



# Real-Time Water Quality Deployment Report

Flora Creek below TLH

September 6 to  
October 19, 2023



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 6<sup>th</sup>, 2023, a clean and calibrated real-time water quality monitoring instrument was deployed at the station Flora Creek below TLH. The instrument was deployed for a period of 43 days and was removed on October 19<sup>th</sup>, 2023. This was the third and final deployment for 2023.

## 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 6 and October 19, 2023 are summarized in Table 2.

**Table 2: Comparison rankings for Flora Creek below TLH station September 6 – October 19, 2023.**

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Flora Creek below TLH	Sept 6, 2023	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Oct 19, 2023	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

- At deployment and removal, all parameters ranked 'excellent'.

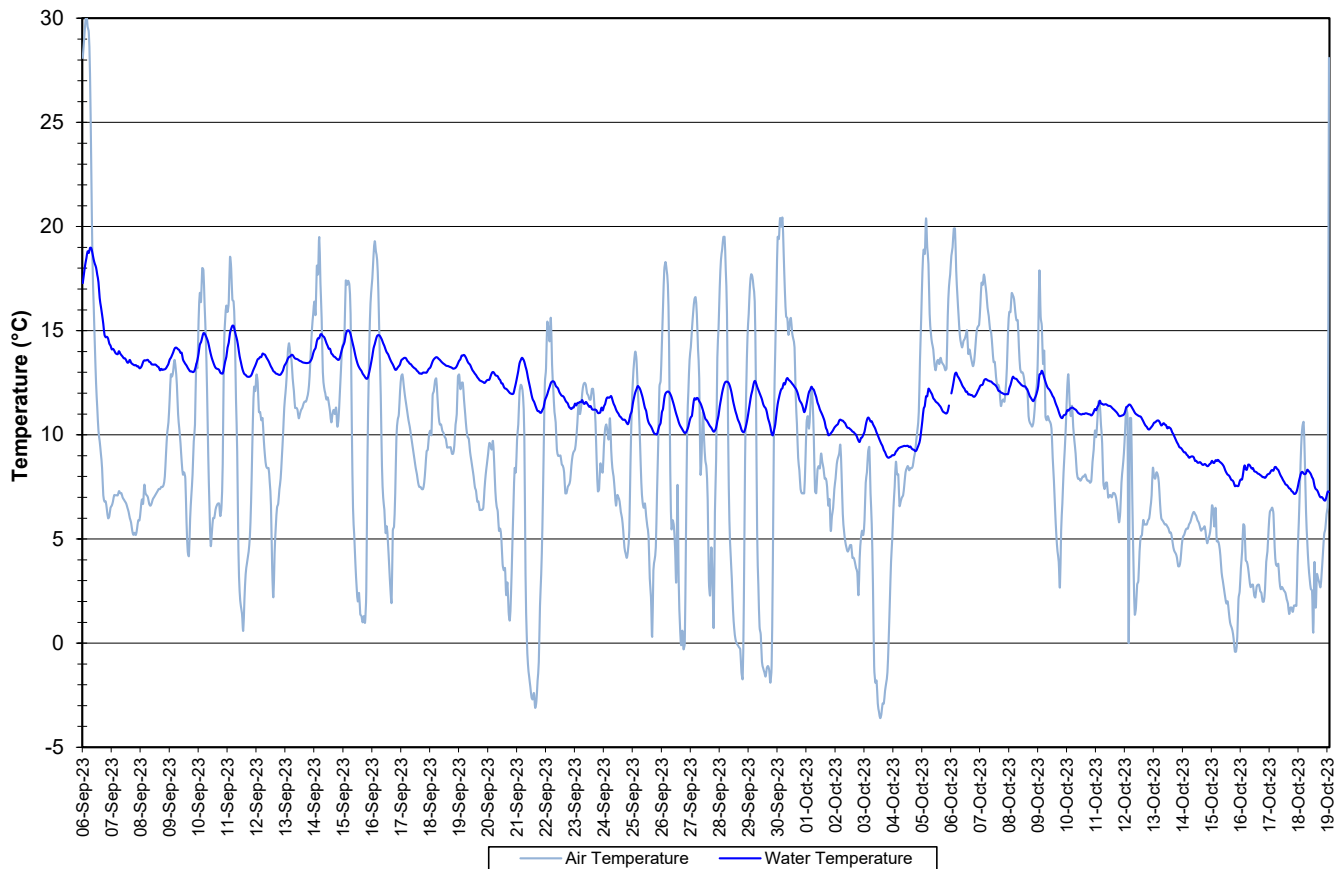
## Data Interpretation

- The following graphs and discussion illustrate water quality related events from September 6 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 6.85 to 18.98°C during this deployment period (Figure 1).
- Overall, water temperature decreased during this deployment period, corresponding with decreasing ambient air temperature into the fall (Figure 1).

**Water and Air Temperature : Flora Creek below TLH  
September 6 to October 19, 2023**



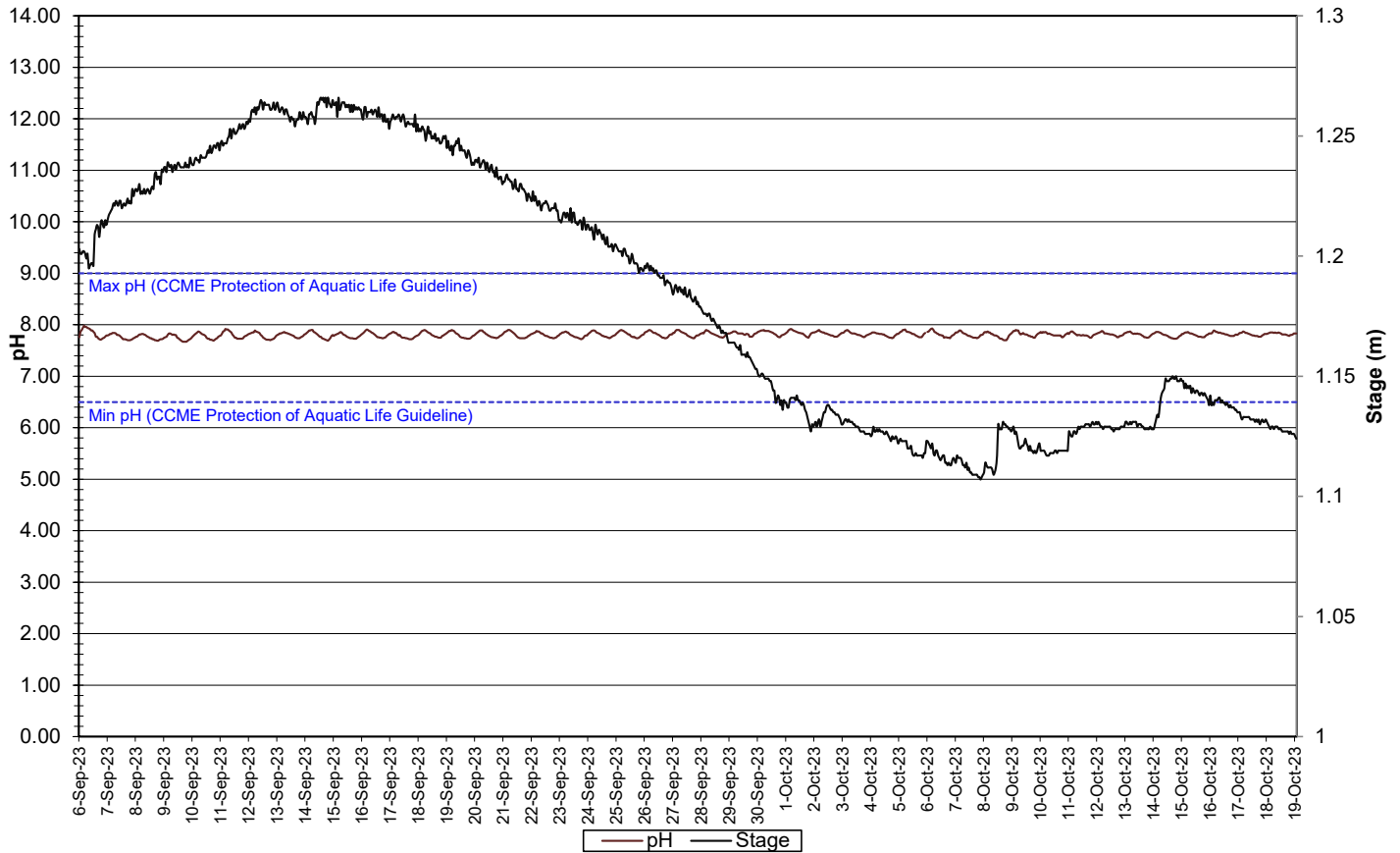
**Figure 1: Water and Air Temperature - Flora Creek below TLH**

(Weather data collected at Moosehead Lake)

Flora Creek below TLH, Newfoundland and Labrador

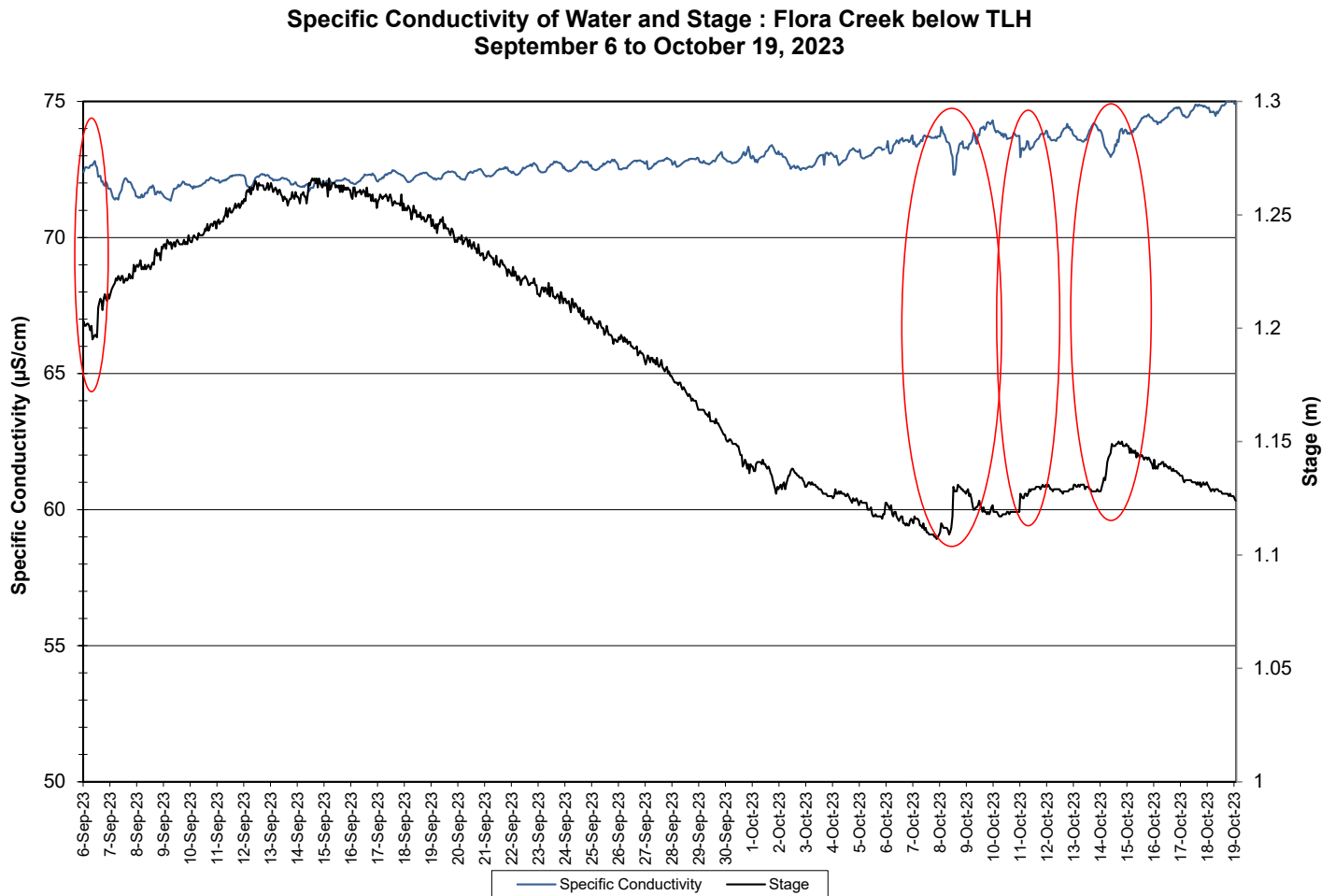
- pH ranged between 7.67 and 7.98 pH units throughout the deployment period, with a median value of 7.81 units (Figure 2).
- pH was stable throughout the entire deployment period.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.

**Water pH and Stage : Flora Creek below TLH  
September 6 to October 19, 2023**



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

- Specific conductivity ranged from 71.4 to 75.1  $\mu\text{S}/\text{cm}$  (Figure 3).
- Specific conductivity increased gradually over the course of the deployment period with noticeable decreases in early September and October, which correspond with sudden increases in stage due to precipitation events. 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.



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

- The saturation of dissolved oxygen ranged from 89.1 to 102.4% and a range of 9.02 to 11.23 mg/l was found for the concentration of dissolved oxygen with a median value of 10.23 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. Overall, dissolved oxygen increased slightly over the course of the deployment period, as is expected with cooling temperatures into Fall.

Dissolved Oxygen Concentration and Saturation : Flora Creek below TLH  
September 6 to October 19, 2023

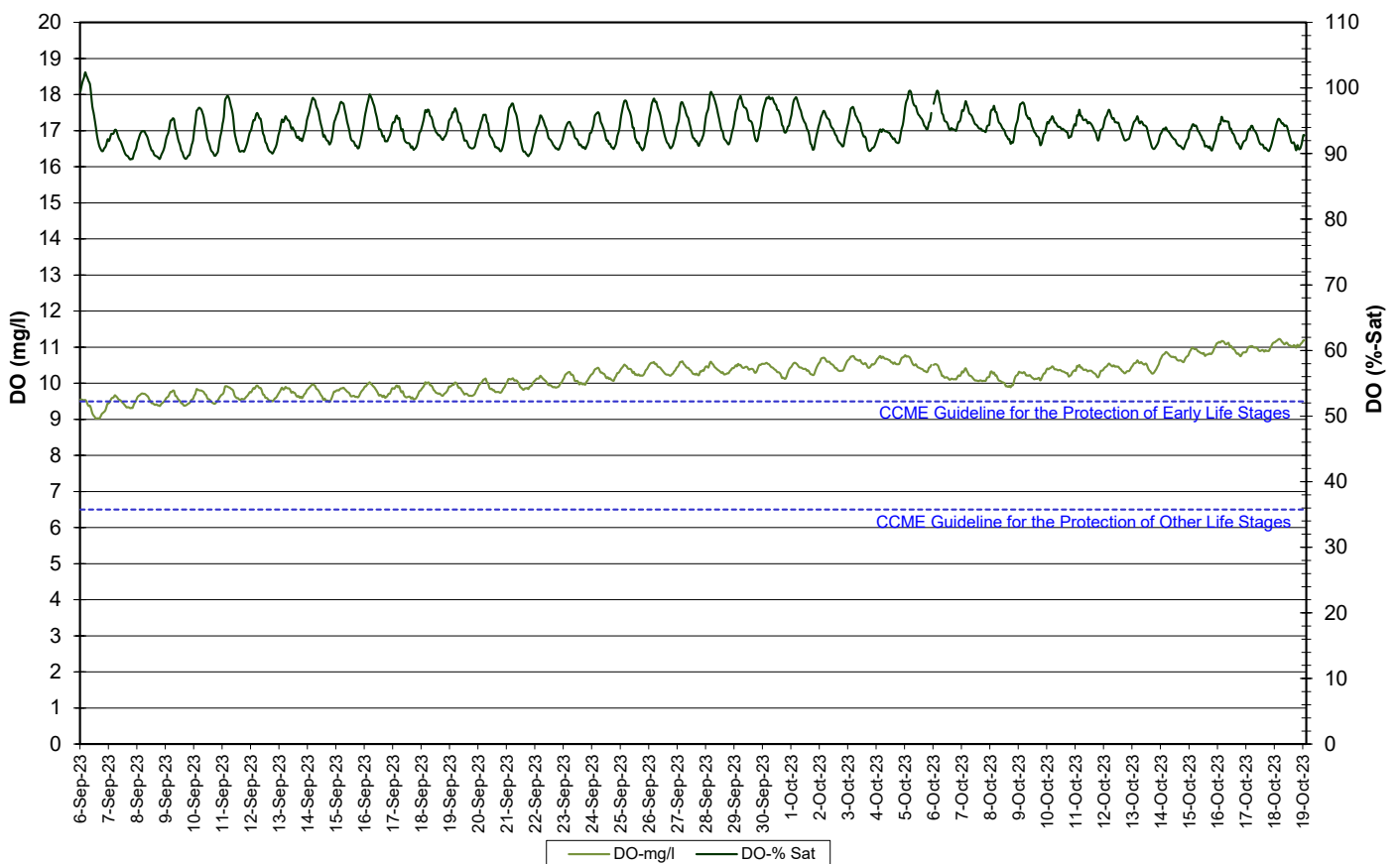
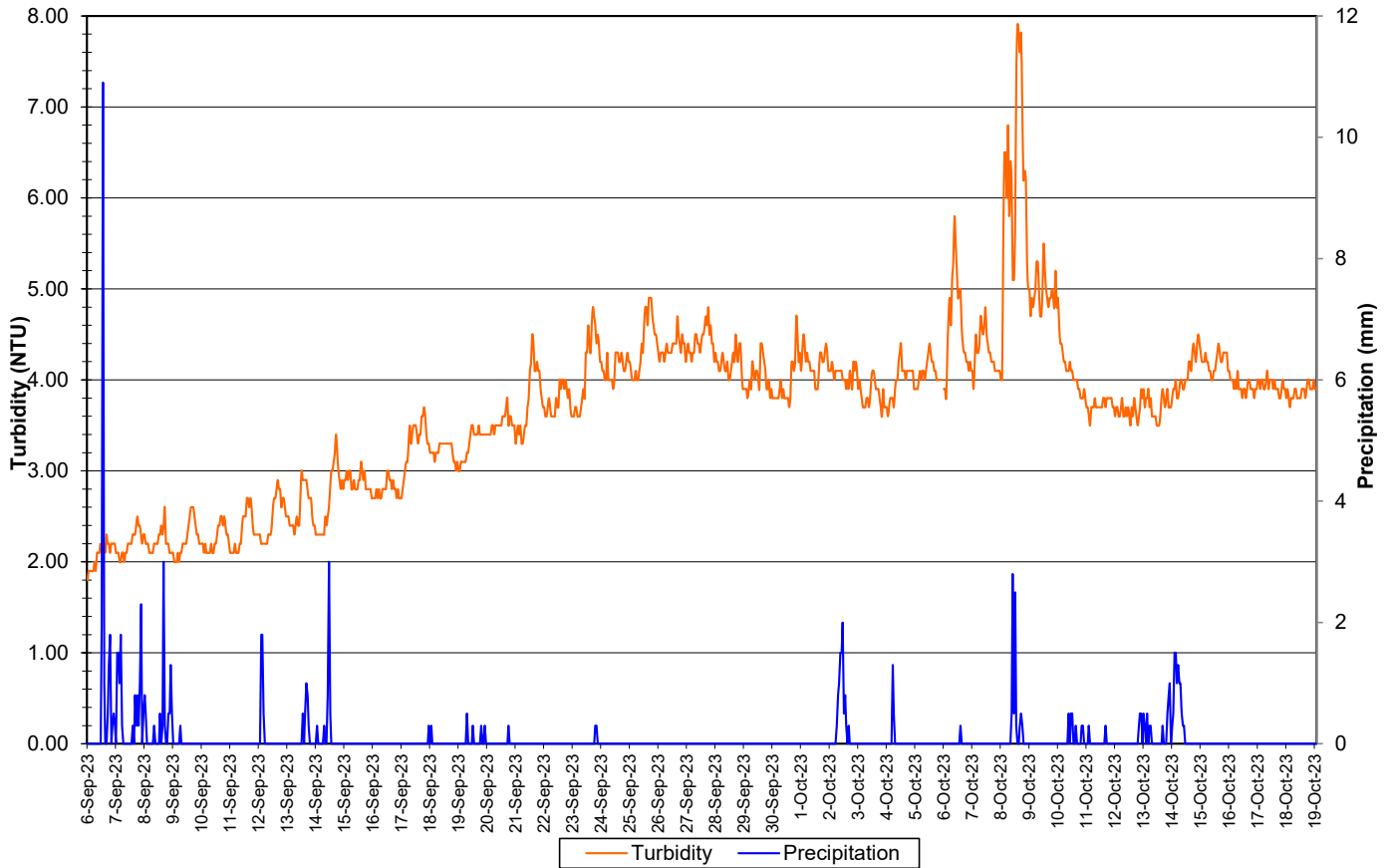


Figure 4: Dissolved Oxygen and Saturation - Flora Creek below TLH



- Turbidity values range from 1.8 NTU to 7.9 NTU (Figure 5).
- Turbidity values were low during this deployment period. Turbidity spikes occurred infrequently, for short periods of time, and generally corresponded to precipitation events.

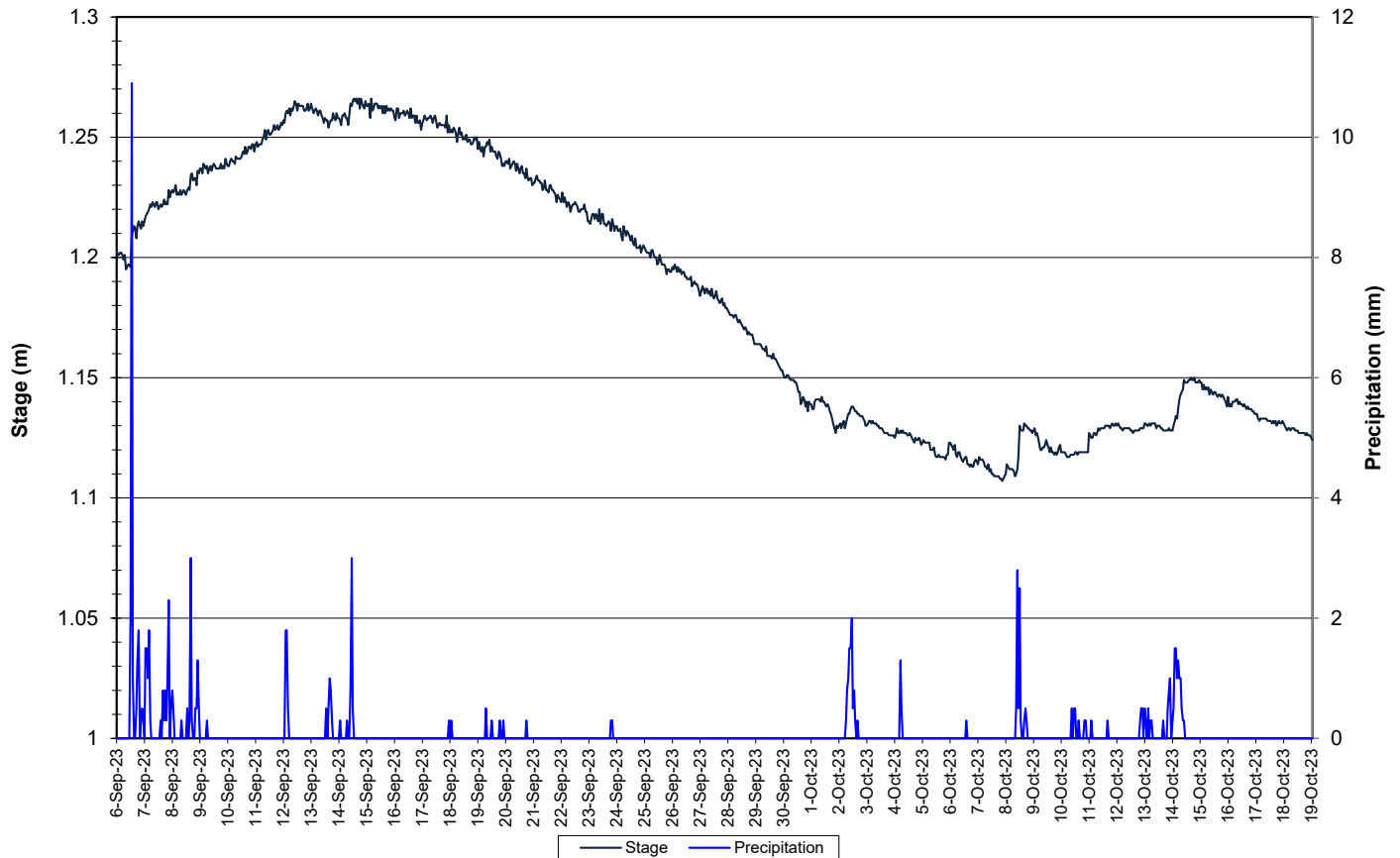
**Water Turbidity and Precipitation : Flora Creek below TLH  
September 6 to October 19, 2023**



**Figure 5: Turbidity - Flora Creek below TLH**

- Precipitation and stage during the deployment period are graphed below (Figure 6). Stage decreased during this deployment period, with short-term increases after some precipitation events.
- 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 6 to October 19, 2023**



**Figure 6: Precipitation and Stage – Flora Creek below TLH**

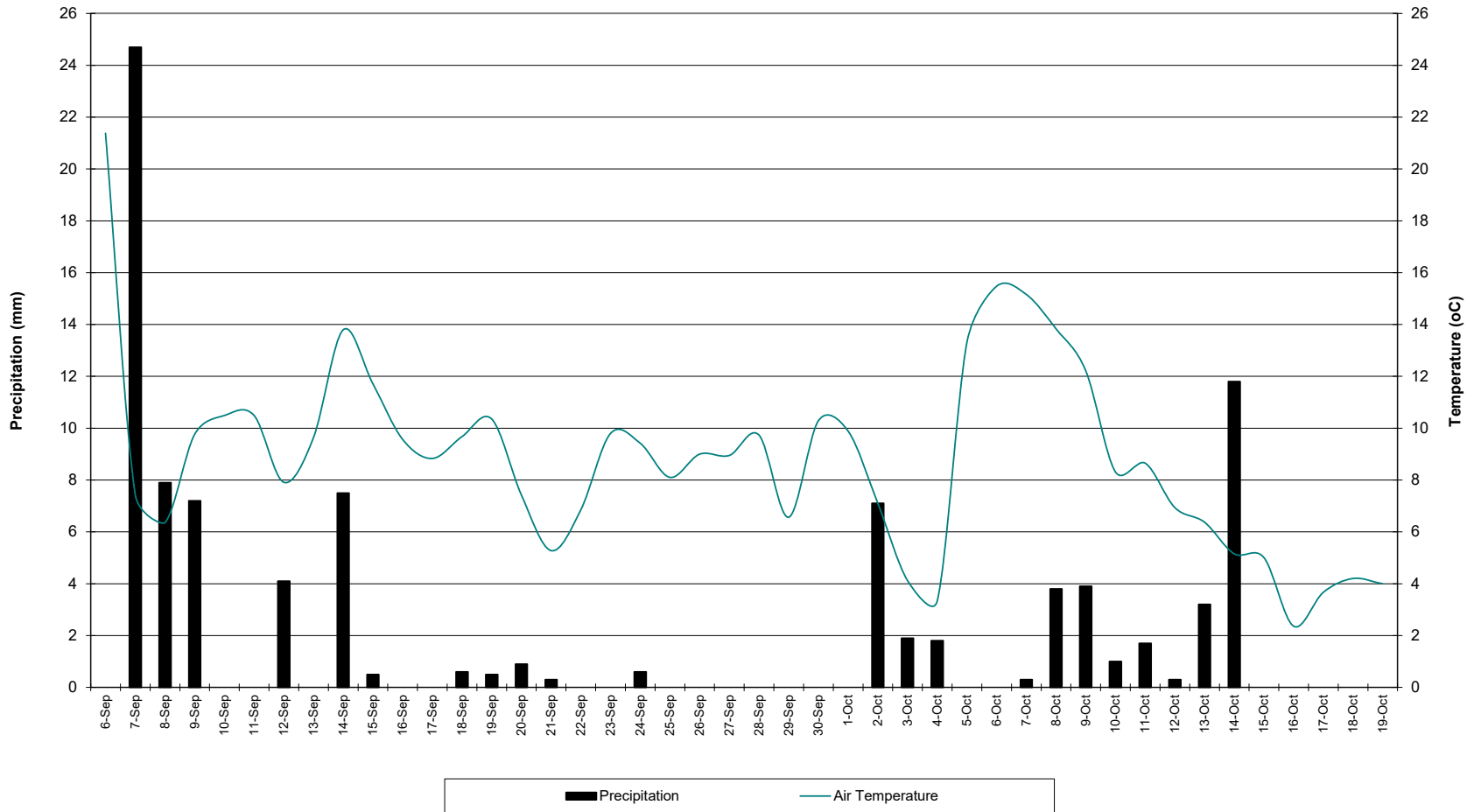
## Conclusions

- A clean and calibrated instrument was deployed at the Flora Creek below TLH water quality monitoring station on September 6, 2023 and removed on October 18, 2023. This was the third and final deployment for 2023.
- In most cases, weather related events or increases/decreases in water level explain parameter fluctuations. Almost all 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 temperatures, ranging between 12.66 and 22.89°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 7.67 and 7.98.
- Specific conductivity increased gradually over the course of the deployment period, ranging from 71.4 to 75.1  $\mu\text{s}/\text{cm}$ .
- 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. The majority 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 values were low with a few small spikes. Values ranged from 1.8 to 7.9 NTU.
- Stage decreased throughout the deployment period with some small increases after precipitation events.
- 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.

Prepared by:  
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Water Resources Management Division  
Phone: 709.896.7981

# Appendix 1

Average Daily Air Temperature and Precipitation: Moosehead Lake  
September 6 to October 19, 2023



**Appendix 2**  
**QA/QC Grab Sample Results**



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Bureau Veritas Job #: C3R8354  
Report Date: 2023/09/22

NL Department of Environment, Climate Change and  
Municipalities  
Site Location: LABRADOR  
Your P.O. #: 220028978-9

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
WYN071 FLORA CREEK								
Sampling Date		2023/09/06 12:10						
Matrix		W						
Sample #		2023-6324-00-SI-SP						
Registration #		SA-0000						
<b>RESULTS OF ANALYSES OF WATER</b>								
<b>Calculated Parameters</b>								
Hardness (CaCO3)	-	34	1.0	mg/L	N/A	2023/09/14		8910068
Nitrate (N)	-	0.27	0.050	mg/L	N/A	2023/09/22		8910070
Total dissolved solids (calc., EC)	-	41	1.0	mg/L	N/A	2023/09/20		8910074
<b>Inorganics</b>								
Conductivity	-	73	1.0	uS/cm	N/A	2023/09/19	LJV	8925305
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2023/09/15	LKH	8917225
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/09/15	LKH	8917225
Sulphate (SO4)	-	4.0	1.0	mg/L	N/A	2023/09/15	LKH	8917225
Total Alkalinity (Total as CaCO3)	-	30	2.0	mg/L	N/A	2023/09/19	LJV	8925306
Colour	-	ND	5.0	TCU	N/A	2023/09/22	HGV	8931412
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/09/19	LJV	8925307
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2023/09/15	2023/09/18	KJP	8921094
Nitrate + Nitrite (N)	-	0.28	0.050	mg/L	N/A	2023/09/22	MCN	8931448
Nitrite (N)	-	0.010	0.010	mg/L	N/A	2023/09/21	MCN	8931471
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2023/09/21	HGV	8929676
Dissolved Organic Carbon (C)	-	1.6	0.50	mg/L	N/A	2023/09/20	ACK	8925785
Total Organic Carbon (C)	-	1.5	0.50	mg/L	N/A	2023/09/19	CPP	8925846
Dup.Total Organic Carbon (C)	-	1.5	0.50	mg/L	N/A	2023/09/19	CPP	8925846
pH	-	7.75		pH	N/A	2023/09/19	LJV	8925302
Total Phosphorus	-	ND	0.004	mg/L	2023/09/19	2023/09/20	SPC	8926617
Total Suspended Solids	-	ND	1.0	mg/L	2023/09/13	2023/09/14	RMK	8912849
Turbidity	-	0.84	0.10	NTU	N/A	2023/09/19	LJV	8925568
<b>MERCURY BY COLD VAPOUR AA (WATER)</b>								
<b>Metals</b>								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/09/20	2023/09/22	SGK	8928182
<b>ELEMENTS BY ICP/MS (WATER)</b>								
<b>Metals</b>								
Total Aluminum (Al)	-	ND	0.0050	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Barium (Ba)	-	0.0013	0.0010	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Boron (B)	-	ND	0.050	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Calcium (Ca)	-	7.7	0.10	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Copper (Cu)	-	ND	0.00050	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Iron (Fe)	-	ND	0.050	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Magnesium (Mg)	-	3.5	0.10	mg/L	2023/09/13	2023/09/14	MTZ	8913579



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VERITAS

Bureau Veritas Job #: C3R8354  
Report Date: 2023/09/22

NL Department of Environment, Climate Change and  
Municipalities  
Site Location: LABRADOR  
Your P.O. #: 220028978-9

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
WYN071 FLORA CREEK								
Sampling Date		2023/09/06 12:10						
Matrix		W						
Sample #		2023-6324-00-SI-SP						
Registration #		SA-0000						
<b>ELEMENTS BY ICP/MS (WATER)</b>								
<b>Metals</b>								
Total Manganese (Mn)	-	0.023	0.0020	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Potassium (K)	-	0.83	0.10	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Sodium (Na)	-	0.84	0.10	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Strontium (Sr)	-	0.0070	0.0020	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Uranium (U)	-	ND	0.00010	mg/L	2023/09/13	2023/09/14	MTZ	8913579
Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/09/13	2023/09/14	MTZ	8913579



BUREAU  
VERITAS

Bureau Veritas Job #: C3X2217  
Report Date: 2023/11/09

NL Department of Environment, Climate Change and  
Municipalities  
Site Location: LABRADOR  
Your P.O. #: 220028978-9

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
XJX198 FLORA CREEK								
Sampling Date		2023/10/19 12:30						
Matrix		W						
Sample #		2023-6335-00-SI-SP						
Registration #		SA-0000						
<b>RESULTS OF ANALYSES OF WATER</b>								
<b>Calculated Parameters</b>								
Hardness (CaCO3)	-	33	1.0	mg/L	N/A	2023/11/08		9004582
Nitrate (N)	-	0.24	0.050	mg/L	N/A	2023/11/06		9004585
Total dissolved solids (calc., EC)	-	42	1.0	mg/L	N/A	2023/10/31		9004878
<b>Inorganics</b>								
Conductivity	-	75	1.0	uS/cm	N/A	2023/10/30	LJV	9011744
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2023/11/02	LKH	9011511
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/11/02	LKH	9011511
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2023/11/02	LKH	9011511
Total Alkalinity (Total as CaCO3)	-	30	2.0	mg/L	N/A	2023/10/30	LJV	9011751
Colour	-	ND	5.0	TCU	N/A	2023/11/03	MCN	9024056
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/10/30	LJV	9011753
Total Kjeldahl Nitrogen (TKN)	-	0.11	0.10	mg/L	2023/11/06	2023/11/07	RTY	9030713
Dup.Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2023/11/06	2023/11/07	RTY	9030713
Nitrate + Nitrite (N)	-	0.24	0.050	mg/L	N/A	2023/11/03	MCN	9024048
Nitrite (N)	-	ND	0.010	mg/L	N/A	2023/11/03	MCN	9024052
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2023/11/08	HGV	9035721
Dissolved Organic Carbon (C)	-	1.8	0.50	mg/L	N/A	2023/11/09	CPP	9037018
Total Organic Carbon (C)	-	1.7	0.50	mg/L	N/A	2023/11/08	CPP	9035685
pH	-	7.56		pH	N/A	2023/10/30	LJV	9011729
Total Phosphorus	-	ND	0.004	mg/L	2023/11/06	2023/11/07	MUM	9030737
Total Suspended Solids	-	ND	1.0	mg/L	2023/10/25	2023/10/26	DME	9004845
Turbidity	-	1.8	0.10	NTU	N/A	2023/10/30	LJV	9011977
<b>MERCURY BY COLD VAPOUR AA (WATER)</b>								
<b>Metals</b>								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/11/03	2023/11/06	SGK	9026346
<b>ELEMENTS BY ICP/MS (WATER)</b>								
<b>Metals</b>								
Total Aluminum (Al)	-	ND	0.0050	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Barium (Ba)	-	0.0020	0.0010	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Boron (B)	-	ND	0.050	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Calcium (Ca)	-	7.2	0.10	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Copper (Cu)	-	ND	0.00050	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Iron (Fe)	-	ND	0.050	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Magnesium (Mg)	-	3.6	0.10	mg/L	2023/11/08	2023/11/08	MTZ	9035660





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Bureau Veritas Job #: C3X2217  
Report Date: 2023/11/09

NL Department of Environment, Climate Change and  
Municipalities  
Site Location: LABRADOR  
Your P.O. #: 220028978-9

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
XJX198 FLORA CREEK								
Sampling Date		2023/10/19 12:30						
Matrix		W						
Sample #		2023-6335-00-SI-SP						
Registration #		SA-0000						
<b>ELEMENTS BY ICP/MS (WATER)</b>								
<b>Metals</b>								
Total Manganese (Mn)	-	0.045	0.0020	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Potassium (K)	-	0.83	0.10	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Sodium (Na)	-	0.88	0.10	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Strontium (Sr)	-	0.0067	0.0020	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Uranium (U)	-	ND	0.00010	mg/L	2023/11/08	2023/11/08	MTZ	9035660
Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/11/08	2023/11/08	MTZ	9035660