Real-Time Water Quality Deployment Report

Voisey's Bay Network

September 19 to October 23, 2017

Newfoundland Labrador

Government of Newfoundland & Labrador

Department of Municipal Affairs and Environment

Water Resources Management Division

Contents

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Real Time Water Quality Monitoring

Staff with the Department of Municipal Affairs and Environment monitors the real-time web pages regularly.

This deployment report discusses water quality related events occurring at four stations in the Voisey's Bay Network: Reid Brook at Outlet of Reid Pond; Camp Pond Brook below Camp Pond; Tributary to Reid Brook; and Reid Brook below Tributary.

On September 19, 2017, Water Resources and Vale Environment staff deployed real-time water quality monitoring instruments at the four real-time stations in the Voisey's Bay network. Instruments were removed by Vale Environment Staff on October 23, 2017. This was the final deployment of the 2017 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. This procedure is based on the approach used by the United States Geological Survey.

At deployment and removal, a QA/QC instrument is temporarily deployed alongside the field instrument. 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 instrument and QA/QC instrument at deployment and at removal, a qualitative statement is made about the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (oC)	<=+/-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 instrument is the most important. All other parameters can be broken down into three groups: temperature dependent; temperature compensated; and temperature independent. Because the temperature sensor is not isolated from the rest of the instrument, the entire instrument 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 Voisey's Bay Network stations are summarized in Table 2.

Table 2: Comparison rankings for Voisey's Bay Network stations

Station Voisey's Bay	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Reid Brook at Outlet	September 19	Deployment	Excellent	Poor	Excellent	Excellent	Excellent
	October 23	Removal	Excellent	N/A *	Excellent	Excellent	Good
Camp Pond Brook	September 19	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	October 23	Removal	Excellent	Excellent	Good	Excellent	Poor
Reid Brook below Tributary	September 19	Deployment	Excellent	Marginal	Excellent	Good	Poor
	October 23	Removal	Good	Good	Excellent	Excellent	Good
Tributary to Reid Brook	September 19	Deployment	Excellent	Fair	Poor	Excellent	Excellent
	October 23	Removal	Excellent	Good	Poor	Excellent	Excellent

* N/A = sensor failure

- **Reid Brook at Outlet of Reid Pond**
  - At deployment, all parameters ranked as 'excellent' except for pH, which ranked as 'poor'. This discrepancy was likely due to the field sonde not being given sufficient time to acclimate and stabilize before a reading was taken. This conclusion is supported by the similarity between the QA/QC and Grab Sample results for pH.
  - At removal, temperature, conductivity and dissolved oxygen all ranked as 'excellent', while turbidity was 'good' and pH was 'poor'. This discrepancy was due to a sensor failure on the field sonde. This data has been removed from the dataset as it is not representative of the water conditions at this station from October 2nd onwards.
- **Camp Pond Brook below Camp Pond**
  - At deployment, all parameters were either 'excellent' or 'good'.
  - At removal, temperature, pH and dissolved oxygen were 'excellent', conductivity was 'good', while turbidity was 'poor'. This discrepancy may have been caused by the QA/QC sonde not being placed in close enough proximity to the field sonde, or by increased sediment build-up around the field sonde.

- **Reid Brook below Tributary**
    - At deployment, temperature and conductivity were 'excellent', dissolved oxygen was 'good', pH was 'marginal' and turbidity was 'poor'. This discrepancy may have been caused by the QA/QC sonde not being placed in close enough proximity to the field sonde, or by temporary disturbance of sediment in the brook by both staff and equipment.
    - At removal, all parameters were either 'excellent' or 'good'.
- **Tributary to Reid Brook**
    - At deployment, temperature, dissolved oxygen and turbidity were 'excellent' and pH was 'fair', while conductivity was 'poor'. This discrepancy was likely due to the field sonde not being given sufficient time to acclimate and stabilize before a reading was taken. This conclusion is supported by the similarity between the QA/QC and Grab Sample results for conductivity.
    - At removal, temperature, dissolved oxygen and turbidity were 'excellent' and pH was 'good', while conductivity was 'poor'. This discrepancy may have been caused by placement of the QA/QC sonde, or the QA/QC not being given adequate time to acclimate before a reading was taken.

It is important to note that, in general, there are several conditions under which a less than ideal QA/QC ranking may be obtained. These include, but are not limited to: placement of the QA/QC sonde in relation to the field sonde; the amount of time each sonde is given to stabilize before readings are recorded; and deteriorating performance of one or more sensors.

Data Interpretation

The following graphs and discussion illustrate significant water quality-related events from September 19th to October 23rd, 2017 in the Voisey's Bay Real-Time Water Quality Monitoring Network.

The Reid Brook below Tributary station experienced a transmission failure after wires were severed by wildlife. Internal log file data was used to provide missing data for most parameters; however, stage and flow data only became available after transmission was restored on October 17th.

With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

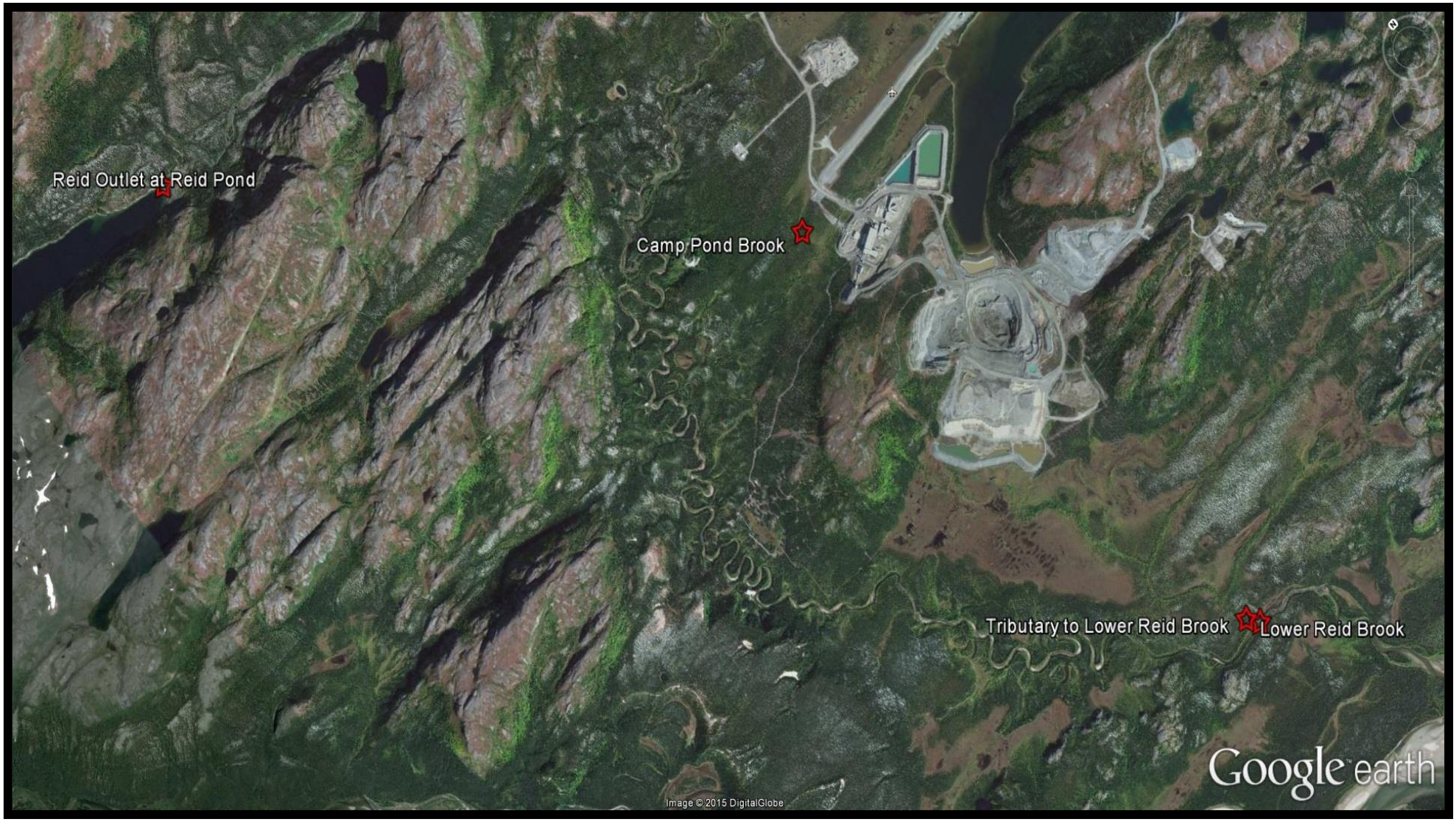

Figure 1: Voisey's Bay Network Station Locations

Reid Brook at Outlet of Reid Pond

Water Temperature

Over the deployment period, water temperature ranged from 4.32°C to 11.36°C, with a median value of 7.39°C (Figure 2). Temperature was steadily decreasing over the course of deployment, which is to be expected due to changing ambient air temperatures into the fall months (Figure 3). This water body takes longer to acclimate to changes in temperature as it has a larger surface area than the smaller brooks.

Please note that the stage data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC. Average Daily Air Temperature was retrieved from Environment Canada's Weather Station in Nain.

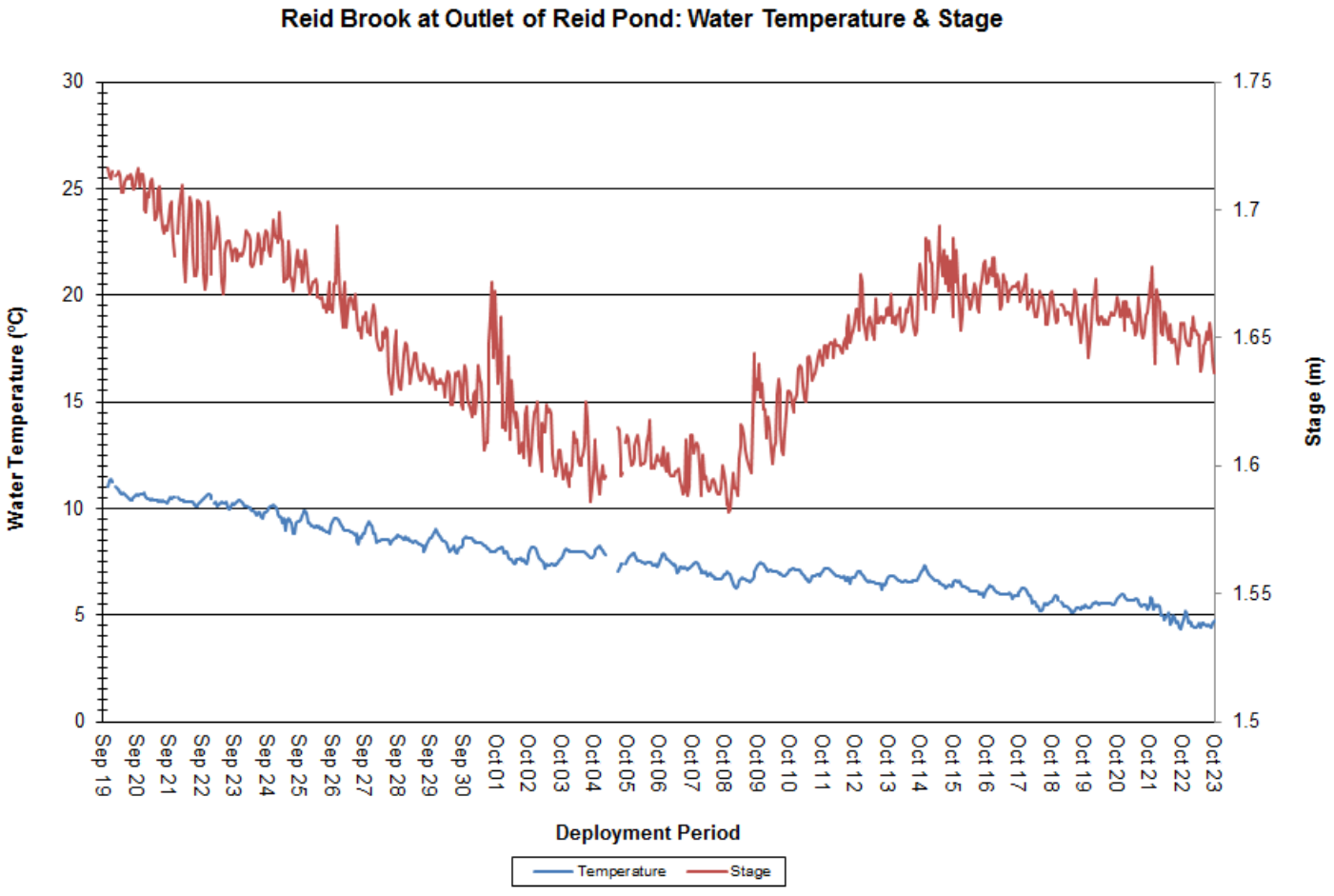

Figure 2: Water Temperature & Stage at Reid Brook at Outlet of Reid Pond

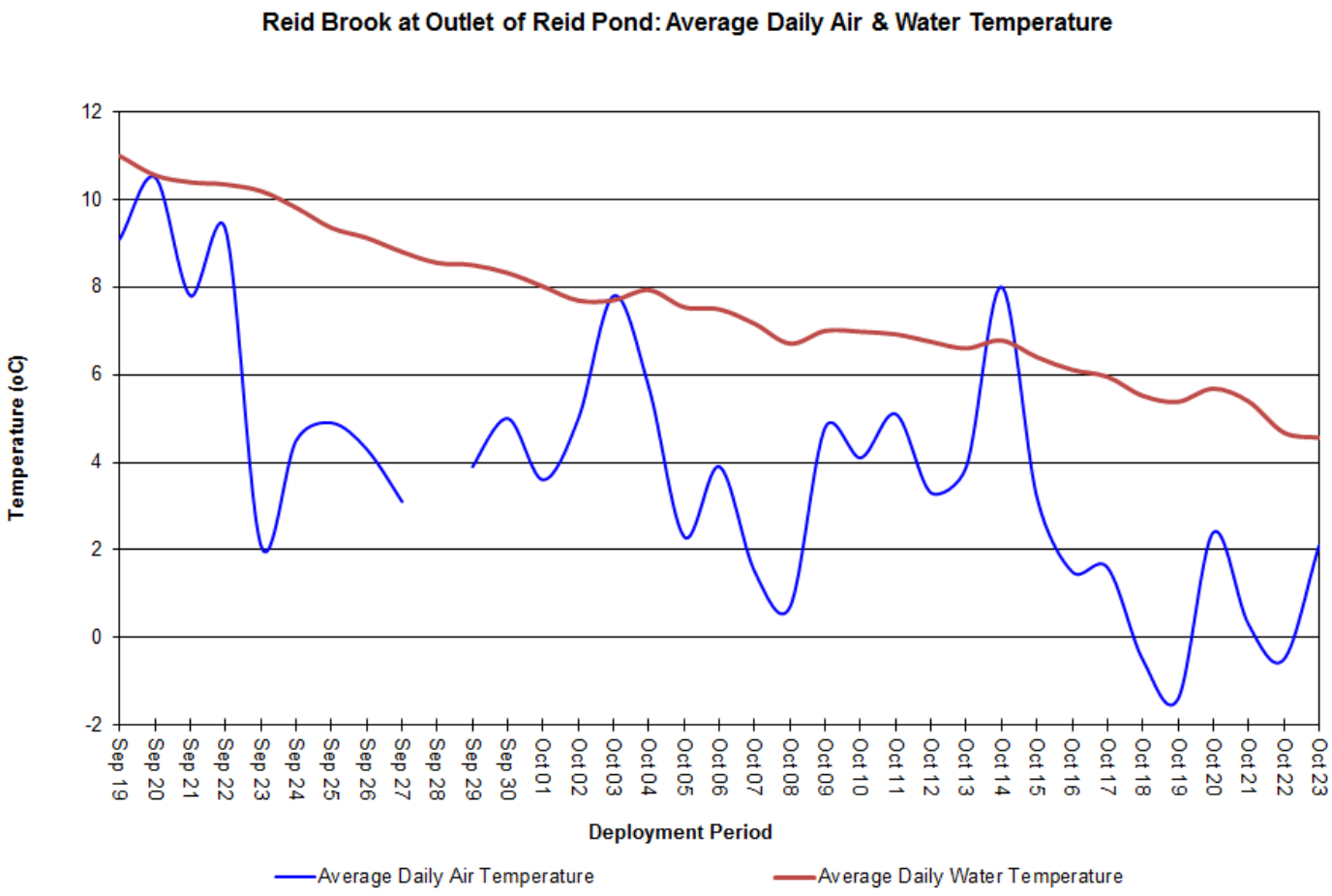

Figure 3: Average Daily Water Temperature at Reid Brook at Outlet of Reid Pond and Average Daily Air Temperature at Nain Weather Station

pH

Over the deployment period, pH values ranged from 6.27 to 6.65 pH units, with a median value of 6.51 pH units (Figure 4). pH values from October 2nd onwards were removed from the data analysis due to a sensor failure.

pH levels increased slightly during the initial deployment period, hovering around the minimum value for the CCME Guidelines for Protection of Aquatic Life. It is not possible to determine if this increasing trend continued for the remainder of the deployment period.

Please note that the stage data used below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

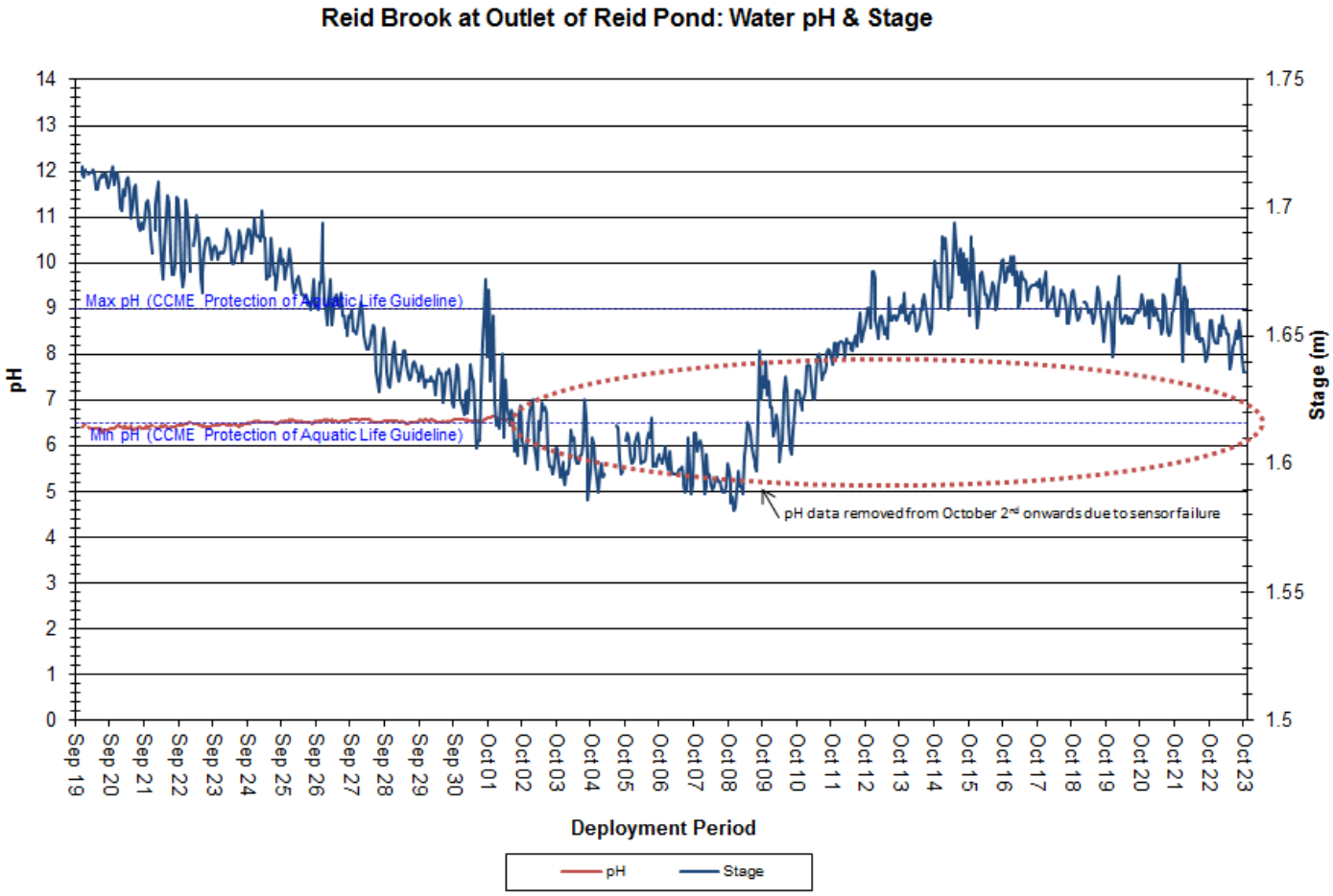

Figure 4: pH & Stage at Reid Brook at Outlet of Reid Pond

Specific Conductivity

Over the deployment period, conductivity levels ranged from 11.9µS/cm to 22.3µS/cm, with a median value of 12.3µS/cm.

The relationship between conductivity and stage level is generally inversed. When stage levels decrease, specific conductance levels increase in response, as the decreased amount of water in the river system concentrates solids that are present. Similarly, as stage levels rise, conductivity levels will decrease in response (Figure 5).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

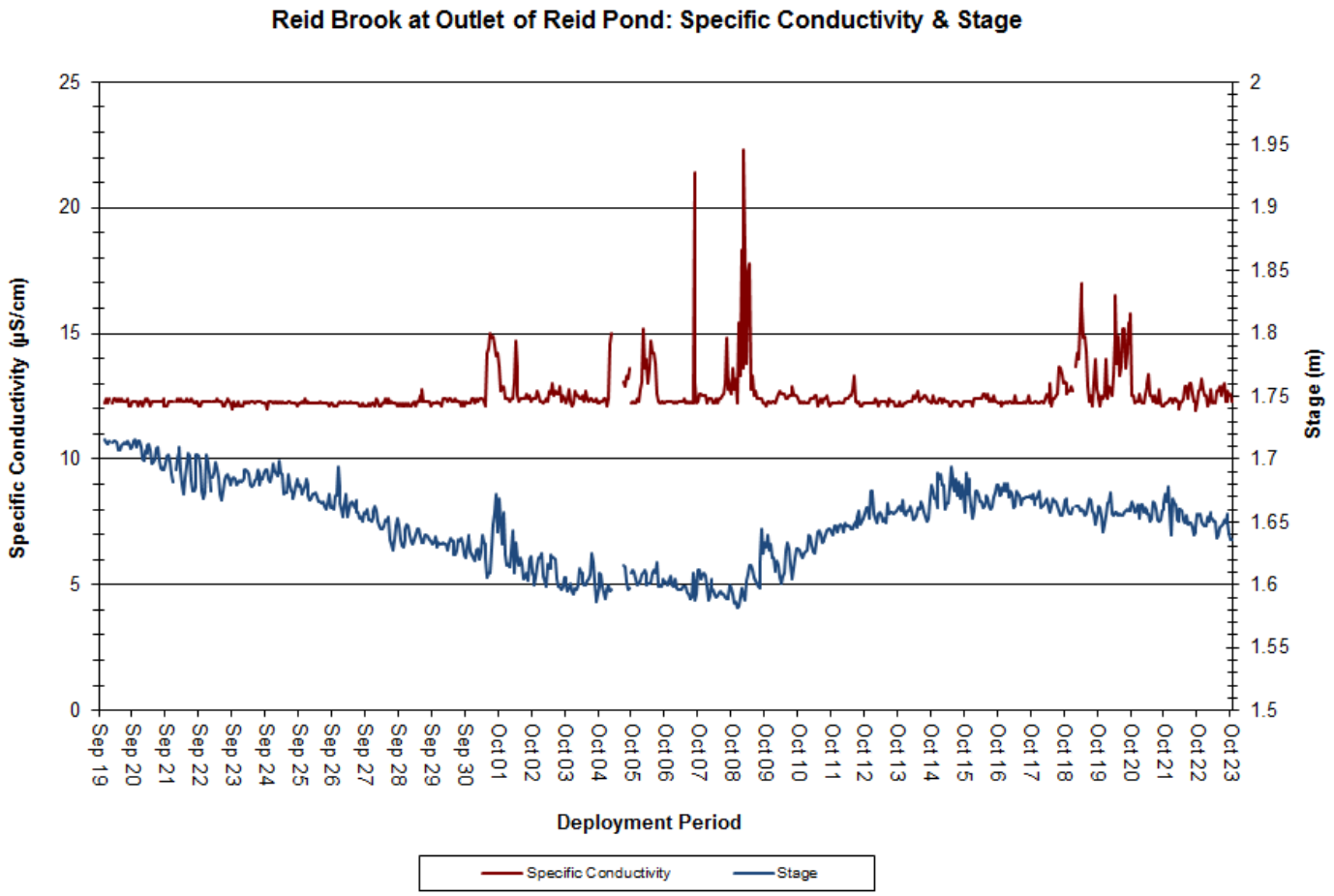

Figure 5: Specific Conductivity & Stage at Reid Brook at Outlet of Reid Pond

Dissolved Oxygen

The water quality instrument measures dissolved oxygen concentration (mg/L) with a dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account water temperature.

Over the deployment period, dissolved oxygen concentration ranged from 10.22mg/L to 11.96mg/L, with a median value of 11.18mg/L. Percent saturation levels ranged from 82.2% to 97.1% saturation, with a median value of 93.0% saturation (Figure 6).

Dissolved oxygen levels steadily increased over the course of deployment, which is to be expected as water temperatures dropped. A waterbody will have higher dissolved oxygen levels at cooler temperatures, and vice versa. Dissolved oxygen concentrations remained above the CCME's Guideline for the Protection of Early Life Stages (9.5 mg/L) for the duration of deployment.

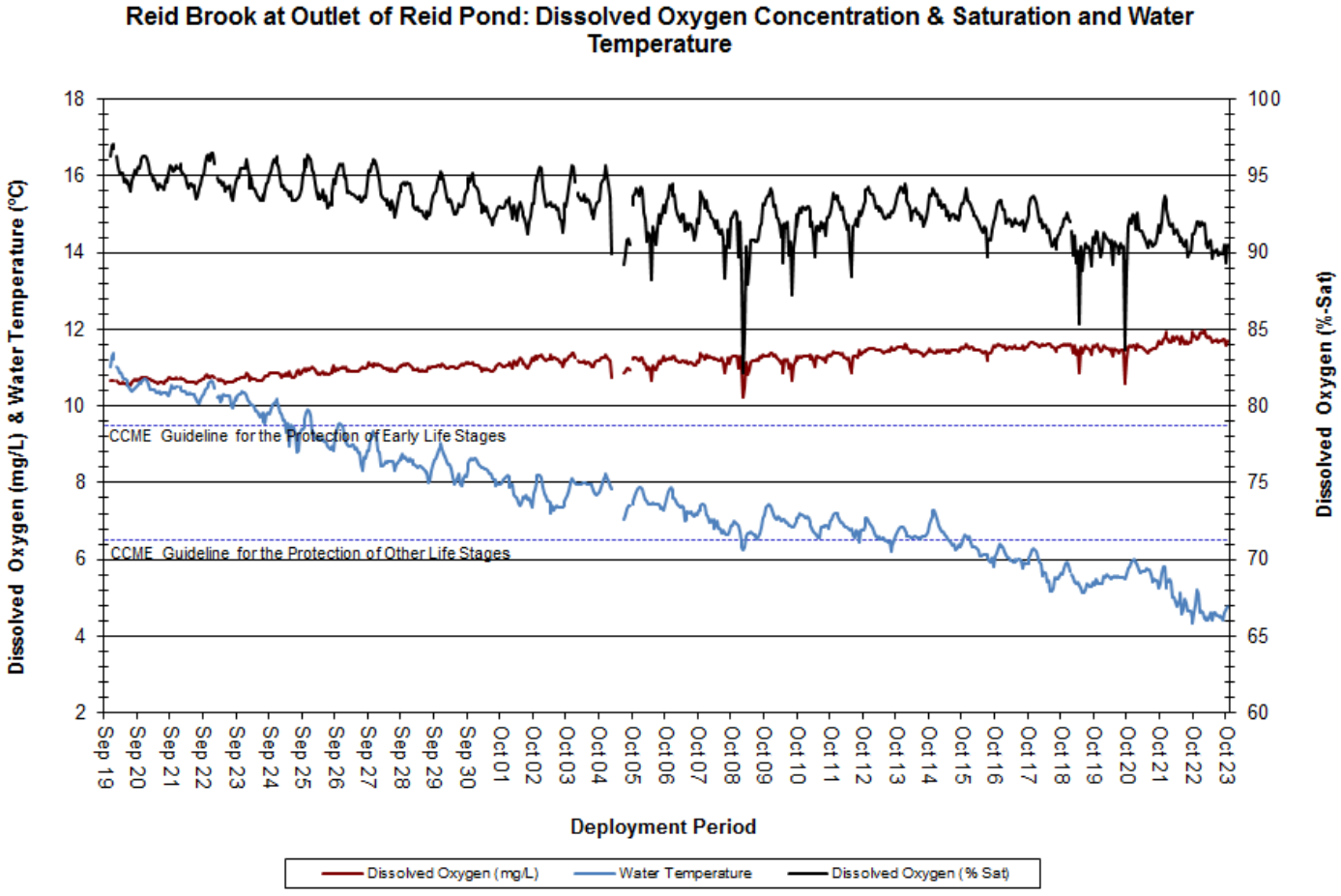

Figure 6: Dissolved Oxygen (mg/L & % Sat) and Water Temperature at Reid Brook at Outlet of Reid Pond

Turbidity

Turbidity levels ranged from 0.0 NTU to 9.7 NTU, with a median value of 0.0 (Figure 7). A median value of 0.0 NTU indicates there was very little natural background turbidity at this station during this deployment period.

All water bodies have a natural level of turbidity. A significant increase in turbidity is of concern when monitoring brooks. Higher turbidity readings would normally be expected during heavy rainfall or runoff events. Generally, turbidity levels increase for a short period of time and then return to within a baseline range.

Turbidity values can also increase when there is a decrease in water level, which causes natural material in the water body to become concentrated.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

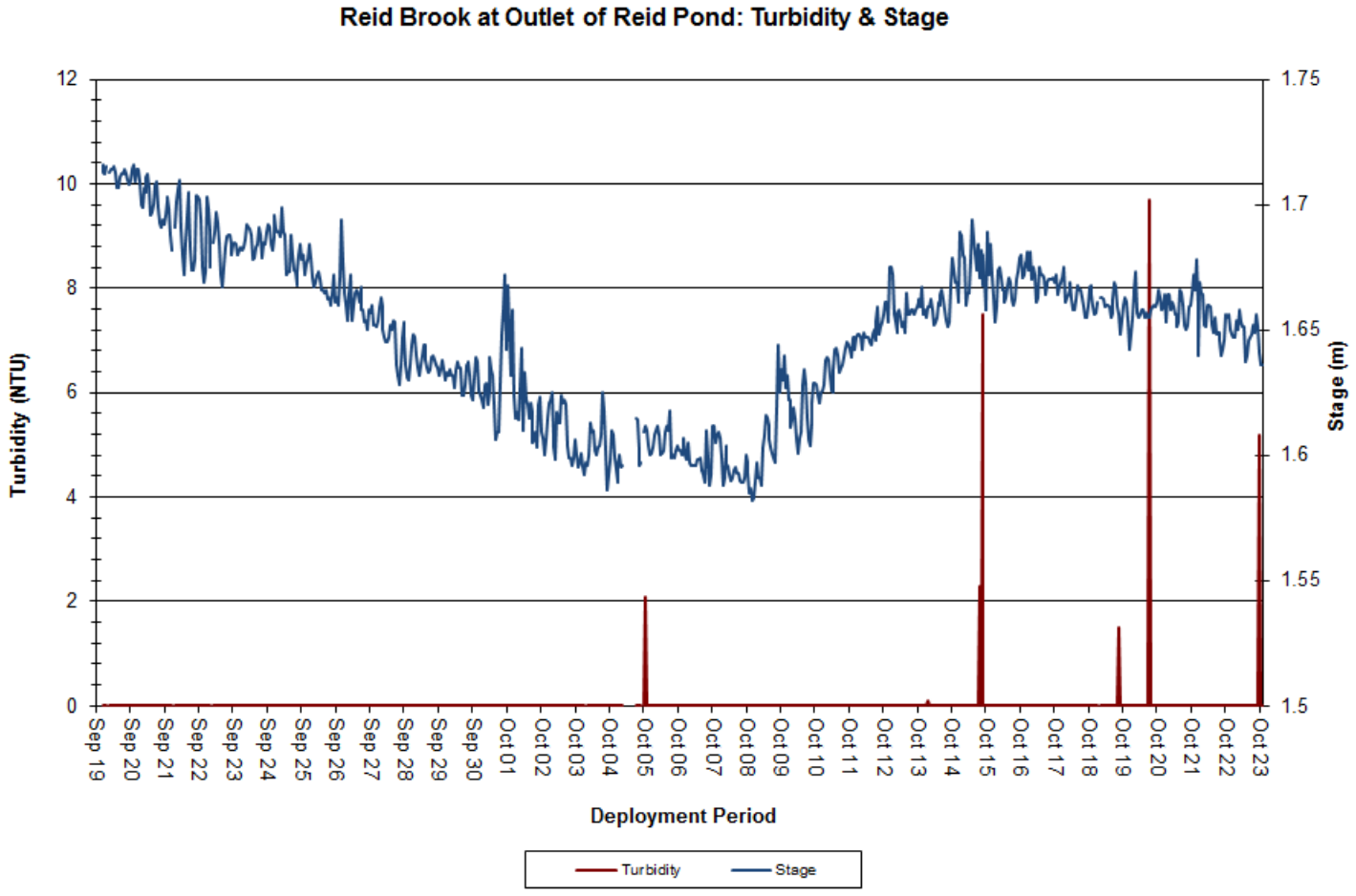

Figure 7: Turbidity & Stage at Reid Brook at Outlet of Reid Pond

Stage, Flow & Precipitation

Stage is an important parameter, as it provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (e.g. specific conductivity, DO, and turbidity). Stage will generally increase during rainfall events (Figure 8) and during any surrounding snow or ice melt; however, direct snowfall will not cause a significant increase in stage.

Over the deployment period, stage values ranged from 1.58m to 1.72m, with a median value of 1.66m. Flow values ranged from 0.41m^3/s to 0.99m^3/s, with a median value of 0.70m^3/s. Precipitation data was obtained from Nain Weather Station. Precipitation amounts during the deployment period ranged from 0.0mm to 10.9mm on October 8th, 2017.

Please note that the stage and flow data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

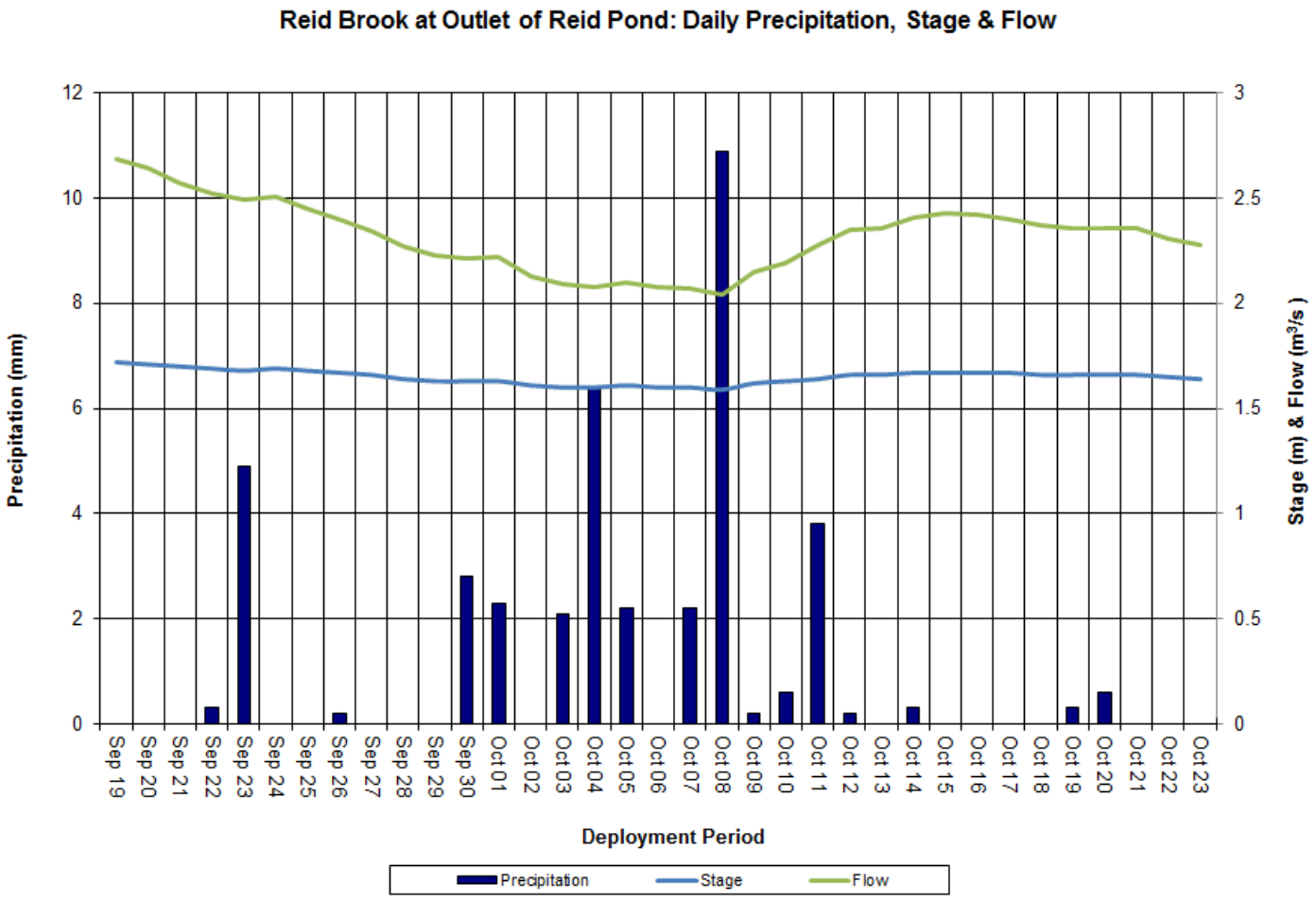

Figure 8: Daily Stage and Flow data from Reid Brook at Outlet of Reid Pond and Total Daily Precipitation from Nain Weather Station

Camp Pond Brook below Camp Pond

Water Temperature

Over the deployment period, water temperature ranged from 0.54°C to 11.02°C, with a median value of 4.57°C (Figure 9).

Water temperature at this station displayed diurnal variations and gradually decreased over the course of deployment. This is to be expected as ambient air temperatures decreased into the fall months (Figure 10).

This stream is sensitive to changes in ambient air temperatures and fluctuates considerably depending on the weather and time of day. This station typically has the highest water temperatures and greatest fluctuations when compared to the other stations in the network.

Please note that the stage data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

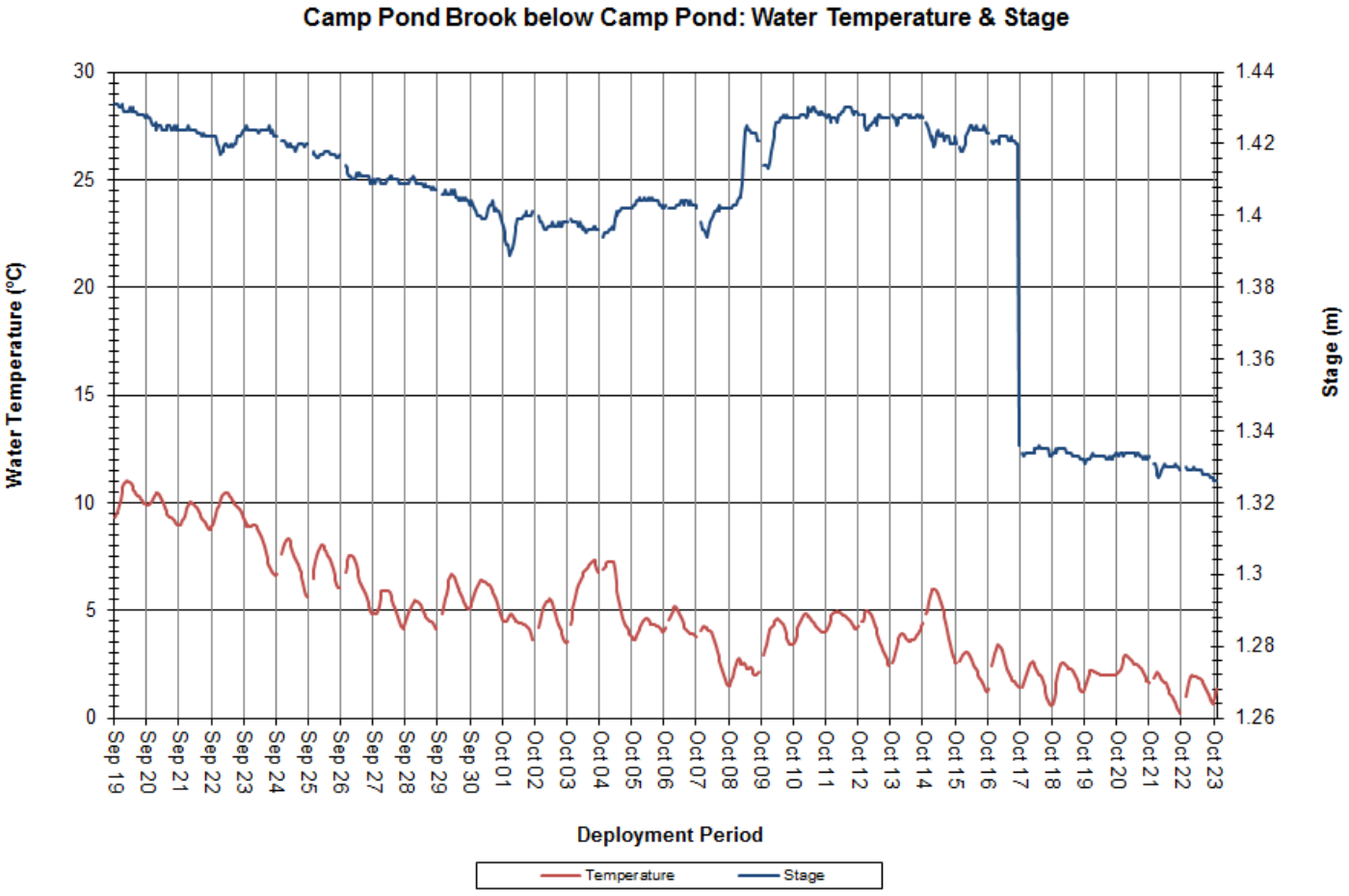

Figure 9: Water Temperature & Stage at Camp Pond Brook below Camp Pond

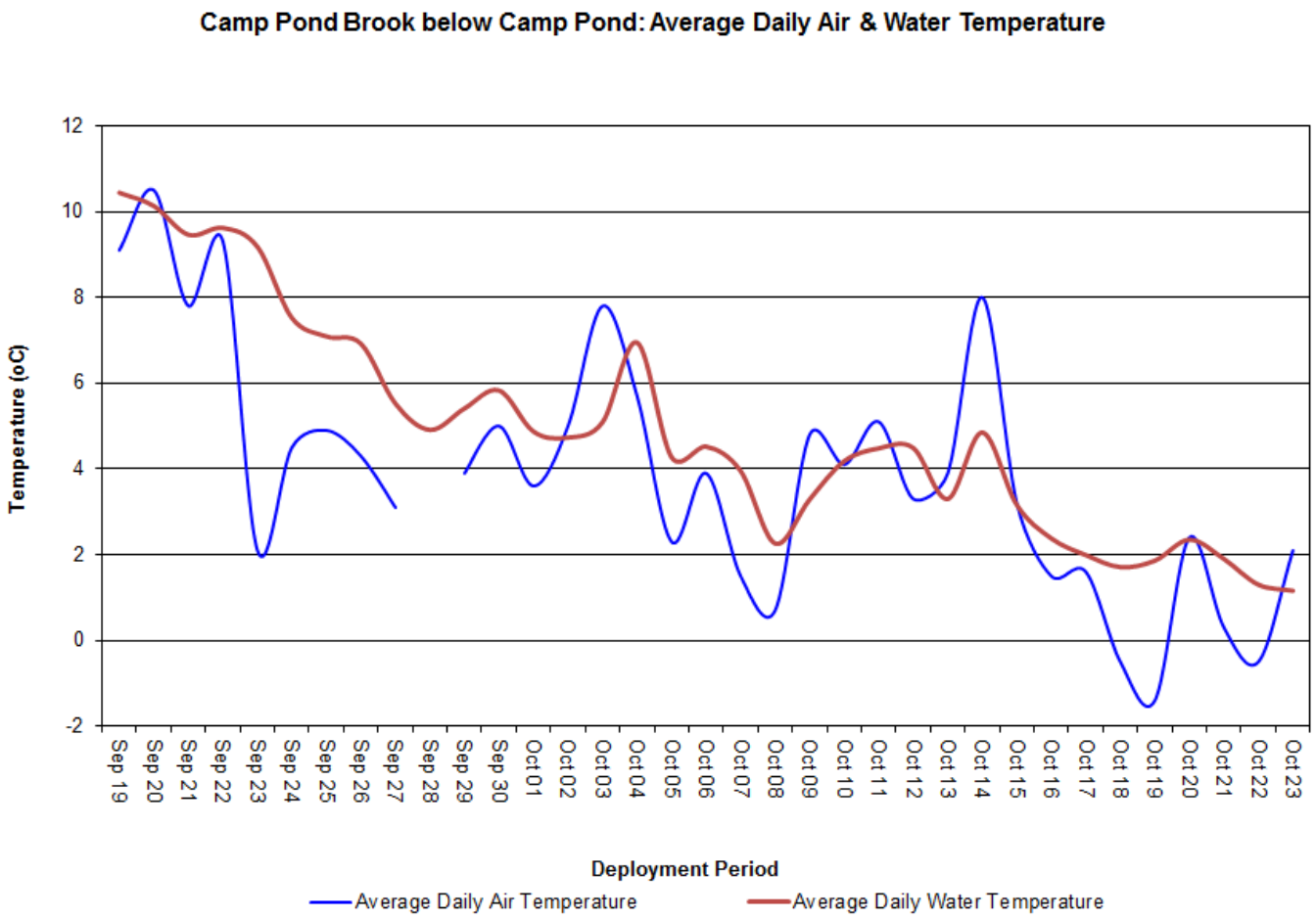

Figure 10: Average Daily Water Temperature at Camp Pond Brook below Camp Pond and Average Daily Air Temperature at Nain Weather Station

pH

Over the deployment period, pH values ranged from 6.66 to 7.04 pH units, with a median value of 6.92 pH units (Figure 11).

pH levels were very consistent over the course of deployment, staying within the Guidelines for Protection of Aquatic Life.

Natural events such as rainfall and snow melt will alter the pH of a brook for a period of time - pH levels will decrease slightly during and after high stage levels. This is a natural process.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

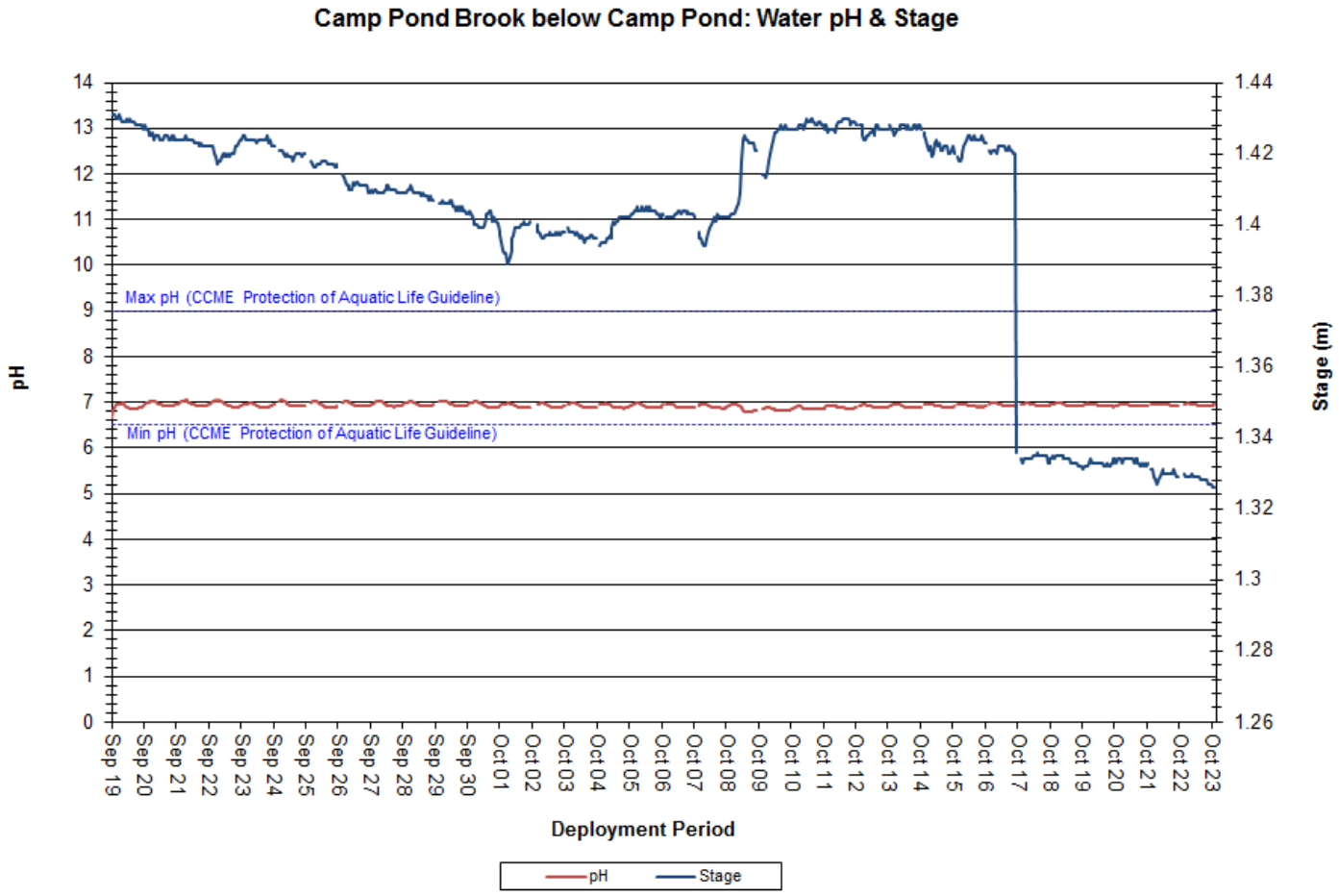

Figure 11: Water pH & Stage at Camp Pond Brook below Camp Pond

Specific Conductivity

Specific conductivity ranged from 41.9µS/cm to 61.1µS/cm, with a median value of 44.6µS/cm (Figure 12).

Rainfall events (Figure 15) tend to correspond with sharp increases in conductivity levels, indicating that additional suspended material was entering the brook during these periods. This can be observed on October 8th, where a heavy rainfall event corresponds with a rapid increase in specific conductivity.

Conductivity levels stayed relatively consistent over the course of deployment. Slight increases in conductivity correlated with decreasing water levels, which generally cause suspended materials in the water column to become more concentrated.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

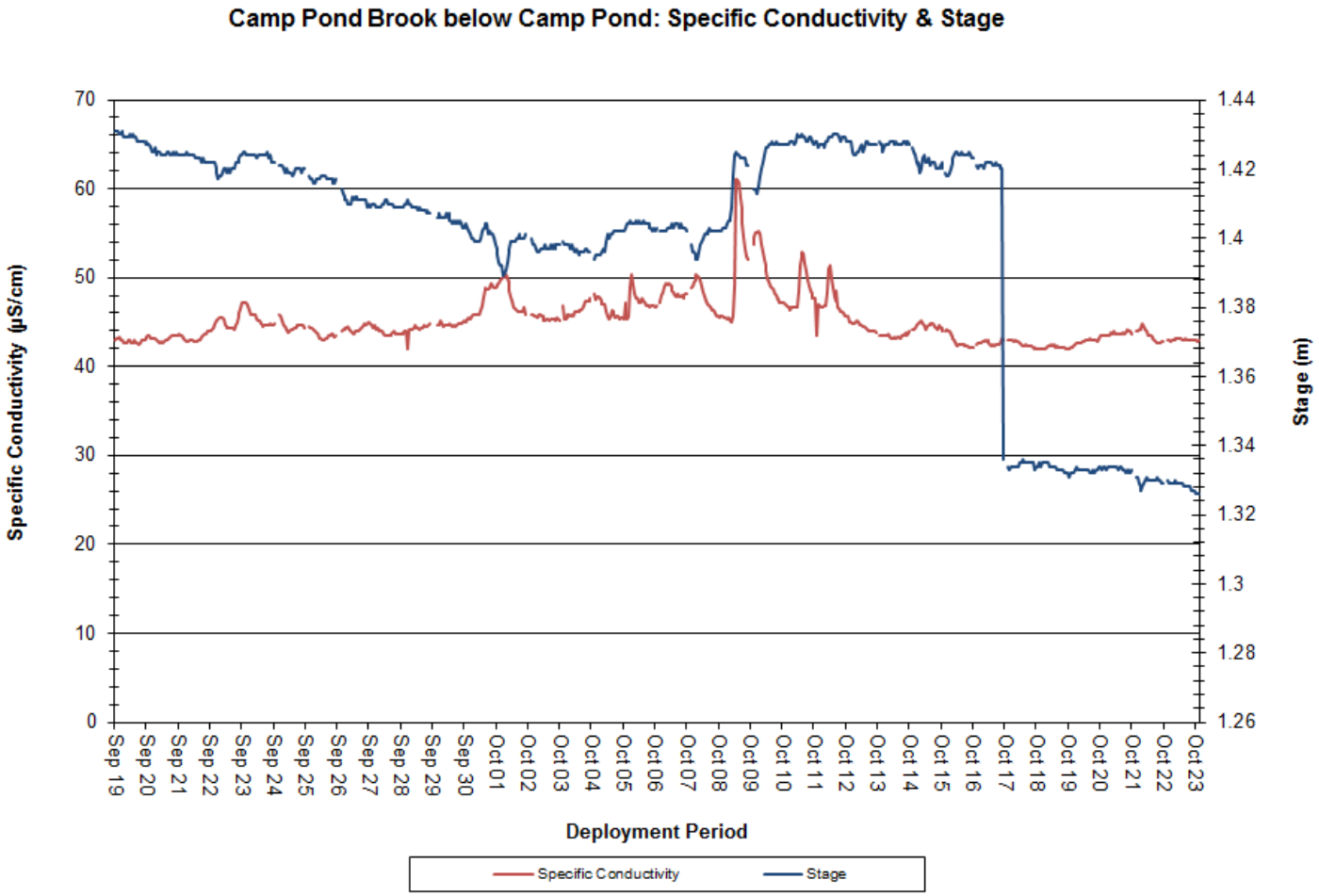

Figure 12: Specific Conductivity & Stage at Camp Pond Brook below Camp Pond

Dissolved Oxygen (mg/L & % Saturation)

Dissolved oxygen concentration levels ranged from 10.40 to 13.31mg/L, with a median value of 11.99mg/L. Saturation of dissolved oxygen ranged from 88.7% to 97.4% saturation, with a median value of 92.7% (Figure 13).

Dissolved oxygen concentrations remained above the CCME Guideline for the Protection of Early Life Stages (9.5mg/L) for the duration of deployment. Dissolved oxygen concentrations increased over the course of deployment, which is to be expected as water temperatures dropped (Figure 13).

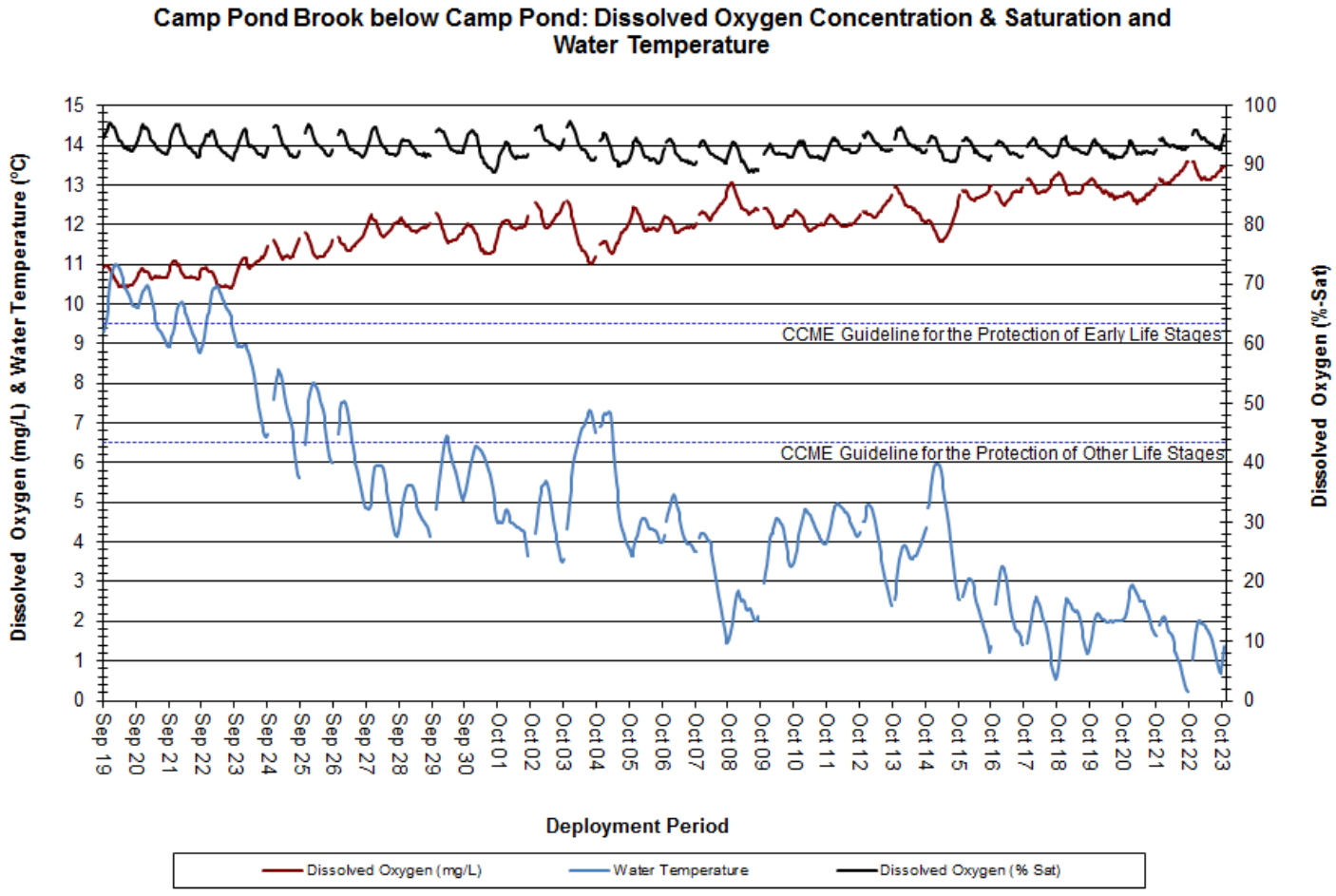

Figure 13: Dissolved Oxygen & Water Temperature at Camp Pond Brook below Camp Pond

Turbidity

Turbidity ranged from 3.7NTU to 182.1NTU, with a median value of 11.5NTU (Figure 14). A median value of 11.5NTU indicates that there is background turbidity at this station.

Turbidity spikes observed during deployment were short-lived and correlated closely with rainfall events (Figure 15). Turbidity levels consistently returned to background levels following rainfall events.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

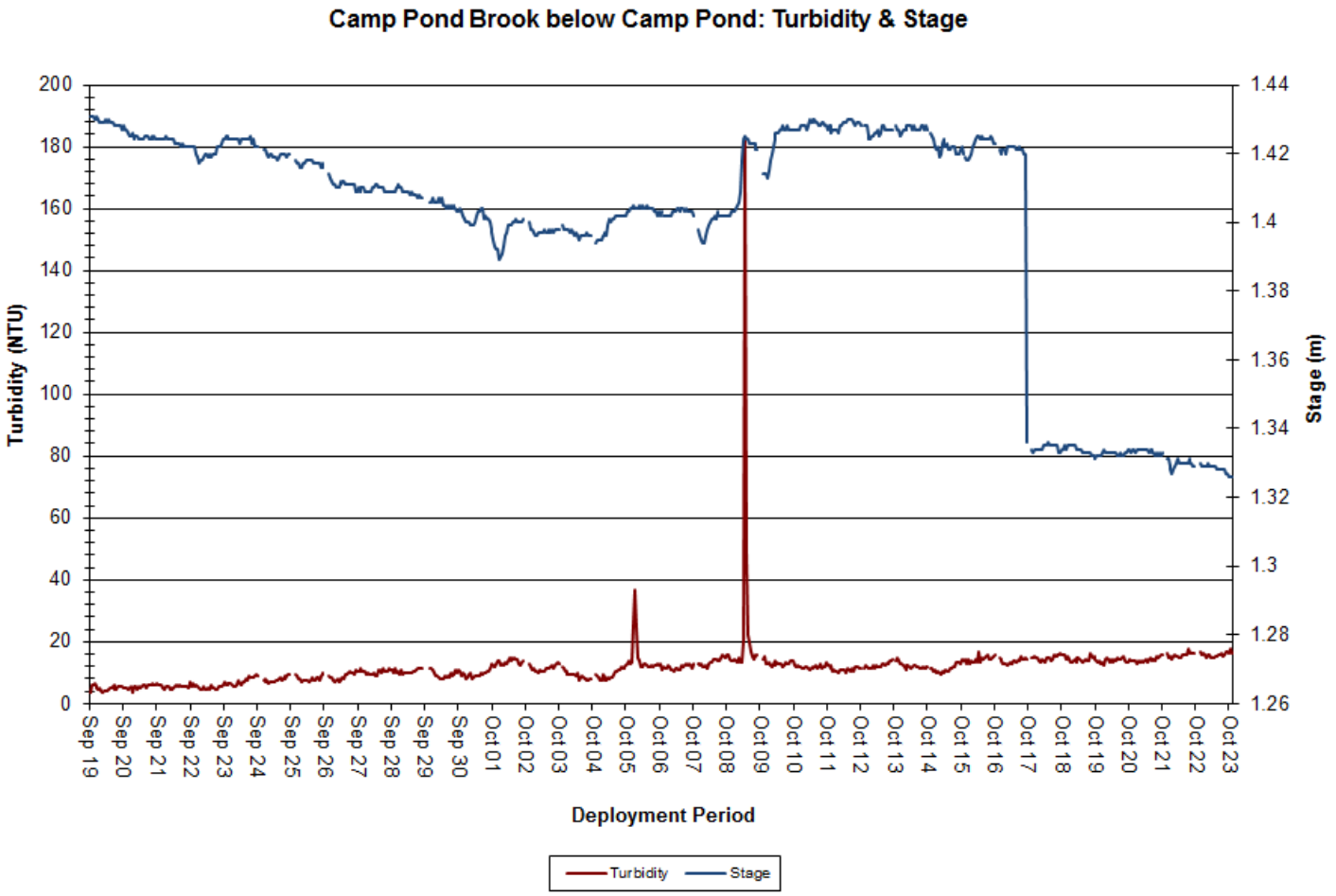

Figure 14: Turbidity & Stage at Camp Pond Brook below Camp Pond

Stage, Flow and Precipitation

Stage values ranged from 1.33m to 1.43m, with a median value of 1.41m.

Flow ranged from 0.13 to 0.44m^3/s, with a median value of 0.36m^3/s.

Precipitation occurs on 17 days during the deployment period, ranging from 0.0mm to 10.9mm. Heavy precipitation events correlated with increases in both stage and flow (Figure 15).

Please note the stage data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

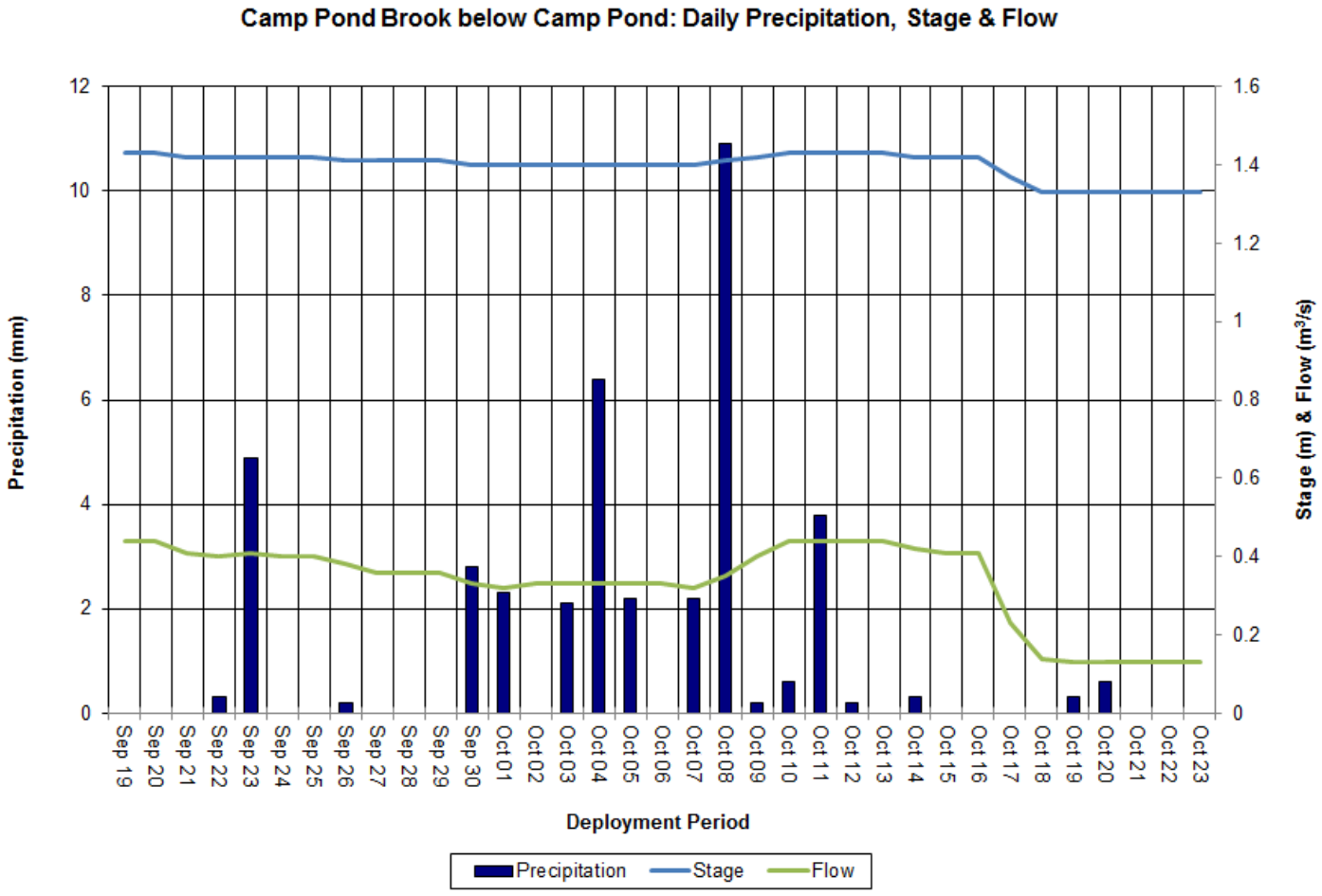

Figure 15: Daily Stage & Flow data from Camp Pond Brook below Camp Pond and Total Daily Precipitation from Nain Weather Station

Reid Brook below Tributary

Water Temperature

Over the deployment period, water temperature ranged from 0.17°C to 8.40°C, with a median value of 3.61°C (Figure 16).

Water temperature at this station displayed diurnal variations, and steadily decreased over the course of deployment. This is to be expected as air temperatures also decreased during this period (Figure 17).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

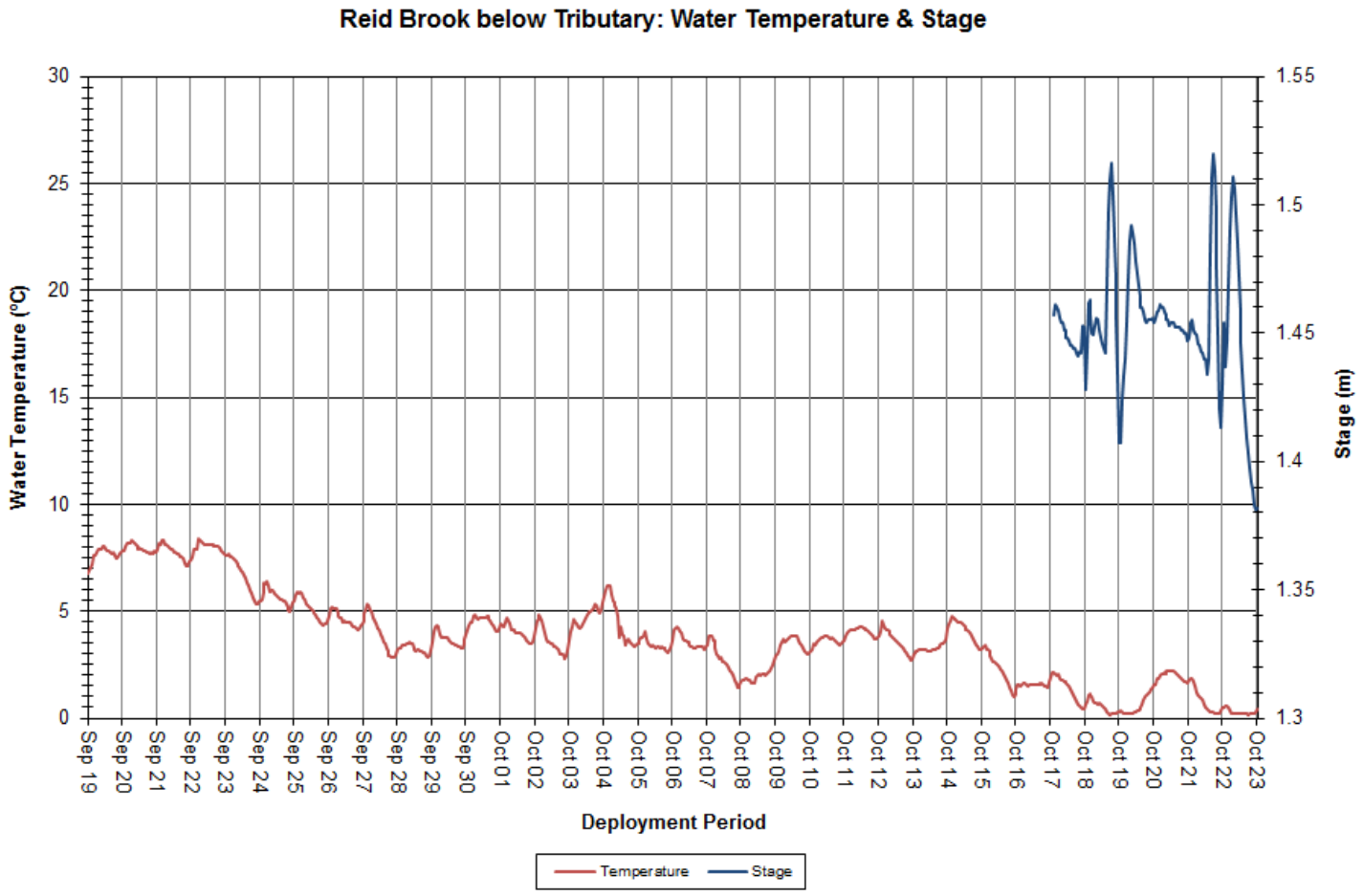

Figure 16: Water Temperature & Stage at Reid Brook below Tributary

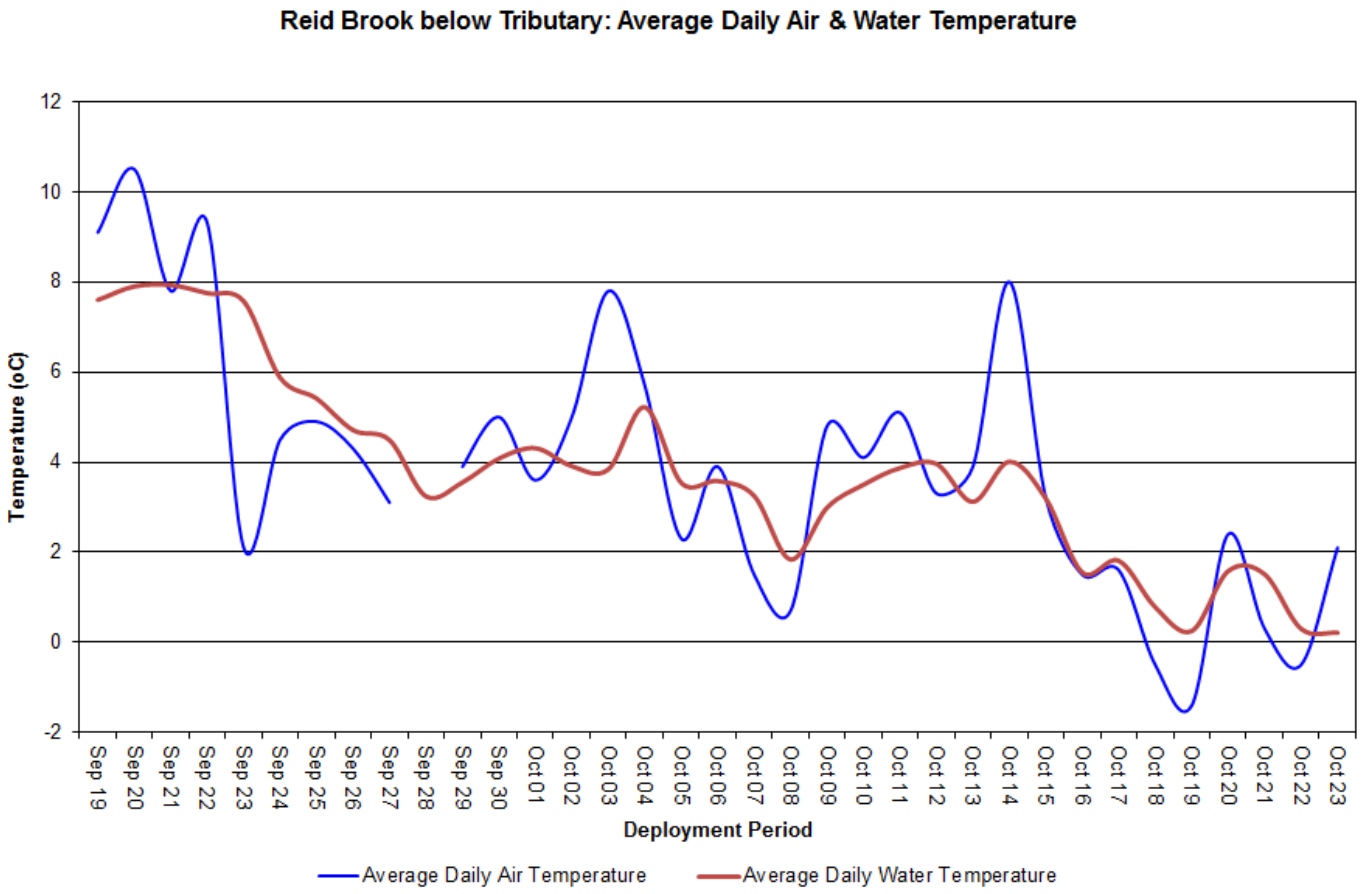

Figure 17: Average Daily Water Temperature at Reid Brook below Tributary and Average Daily Air Temperature from Nain Weather Station

pH

During deployment, pH ranged from 6.69 to 7.10 pH units, with a median value of 6.98 (Figure 18).

Overall, pH levels at this station remained consistent and were within the CCME guidelines for the protection of aquatic life for the duration of deployment.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

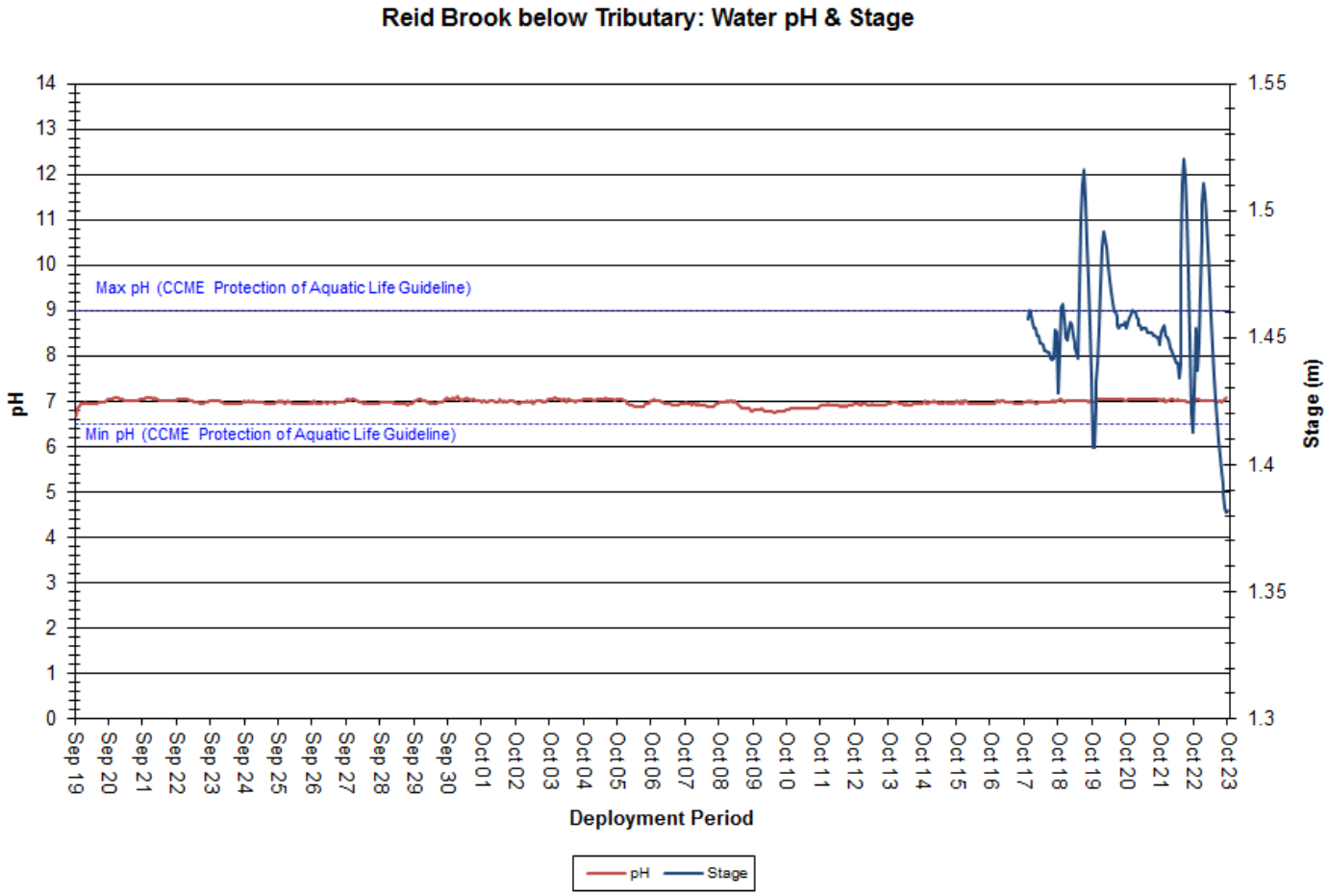

Figure 18: pH & Stage at Reid Brook below Tributary

Specific Conductivity

Specific conductivity ranged from 24.0µS/cm to 43.0µS/cm, with a median value of 39.0µS/cm (Figure 19).

Stage and specific conductivity generally exhibit an inverse relationship: as one parameter increases, the other decreases. This is likely a result of dissolved solids being flushed through the brook for short periods of time. This relationship is difficult to see from the graph below given the lack of stage data.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

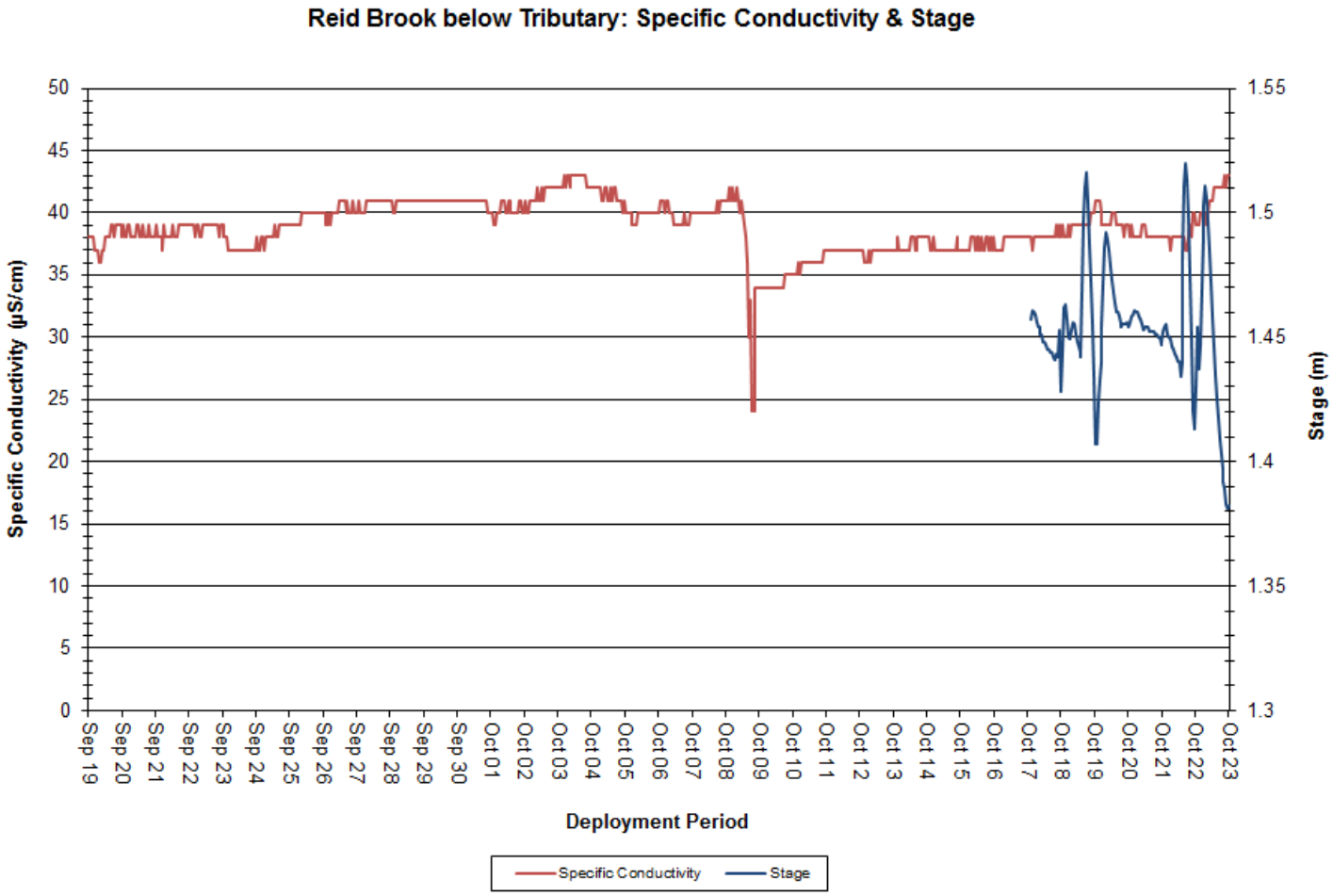

Figure 19: Specific Conductivity & Stage at Reid Brook below Tributary

Dissolved Oxygen

Dissolved oxygen content ranged from 10.81 to 13.56mg/L, with a median value of 12.11mg/L. The saturation of dissolved oxygen ranged from 89.4% to 97.4% saturation, with a median value of 92.8% (Figure 20).

Dissolved oxygen concentrations remained above the CCME Guideline for the Protection of Early Life Stages (9.5mg/L) for the duration of deployment. Dissolved oxygen levels steadily increased over the deployment period, which is to be expected as water temperatures dropped. Dissolved oxygen levels are generally lower at warmer water temperatures, and vice versa.

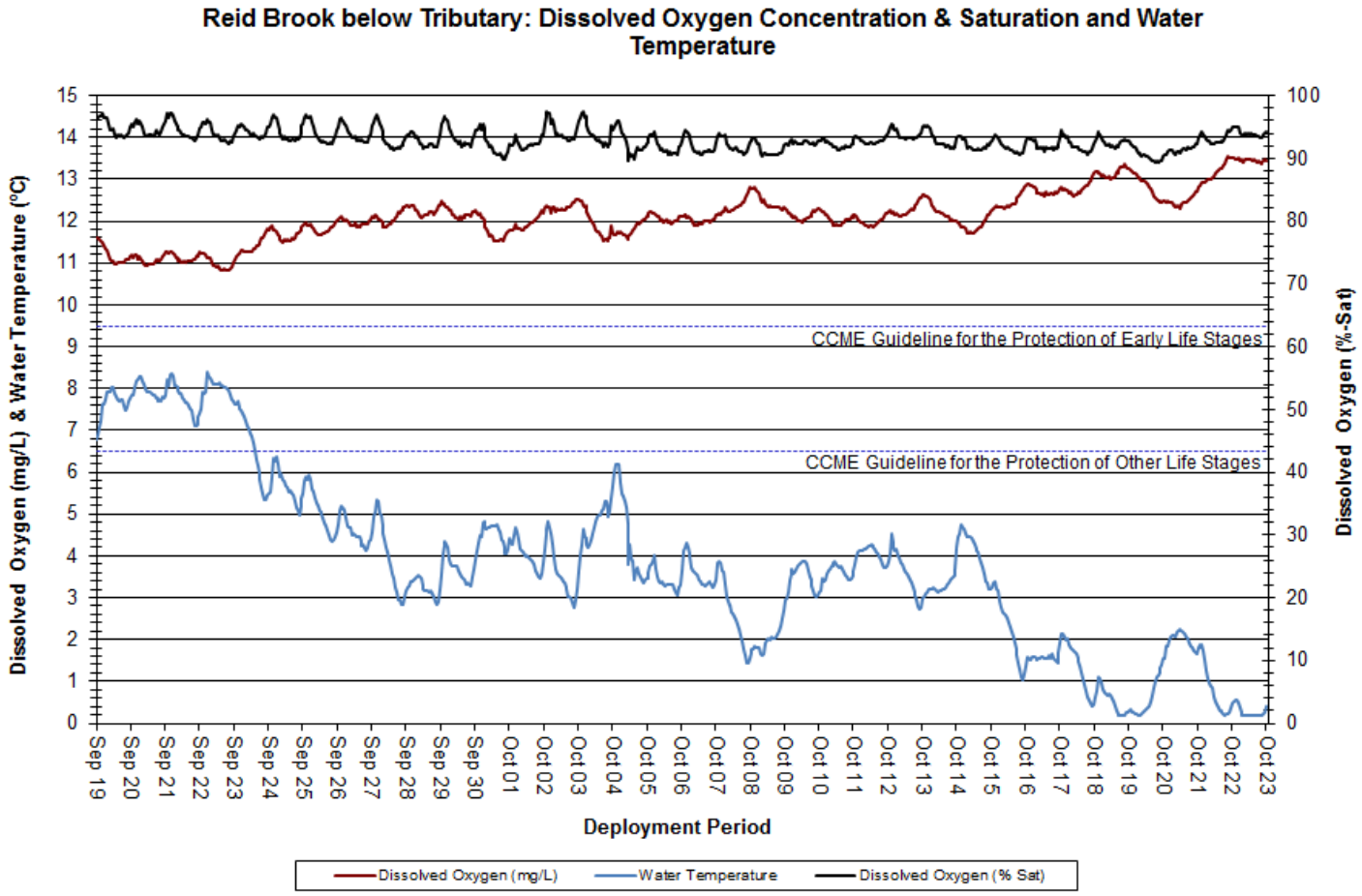

Figure 20: Dissolved Oxygen & Water Temperature at Reid Brook below Tributary

Turbidity

During deployment, turbidity ranged from 0.0 to 23.4 NTU, with a median value of 0.0 NTU (Figure 21). A median value of 0.0 NTU indicates that there is very little background turbidity at this station.

Turbidity was relatively stable at this station for the duration of deployment. Larger turbidity events generally correlated with precipitation events (Figure 22), which can cause mixing of solids in the water column. This correlation was particularly evident on October 1st, 8th and 11th.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

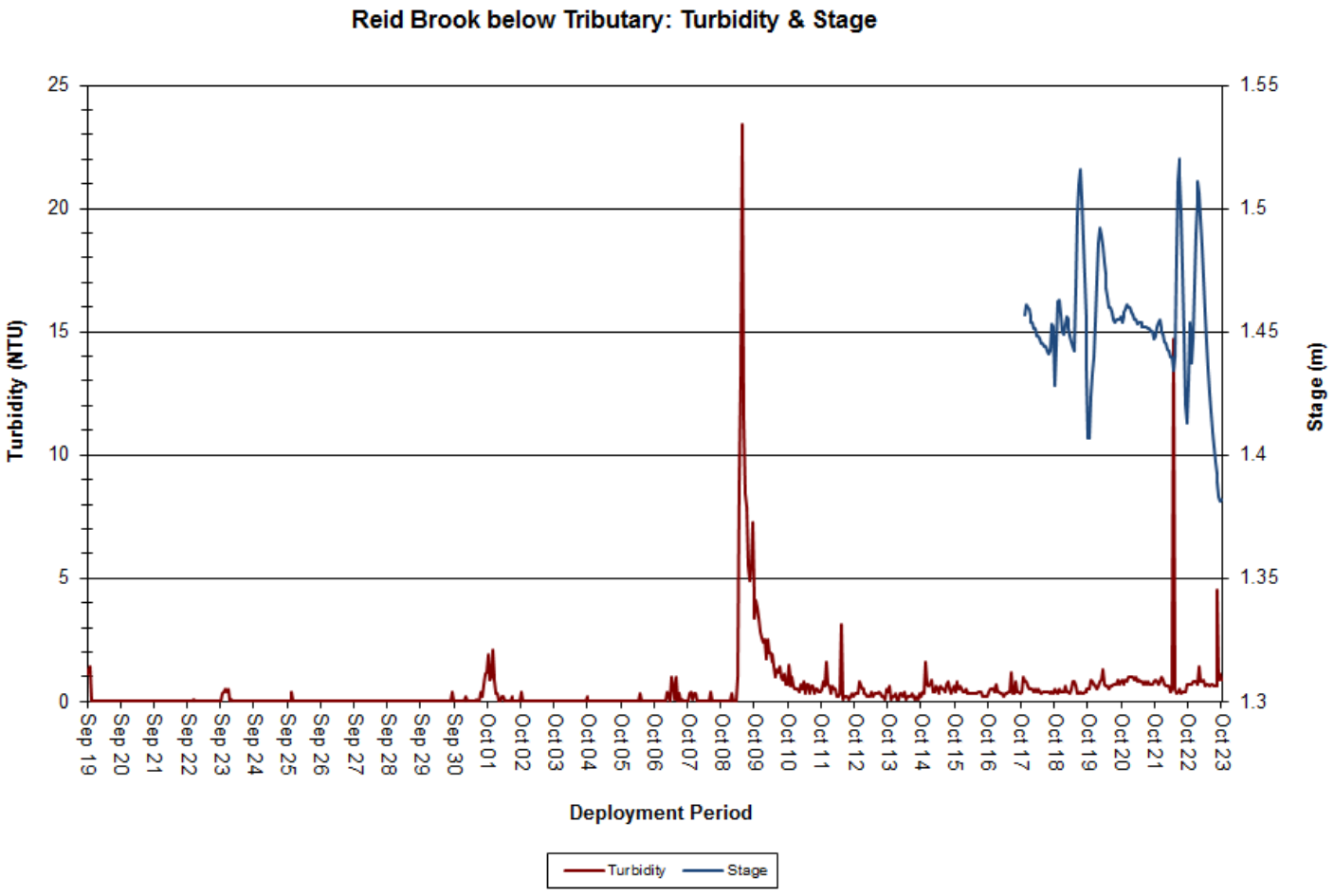

Figure 21: Turbidity & Stage at Reid Brook below Tributary

Stage, Flow and Precipitation

Stage ranged from 1.38m to 1.52m, with a median of 1.45m.

Flow ranged from 0.74m^3/s to 2.65m^3/s, with a median value of 1.53m^3/s.

Stage, flow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). While increases in stage (m) and flow (m³/s) are generally linked to precipitation events, this relationship is difficult to observe in the graph below due to lacking stage and flow data.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

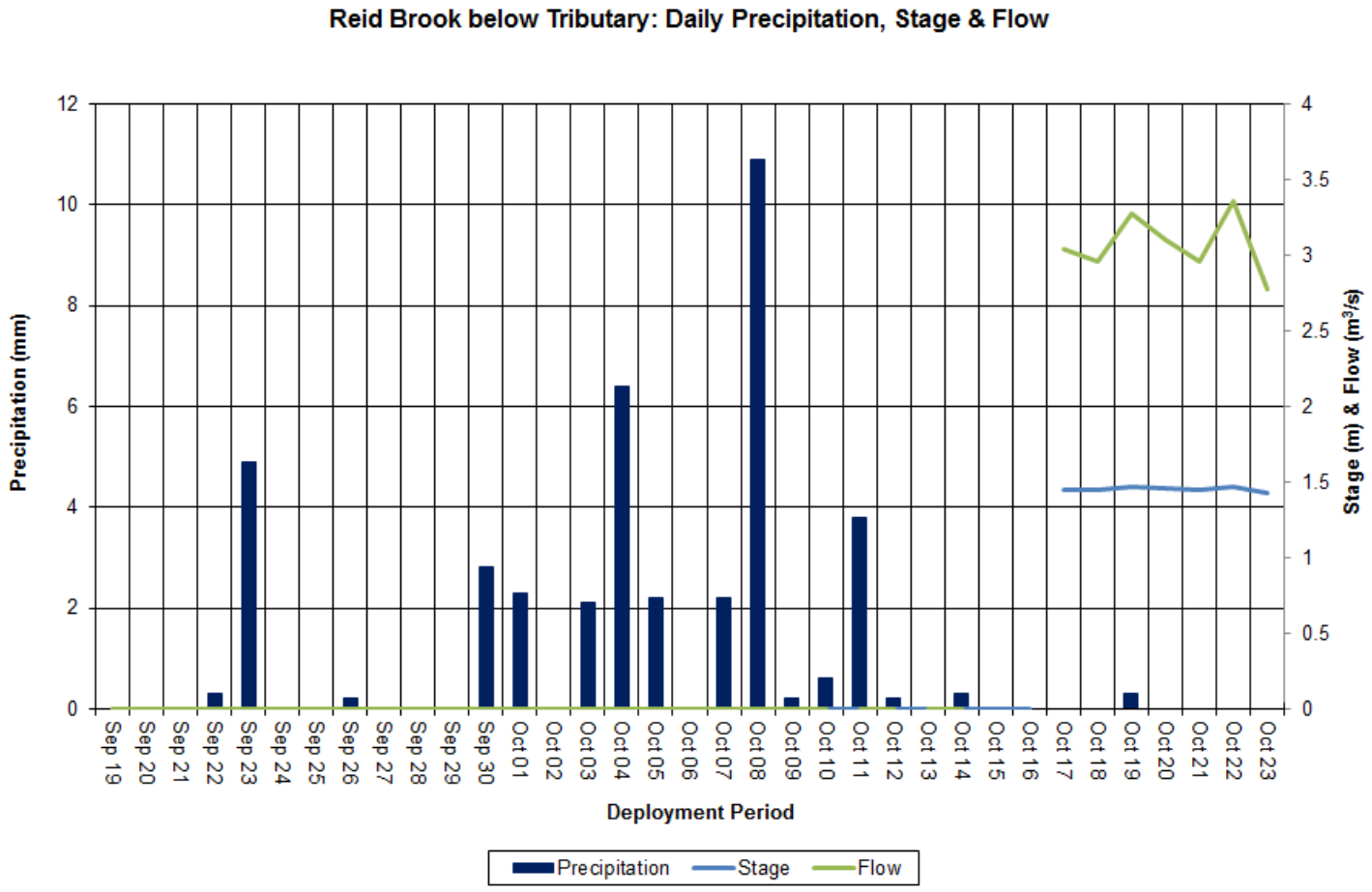

Figure 22: Daily Stage & Flow data from Reid Brook below Tributary and Total Daily Precipitation from Nain Weather Station

Tributary to Reid Brook

Water Temperature

Water temperature ranged from 0.00°C to 8.00°C, with a median value of 3.50°C (Figure 23). Streams and brooks are sensitive to changes in the ambient air temperature, thus water temperature will fluctuate considerably depending on the weather and the time of day (Figure 24).

Water temperature data displayed a natural diurnal pattern. As expected, water temperature decreased steadily over the course of deployment in line with ambient air temperatures.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

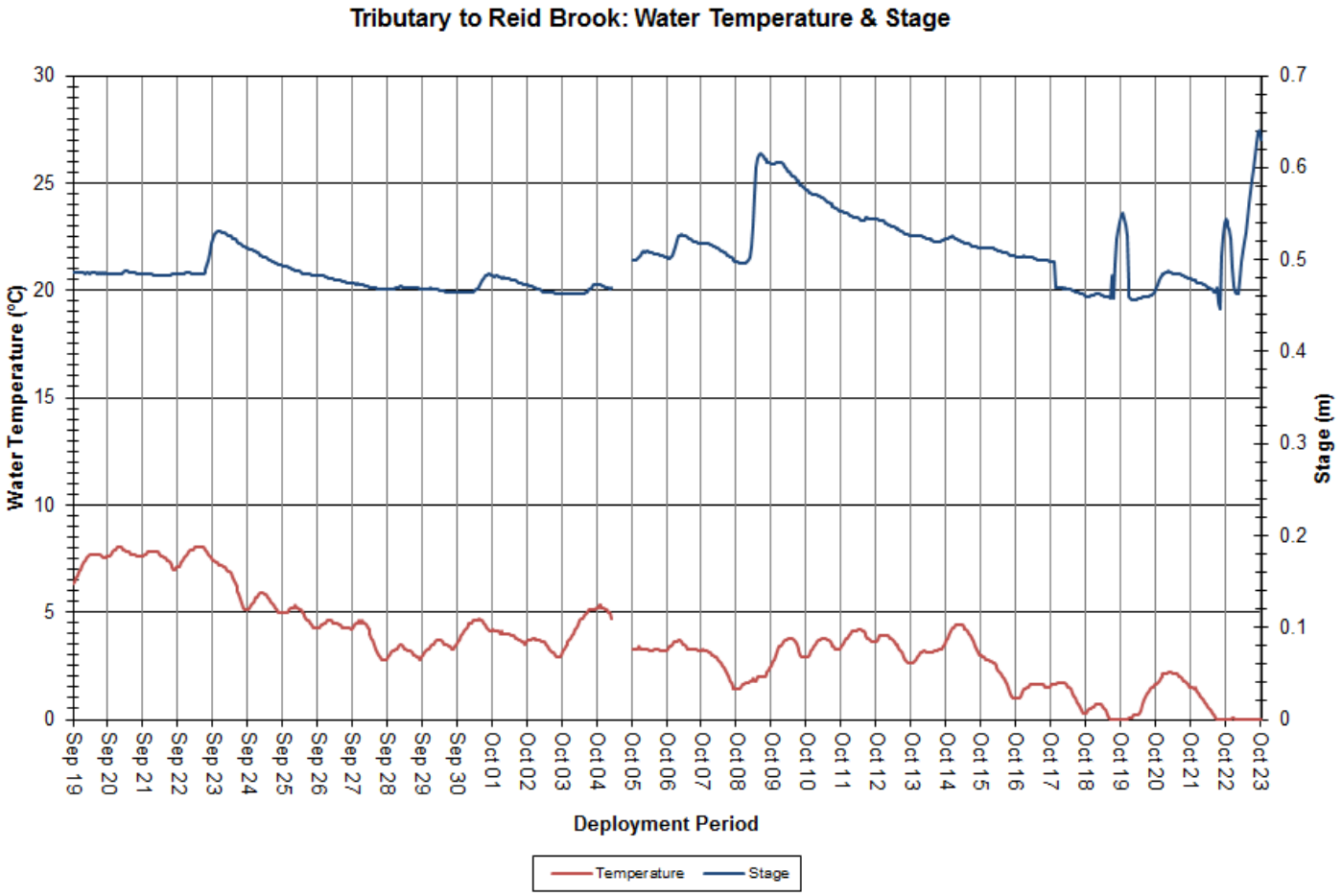

Figure 23: Water Temperature and Stage at Tributary to Reid Brook

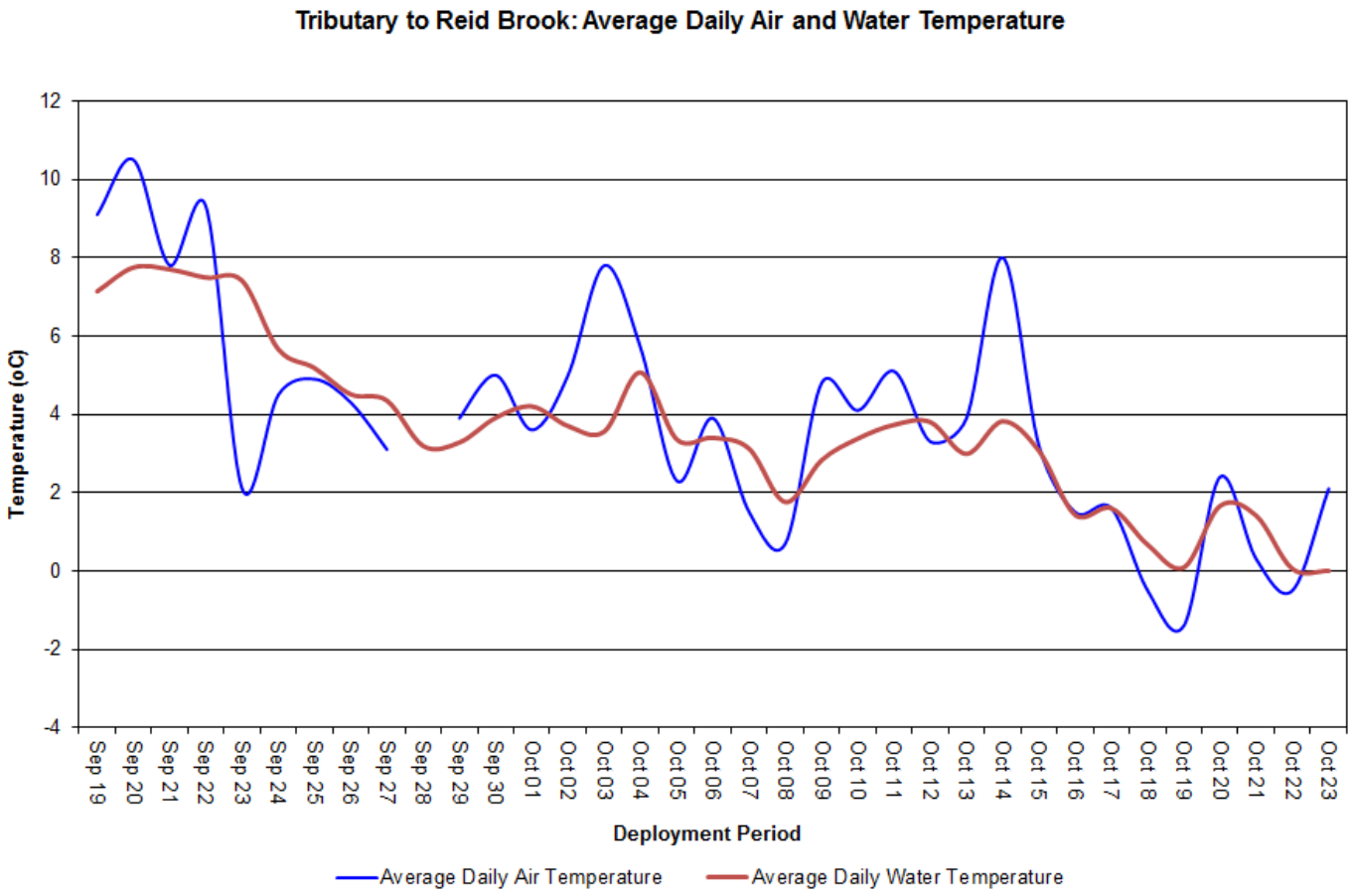

Figure 24: Average Daily Water Temperature at Tributary to Reid Brook and Average Daily Air Temperature from Nain Weather Station

pH

Over deployment, pH ranged from 6.63 to 7.09 pH units, with a median value of 7.02 (Figure 25).

Stage increases often indicate a rainfall event; rainfall will cause pH values to decrease for a short period of time (Figure 29). This is evidenced by a sharp decrease in pH values around October 9th following heavy precipitation on October 8th (Figure 25).

pH values remained within the CCME Guidelines for the Protection of Aquatic Life for the duration of deployment.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

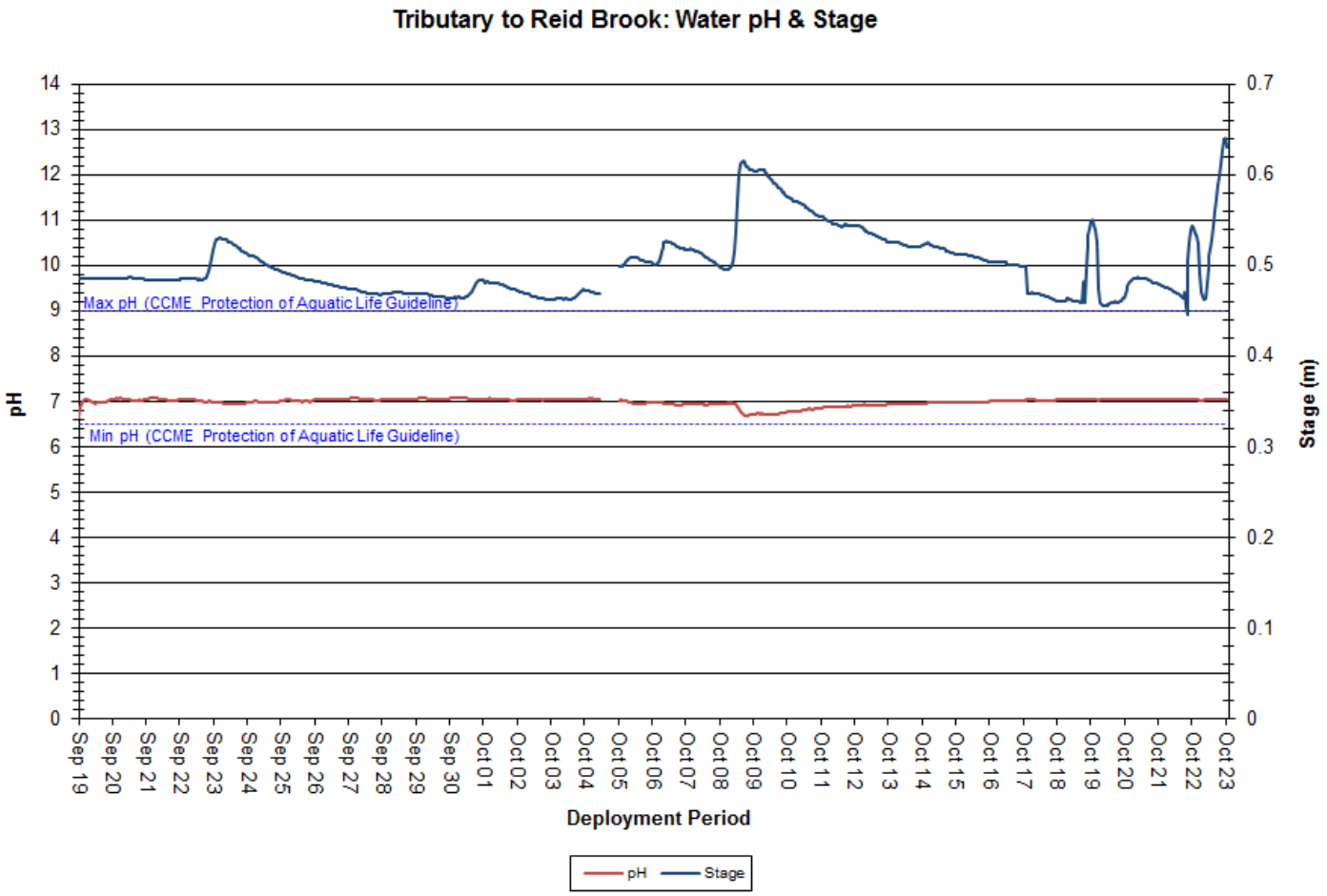

Figure 25: pH & Stage Level at Tributary to Reid Brook

Specific Conductivity

Specific conductivity ranged from 26.2µS/cm to 34.0µS/cm, with a median value of 30.6µS/cm (Figure 26).

Specific conductance and stage generally exhibit an inverse relationship: as one parameter increases, the other decreases. An increased amount of water in the river system dilutes solids causing a decrease in conductivity, and vice versa. Precipitation events over the course of deployment (Figure 29) likely influenced decreases in specific conductivity on the same dates, most notably on September 23rd, October 4th, and around October 8th and 9th.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

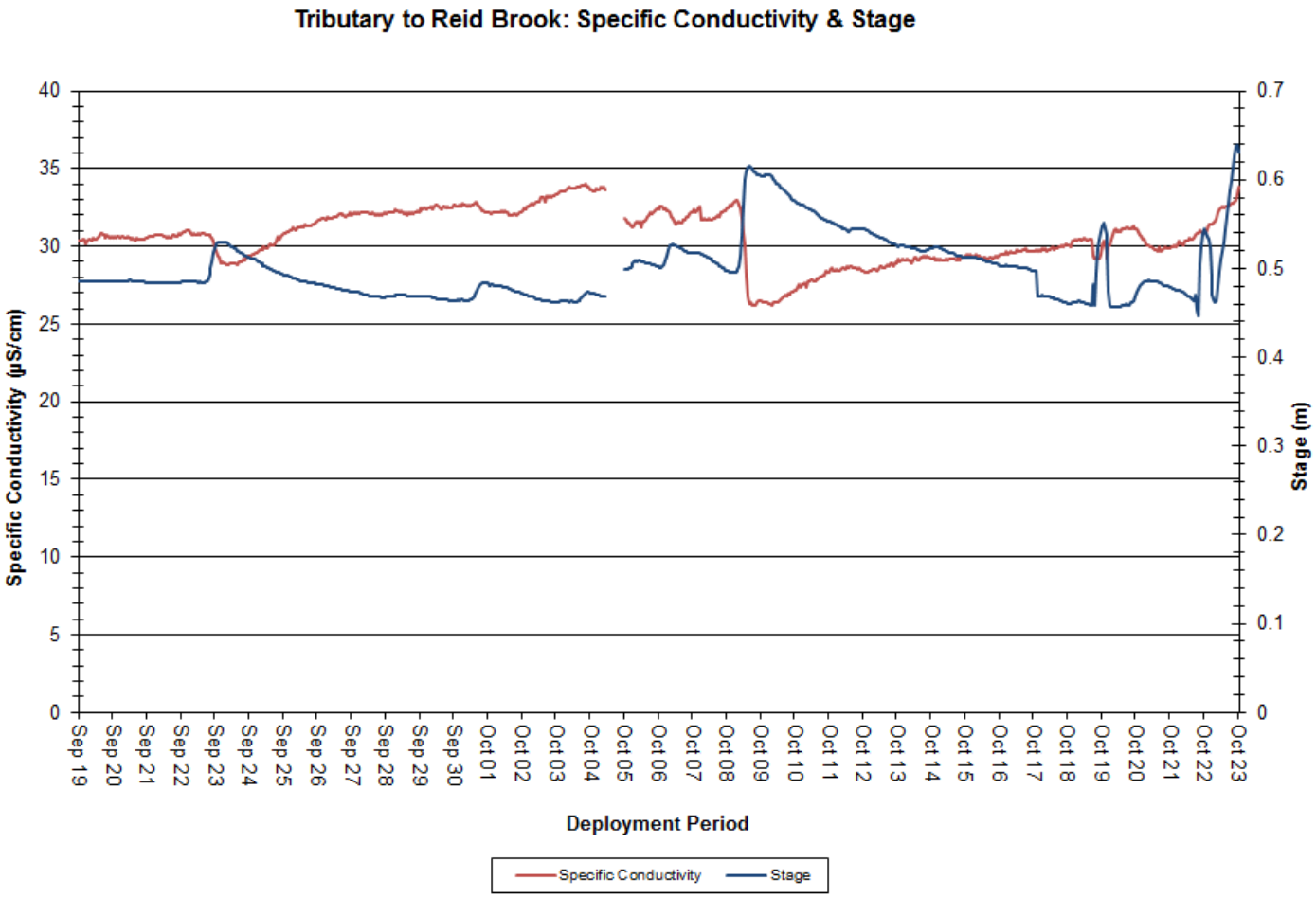

Figure 26: Specific Conductivity & Stage at Tributary to Reid Brook

Dissolved Oxygen

Dissolved oxygen content ranged from 11.24 to 14.19mg/L, with a median value of 12.63mg/L. The saturation of dissolved oxygen ranged from 92.4% to 97.9% saturation, with a median value of 94.8% (Figure 27).

Dissolved oxygen concentrations steadily increased over the deployment period. This is to be expected as water temperatures dropped. Dissolved oxygen levels remained above the CCME Guidelines for the Protection of Early/Other Life Stages for the duration of deployment.

Dissolved oxygen data displays a diurnal pattern. During nightfall, dissolved oxygen levels are higher as cooler temperatures allow for more DO to be stored in the water column. During daytime hours, dissolved oxygen levels are lower; warmer water temperatures and photosynthesis by aquatic plants results in less dissolved oxygen in the water column.

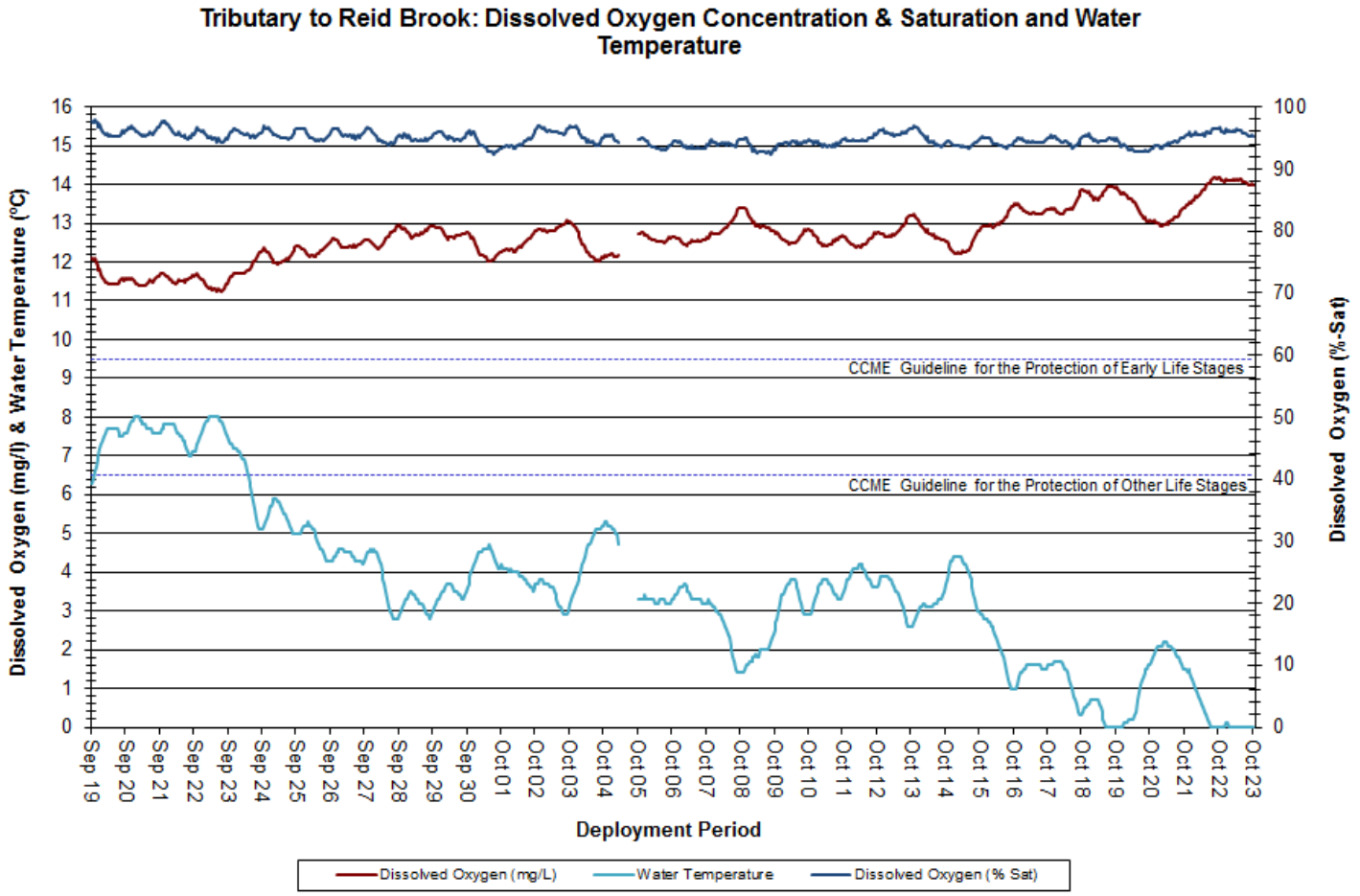

Figure 27: Dissolved Oxygen Concentration & Water Temperature at Tributary to Reid Brook

Turbidity

During deployment, turbidity ranged from 0.0 to 39.5 NTU, with a median value of 0.0 NTU (Figure 28). A median value of 0.0 NTU indicates that there was very little natural background turbidity at this station.

There are a number of turbidity events at this station, many of which correlate with increases in stage, which further correlate with rainfall events (Figure 29). An increase in water volume serves to stir up solid materials in the water column, in turn increasing turbidity. This site is particularly prone to variable turbidity, as it has a sandy-clay bottom that is easily disturbed by precipitation events.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

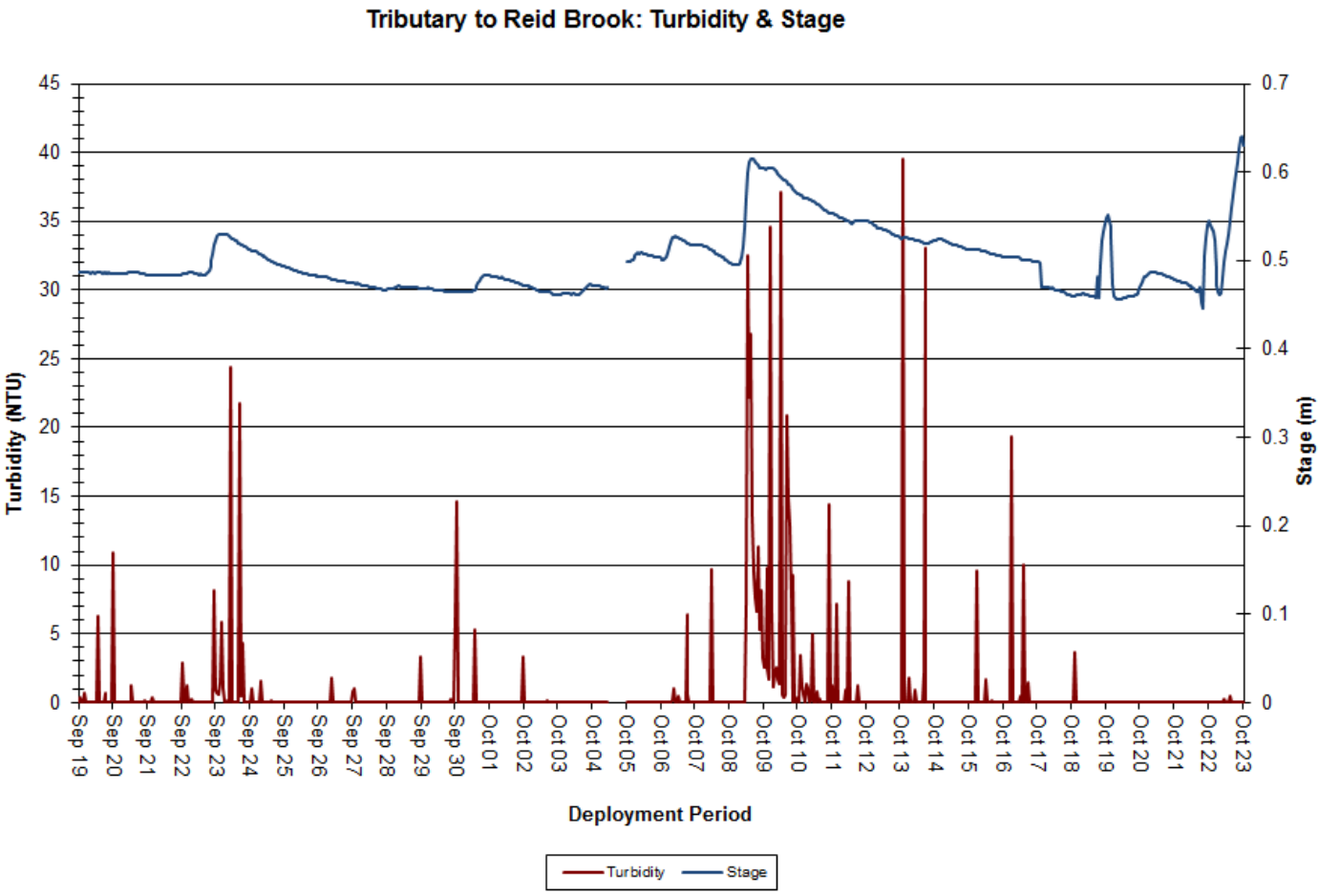

Figure 28: Turbidity & Stage at Tributary to Reid Brook

Stage, Flow and Precipitation

Stage ranged from 0.45m to 0.62m, with a median value of 0.49m.

Flow ranged from 0.12 to 0.51m^3/s, with a median value of 0.18m^3/s.

Stage, flow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 29). Increases in stage and flow generally correlate with precipitation events.

Please note that the stage and streamflow data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

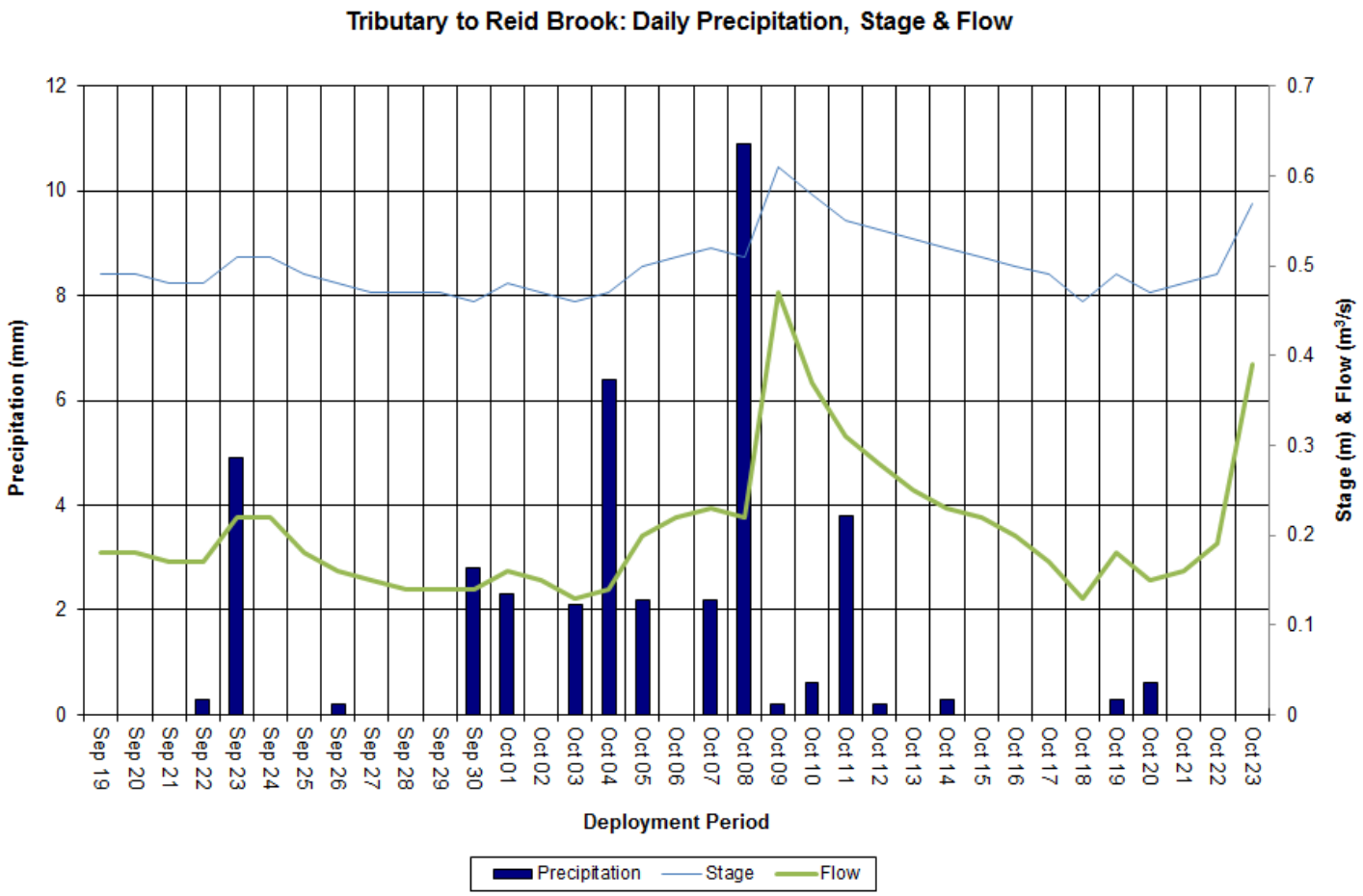

Figure 29: Daily Stage & Flow data from Tributary to Reid Brook and Total Daily Precipitation from Nain Weather Station

Conclusions

Water temperatures across all stations ranged from a minimum of 0.00°C at Tributary to Reid Brook to a maximum of 11.36°C at Reid Brook at Outlet of Reid Pond. Overall, water temperature was decreasing across the deployment period. Stations at Camp Pond Brook, Tributary to Reid Brook, and Reid Brook below Tributary are more sensitive to changes in the ambient air temperatures as these sites are brooks with continuously moving water. In contrast, Reid Brook at Outlet of Reid Pond is a large pond with a high surface area and deeper, slower-moving water.

pH values across all stations ranged from a minimum of 6.27pH units at Reid Brook at Outlet of Reid Pond to a maximum of 7.10pH units at Reid Brook below Tributary. pH values at all stations were relatively consistent. Changes in pH values often coincided with changes in stage brought on by rainfall events.

Specific conductivity across all stations ranged from a minimum of 11.9µS/cm at Reid Brook at Outlet of Reid Pond to a maximum of 61.1µS/cm at Camp Pond Brook below Camp Pond. Conductivity values at Reid Brook at Outlet of Reid Pond were the lowest across the network. Camp Pond Brook below Camp Pond maintains the highest median value at 44.6µS/cm, which is to be expected given the station's proximity to the Voisey's Bay mine site and increased potential for roadway runoff and other anthropogenic influences. Conductivity levels were clearly affected by heavy precipitation on October 8th.

Dissolved oxygen levels across all stations ranged from a minimum of 10.22mg/L at Reid Brook at Outlet of Reid Pond to a maximum of 14.19mg/L at Tributary to Reid Brook. Dissolved oxygen was generally increasing over the course of deployment, as water temperatures decreased. Dissolved oxygen levels also vary diurnally as water temperature is greatly affected by ambient air temperature. Dissolved oxygen levels remained above the CCME Guideline for the Protection of Early/Other Life Stages at all stations for the duration of deployment.

Turbidity levels across all stations ranged from a minimum of 0.0 NTU at three stations to a maximum of 182.1NTU at Camp Pond Brook below Camp Pond. Turbidity levels showed natural increases and decreases corresponding to changes in stage and precipitation events.

Overall, the changes in water quality parameters over the course of this deployment can be explained by natural events. Camp Pond Brook below Camp Pond does have the potential for anthropogenic influences as the site is the closest to the inhabited area. It is important to note that during a change (a decrease or increase) in water quality, change only occurs for a short period of time and then water quality parameters return to baseline.

References

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Swanson, H.A., and Baldwin, H.L., (1965) "A Primer on Water Quality" U.S. Geological Survey. Retrieved from: http://ga.water.usgs.gov/edu/characteristics.html

APPENDIX A

Comparison Graphs

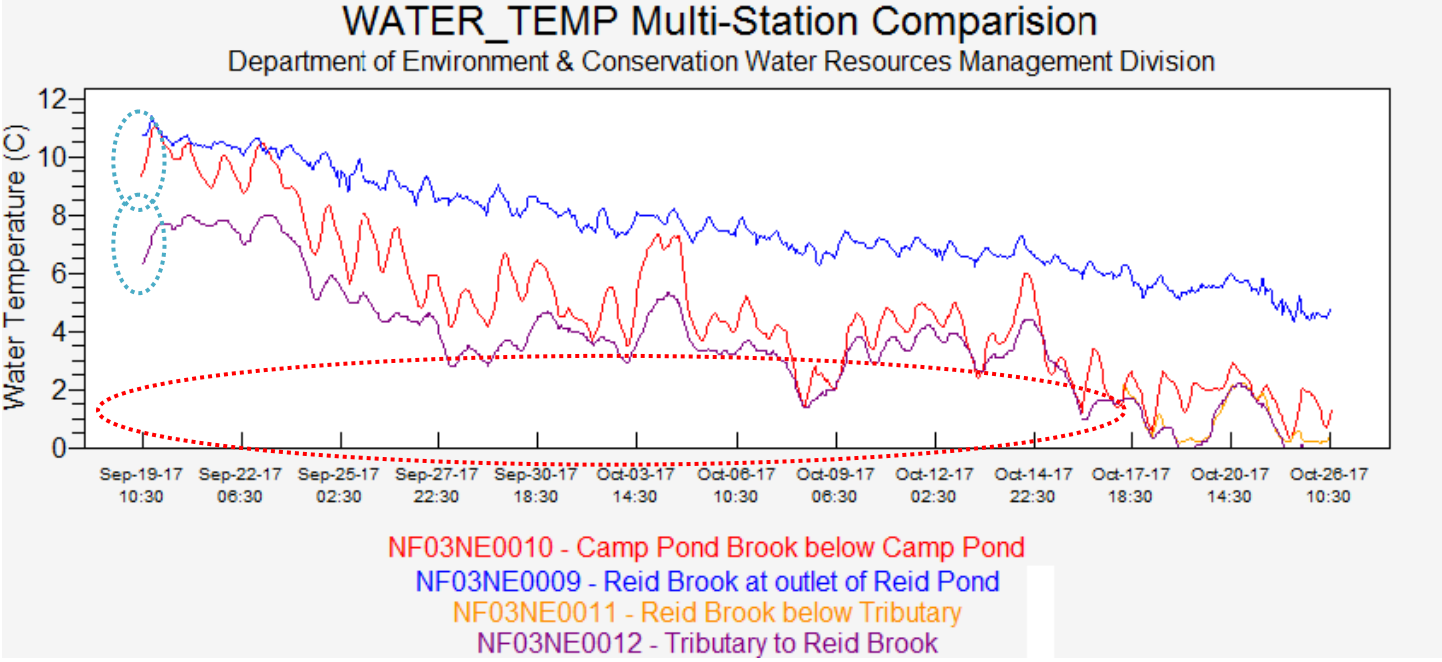

Figure A1: Comparison of Water Temperature (^{0}C) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure. Blue circles indicate data removed for QA/QC purposes

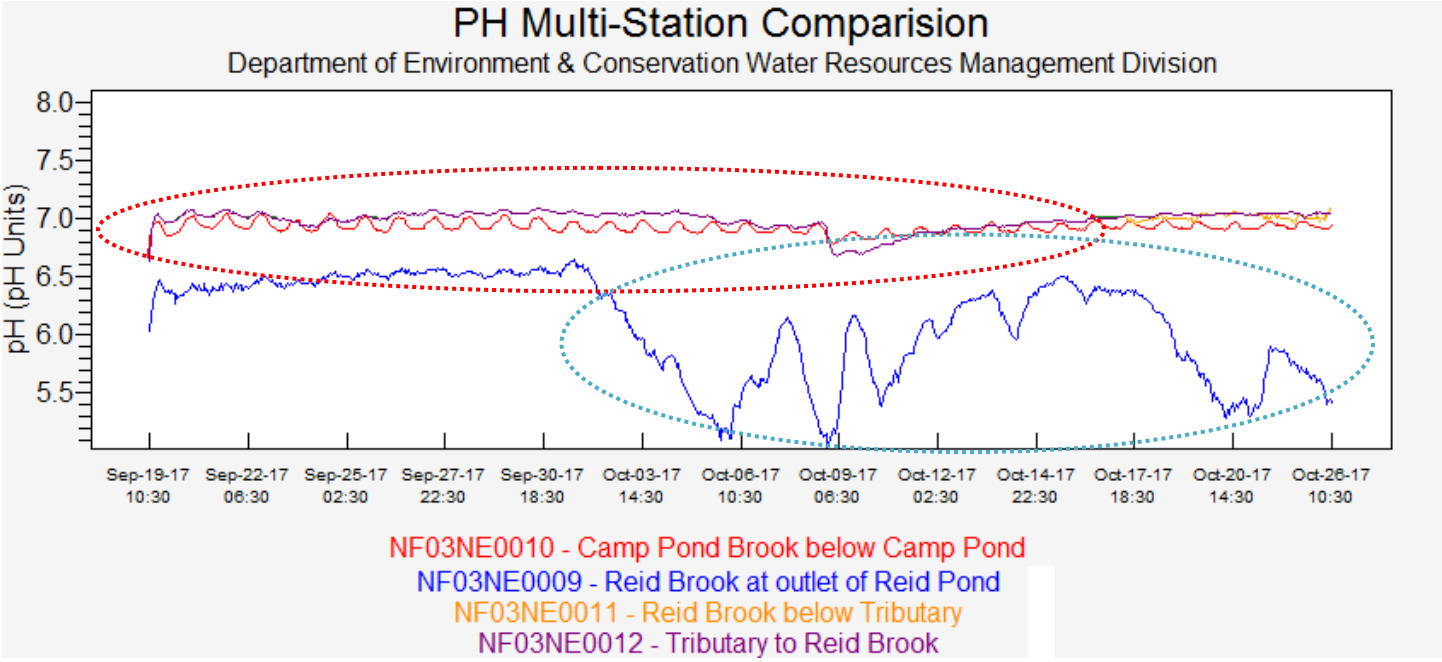

Figure A2: Comparison of pH between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure. Blue circle indicates data removed for QA/QC purposes.

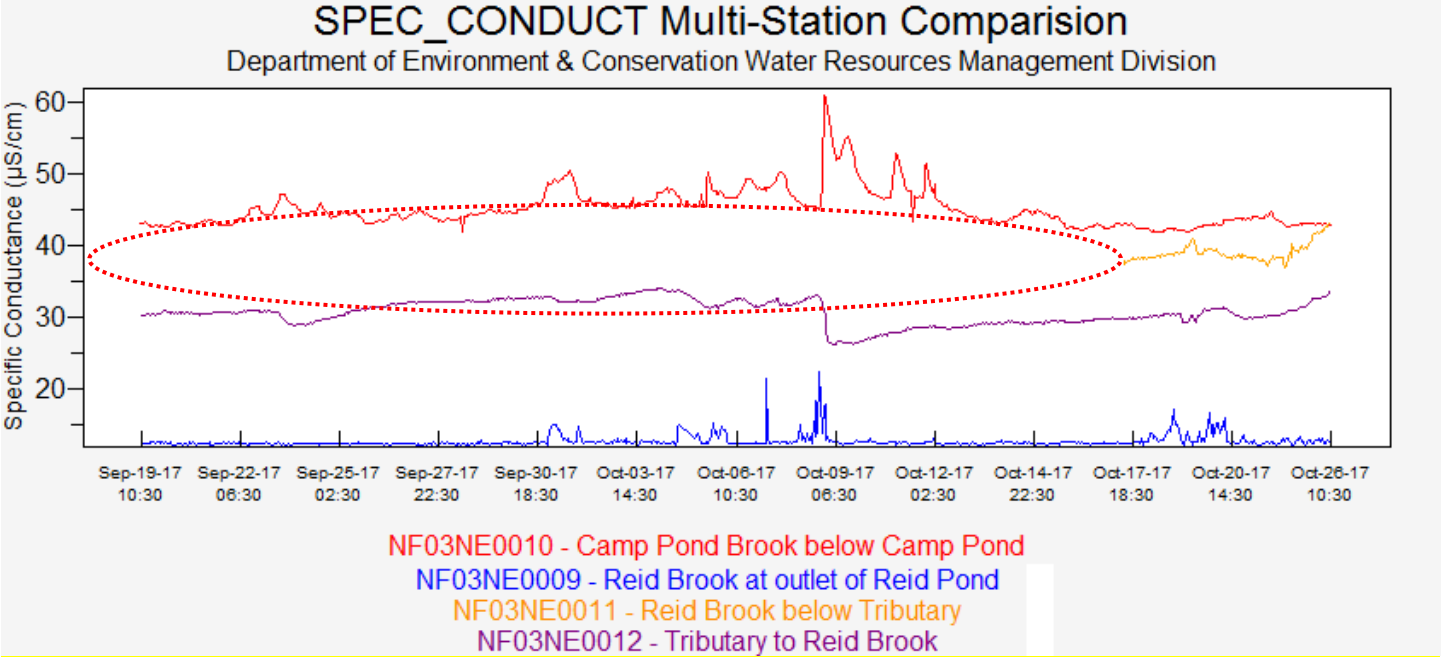

Figure A3: Comparison of Specific Conductivity (µS/cm) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure.

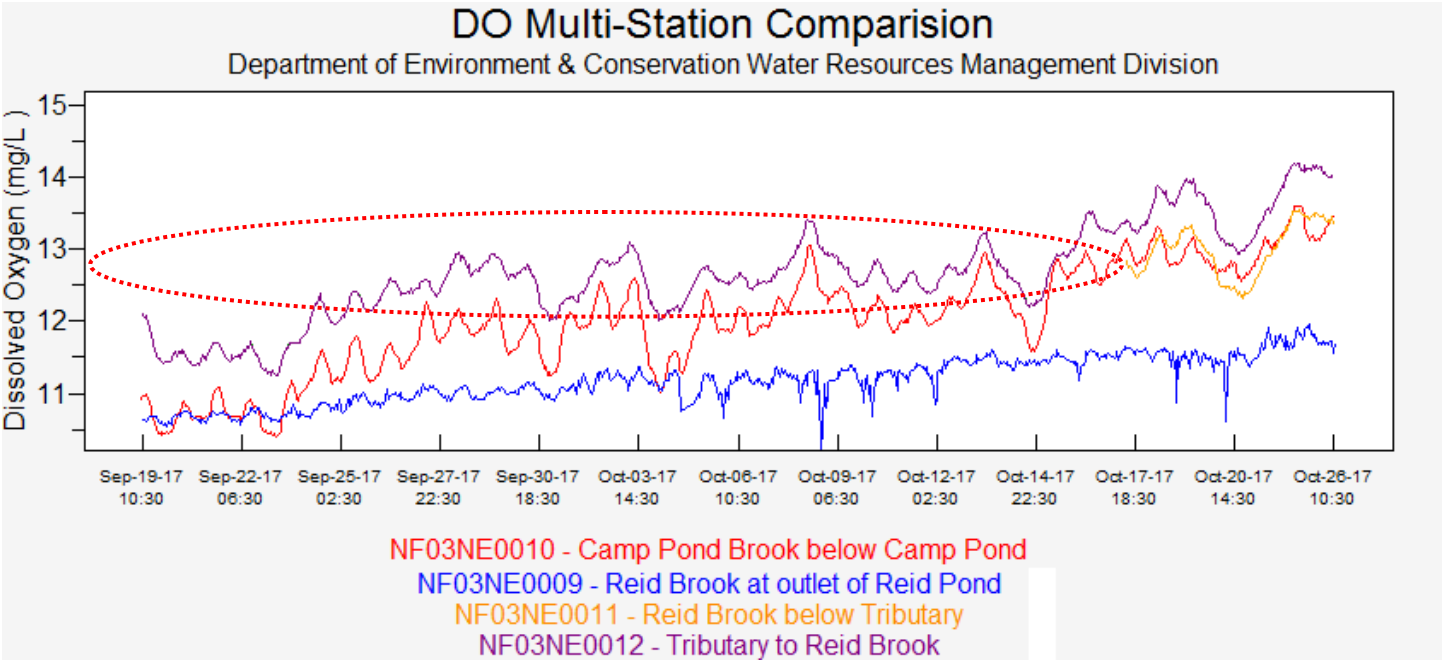

Figure A4: Comparison of Dissolved Oxygen (mg/L) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure.

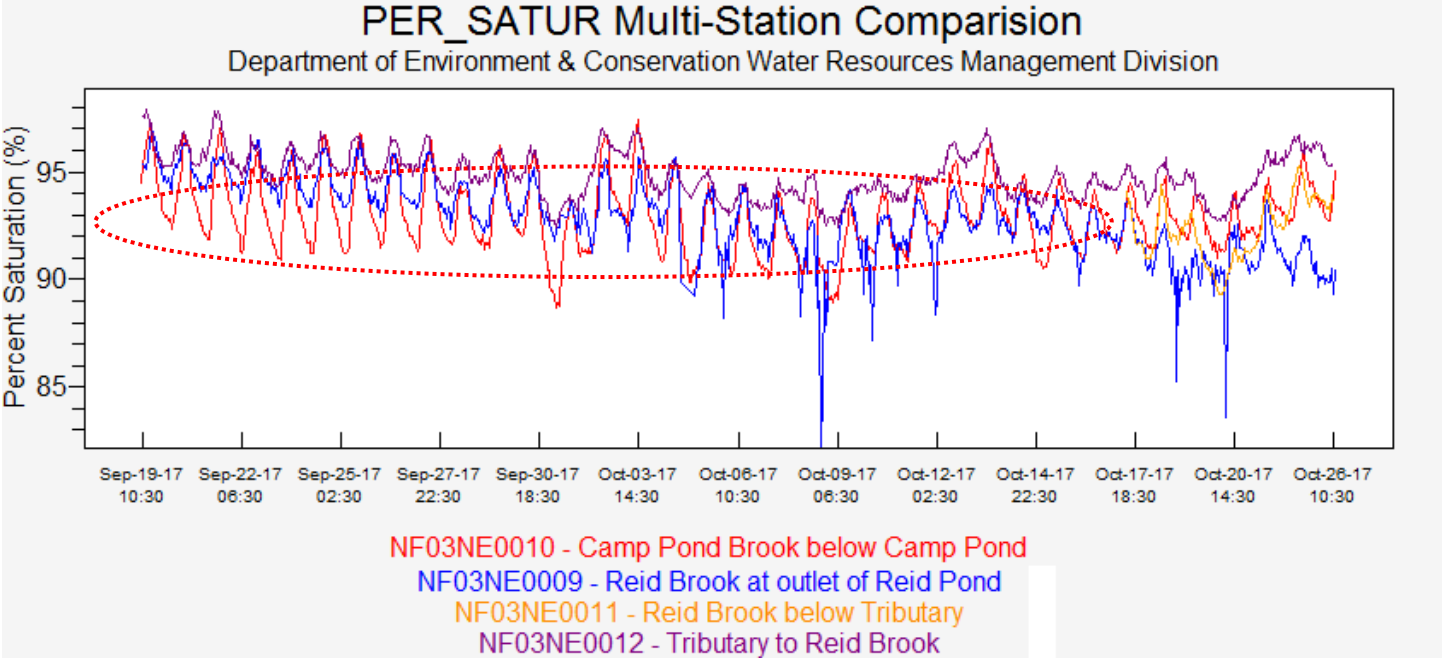

Figure A5: Comparison of Dissolved Oxygen (% Sat) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure.

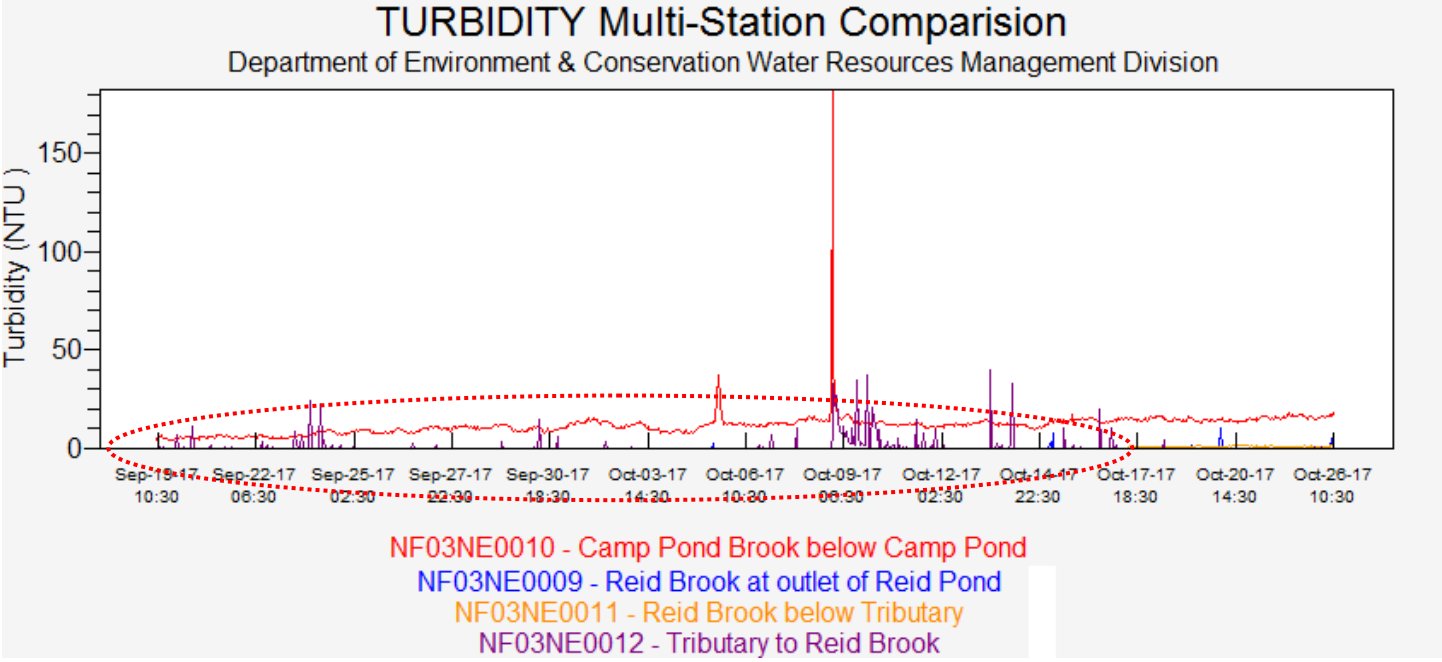

Figure A6: Comparison of Turbidity (NTU) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure.

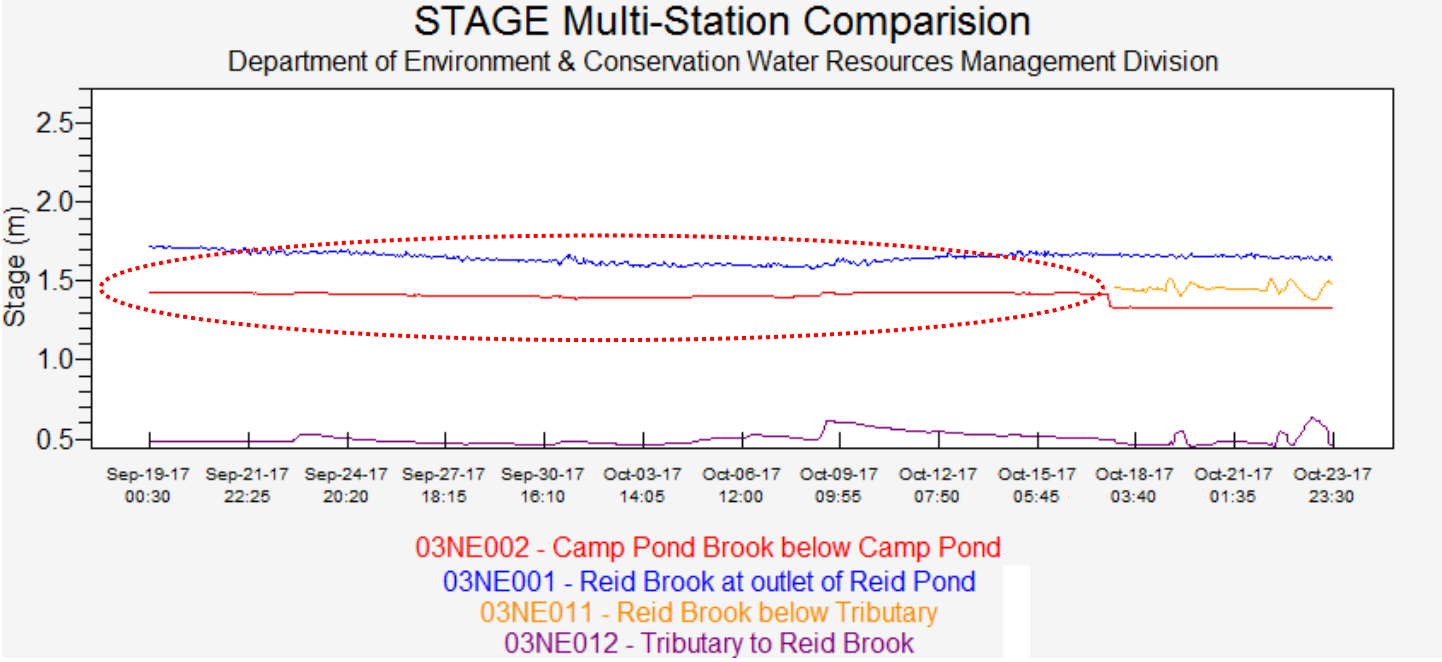

Figure A7: Comparison of Stage (m) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure. Please note that stage data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

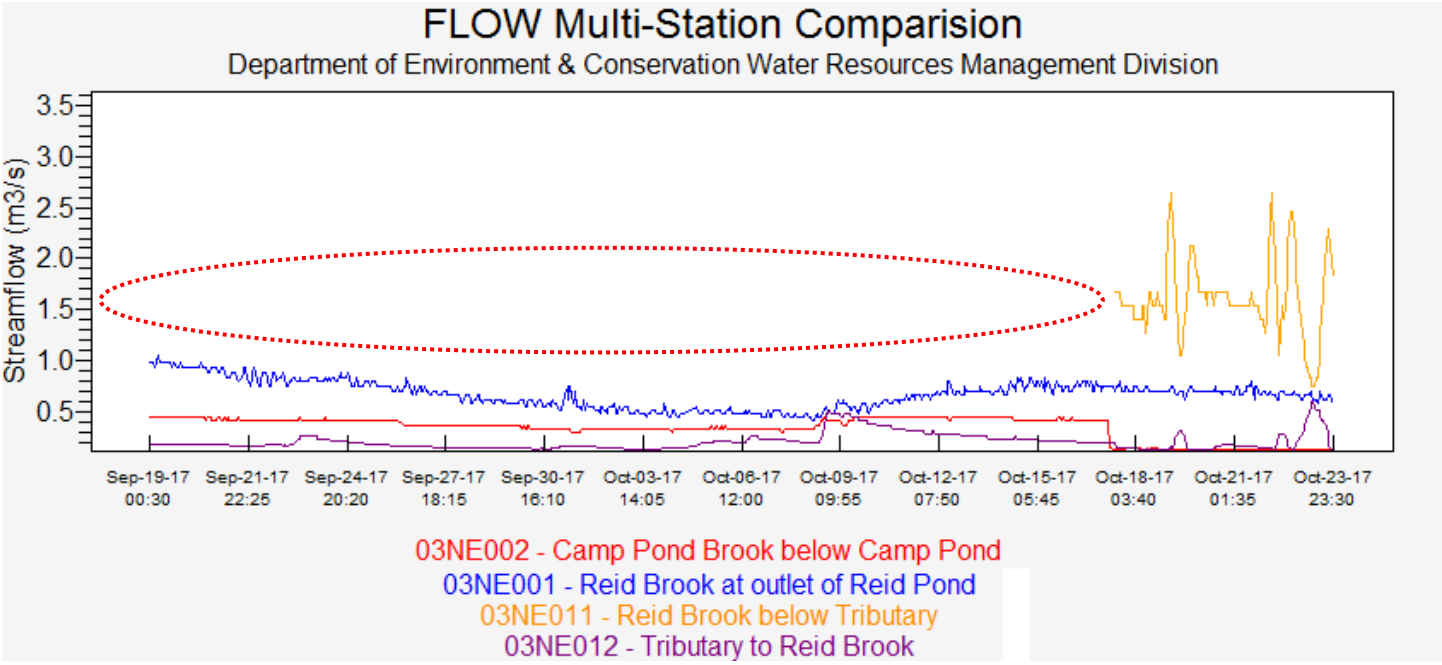

Figure A8: Comparison of Flow (m^3/s) between all Real-Time Stations in Voisey's Bay. Red Circle indicates missing data from Reid Brook below Tributary due to a transmission failure. Please note that flow data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data.

APPENDIX B

Water Parameter Description

Water Parameter Description

Dissolved Oxygen: The amount of Dissolved Oxygen (DO) (mg/l or % saturation) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (CCME 2014).

Flow: Flow (m3/s) is a measure of how quickly a volume of water is displaced in streams, rivers, and other channels.

pH: pH is the measure of hydrogen ion activity and affects: (i) the availability of nutrients to aquatic life; (ii) the concentration of biochemical substances dissolved in water; (iii) the efficiency of hemoglobin in the blood of vertebrates; and (iv) the toxicity of pollutants. Changes in pH can be attributed to industrial effluence, saline inflows or aquatic organisms involved in the photosynthetic cycling of CO_2 (CCME 2014).

Specific conductivity: Specific conductivity (µS/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25°C. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Swanson and Baldwin 1965).

Stage: Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature: Essential to the measurement of most water quality parameters, temperature (°C) controls most processes and dynamics of limnology. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth (OTT Hydromet 2017).

Total Dissolved Solids: Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (CCME 2014; Swanson and Baldwin 1965).

Turbidity: Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Sadar, 2017).

APPENDIX C

Grab Sample Results

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B7K9250
Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN887 2017-6412-00-SI-SP								
Sampling Date 2017/09/20 09:30								
Matrix W								
Sample # 2017-6412-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	29	1.0	mg/L	N/A	2017/10/03	2017/10/03		5180318
Hardness (CaCO3)	16	1.0	mg/L	N/A	2017/09/26	2017/09/26		5180311
Nitrate (N)	0.070	0.050	mg/L	N/A	2017/10/02	2017/10/02		5180314
Inorganics								
Conductivity	43	1.0	uS/cm	N/A	2017/09/27	2017/09/27	JMV	5184239
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/09/27	2017/09/27	FD	5184003
Total Alkalinity (Total as CaCO3)	11	5.0	mg/L	N/A	2017/10/03	2017/10/03	NRG	5189013
Dissolved Chloride (Cl)	2.0	1.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189018
Colour	21	5.0	TCU	N/A	2017/10/02	2017/10/02	NRG	5189024
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/09/27	2017/09/27	JMV	5184240
Total Kjeldahl Nitrogen (TKN)	0.13	0.10	mg/L	+/- <RDL	2017/09/26	2017/09/27	BMO	5182996
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/09/29	2017/09/29	NRG	5189027
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189644
Dissolved Organic Carbon (C)	3.6	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191806
Total Organic Carbon (C)	3.7	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191799
pH	7.00	N/A	pH	N/A	2017/09/27	2017/09/27	JMV	5184238
Total Phosphorus	<0.004	0.004	mg/L	N/A	2017/09/27	2017/09/27	ASP	5184483
Dissolved Sulphate (SO4)	5.9	2.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189021
Turbidity	1.1	0.10	NTU	N/A	2017/09/28	2017/09/28	JMV	5186458
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/09/28	2017/09/29	ARS	5186751
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.74	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Barium (Ba)	0.015	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Cadmium (Cd)	0.000035	0.000010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Calcium (Ca)	4.3	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Chromium (Cr)	0.0019	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Copper (Cu)	0.010	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Iron (Fe)	2.4	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Magnesium (Mg)	1.3	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Manganese (Mn)	0.10	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Nickel (Ni)	0.056	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Potassium (K)	0.88	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

Maxxam Analytics International Corporation o/a Maxxam Analytics 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.maxxamanalytics.com

Maxxam Job #: B7K9250
Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN887 2017-6412-00-SI-SP								
Sampling Date 2017/09/20 09:30								
Matrix W								
Sample # 2017-6412-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Sodium (Na)	2.5	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Strontium (Sr)	0.025	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Zinc (Zn)	0.014	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

Maxxam Analytics International Corporation o/a Maxxam Analytics 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.maxxamanalytics.com

Maxxam Job #: B7K9250
Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN888 2017-6413-00-SI-SP								
Sampling Date 2017/09/20 10:00								
Matrix W								
Sample # 2017-6413-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	8.0	1.0	mg/L	N/A	2017/10/03	2017/10/03		5180318
Hardness (CaCO3)	4.5	1.0	mg/L	N/A	2017/09/26	2017/09/26		5180311
Nitrate (N)	0.054	0.050	mg/L	N/A	2017/10/02	2017/10/02		5180314
Inorganics								
Conductivity	13	1.0	uS/cm	N/A	2017/09/27	2017/09/27	JMV	5184239
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/09/27	2017/09/27	FD	5184003
Total Alkalinity (Total as CaCO3)	5.5	5.0	mg/L	N/A	2017/10/03	2017/10/03	NRG	5189013
Dissolved Chloride (Cl)	<1.0	1.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189018
Colour	9.0	5.0	TCU	N/A	2017/10/02	2017/10/02	NRG	5189024
Dissolved Fluoride (F-)	<0.10	0.10	mg/L	N/A	2017/09/27	2017/09/27	JMV	5184240
Total Kjeldahl Nitrogen (TKN)	<0.10	0.10	mg/L	N/A	2017/09/26	2017/09/27	BMO	5182996
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/09/29	2017/09/29	NRG	5189027
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189644
Dissolved Organic Carbon (C)	1.8	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191806
Total Organic Carbon (C)	2.0	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191799
pH	7.11	N/A	pH	N/A	2017/09/27	2017/09/27	JMV	5184238
Total Phosphorus	<0.004	0.004	mg/L	N/A	2017/09/27	2017/09/27	ASP	5184483
Dissolved Sulphate (SO4)	<2.0	2.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189021
Turbidity	0.80	0.10	NTU	N/A	2017/09/28	2017/09/28	JMV	5186458
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/09/28	2017/09/29	ARS	5186751
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.051	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Barium (Ba)	0.0022	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Calcium (Ca)	1.4	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Iron (Fe)	<0.050	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Magnesium (Mg)	0.26	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Manganese (Mn)	<0.0020	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Nickel (Ni)	<0.0020	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Potassium (K)	0.10	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

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Maxxam Job #: B7K9250
Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN888 2017-6413-00-SI-SP								
Sampling Date 2017/09/20 10:00								
Matrix W								
Sample # 2017-6413-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Sodium (Na)	0.74	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Strontium (Sr)	0.0050	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

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Maxxam Job #: B7K9250
Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN889 2017-6414-00-SI-SP								
Sampling Date 2017/09/20 10:25								
Matrix W								
Sample # 2017-6414-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	30	1.0	mg/L	N/A	2017/10/03	2017/10/03		5180318
Hardness (CaCO3)	13	1.0	mg/L	N/A	2017/09/27	2017/09/27		5180311
Nitrate (N)	0.064	0.050	mg/L	N/A	2017/10/02	2017/10/02		5180314
Inorganics								
Conductivity	38	1.0	uS/cm	N/A	2017/09/27	2017/09/27	JMV	5184239
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/09/27	2017/09/27	FD	5184003
Total Alkalinity (Total as CaCO3)	13	5.0	mg/L	N/A	2017/10/03	2017/10/03	NRG	5189013
Dissolved Chloride (Cl)	2.4	1.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189018
Colour	30	5.0	TCU	N/A	2017/10/02	2017/10/02	NRG	5189024
Dissolved Fluoride (F-)	0.12	0.10	mg/L	N/A	2017/09/27	2017/09/27	JMV	5184240
Total Kjeldahl Nitrogen (TKN)	0.20	0.10	mg/L	+/- <RDL	2017/09/26	2017/09/27	BMO	5182996
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/09/29	2017/09/29	NRG	5189027
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189644
Dissolved Organic Carbon (C)	3.9	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191806
Total Organic Carbon (C)	4.2	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191799
pH	7.19	N/A	pH	N/A	2017/09/27	2017/09/27	JMV	5184238
Total Phosphorus	0.057	0.004	mg/L	+/- 0.009	2017/09/27	2017/09/27	ASP	5184483
Dissolved Sulphate (SO4)	3.2	2.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189021
Turbidity	0.69	0.10	NTU	N/A	2017/09/28	2017/09/28	JMV	5186458
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/09/28	2017/09/29	ARS	5186751
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.090	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Barium (Ba)	0.0056	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Calcium (Ca)	3.4	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Iron (Fe)	0.48	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Magnesium (Mg)	1.0	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Manganese (Mn)	0.0098	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Nickel (Ni)	0.0065	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Potassium (K)	0.52	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

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Maxxam Job #: B7K9250
Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN889 2017-6414-00-SI-SP								
Sampling Date 2017/09/20 10:25								
Matrix W								
Sample # 2017-6414-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Sodium (Na)	2.5	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Strontium (Sr)	0.020	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

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Report Date: 2017/10/03

Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
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Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN890 2017-6415-00-SI-SP								
Sampling Date 2017/09/20 10:50								
Matrix W								
Sample # 2017-6415-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Calculated TDS	28	1.0	mg/L	N/A	2017/10/03	2017/10/03		5180318
Hardness (CaCO3)	13	1.0	mg/L	N/A	2017/09/27	2017/09/27		5180311
Nitrate (N)	<0.050	0.050	mg/L	N/A	2017/10/02	2017/10/02		5180314
Inorganics								
Conductivity	36	1.0	uS/cm	N/A	2017/09/27	2017/09/27	JMV	5184239
Bromide (Br-)	<1.0	1.0	mg/L	N/A	2017/09/27	2017/09/27	FD	5184003
Total Alkalinity (Total as CaCO3)	12	5.0	mg/L	N/A	2017/10/03	2017/10/03	NRG	5189013
Dissolved Chloride (Cl)	2.2	1.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189018
Colour	28	5.0	TCU	N/A	2017/10/02	2017/10/02	NRG	5189024
Dissolved Fluoride (F-)	0.12	0.10	mg/L	N/A	2017/09/27	2017/09/27	JMV	5184240
Total Kjeldahl Nitrogen (TKN)	0.12	0.10	mg/L	+/- <RDL	2017/09/26	2017/09/27	BMO	5182996
Nitrite (N)	<0.010	0.010	mg/L	N/A	2017/09/29	2017/09/29	NRG	5189027
Nitrogen (Ammonia Nitrogen)	<0.050	0.050	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189644
Dissolved Organic Carbon (C)	3.7	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191806
Total Organic Carbon (C)	3.8	0.50	mg/L	N/A	2017/10/02	2017/10/02	SMT	5191799
pH	7.15	N/A	pH	N/A	2017/09/27	2017/09/27	JMV	5184238
Total Phosphorus	0.004	0.004	mg/L	N/A	2017/09/27	2017/09/27	ASP	5184483
Dissolved Sulphate (SO4)	2.9	2.0	mg/L	N/A	2017/10/02	2017/10/02	NRG	5189021
Turbidity	1.7	0.10	NTU	N/A	2017/09/28	2017/09/28	JMV	5186458
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	<0.000013	0.000013	mg/L	N/A	2017/09/28	2017/09/29	ARS	5186751
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	0.12	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Antimony (Sb)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Arsenic (As)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Barium (Ba)	0.0059	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Boron (B)	<0.050	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Cadmium (Cd)	<0.000010	0.000010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Calcium (Ca)	3.4	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Chromium (Cr)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Copper (Cu)	<0.0020	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Iron (Fe)	0.55	0.050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Lead (Pb)	<0.00050	0.00050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Magnesium (Mg)	0.98	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Manganese (Mn)	0.010	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Nickel (Ni)	0.0062	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Potassium (K)	0.48	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

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Maxxam Job #: B7K9250
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Department of Municipal Affairs and Environment
Site Location: VOISEY'S BAY RT GRAB
Your P.O. #: 215062145-3

Sample Details/Parameters	Result	RDL	UNITS	MU	Extracted	Analyzed	By	Batch
FEN890 2017-6415-00-SI-SP								
Sampling Date 2017/09/20 10:50								
Matrix W								
Sample # 2017-6415-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Selenium (Se)	<0.0010	0.0010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Sodium (Na)	2.5	0.10	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Strontium (Sr)	0.019	0.0020	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Uranium (U)	<0.00010	0.00010	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964
Total Zinc (Zn)	<0.0050	0.0050	mg/L	N/A	2017/09/26	2017/09/26	BAN	5181964

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