Real-Time Water Quality Deployment Report

Flora Creek below TLH

June 7 to
July 13, 2023

Newfoundland Labrador

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

Contents

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 July 13th, 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 55 days and was removed on September 6th, 2023. This was the second 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

	Rank				
Parameter	**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 July 13 and September 6, 2023 are summarized in Table 2.

Table 2: Comparison rankings for Flora Creek below TLH station July 13 – September 6, 2023.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Flora Creek below TLH	July 13, 2023	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Sept 6, 2023	Removal	Excellent	Good	Excellent	Fair	Excellent

- At deployment, all parameters ranked 'excellent'.
- At removal, dissolved oxygen ranked 'fair'. The field sonde read a value of 10.03 mg/L, while the QA/QC sonde read a value of 9.51 mg/L. All other parameters ranked either 'good' or 'excellent'.
- 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 July 13 to September 6 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 12.66 to 22.89°C during this deployment period (Figure 1).
- Overall, water temperature decreased during this deployment period, corresponding with decreasing ambient air temperatures (Figure 1).

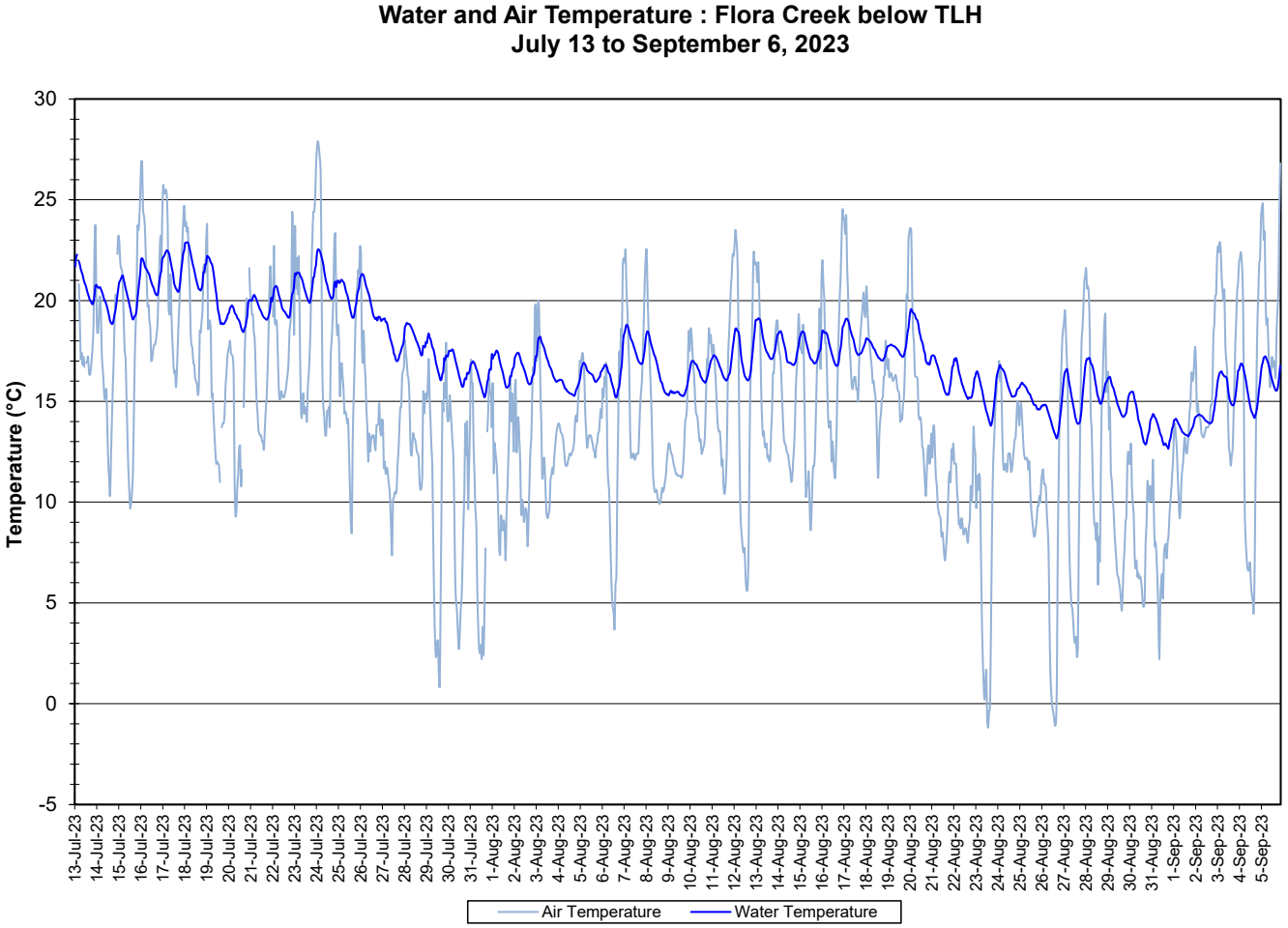

Figure 1: Water and Air Temperature - Flora Creek below TLH

(Weather data collected at Moosehead Lake)

- pH ranged between 7.69 and 8.11 pH units throughout the deployment period, with a median value of 7.90 units (Figure 2).
- pH decreased slightly during the second week of August 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.

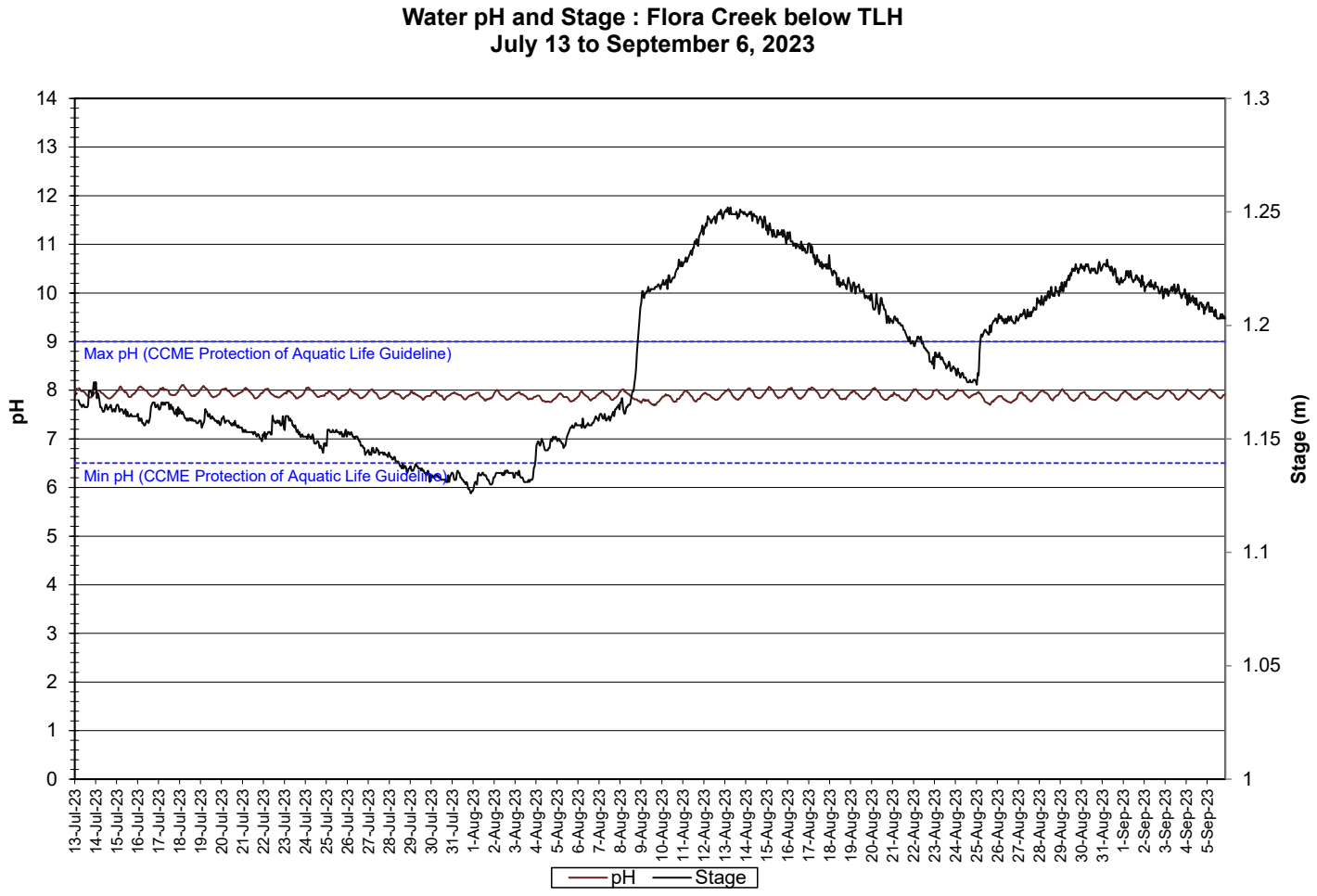

Figure 2: Water pH and Stage - Flora Creek below TLH

- Specific conductivity ranged from 69.2 to 73.4 µs/cm (Figure 3).
- Specific conductivity increased gradually over the course of the deployment period with a noticeable decrease the first week of August, which corresponds with a sudden increase in stage due to a high precipitation event. 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.

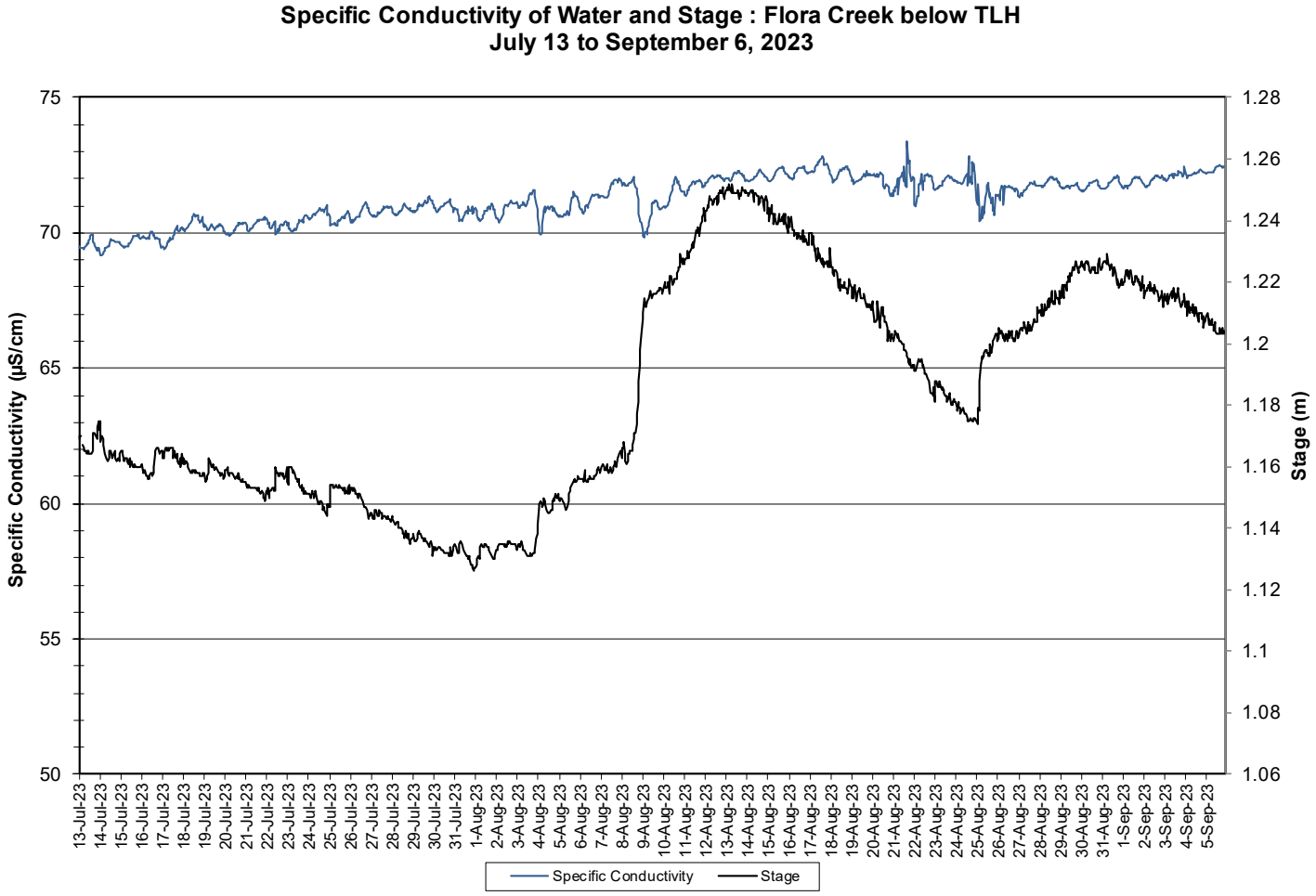

Figure 3: Specific Conductivity of Water and Stage - Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 92.7 to 106.7% and a range of 8.46 to 10.54 mg/l was found for the concentration of dissolved oxygen with a median value of 9.59 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 temperatures began to cool into the Fall.

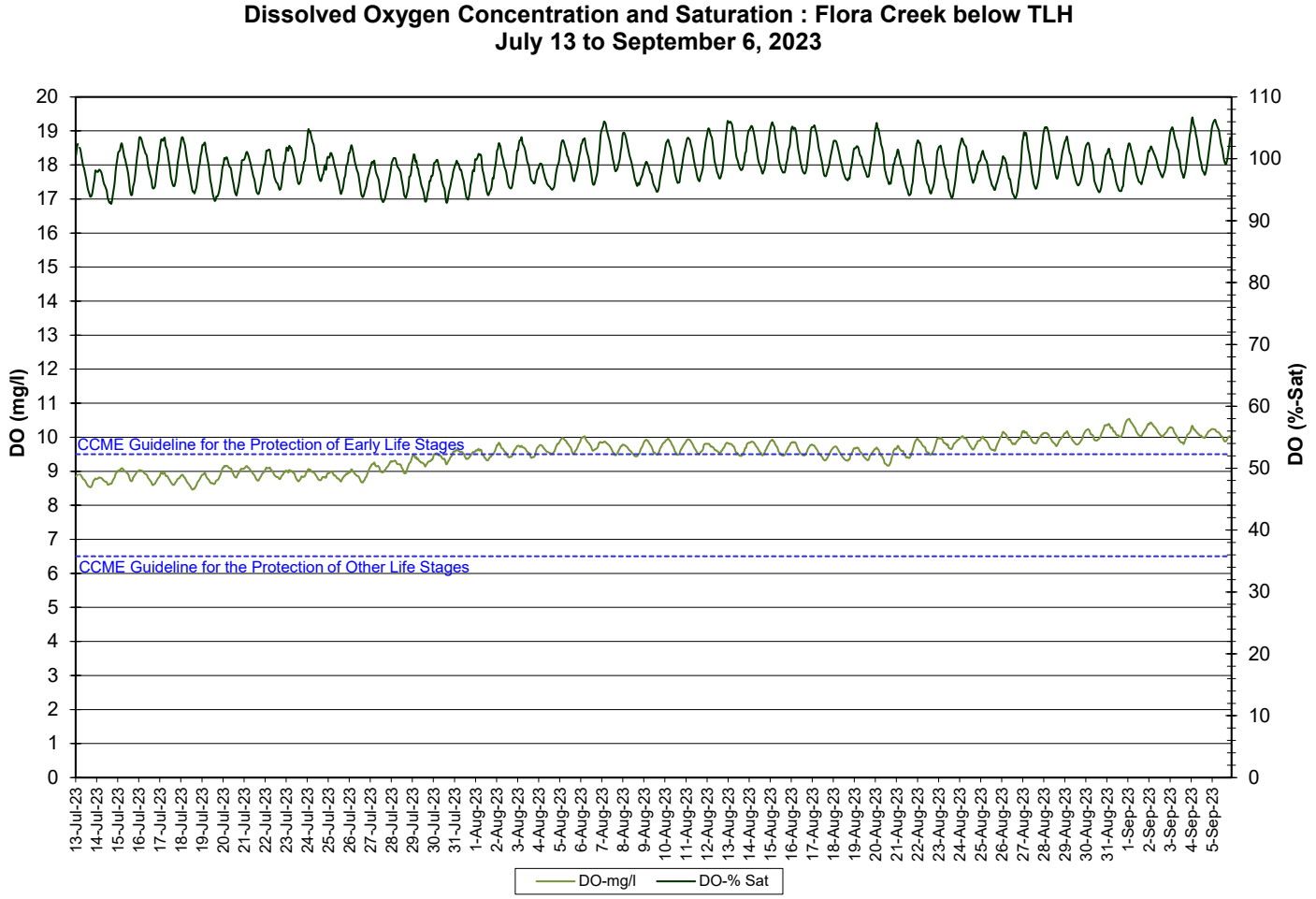

Figure 4: Dissolved Oxygen and Saturation - Flora Creek below TLH

- Turbidity values range from 1.5 NTU to 13.8 NTU (Figure 5).
- Turbidity values were low during this deployment period. Turbidity spikes occurred infrequently and for short periods of time.

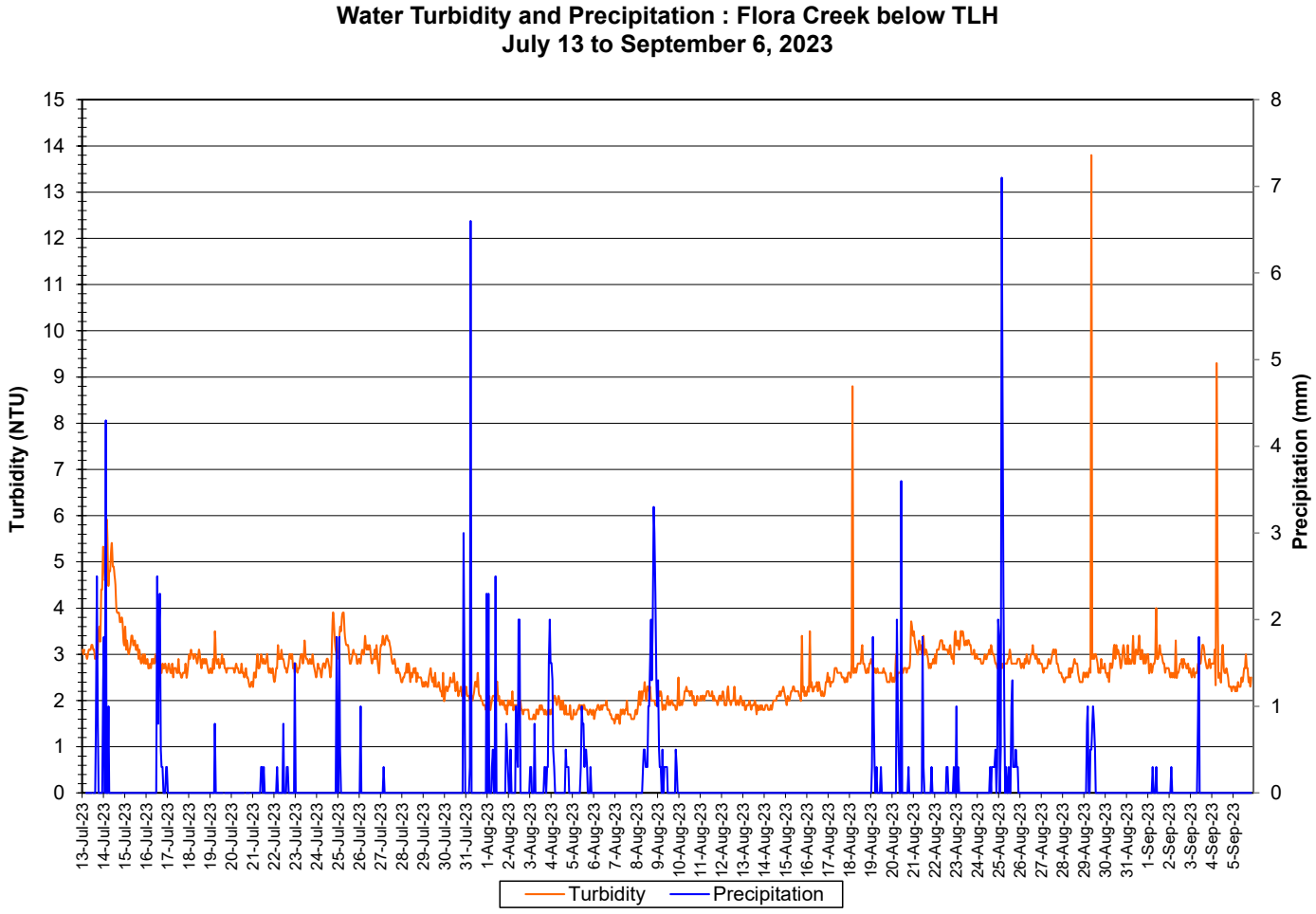

Figure 5: Turbidity - Flora Creek below TLH

- Precipitation and stage during the deployment period are graphed below (Figure 6). Stage increased after prolonged precipitation events, followed by gradual decreases.
- 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.

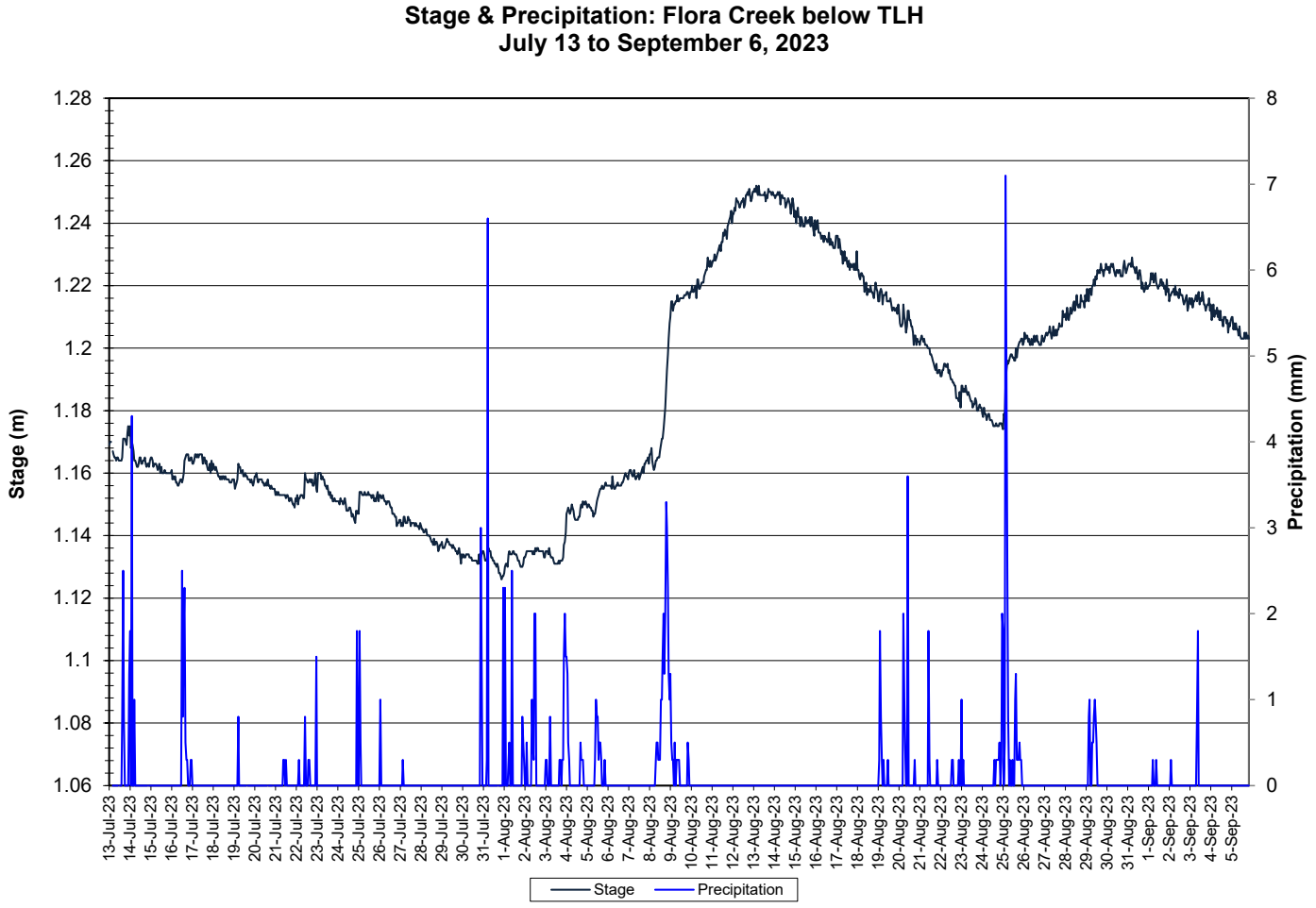

Figure 6: Precipitation and Stage – Flora Creek below TLH

Conclusions

- A clean and calibrated instrument was deployed at the Flora Creek below TLH water quality monitoring station on July 13, 2023 and removed on September 6, 2023. This was the second deployment for 2023.
- 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 12.66 and 22.89^{o}C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 7.69 and 8.11.
- Specific conductivity increased gradually over the course of the deployment period, ranging from 69.2 to 73.4 µs/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 1.5 to 13.8 NTU.
- Stage increased after several continuous days with precipitation.
- 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.

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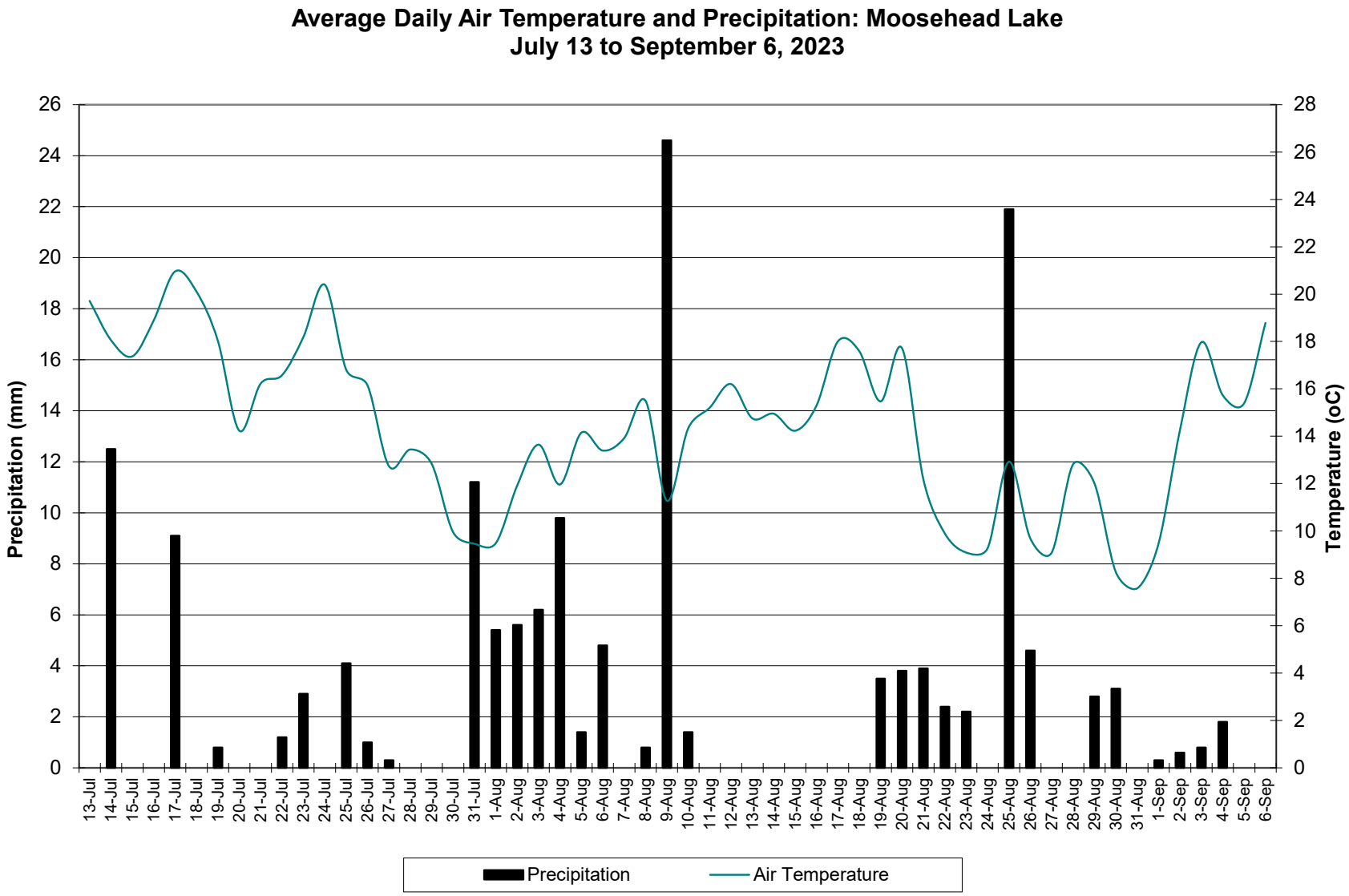
Appendix 1


Average Daily Air Temperature and Precipitation: Moosehead Lake
July 13 to September 6, 2023
Precipitation (mm)
Temperature (oC)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
13-Jul
14-Jul
15-Jul
16-Jul
17-Jul
18-Jul
19-Jul
20-Jul
21-Jul
22-Jul
23-Jul
24-Jul
25-Jul
26-Jul
27-Jul
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9-Aug
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16-Aug
17-Aug
18-Aug
19-Aug
20-Aug
21-Aug
22-Aug
23-Aug
24-Aug
25-Aug
26-Aug
27-Aug
28-Aug
29-Aug
30-Aug
31-Aug
1-Sep
2-Sep
3-Sep
4-Sep
5-Sep
6-Sep
Precipitation
Air Temperature

Appendix 2
QA/QC Grab Sample Results

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
WKU548 FIORA CREEK								
Sampling Date 2023/07/13 15:25								
Matrix W								
Sample # 2023-6314-00-SI-SP								
Registration # SA-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	32	1.0	mg/L	N/A	2023/08/09		8797883
Nitrate (N)	-	0.29	0.050	mg/L	N/A	2023/08/04		8797888
Total dissolved solids (calc., EC)	-	39	1.0	mg/L	N/A	2023/08/04		8797896
Inorganics								
Conductivity	-	70	1.0	uS/cm	N/A	2023/08/04	LJV	8832113
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2023/07/25	SUR	8806696
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/07/25	SUR	8806696
Sulphate (SO4)	-	2.9	1.0	mg/L	N/A	2023/07/25	SUR	8806696
Total Alkalinity (Total as CaCO3)	-	28	2.0	mg/L	N/A	2023/08/04	LJV	8832118
Colour	-	ND	5.0	TCU	N/A	2023/08/04	MCN	8831846
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/08/04	LJV	8832121
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2023/07/21	2023/07/24	RTY	8804787
Nitrate + Nitrite (N)	-	0.29	0.050	mg/L	N/A	2023/08/04	MCN	8831861
Nitrite (N)	-	ND	0.010	mg/L	N/A	2023/08/03	MCN	8831867
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2023/08/01	MCN	8825494
Dissolved Organic Carbon (C)	-	1.5	0.50	mg/L	N/A	2023/08/05	CPP	8834211
Total Organic Carbon (C)	-	1.6	0.50	mg/L	N/A	2023/07/27	CPP	8816609
pH	-	7.72		pH	N/A	2023/08/04	LJV	8832103
Total Phosphorus	-	ND	0.004	mg/L	2023/07/21	2023/07/22	MUM	8804799
Total Suspended Solids	-	1.0	1.0	mg/L	2023/07/20	2023/07/20	RMK	8800716
Turbidity	-	1.5	0.10	NTU	N/A	2023/08/04	LJV	8833723
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/07/27	2023/07/28	SGK	8815475
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.0066	0.0050	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Barium (Ba)	-	0.0024	0.0010	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Boron (B)	-	ND	0.050	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Calcium (Ca)	-	7.0	0.10	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Copper (Cu)	-	ND	0.00050	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Iron (Fe)	-	ND	0.050	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Magnesium (Mg)	-	3.4	0.10	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Manganese (Mn)	-	0.063	0.0020	mg/L	2023/08/08	2023/08/09	JHY	8838136

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Bureau Veritas Job #: C3L3902
Report Date: 2023/08/09

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-9
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
WKU548 FIORA CREEK Sampling Date 2023/07/13 15:25 Matrix W Sample # 2023-6314-00-SI-SP Registration # SA-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Potassium (K)	-	0.77	0.10	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Sodium (Na)	-	0.79	0.10	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Strontium (Sr)	-	0.0068	0.0020	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Uranium (U)	-	ND	0.00010	mg/L	2023/08/08	2023/08/09	JHY	8838136
Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/08/08	2023/08/09	JHY	8838136

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