

# Real-Time Water Quality Annual Report

Flora Creek below TLH

June 15 to  
October 13, 2022



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

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## **Acknowledgements**

The Real-Time Water Quality Monitoring station (RTWQ) at Flora Creek is funded by Tacora Resources, Inc. The program is a joint partnership between Tacora Resources, Environment and Climate Change Canada (ECCC), and the Newfoundland & Labrador Department of Environment & Climate Change (ECC).

Various individuals from each sector have been diligently involved to ensure this program is a successful operation including, various WRMD staff (ECC), Sharlene Baird and Katherine Jacobs (Tacora Resources, Inc.), and various WSC staff (ECCC). In addition to these managers, there have been a team of individuals who work together to ensure the day to day operation of this station is providing quality data. Maria Murphy (ECC) was responsible for this water quality station during 2021; responsibilities included deployment and removal of the instrument, maintenance and calibration of the instrument and preparation of monthly deployment reports. Brenda Congram, Jason Barnes and Kyla Brake (ECC) are acknowledged for their assistance during deployment and removal procedures in 2021.

ECCC staff are essential in the operation of the data logging/communication aspect of the network. Staff of the Meteorological Service of Canada Division – Water Survey of Canada, visit the station regularly to ensure that the data logging and data transmitting equipment is working properly. ECCC is also the lead on dealing with water stage and flow issues.

## Introduction

- The real-time water quality monitoring station on Flora Creek was established during the summer of 2014 as a partnership between the Newfoundland & Labrador Department of Environment and Climate Change and Cliffs Natural Resources. In 2017, the mine was sold and the partnership transferred to Tacora Resources and the Newfoundland & Labrador Department of Environment, Climate Change & Municipalities (currently ECC).
- The official name of the station is Flora Creek below TLH, also referred to as the Flora Creek station.
- This station measures water quality parameters water temperature, pH, specific conductivity, dissolved oxygen and turbidity, as well as water quantity parameters stage and flow. Parameters are recorded on an hourly basis during the deployment period.



Figure 1: Map of Western Labrador area showing the RTWQ Flora Creek station.

- The purpose of this network is to monitor, process, and distribute water quality/quantity data to Tacora Resources, ECC and ECCC, for assessment and management of water resources, as well as to provide an early warning for any potential or emerging water issues so that mitigative measures can be implemented in a timely manner.
- ECC provides Tacora Resources with monthly and annual deployment reports. Data is available in near real-time on the Department of Environment & Climate Change’s website.
- A RTWQ monitoring instrument has been deployed at this station each season since 2014, near a continuously evolving mine site. Unless otherwise stated, small gaps on graphs indicate the time frame where the instrument was removed from the water for calibration and maintenance.
- The initial deployment for the 2021 season was on June 15<sup>th</sup>. The instrument was removed for the winter season on October 13<sup>th</sup>. The following report depicts and discusses water quality events throughout this time period.

## **Maintenance and Calibration**

- To ensure accurate data collection, maintenance and calibration of the water quality instrumentation is performed normally approximately every 45 days.
- Maintenance includes a thorough cleaning of the instrument and replacement of any small sensor parts that are damaged or unsuitable for reuse. Once the instrument is cleaned, ECC staff carefully calibrate each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity to ensure accurate data collection.
- Installation and removal dates for the 2021 season are summarized in the table below.

**Table 1: Water quality instrument deployment start and end dates for 2021**

<b>Installation</b>	<b>Removal</b>	<b>Deployment duration (days)</b>
<b>June 15</b>	July 28	43
<b>July 28</b>	September 9	43
<b>September 9</b>	October 13	34

## 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 each 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 adjacent to 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 2).

**Table 2: 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. Since 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 Flora Creek water quality station for the two deployment periods from June 15<sup>th</sup> to October 13<sup>th</sup>, 2021, are summarized in Table 3.
- For additional information and explanations of rankings, please refer to the 2021 monthly deployment reports.

**Table 3: QA/QC comparison rankings for Flora Creek June 15 to October 13, 2021**

	Date		Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
<b>Flora Creek</b>	15-Jun-21	Deployment	Excellent	Excellent	Excellent	Excellent	Good
	28-Jul-21	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
	28-Jul-21	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	9-Sep-21	Removal	Excellent	Fair	Excellent	Excellent	Excellent
	9-Sep-21	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	13-Oct-21	Removal	Excellent	Poor	Excellent	Excellent	Excellent



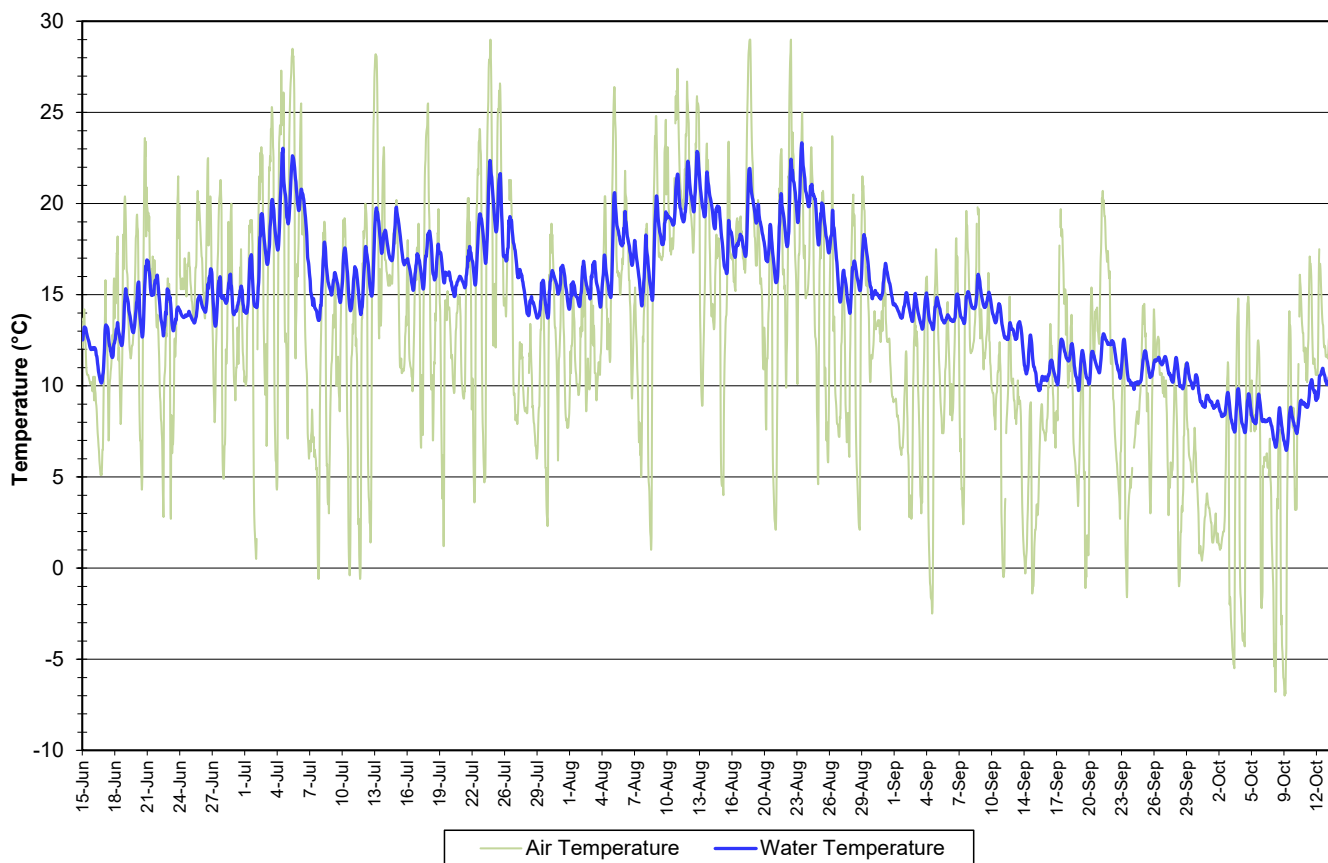
## Data Interpretation

- The following graphs and discussion illustrate water quality-related events from June 15<sup>th</sup>, 2021 to October 13<sup>th</sup>, 2021 at Flora Creek.
- 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.

### Flora Creek below TLH

- Water temperature ranged from 6.46 to 23.34°C during the 2021 deployment season. The median value was 14.92 °C (Figure 2).
- Water temperature increases at the beginning of the season and decreases during the later portion of the season. This is expected as ambient air temperature is warmer in the summer and cooler in the fall.

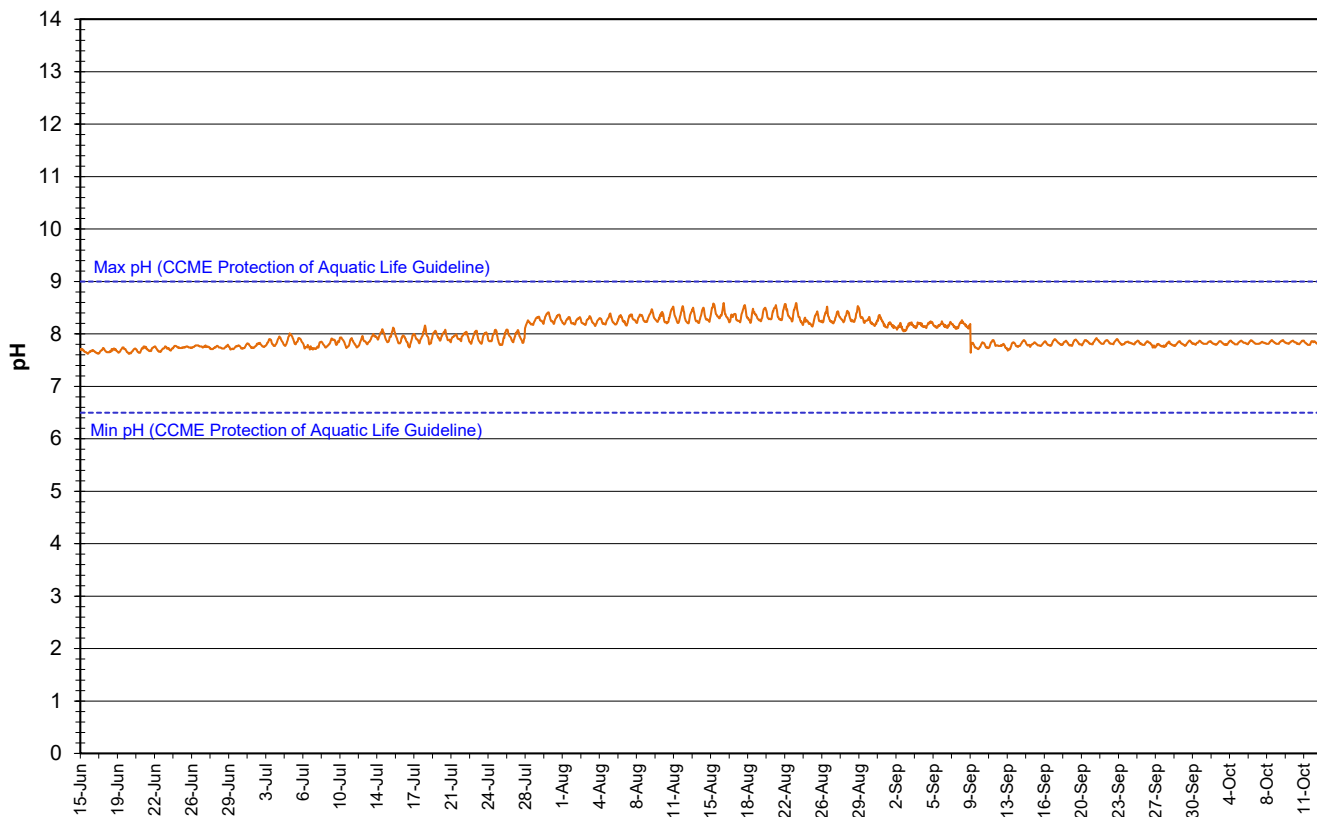
**Water and Air Temperature: Flora Creek below TLH  
June 15 to October 13, 2021**



**Figure 2: Water and Air Temperature – Flora Creek below TLH  
(Weather data collected from climate station near Moosehead Lake)**

- pH ranges from 7.62 to 8.59 pH units at Flora Creek, throughout the 2021 deployment season (Figure 3). The median pH is 7.87.
- pH increased slightly after the first deployment and decreased slightly after the second deployment. This may be due to a slight calibration error. pH fluctuates daily. Peaks are observed during late afternoon and early evening.
- All values during the deployment are within the CCME Water Quality Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units).

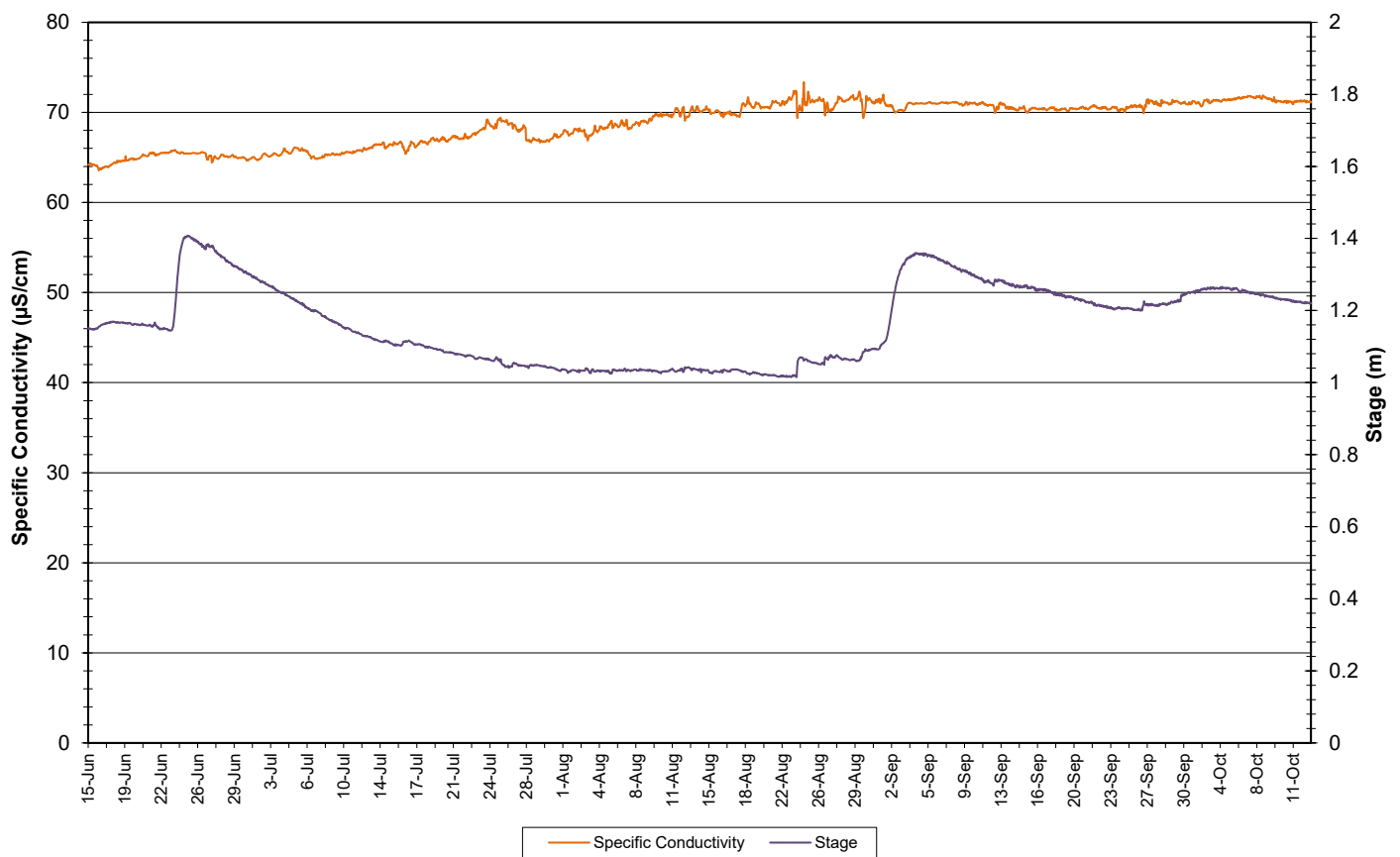
**Water pH: Flora Creek below TLH  
June 15 to October 13, 2021**



**Figure 3: pH – Flora Creek below TLH**

- Throughout the 2021 deployment season, specific conductivity ranged from 63.5 to 73.4  $\mu\text{S}/\text{cm}$ , with a median value of 69.9  $\mu\text{S}/\text{cm}$  at Flora Creek (Figure 4).
- Conductivity gradually increased over the course of the 2021 deployment season. Conductivity levels were not significantly impacted by increases in stage.
- 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.

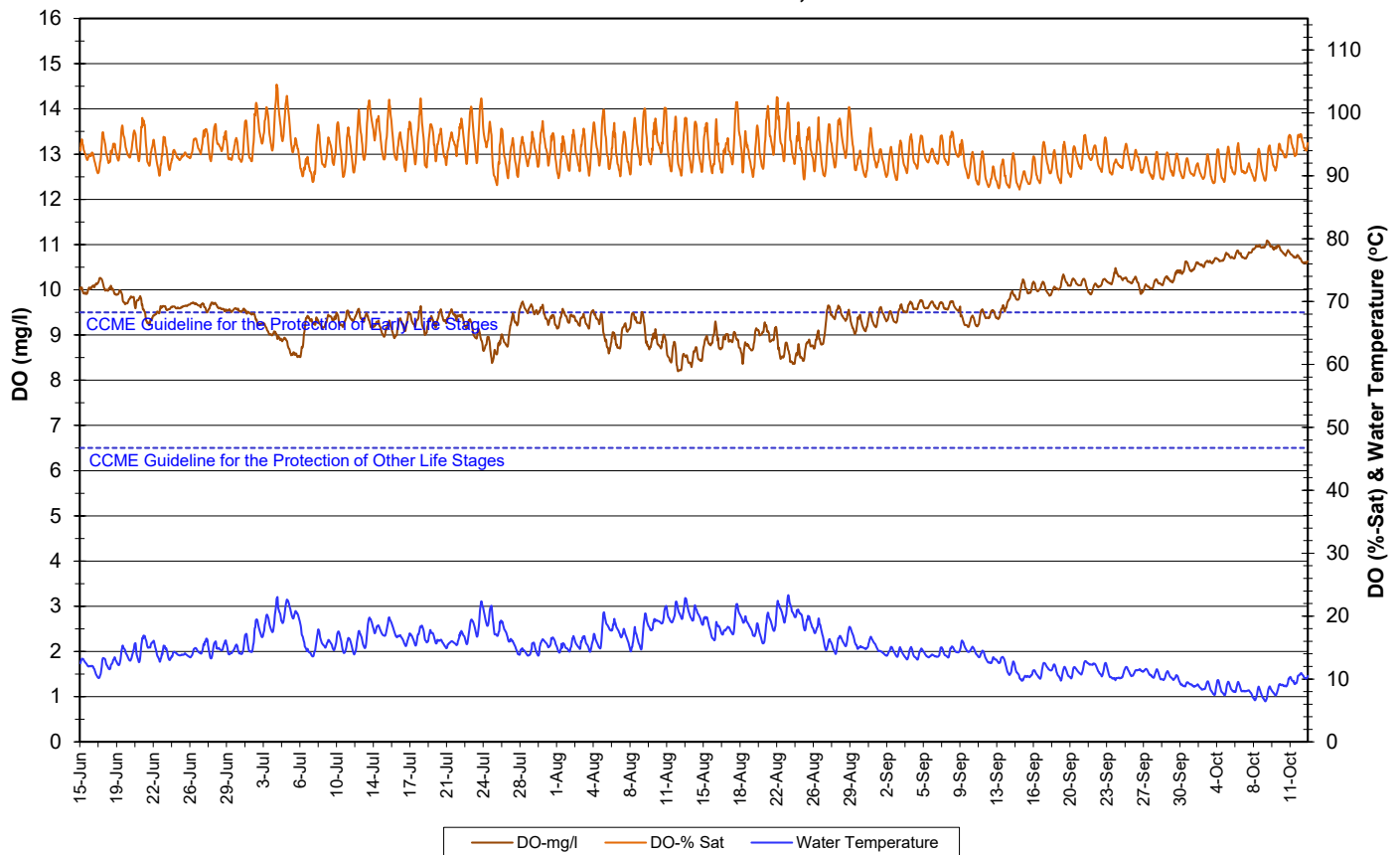
**Specific Conductivity and Stage: Flora Creek below TLH  
June 15 to October 13, 2021**



**Figure 4: Specific Conductivity and Stage – Flora Creek below TLH**

- The saturation of dissolved oxygen ranged from 87.8 to 104.5%, while the dissolved oxygen content ranged from 8.20 to 11.09 mg/l, with a median value of 9.46 mg/l (Figure 5).
- Dissolved oxygen fluctuated daily with decreases observed at night.
- Dissolved oxygen decreases slightly in June, due to warming water temperature. It is then relatively stable until the end of August, before increasing during the last deployment period of the season as water temperatures cool into the fall.
- All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages of 6.5 mg/l. The majority of values recorded were above the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.

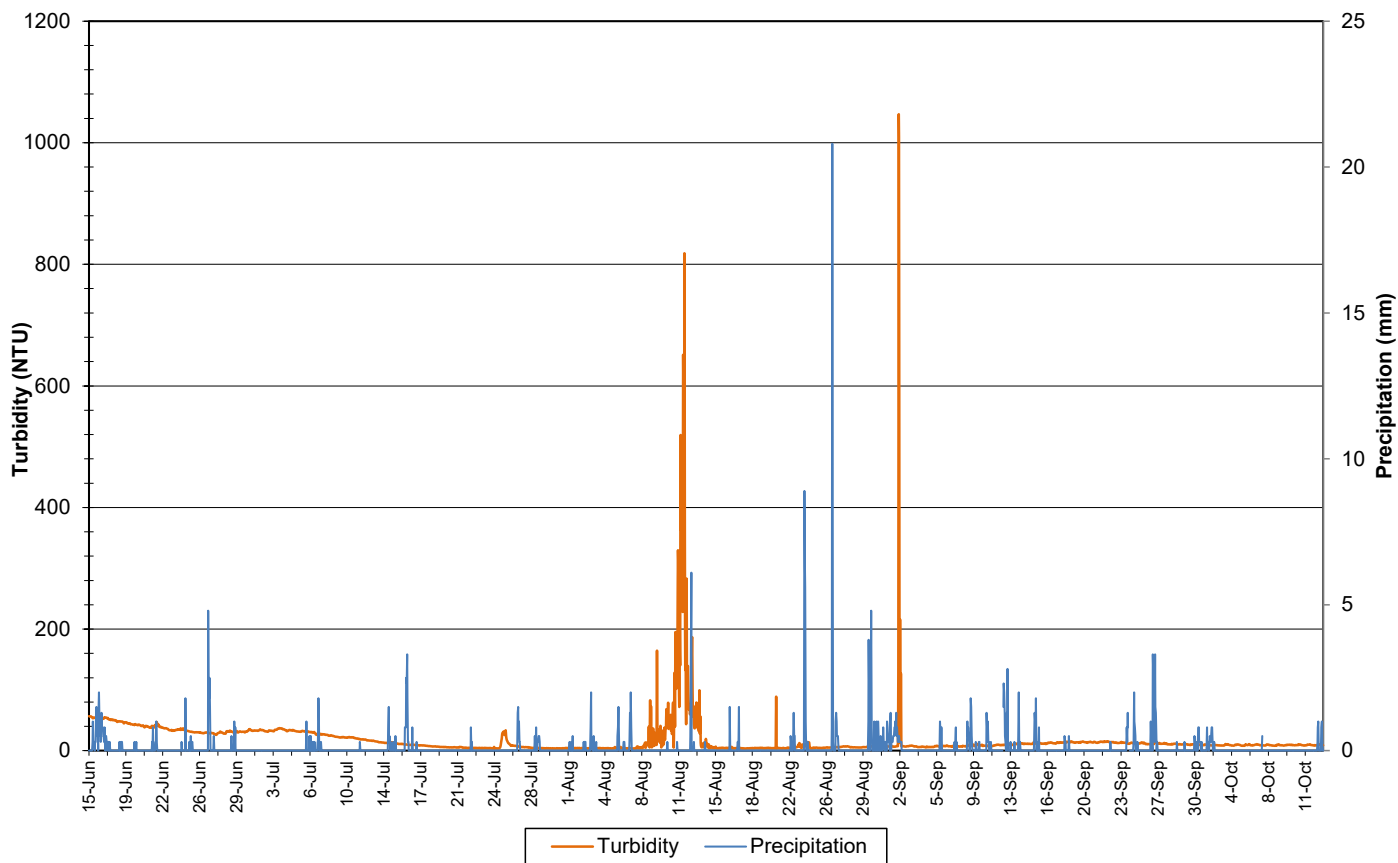
**Dissolved Oxygen Concentration & Saturation and Water Temperature:  
Flora Creek below TLH  
June 15 to October 13, 2021**



**Figure 5: Dissolved Oxygen Concentration and Saturation and Water Temperature – Flora Creek below TLH**

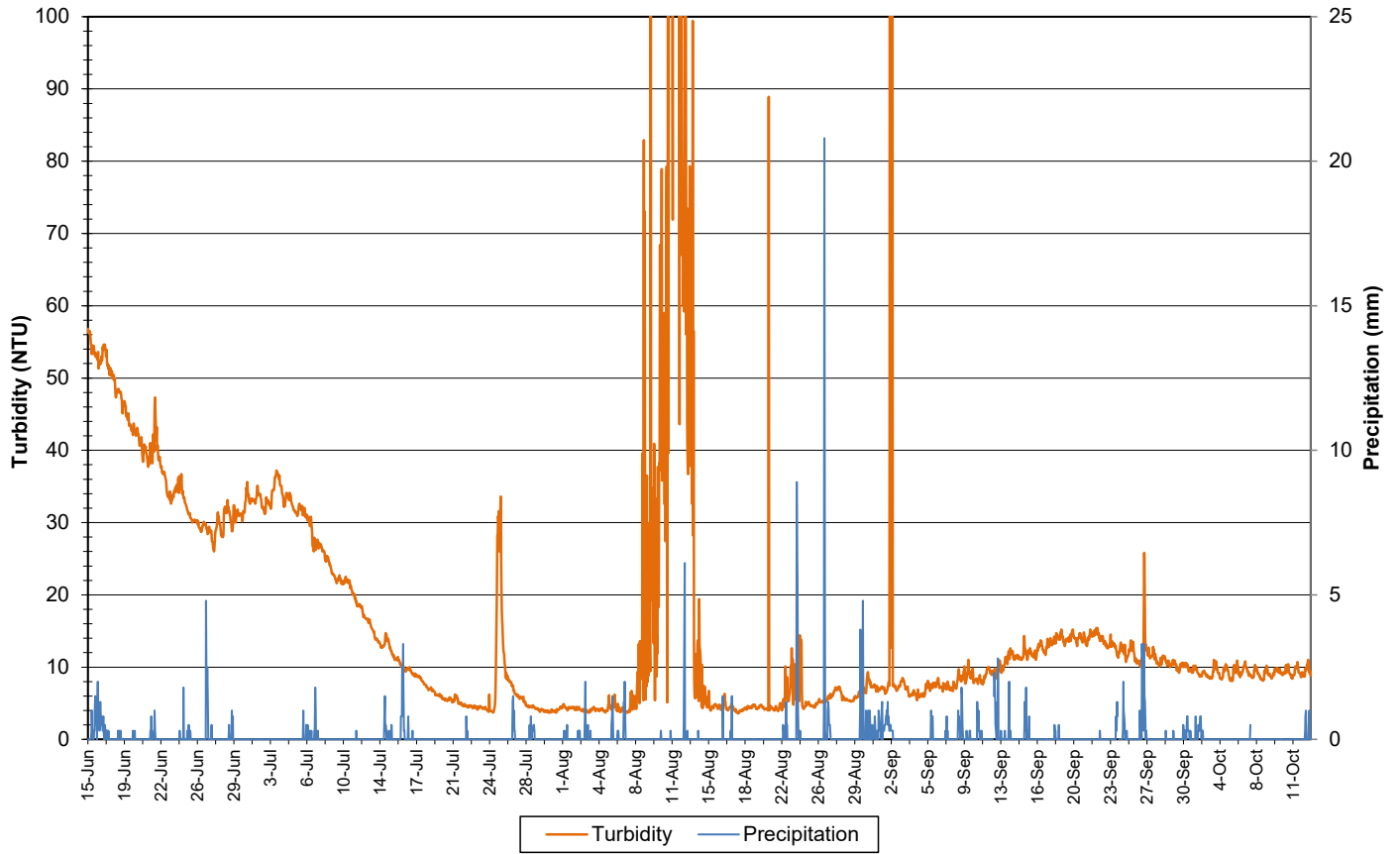
- At the Flora Creek station, turbidity values range from 3.6 to 1047.0 NTU with a median value of 1.16 NTU (Figure 6a & 6b).
- This station was somewhat turbid for the entire season with values remaining below 60 NTU for a large part of the season. Turbidity spiked for a prolonged period in August. Some spikes are noted during and after significant precipitation events.
- Turbidity was high at the beginning of the season due to late winter melt/freshet. However, it was not as high as it usually is at this time of year.

**Water Turbidity and Precipitation: Flora Creek below TLH  
June 15 to October 13, 2021**



**Figure 6a: Turbidity and Precipitation - Flora Creek below TLH**

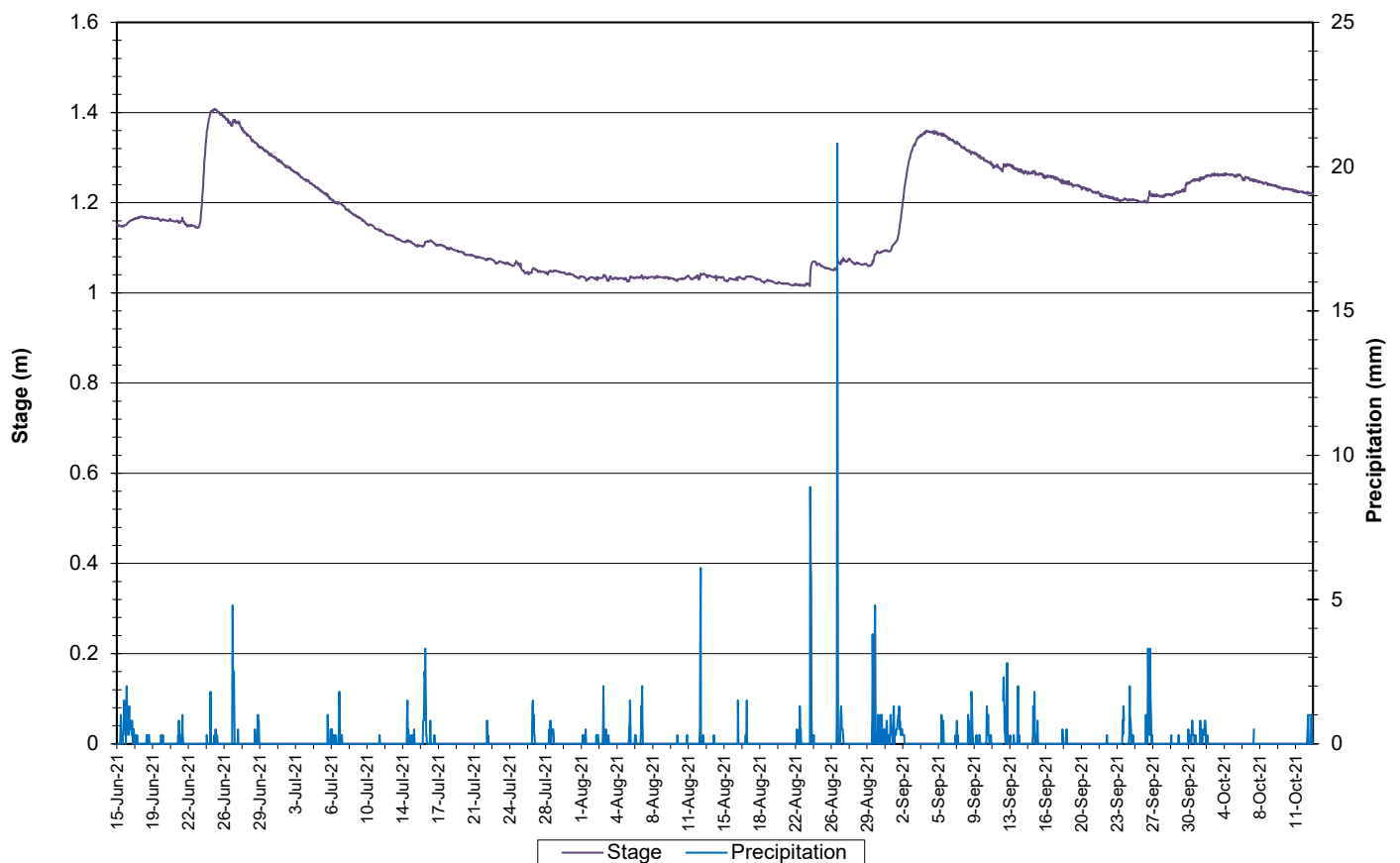
**Water Turbidity <100 NTU and Precipitation: Flora Creek below TLH  
June 15 to October 13, 2021**



**Figure 6b: Turbidity <100 NTU and Precipitation - Flora Creek below TLH**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Flora Creek (Figure 7).
- Stage increased at the end of June, likely due to the late freshet. It then decreased until September, with small periodic increases after precipitation events. There was a noticeable increase in September after a significant precipitation event. Stage gradually decreased from then onward.
- 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  
June 15 to October 13, 2021**



**Figure 7: Stage and Precipitation - Flora Creek below TLH  
(Weather data collected from climate station near Moosehead Lake)**

## **Conclusions**

- The instrument at the water quality monitoring station on Flora Creek was deployed on June 15<sup>th</sup>, 2021 and removed on October 13<sup>th</sup>, 2021 for the winter season.
- Deployment periods ranged from 34 to 43 days.
- In most cases, weather related events or increases/decreases in water level explain the data fluctuations.
- Most values recorded were within ranges as suggested by the CCME Water Quality Guidelines for the Protection of Aquatic Life.
- The instrument performed well for the 2021 season with no issues.
- Water temperature followed the seasonal trend of increasing during the summer and decreasing into the fall. Water temperature corresponded with air temperature.
- All pH values were within the acceptable range of the CCME Water Quality Guidelines for Protection of Aquatic Life.
- Specific conductivity increased during the 2021 deployment season.
- When the water was warmest, dissolved oxygen values were below the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold water Biota at Other Life Stages of 6.5 mg/l.
- This station tends to have high turbidity values. Highest values usually occur during the late winter melt/freshet. However, there was a prolonged period of high turbidity during August of this deployment season.



## **Path Forward**

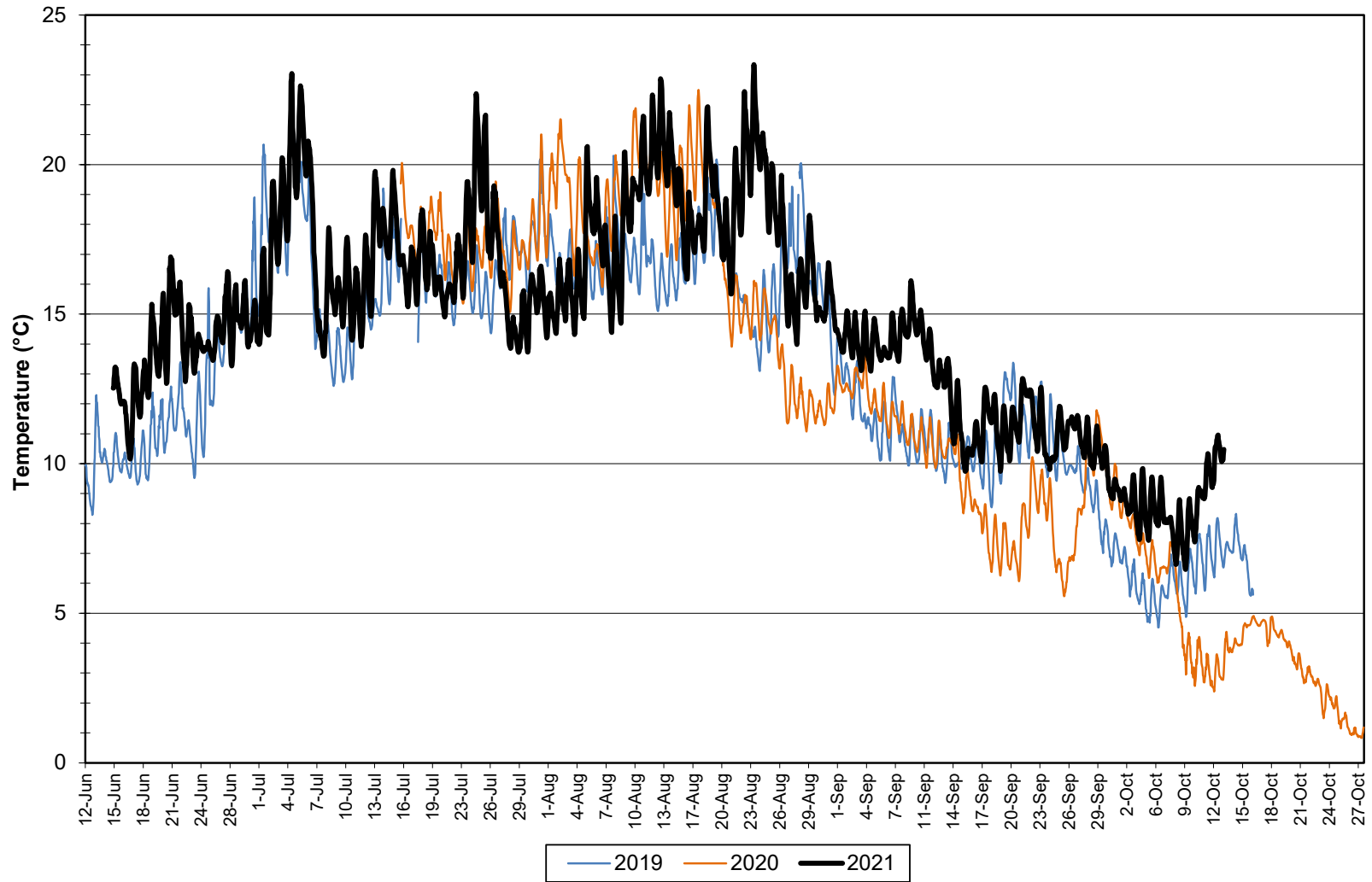
- The field instrument will undergo proficiency testing and evaluation during the winter of 2021-2022. ECC will inform Tacora Resources of any instrument performance issues.
- ECC staff will deploy real time water quality instruments in spring 2022 when ice conditions allow and perform regular site visits throughout the 2022 deployment season for calibration and maintenance of the instrument.
- If necessary, deployment techniques will be evaluated and modified, ensuring secure and suitable conditions for RTWQ monitoring.
- ECC will continue to work on its Automatic Data Retrieval System, to incorporate new capabilities in data management and data display.
- Open communication lines will continue to be maintained between ECC, ECCC and Tacora Resources in order to respond to emerging issues on a proactive basis. Tacora Resources will receive monthly deployment reports and an annual report, summarizing the events of the deployment season.

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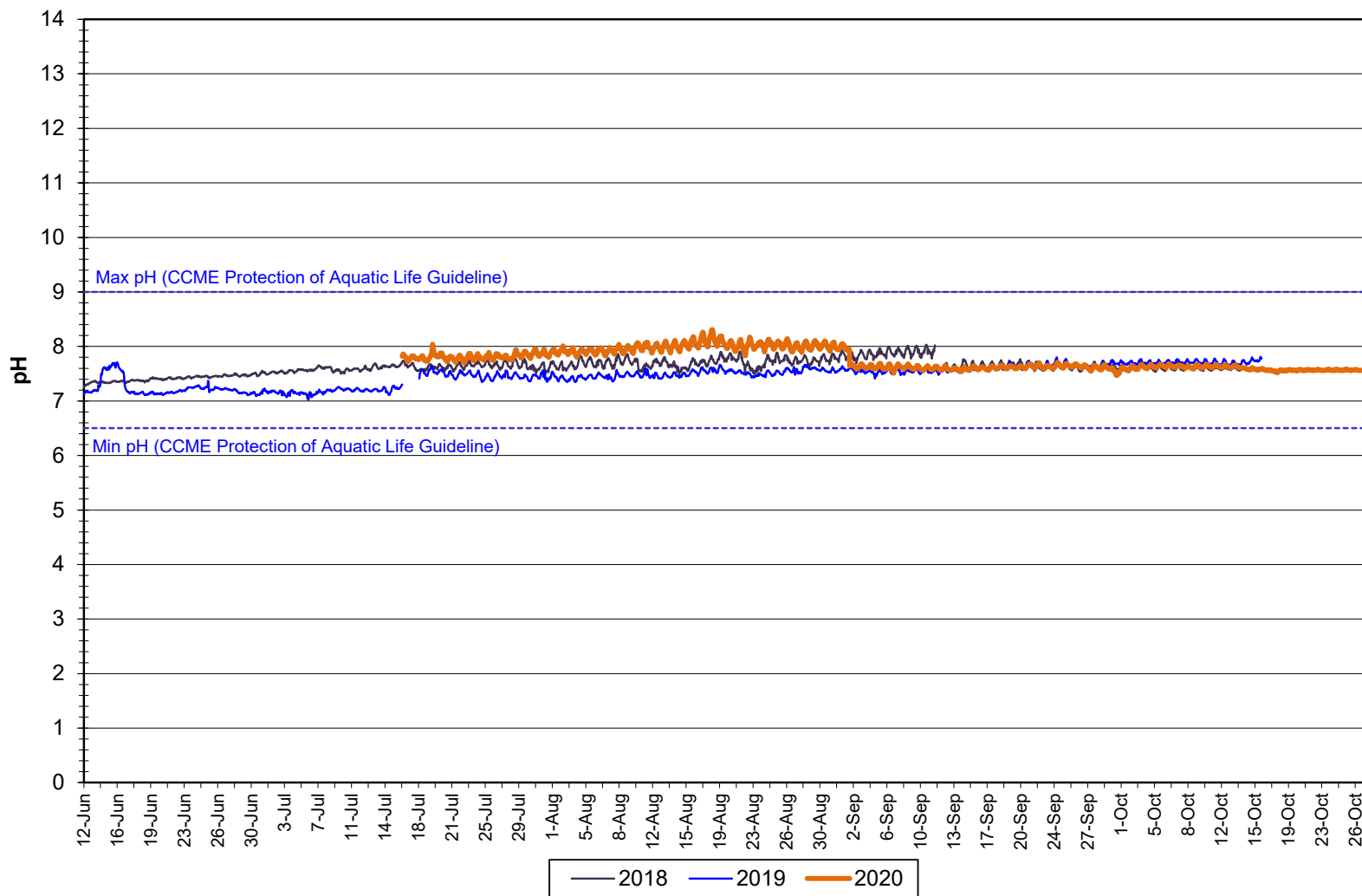
# **Appendix 1**

## **3 Year Comparisons**

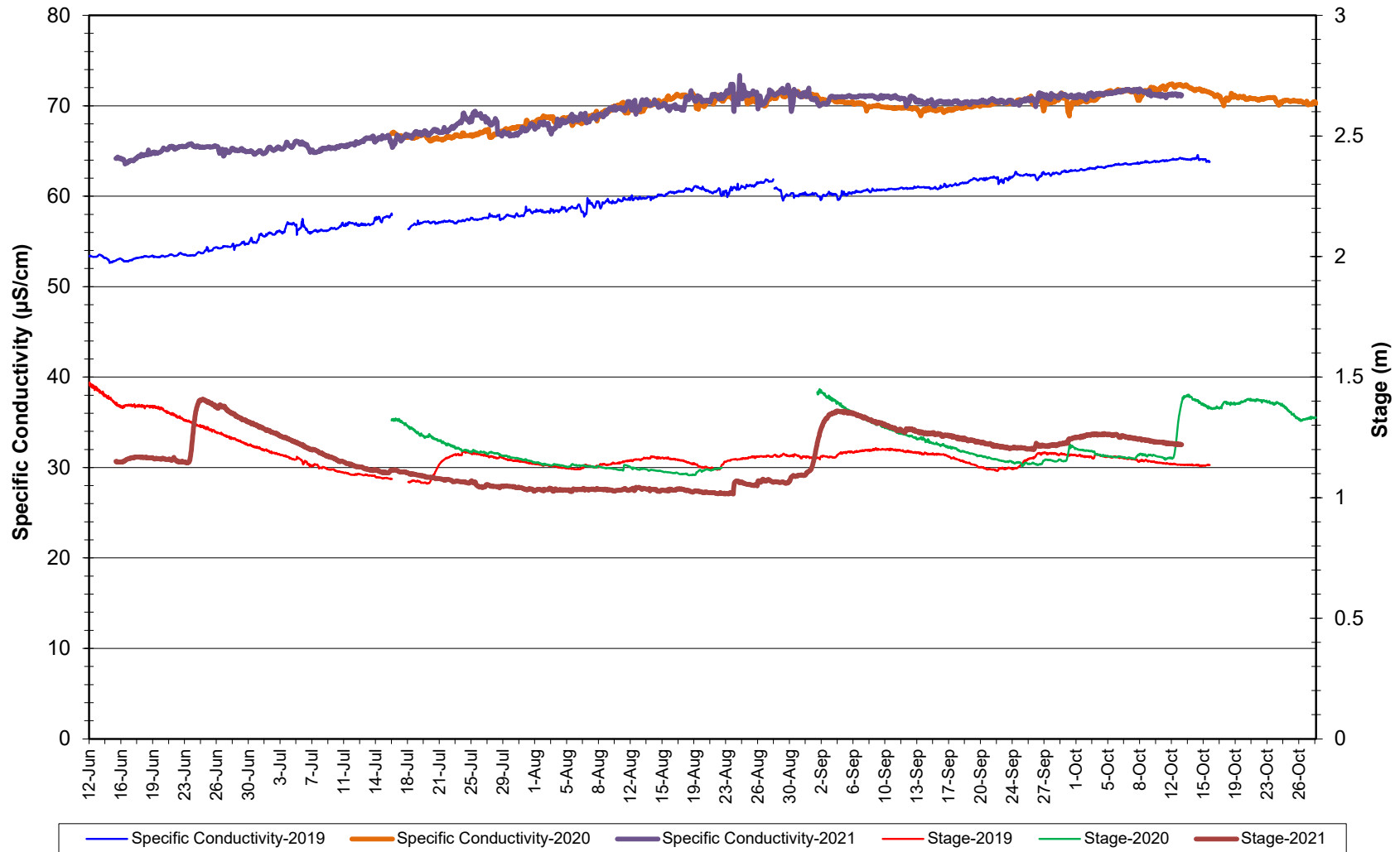
### Water Temperature: Flora Creek below TLH 2019-2021



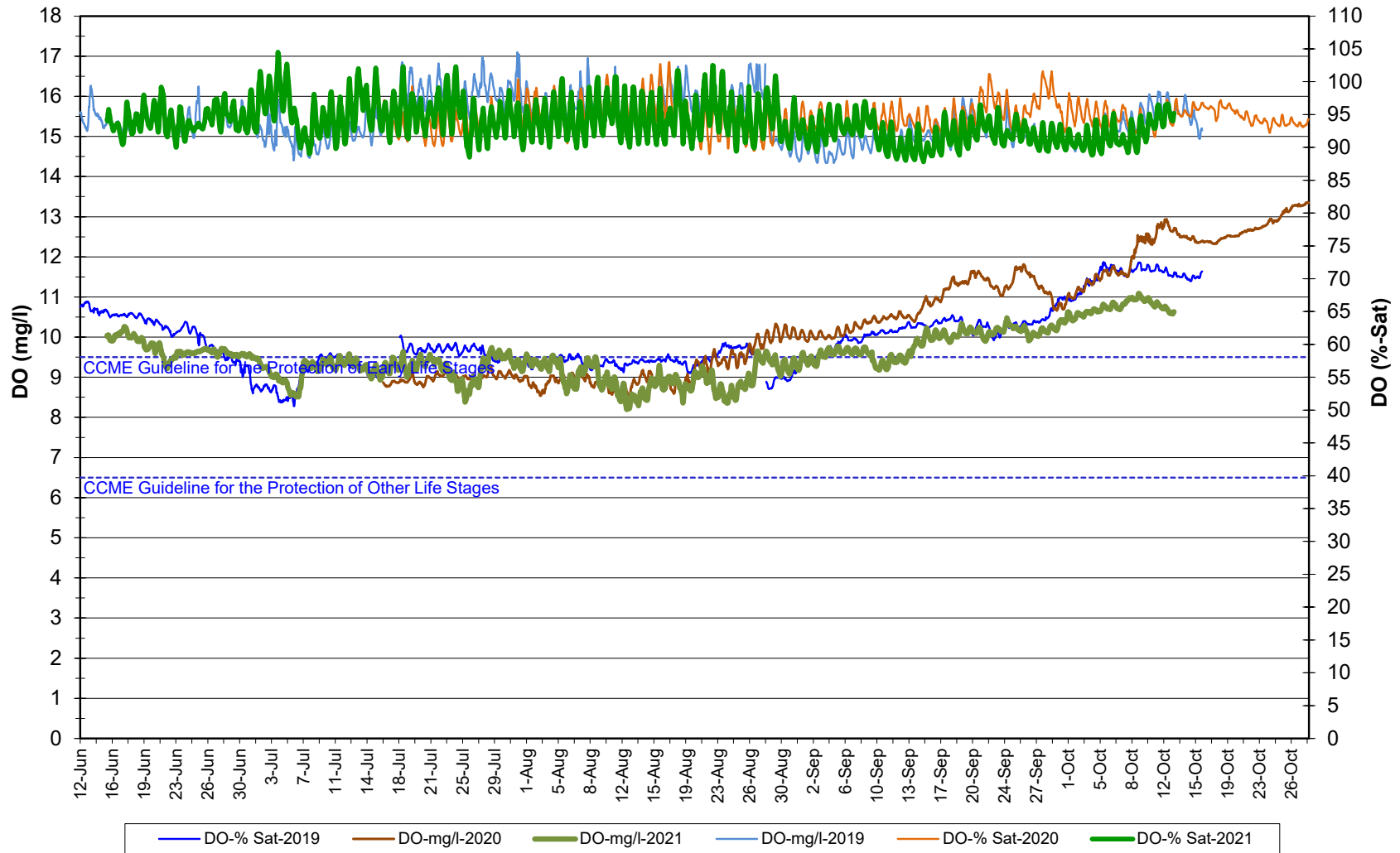
### Water pH: Flora Creek below TLH 2019-2021



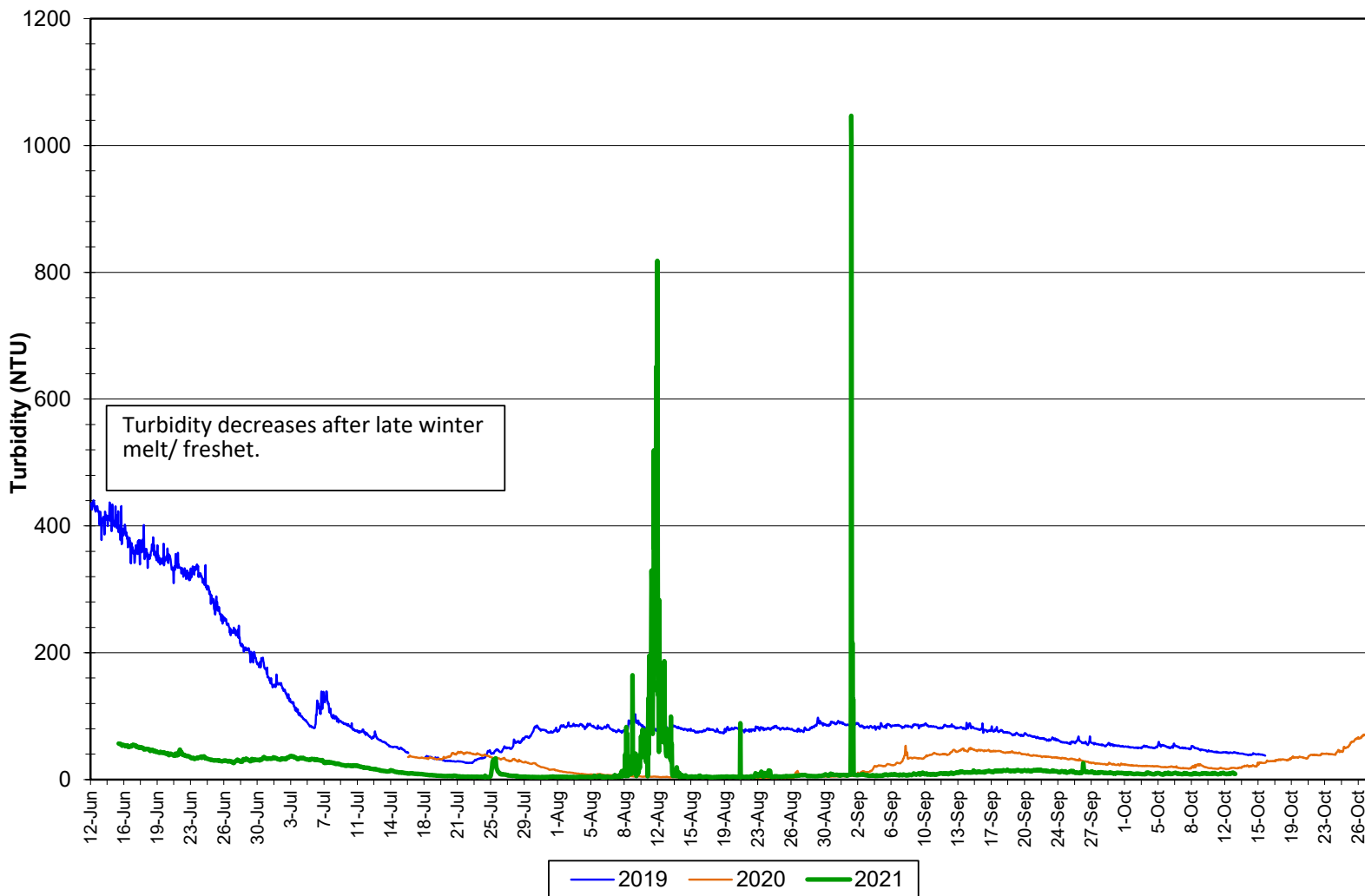
### Specific Conductivity and Stage: Flora Creek below TLH 2019-2021



### Dissolved Oxygen Concentration and Saturation: Flora Creek below TLH 2019-2021



### Water Turbidity: Flora Creek below TLH 2019-2021



## **Appendix 2**

### **Air Temperature and Precipitation**



### Average Daily Air Temperature and Precipitation: Moosehead Lake June 15 to October 13, 2021

