



Real-Time Water Quality Deployment Report

Iron Ore Company of Canada
Labrador West Network

July 23 to
September 12, 2018



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

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General

- The Water Resources Management Division, in partnership with the Iron Ore Company of Canada (IOC) and Environment and Climate Change Canada (ECCC), maintain two real-time water quality (RTWQ) and water quantity stations at Wabush Lake.
- The official name of each station is *Wabush Lake at Dolomite Road* and *Wabush Lake at Lake Outlet*, hereafter referred to as the Dolomite Road station and the Julienne Narrows station.
- These stations are situated upstream (Dolomite Road) and downstream (Julienne Narrows) of the IOC tailings disposal area in Wabush Lake.
- On June 8th, 2016, an additional station was commissioned under this agreement. This station is located at *Dumbell Stream above Dumbell Lake*, hereafter referred to as Dumbell Stream.
- On June 12th, 2017 a new station was commissioned under this agreement. This station is located at *Pumphouse Stream above Drum Lake*, hereafter referred to as Pumphouse Stream.
- Water Resources Management Division staff monitor the real-time graphs regularly. They will inform IOC of any significant water quality events by email notification and by monthly deployment reports.
- Between July 23 and 25th, real-time water quality monitoring instruments were deployed at the four IOC stations. The instruments were deployed for a period of 49 days at Dolomite Road and Dumbell Stream and 48 days at Pumphouse Stream. Due to a logistical issue, the instrument at Julienne Narrows was deployed for 65 days, from June 13th to August 17th. A clean, calibrated instrument was deployed on August 17th and removed on September 11th. The instruments were removed between September 10th and 12th.



Figure 1: RTWQ Monitoring Stations in Labrador West

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 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 IOC water quality stations deployed between July 23-25 and September 10-12, 2018 are summarized in Table 2.

Table 2: QA/QC comparison rankings for IOC stations between July 23 and September 12, 2018.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Dolomite Road	July 23, 2018	Deployment	Excellent	Excellent	Excellent	Excellent	Poor
	Sept 10, 2018	Removal	Excellent	Excellent	Good	Excellent	Excellent
Julienne Narrows	Aug 17, 2018	Deployment	Excellent	Excellent	Excellent	Excellent	Fair
	Sept 11, 2018	Removal	Excellent	N/A	Good	Excellent	Excellent
Dumbell Stream	July 25, 2018	Deployment	Excellent	Excellent	Excellent	Excellent	N/A
	Sept 12, 2018	Removal	Excellent	Good	Excellent	Excellent	Excellent
Pumphouse Stream	July 24, 2018	Deployment	Good	Excellent	Excellent	Good	Poor
	Sept 12, 2018	Removal	Good	Excellent	Excellent	Fair	Good

▪ **Dolomite Road**

At deployment, all parameters besides turbidity ranked ‘excellent’. Turbidity ranked ‘poor’. The field instrument read a value of 26.8 NTU, while the QA/QC instrument read a value of 7.0 NTU.

At removal, all parameters ranked either ‘excellent’ or ‘good’.

▪ **Julienne Narrows**

At deployment, all parameters with the exception of turbidity ranked either ‘good’ or ‘excellent’. Turbidity ranked ‘fair’. The field instrument read a value of 1.0 NTU, while the QA/QC instrument read a value of 7.0 NTU.

At removal, all parameters with the exception of pH ranked either ‘good’ or ‘excellent’. pH could not be ranked due to an issue with the QA/QC sonde.

▪ **Dumbell Stream**

At deployment , all parameters besides turbidity ranked ‘excellent’. Turbidity could not be ranked due to an issue with the QA/QC sonde.

At removal, all parameters ranked either ‘good’ or ‘excellent’.

▪ **Pumphouse Stream**

At deployment, all parameters besides turbidity ranked either ‘good’ or ‘excellent’. Turbidity ranked ‘poor’. The field sonde read a value of 51.5 NTU, while the QA/QC sonde read a value of 78.5 NTU.

At removal, all parameters besides dissolved oxygen ranked either ‘good’ or ‘excellent’. Dissolved oxygen ranked ‘fair’. The field instrument read a value of 10.85 mg/l, while the QA/QC instrument read a value of 10.09 mg/l.

- There are a 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 or more of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from July 23 to September 12, 2018 at the IOC RTWQ monitoring stations in Labrador West.
- With the exception of water quantity data (Stage and Flow), 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.
- There is a portion of data missing from the Julienne Narrows station due to a power issue with the station. This issue was rectified on August 17th.

Wabush Lake Network

- Water temperature ranged from 12.21 to 21.70°C at Dolomite Road and 9.80 to 16.60°C at Julienne Narrows during this deployment period (Figure 2). Water temperature at Dolomite Road is slightly higher than at Julienne Narrows.
- Water temperature decreased during this deployment period, which corresponds with decreasing ambient air temperature at this time (Figure 2).

Water and Air Temperature : Wabush Lake Network
July 23 to September 11, 2018

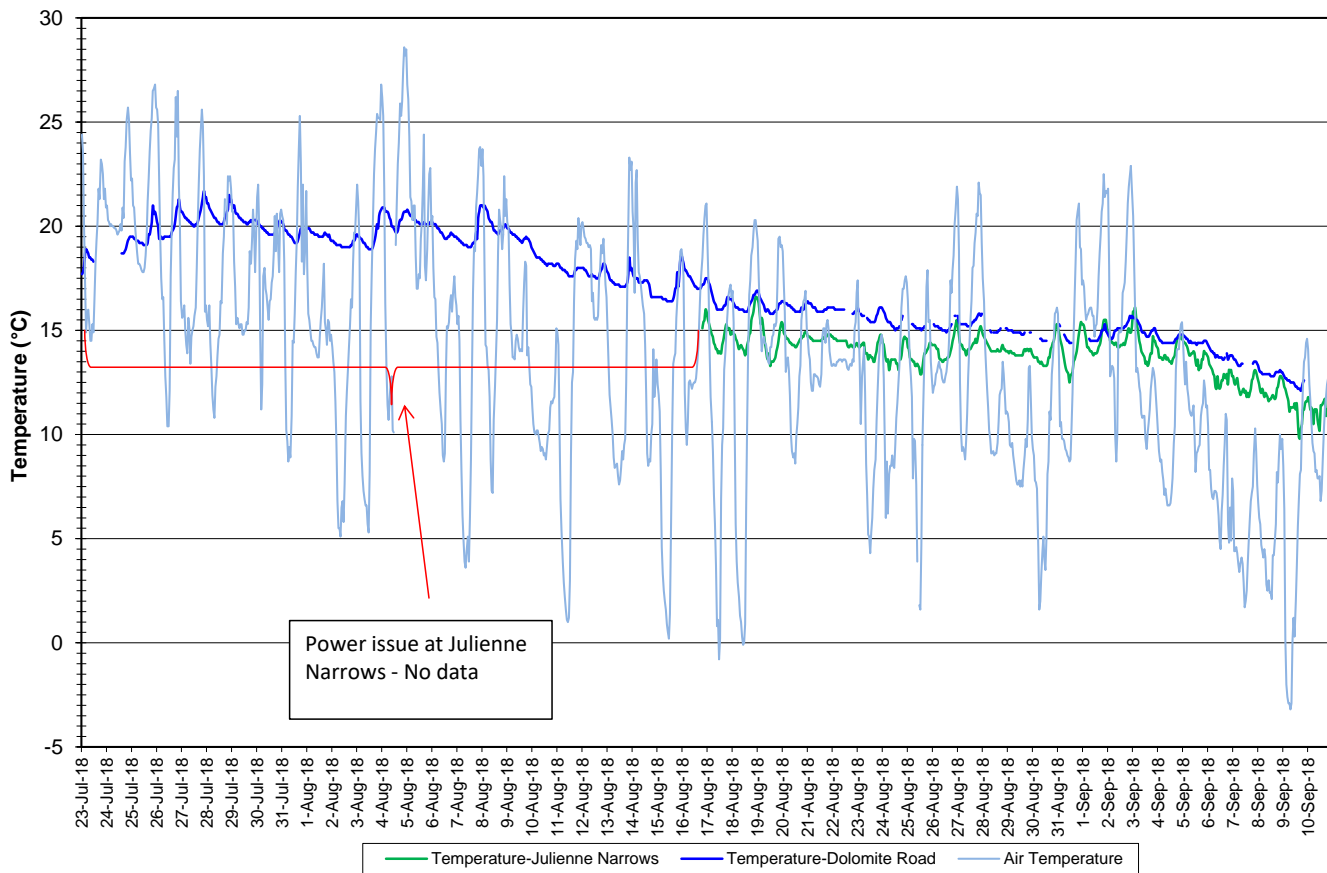


Figure 2: Water and Air Temperature - Wabush Lake network

(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

- pH ranges from 7.41 to 7.89 pH units at Dolomite Road, and from 7.80 to 8.24 pH units at Julienne Narrows throughout the deployment period (Figure 3). The median pH is 7.61 and 7.95 units respectively.
- 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 throughout the day and night.
- With the exception of water quantity data (Stage and Flow), 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.

**Water pH : Wabush Lake Network
July 23 to September 11, 2018**

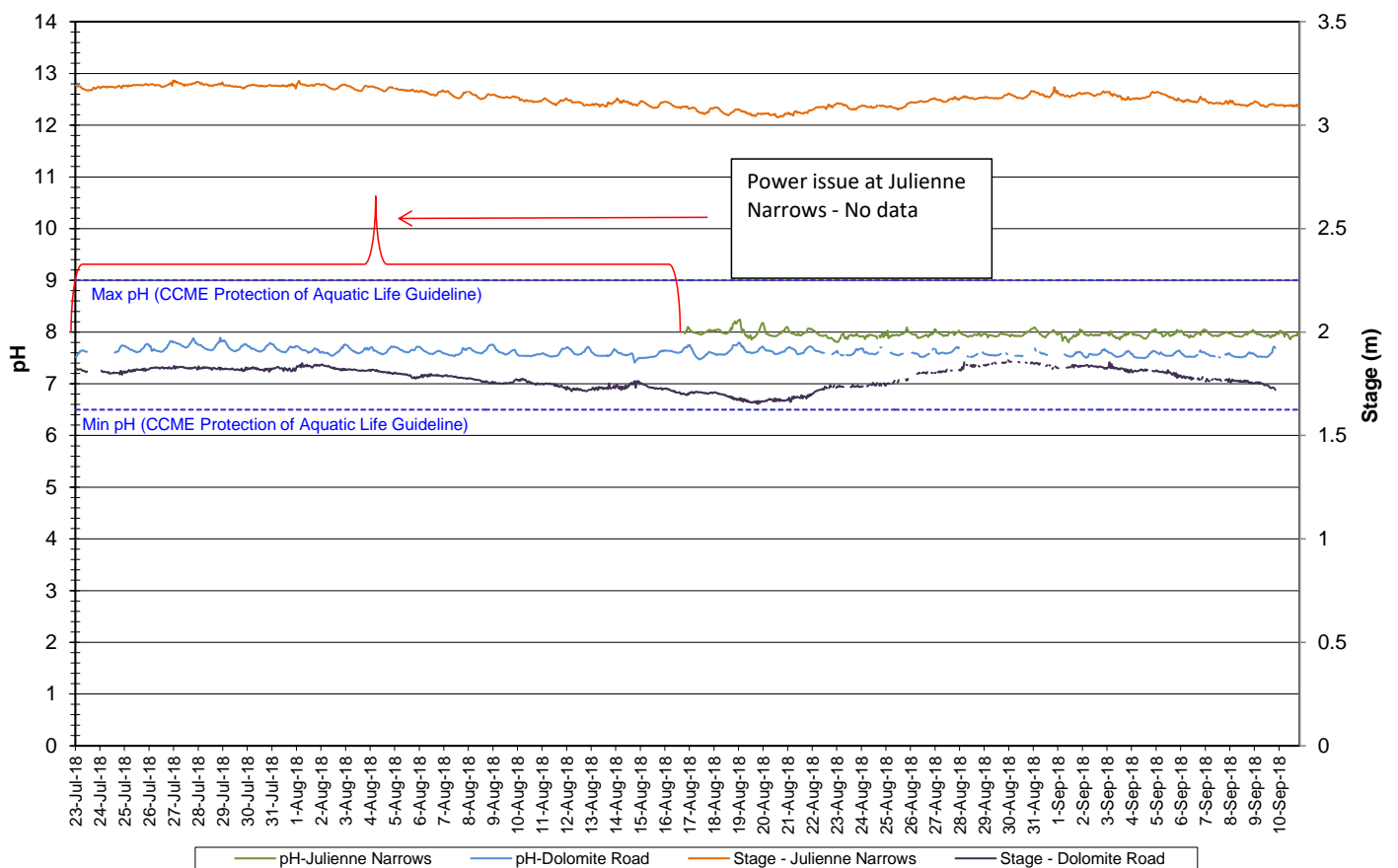


Figure 3: Water pH and stage– Wabush Lake network

- Specific conductivity ranged from 49.4 to 56.6 $\mu\text{S}/\text{cm}$ at Dolomite Road and from 70.0 to 104.0 $\mu\text{S}/\text{cm}$ at Julienne Narrows throughout the deployment period (Figure 4).
- Daily fluctuations are evident at the Julienne Narrows station. This can be attributed to varying contributions of iron ore tailings deposited into Wabush Lake upstream of Julienne Narrows and downstream of Dolomite Road. This can also explain the difference in specific conductivity levels between the two stations as conductance values are generally higher at Julienne Narrows.
- Specific conductance increases slightly at Dolomite Road during this deployment period.
- With the exception of water quantity data (Stage and Flow), 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.

**Specific Conductivity and Stage: Wabush Lake Network
July 23 to September 11, 2018**

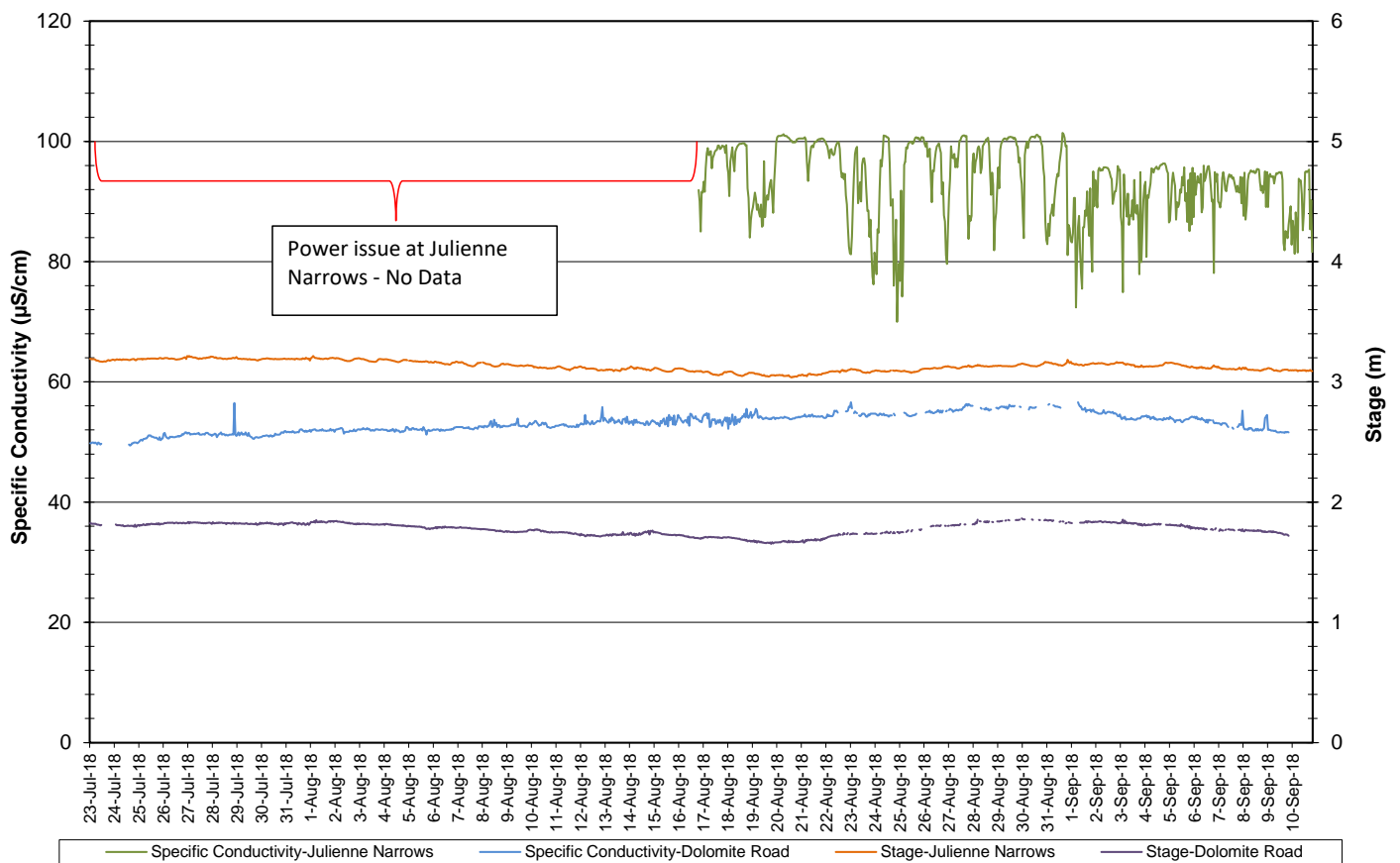


Figure 4: Specific conductivity and stage – Wabush Lake network

- At the Dolomite Road station, the saturation of dissolved oxygen ranged from 85.6 to 102.6% while the dissolved oxygen content ranged from 8.43 to 10.02 mg/l with a median value of 8.98 mg/l (Figure 5).
- At the Julienne Narrows station, the saturation of dissolved oxygen ranged from 88.3 to 101.0% while the dissolved oxygen content ranged from 9.32 to 10.68 mg/l with a median value of 9.645 mg/l (Figure 5).
- All values recorded at Julienne Narrows and Dolomite Road were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota of Other Life Stages of 6.5 mg/l.
- The majority of values recorded at Julienne Narrows were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota of Early Life Stages of 9.5 mg/l, while most values recorded at Dolomite Road were below the guideline. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen increased at Dolomite Road towards the end of this deployment period, as water temperature decreased. Dissolved oxygen fluctuated daily with decreases observed at night.

**Dissolved Oxygen : Wabush Lake Network
July 23 to September 11, 2018**

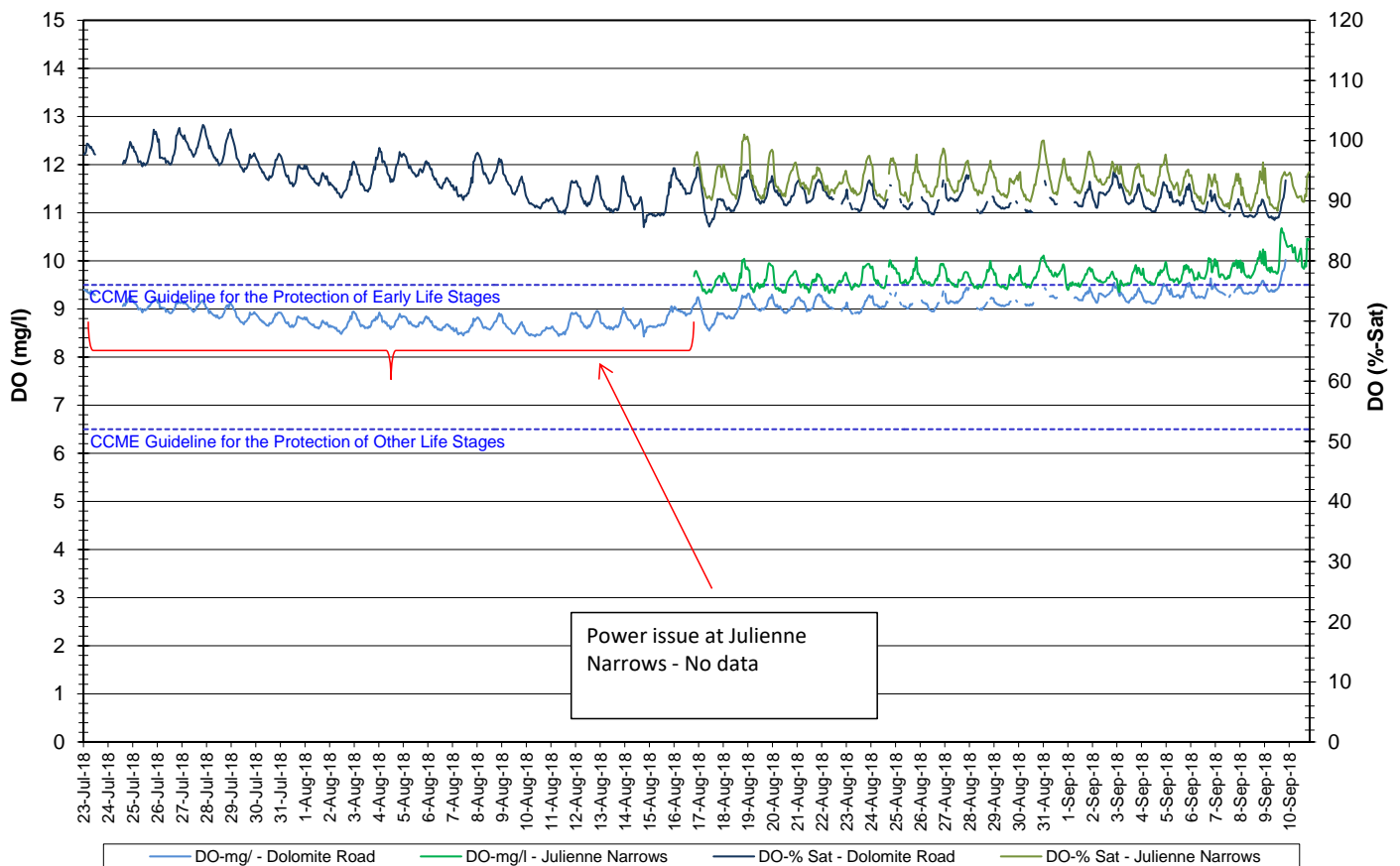


Figure 5: Dissolved oxygen and percent saturation – Wabush Lake Network

- At the Julienne Narrows station, turbidity values range from 0.0 to 161.7 NTU throughout the deployment period (Figure 6). The median value was 0.0 NTU.
- In some instances, turbidity spikes can be attributed to precipitation events.

**Water Turbidity and Precipitation: Julienne Narrows
July 23 to September 11, 2018**

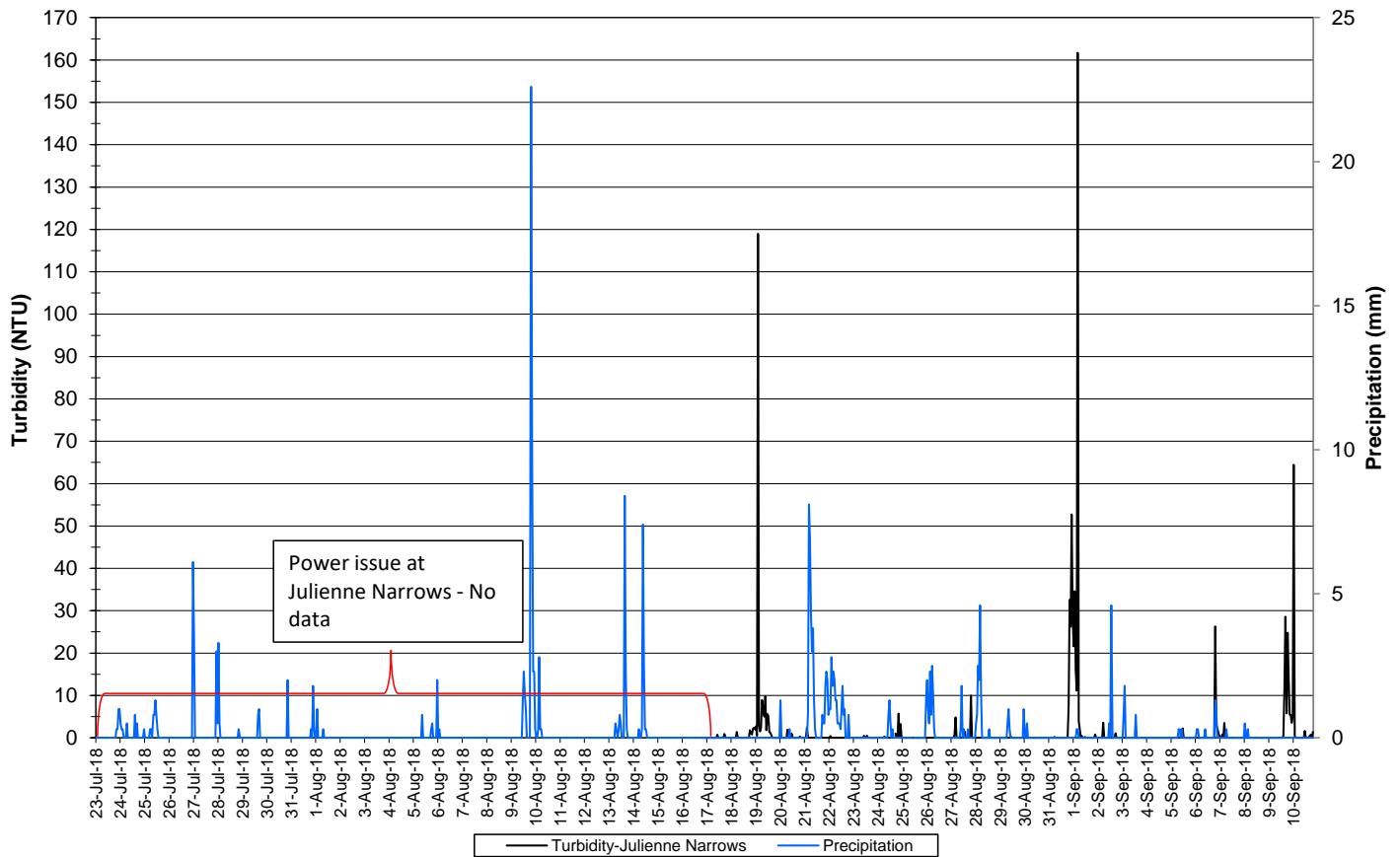


Figure 6: Turbidity and precipitation – Julienne Narrows
(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

- At the Dolomite Road station, turbidity values ranged from 0.0 NTU to 43.4 NTU, throughout the deployment period (Figure 7). The median value was 0.0 NTU.
- These frequent spikes in turbidity are unusual for this station. In some instances, turbidity spikes can be attributed to precipitation events.

**Turbidity and Precipitation : Dolomite Road
June 13 to July 23, 2018**

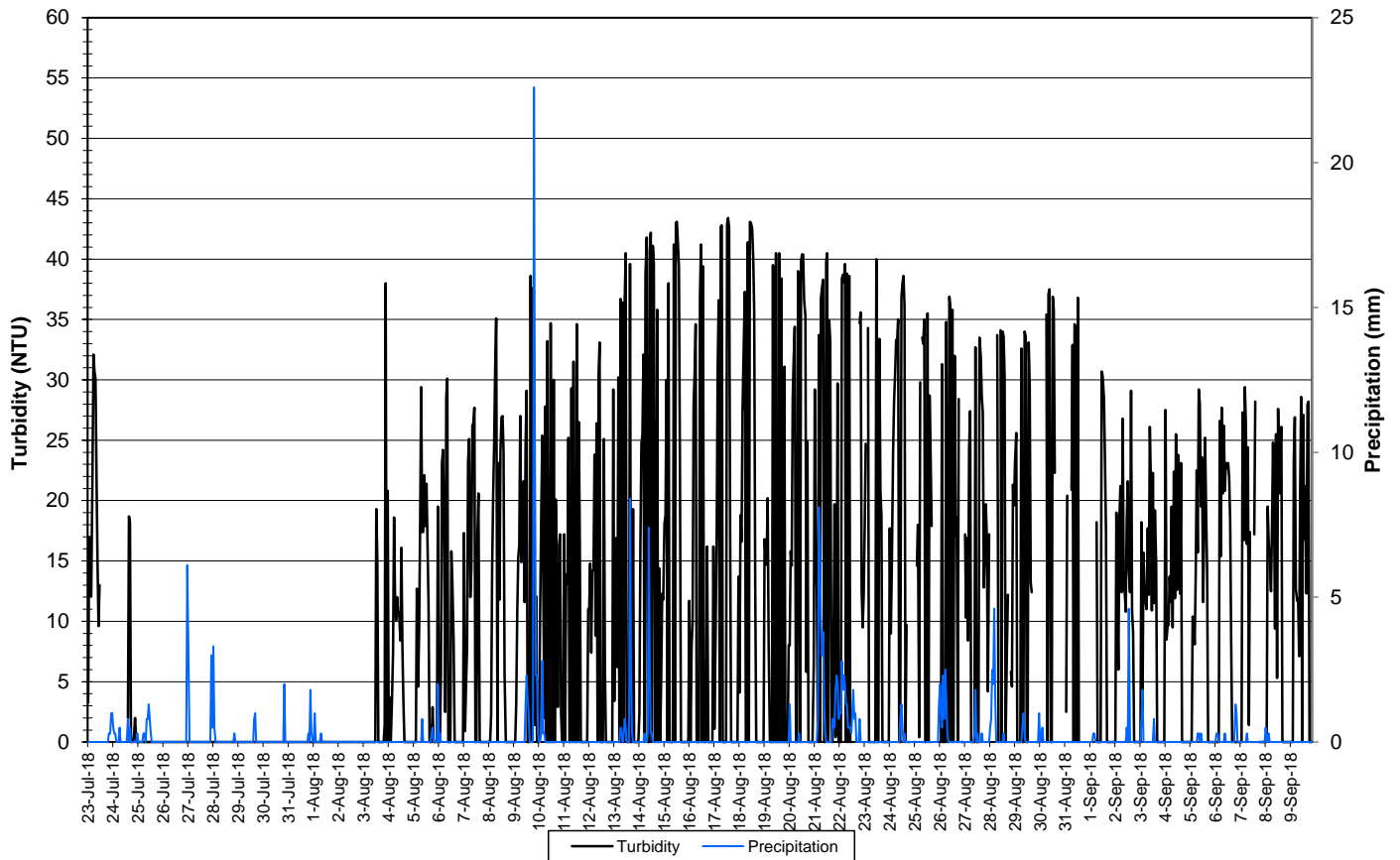
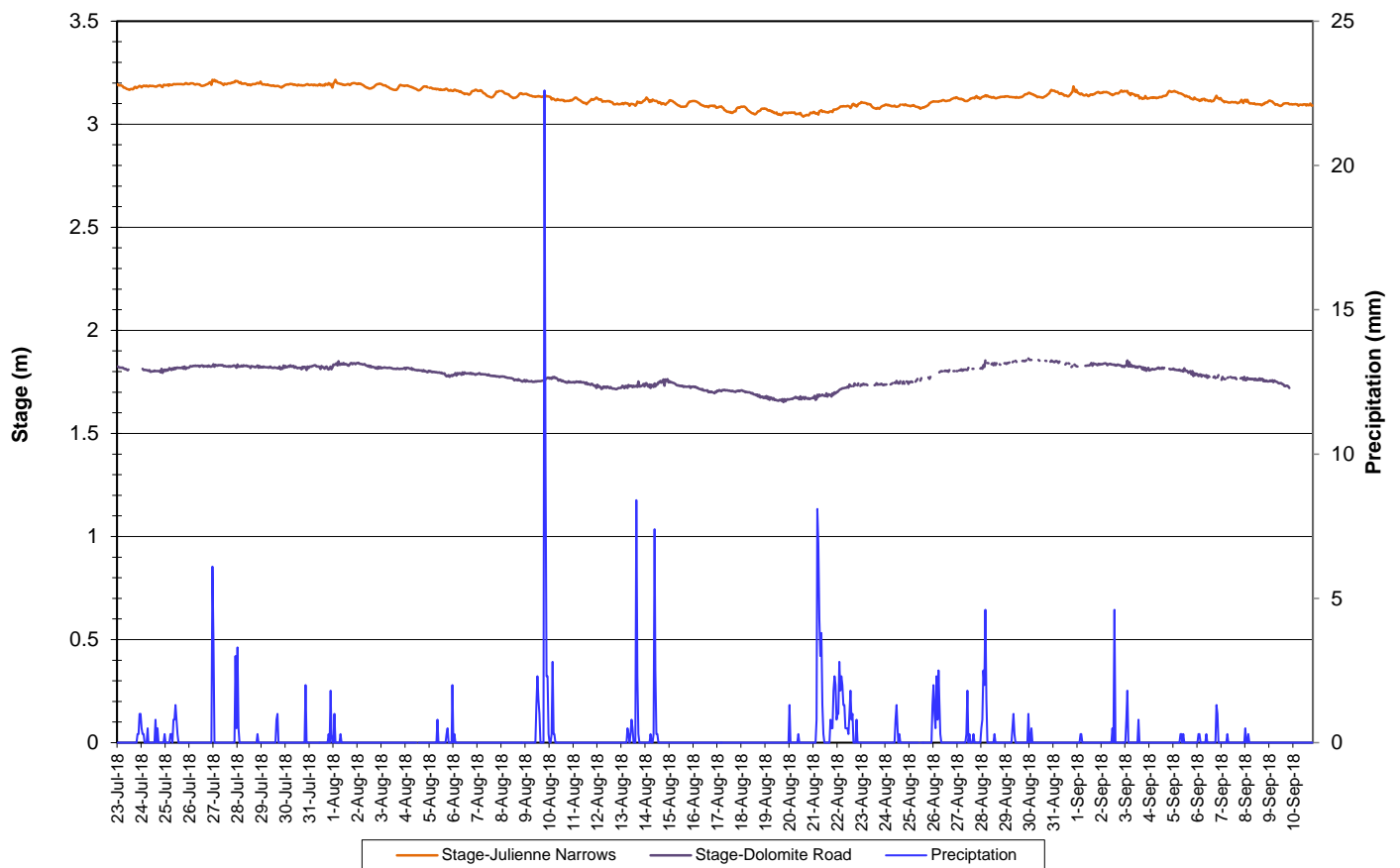


Figure 7: Turbidity and precipitation – Dolomite Road

(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Dolomite Road and Julienne Narrows (Figure 8).
- Overall, stage is relatively stable throughout the deployment period at both stations. There is a small decrease during August, during a time with no precipitation.
- With the exception of water quantity data (Stage and Flow), 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.

**Stage and Precipitation: Wabush Lake Network
July 23 to September 11, 2018**



**Figure 8: Stage and precipitation – Wabush Lake Network
(Weather data collected at climate station located on TLH between Churchill Falls and Labrador City)**

Dumbell Stream

- Water temperature ranged from 2.39 to 7.03°C during this deployment period (Figure 9).
- Water temperature generally fluctuated within this range for the deployment period. This area is very shaded. Temperature decreased slightly during the later portion of the deployment period due to decreasing air temperature into the fall season (Figure 9).

Water and Air Temperature : Dumbell Stream above Dumbell Lake
July 25 to September 12, 2018

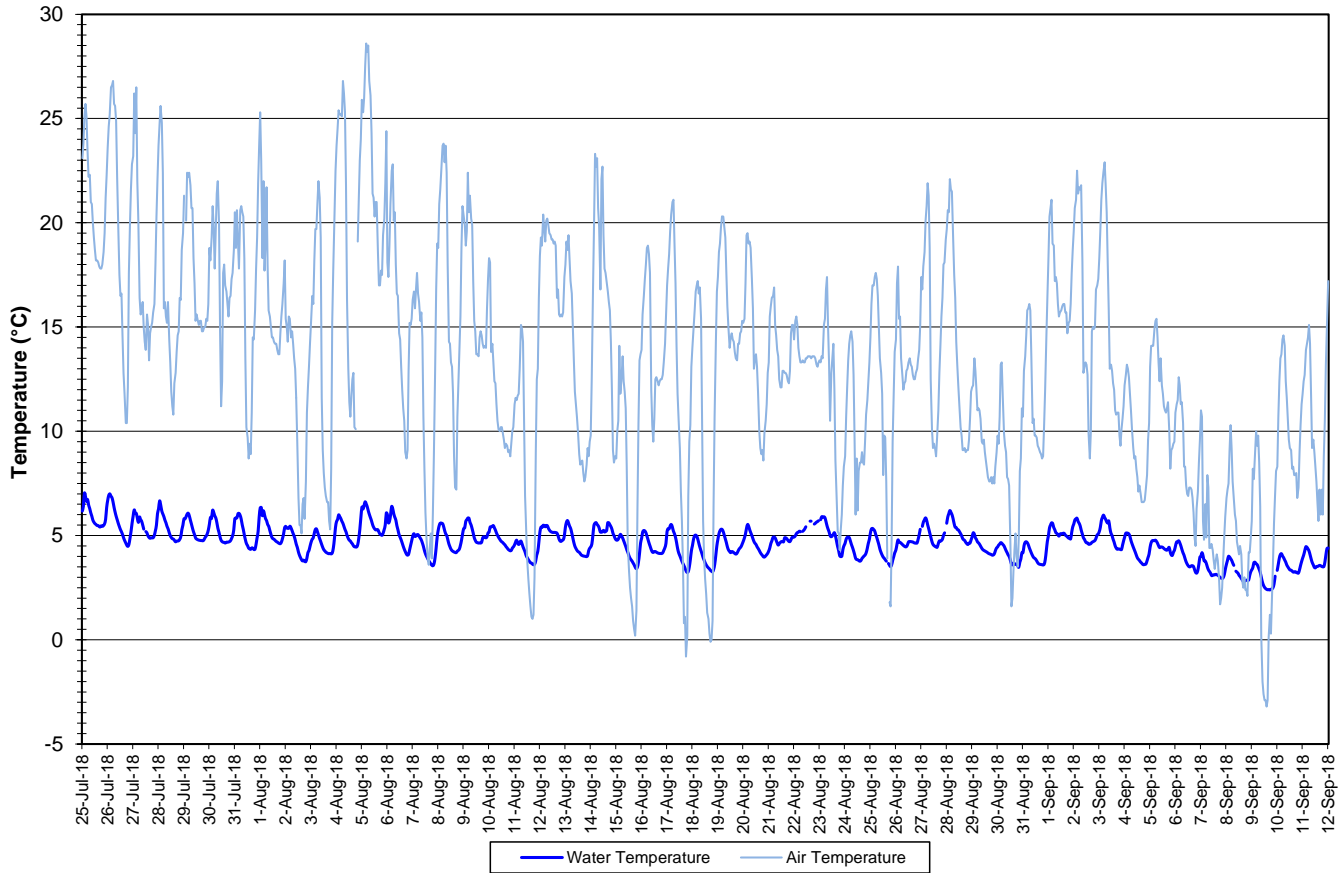


Figure 9: Water and air temperature – Dumbell Stream
(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

- pH ranged from 7.32 to 7.70 pH units (Figure 10). The median pH was 7.55.
- 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 throughout the day and night.
- With the exception of water quantity data (Stage and Flow), 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.

Water pH and Stage: Dumbell Stream above Dumbell Lake
July 25 to September 12, 2018

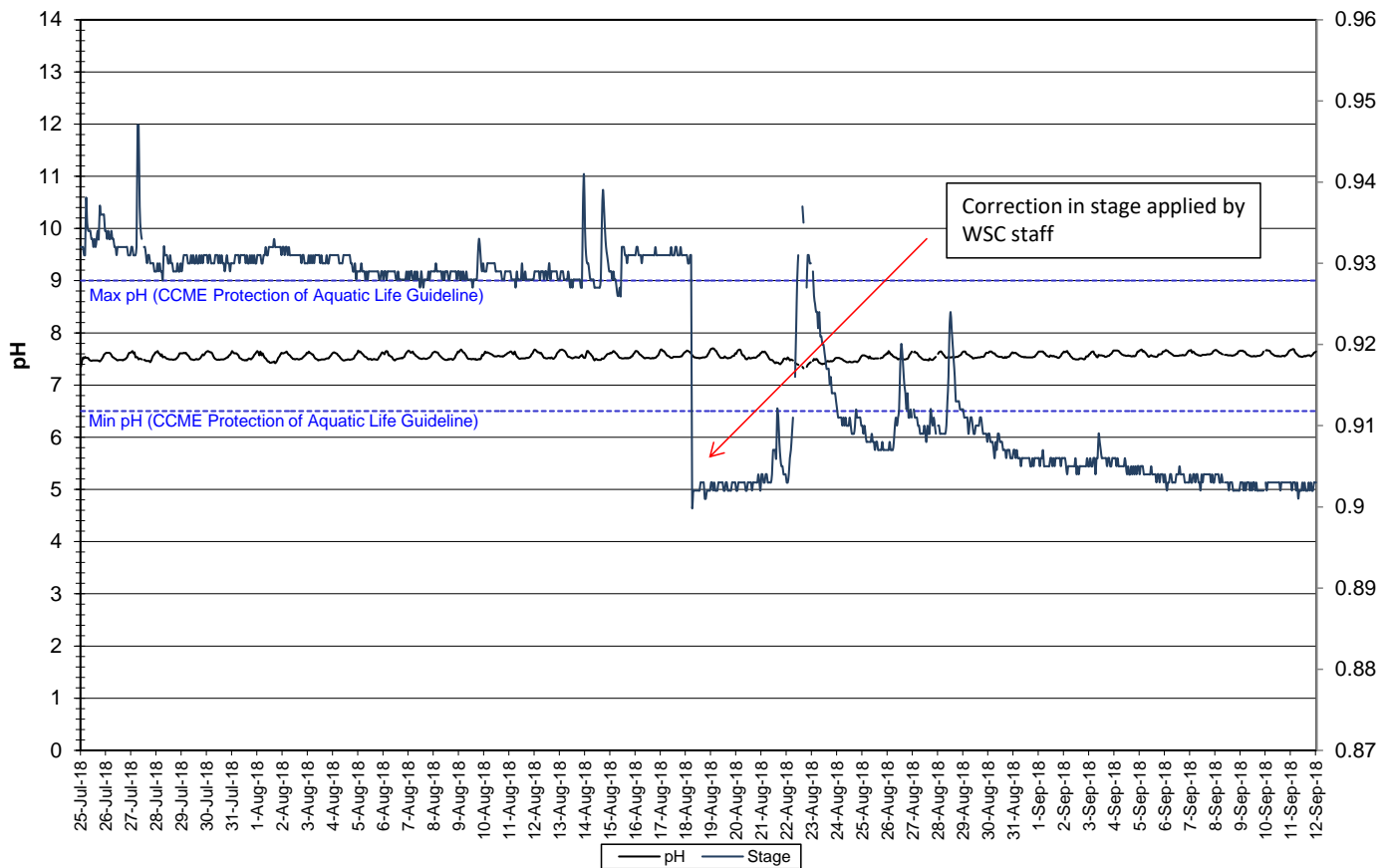


Figure 10: Water pH and stage – Dumbell Stream

- Specific conductivity ranged from 59.6 to 71.8 $\mu\text{S}/\text{cm}$, throughout the deployment period (Figure 14).
- Decreases in specific conductivity correspond to increases in stage. As more water is added to the system from precipitation, the solids in the water are diluted, decreasing conductivity. These decreases are indicated in red on Figure 11.
- With the exception of water quantity data (Stage and Flow), 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.

Specific Conductivity of Water and Stage: Dumbell Stream above Dumbell Lake
July 25 to September 12, 2018

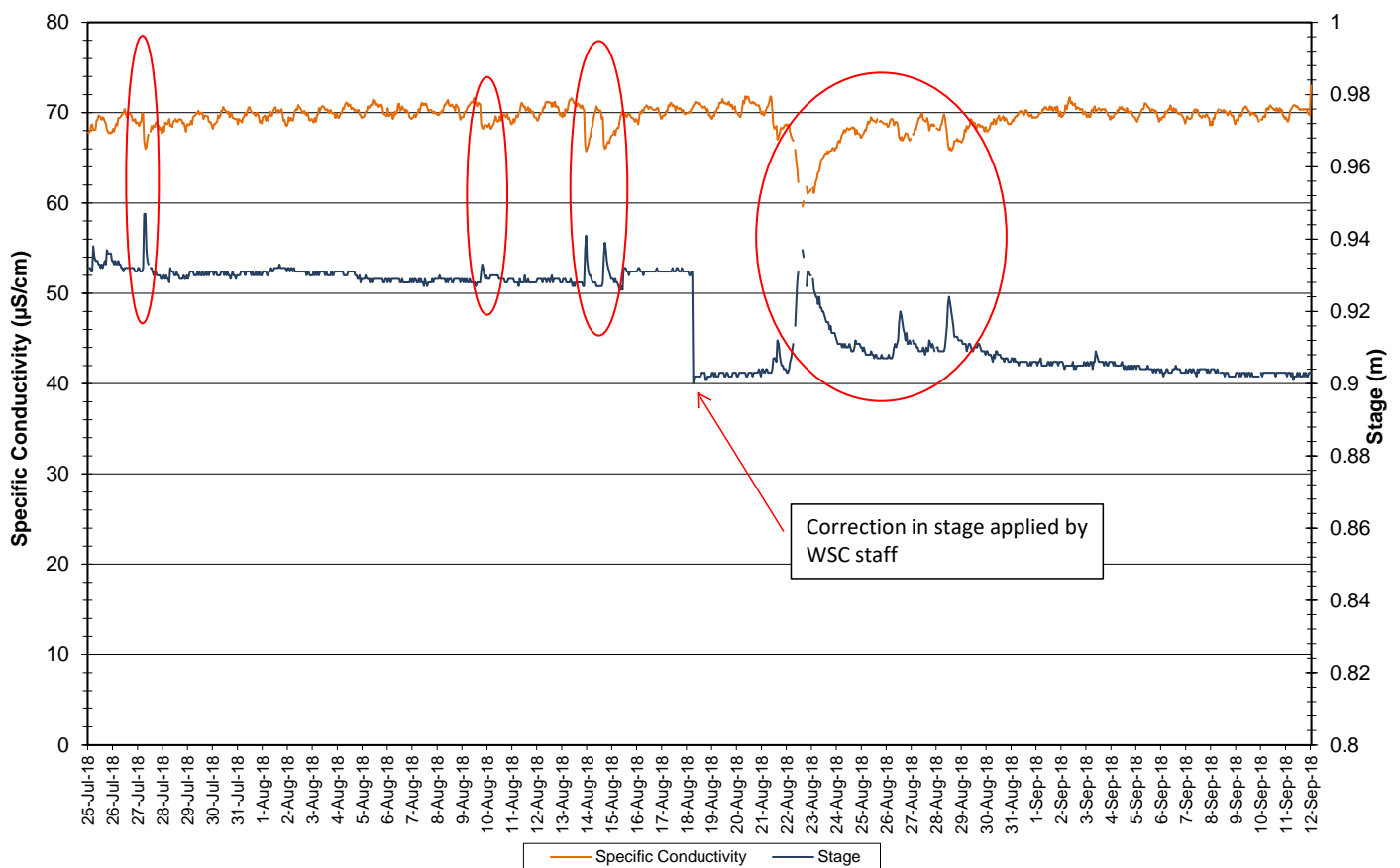


Figure 11: Specific conductivity and stage – Dumbell Stream

- The saturation of dissolved oxygen ranged from 87.2 to 91.4% while the dissolved oxygen content ranged from 10.92 to 12.36 mg/l with a median value of 11.55 mg/l (Figure 12).
- All values recorded at Dumbell Stream were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota of Other Life Stages of 6.5 mg/l and the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota of Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen increased slightly during this deployment period as water temperature decreased.
- Dissolved oxygen fluctuated daily with decreases observed at night.

Dissolved Oxygen Concentration and Saturation : Dumbell Stream at Dumbell Lake
July 25 to September 12, 2018

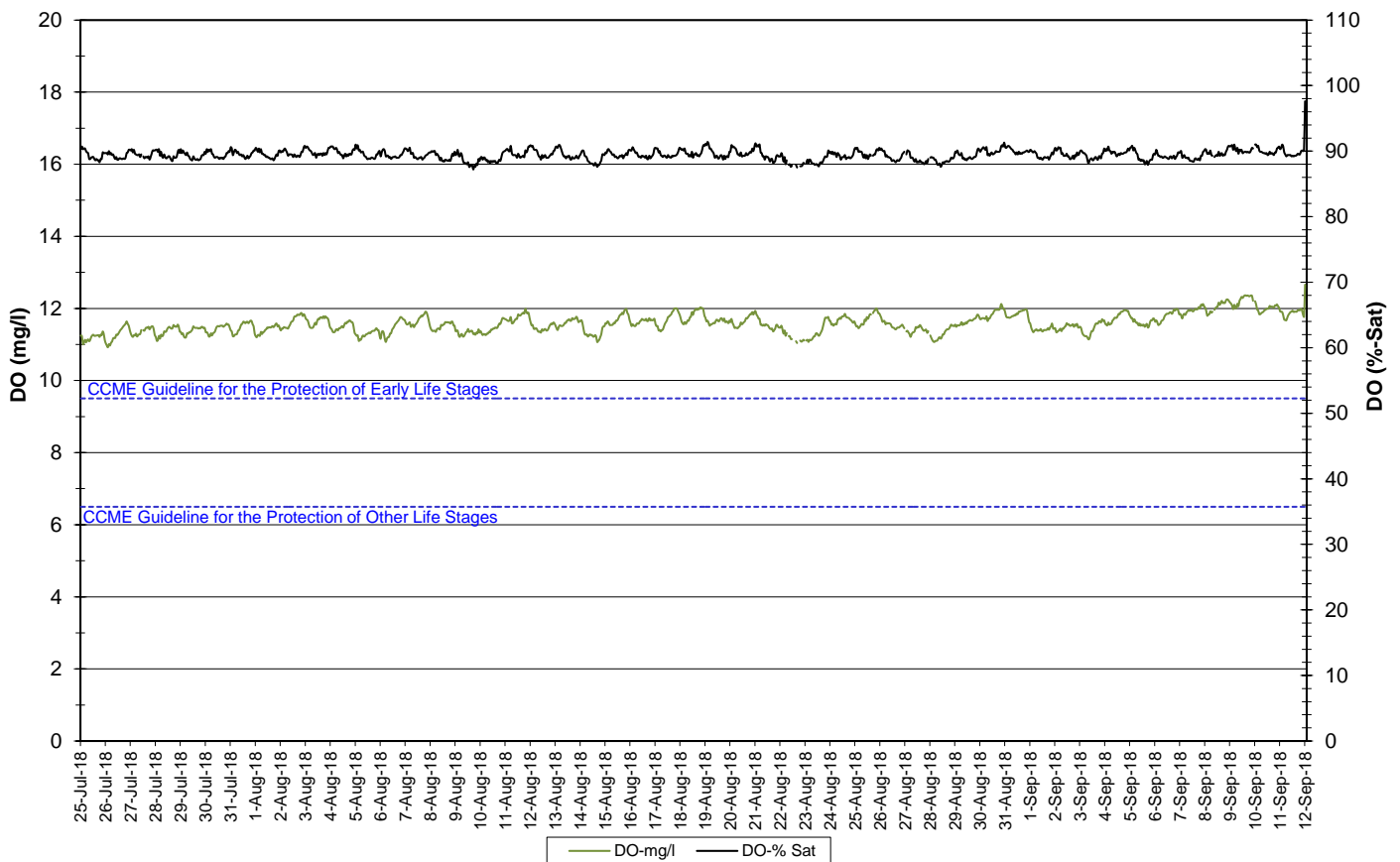


Figure 12: Dissolved oxygen – Dumbell Stream

- Turbidity values remained at 0.0 NTU throughout the deployment period (Figure 13).

**Water Turbidity and Precipitation : Dumbell Stream above Dumbell Lake
July 25 to September 12, 2018**

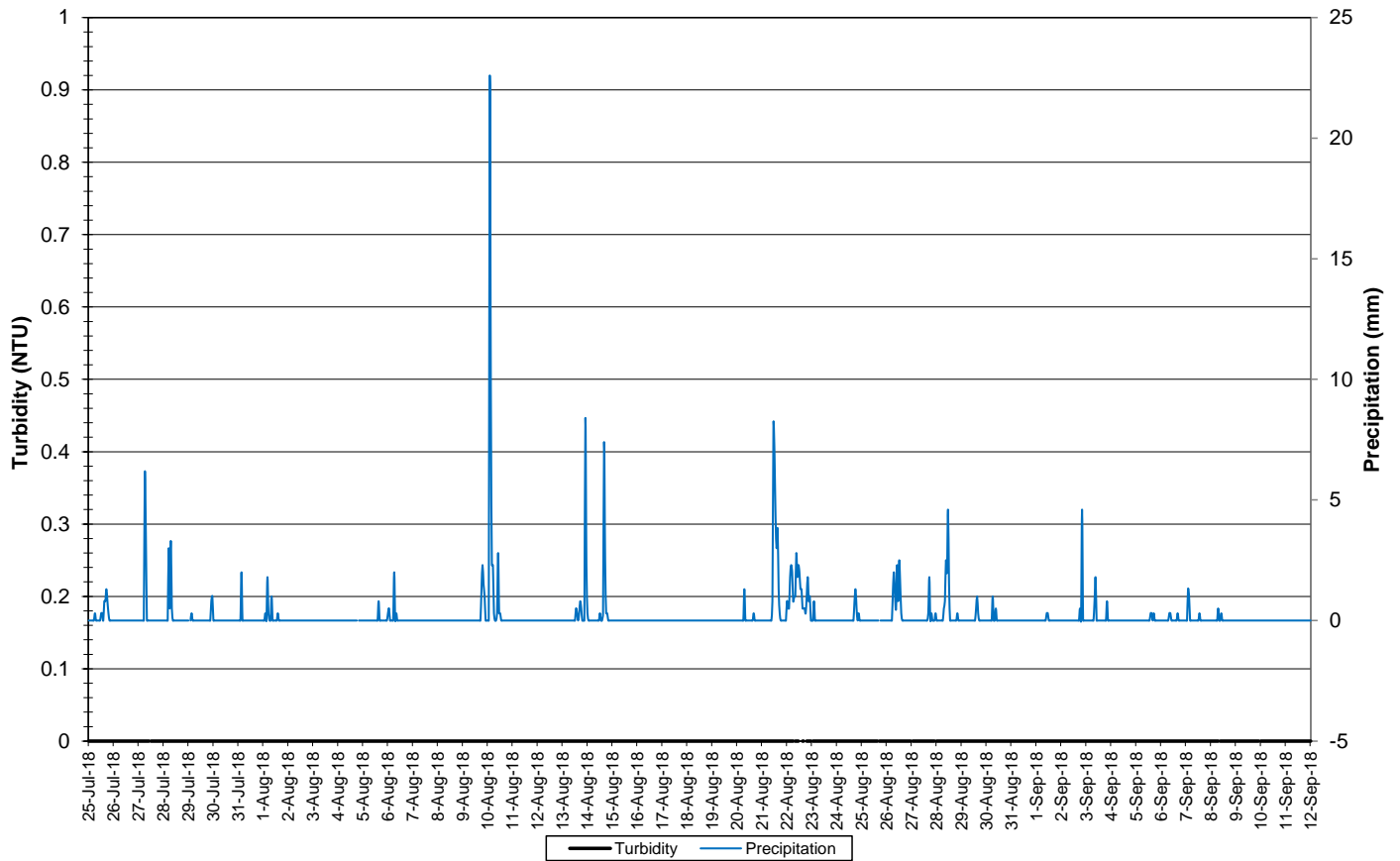


Figure 13: Turbidity and precipitation – Dumbell Stream

(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Dumbell Stream (Figure 14).
- Stage decreases throughout the deployment period, with precipitation events causing periodic increases in stage.
- With the exception of water quantity data (Stage and Flow), 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.

Stage and Precipitation: Dumbell Stream
July 25 to September 12, 2018

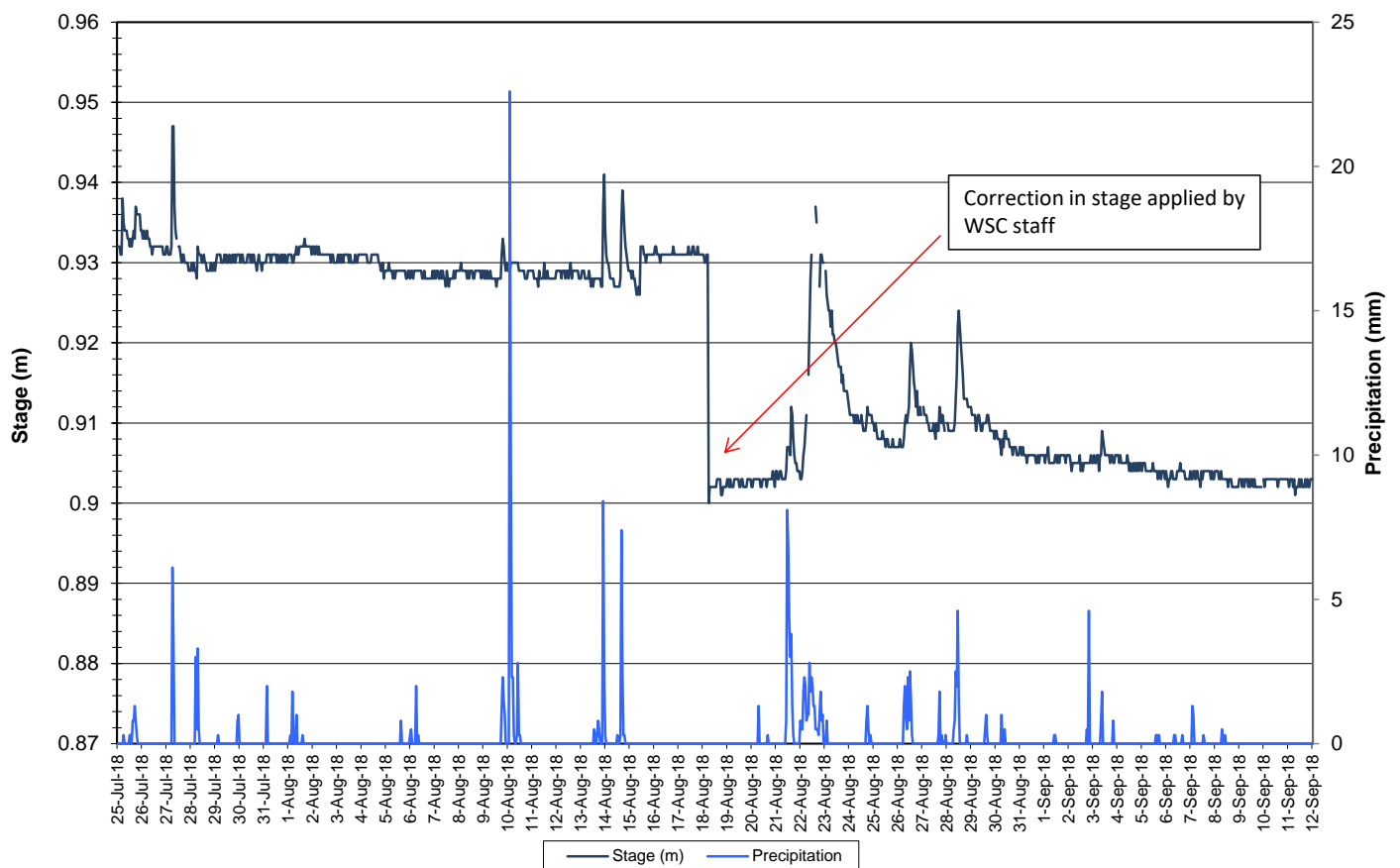


Figure 14: Stage and precipitation – Dumbell Stream

(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

Pumphouse Stream

- Water temperature ranged from 6.90 to 20.70°C during this deployment period (Figure 15).
- Water temperature decreased over the course of this deployment period, corresponding to decreasing ambient air temperatures into summer (Figure 15).

**Water and Air Temperature : Pumphouse Stream above Drum Lake
July 24 to September 12, 2018**

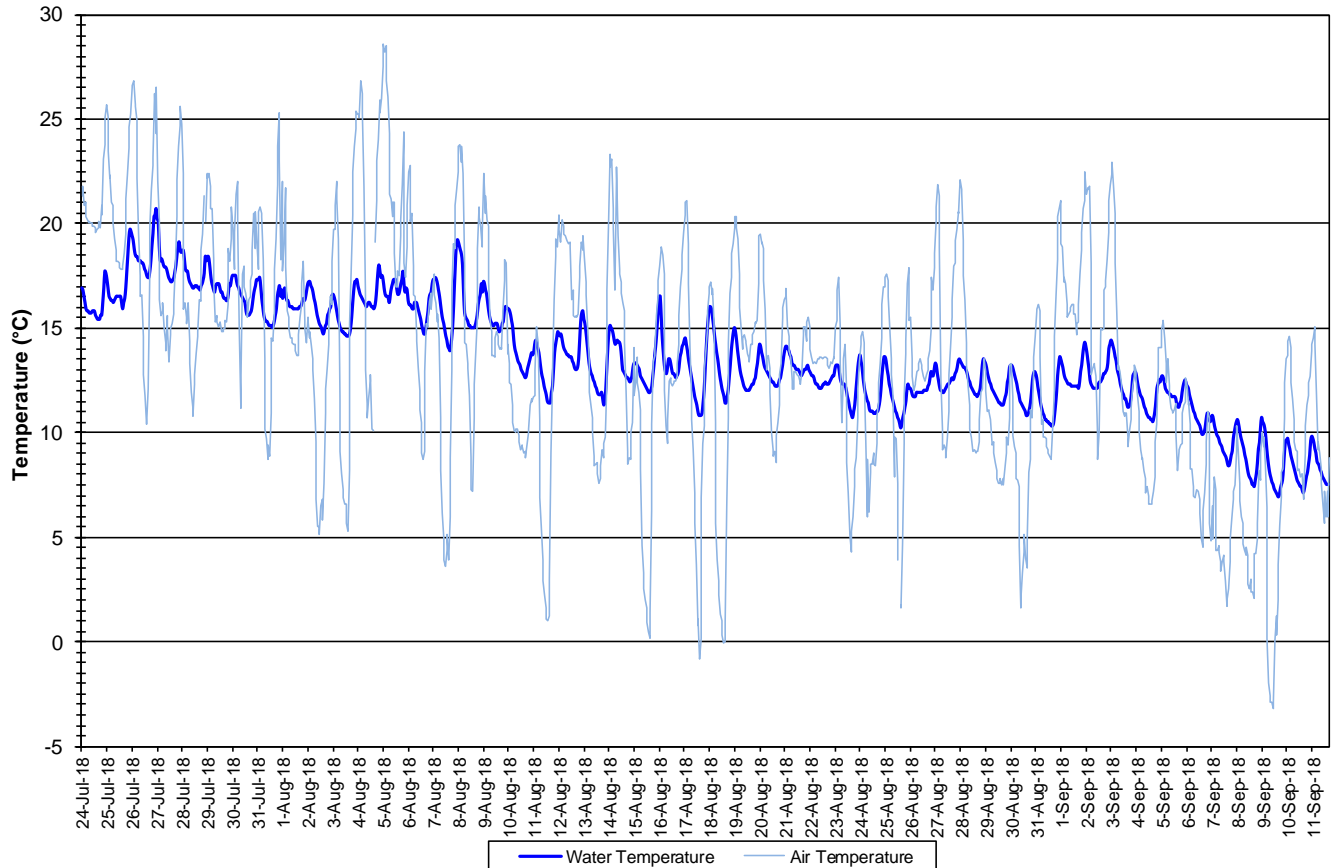


Figure 15: Water and air temperature – Pumphouse Stream

(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)

- pH ranged from 6.34 to 7.73 pH units (Figure 16). The median pH was 7.32.
- The majority of 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 throughout the day and night.
- With the exception of water quantity data (Stage and Flow), 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.

Water pH and Stage: Pumphouse Stream above Drum Lake
July 24 to September 12, 2018

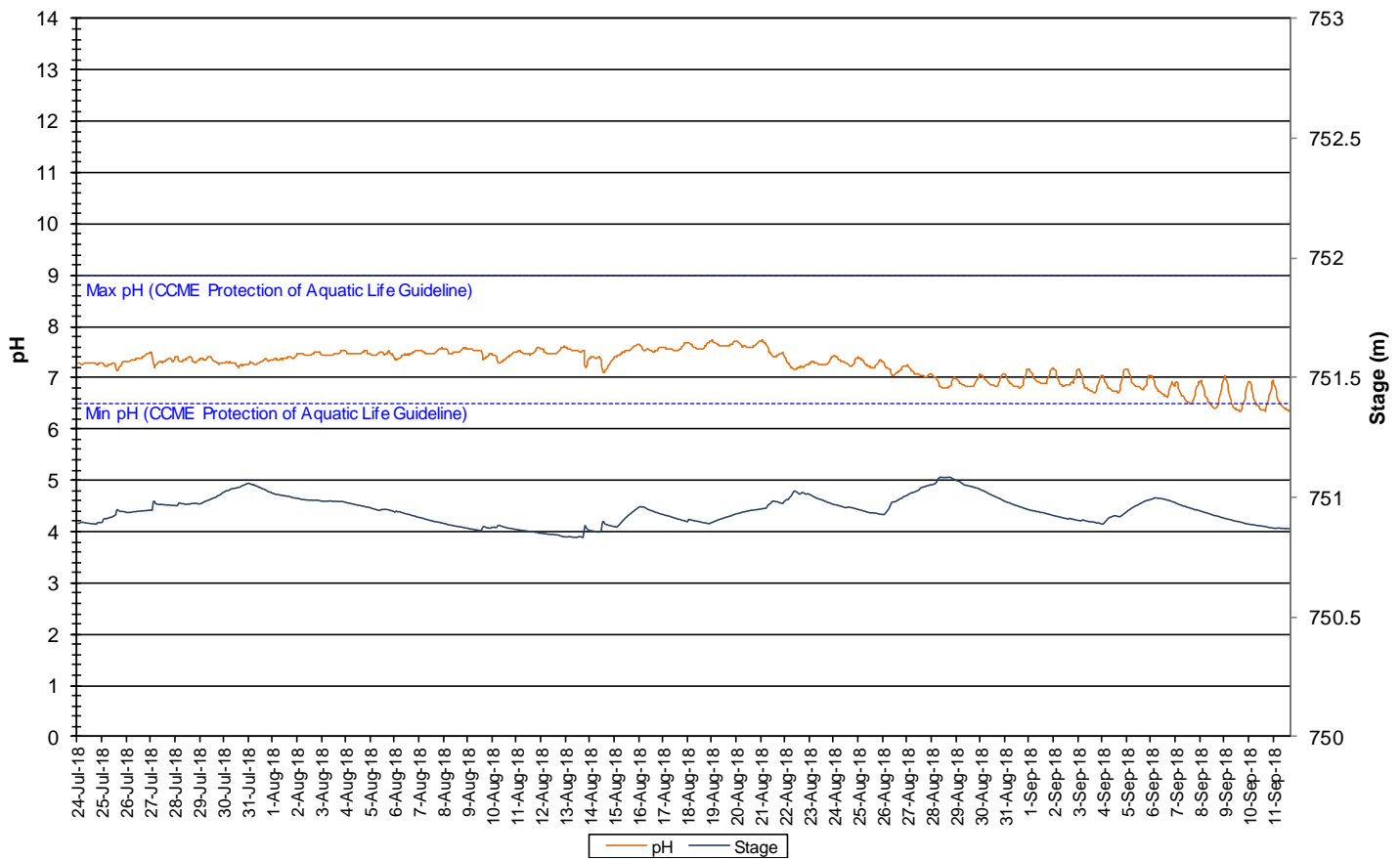


Figure 16: Water pH and stage – Pumphouse Stream

- Specific conductivity ranged from 112.0 to 156.0 $\mu\text{S}/\text{cm}$, throughout the deployment period (Figure 17).
- Some decreases in specific conductivity correspond to increases in stage. As more water is added to the system from precipitation, the solids in the water are diluted, decreasing conductivity.
- With the exception of water quantity data (Stage and Flow), 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.

**Specific Conductivity of Water and Stage: Pumphouse Stream above Drum Lake
July 24 to September 12, 2018**

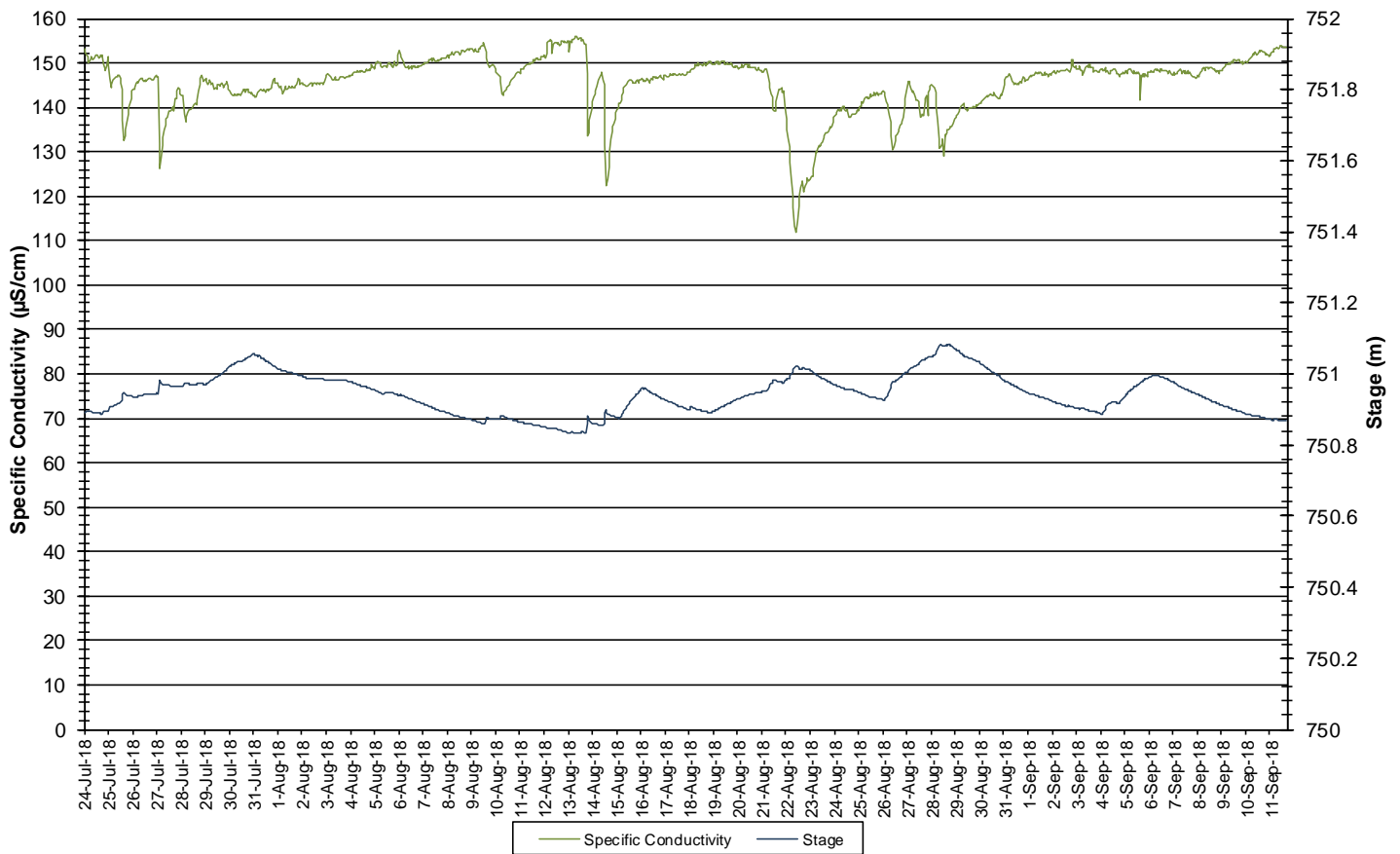


Figure 17: Specific Conductivity and stage – Pumphouse Stream

- The saturation of dissolved oxygen ranged from 70.6 to 103.2% while the dissolved oxygen ranged from 7.07 to 11.83 mg/l with a median value of 9.07 mg/l (Figure 18).
- All values recorded at Pumphouse Stream were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota of Other Life Stages of 6.5 mg/l. The majority of values were below the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota of Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 18.
- Dissolved oxygen increased during this deployment period as water temperature decreased.
- Dissolved oxygen fluctuated daily with decreases observed at night.

**Dissolved Oxygen Concentration and Saturation : Pumphouse Stream above Drum Lake
July 24 to September 12, 2018**

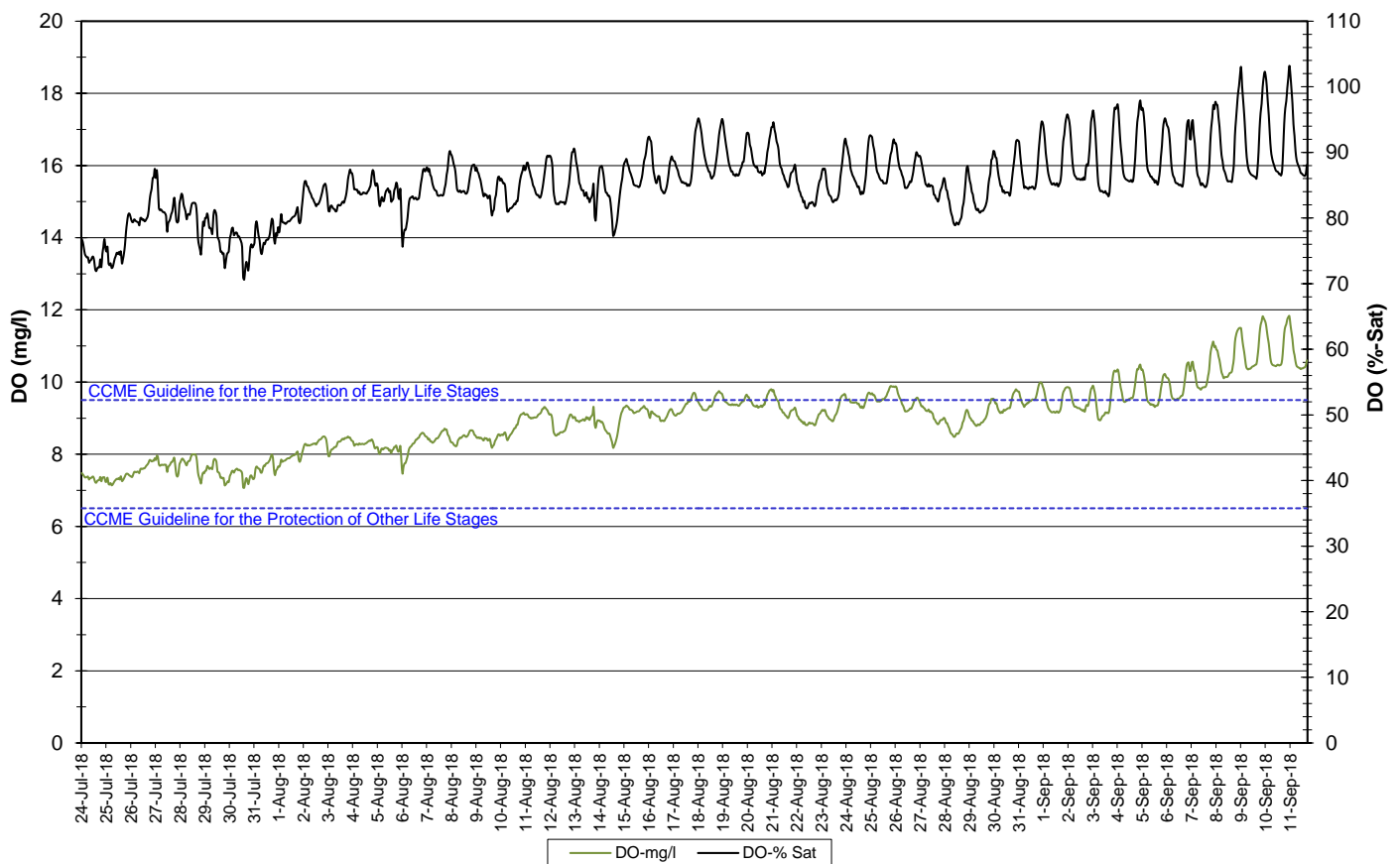
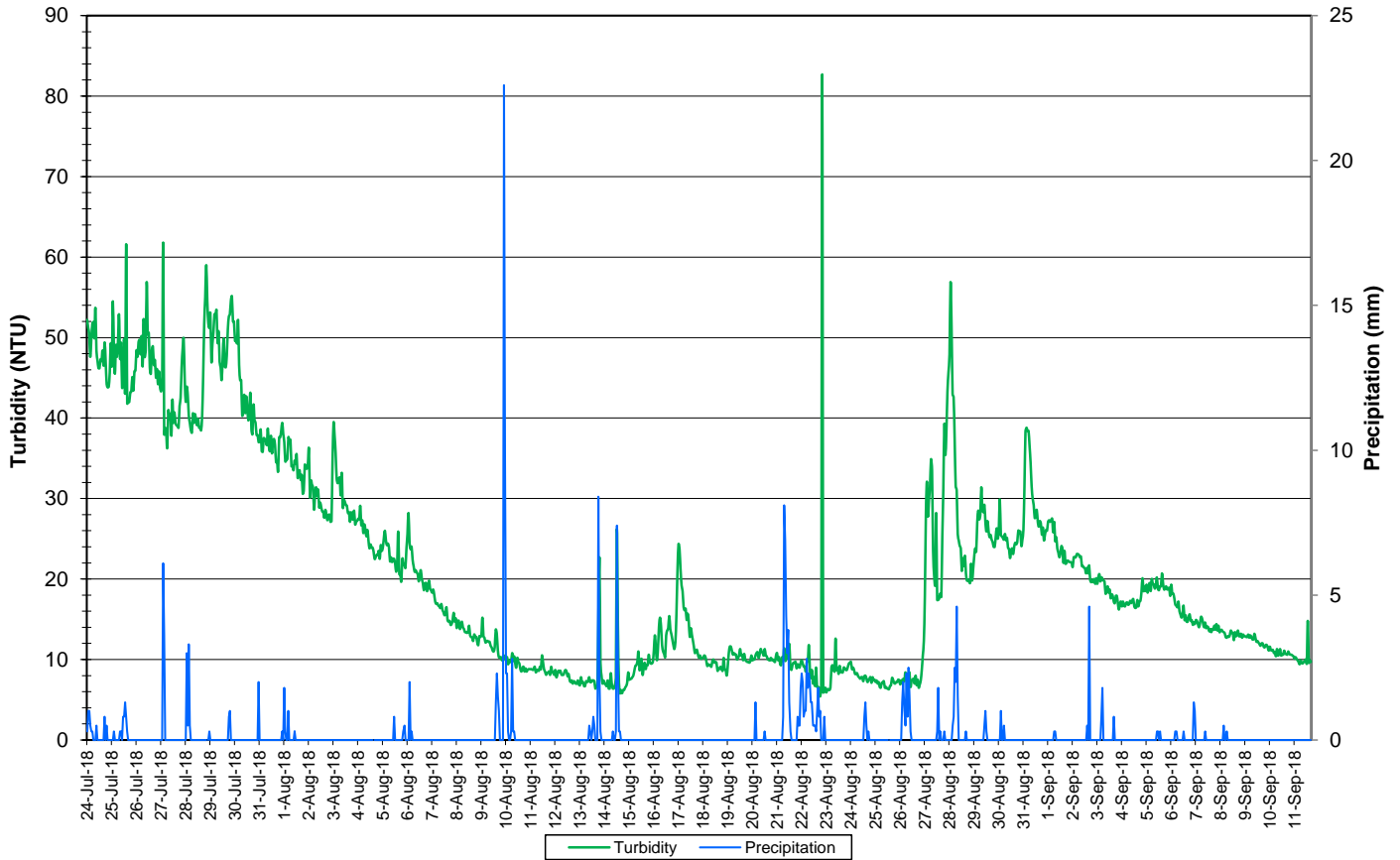


Figure 18: Dissolved oxygen – Pumphouse Stream

- Turbidity values range from 5.4 to 82.7 NTU throughout the deployment period (Figure 19). The median value was 16.6 NTU.
- In some instances, turbidity spikes can be attributed to precipitation events.

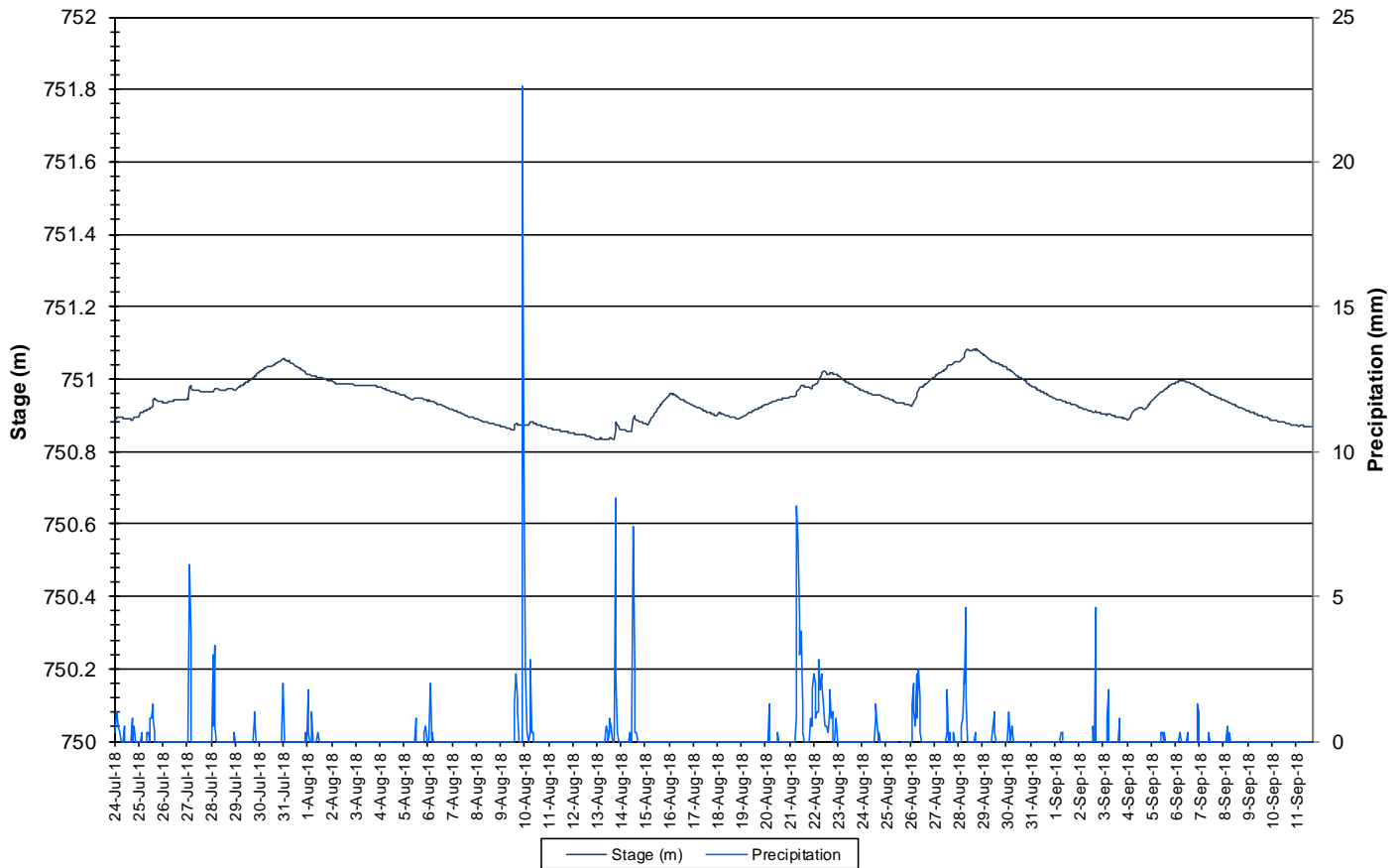
**Water Turbidity and Precipitation : Pumphouse Stream above Drum Lake
July 24 to September 12, 2018**



**Figure 19: Turbidity and precipitation – Pumphouse Stream
(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Pumphouse Stream (Figure 20).
- With the exception of water quantity data (Stage and Flow), 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.

**Stage and Precipitation: Pumphouse Stream above Drum Lake
July 24 to September 12, 2018**



**Figure 20: Stage and precipitation – Pumphouse Stream
(Weather data collected from climate station on TLH between Churchill Falls and Labrador City)**

Conclusions

- Instruments were deployed between July 23rd and 25th and removed by September 12th, 2018, with the exception of Julienne Narrows. There is a large portion of data missing from the Julienne Narrows station due to a power issue. This was rectified on August 17th.
- In most cases, precipitation events or increase/decreases in water level could be used to explain the data 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 air temperature at Julienne Narrows, Dolomite Road and Pumphouse Stream. The temperature typically ranged between 6.90 and 21.70°C, at these three stations, while Dumbell ranged lower at 2.39 to 7.03 °C.
- The majority of pH values were within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.34 and 8.24. Fluctuations were noted between day and night.
- Specific conductivity differed between the two Wabush Lake stations. This can be attributed to varying concentrations of iron ore tailings deposited between the stations. Specific conductivity ranged from 49.4 µs/cm to 104.0 µs/cm at the Wabush Lake stations, 59.6 to 71.8 µs/cm at Dumbell Stream and 112.0 to 156.0 µs/cm at Pumphouse Stream.
- At all four stations, all 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. When dissolved oxygen values are compared to the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/L, Dolomite Road and Pumphouse Stream were generally below the guideline while Julienne Narrows and Dumbell Stream were above the guideline.
- Turbidity at Dolomite Road fluctuated unusually during this deployment period. The median value was 0.0 NTU. Turbidity spikes at Julienne Narrows were higher than at Dolomite Road but less frequent.
- Turbidity at Dumbell Stream remained at 0.0 NTU for the entire development period with some spikes.
- Turbidity at Pumphouse Stream fluctuated throughout the deployment period with some high spikes. Some can be attributed to precipitation events. The median value was 16.6 NTU.
- Stage decreased at Dolomite Road and Julienne Narrows during the first half of the deployment period, and then increased. At Dumbell Stream, stage decreased overall, with small increases noted after precipitation events. At Pumphouse Stream, stage fluctuated and showed increases after precipitation events.
- With the exception of water quantity data (Stage and Flow), 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.

Appendix 1

Air Temperature and Precipitation: Labrador City, NL July 23 to September 12, 2018

