Real-Time Water Quality Deployment Report

Iron Ore Company of Canada
Lab West Network

August 31 to
October 13, 2016

Newfoundland Labrador

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

Contents

General 3

Data Interpretation 6

Wabush Lake Network 6

Dumbell Stream 16

Conclusions 23

Appendix 1 24

General

- The Water Resources Management Division, in partnership with the Iron Ore Company of Canada (IOC) and Environment and Climate Change Canada, maintain three real-time water quality and water quantity stations in Labrador West.
- The official name of each station is *Wabush Lake at Dolomite Road*, *Wabush Lake at Lake Outlet* and *Dumbell Stream above Dumbell Lake*, hereafter referred to as the Dolomite Road station, Julienne Narrows station and Dumbell Stream station.
- The Wabush Lake network stations are situated upstream (Dolomite Road) and downstream (Julienne Narrows) of the IOC tailings disposal area in Wabush Lake.
- The station at Dumbell Stream was commissioned in June of 2016, this site was chosen to measure water quality/quantity as part of IOC's future Wabush 3 project.
- Water Resources Management Division staff monitors the real-time graphs regularly. They will inform IOC of any significant water quality events by email notification and by monthly deployment reports.
- On August 31st, 2016, real-time water quality monitoring instruments were deployed at the three IOC stations. The instrument was deployed for a period of 42 days at Dolomite Road and Julienne Narrows, and 43 days at Dumbell Stream. The instruments were removed on October 12th and 13th, 2016. This was the last deployment of the 2016 field season.

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.

- Deployment and removal comparison rankings for the IOC water quality stations deployed between August 31 and October 13, 2016 is summarized in Table 2.

Table 2: Comparison rankings for IOC stations between August 31 and October 13, 2016.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Dolomite Road	Aug 31, 2016	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	Oct 12, 2016	Removal	Excellent	Good	Poor	Fair	N/A
Julienne Narrows	Aug 31, 2016	Deployment	Poor	Excellent	Fair	Good	Excellent
	Oct 12, 2016	Removal	N/A	N/A	N/A	N/A	N/A
Dumbell Stream	Aug 31, 2016	Deployment	Good	Excellent	Excellent	Fair	Excellent
	Oct 13, 2016	Removal	Excellent	Good	Marginal	Poor	N/A

- **Dolomite Road**

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

  At removal, temperature and pH ranked either 'good' or 'excellent'. Conductivity ranked 'poor', the field instrument read a value of 55.6 µs/cm and the QA/QC instrument read a value of 39.7 µs/cm. Dissolved oxygen ranked 'fair', the field instrument read a value of 11.19 mg/l, while the QA/QC sonde read a value of 10.41 mg/l. Turbidity could not be ranked at removal due to a sensor issue on the QA/QC instrument.

- **Julienne Narrows**

  At deployment, pH, dissolved oxygen, and turbidity ranked either 'good' or 'excellent'. Temperature ranked 'poor', the field sonde read a value of 14.40^{o} C, while the QA/QC instrument read a value of 15.46^{o} C. Conductivity ranked 'fair', the field instrument read a value of 115.0 µs/cm, while the QA/QC instrument read a value of 98.0 µs/cm.

  QA/QC readings were not available for the removal portion of the deployment period due to the loss of power to the field instrument.

- **Dumbell Stream**

  At deployment, all parameters besides dissolved oxygen ranked either 'good' or 'excellent'. Dissolved oxygen ranked 'fair', the field instrument read a value of 12.81 mg/l, while the QA/QC instrument read a value of 12.23 mg/l.

At removal, temperature and pH ranked either 'good' or 'excellent'. Conductivity ranked 'marginal', the field instrument read a value of 69.0 µs/cm, while the QA/QC instrument read a value of 55.8 µs/cm. Dissolved oxygen ranked 'poor', the field instrument read a value of 12.92 mg/l, while the QA/QC instrument read a value of 11.82 mg/l. Turbidity could not be ranked at removal due to a sensor issue on the QA/QC instrument.

- There are a few instances when less than ideal QA/QC rankings can 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 of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from August 31, 2016 to October 13, 2016 at Dolomite Road, Julienne Narrows and Dumbell Stream.
- 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 no data from Julienne Narrows after October 9th, 2016. There was a power issue at the station.

Wabush Lake Network

- Water temperature ranged from 7.40 to 15.70°C at Dolomite Road and 6.60 to 16.00°C at Julienne Narrows during this deployment period (Figure 1). Water temperature at Dolomite Road is slightly higher than at Julienne Narrows for the majority of the period.

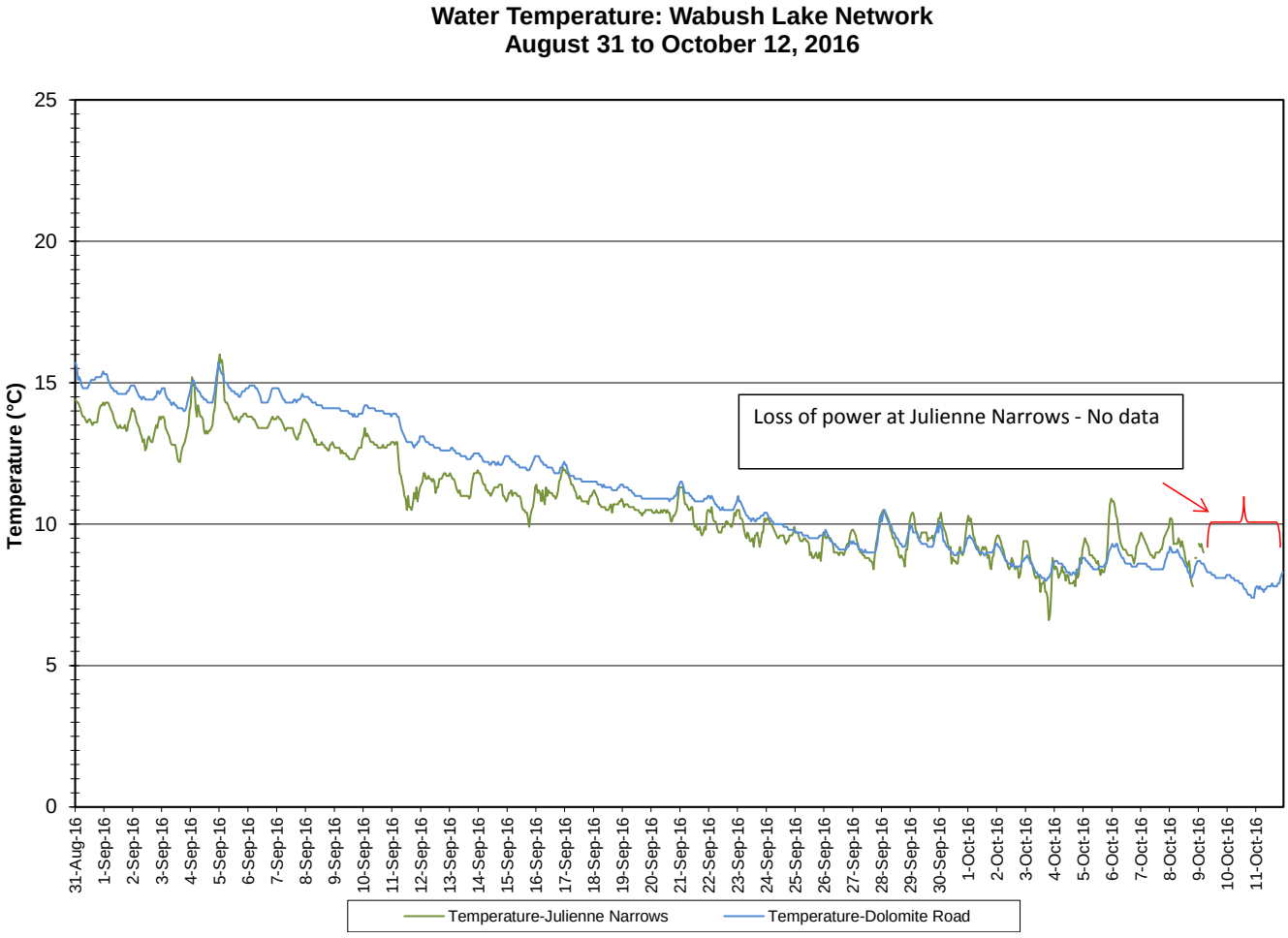

Figure 1: Water temperature - Wabush Lake network

- Water temperature decreased during the deployment period. Much of the weather data is missing for this deployment period, making it difficult to see a correlating trend between water temperature and air temperature (Figure 2).

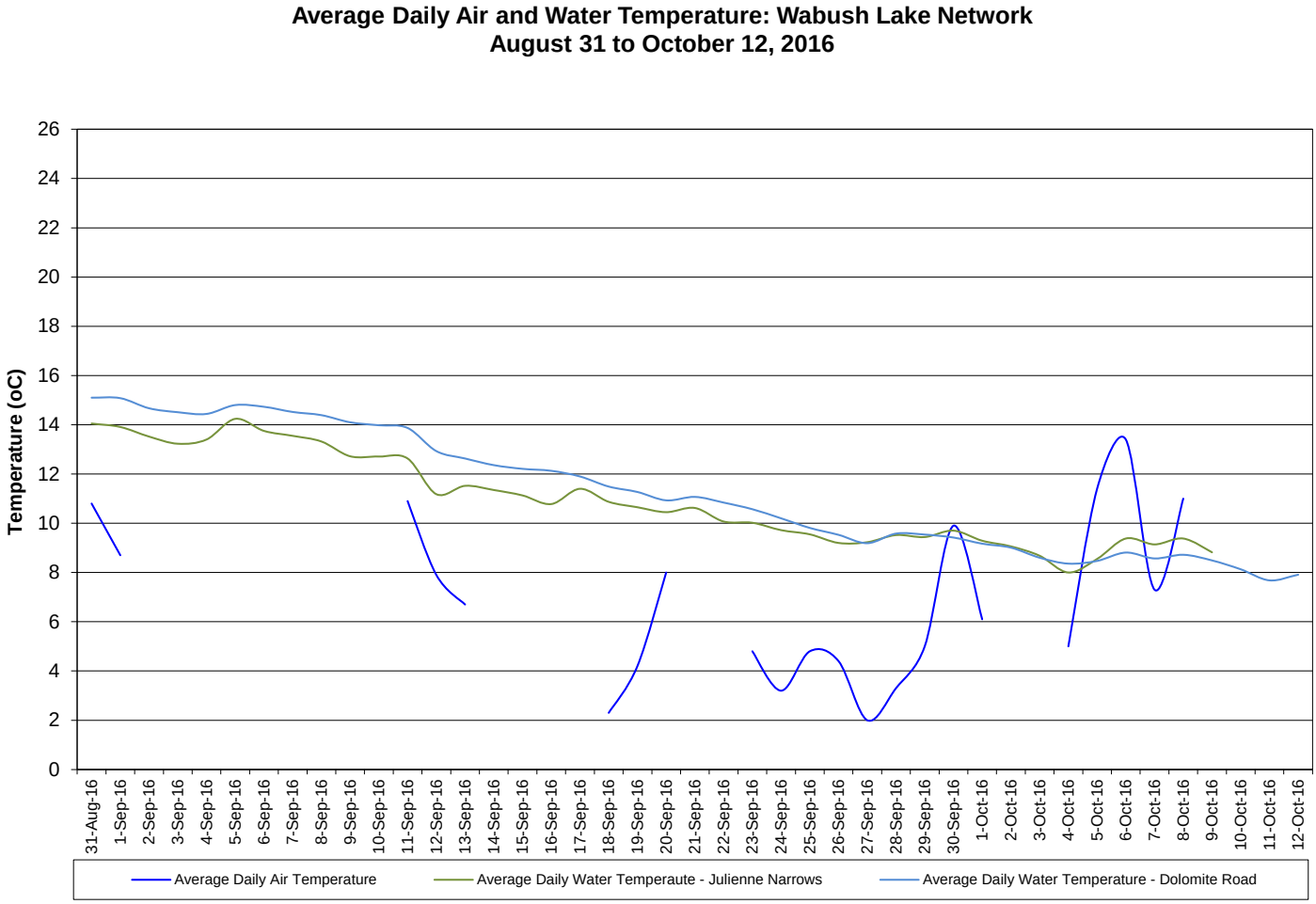

Figure 2: Average daily air and water temperatures – Wabush Lake network

(Weather data collected at Wabush Airport)

- pH ranges from 7.31 to 7.67 pH units at Dolomite Road, and from 7.30 to 8.11 pH units at Julienne Narrows, throughout the deployment period (Figure 3). The median pH is 7.45 and 7.93 units respectively.
- All values during the deployment are within the CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during 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.

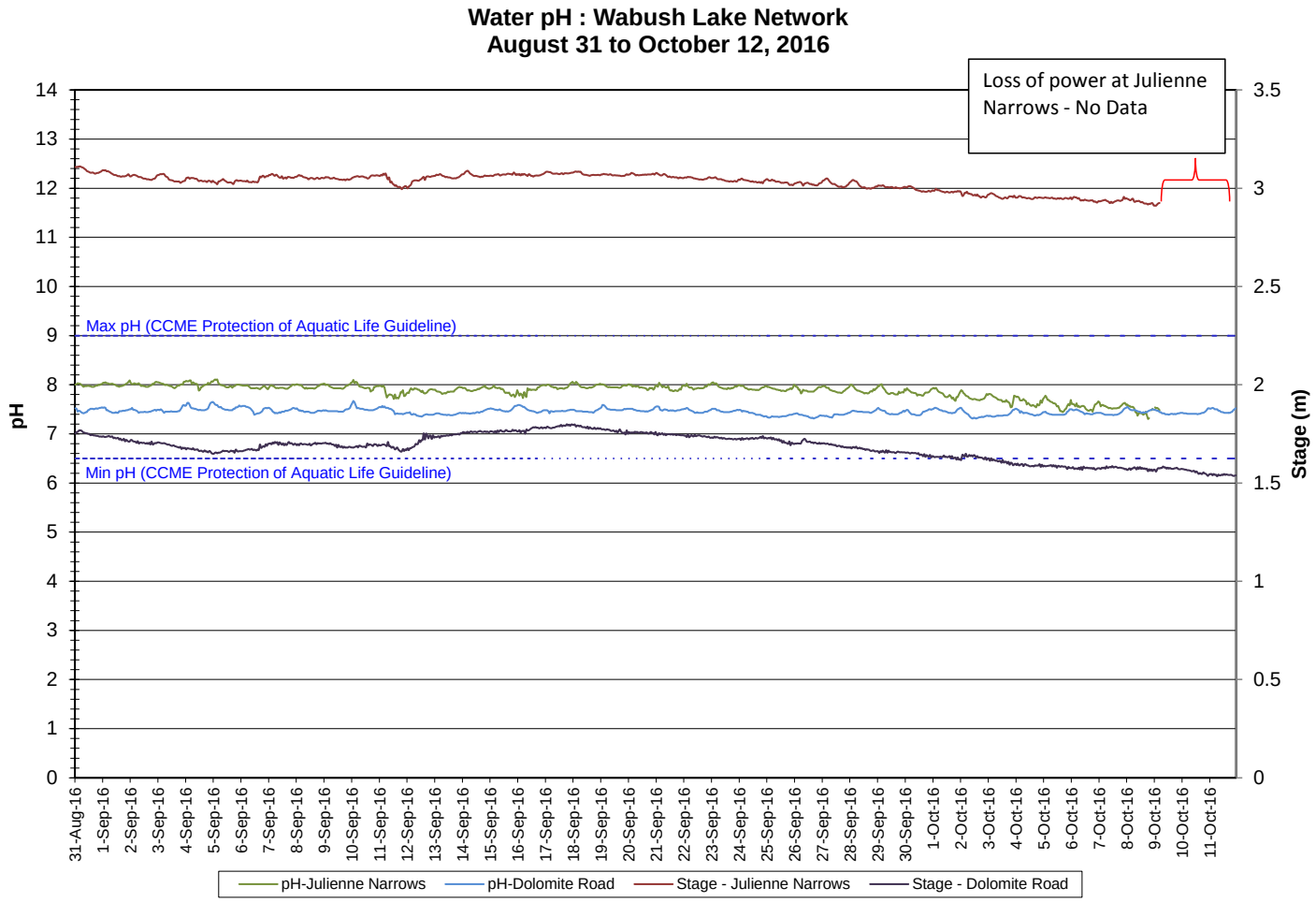

Figure 3: pH – Wabush Lake network

- Specific conductivity ranged from 53.5 to 58.6 µs/cm at Dolomite Road and from 73.1 to 118.8 µs/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.
- Stage is relatively stable at both locations.
- 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.

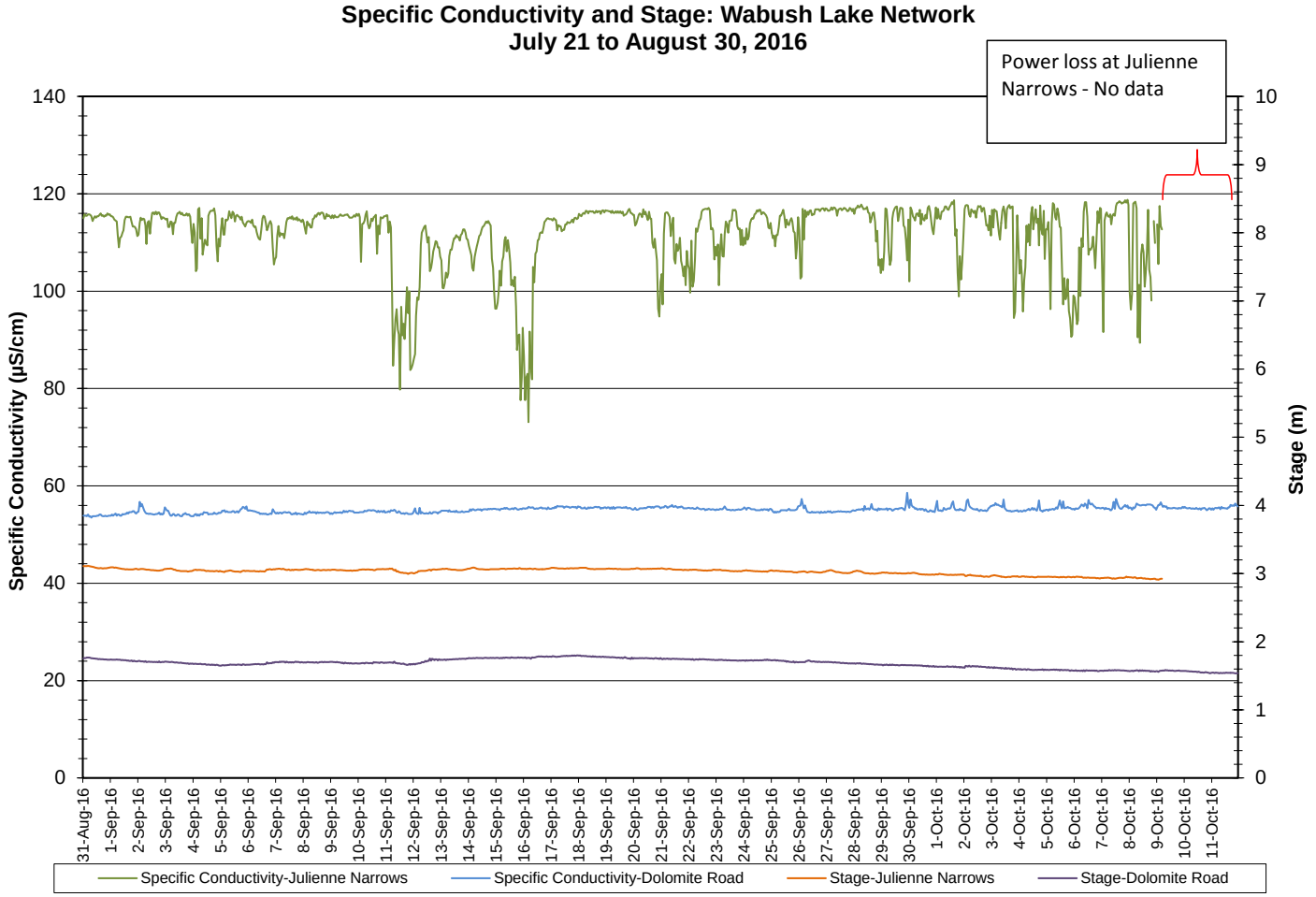

Figure 4: Specific conductivity – Wabush Lake network

- At the Dolomite Road station, the saturation of dissolved oxygen ranged from 86.9 to 98.8% and a range of 9.04 to 11.29 mg/l was found in the concentration of dissolved oxygen with a median value of 10.03 mg/l (Figure 5).
- At the Julienne Narrows station, the saturation of dissolved oxygen ranged from 93.3 to 105.0% and a range from 9.84 to 11.78 mg/l was found in the concentration of dissolved oxygen with a median value of 10.58 mg/l (Figure 5).
- All values recorded at Julienne Narrows 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 5.
- All values recorded at 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. Most 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 5.
- Dissolved oxygen increases throughout the deployment period as water temperature decreases.
- Dissolved oxygen fluctuated daily with decreases observed at night.

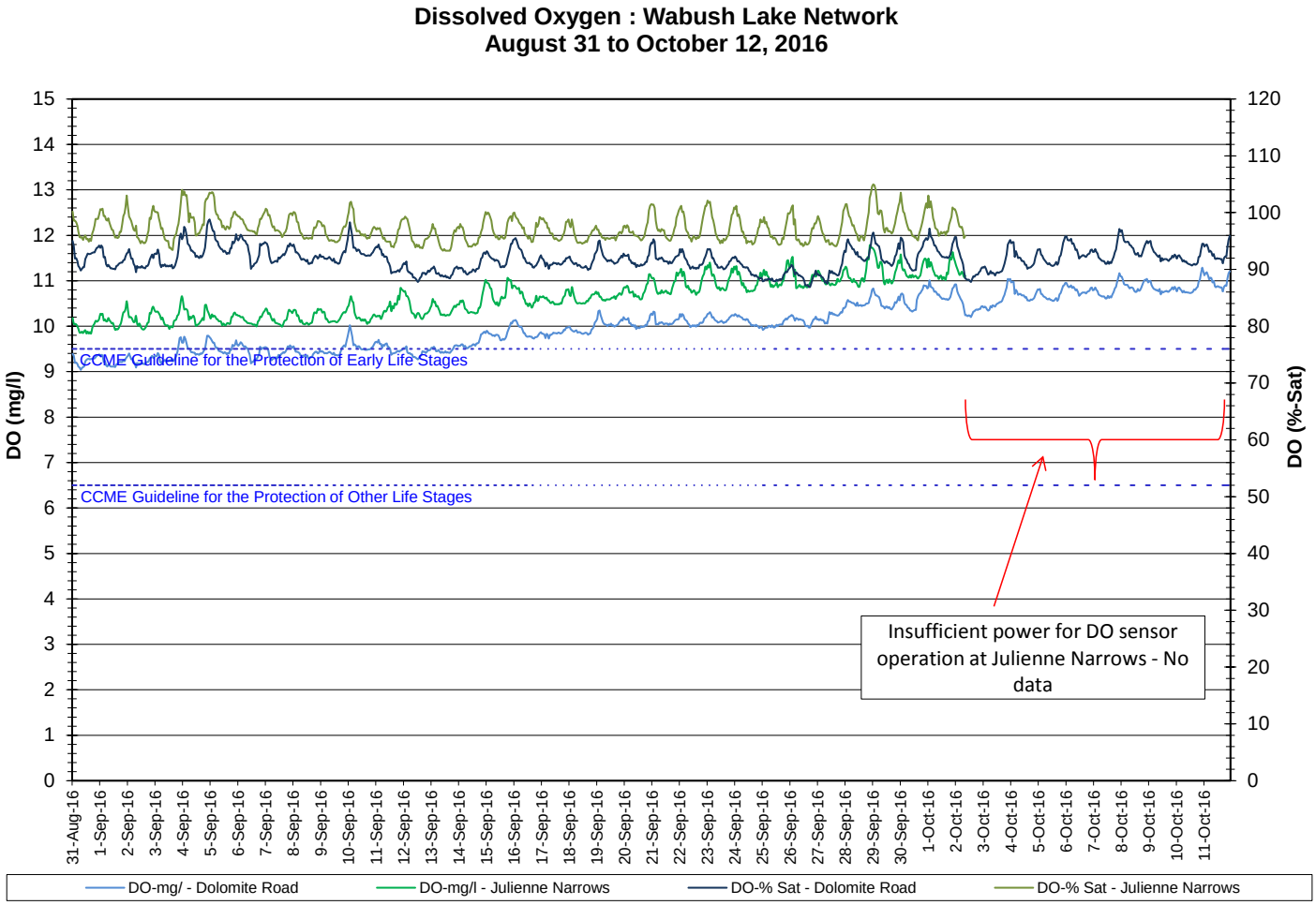

Figure 5: Dissolved oxygen and percent saturation – Wabush Lake Network

- At the Julienne Narrows station, turbidity values range from 0.0 to 38.7 NTU throughout the deployment period (Figure 6). The median value was 0.0 NTU.
- In some instances, turbidity spikes can be attributed to precipitation at the time. They are indicated on the graph in red
- A portion of turbidity data was removed from the dataset, due to the possibility of an object lodged on the turbidity sensor.

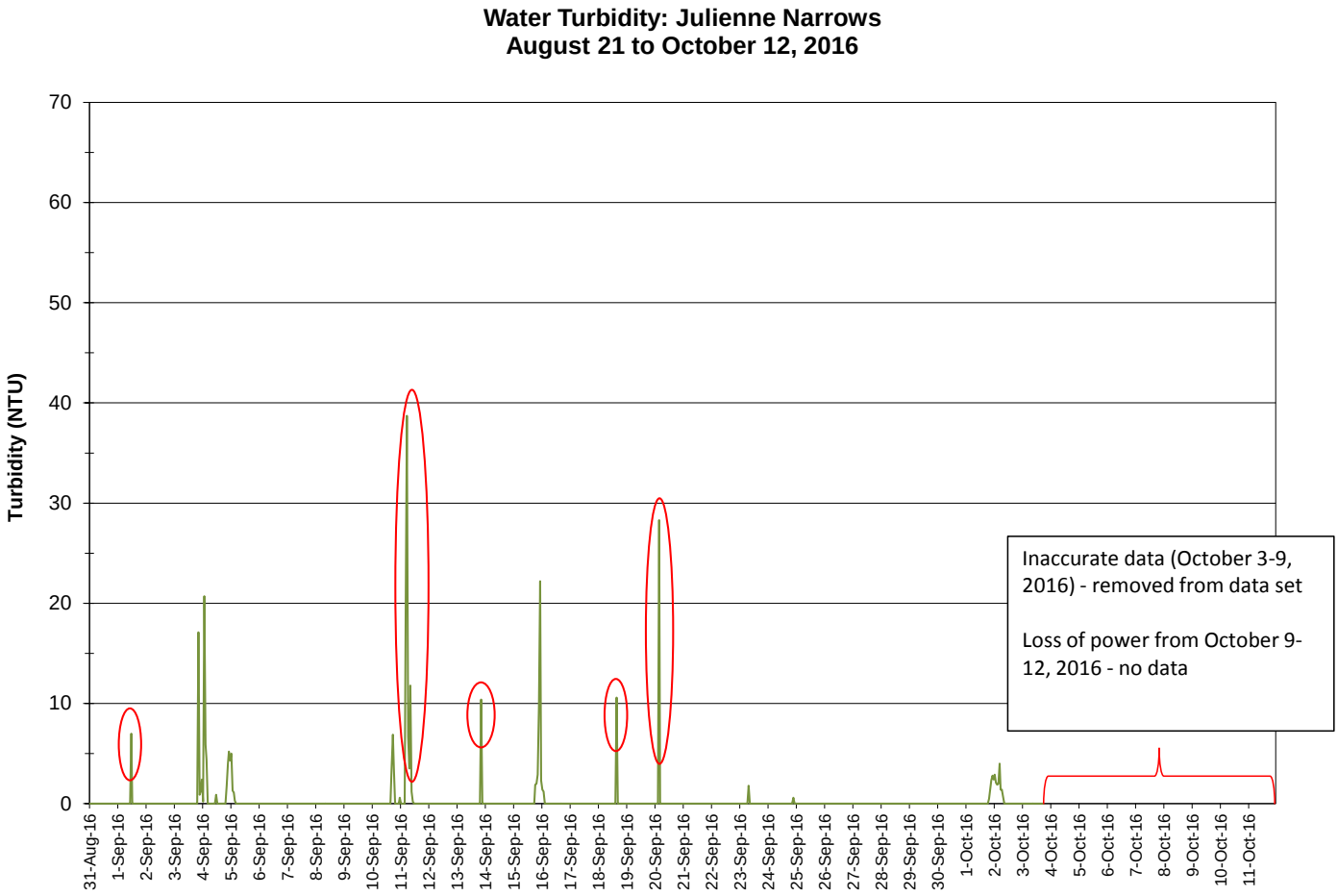

Figure 6: Turbidity – Julienne Narrows

- At the Dolomite Road station, turbidity values range from 0.0 to 4.8 NTU throughout the deployment period (Figure 7). The median value was 0.0 NTU.
- A turbidity spike on the 11th of September can be attributed to precipitation at the time. It is indicated on the graph in red
- A portion of turbidity data was removed from the dataset. This is due to suspected false readings.

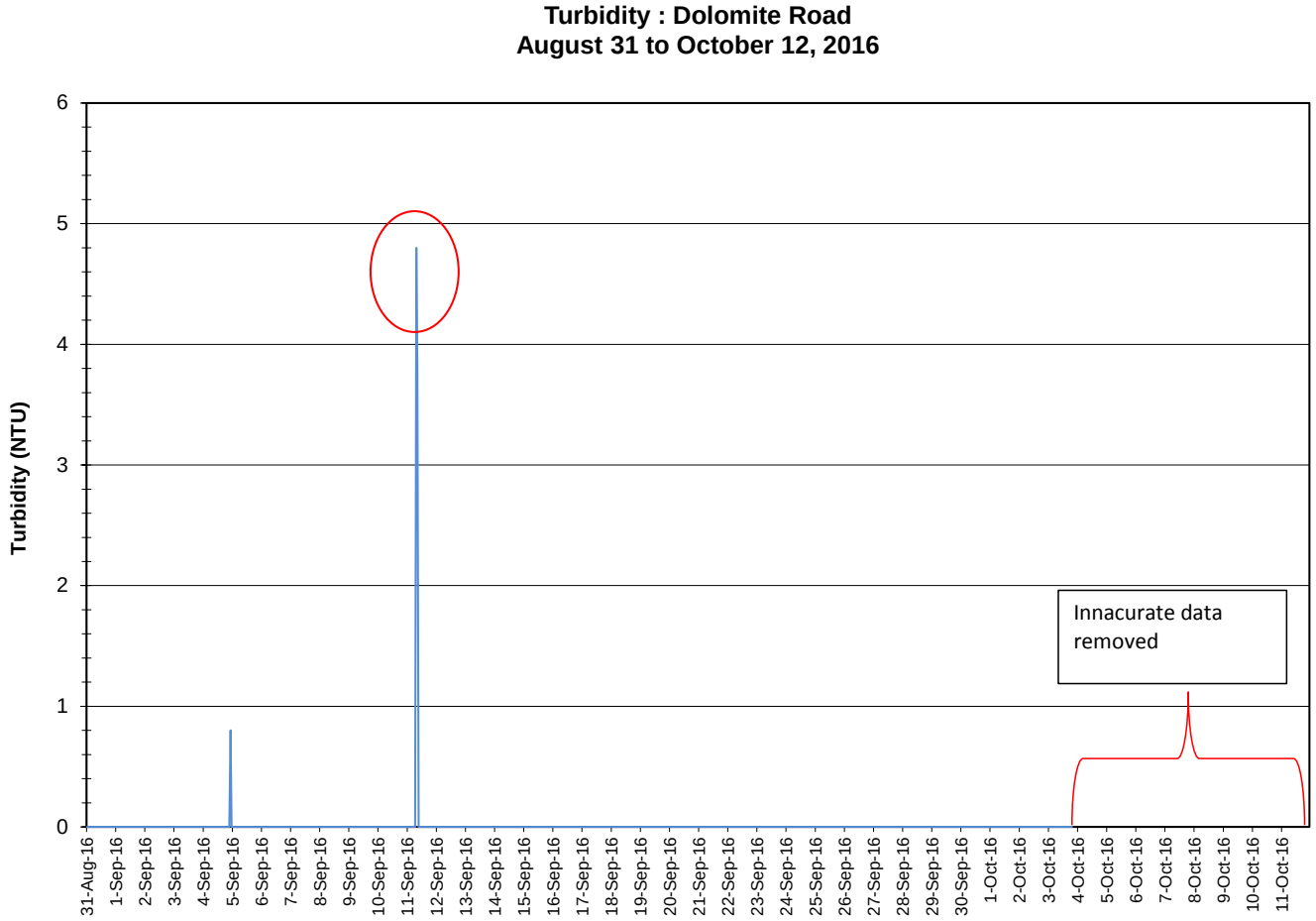

Figure 7: Turbidity – Dolomite Road

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Julienne Narrows (Figure 8).
- Stage decreased slightly throughout the deployment period, with varying precipitation records.
- 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.

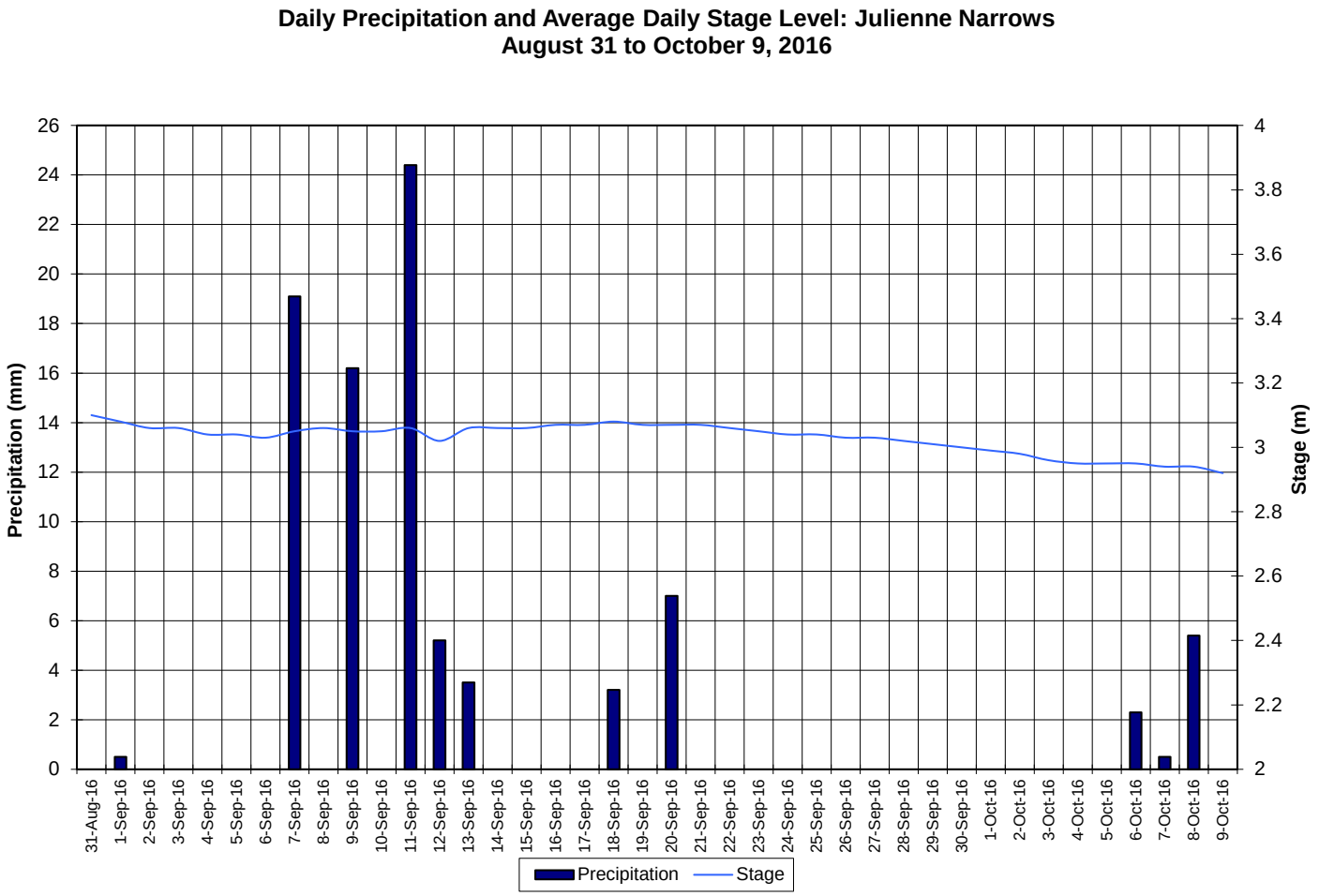

Figure 8: Precipitation and Stage –Julienne Narrows

(Weather data collected at Wabush Airport)

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Dolomite Road (Figure 9).
- Stage decreases during the beginning of September before increasing again a week later, then it begins a decreasing trend for the remainder of the deployment period, with varying precipitation records.
- 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.

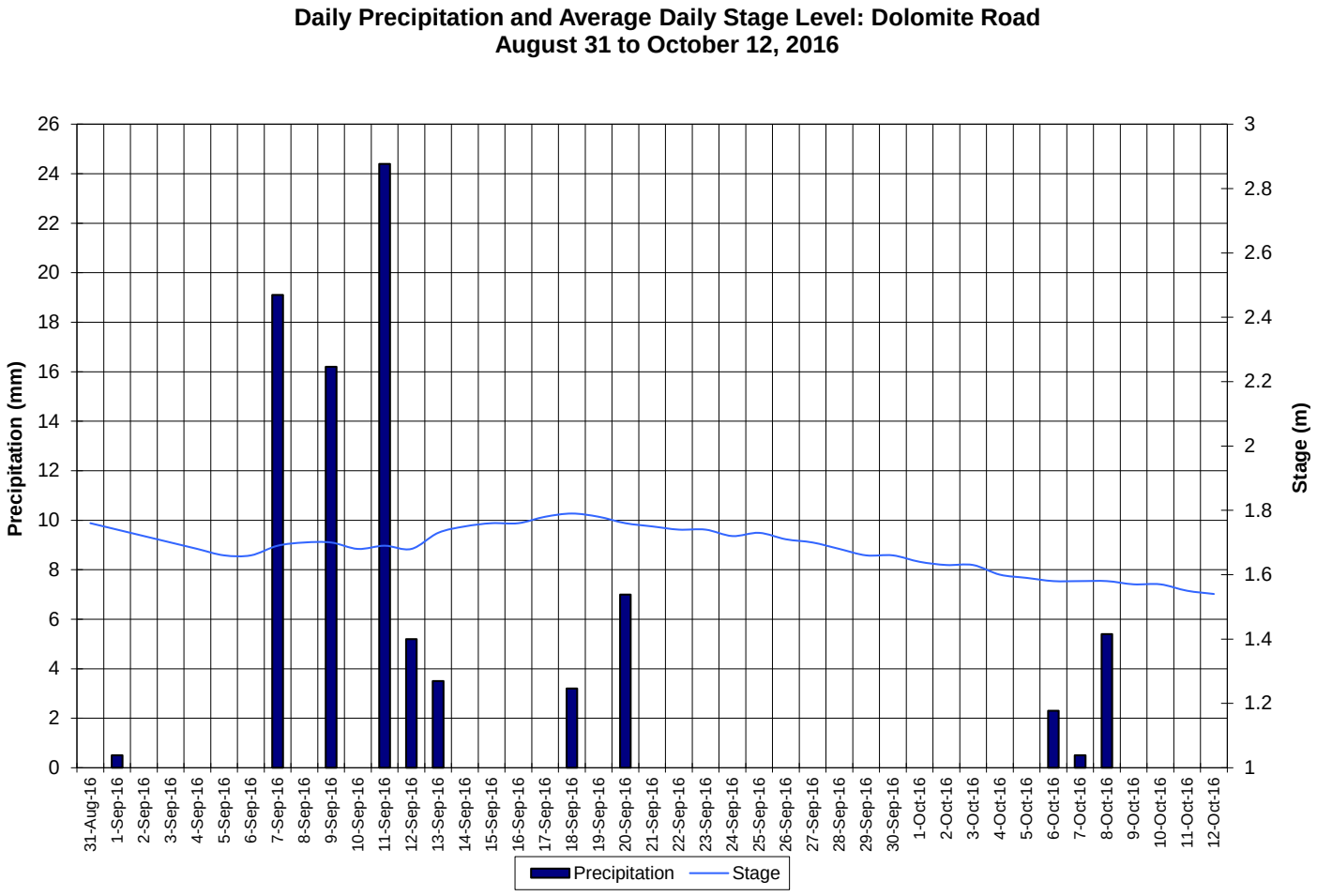

Figure 9: Precipitation and Stage –Dolomite Road

(Weather data collected at Wabush Airport)

Dumbell Stream

- There are small gaps in data for this station as you will see on the graphs; this is due to transmission issues at this site.
- Water temperature ranged from 1.11 to 7.72^{o}C during this deployment period (Figure 10). This stream is considerably colder then Dolomite Road and Julienne Narrows.
- Water temperature generally fluctuated within this range for the deployment period, decreasing towards the end of the period. In some instances, corresponding with fluctuations in ambient air temperature (Figure 11).

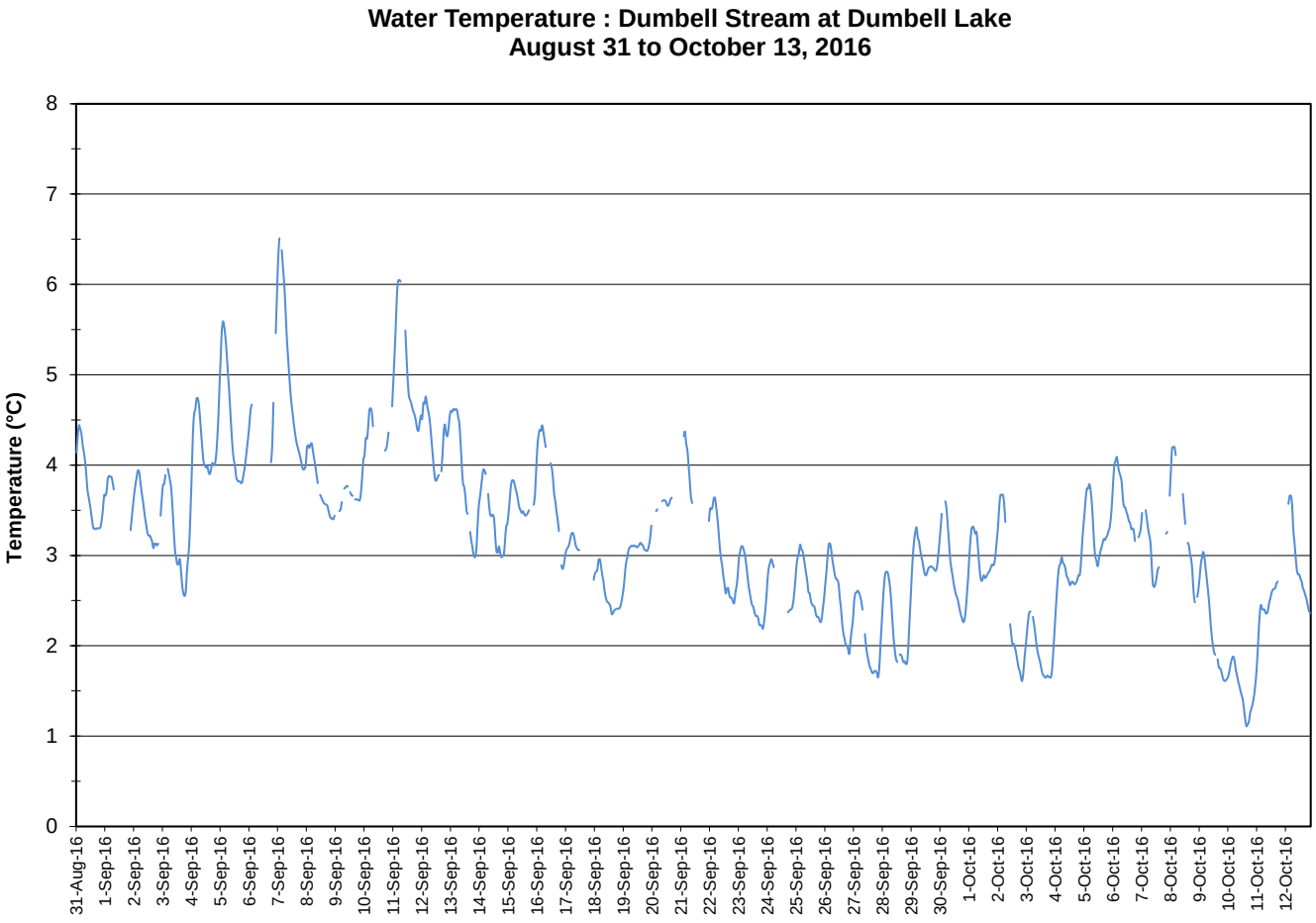

Figure 10: Water Temperature – Dumbell Stream

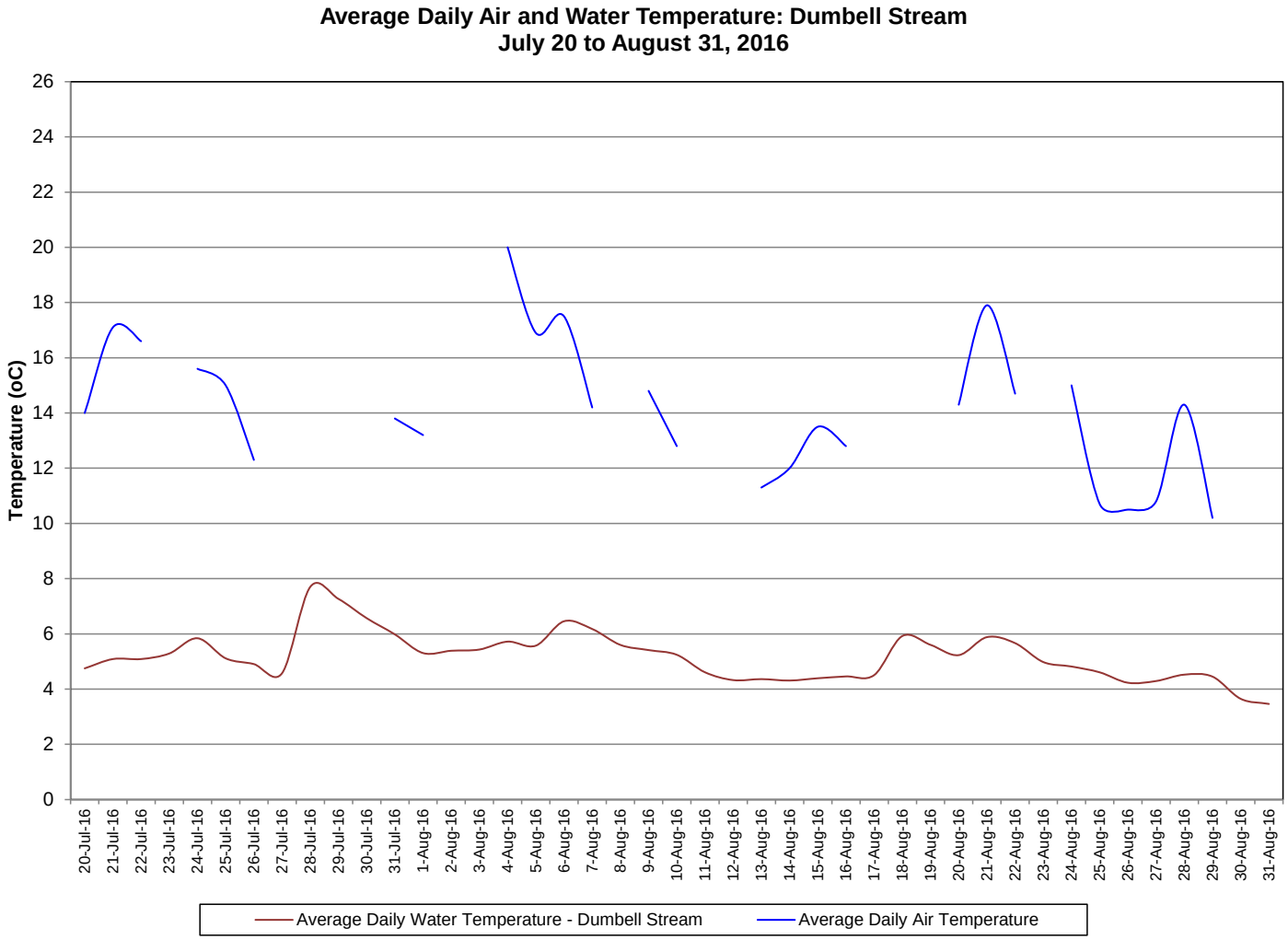

Figure 11: Average daily air and water temperatures – Dumbell Stream

(Weather data collected at Wabush Airport)

- pH ranged from 7.72 to 7.91 pH units (Figure 12). The median pH was 7.81.
- All values during the deployment are within the CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.

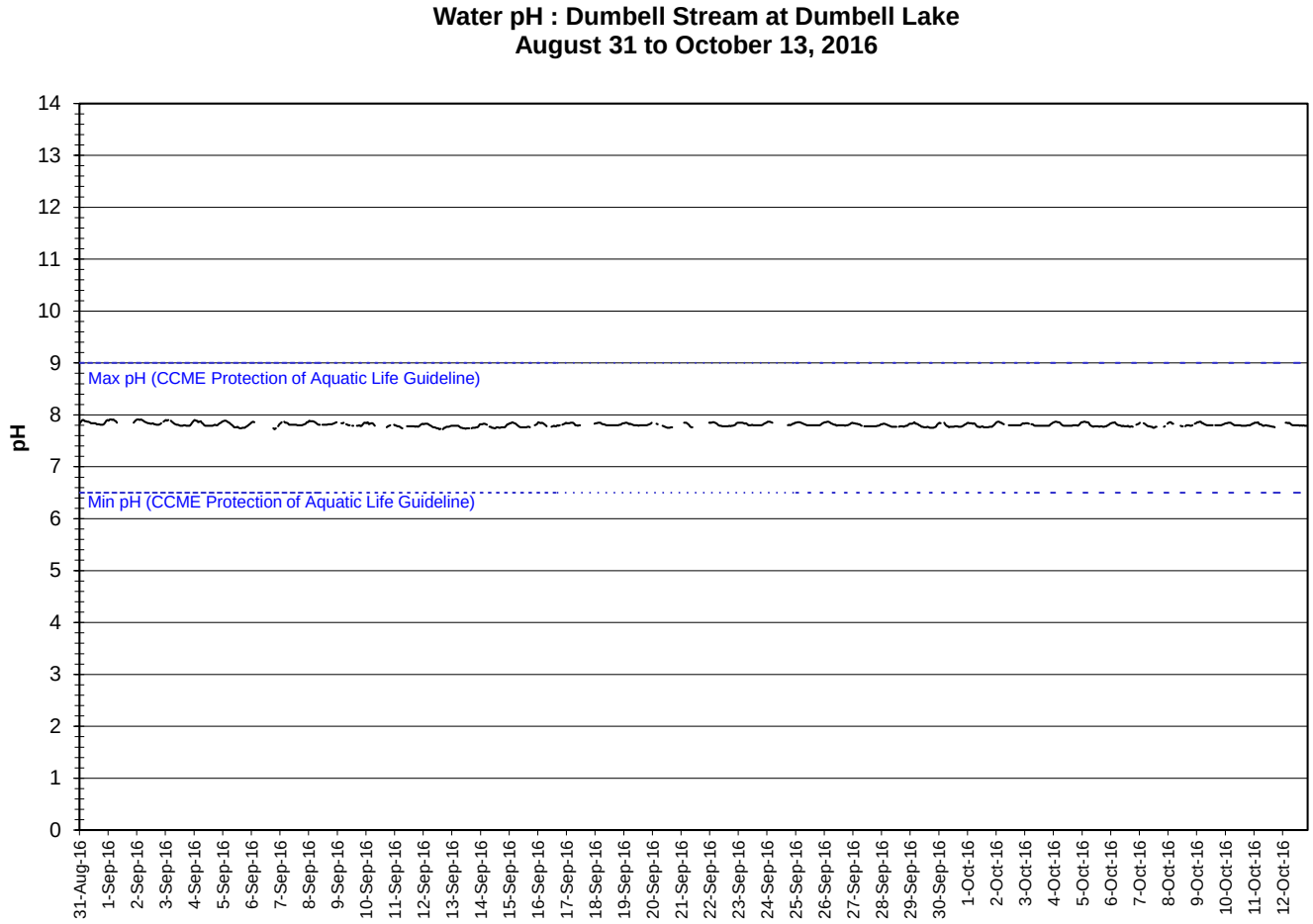

Figure 12: Water pH – Dumbell Stream

- Specific conductivity ranged from 56.8 to 70.0 µs/cm, throughout the deployment period (Figure 13).
- 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.
- There were a few significant decreases in specific conductivity during the deployment period; they correspond with precipitation events at the time. They are identified on the graph in red.

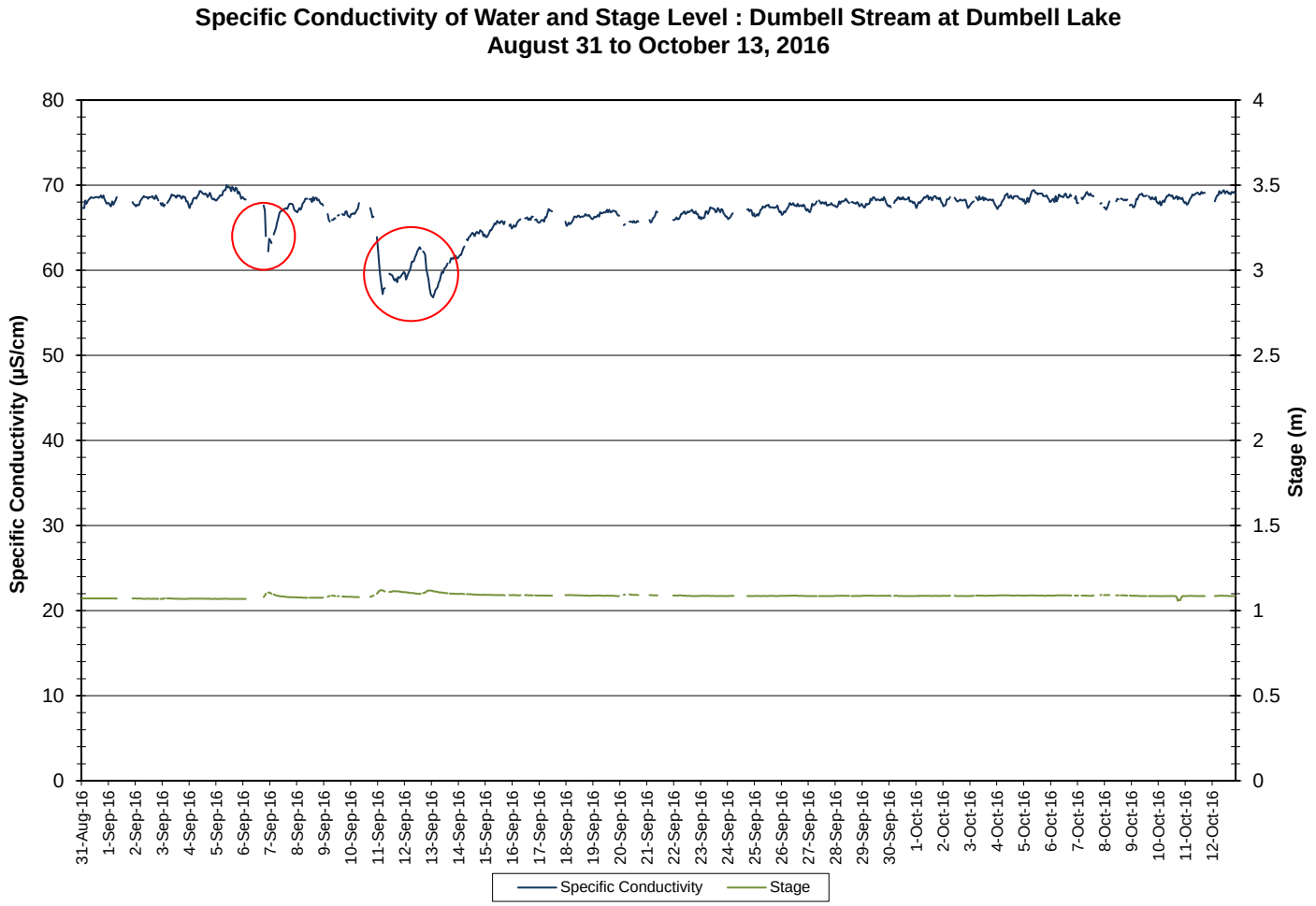

Figure 13: Specific Conductivity – Dumbell Stream

- The saturation of dissolved oxygen ranged from 89.0 to 92.7% and a range of 10.50 to 12.15 mg/l was found in the concentration of dissolved oxygen with a median value of 11.52 mg/l (Figure 14).
- 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/. The guidelines are indicated in blue on Figure 14.
- Dissolved oxygen fluctuated daily with decreases observed at night.
- There are some instances when the dissolved oxygen decreases; they are identified on the graph in red. These decreases correspond with precipitation events.

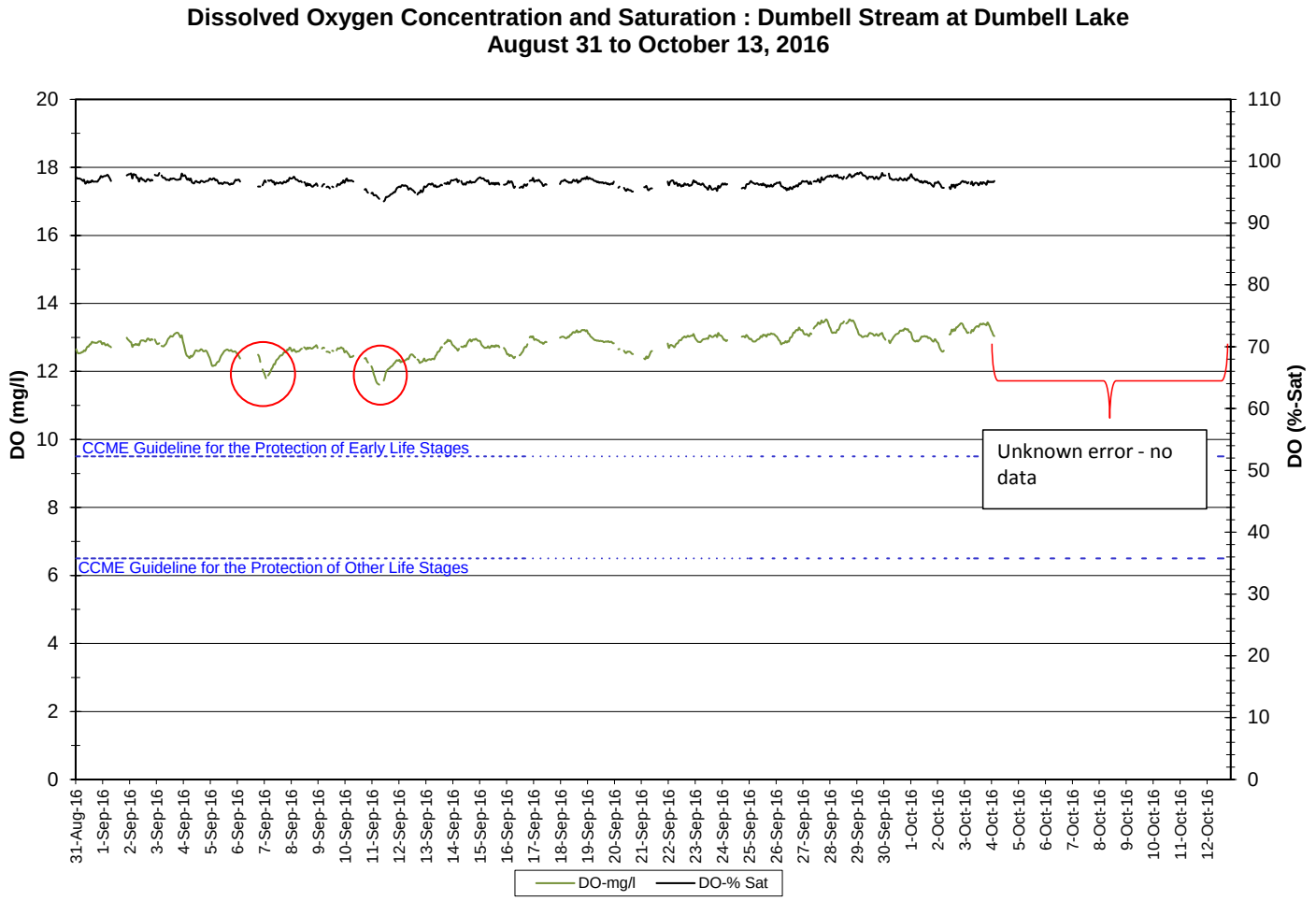

Figure 14: Dissolved Oxygen – Dumbell Stream

- Turbidity values range from 0.0 to 36.8 NTU throughout the deployment period (Figure 15). The median value was 0.0 NTU.
- Turbidity spikes can be attributed to precipitation at the time. They are indicated on the graph in red.

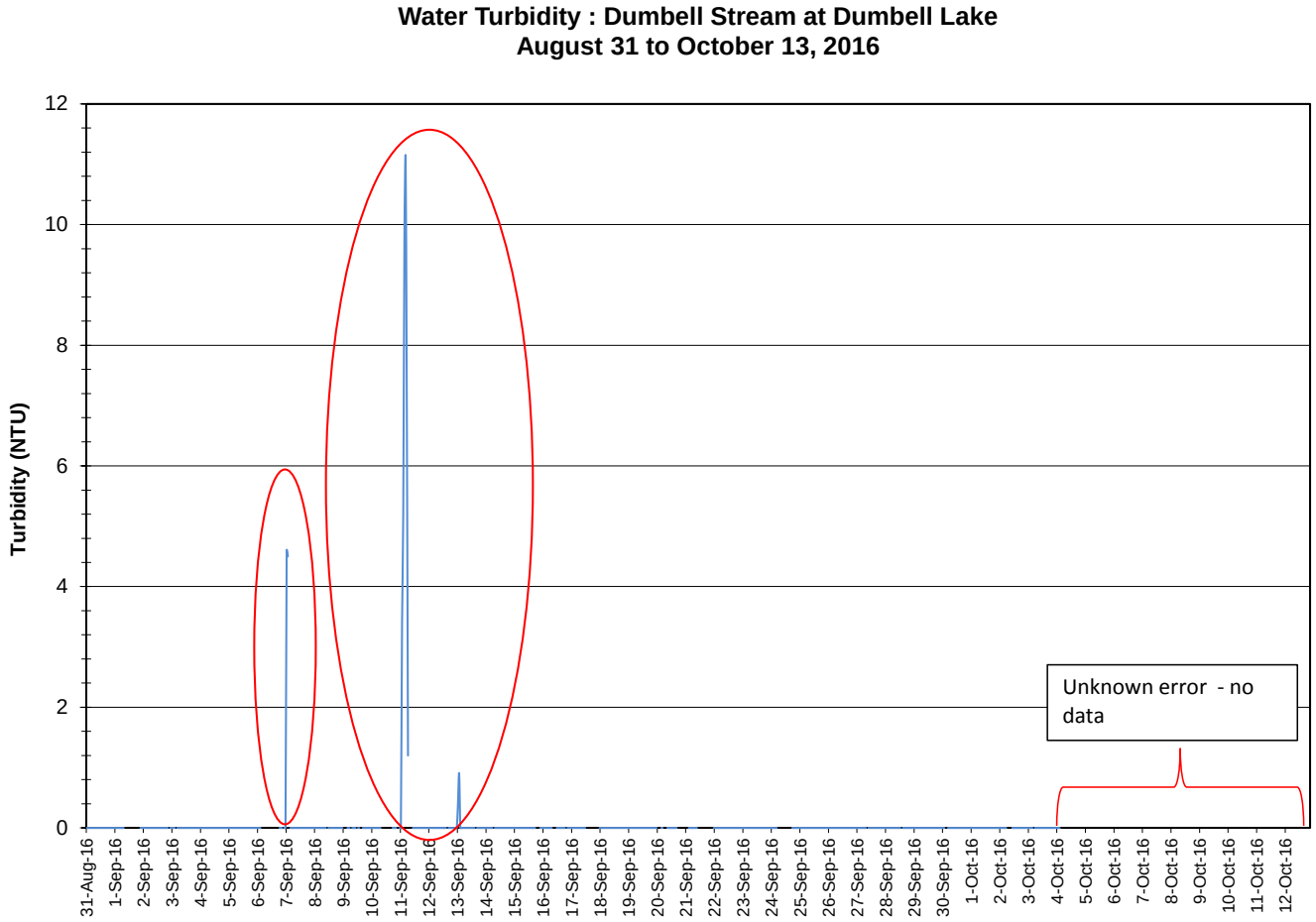

Figure 15: Turbidity – Dumbell Stream

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Dumbell Stream (Figure 16).
- Stage is relatively stable throughout the deployment period, with varying precipitation records. There is a slight decrease in stage on the 8th of October.
- 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.

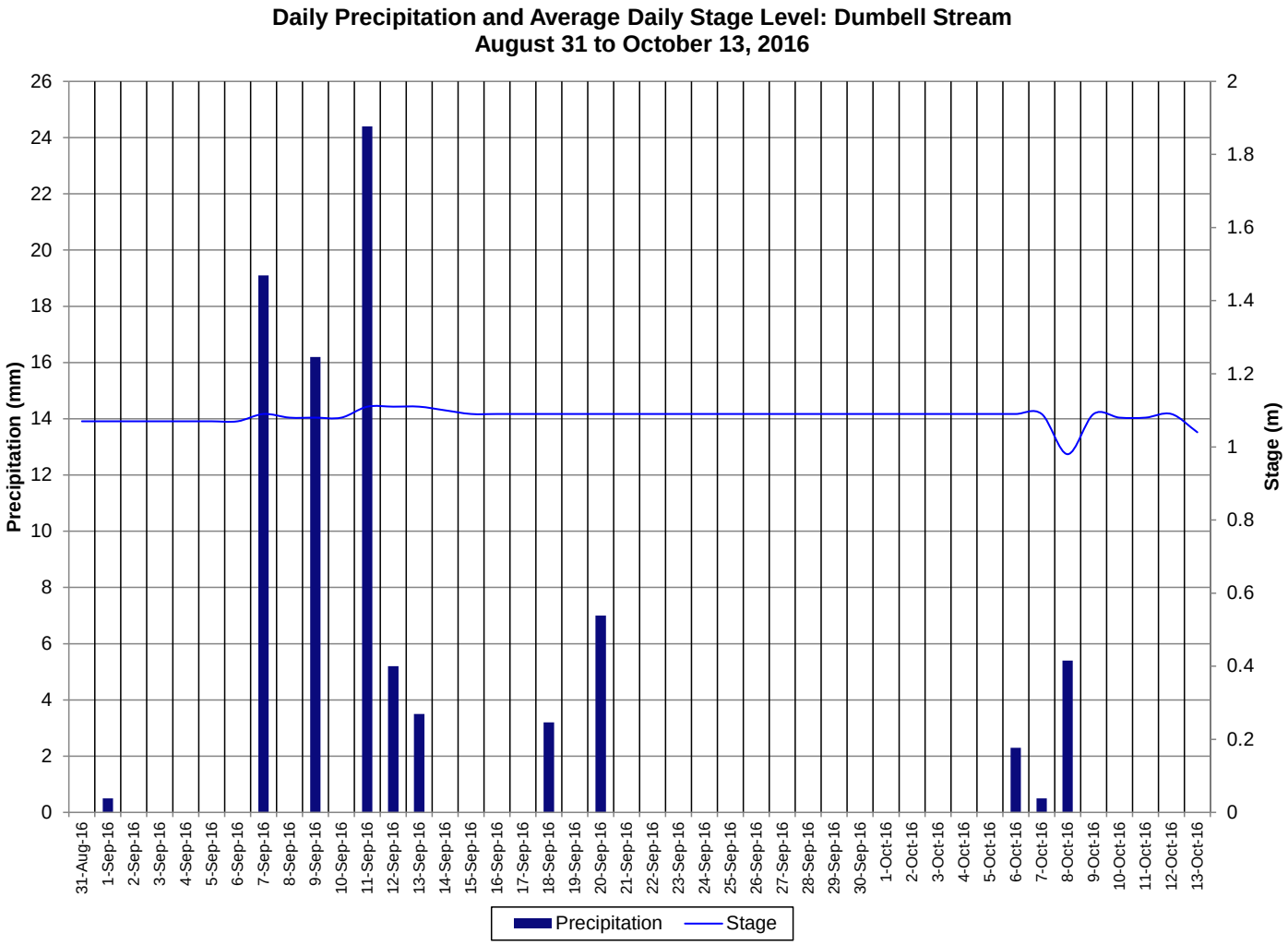

Figure 16: Precipitation and Stage –Dumbell Stream

(Weather data collected at Wabush Airport)

Conclusions

- Instruments were deployed on August 31st, and removed on October 12th and 13th, 2016.
- In most cases, weather related events or increase/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 corresponded with air temperature at all three stations. The temperature typically ranged between 1.11 and 15.70^{o} C, at the three stations.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.51 and 8.11. 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 53.5 µs/cm to 118.8 µs/cm at Julienne Narrows and Dolomite Road. Specific conductivity at Dumbell Stream ranged from 56.8 to 70.0 µs/cm.
- At Dolomite Road, 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 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.
- At Julienne Narrows and Dumbell Stream, 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 and the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l.
- Turbidity values at Julienne Narrows were higher than at Dolomite Road. There were a few large spikes, some attributed to precipitation at the time.
- Turbidity at Dumbell Stream remained at 0.0 NTU for the majority of the deployment period. There were a few spikes that corresponded with precipitation events. The median value was 0.0 NTU.
- Stage was relatively stable at Julienne Narrows and Dolomite Road. Stage was stable at dumbell stream except for a small decrease during the later portion of the 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.
- This was the final deployment of the 2016 field season; instruments were removed for the winter and will be deployed once conditions permit, in the spring/summer of 2017.

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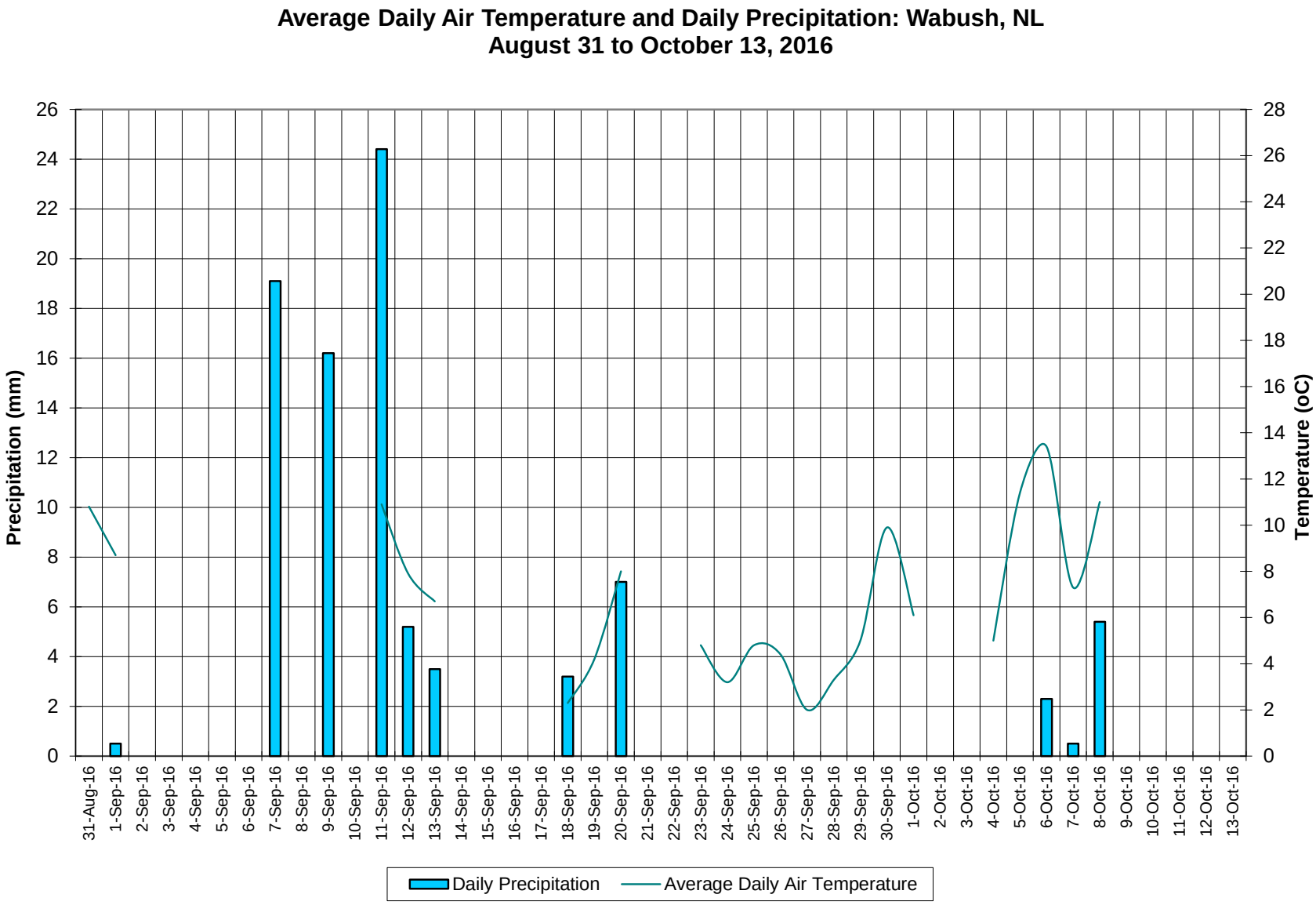
Appendix 1


Average Daily Air Temperature and Daily Precipitation: Wabush, NL
August 31 to October 13, 2016
Precipitation (mm)
Temperature (oC)
0
2
4
6
8
10
12
14
16
18
20
22
24
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10-Oct-16
11-Oct-16
12-Oct-16
13-Oct-16
Daily Precipitation
Average Daily Air Temperature