

# Real-Time Water Quality Deployment Report

Iron Ore Company of Canada  
Labrador West Network

September 12 to  
October 24, 2017



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 (EC), 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 8<sup>th</sup>, 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 12<sup>th</sup>, 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 September 12<sup>th</sup> and 13<sup>th</sup>, 2017, real-time water quality monitoring instruments were deployed at the four IOC stations. The instruments were deployed for periods of 40 days at Dolomite Road, and 41 days at Dumbell Stream, Pumphouse Stream, and Julienne Narrows. The instruments were removed on October 23<sup>rd</sup> and 24<sup>th</sup>. This was the third and final deployment for 2017.



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 September 12 and October 24, 2017 are summarized in Table 2.

Table 2: QA/QC comparison rankings for IOC stations between September 12 and October 24, 2017.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Dolomite Road	Sept 13, 2017	Deployment	Good	Excellent	Good	Good	Excellent
	Oct 23, 2017	Removal	Good	Good	Poor	Fair	Excellent
Julienne Narrows	Sept 12, 2017	Deployment	Good	Good	Fair	Excellent	N/A
	Oct 23, 2017	Removal	Fair	Fair	Good	Excellent	N/A
Dumbell Stream	Sept 13, 2017	Deployment	Good	Excellent	Fair	Poor	Excellent
	Oct 24, 2017	Removal	Good	Good	Excellent	Good	Excellent
Pumphouse Stream	Sept 13, 2017	Deployment	Excellent	Good	Good	Fair	Good
	Oct 24, 2017	Removal	Excellent	Good	Poor	Marginal	Excellent

▪ **Dolomite Road**

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

At removal, temperature, pH, and turbidity, ranked either ‘excellent’ or ‘good’. Conductivity ranked ‘poor’. The field instrument read a value of 39.2 µs/cm, while the QA/QC instrument read a value of 49.0 µs/cm. Dissolved oxygen ranked ‘fair’. The field instrument read a value of 11.34 mg/l, while the QA/QC instrument read a value of 11.85.

▪ **Julienne Narrows**

At deployment, temperature, pH, and dissolved oxygen ranked either ‘excellent’ or ‘good’. Conductivity ranked ‘fair’. The field instrument read a value of 109.2 µs/cm, while the QA/QC instrument read a value of 98.0 µs/cm. Turbidity could not be ranked due to the failure of the turbidity sensor on the QA/QC sonde.

At removal, conductivity and dissolved oxygen ranked ‘good’ and ‘excellent’, respectively. Temperature ranked ‘fair’. The field instrument read a value of 4.10°C, while the QA/QC instrument read a value of 4.66 °C. pH ranked ‘fair’. The field instrument read a value of 7.84, while the QA/QC instrument read a value of 7.25. Turbidity could not be ranked once again due to a failure of the sensor on the QA/QC sonde.

▪ **Dumbell Stream**

At deployment, temperature, pH and turbidity ranked either ‘good’ or ‘excellent’. Conductivity ranked ‘fair’. The field instrument read a value of 74.0 µs/cm, while the QA/QC instrument read a value of 65.0 µs/cm. Dissolved oxygen ranked ‘poor’. The field instrument read a value of 11.27 mg/l, while the QA/QC instrument read a value of 11.7 mg/l.

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

▪ **Pumphouse Stream**

At deployment, all parameters except dissolved oxygen ranked either ‘excellent’ or ‘good’. Dissolved oxygen ranked ‘fair’. The field instrument read a value of 10.00 mg/l, while the QA/QC instrument read a value of 9.35 mg/l.

At removal, temperature, pH, and turbidity ranked either 'excellent' or 'good'. Conductivity was ranked 'poor'. The field instrument read a value of 50.9  $\mu\text{s}/\text{cm}$ , while the QA/QC instrument read a value of 66.3  $\mu\text{s}/\text{cm}$ . Dissolved Oxygen ranked 'marginal'. The field instrument read a value of 13.12 mg/l, while the QA/QC instrument read a value of 12.12 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.

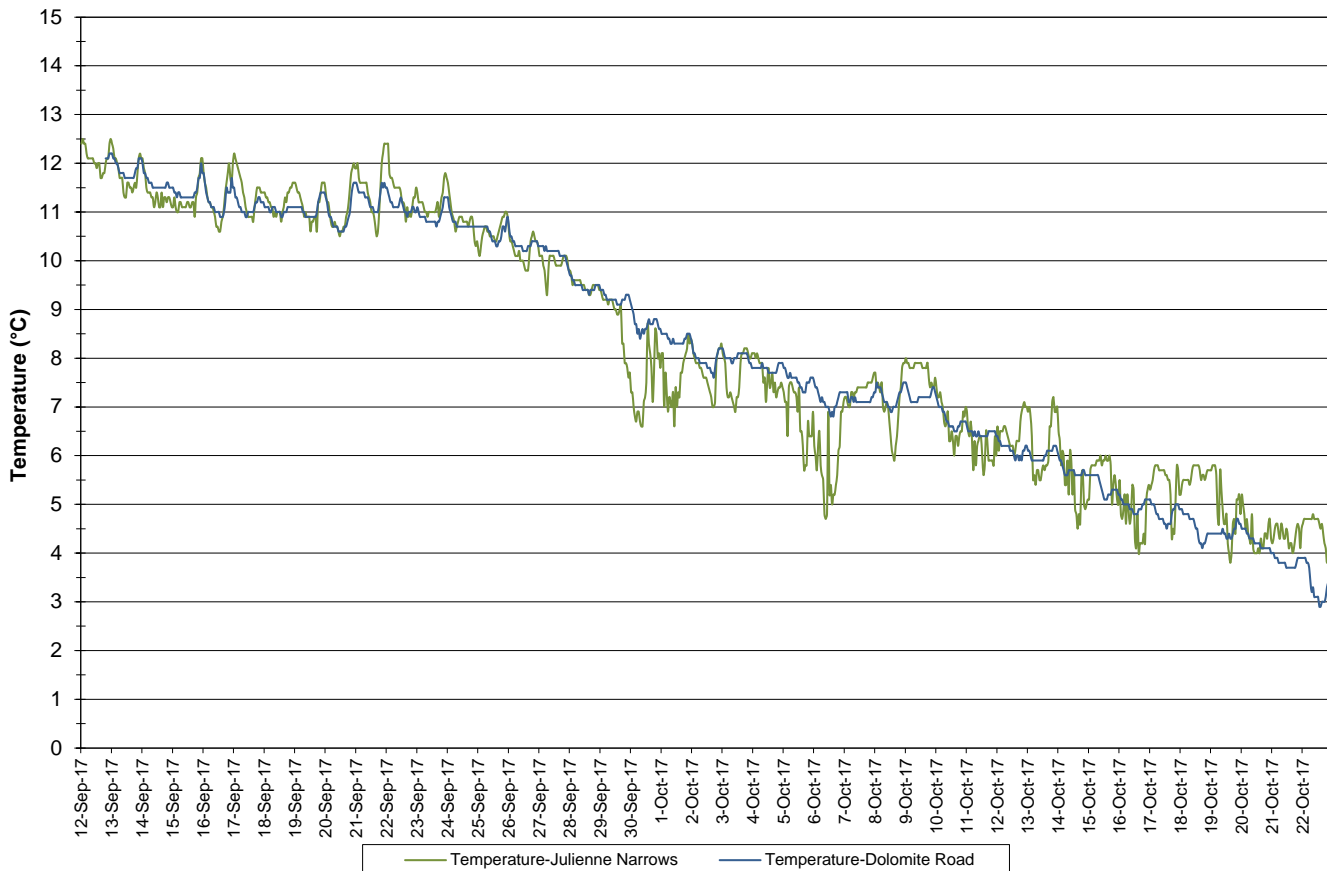
## Data Interpretation

- The following graphs and discussion illustrate water quality-related events from September 12, 2017 to October 24, 2017 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.

### Wabush Lake Network

- Water temperature ranged from 2.90 to 12.20°C at Dolomite Road and 3.80 to 12.40°C at Julienne Narrows during this deployment period (Figure 2). Water temperature fluctuated within similar ranges at each of these stations.

**Water Temperature: Wabush Lake Network  
September 12 to October 23, 2017**

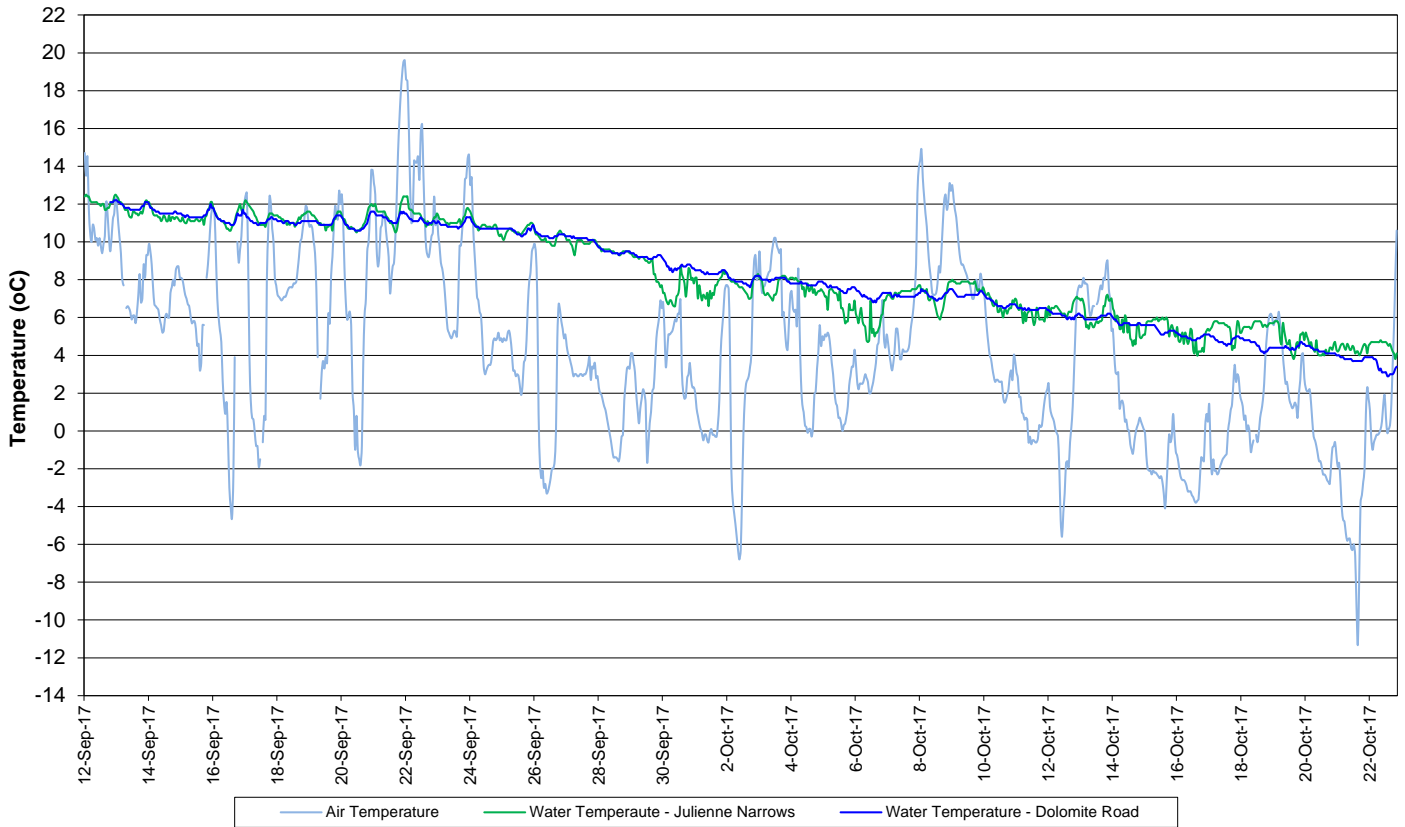


**Figure 2: Water temperature - Wabush Lake network**



- Water temperature decreased during the later portion of the deployment period, which corresponds with decreasing ambient air temperature at this time (Figure 3).

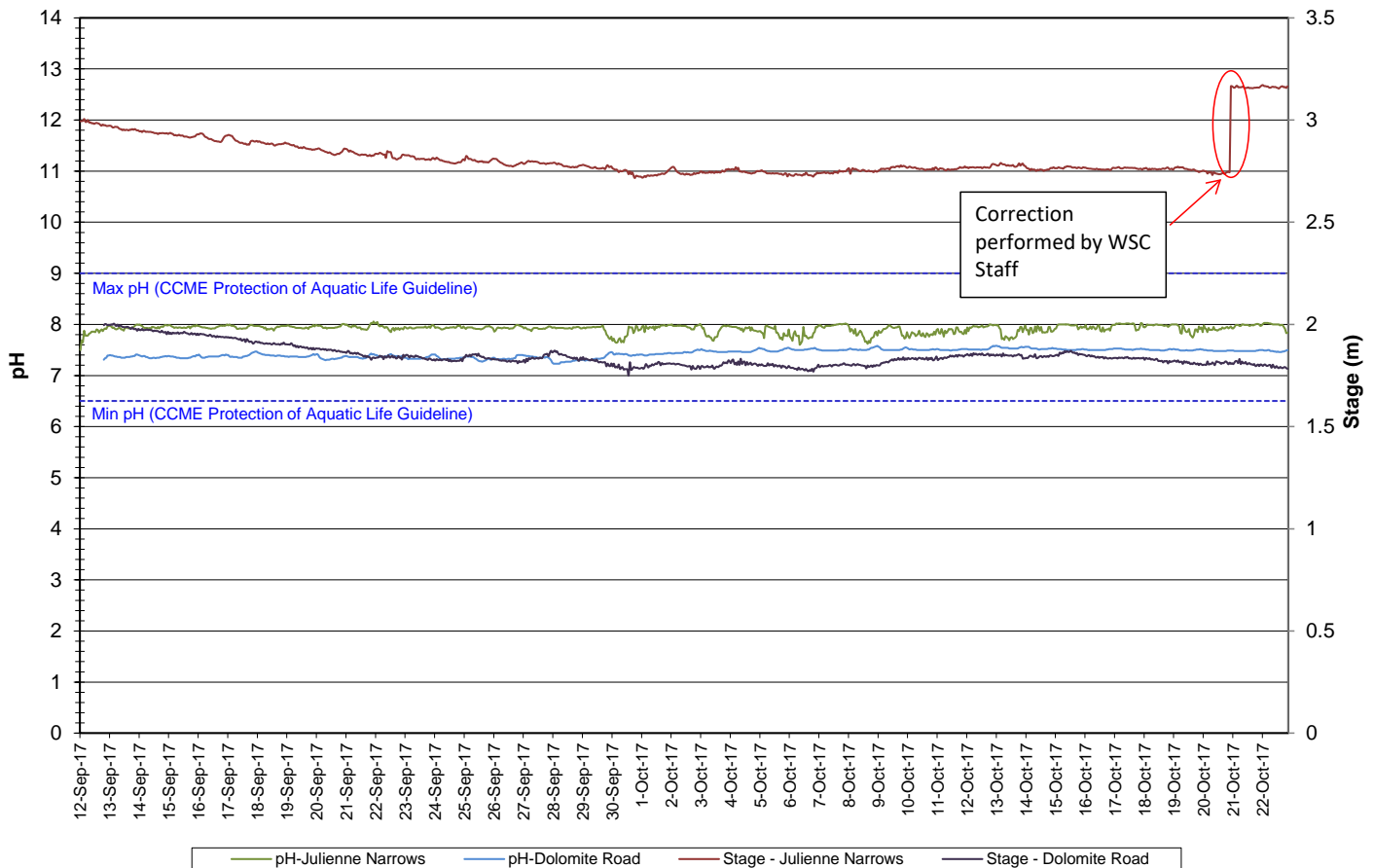
**Air and Water Temperature: Wabush Lake Network  
September 12 to October 23, 2017**



**Figure 3: Daily air and water temperatures – Wabush Lake network**

- pH ranges from 7.23 to 7.58 pH units at Dolomite Road, and from 7.60 to 8.06 pH units at Julienne Narrows throughout the deployment period (Figure 4). The median pH is 7.46 and 7.94 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.
- An increase in stage is noticeable at Julienne Narrows on the 21<sup>st</sup> of October due to a correction performed by WSC staff to the equipment.
- 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.

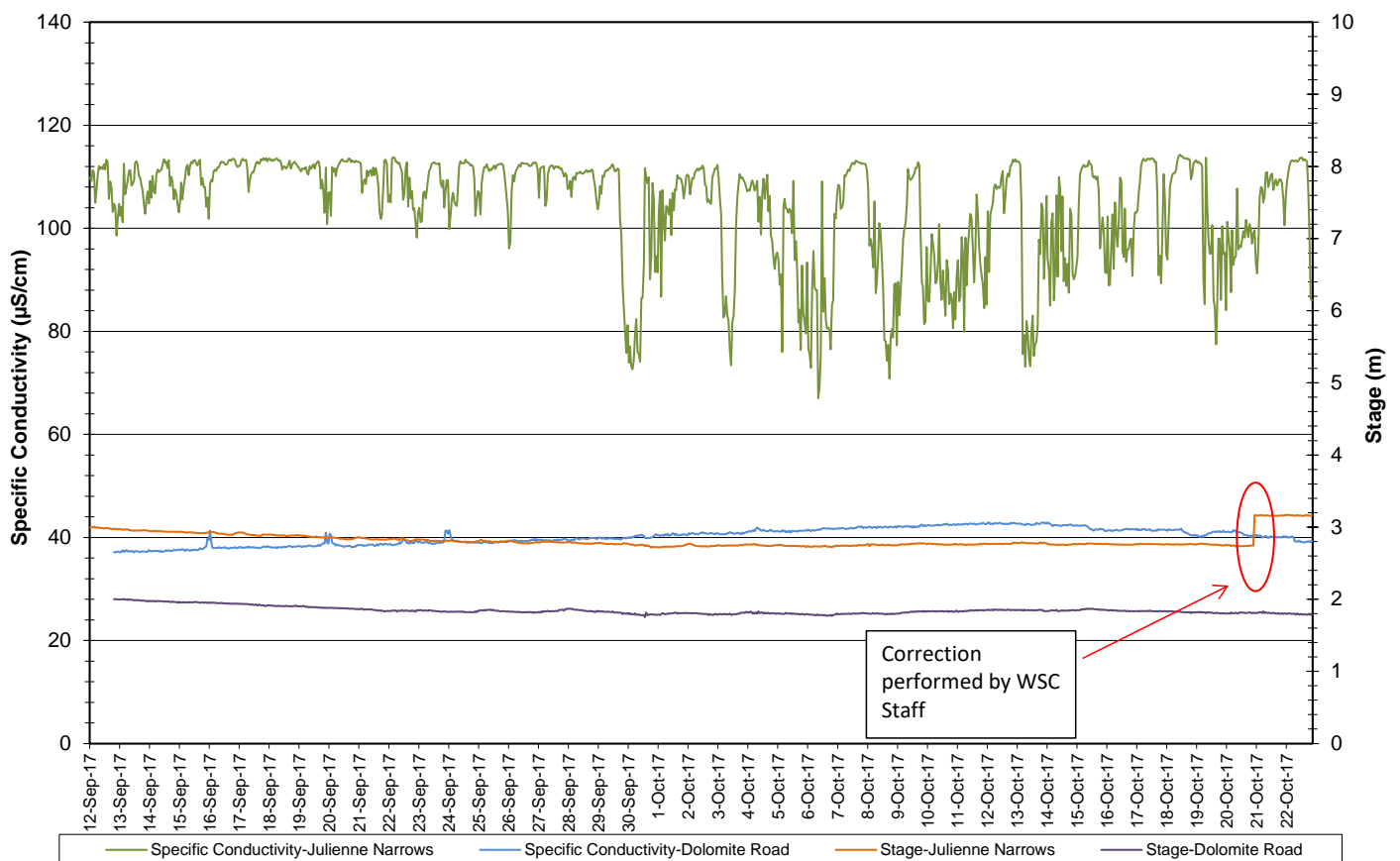
**Water pH : Wabush Lake Network  
September 12 to October 23, 2017**



**Figure 4: pH – Wabush Lake network**

- Specific conductivity ranged from 37.1 to 42.9  $\mu\text{S}/\text{cm}$  at Dolomite Road and from 67.0 to 114.3  $\mu\text{S}/\text{cm}$  at Julienne Narrows throughout the deployment period (Figure 5).
- 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.
- 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.

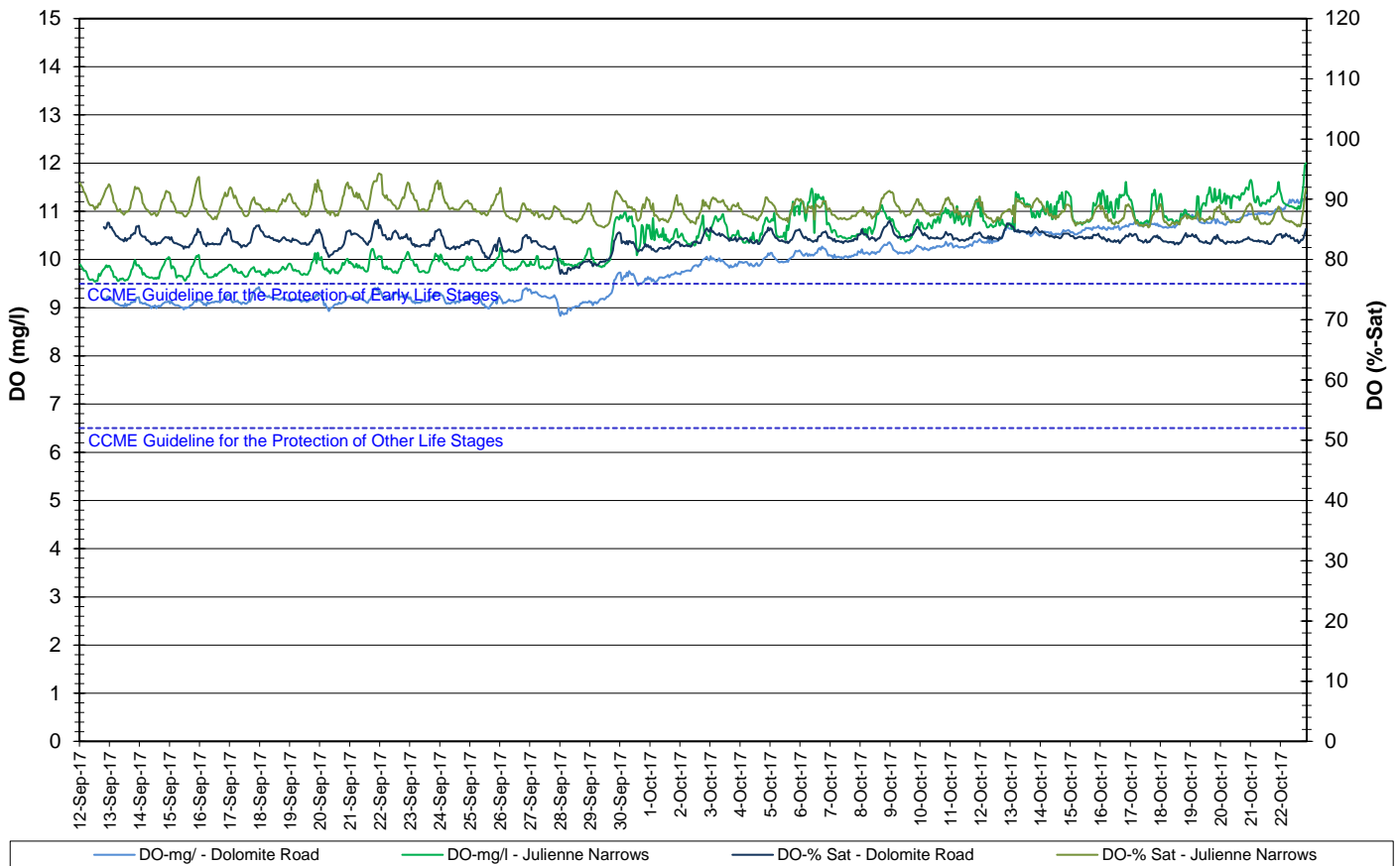
**Specific Conductivity and Stage: Wabush Lake Network  
September 12 to October 23, 2017**



**Figure 5: Specific conductivity – Wabush Lake network**

- At the Dolomite Road station, the saturation of dissolved oxygen ranged from 77.6 to 86.6% while the dissolved oxygen content ranged from 8.83 to 11.34 mg/l with a median value of 9.87 mg/l (Figure 6).
- At the Julienne Narrows station, the saturation of dissolved oxygen ranged from 85.3 to 94.3% while the dissolved oxygen content ranged from 9.64 to 12.00 mg/l with a median value of 10.62 mg/l (Figure 6).
- 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.
- All 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 above the guideline. The guidelines are indicated in blue on Figure 6.
- Dissolved oxygen increased slightly at both stations towards the end of this deployment period, as water temperature cooled into fall. Dissolved oxygen fluctuated daily with decreases observed at night.

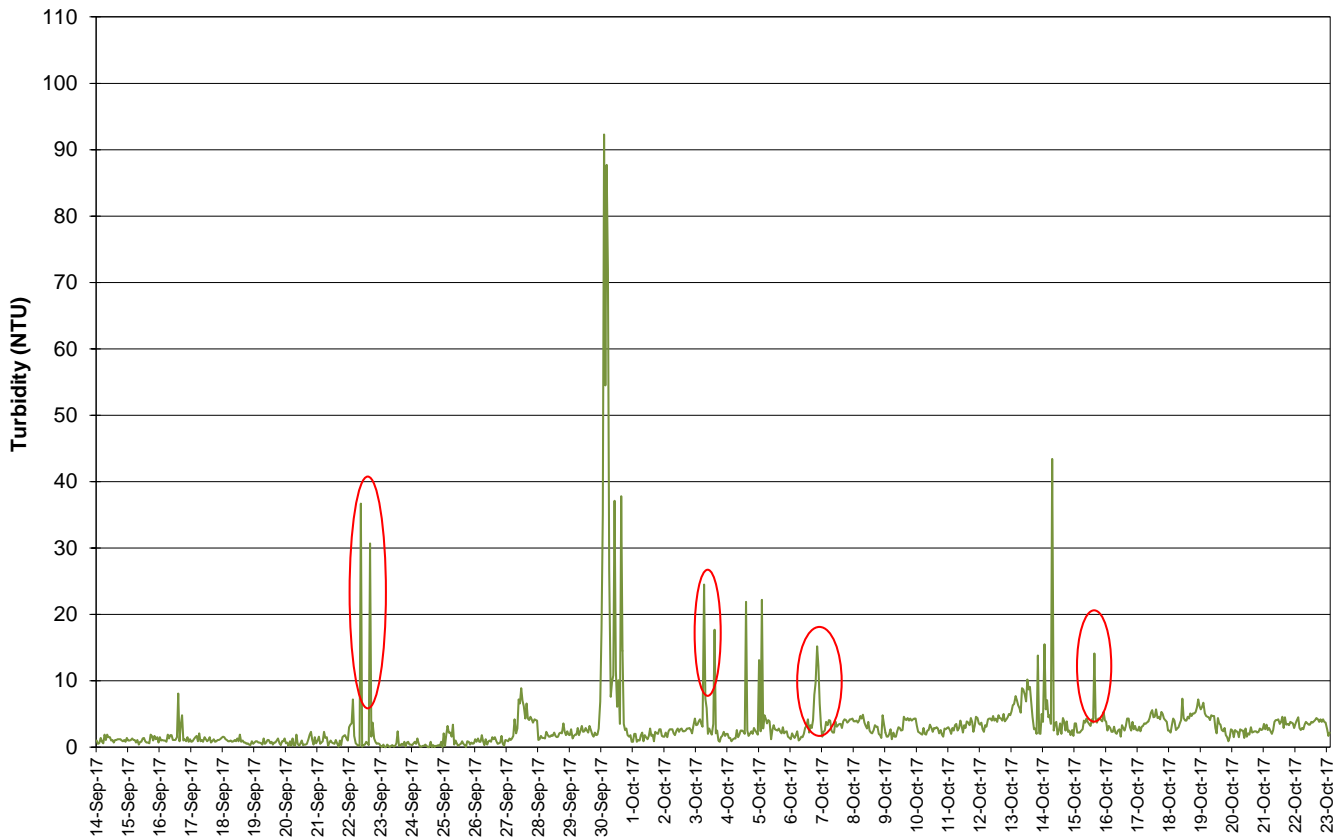
**Dissolved Oxygen : Wabush Lake Network  
September 12 to October 23, 2017**



**Figure 6: Dissolved oxygen and percent saturation – Wabush Lake Network**

- At the Julienne Narrows station, turbidity values range from 0.0 to 92.3 NTU throughout the deployment period (Figure 7). The median value was 2.5 NTU.
- In some instances, turbidity spikes can be attributed to precipitation events. They are indicated on Figure 7 in red.

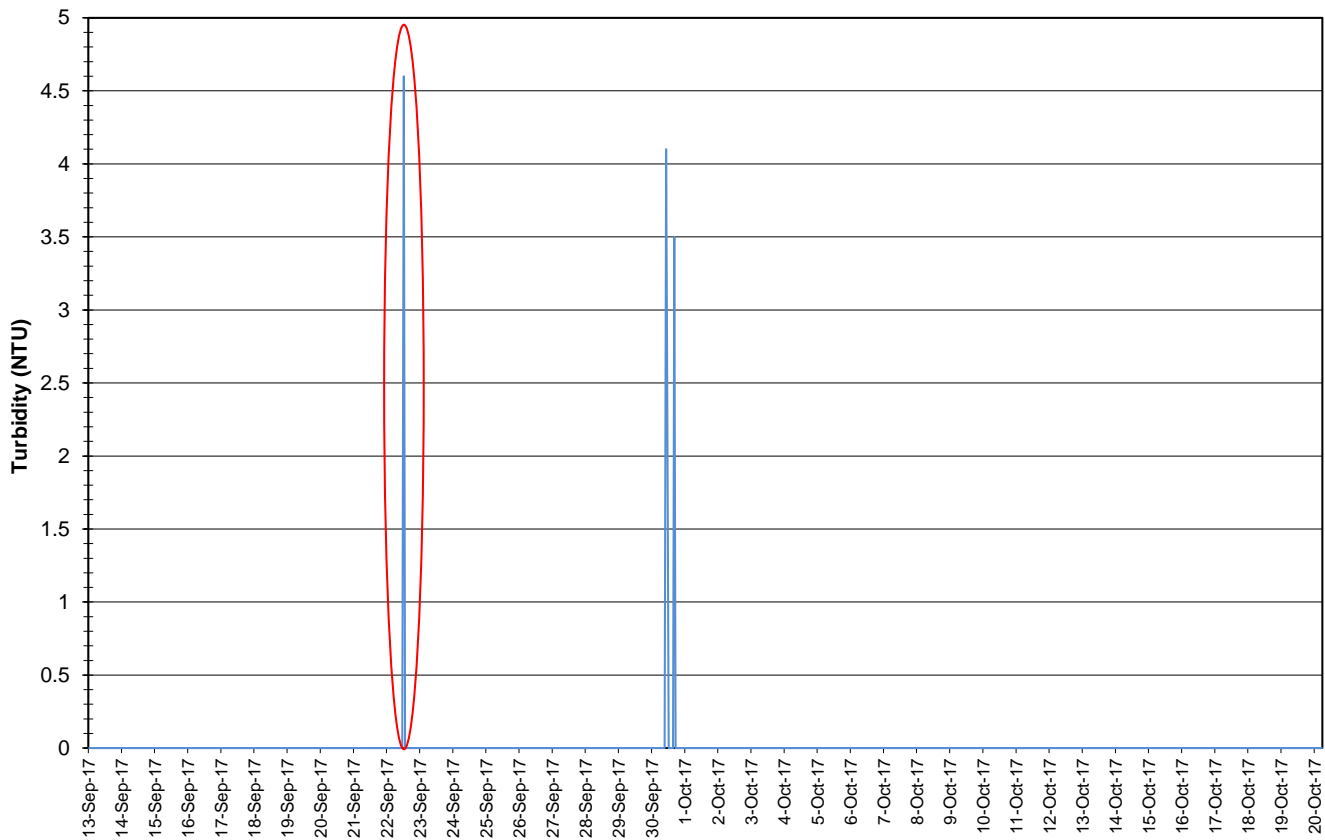
**Water Turbidity: Julienne Narrows  
September 12 to October 23, 2017**



**Figure 7: Turbidity – Julienne Narrows**

- At the Dolomite Road station, turbidity values ranged from 0.0 NTU to 4.6 NTU, throughout the deployment period (Figure 8).
- In one instance, a turbidity spike can be attributed to precipitation events. It is indicated on Figure 8 in red.

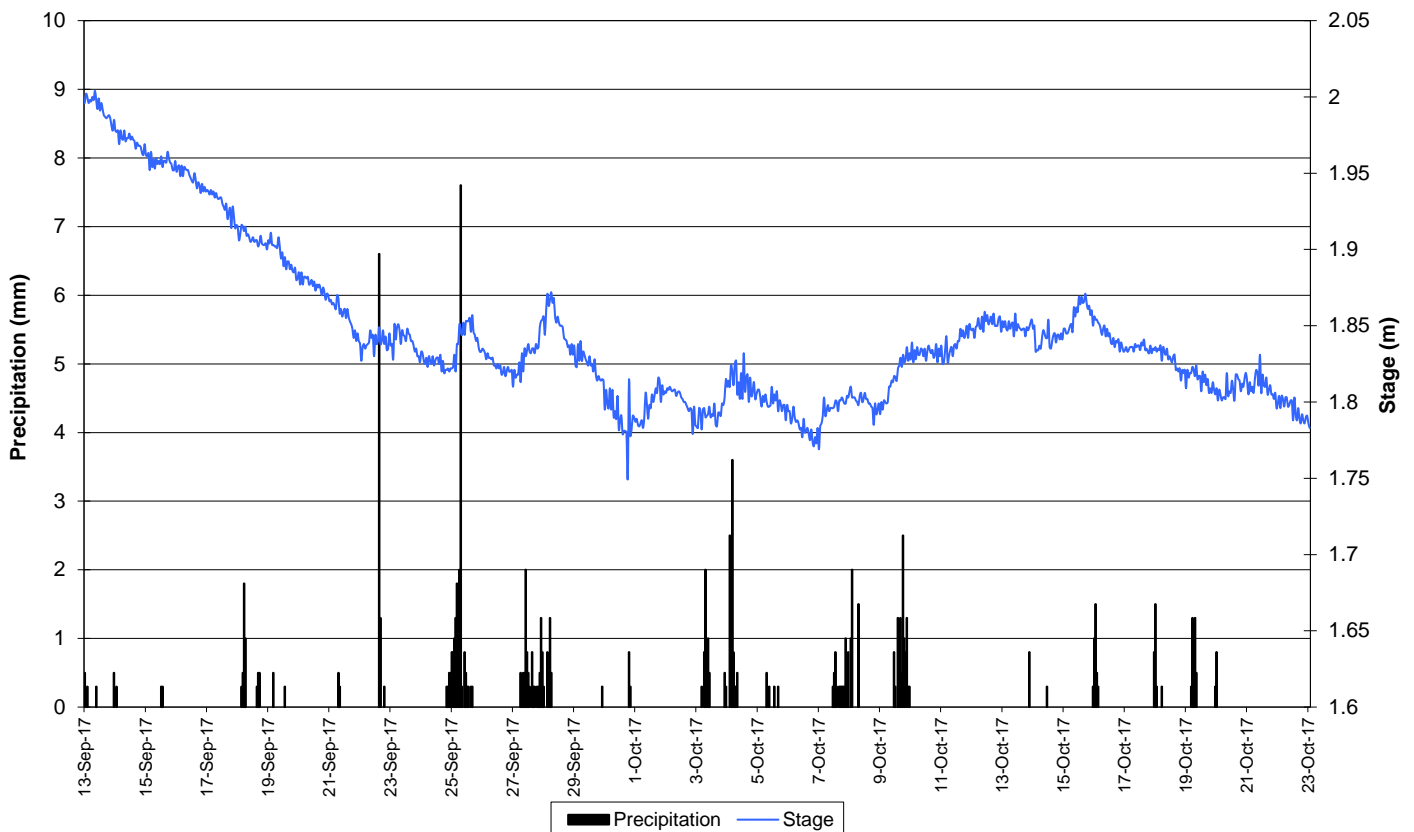
**Turbidity : Dolomite Road  
September 13 to October 23, 2017**



**Figure 8: Turbidity – Dolomite Road**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Dolomite Road (Figure 9).
- Stage decreases during the first portion of the deployment period with precipitation events causing periodic increases in stage. Stage increases slightly during the last few weeks of deployment.
- 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.

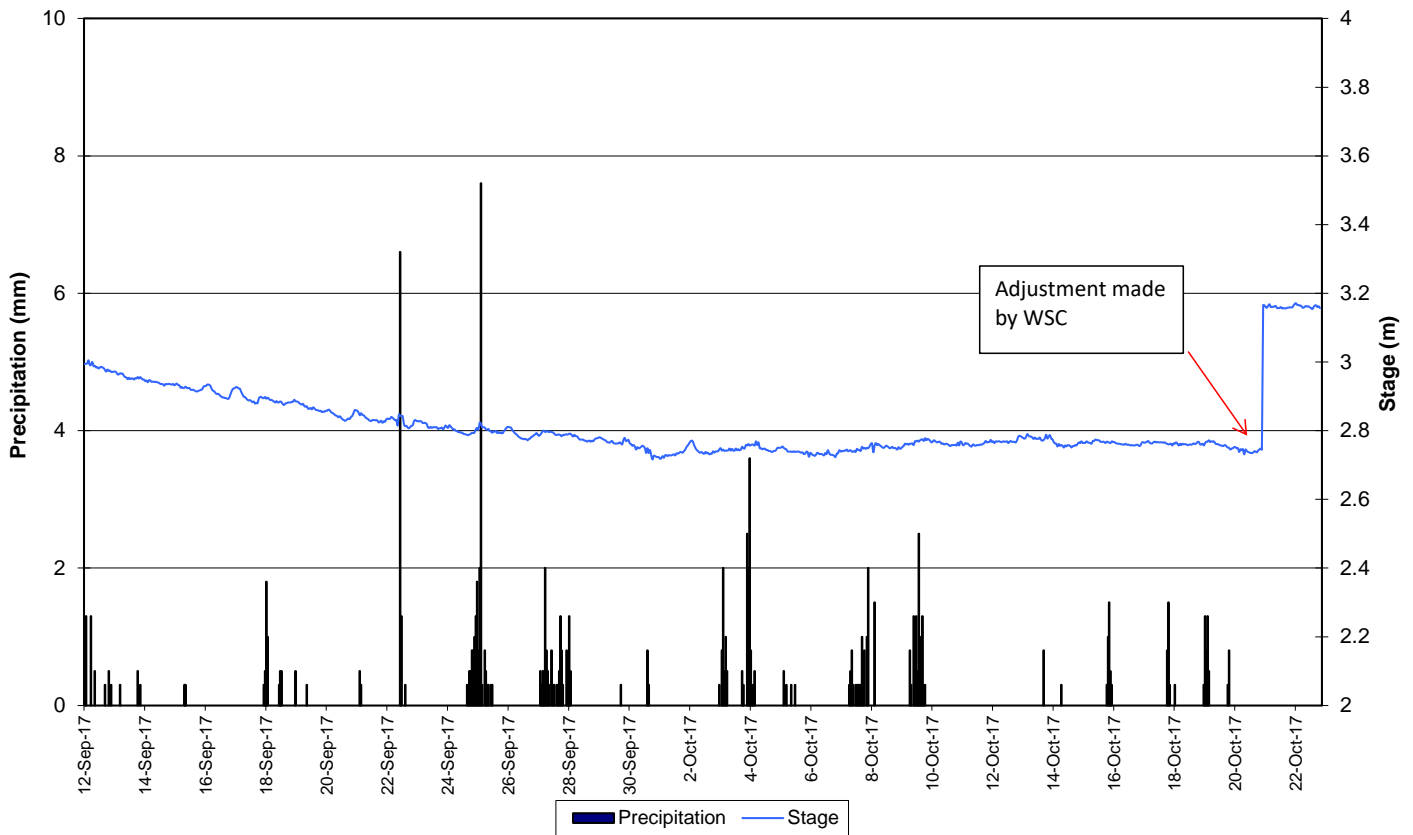
**Precipitation and Stage: Dolomite Road  
September 13 to October 23, 2017**



**Figure 9: Precipitation and Stage –Dolomite Road**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Julienne Narrows (Figure 10).
- Stage gradually decreases throughout this deployment period.
- There was a correction in stage by EC at the end of October. It is identified on Figure 10.
- 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.

**Precipitation and Stage : Julienne Narrows  
September 12 to October 23, 2017**



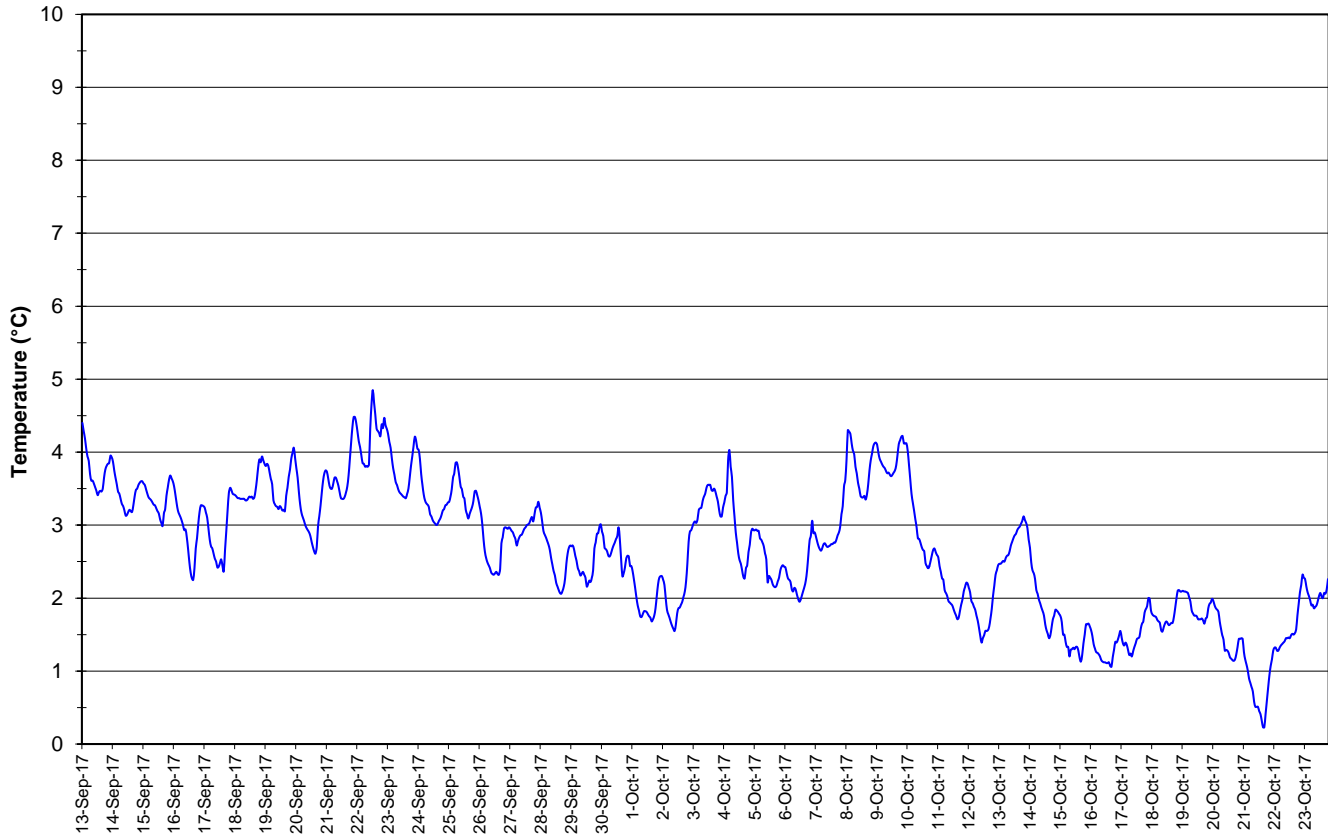
**Figure 10: Precipitation and Stage –Julienne Narrows**



**Dumbell Stream**

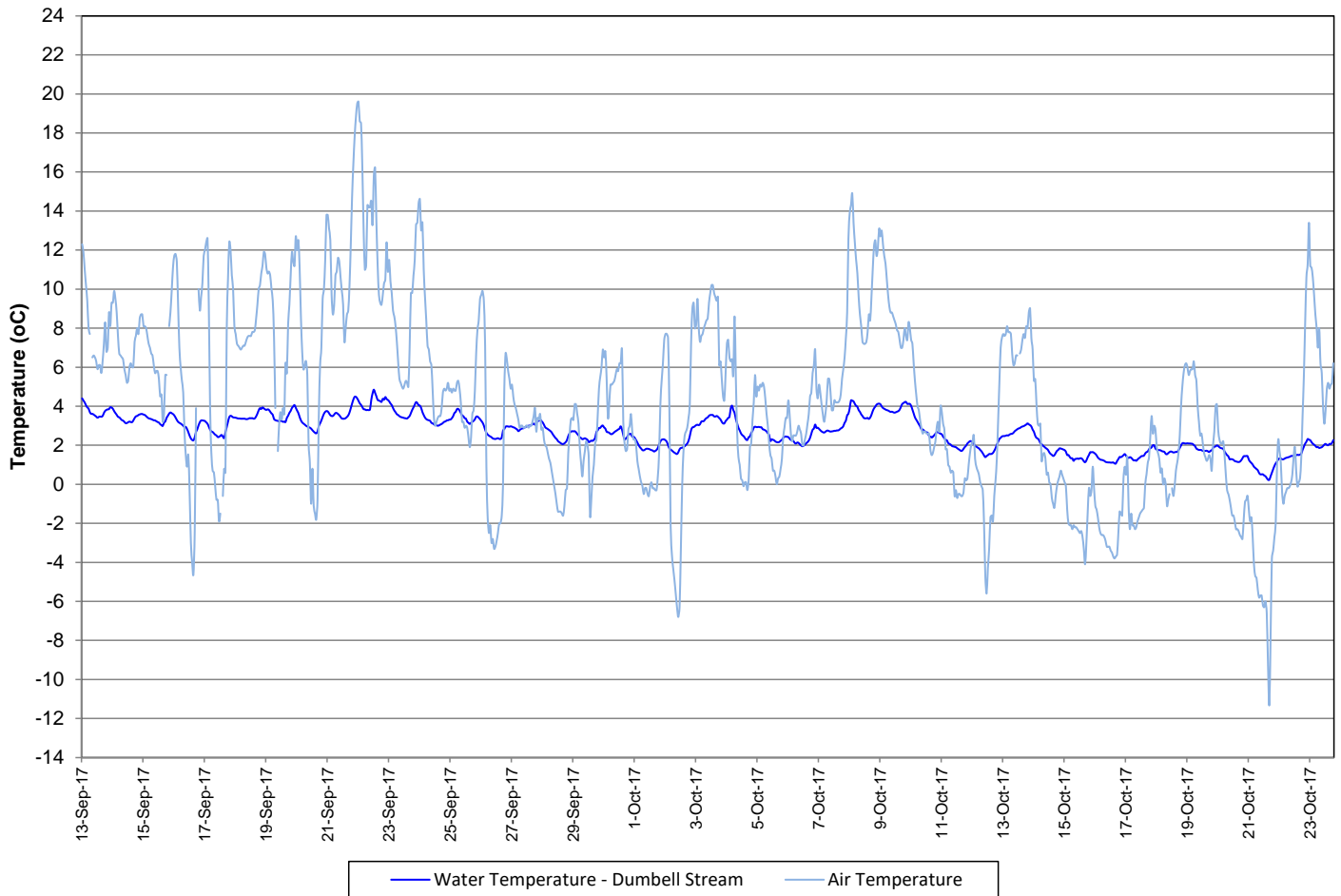
- Water temperature ranged from 0.23 to 4.85°C during this deployment period (Figure 11).
- Water temperature generally fluctuated within this range for the deployment period. This area is very shaded. Temperature decreased overall, following the decreasing trend of air temperature into the fall season (Figure 12).

**Water Temperature : Dumbell Stream above Dumbell Lake  
September 13 to October 24, 2017**



**Figure 11: Water Temperature – Dumbell Stream**

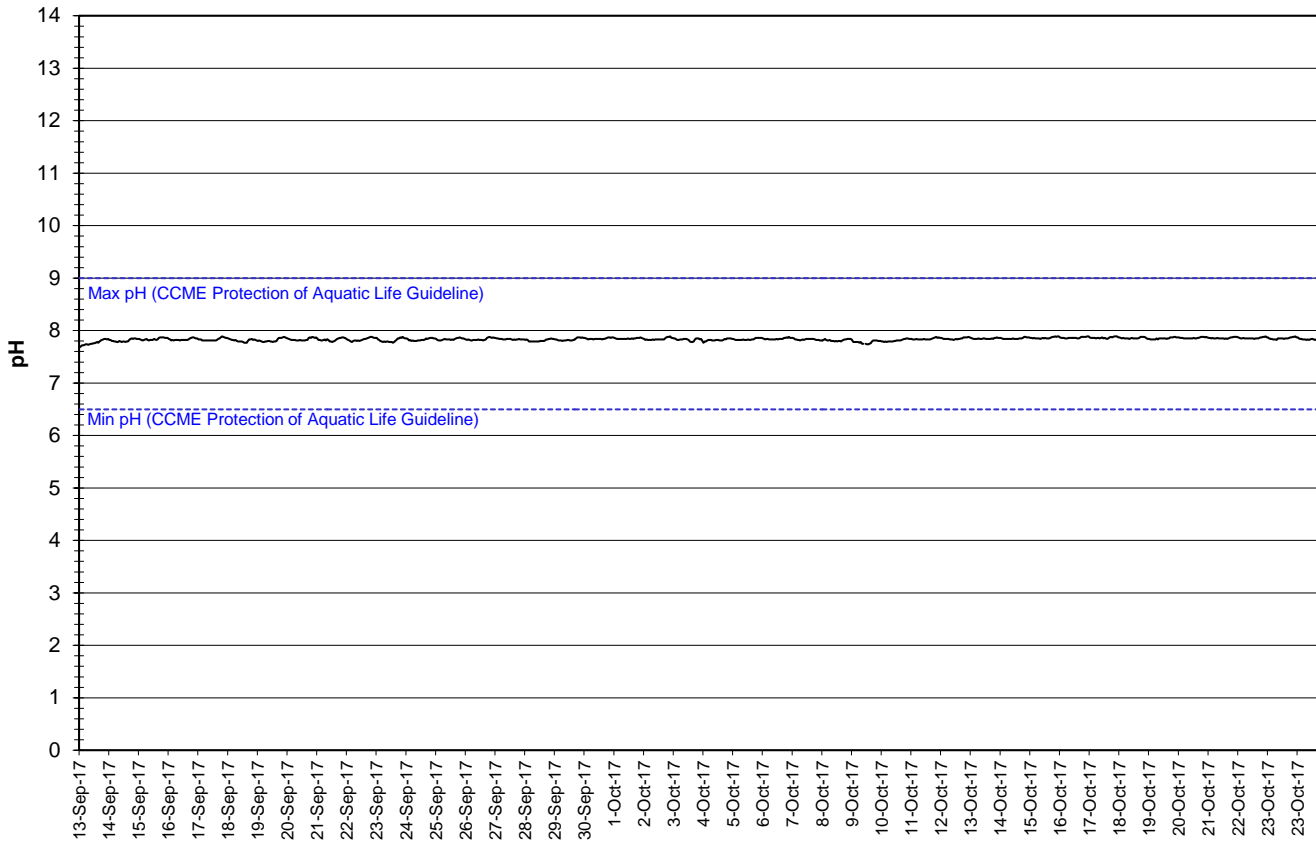
**Air and Water Temperature: Dumbell Stream  
September 13 to October 24, 2017**



**Figure 12: Daily air and water temperatures – Dumbell Stream**

- pH ranged from 7.68 to 7.89 pH units (Figure 13). The median pH was 7.84.
- 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.

**Water pH : Dumbell Stream above Dumbell Lake  
September 13 to October 24, 2017**



**Figure 13: Water pH – Dumbell Stream**

- Specific conductivity ranged from 69.0 to 75.4  $\mu\text{S}/\text{cm}$ , 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 14.
- 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 Level : Dumbell Stream above Dumbell Lake  
September 13 to October 24, 2017

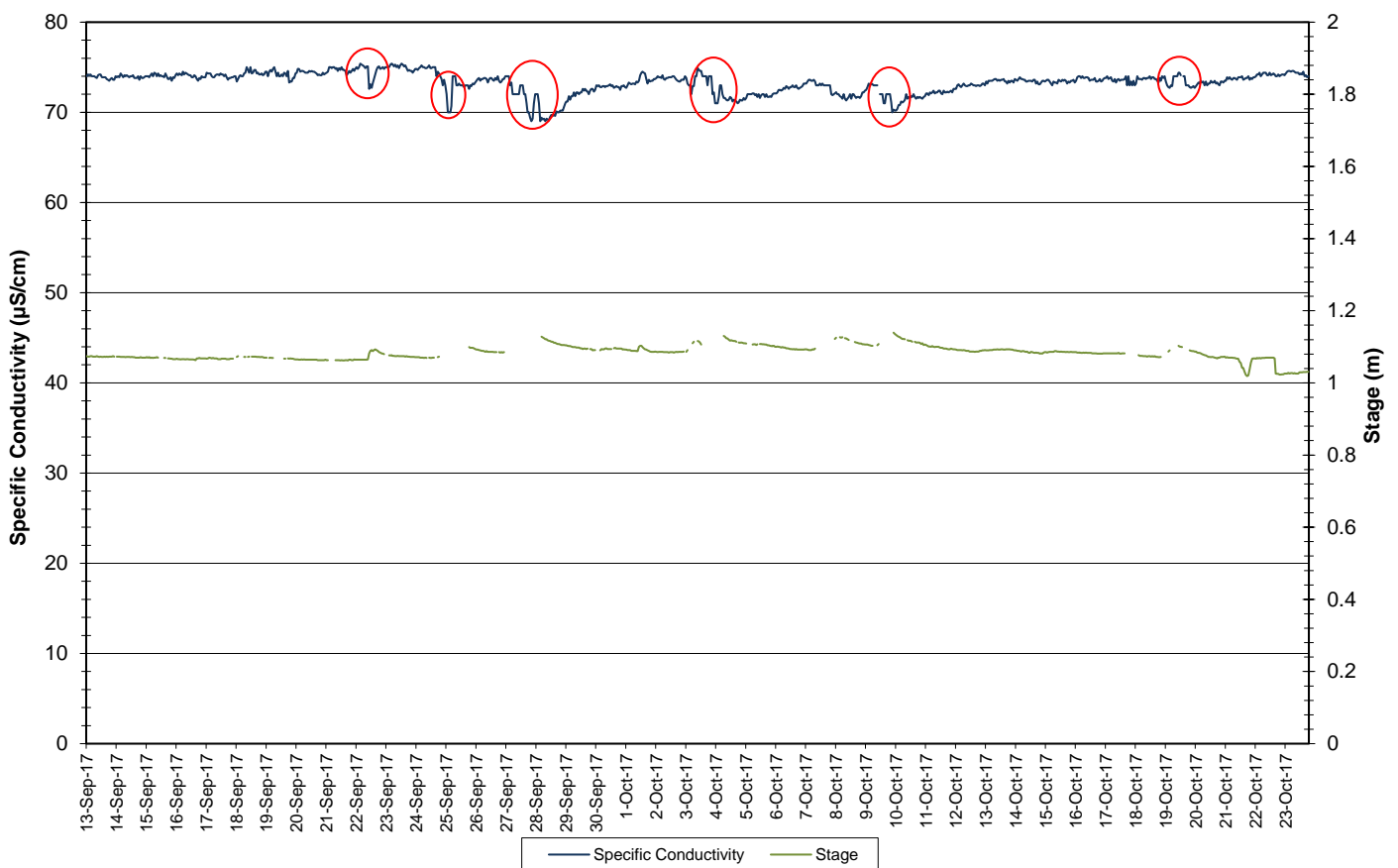
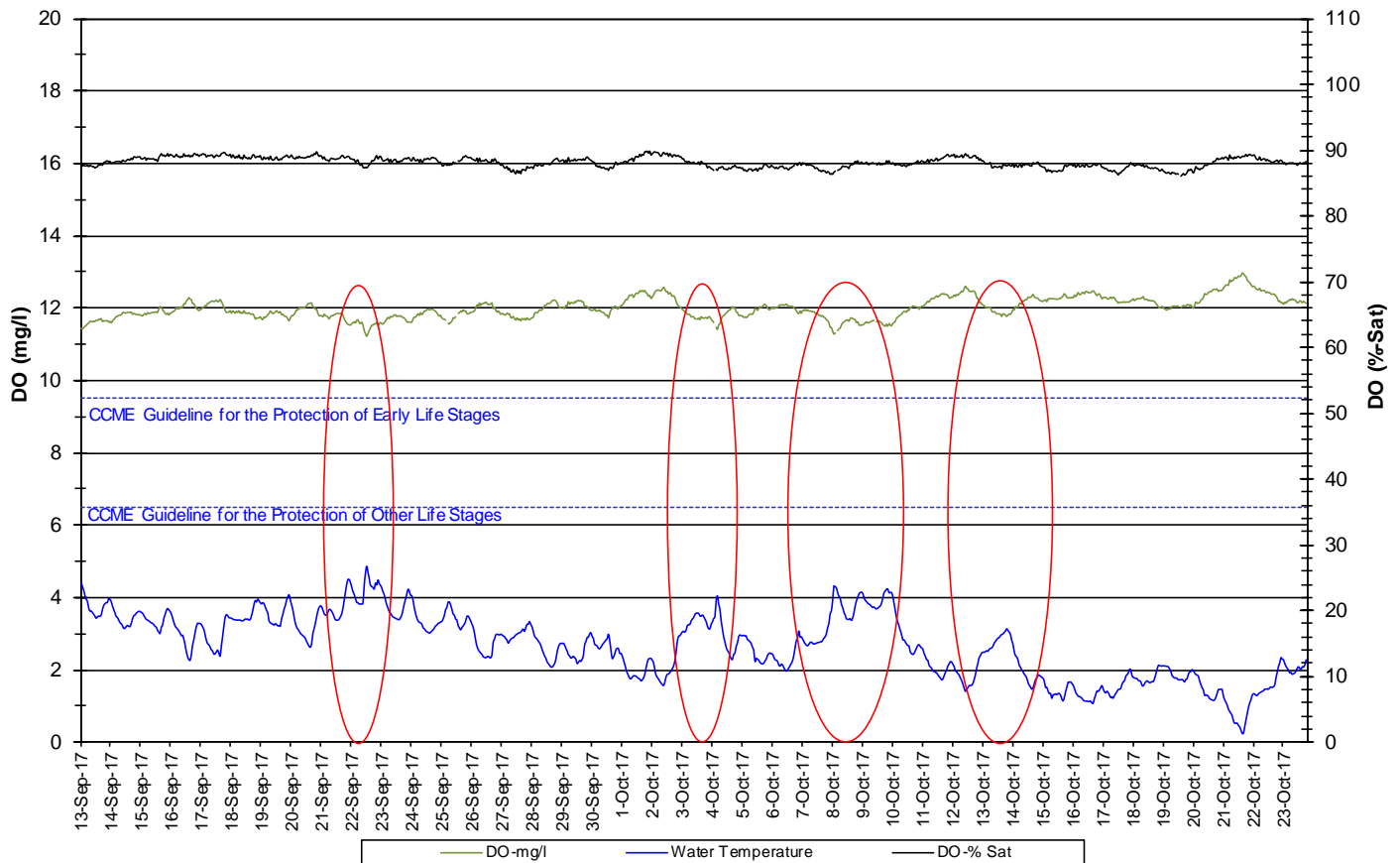


Figure 14: Specific Conductivity – Dumbell Stream

- The saturation of dissolved oxygen ranged from 86.0 to 89.9% while the dissolved oxygen content ranged from 11.21 to 12.96 mg/l with a median value of 11.98 mg/l (Figure 15).
- 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 15.
- Noticeable decreases in dissolved oxygen correspond with rises in temperature at the same time. They are indicated on Figure 15 in red.
- Dissolved oxygen fluctuated daily with decreases observed at night.

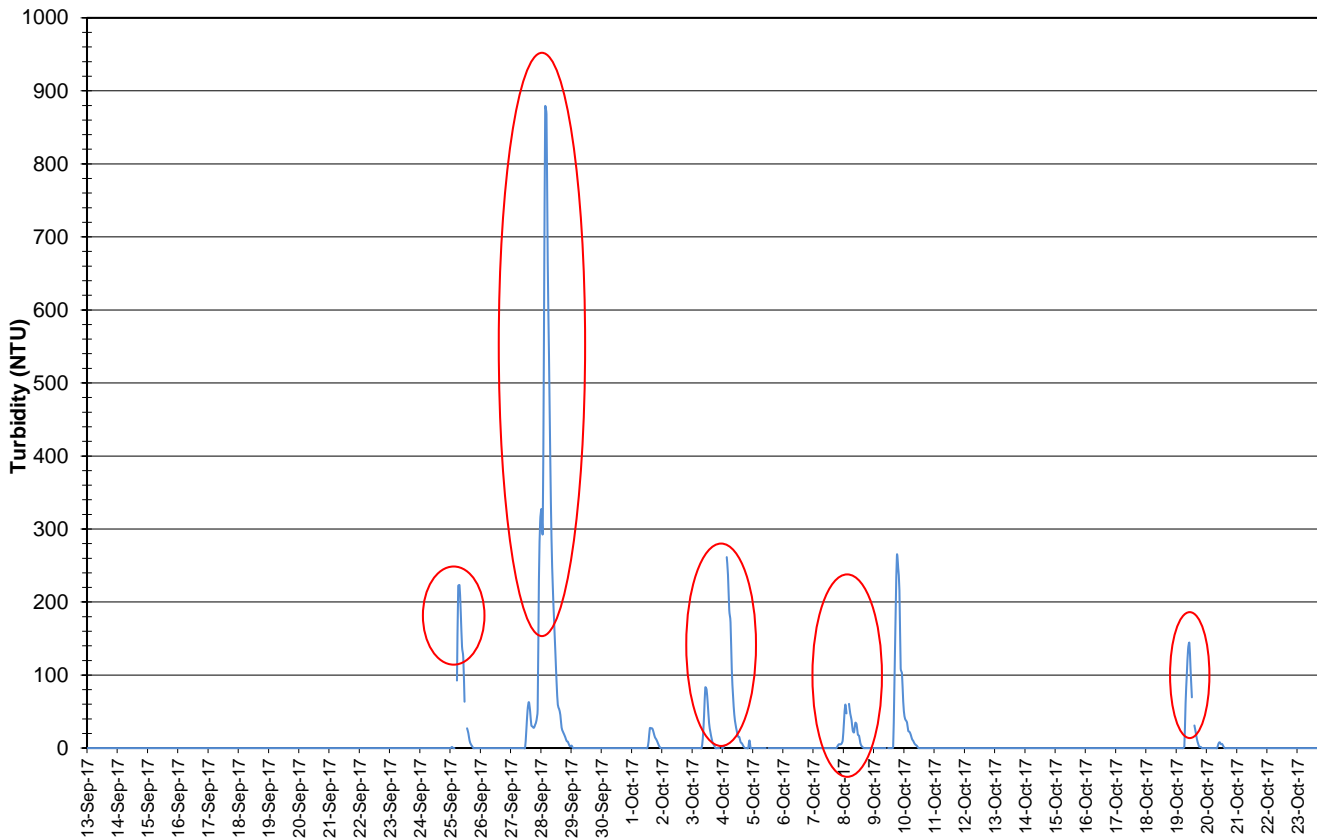
**Dissolved Oxygen Concentration and Saturation : Dumbell Stream at Dumbell Lake  
September 13 to October 24, 2017**



**Figure 15: Dissolved Oxygen – Dumbell Stream**

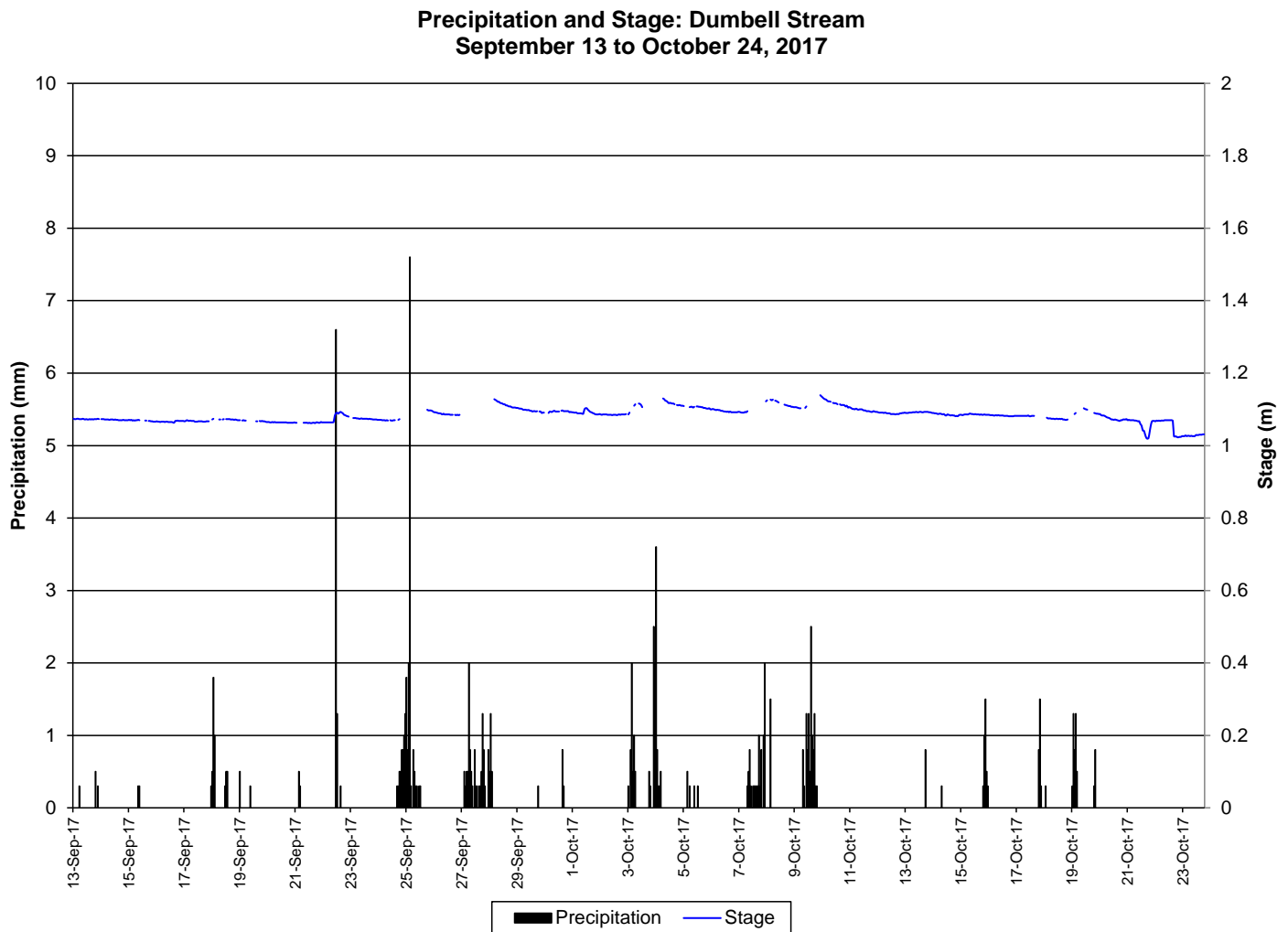
- Turbidity values range from 0.0 to 878.0 NTU throughout the deployment period (Figure 16). The median value was 0.0 NTU.
- In some instances, turbidity spikes can be attributed to precipitation events. They are indicated on the Figure 16 in red.

**Water Turbidity : Dumbell Stream above Dumbell Lake  
September 13 to October 24, 2017**



**Figure 16: Turbidity – Dumbell Stream**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Dumbell Stream (Figure 17).
- Overall, stage is relatively stable 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.

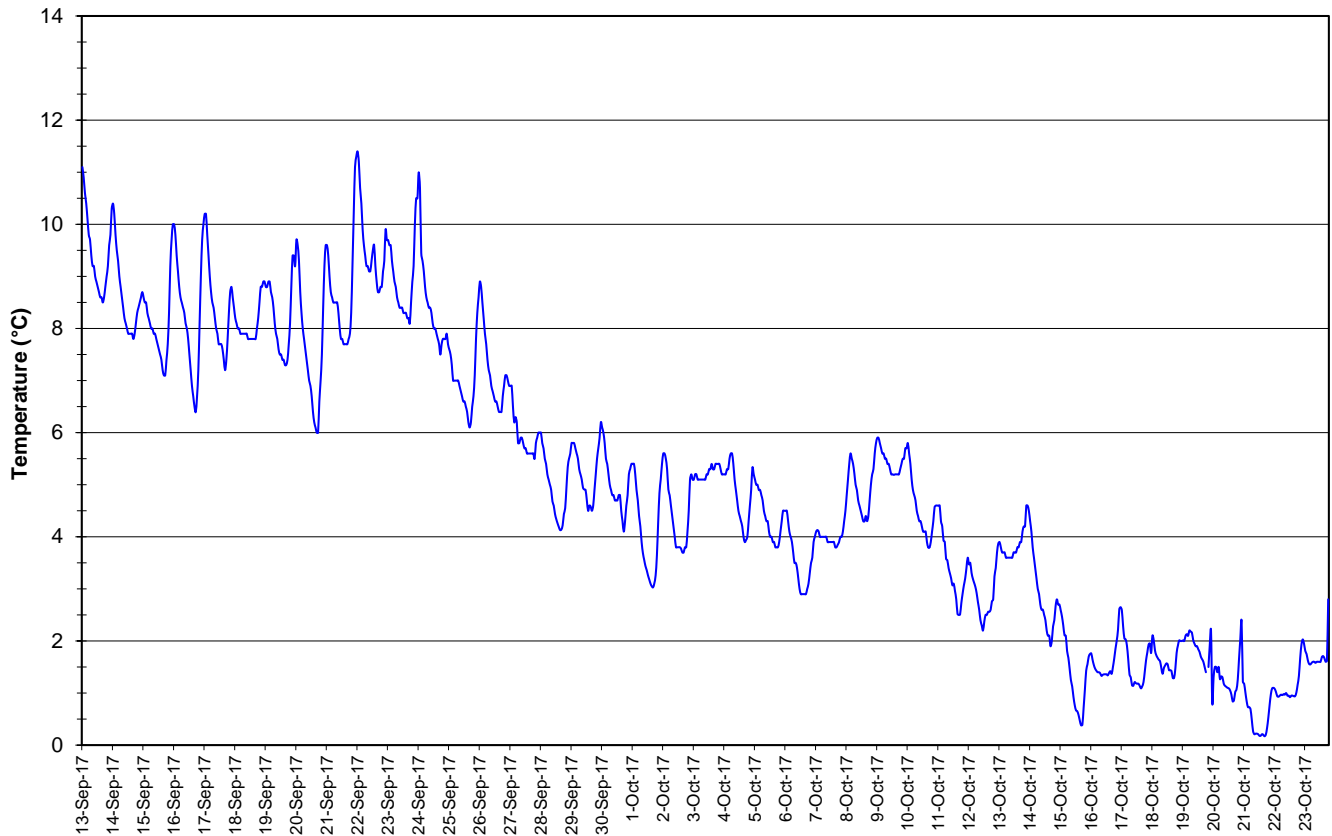


**Figure 17: Precipitation and Stage –Dumbell Stream**

### Pumphouse Stream

- Water temperature ranged from 0.17 to 11.4°C during this deployment period (Figure 18).
- Water temperature decreased over the course of this deployment period, corresponding to decreasing ambient air temperatures into fall (Figure 19).

**Water Temperature : Pumphouse Stream above Drum Lake  
September 13 to October 24, 2017**



**Figure 18: Water Temperature – Pumphouse Stream**



### Air and Water Temperature: Pumphouse Stream September 13 to October 24, 2017

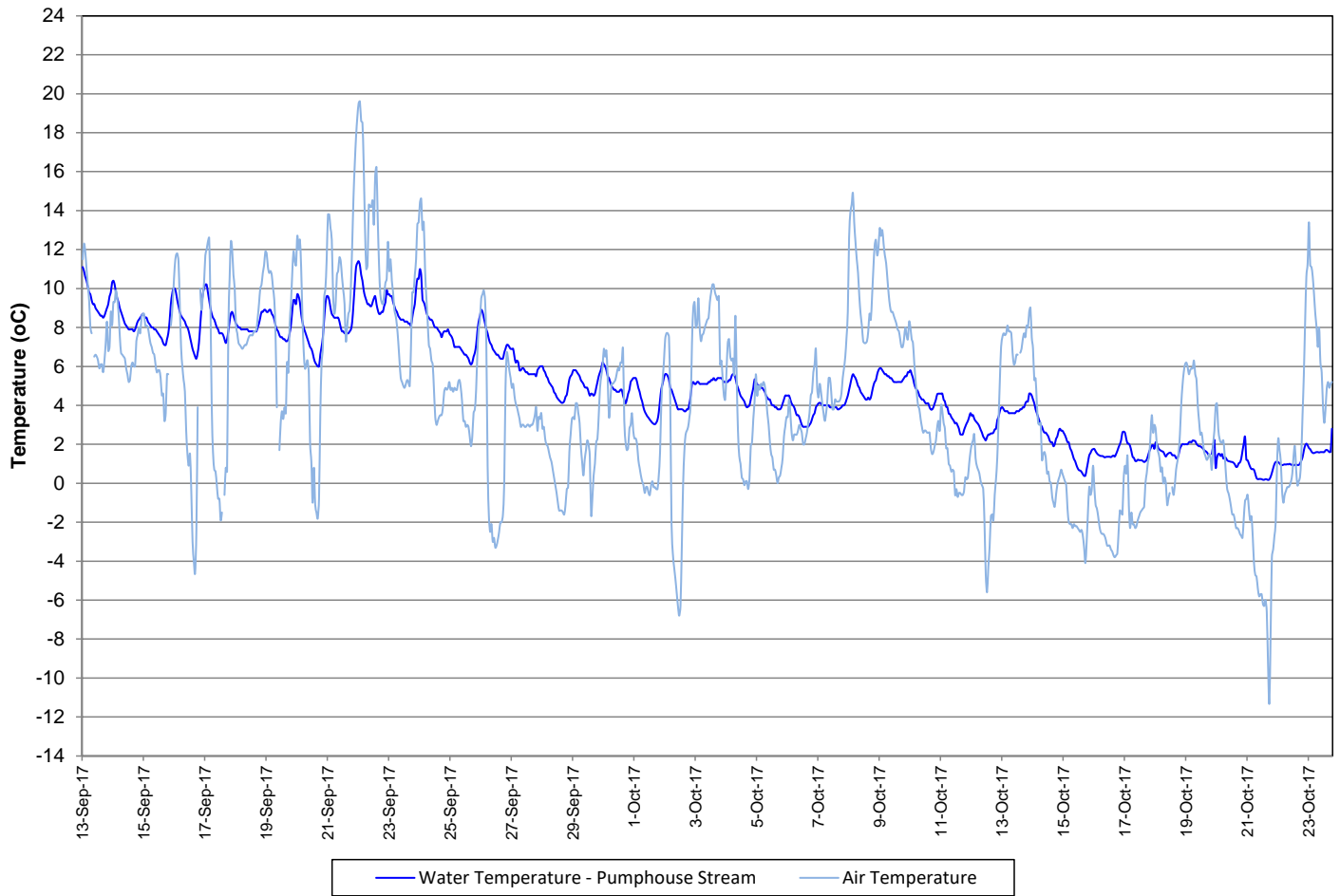
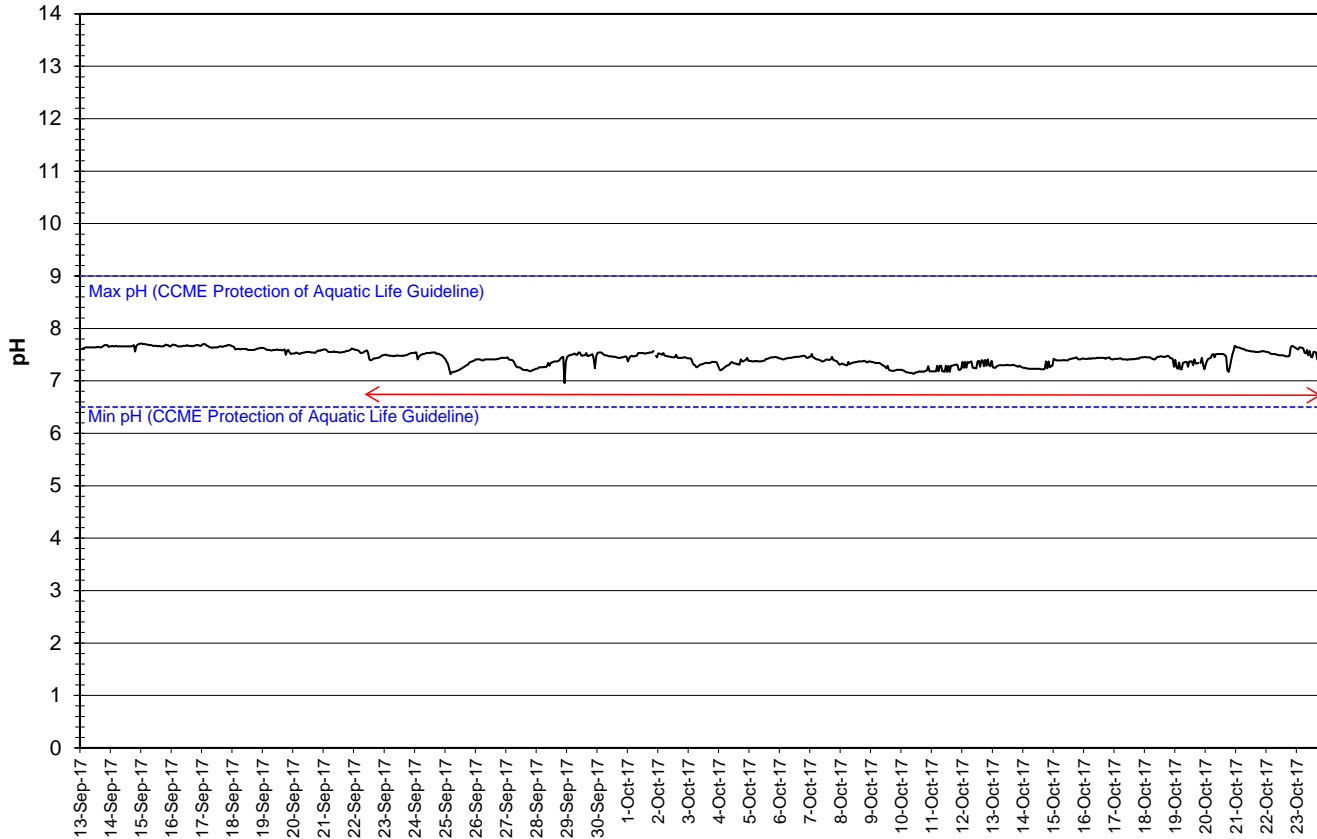


Figure 19: Average daily air and water temperatures – Pumphouse Stream

- pH ranged from 6.96 to 7.71 pH units (Figure 20). The median pH was 7.44.
- 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.
- pH values decrease after September. This may be related to dewatering that was occurring in the pond above the stream, this was noted during removal of the instrument.

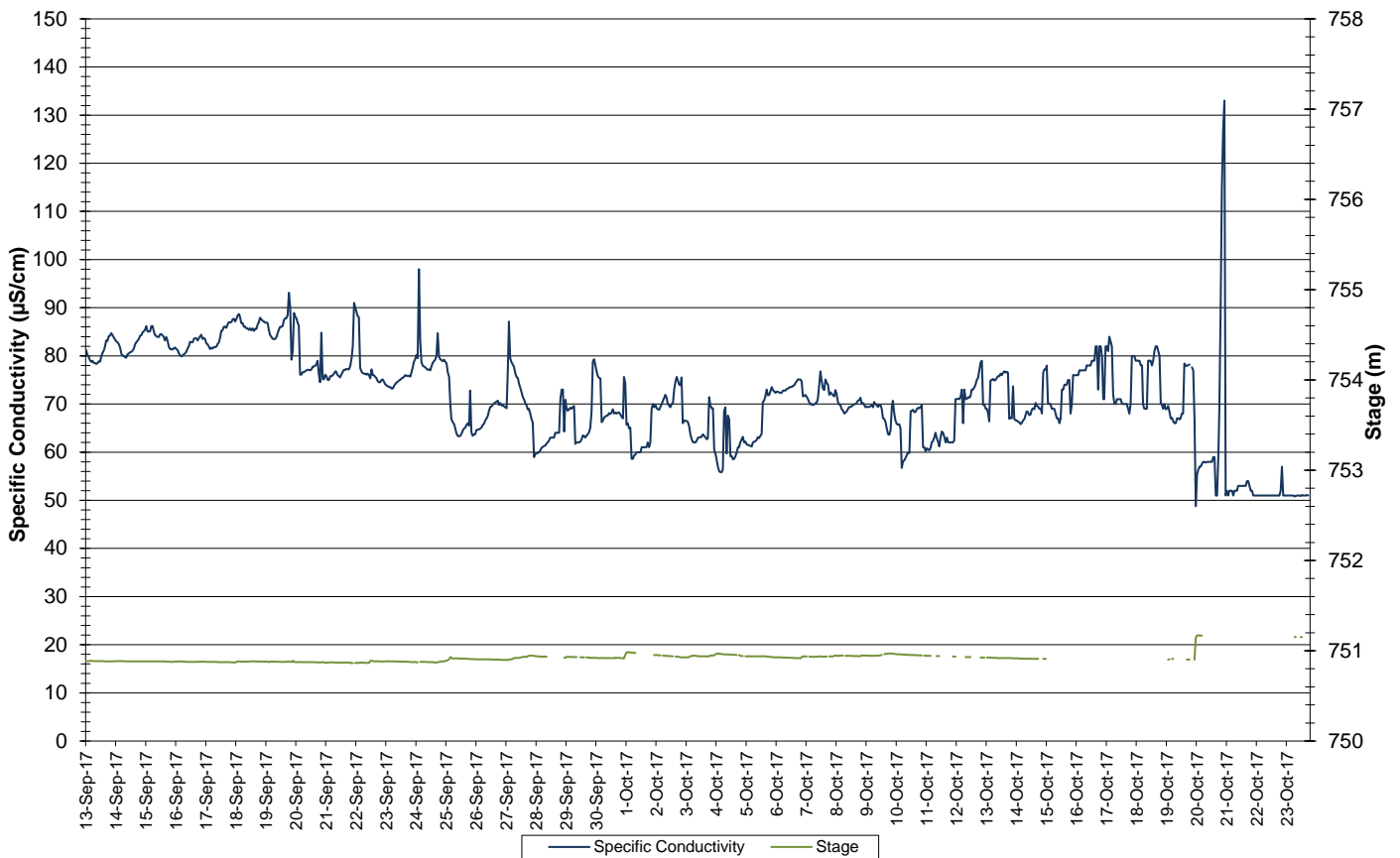
**Water pH : Pumphouse Stream above Drum Lake  
September 13 to October 24, 2017**



**Figure 20: Water pH – Pumphouse Stream**

- Specific conductivity ranged from 48.8 to 133.0  $\mu\text{S}/\text{cm}$ , throughout the deployment period (Figure 21).
- 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. They are indicated on Figure 21 in red.
- 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 Level : Pumphouse Stream above Drum Lake  
September 12 to October 24, 2017**



**Figure 21: Specific Conductivity and Stage – Pumphouse Stream**

- The saturation of dissolved oxygen ranged from 75.0 to 98.1% while the dissolved oxygen ranged from 9.3 to 13.59 mg/l with a median value of 11.43 mg/l (Figure 22).
- 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 above 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 22.
- Dissolved oxygen increased slightly towards the end of this deployment period, as water temperature cooled into fall. Dissolved oxygen fluctuated daily with decreases observed at night.

Dissolved Oxygen Concentration and Saturation : Pumphouse Stream above Drum Lake  
September 13 to October 24, 2017

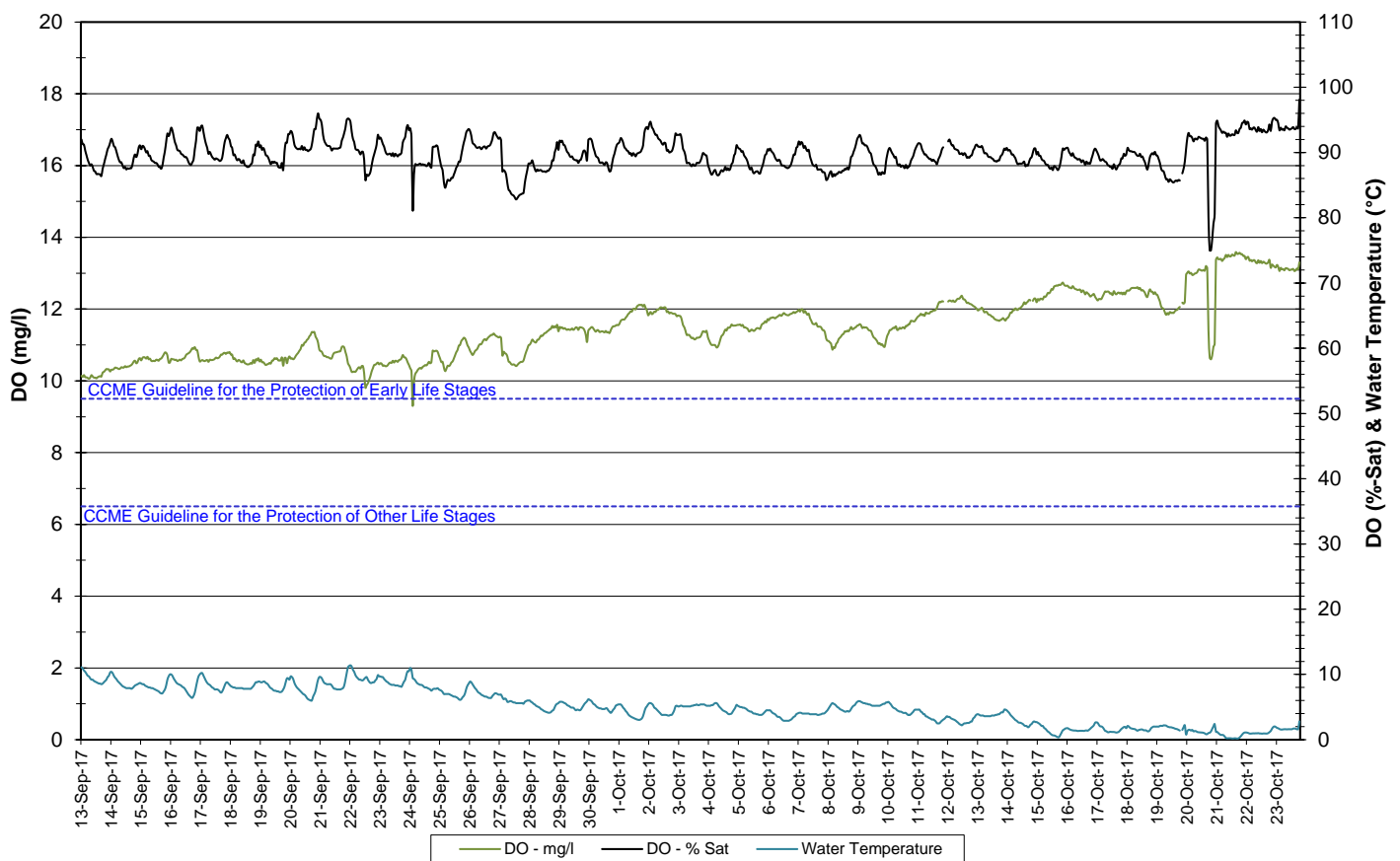
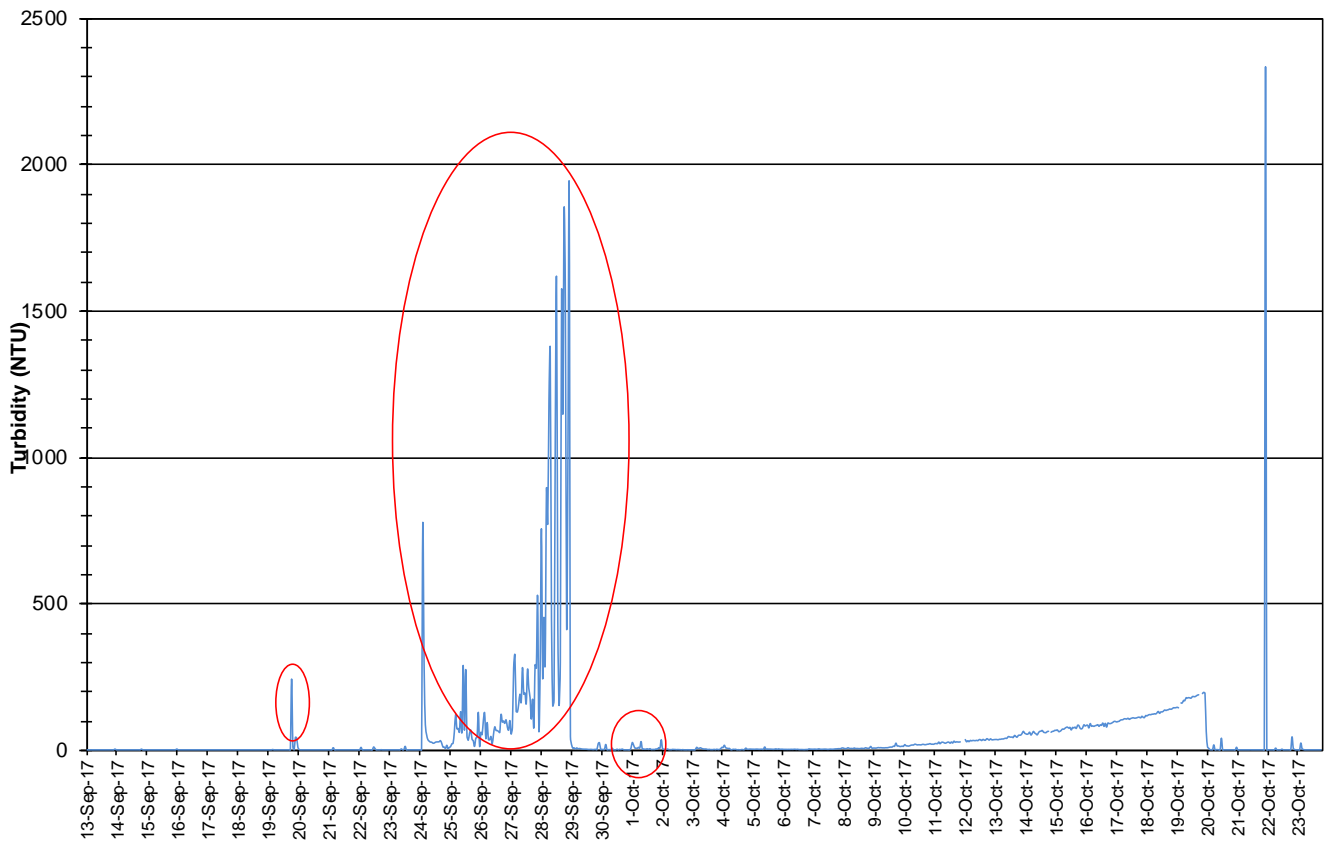


Figure 22: Dissolved Oxygen – Pumphouse Stream

- Turbidity values range from 0.0 to 2336.0 NTU throughout the deployment period (Figure 23). The median value was 2.6 NTU.
- In some instances, turbidity spikes can be attributed to precipitation events. They are indicated on Figure 23 in red.

**Water Turbidity : Pumphouse Stream above Drum Lake  
September 13 to October 24, 2017**



**Figure 23: Turbidity – Pumphouse Stream**

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Pumphouse Stream (Figure 24).
- 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.

Precipitation and Stage: Pumphouse Stream  
September 13 to October 24, 2017

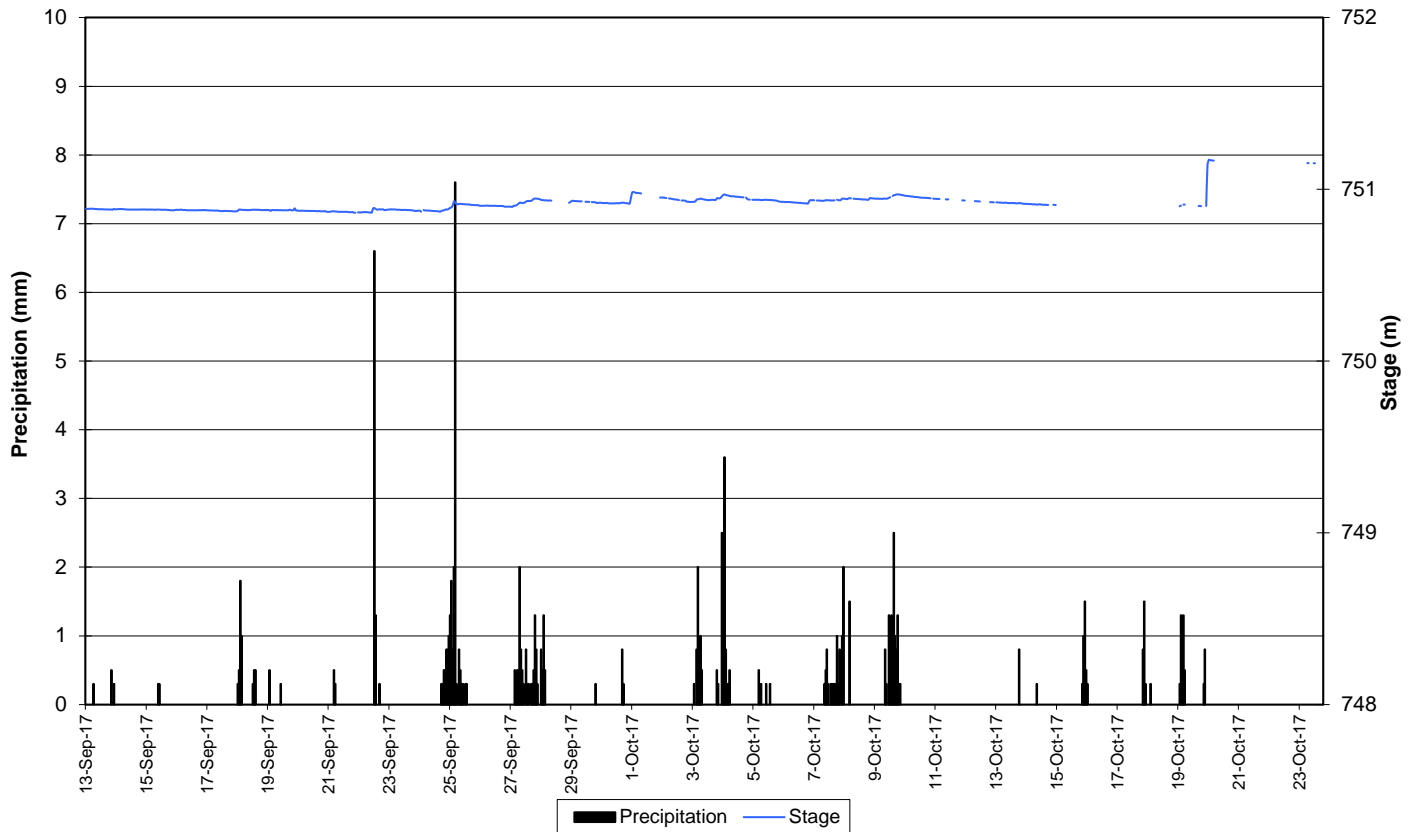


Figure 24: Precipitation and Stage –Pumphouse Stream

## Conclusions

- Instruments were deployed between September 12<sup>th</sup> and 13<sup>th</sup> and removed by October 24<sup>th</sup>, 2017.
- 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 0.17 and 12.40°C at these three stations, while Dumbell ranged lower at 0.23 to 4.85 °C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.96 and 8.06. Fluctuations were noted between day and night. There were some noticeable decreases in pH at Dumbell Stream due to precipitation events. At Pumphouse Stream values fluctuated during the later portion of the deployment period, possibly be due to dewatering at Pumphouse Pond.
- 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 37.1 µs/cm to 114.3 µs/cm at the Wabush Lake stations, 69.0 to 75.4 µs/cm at Dumbell Stream and 44.3 to 133.0 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, the majority of values at Dolomite Road and Pumphouse Stream were above the guideline, while all values at Julienne Narrows and Dumbell Stream were above the guideline.
- Turbidity at Dolomite Road remained at 0.0 NTU for the majority of the deployment period. Turbidity values at Julienne Narrows were higher than at Dolomite Road with a few large spikes.
- Turbidity at Dumbell Stream remained at 0.0 NTU for the majority of the deployment period. There were a few spikes during the deployment period which can be attributed to precipitation. The median value was 0.0 NTU.
- Turbidity at Pumphouse Stream had some high spikes. Several can be attributed to precipitation events. The median value was 2.6 NTU.
- Stage decreased at Dolomite Road and at Julienne Narrows during this deployment period. Stage was relatively stable at Dumbell Stream, with small increases noted after precipitation events. At Pumphouse Stream, stage was relatively stable and there was a noticeable increase at the end of the deployment.
- 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.

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### Appendix 1

#### Air Temperature and Precipitation: Labrador City, NL September 12 to October 24, 2017

