Real-Time Water Quality Deployment Report

Flora Creek below TLH

August 19 to
September 22, 2015

Newfoundland Labrador

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

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General

- The Water Resources Management Division, in partnership with Cliffs Natural Resources – 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 monitors the real-time web pages regularly.
- On August 19, 2015, a real-time water quality monitoring instrument was deployed at the station Flora Creek below TLH. The instrument was deployed for a period of 34 days. The instrument was removed on September 22nd, 2015.

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.

Flora Creek below TLH, Newfoundland and Labrador

- Deployment and removal comparison rankings for the station on Flora Creek deployed between August 19 and September 22, 2015 is summarized in Table 2.

Table 2: Comparison rankings for Flora Creek below TLH station August 19 – September 22, 2015.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Flora Creek below TLH	Aug 19, 2015	Deployment	Good	Excellent	Excellent	Good	Good
	Sept 22, 2015	Removal	Good	Excellent	Excellent	Fair	Good

- At deployment, all parameters ranked either 'excellent' or 'good'.

- At removal, all parameters besides dissolved oxygen ranked either 'excellent' or 'good'. Dissolved oxygen ranked 'poor', the field sonde read a value of 10.63 mg/l and the QA/QC instrument read a value of 9.95 mg/l. This ranking could be due to the placement of the QA/QC instrument in relation to the field sonde, or the amount of time the instrument was given to stabilize.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from August 19 to September 22 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 10.88 to 21.62°C during this deployment period (Figure 1).
- Water temperature decreased during this deployment period, corresponding with ambient air temperature (Figure 2).

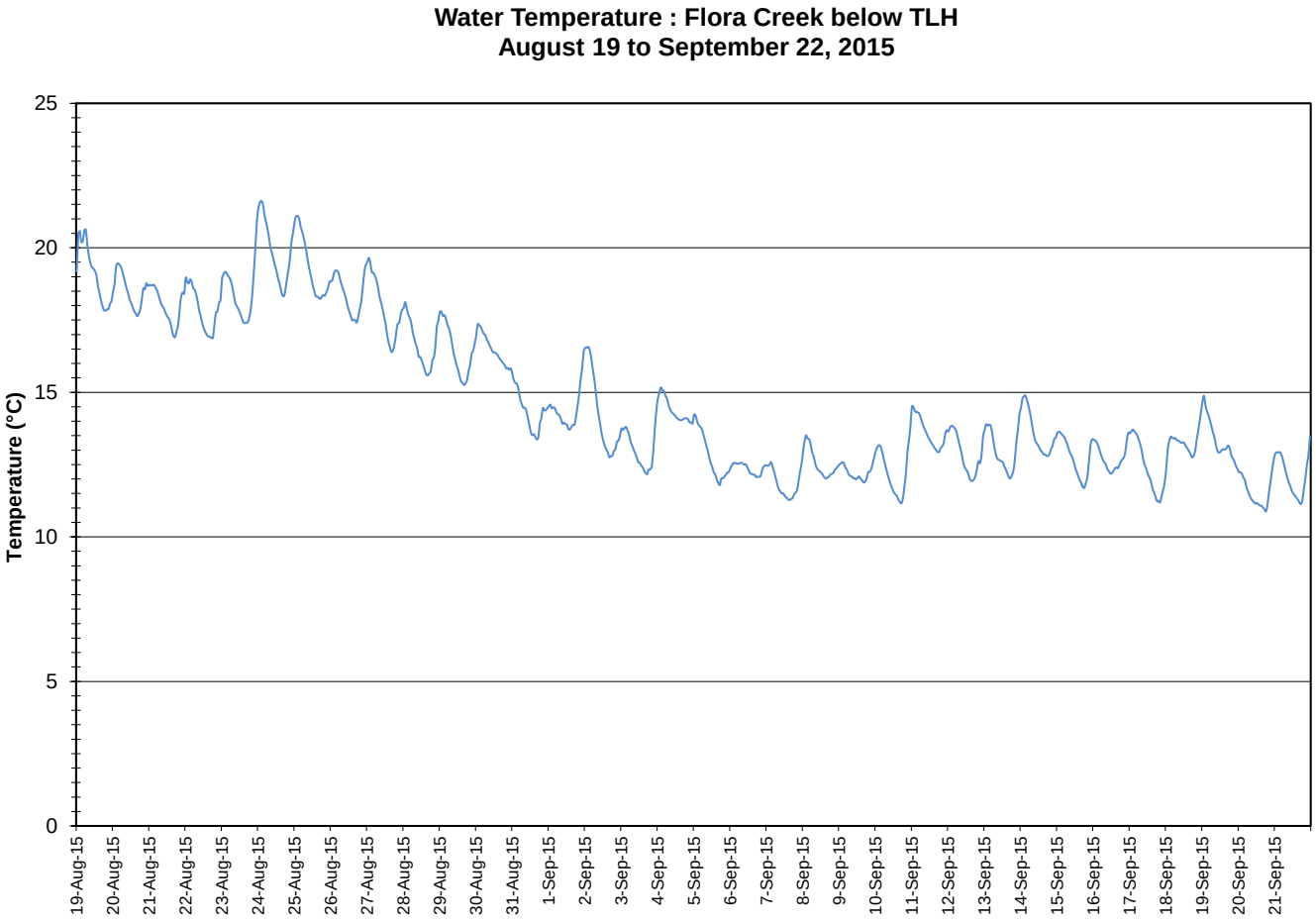

Figure 1: Water temperature - Flora Creek below TLH

Flora Creek below TLH, Newfoundland and Labrador

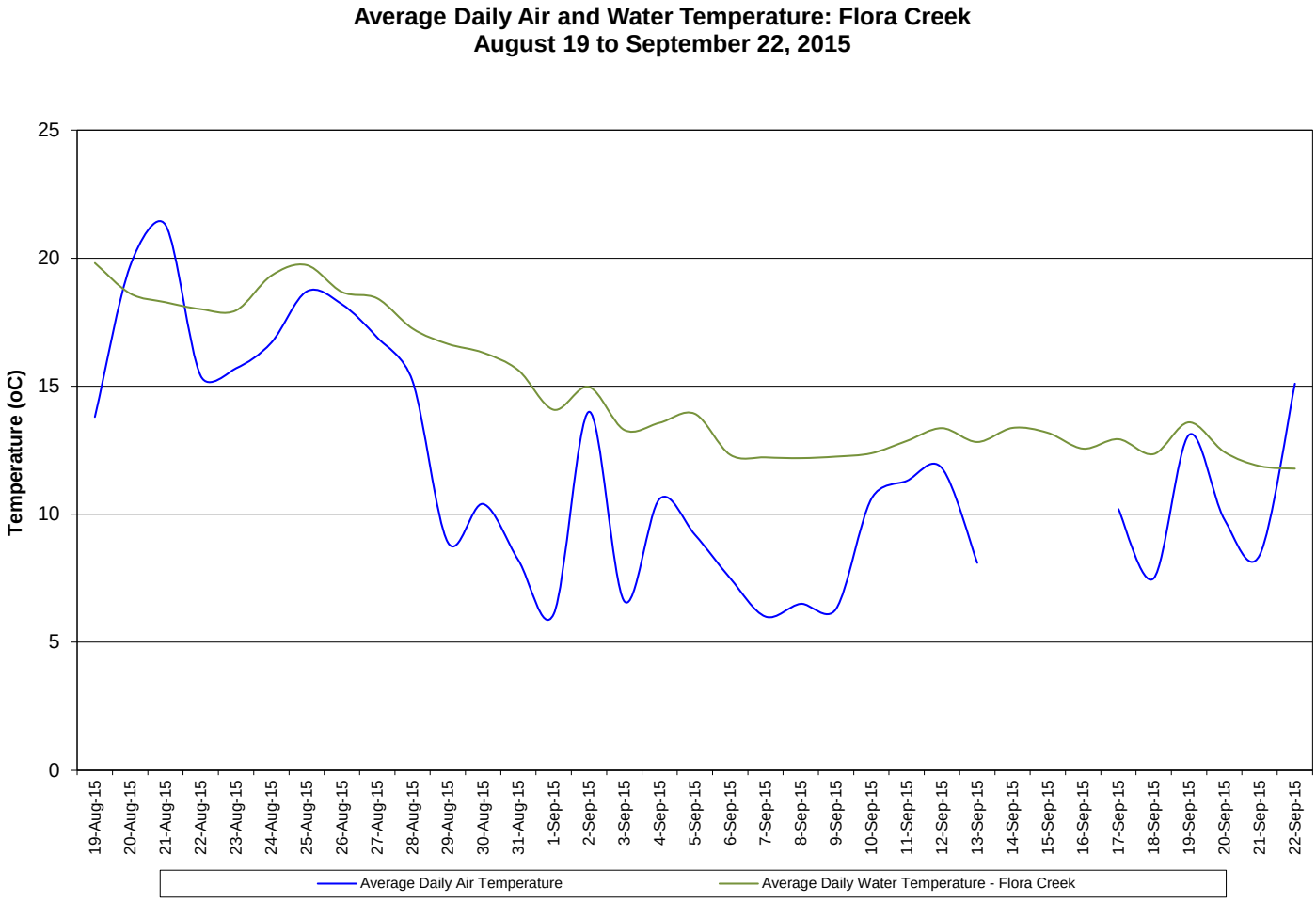

Figure 2: Average daily air and water temperatures - Flora Creek below TLH

(Weather data collected at Churchill Falls)

Flora Creek below TLH, Newfoundland and Labrador

- pH ranged between 7.46 and 7.94 pH units throughout the deployment period, with a median value of 7.56 units (Figure 3).
- 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.

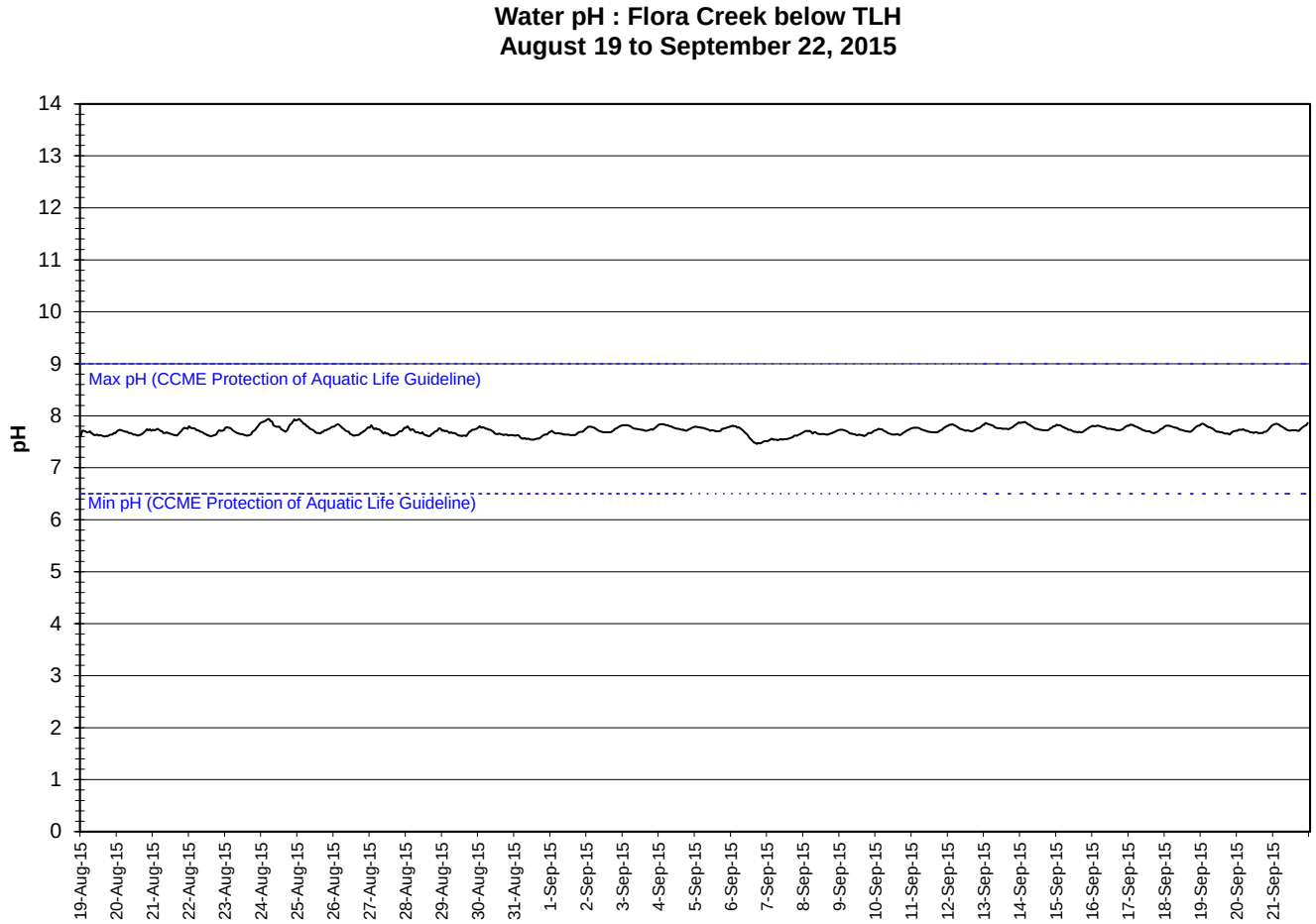

Figure 3: pH - Flora Creek below TLH

- Specific conductivity ranged from 74.7 to 90.2 µs/cm (Figure 4).
- Specific conductivity and stage were relatively stable during 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.

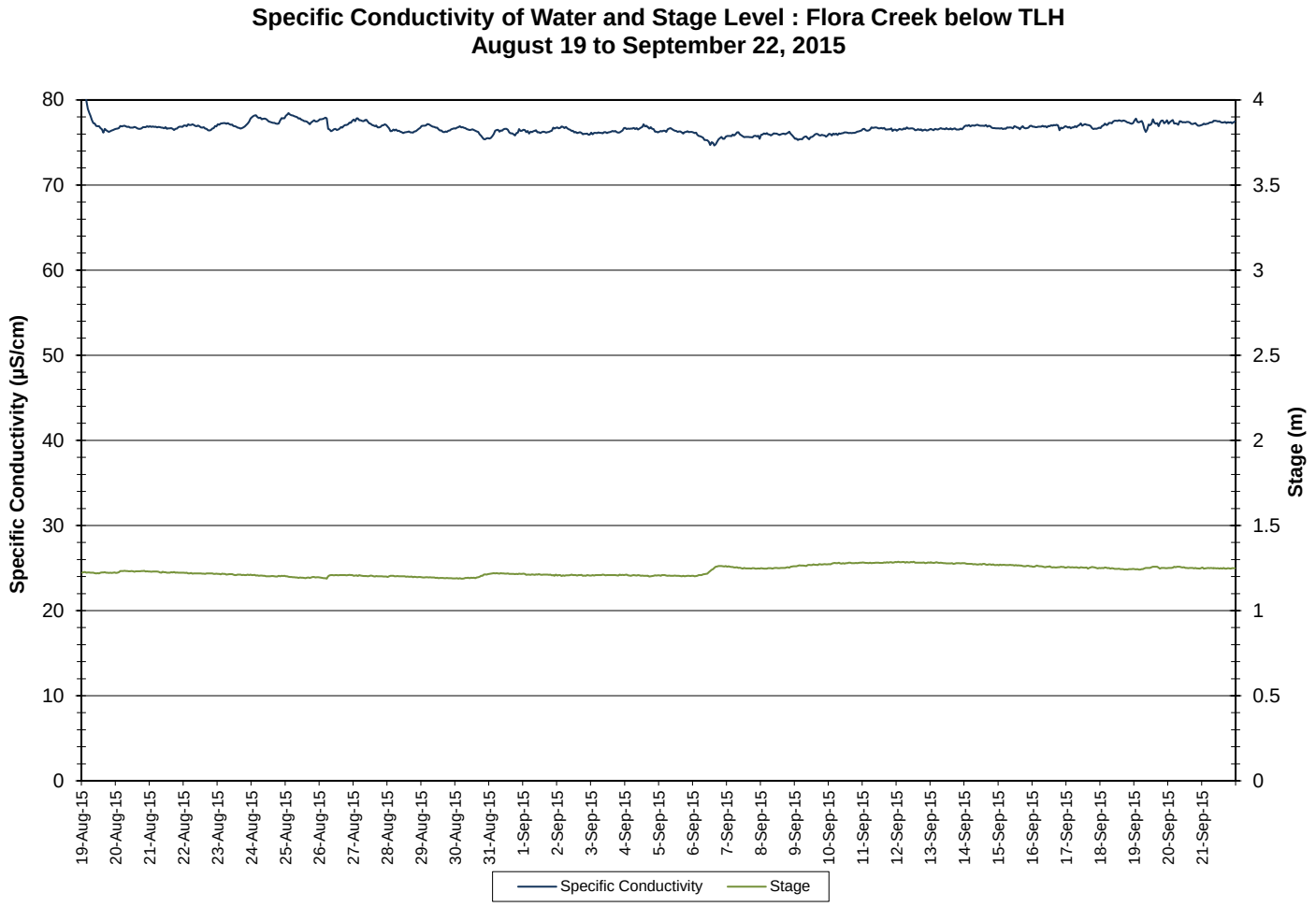

Figure 4: Specific conductivity and stage level - Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 90.2 to 106.1% and a range of 9.03 to 10.69 mg/l was found in the concentration of dissolved oxygen with a median value of 10.03mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. Most values were above the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature. Dissolved oxygen increased during this deployment period, due to the decreasing water temperature.

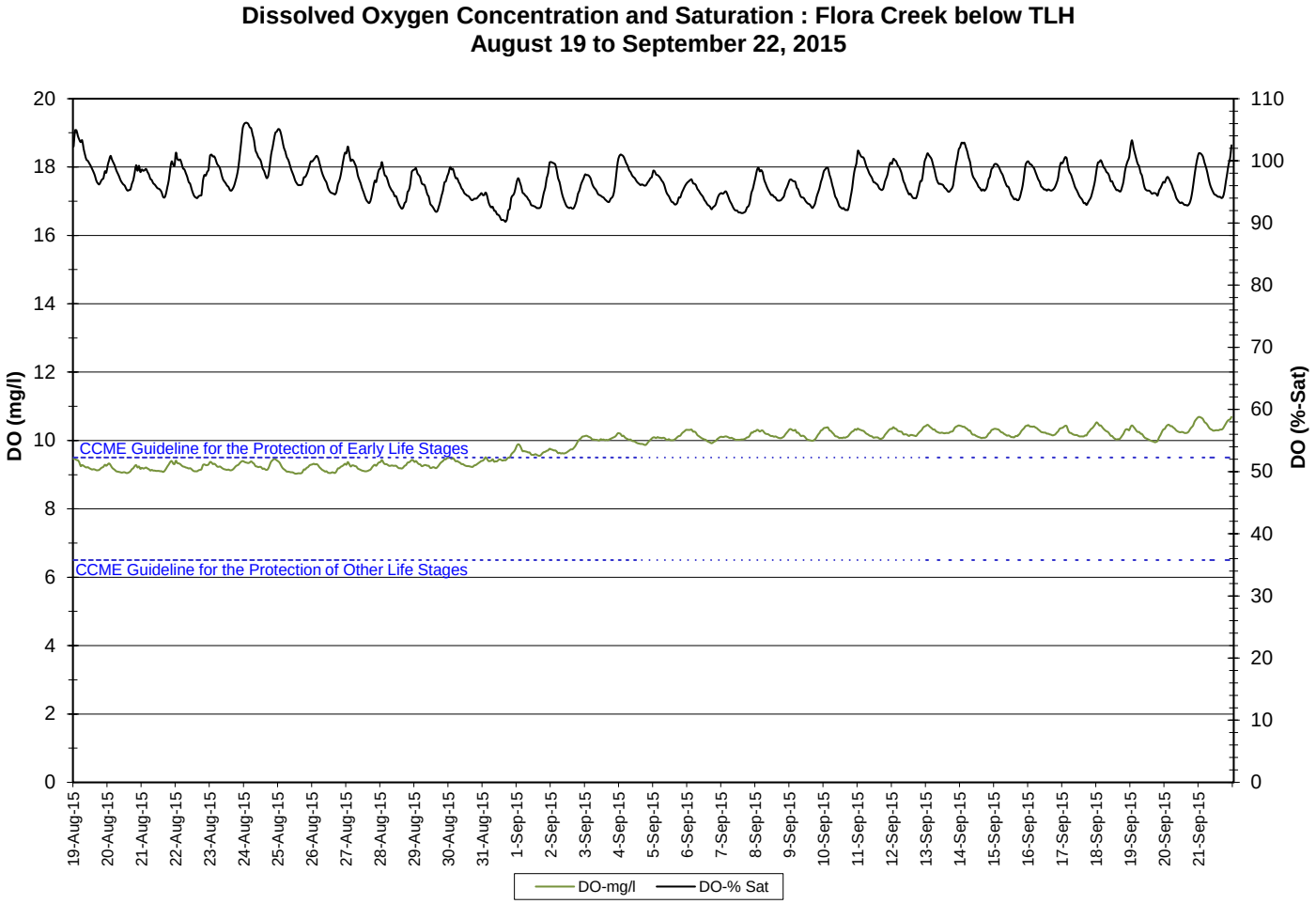

Figure 5: Dissolved oxygen and percent saturation - Flora Creek below TLH

Flora Creek below TLH, Newfoundland and Labrador

- Turbidity values range from 14.0 NTU to 77.1 NTU, the highest readings being recorded at the beginning of the deployment period. Turbidity decreased during the first portion of the deployment period, and then is relatively stable for the rest of the period (Figure 6).
- In some instances, turbidity spikes can be attributed to precipitation at the time (weather data collected at Churchill Falls). They are indicated on the graph in red.
- This site has very turbid water at times. Turbidity levels have dropped significantly since the beginning of this deployment season.

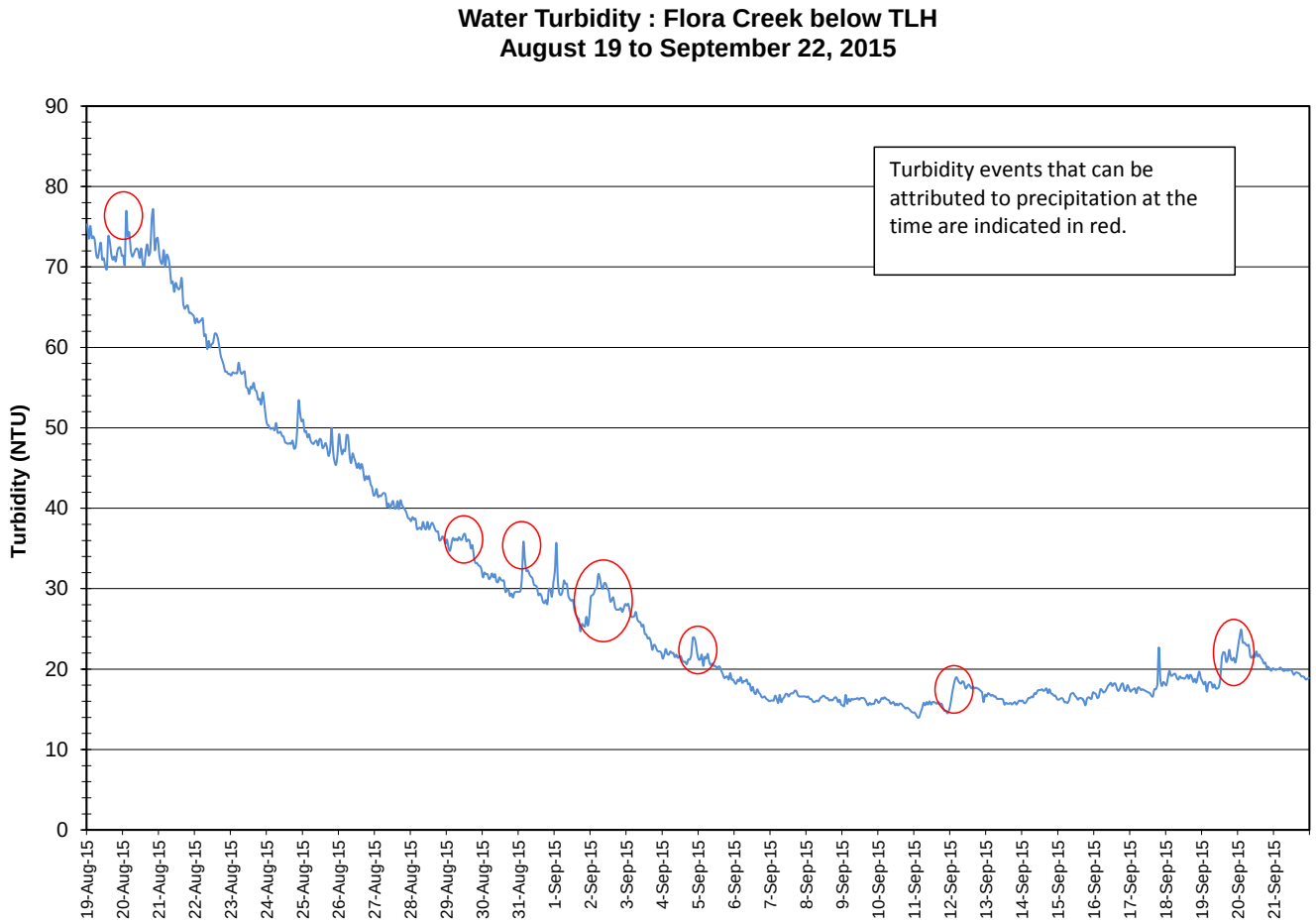

Figure 6: Turbidity - Flora Creek below TLH

- Precipitation and stage during the deployment period is graphed below (Figure 7). Stage fluctuated during the first portion of the deployment period and then increased after a number of days of significant precipitation, before decreasing slightly.
- It is important to note that weather data was collected from Churchill Falls, ~200 km away. Data from the local area was not available for this 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.

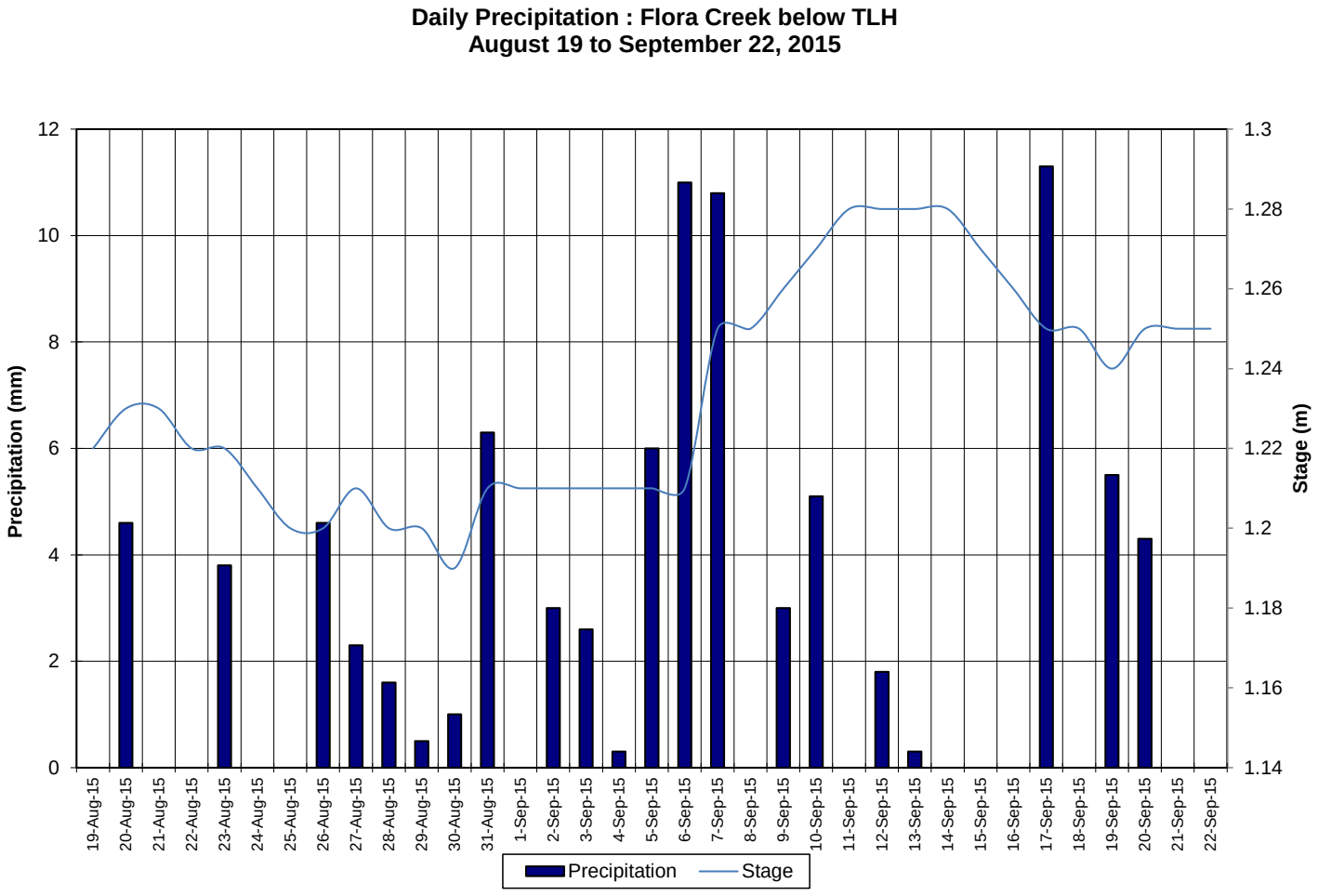

Figure 7: Precipitation and Stage – Flora Creek below TLH

(Weather data collected at Churchill Falls)

Conclusions

- An instrument at the water quality monitoring station on the Flora Creek below TLH station was deployed on August 19 and removed on September 22, 2015.
- 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 Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen.
- Water temperature decreased during the deployment period. Water temperature corresponded with air temperature. The temperature typically ranged between 10.88 and 21.62^{o}C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 7.46 and 7.94.
- Specific conductivity ranged from 74.7 to 90.2 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 and most 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 decreased significantly during the first portion of the deployment period and were then relatively stable for the remainder of the period.
- Stage fluctuated during the first portion of the deployment period and then increased after a number of days of significant precipitation, before decreasing slightly.
- 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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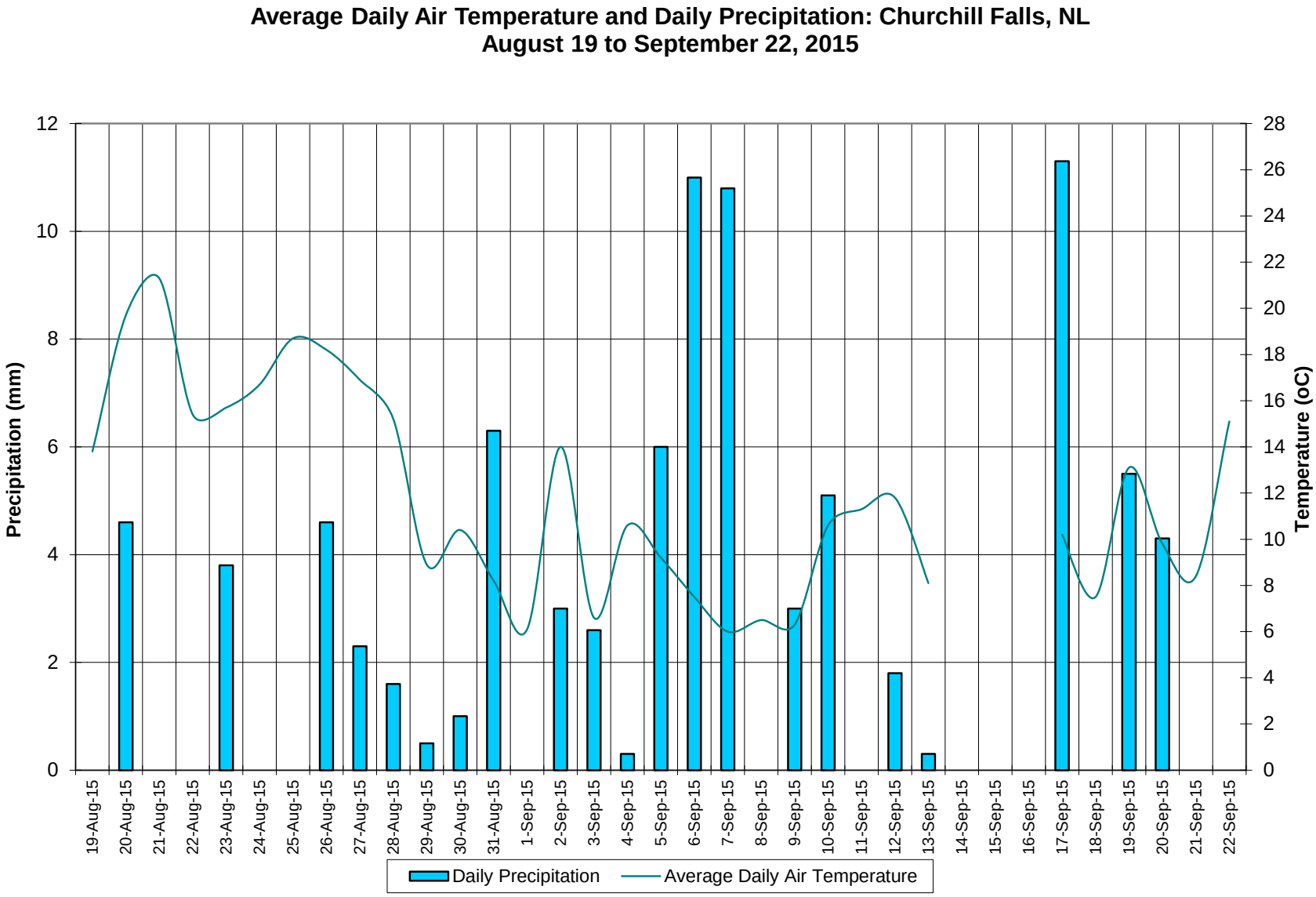
Appendix 1


Average Daily Air Temperature and Daily Precipitation: Churchill Falls, NL
August 19 to September 22, 2015
Precipitation (mm)
Temperature (oC)
0
2
4
6
8
10
12
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
19-Aug-15
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1-Sep-15
2-Sep-15
3-Sep-15
4-Sep-15
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20-Sep-15
21-Sep-15
22-Sep-15
Daily Precipitation
Average Daily Air Temperature