Real-Time Water Quality Annual Report

Flora Creek below TLH

June 11 to
October 12, 2016

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs and Environment
Water Resources Management Division

Contents

Acknowledgements

The Real-Time Water Quality Monitoring station (RTWQ) at Flora Creek is fully funded by Cliffs Natural Resources - Wabush Mines. The program is made successful by a joint partnership between Cliffs Natural Resources, Environment and Climate Change Canada (EC), and the Newfoundland & Labrador Department of Municipal Affairs and Environment (MAE).

Various individuals from each sector have been diligently involved to ensure this program is a successful operation, they include, Renee Paterson (MAE), Patrick Ryan (Cliffs Natural Resources), and Howie Wills (EC). 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 (MAE) was responsible for this water quality station during 2016; responsibilities included deployment and removal of the instrument, maintenance and calibration of the instrument and preparation of monthly deployment reports. Kelly Maher (MAE) is acknowledged for her assistance during deployment and removal procedures in 2016.

EC 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. EC is also the lead on dealing with stage and flow issues.

Introduction

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

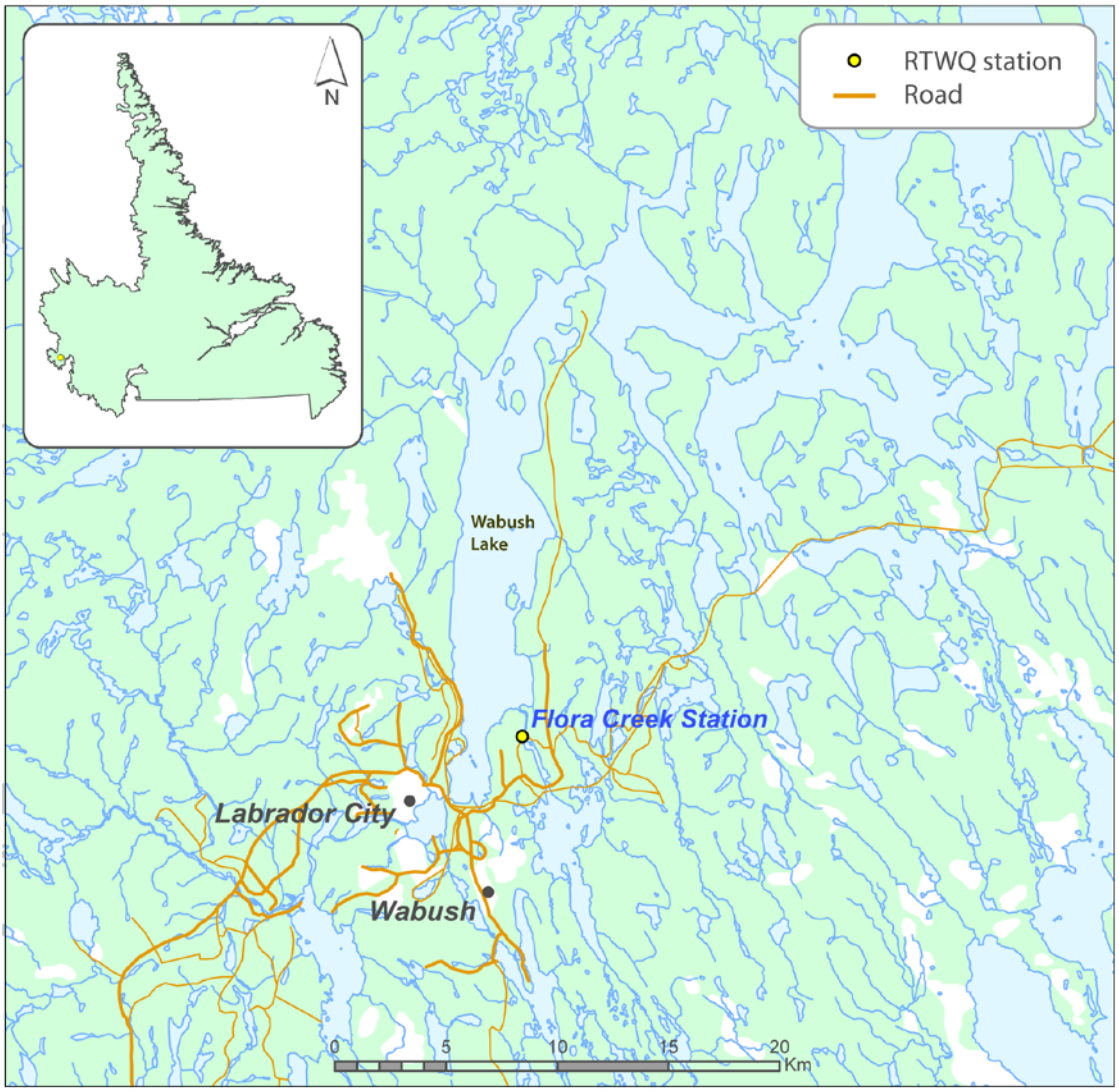

Figure 1: Map of Western Labrador area showing the RTWQ Flora Creek station.

- Initial deployment for the 2016 season was on June 11th. The instrument was removed for the winter season on October 12th. The following report depicts and discusses water quality events throughout this time period.
- The purpose of this network is to monitor, process, and distribute water quality/quantity data to Cliffs Natural Resources, MAE, EC, for assessment and management of water resources, as well as to provide an early warning for any potential or emerging water issues. Therefore, mitigative measures can be implemented in a timely manner.
- MAE provides Cliffs Natural Resources with monthly and annual deployment reports.
- Wabush Mines was in full operation when the Memorandum of Agreement to establish this station was signed in May 2013. In February of 2014, it was announced that Wabush Mines would be idling its operations while a buyer was sought. The RTWQ instrument was deployed in June, while the mine was in its idling phase. In October 2014, after the instrument had been removed for the winter season, it was announced that Wabush Mines would be closed permanently. This station will remain in place during the closing/rehabilitation of the mine. The instrument was deployed for a full season in 2016.
- There are some small gaps in data on the graphs included in this report. Unless otherwise stated, these gaps indicate the time frame where the instrument was removed from the water for calibration and maintenance.

Maintenance and Calibration

- To ensure accurate data collection, maintenance and calibration of the water quality instrumentation are performed preferably on a monthly basis.
- 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, MAE staff carefully calibrates each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity.
- Installation and removal dates for the 2016 season are summarized in the table below.

Table 1: Water quality instrument deployment start and end dates for 2016

Installation	Removal	Deployment duration (days)
June 11	July 20	39
July 21	August 30	40
August 31	October 12	42

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 2).

Table 2: 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 Flora Creek water quality station for the three deployment periods from June 11th to October 12th, 2016, are summarized in Table 3.
- For additional information and explanations of ranking including “N/A” rankings, please refer to the monthly deployment reports.

Table 3: Comparison rankings for Flora Creek June 11 – October 12, 2016

	Date		Instrument #	Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Flora Creek	11-Jun-16	Deployment	13G101500	Excellent	Excellent	Excellent	Excellent	Excellent
	20-Jul-16	Removal	13G101500	Excellent	Good	Excellent	Excellent	Excellent
	21-Jul-16	Deployment	13G101500	Excellent	Good	Good	Fair	Fair
	30-Aug-16	Removal	13G101500	Excellent	Good	Excellent	Fair	Excellent
	31-Aug-16	Deployment	13G101500	Excellent	Excellent	Good	Excellent	Excellent
	12-Oct-16	Removal	13G101500	N/A	N/A	N/A	N/A	N/A

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from June 11th, 2016 to October 12th, 2016 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 5.25 to 23.46°C, during the 2016 deployment season. The median value was 14.49 °C (Figure 1).
- 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.

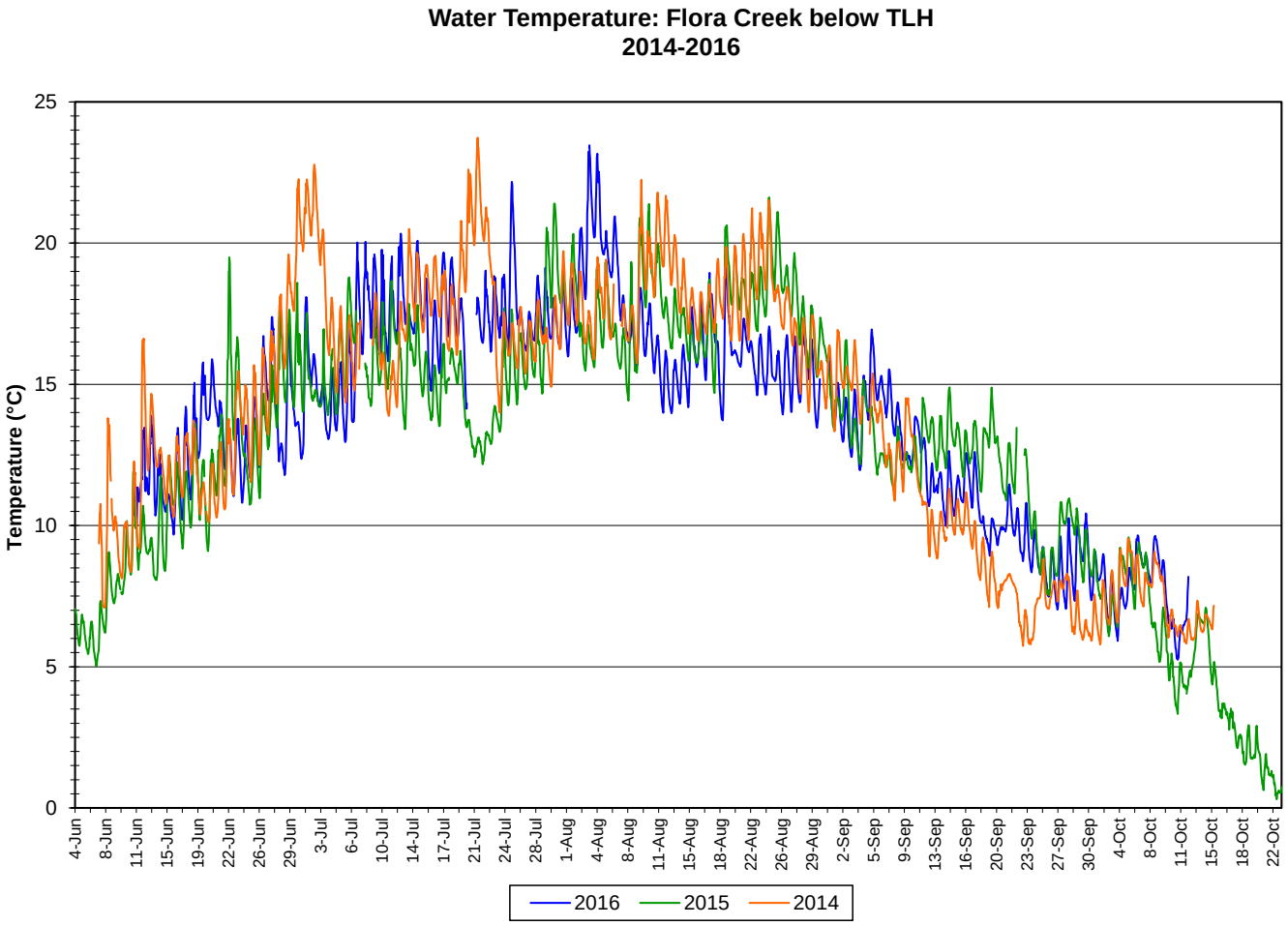

Figure 1: Water temperature (2014-2016) – Flora Creek below TLH

- Water temperature values show a typical seasonal trend, warm in the summer and decreasing into the fall season. Water temperature fluctuations correspond moderately well with the ambient air temperature recorded by Environment Canada (Figure 2).

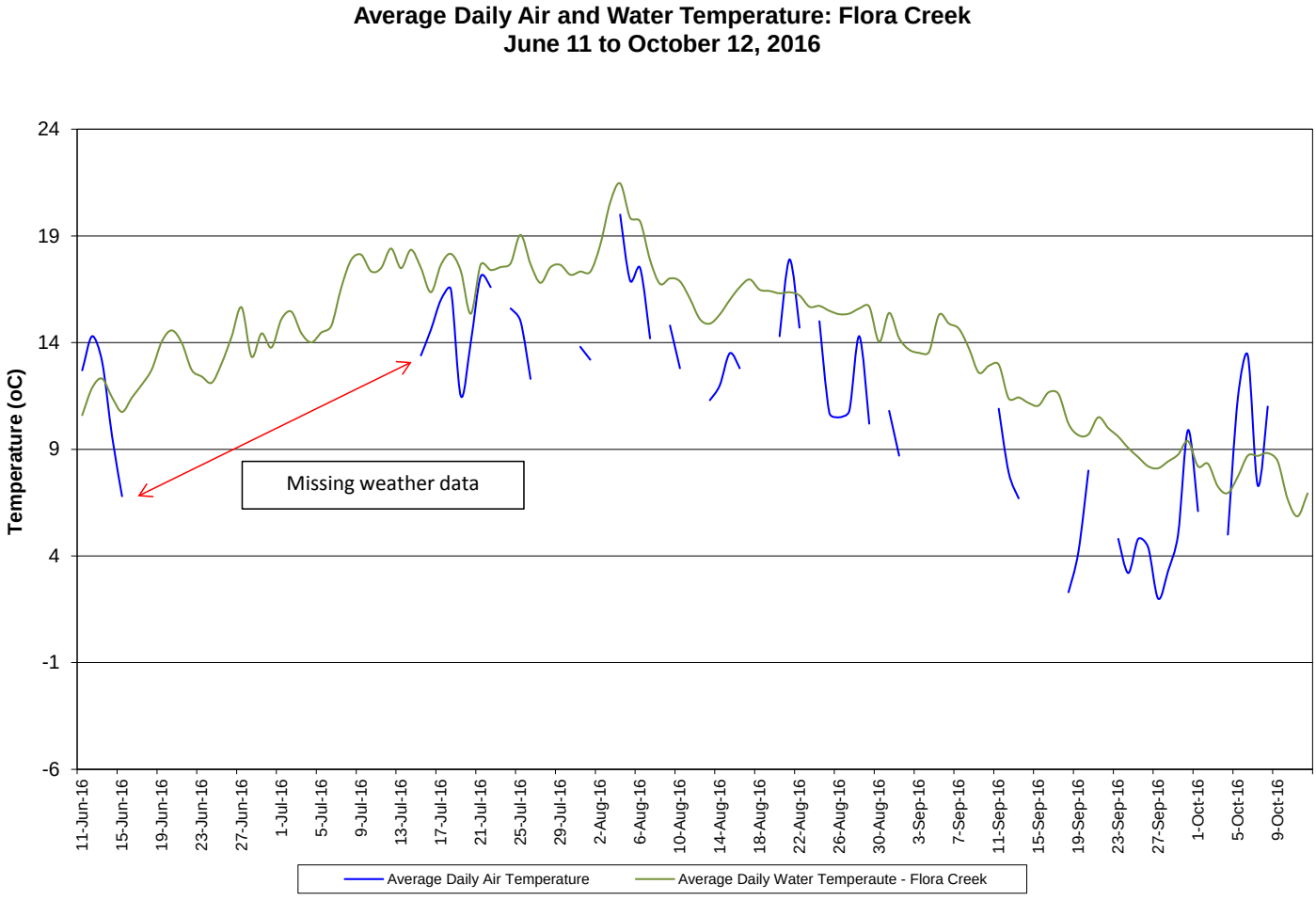

Figure 2: Average daily air and water temperatures – Flora Creek below TLH

(Weather data collected at Wabush Airport)

- pH ranges from 7.44 to 8.00 pH units at Flora Creek (Figure 3), throughout the 2016 deployment season. The median pH is 7.72.
- pH fluctuates daily. Peaks are observed during late afternoon, 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).
- pH increases slightly during the beginning of the season, and then it is relatively stable until the end of the season.

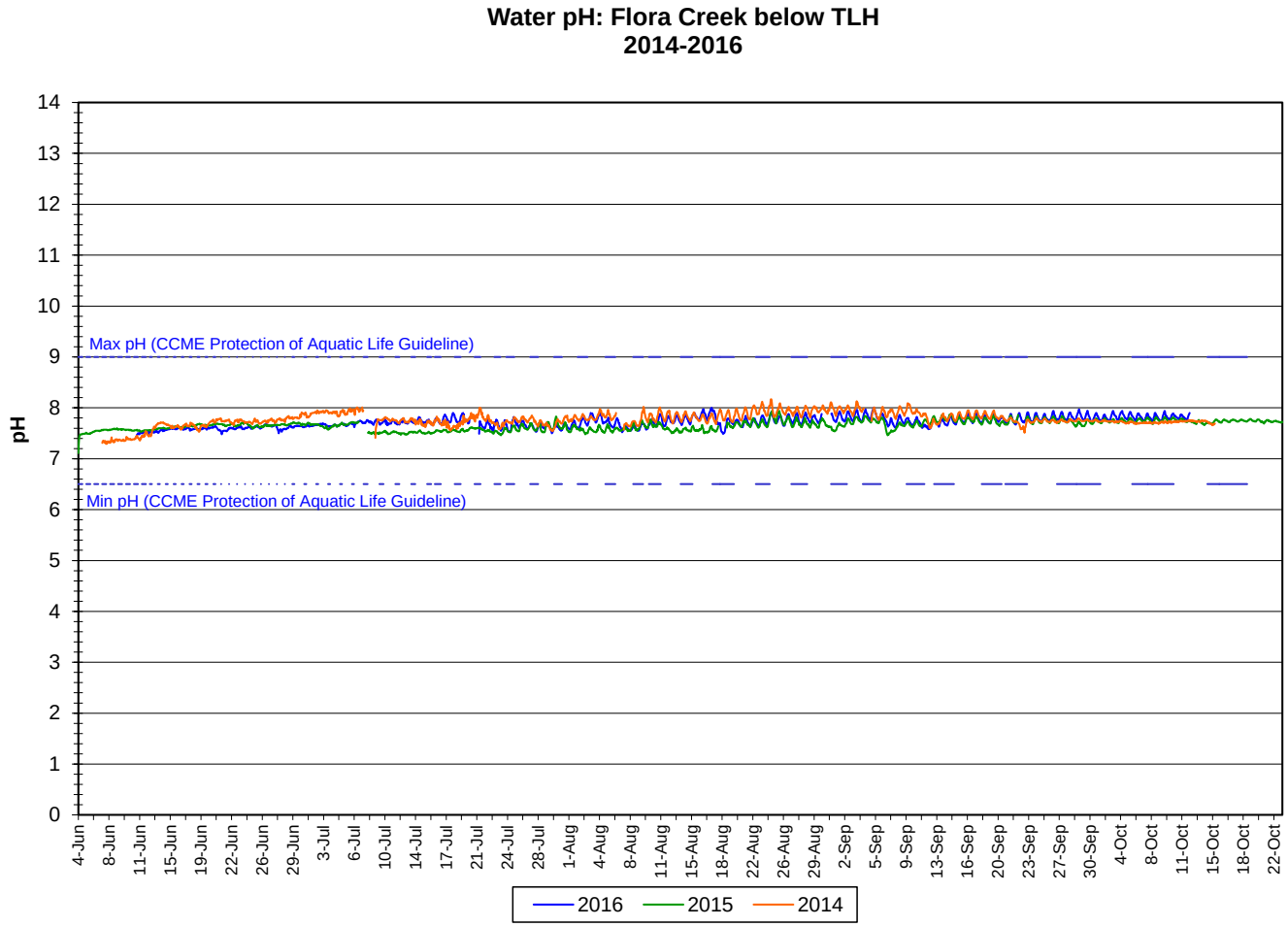

Figure 3: pH (2014-2016) – Flora Creek below TLH

- Throughout the 2016 deployment season, specific conductivity ranged from 66.5 to 76.5 µs/cm at Flora Creek (Figure 4).
- In 2014 and 2015, the conductivity sensor on this instrument required a substantial amount of time to stabilize, as evident on the graph below. However, after the 2015 field season the conductivity sensor was replaced as part of an upgrade program and this problem does not occur anymore.
- Conductivity increases during the beginning of the deployment season, decreasing after the second deployment period before increasing again for the remainder of the season.
- 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.

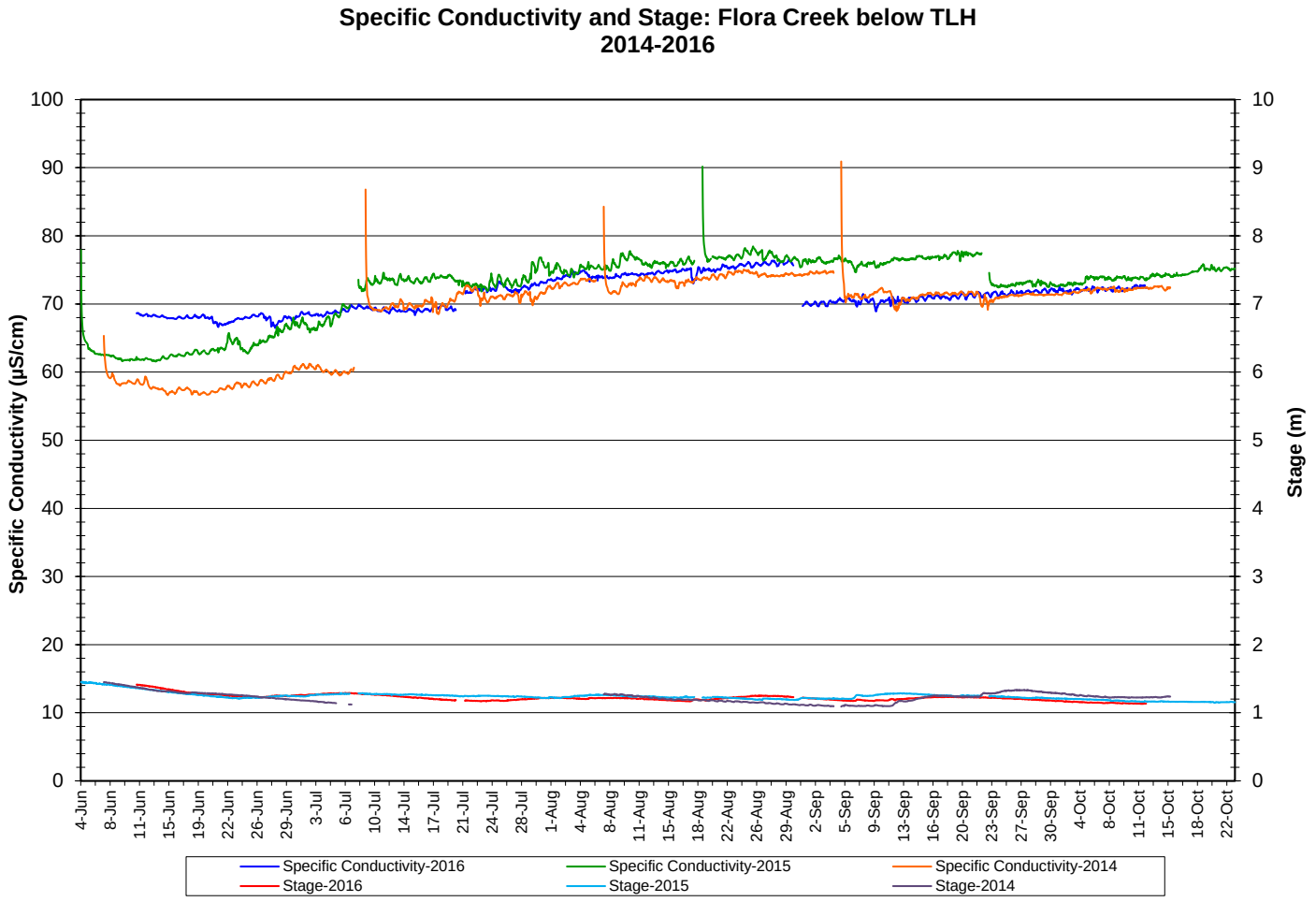

Figure 4: Specific conductivity (2014-2016) – Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 87.4 to 111.9% and a range of 8.54 to 11.69 mg/l was found in the concentration of dissolved oxygen with a median value of 9.71 mg/l (Figure 5).
- Dissolved oxygen fluctuated daily with decreases observed at night.
- Dissolved oxygen decreases during the summer months throughout the time when water temperature is increasing, it then increases during the last deployment period of the season, when water temperature is decreasing in 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. Most 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.

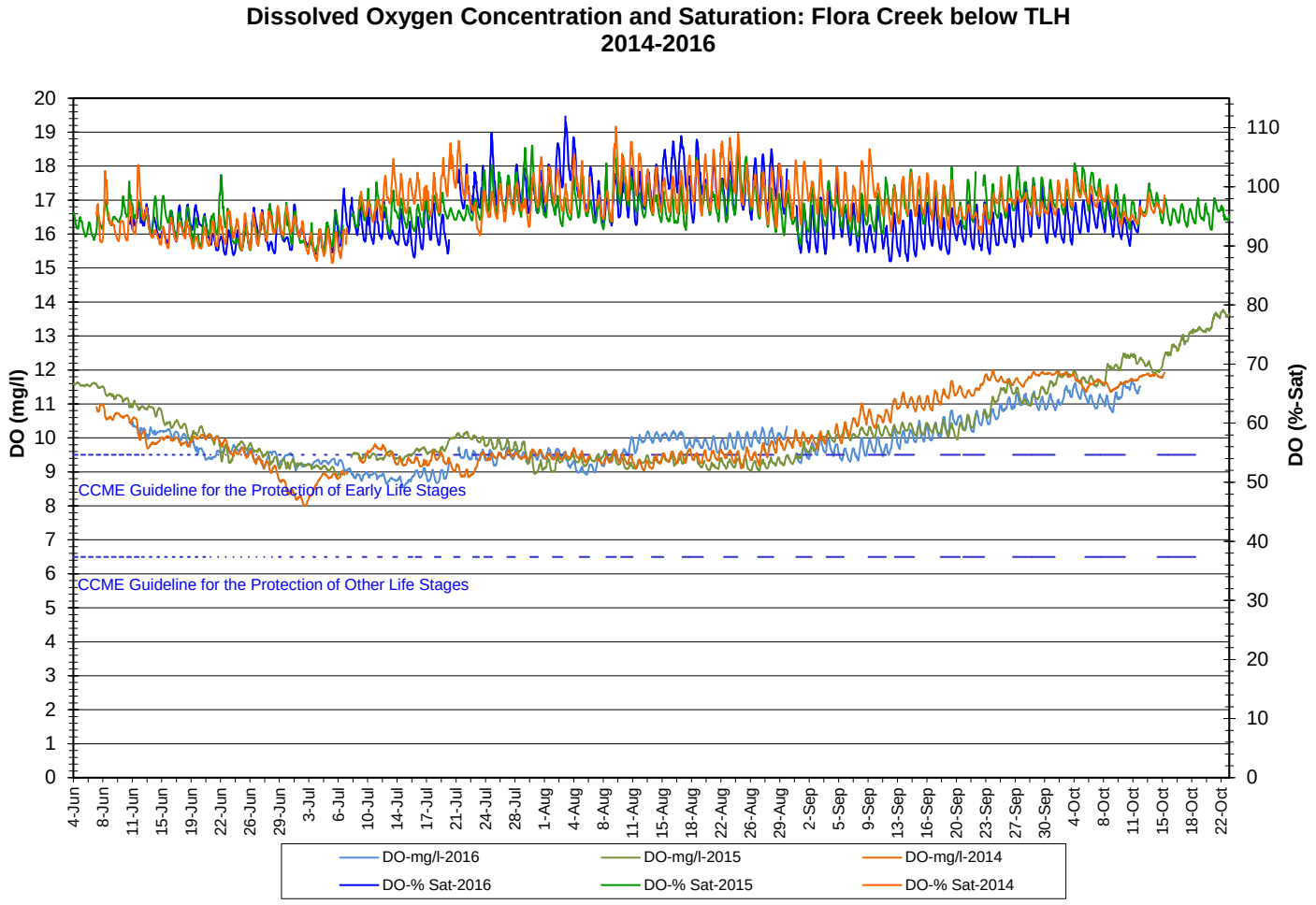

Figure 5: Dissolved oxygen and percent saturation (2014-2016) – Flora Creek below TLH

- At the Flora Creek station, turbidity values range from 5.5 to 583.5 NTU with a median value of 20.7 NTU (Figure 6). This station was somewhat turbid for the entire season.
- Turbidity at the beginning of the season was very high and decreased over time; this was due to the late winter melt/freshet. Turbidity is generally lower than in previous years.
- After the significant decrease in the beginning of the season, turbidity readings >100NTU occur occasionally and for small periods of time.

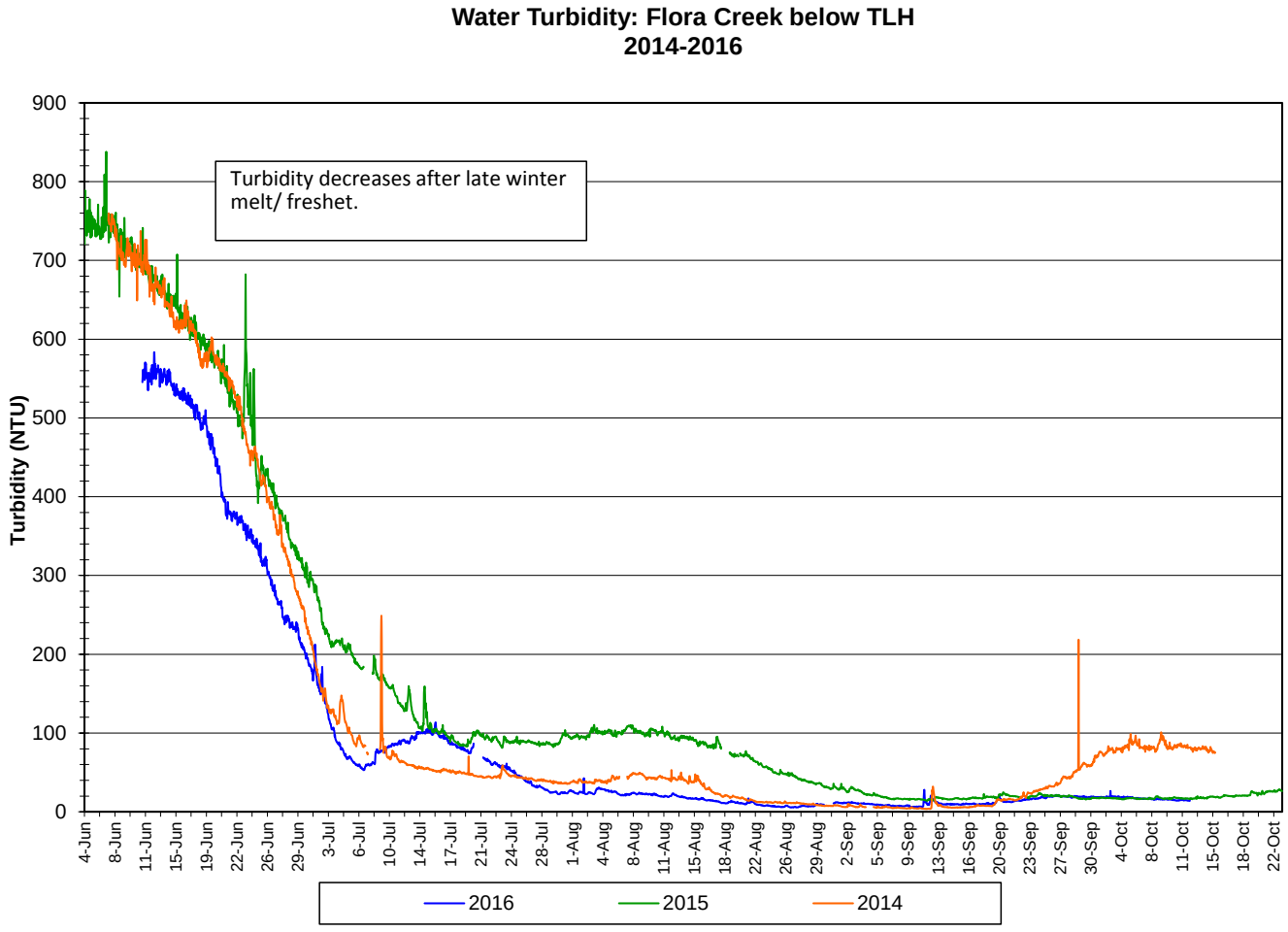

Figure 6: Turbidity at Flora Creek below TLH

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Flora Creek (Figure 7).
- Stage decreases slightly in the June deployment period, it is then relatively stable for the remainder of the deployment season, with fluctuating precipitation levels.
- 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.

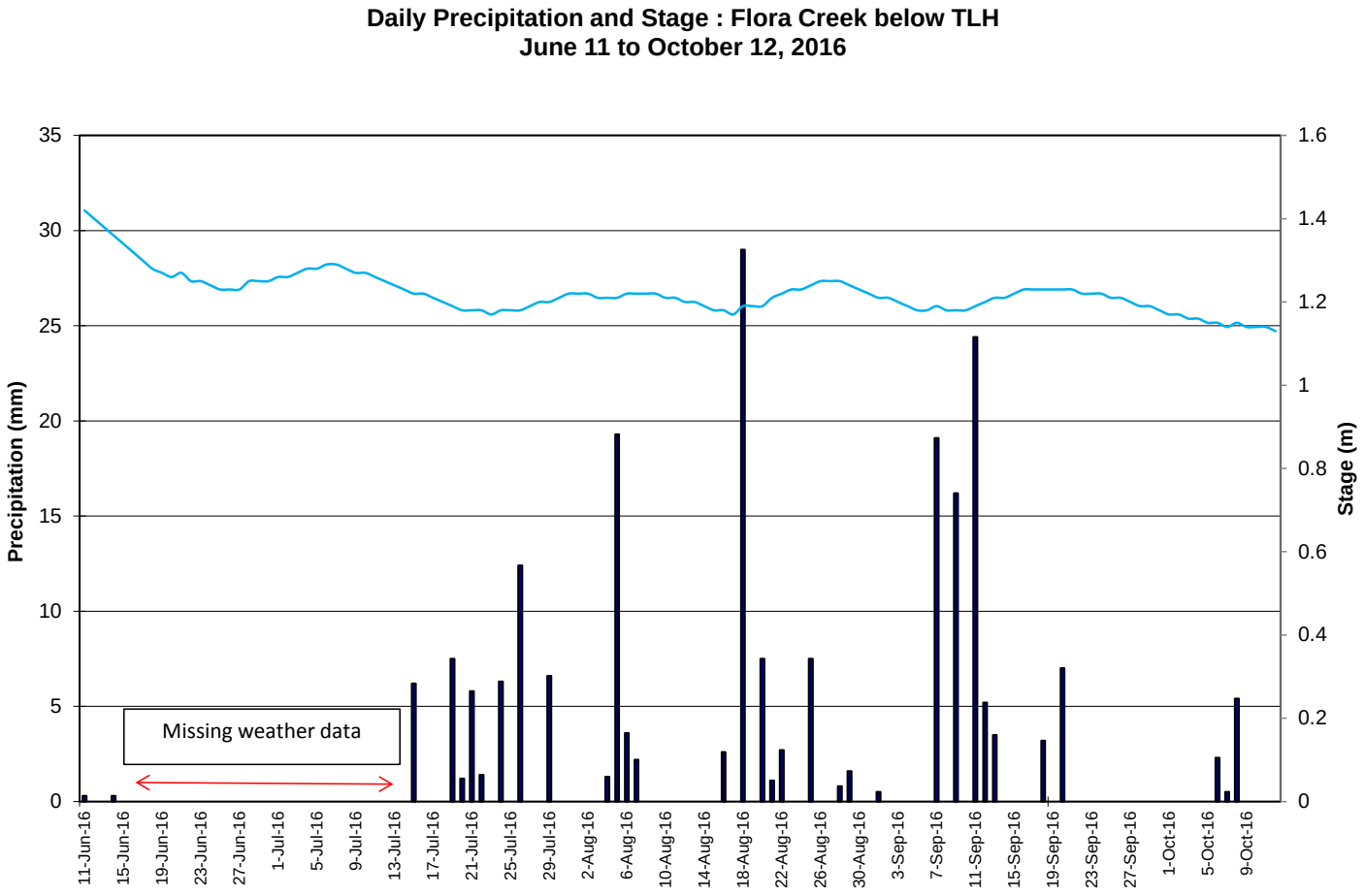

Figure 7: Stage and precipitation at Flora Creek below TLH

(Weather data collected at Wabush Airport)

Conclusions

- The instrument at the water quality monitoring station on Flora Creek was deployed on June 11th, 2016 and removed on October 12th, 2016 for the winter season.
- Regular visits on a near 40 day deployment schedule have been adhered to for the most part.
- In most cases, weather related events or increases/decreases in water level could be used to explain the 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 2016 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 after the first deployment period and then was relatively stable until the last deployment period of the season. There is no longer a waiting period for the conductivity sensor to stabilize as this sensor was replaced before the 2016 season.
- In some cases, 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. A decrease was noted after the late winter melt/freshet.

Path Forward

- The field instrument will undergo proficiency testing and evaluation during the winter of 2016-2017. MAE will inform Cliffs Natural Resources of any instrument performance issues.
- MAE staff will deploy real time water quality instruments in spring 2017, when ice conditions allow and perform regular site visits throughout the 2017 deployment season for calibration and maintenance of the instruments.
- If necessary, deployment techniques will be evaluated and modified, ensuring secure and suitable conditions for RTWQ monitoring.
- MAE 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 MAE, EC and Cliffs Natural Resources in order to respond to emerging issues on a proactive basis. Cliffs Natural Resources will receive monthly deployment reports and an annual report, summarizing the events of the deployment season.
- A discussion will be held between MAE and the industry partner regarding high turbidity values during the spring runoff, and potential mitigative measures that can be taken to reduce these values.

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Appendix 1

Average Daily Air Temperature and Daily Precipitation: Churchill Falls, NL
June 11 to October 12, 2016