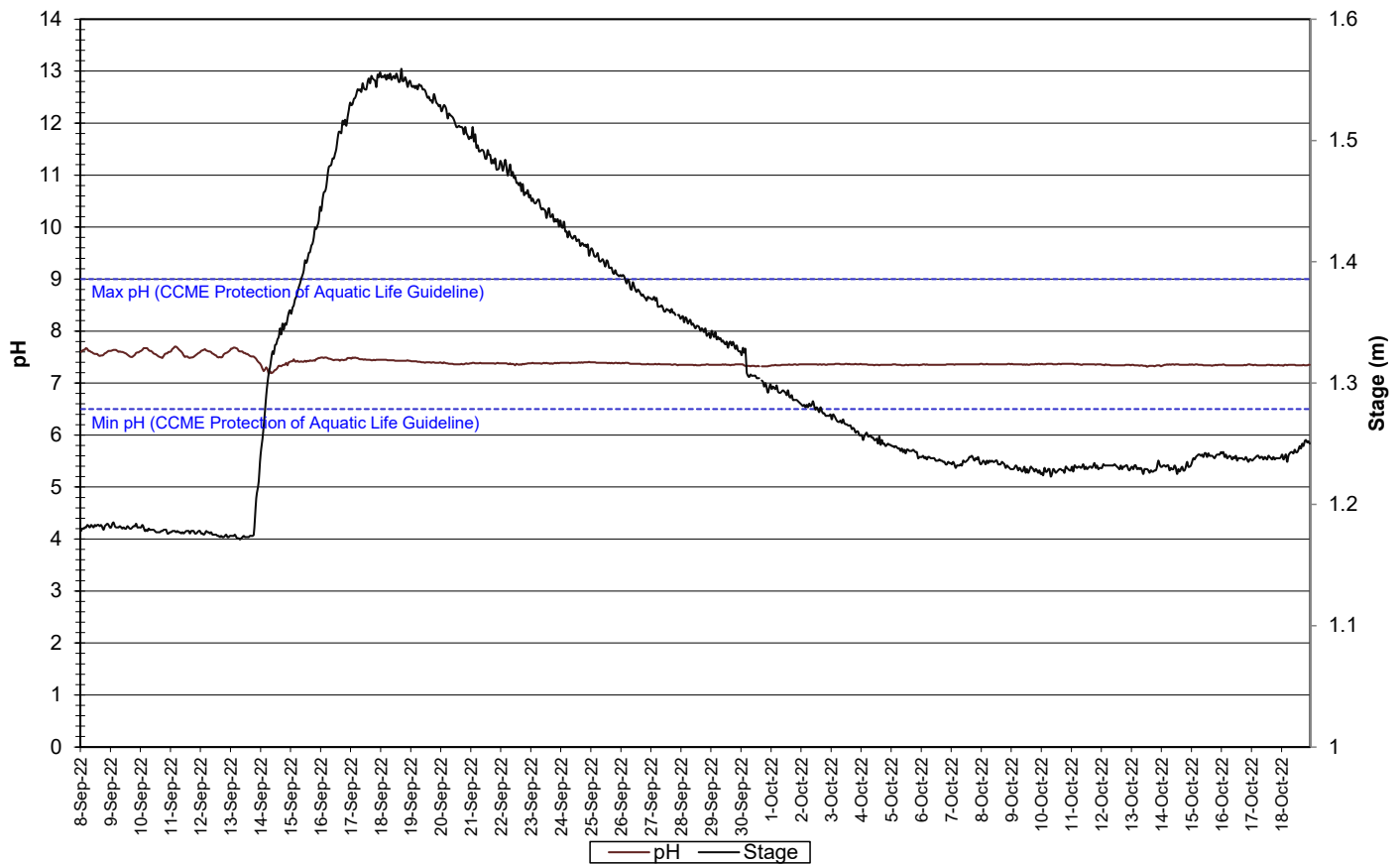


Figure 2: Water pH and Stage - Flora Creek below TLH

- Specific conductivity ranged from 61.7 to 66.5 $\mu\text{S}/\text{cm}$ (Figure 3).
- Specific conductivity decreased during the middle of September, when stage increased. It then increased for a short time when there was little to no precipitation, before decreasing due to varying precipitation.
- There is a noticeable decrease in conductivity that corresponds with a prolonged precipitation event. This can be expected after rainfall. As the amount of water in the creek increases, this dilutes the solids that are present, decreasing the conductivity. Some of these events are identified on the graph in red (Figure 3).
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

**Specific Conductivity of Water and Stage : Flora Creek below TLH
September 8 to October 19, 2022**

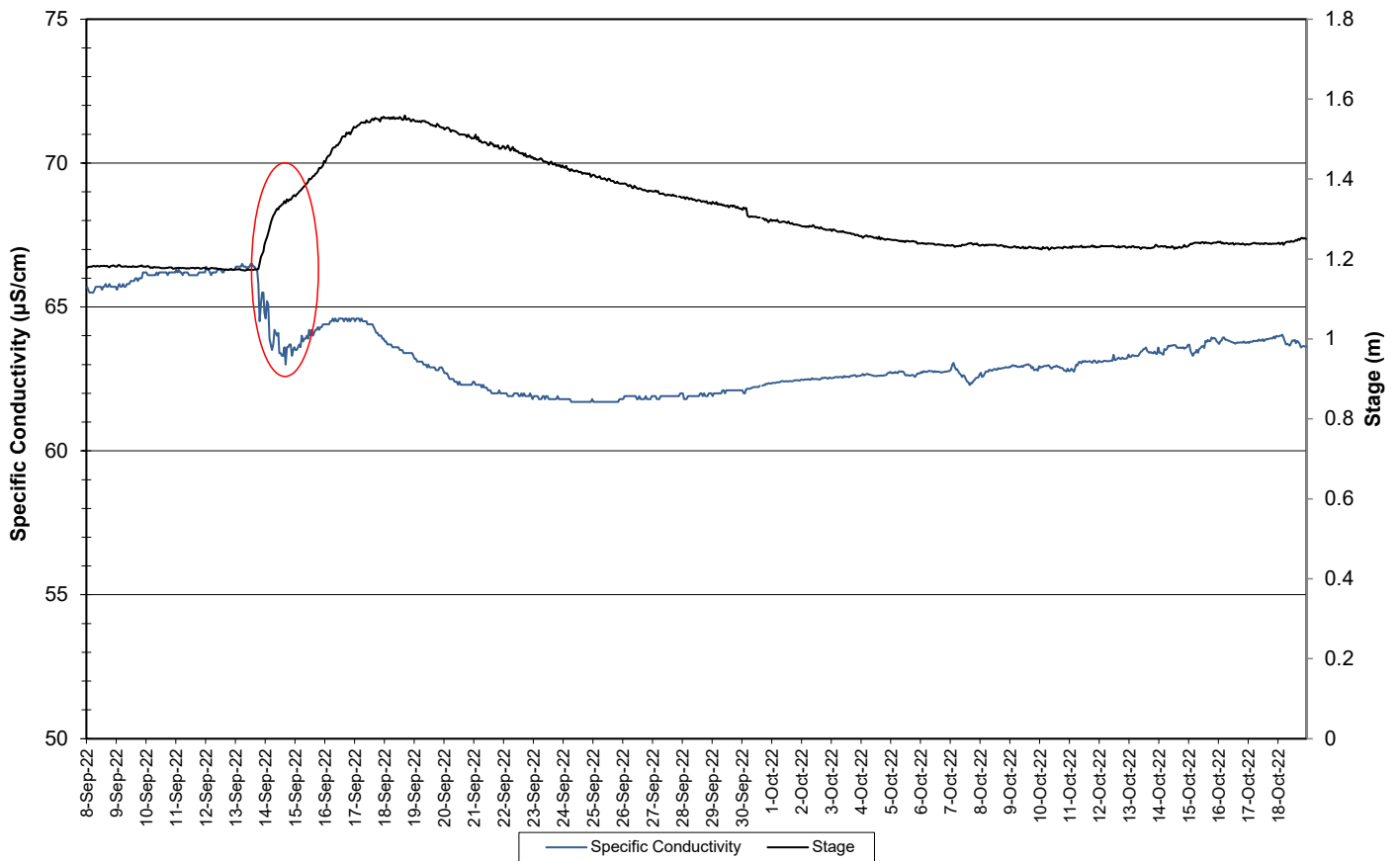


Figure 3: Specific Conductivity of Water and Stage - Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 88.0 to 101.4% and a range of 9.19 to 11.82 mg/l was found for the concentration of dissolved oxygen with a median value of 10.64 mg/l (Figure 4).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stages for Cold Water Biota of 6.5 mg/l. The majority of values were above the minimum CCME Guideline for the Protection of Early Life Stage for Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in blue on Figure 4.
- Dissolved oxygen content fluctuates diurnally and displays an inverse relationship to water temperature. DO increases after the middle of September, as water temperature cools into the fall.

**Dissolved Oxygen Concentration and Saturation : Flora Creek below TLH
September 8 to October 19, 2022**

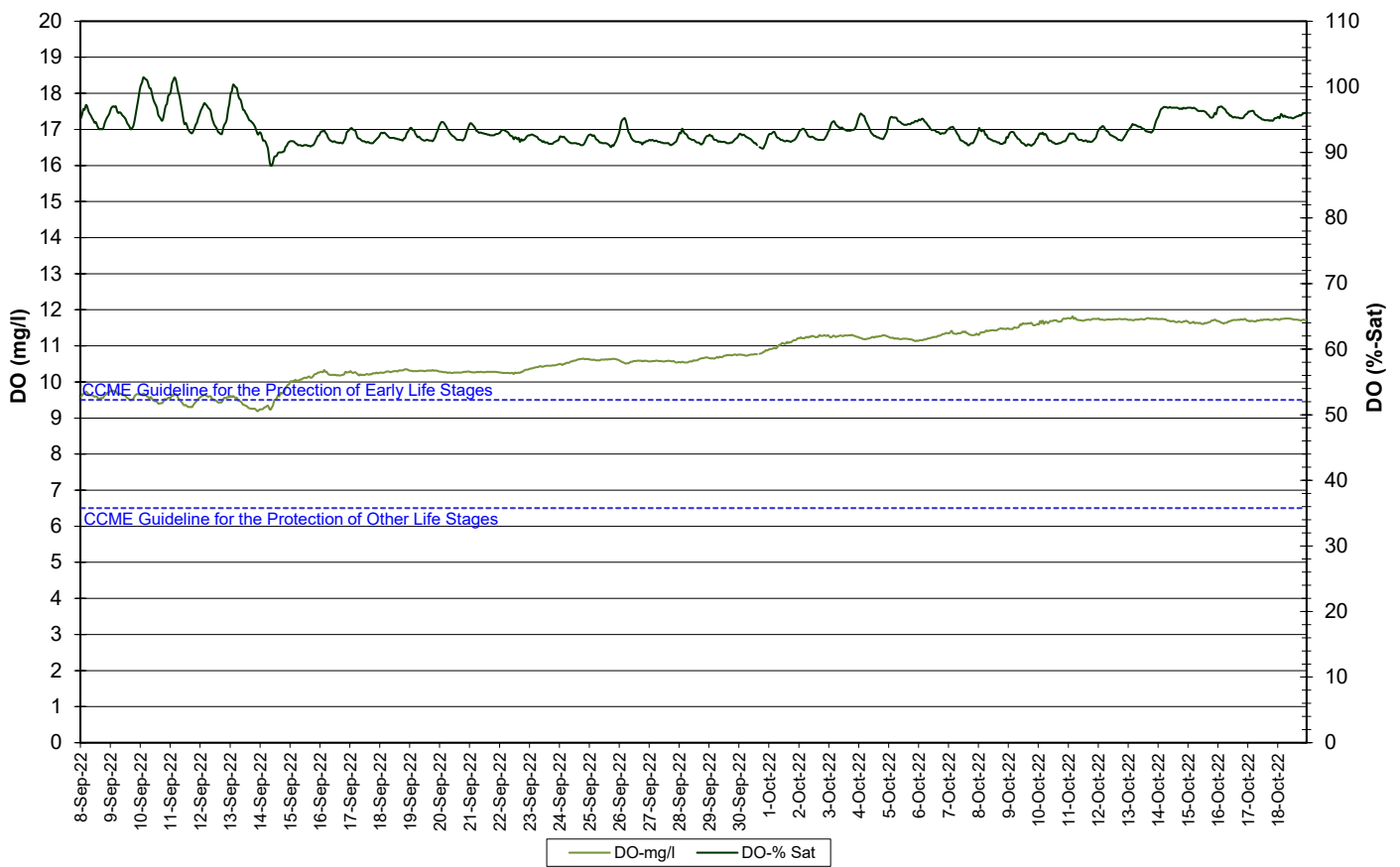


Figure 4: Dissolved Oxygen and Saturation - Flora Creek below TLH

- Turbidity values range from 7.4 NTU to 161.2 NTU (Figure 5).
- This site has very turbid water at times. Turbidity increased after a prolonged precipitation event. It then gradually decreased until the end of the deployment period, with temporary spikes noted following short term precipitation.

Water Turbidity and Precipitation : Flora Creek below TLH
September 8 to October 19, 2022

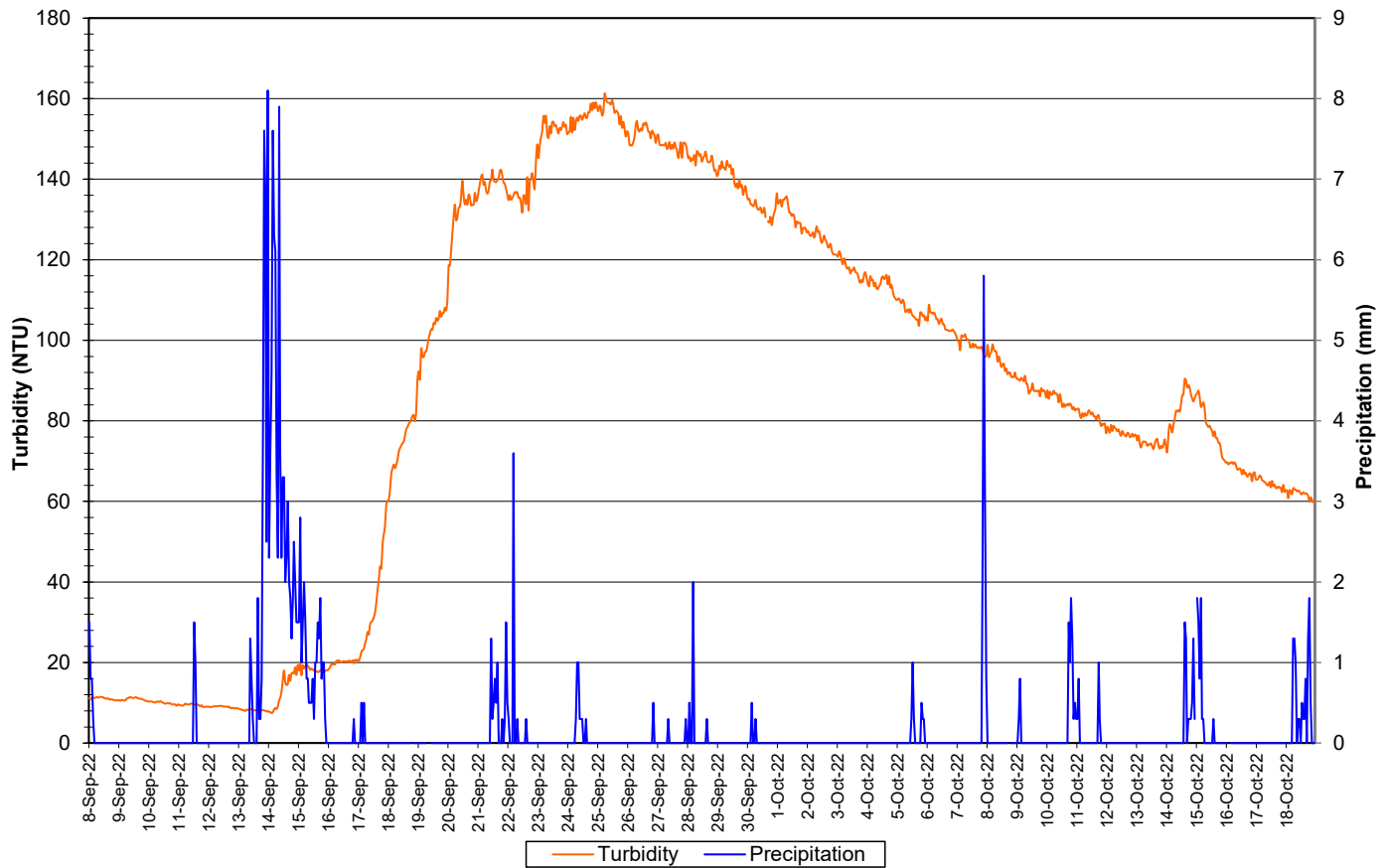


Figure 5: Turbidity - Flora Creek below TLH

- Precipitation and stage during the deployment period are graphed below (Figure 6). Stage increased after a prolonged precipitation event. It then decreased gradually until the end of the deployment period.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Stage & Precipitation: Flora Creek below TLH
September 8 to October 19, 2022

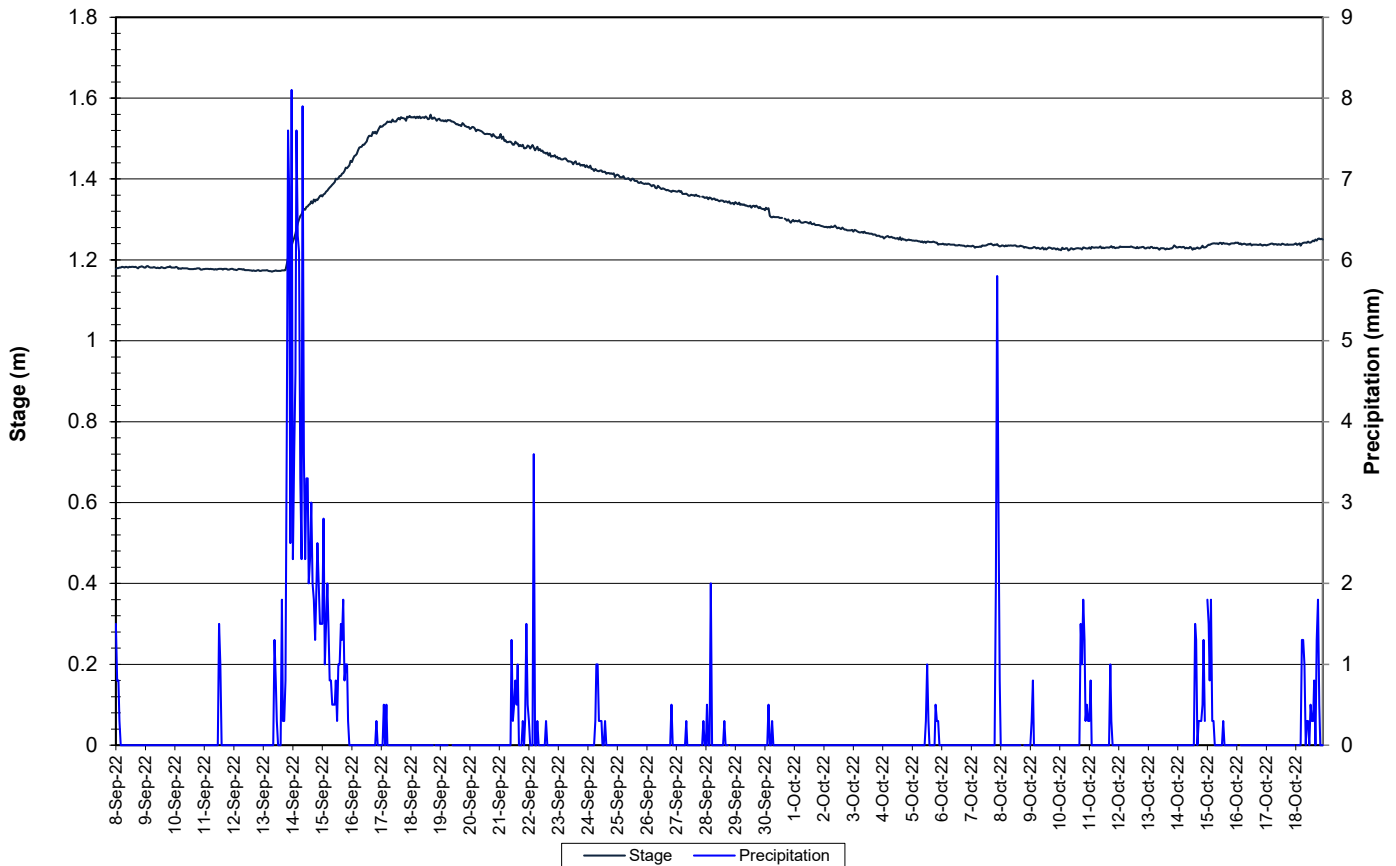


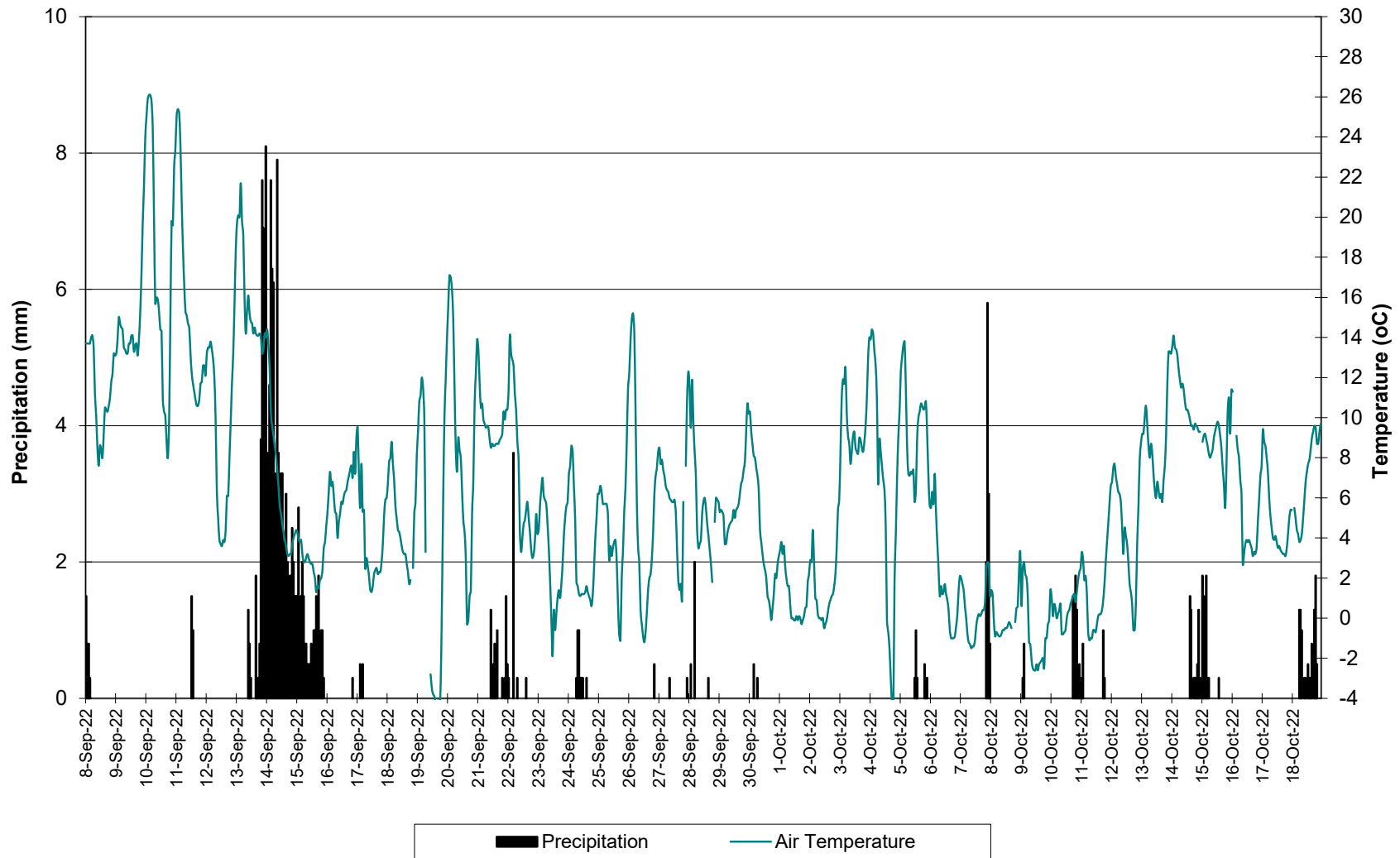
Figure 6: Precipitation and Stage – Flora Creek below TLH

Conclusions

- A clean and calibrated instrument was deployed at the Flora Creek below TLH water quality monitoring station on September 8th, 2022 and removed on October 19th, 2022. This was the third and last deployment for 2022. The Instrument was removed for the winter season. It will be redeployed in the spring, when snow/ice conditions permit.
- In most cases, weather related events or increases/decreases in water level explain parameter fluctuations. Most values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen.
- Water temperature corresponded with ambient air temperature, ranging between 4.80 and 17.78°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 7.17 and 7.70.
- Specific conductivity decreased during the middle of September. It increased for a short time before decreasing again and fluctuated in a small range for the remainder of the period, ranging from 61.7 to 66.5 $\mu\text{s}/\text{cm}$.
- Dissolved oxygen values were above the minimum CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages of 6.5 mg/l. Almost all of the values were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l.
- Turbidity increased after a prolonged precipitation event. It then gradually decreased until the end of the deployment period. Turbidity ranged from 7.4 to 161.2 NTU.
- Stage increased slightly during the middle of September. It then decreased gradually over the remainder of the deployment period.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Appendix 1

Air Temperature and Precipitation: Moosehead Lake September 8 to October 19, 2022



Appendix 2
QA/QC Grab Sample Results



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Bureau Veritas Job #: C2Q5745
Report Date: 2022/10/26

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TSX701 FLORA CREEK								
Sampling Date		2022/09/08 14:15						
Matrix		W						
Sample #		2022-6327-00-SI-SP						
Registration #		SA-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	29	1.0	mg/L	N/A	2022/09/28		8226156
Nitrate (N)	-	0.27	0.050	mg/L	N/A	2022/10/03		8226811
Total dissolved solids (calc., EC)	-	36	1.0	mg/L	N/A	2022/09/27		8225896
Inorganics								
Conductivity	-	66	1.0	uS/cm	N/A	2022/09/26	AAO	8246599
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2022/10/19	SUR	8291285
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/10/19	SUR	8291285
Sulphate (SO4)	-	3.5	1.0	mg/L	N/A	2022/10/19	SUR	8291285
Total Alkalinity (Total as CaCO3)	-	26	2.0	mg/L	N/A	2022/09/26	AAO	8246615
Colour	-	7.7	5.0	TCU	N/A	2022/10/01	TGO	8257469
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/09/26	AAO	8246617
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2022/10/24	2022/10/25	RTY	8302061
Nitrate + Nitrite (N)	-	0.27	0.050	mg/L	N/A	2022/10/03	TGO	8257686
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/09/30	TGO	8257689
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2022/09/28	TGO	8251491
Dissolved Organic Carbon (C)	-	1.6	0.50	mg/L	N/A	2022/09/22	RSL	8237674
Total Organic Carbon (C)	-	1.7	0.50	mg/L	N/A	2022/09/21	RSL	8237613
pH	-	7.74		pH	N/A	2022/09/26	AAO	8246614
Total Phosphorus	-	ND	0.004	mg/L	2022/10/24	2022/10/25	SPC	8302289
Total Suspended Solids	-	ND	1.0	mg/L	2022/09/15	2022/09/16	A1M	8226981
Turbidity	-	1.7	0.10	NTU	N/A	2022/10/02	KMC	8257439
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/09/26	2022/09/26	FJO	8243688
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.0077	0.0050	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Barium (Ba)	-	0.0035	0.0010	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Boron (B)	-	ND	0.050	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Calcium (Ca)	-	6.4	0.10	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Copper (Cu)	-	ND	0.00050	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Iron (Fe)	-	ND	0.050	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Magnesium (Mg)	-	3.1	0.10	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Manganese (Mn)	-	0.096	0.0020	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/09/26	2022/09/27	EPU	8247117



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VERITAS

Bureau Veritas Job #: C2Q5745
Report Date: 2022/10/26

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TSX701 FLORA CREEK								
Sampling Date		2022/09/08 14:15						
Matrix		W						
Sample #		2022-6327-00-SI-SP						
Registration #		SA-0000						
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Potassium (K)	-	0.79	0.10	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Sodium (Na)	-	0.75	0.10	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Strontium (Sr)	-	0.0054	0.0020	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Uranium (U)	-	ND	0.00010	mg/L	2022/09/26	2022/09/27	EPU	8247117
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/09/26	2022/09/27	EPU	8247117



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Bureau Veritas Job #: C2V0653
Report Date: 2022/11/15

NL Department of Environment, Climate Change and
Municipalities
Client Project #: RTWQ
Site Location: LABRADOR
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
UCI844 FLORA CREEK								
Sampling Date		2022/10/19 11:45						
Matrix		W						
Sample #		2022-6336-00-SI-SP						
Registration #		SA-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	29	1.0	mg/L	N/A	2022/11/10		8303544
Nitrate (N)	-	0.68	0.050	mg/L	N/A	2022/11/15		8303525
Total dissolved solids (calc., EC)	-	65	1.0	mg/L	N/A	2022/11/01		8304187
Inorganics								
Conductivity	-	120	1.0	uS/cm	N/A	2022/10/31	AA0	8316101
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2022/11/02	LKH	8313927
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/11/02	LKH	8313927
Sulphate (SO4)	-	3.3	1.0	mg/L	N/A	2022/11/02	LKH	8313927
Total Alkalinity (Total as CaCO3)	-	24	2.0	mg/L	N/A	2022/10/31	AA0	8316185
Colour	-	17	5.0	TCU	N/A	2022/11/14	TGO	8343336
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/10/31	AA0	8316189
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2022/11/07	2022/11/07	RTY	8330264
Nitrate + Nitrite (N)	-	0.68	0.050	mg/L	N/A	2022/11/14	TGO	8343343
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/11/13	TGO	8343344
Nitrogen (Ammonia Nitrogen)	-	0.055	0.050	mg/L	N/A	2022/11/02	TGO	8320831
Dissolved Organic Carbon (C)	-	46	0.50	mg/L	N/A	2022/10/28	RSL	8312397
Total Organic Carbon (C)	-	2.5	0.50	mg/L	N/A	2022/10/28	RSL	8311669
pH	-	6.34		pH	N/A	2022/10/31	AA0	8316158
Total Phosphorus	-	ND	0.004	mg/L	2022/11/07	2022/11/08	SPC	8330342
Total Suspended Solids	-	2.5	2.5	mg/L	2022/10/25	2022/10/28	A1M	8304588
Turbidity	-	31	0.10	NTU	N/A	2022/11/01	AA0	8318403
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/11/03	2022/11/03	EPU	8321481
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.014	0.0050	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Barium (Ba)	-	0.012	0.0010	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Boron (B)	-	ND	0.050	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Calcium (Ca)	-	6.5	0.10	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Chromium (Cr)	-	0.0016	0.0010	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Copper (Cu)	-	ND	0.00050	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Iron (Fe)	-	0.18	0.050	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Magnesium (Mg)	-	3.0	0.10	mg/L	2022/11/07	2022/11/09	JHY	8330507



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Bureau Veritas Job #: C2V0653
Report Date: 2022/11/15

NL Department of Environment, Climate Change and
Municipalities
Client Project #: RTWQ
Site Location: LABRADOR
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
UCI844 FLORA CREEK								
Sampling Date 2022/10/19 11:45								
Matrix W								
Sample # 2022-6336-00-SI-SP								
Registration # SA-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.32	0.0020	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Potassium (K)	-	0.73	0.10	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Sodium (Na)	-	0.72	0.10	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Strontium (Sr)	-	0.0053	0.0020	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Uranium (U)	-	ND	0.00010	mg/L	2022/11/07	2022/11/09	JHY	8330507
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/11/07	2022/11/09	JHY	8330507