



# Real-Time Water Quality Deployment Report

## Voisey's Bay Network

July 18 to August 18, 2015



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

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Prepared by:  
Kelly Maher  
Environmental Scientist  
Water Resources Management Division  
Department of Environment & Conservation  
Phone (709) 896 - 5542  
Fax (709) 896 - 9566  
[kellymaher@gov.nl.ca](mailto:kellymaher@gov.nl.ca)

## Real Time Water Quality Monitoring

Department of Environment and Conservation staff 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 to Reid Pond, Camp Pond Brook, Tributary to Lower Reid Brook, and Lower Reid Brook.

On July 18 and 19, 2015, Vale Environment and Water Resources Staff deployed real-time water quality monitoring instruments at the four real time stations in the Voisey's Bay network for a period of 29 to 30 days. Instruments were removed by Vale Environment Staff on August 18, 2015.

## Quality Assurance and Quality Control

As part of the Quality Assurance and Quality Control protocol (QAQC), 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 QAQC 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 QAQC Instrument 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 (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 dependant, 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 (44175)	July 18, 2015	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	August 18, 2015	Removal	Excellent	Poor	Excellent	Fair	Excellent
Camp Pond Brook (62885)	July 19, 2015	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	August 18, 2015	Removal	Excellent	Excellent	Excellent	Good	Excellent
Tributary to Lower Reid Brook (62886)	July 19, 2015	Deployment	Excellent	Good	Excellent	Fair	Excellent
	August 18, 2015	Removal	Excellent	Excellent	Excellent	NA	Poor
Lower Reid Brook (62887)	July 19, 2015	Deployment	Excellent	Marginal	Excellent	Good	Excellent
	August 18, 2015	Removal	Excellent	Fair	Excellent	Poor	Excellent

During the deployment for Reid Brook at Outlet of Reid Pond, the temperature, pH, conductivity, dissolved oxygen, and turbidity all ranked as 'good' or 'excellent'. Upon removal, temperature, conductivity, and turbidity all ranked as 'excellent'. Dissolved oxygen ranked as 'fair' and pH ranked as 'poor'. The discrepancy in dissolved oxygen values could be attributed to the location of the QA/QC sonde and the field sonde. The field value for pH was 8.01 while the QA/QC value was 6.57. At the time of removal the values could not be compared because the station was offline. Therefore the QA/QC sonde may have not had enough time to stabilize to the environment.

At the station on Camp Pond Brook, temperature, pH, conductivity, dissolved oxygen and turbidity all ranked as 'excellent'. During removal, temperature, pH, conductivity, dissolved oxygen, and turbidity all ranked as 'good' or 'excellent'.

At Tributary to Lower Reid Brook station, the water quality parameters that ranked as 'excellent' or 'good' were temperature, pH, conductivity, and turbidity. Dissolved oxygen data ranked as 'fair' at deployment. The field value for DO was 10.42mg/l while this QA/QC value was 11.09mg/l. This is likely due to the DO sensor having not acclimatized to the environment before the value was recorded. During removal, temperature, pH, and conductivity all ranked 'excellent'. Turbidity ranked as 'poor'. The field value for turbidity was 21.1 NTU while the QA/QC value was 3.4NTU. This discrepancy in values resulting in a poor ranking is likely due to a difference in location of the sondes. In addition, the field sonde may have been covered in debris from the month long deployment. Upon removal the DO sensor was not functioning properly and a ranking could not be determined.

At Lower Reid Brook temperature, conductivity, dissolved oxygen, and turbidity all ranked as 'good' or 'excellent' during deployment. pH ranked as 'marginal'. The field value of pH was 5.80 and the QA/QC value was 6.61, while the grab sample value was 6.95. This discrepancy in values is likely due to the field sonde having not acclimatized to the environment before the value was recorded. Upon removal, temperature, conductivity, and turbidity all ranked as 'excellent'. pH ranked as 'fair'. The field value of pH was 5.95 and the

QA/QC value was 6.68. This discrepancy in values is likely due to the field sonde having not acclimatized to the environment before the value was recorded. Dissolved oxygen ranked as 'poor'. The field value was 10.20mg/l and the QA/QC value of 11.29mg/l. The discrepancy in values could be due to sonde locations or the sensor not being acclimatized to the environment before the value was record.

## **Data Interpretation**

- The following graphs and discussion illustrate significant water quality-related events from July 18<sup>th</sup> to August 18<sup>th</sup>, 2015 in the Voisey's Bay Real Time Water Quality Monitoring Network.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request.
- Reid Brook at Outlet of Reid Pond had technical issues with the communication capability of the station during this deployment. The station was unable to transmit quality and quantity real-time data for the entire deployment period. The water quality data was taken from the log file of the instrument which records as a backup in case of communication and transmission issues. Total dissolved solids are a calculated parameter which cannot be recorded to an accurate decimal place on the internal log file.
- Tributary to Lower Reid Book sonde had a Dissolved Oxygen sensor failure and therefore no accurate DO data was recorded for the deployment period. Some flow data is absent due to transmission errors at this station.



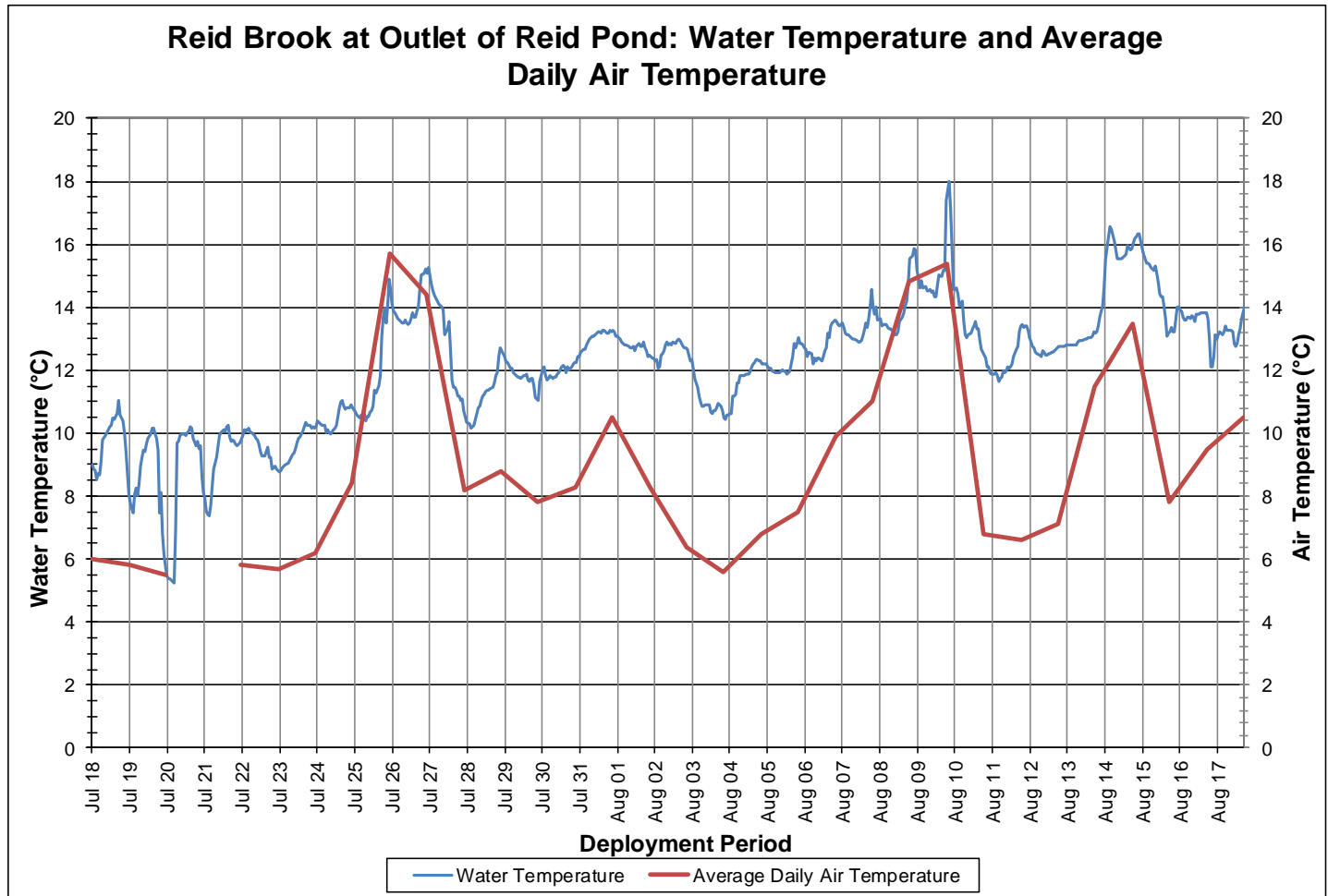


**Figure 1: Voisey's Bay Network Station Locations**

## Reid Brook at Outlet of Reid Pond

### Water Temperature

- Water temperature ranges from 5.25 °C to 18.01 °C, with a median value of 12.45 °C (Figure 2).
- Water temperature is gradually increasing throughout the deployment period. This trend is expected as the air temperatures warm in the summer months.
- A significant increase in air temperature on July 26<sup>th</sup>, August 8, 9, 13, and 14<sup>th</sup> resulted in a significant increase in water temperature at Reid Brook (Figure 2).



**Figure 2: Water Temperature & Average Daily Air Temperature at Reid Brook at Outlet of Reid Pond**



**pH Levels**

- The pH sensor on this instrument was produced a poor QA/QC reading upon removal and the data was deemed inaccurate.

### Specific Conductivity

- Specific conductance ranges between 12.0  $\mu\text{S}/\text{cm}$  to 13.0  $\mu\text{S}/\text{cm}$ , with a median value of 12.0  $\mu\text{S}/\text{cm}$  (Figure 4).
- The conductivity at Reid Brook remains very stable. This is expected at this site as it is pristine in nature and a larger distance from any anthropogenic disturbances that could affect water parameters.

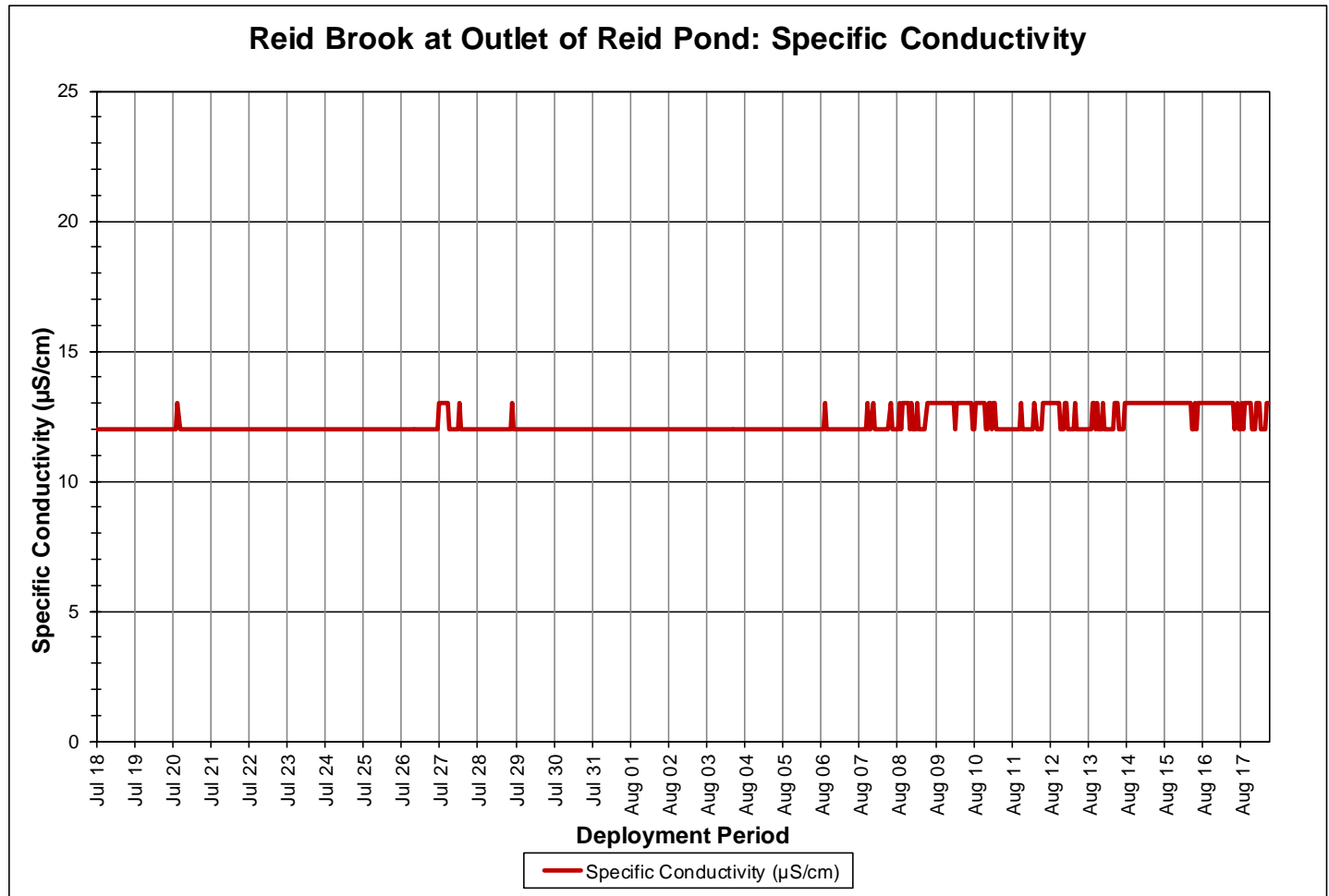


Figure 3: Specific Conductivity at Reid Brook at Outlet of Reid Pond

### Dissolved Oxygen (mg/L & % Saturation)

- Dissolved oxygen content ranges between 9.76mg/l and 12.31mg/l during the deployment period. The saturation of dissolved oxygen ranges from 95.5% to 105.9% (Figure 5).
- The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.
- Dissolved oxygen remained above the CCME guideline of 9.5mg/L during the deployment period (Figure 5).

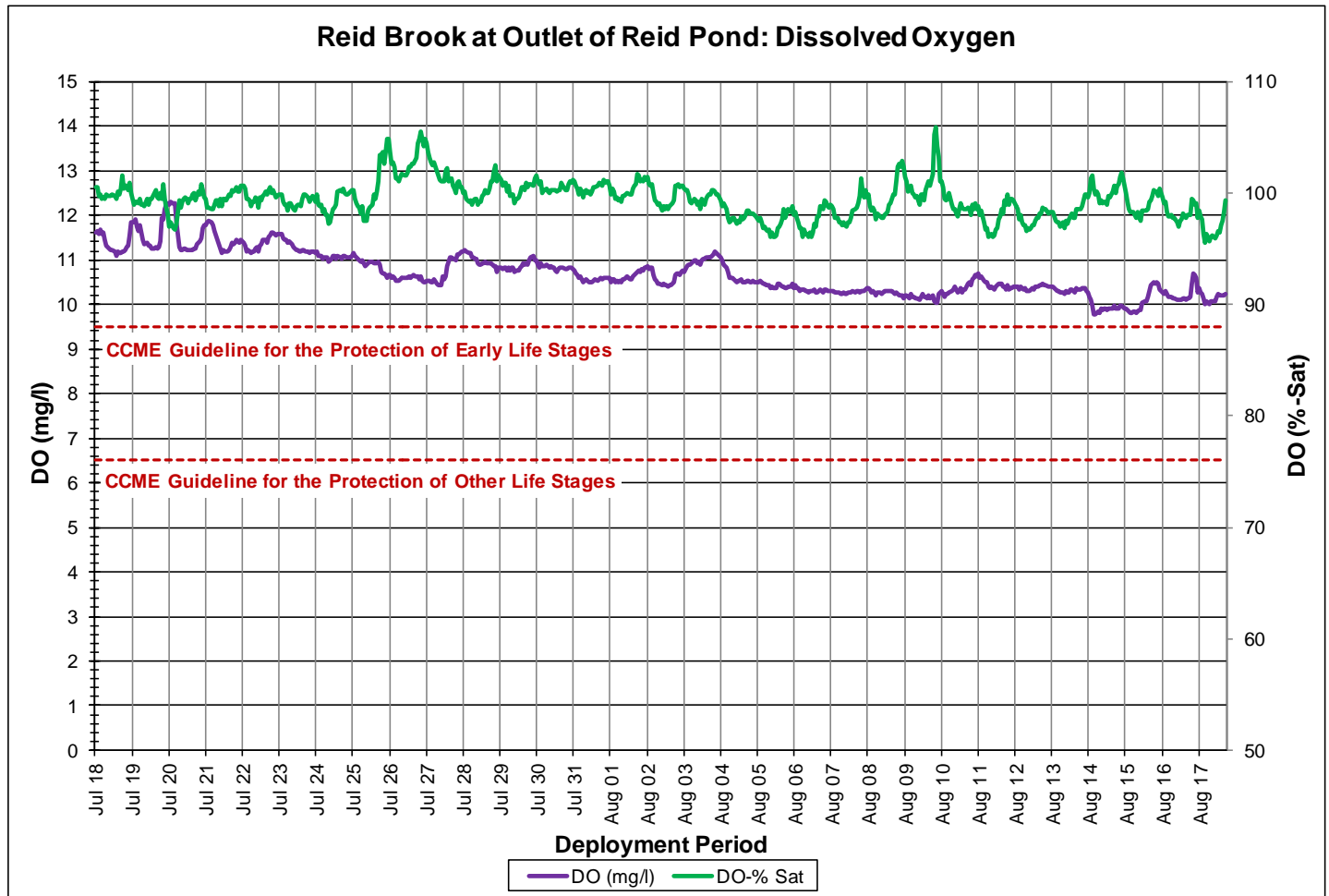


Figure 4: Dissolved Oxygen at Reid Brook at Outlet of Reid Pond

### Turbidity

- Turbidity values remain low at this location. It is not unusual for this station to have low turbidity readings, as the water flowing from the lake is typically very clean, clear, and cold (Figure 6).

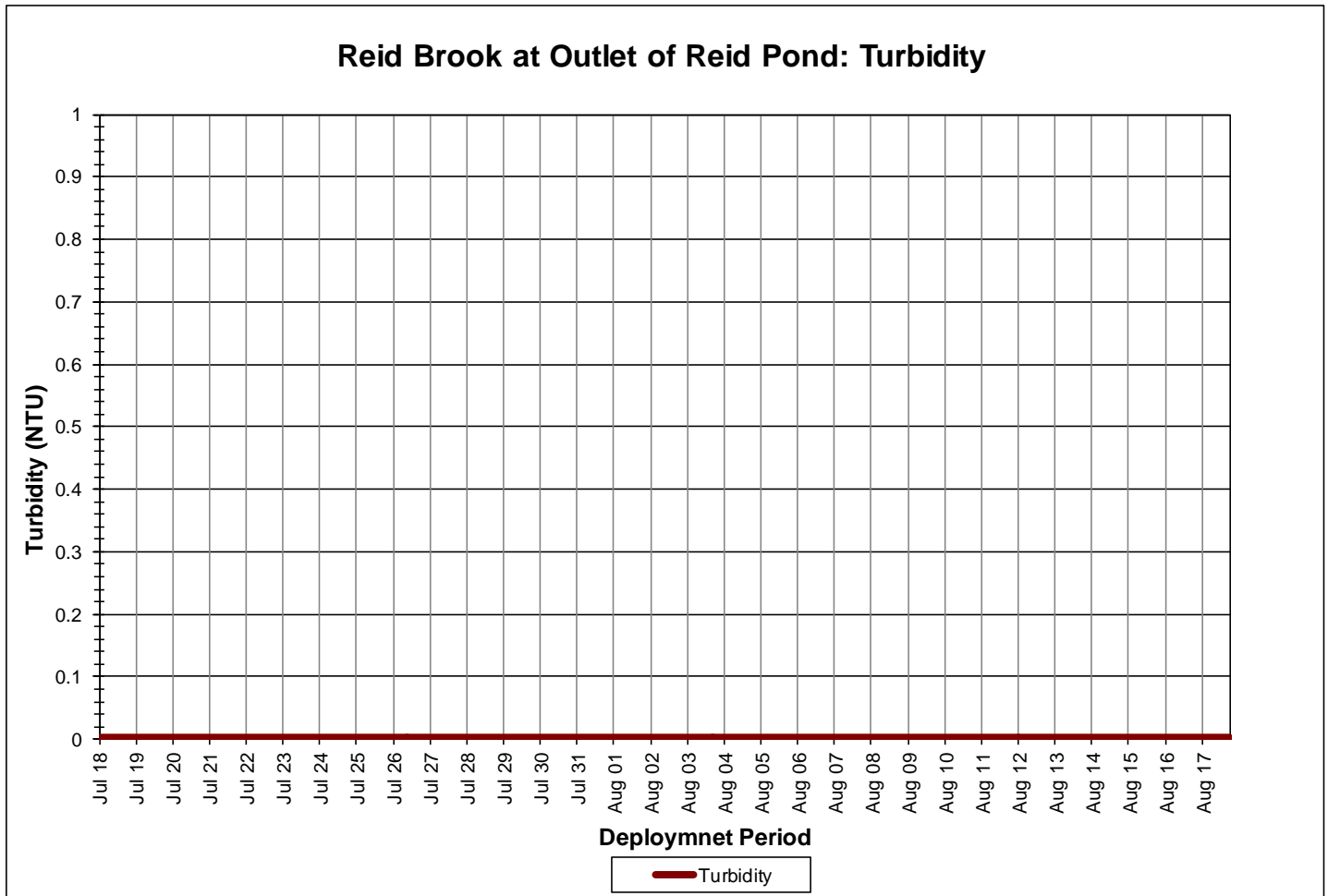


Figure 5: Turbidity at Reid Brook at Outlet of Reid Pond

### Stage, Flow & Precipitation

- Due to transmission errors during this deployment no stage or flow data was available.
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.
- Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay (Figure 7).
- Precipitation occurs on 14 days during the deployment period and amounts are small in magnitude, with the exception of the largest on August 17<sup>th</sup> with 22.3mm of rain.

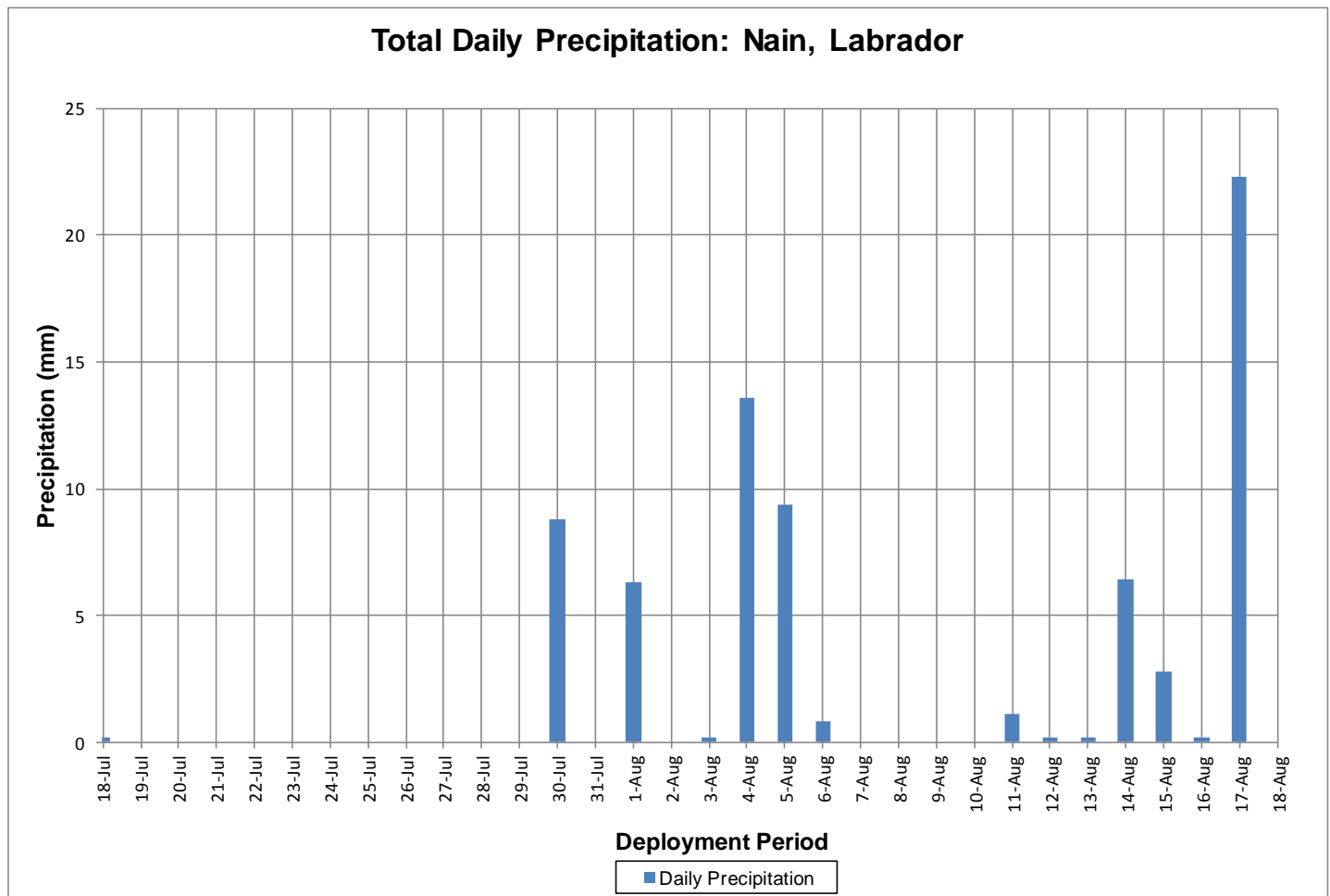


Figure 6: Total Daily Precipitation from Nain, Labrador Weather Station



## Camp Pond Brook

### Water Temperature

- Water temperature ranges from 11.03 °C to 19.66 °C, with a median value of 14.94 °C (Figure 8).
- Water temperature is gradually increasing throughout the deployment period. This trend is expected as the air temperatures warm in the summer months.
- This stream is sensitive to changes in the ambient air temperature 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.

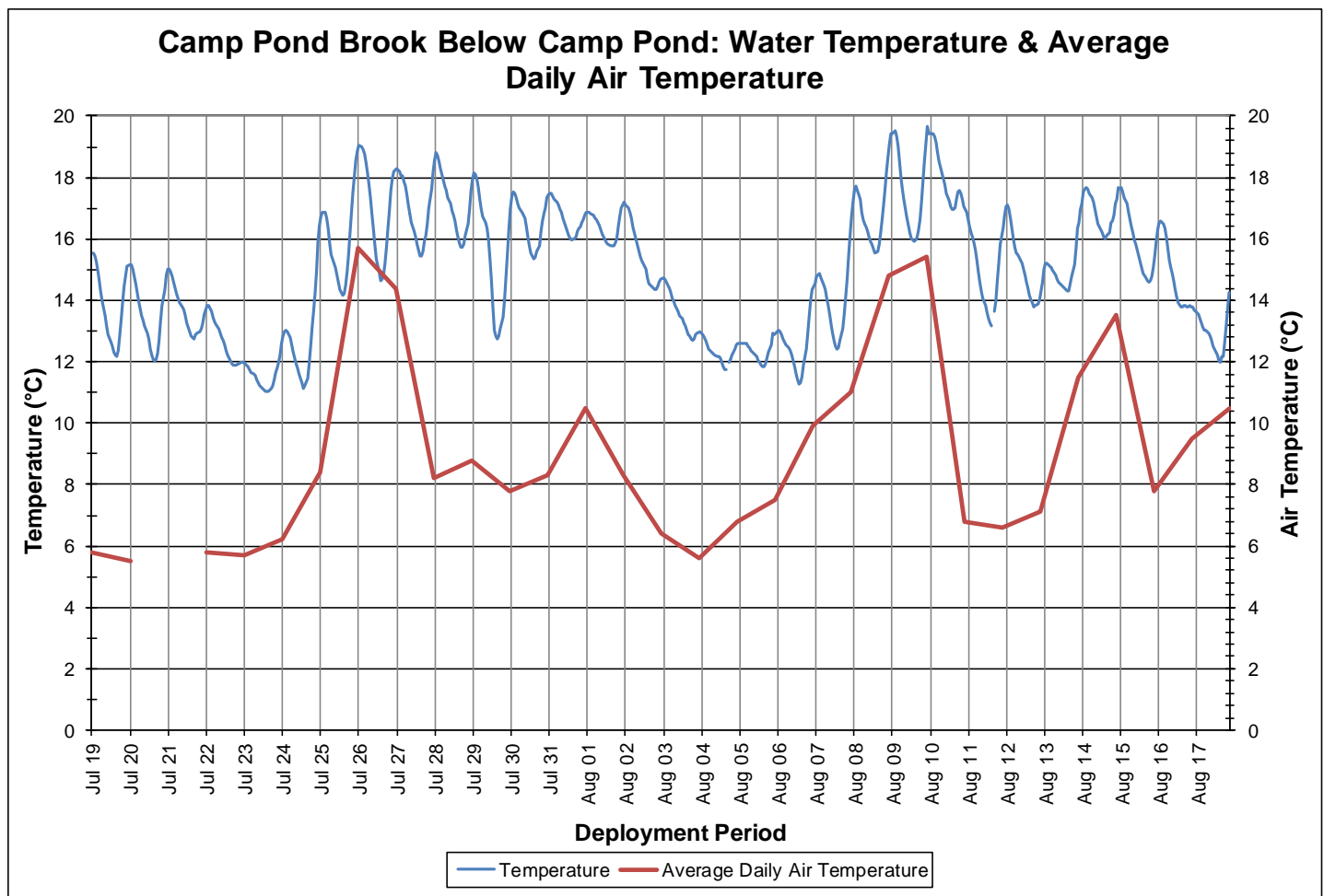


Figure 7: Water Temperature & Daily Average Air Temperature at Camp Pond Brook below Camp Pond

### pH

- pH ranges from 6.50 to 7.06 pH units, with a median value of 6.85 (Figure 9).
- The pH values are very stable at this station, fluctuating diurnally during the deployment period.
- The pH values in this deployment period are near or below the lower CCME guidelines of 6.5 pH units.

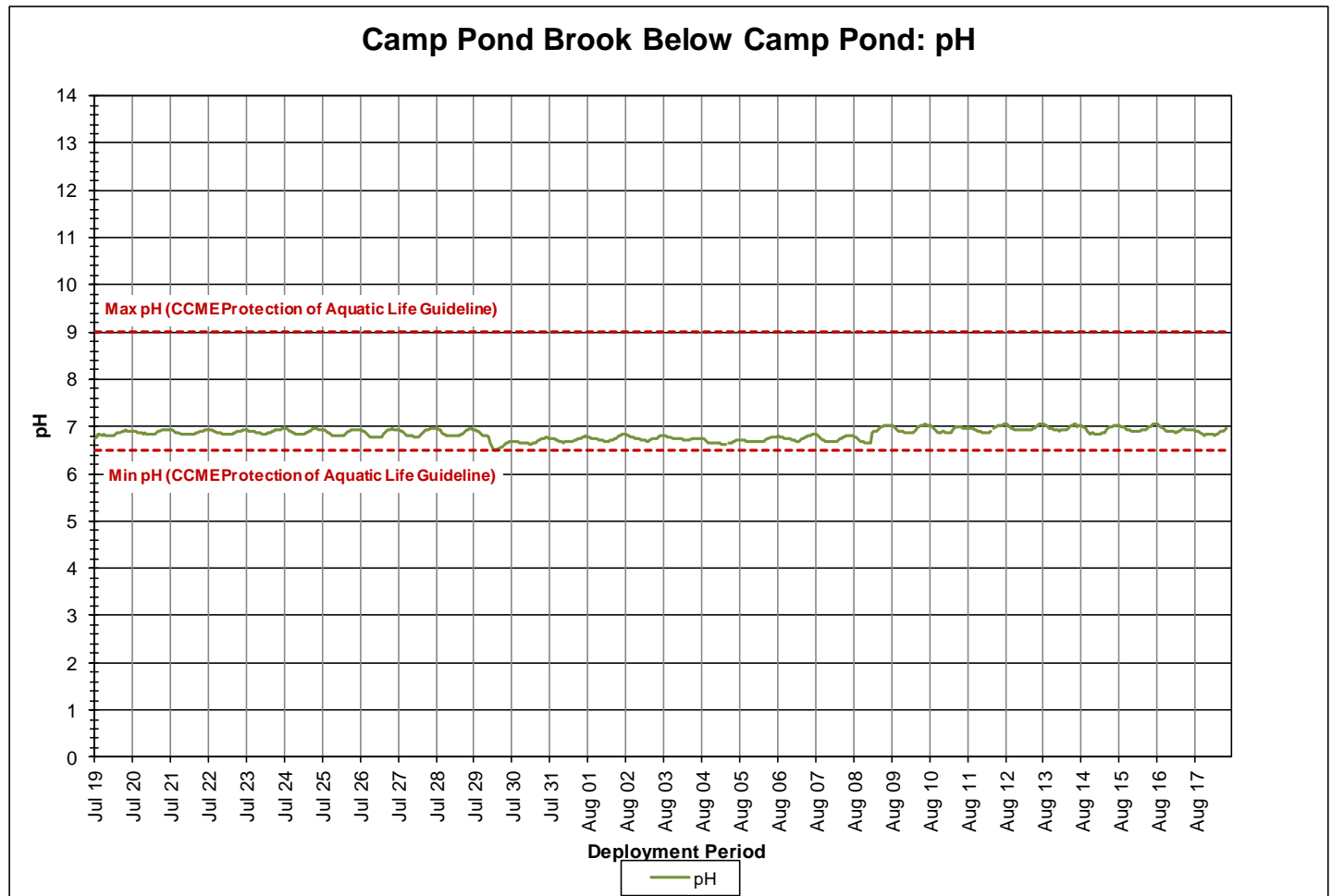


Figure 8: pH at Camp Pond Brook below Camp Pond

### Specific Conductivity

- Specific conductivity ranges from 30.4 $\mu$ S/cm to 55.5 $\mu$ S/cm with a median of 32.1 $\mu$ S/cm. (Figure 10).
- Total Dissolved Solids (TDS) ranges between 0.0194 g/mL to 0.0355 g/mL during the deployment period, with a median of 0.0205 g/mL (Figure 11).
- Specific conductivity and TDS have a direct relationship but are two separate parameters. Specific conductivity is the ability of the water to conduct electricity. Therefore the value of TDS can be calculated by the conductivity of the water (Figure 11).
- Typically, as stage level decreases, the specific conductivity of the water increases because of the increase in concentration of dissolved solids present in the water column. Inversely, as stage levels increase, specific conductivity generally decreases as the dissolved solids become more diluted in the water column. This trend is not typically experienced at this station (Figure 10). Instead, there is a positive relationship between water level and specific conductance. At this location the increase in specific conductivity is likely from runoff on nearby roadways and heavily used areas causing substances to be flushed into the brook.
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.

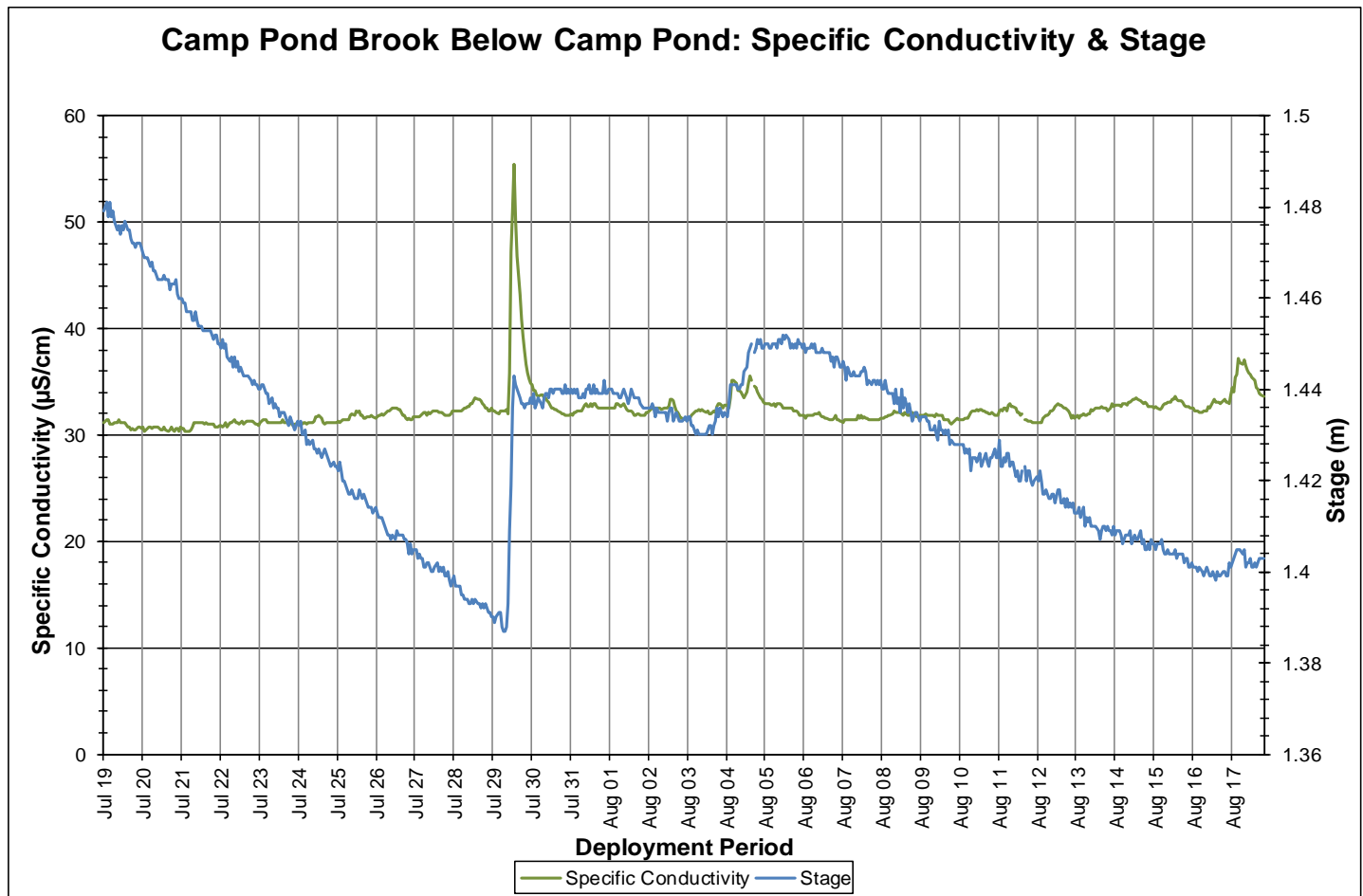


Figure 9: Specific Conductivity & Stage at Camp Pond Brook below Camp Pond

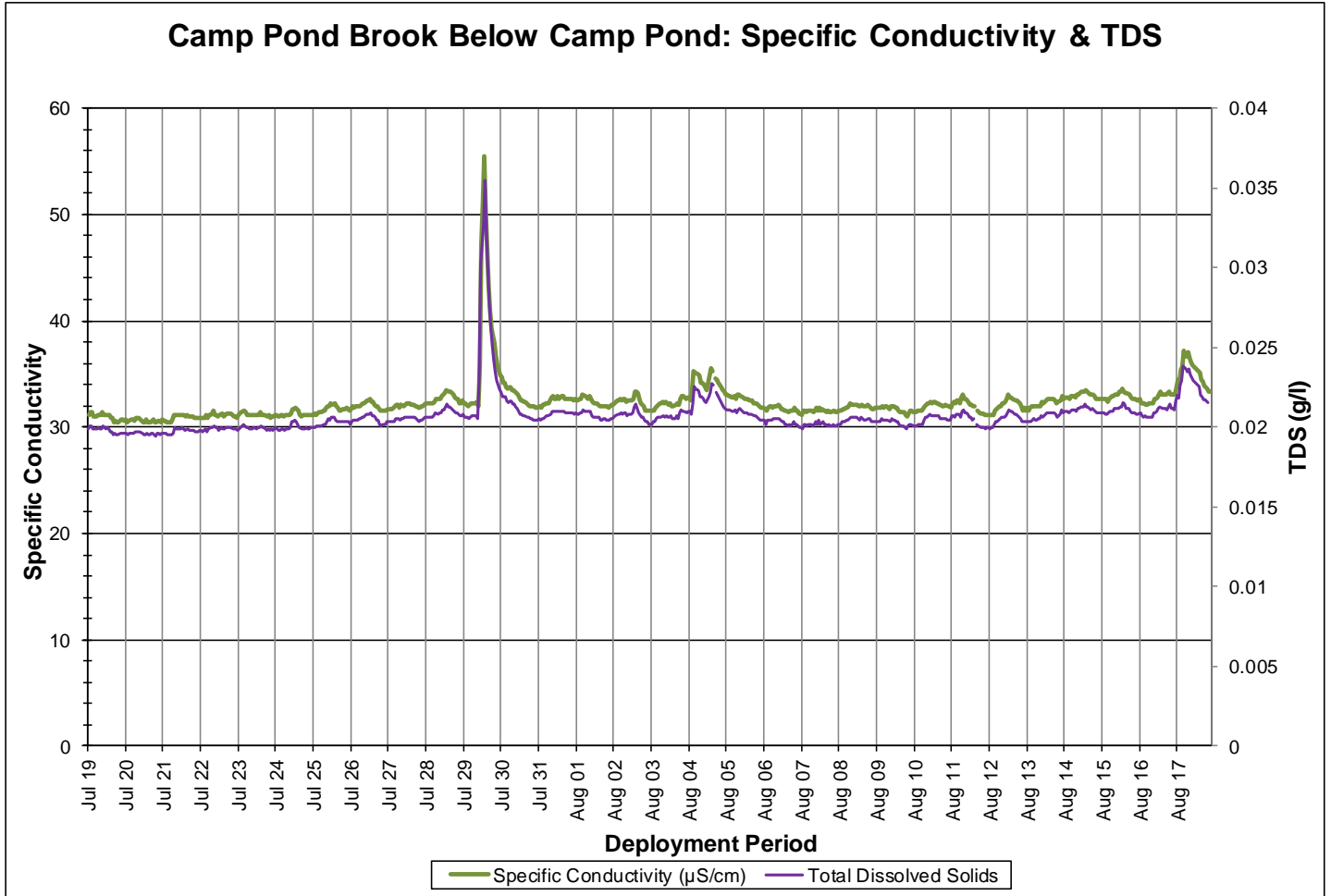


Figure 10: Specific Conductivity & TDS at Camp Pond Brook below Camp Pond

### Dissolved Oxygen (mg/L & % Saturation)

- Dissolved oxygen content ranges between 8.91mg/l and 10.47mg/l during the deployment period. The saturation of dissolved oxygen ranges from 89.3% to 100.8% (Figure 12).
- The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.
- Dissolved oxygen dipped below the CCME guideline of 9.5mg/L during the deployment period. This occurrence corresponds with the warmest water temperature during the deployment period (Figure 12). This is expected as water temperature directly influences the level of dissolved oxygen present in the water column.

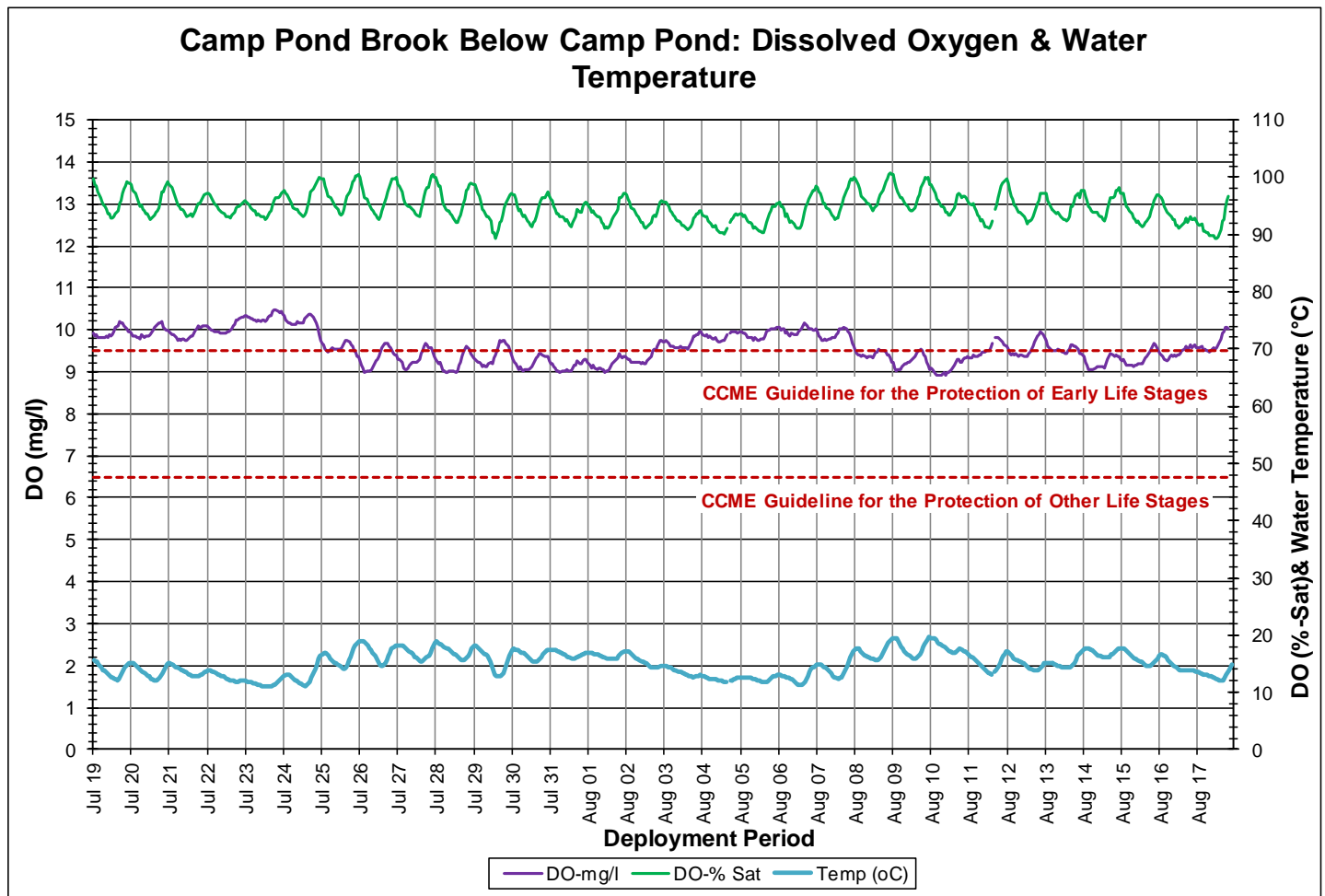


Figure 11: Dissolved Oxygen & Water Temperature at Camp Pond Brook below Camp Pond



## Turbidity

- Turbidity ranges from 0.0NTU to 19.3NTU during the deployment period, with a median value of 0.2NTU (Figure 13).
- A median value of 0.2 NTU indicates there is very little natural background turbidity at this station during this deployment period.
- There are a number of low - medium turbidity events at this station throughout the duration of this deployment. Some of the larger turbidity events correlate with precipitation causing increase in stage level and mixing of solids into the water column. (Figure 13, 14).
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.

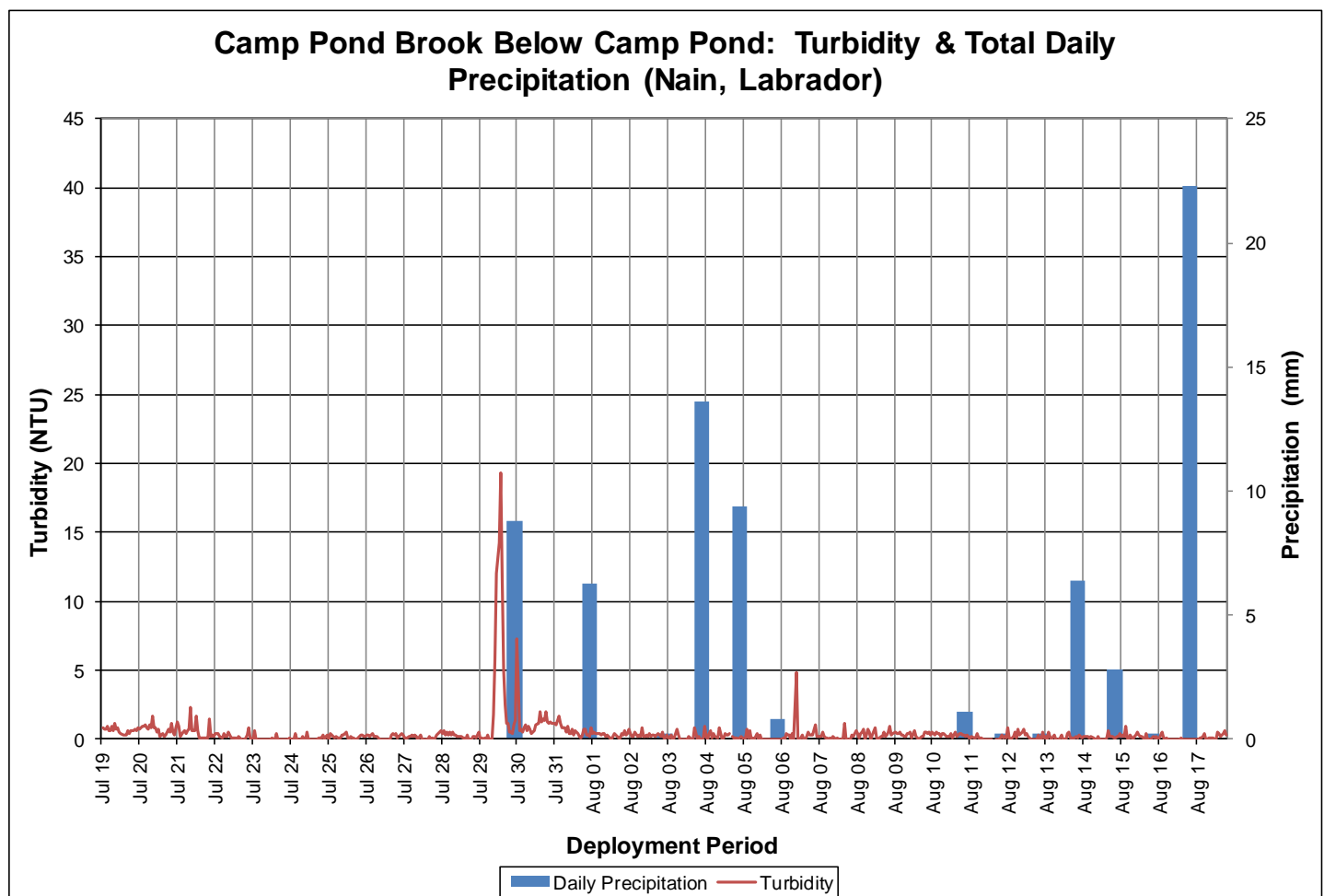


Figure 12: Turbidity & Total Daily Precipitation (Nain, Labrador Weather Station) at Camp Pond Brook below Camp Pond

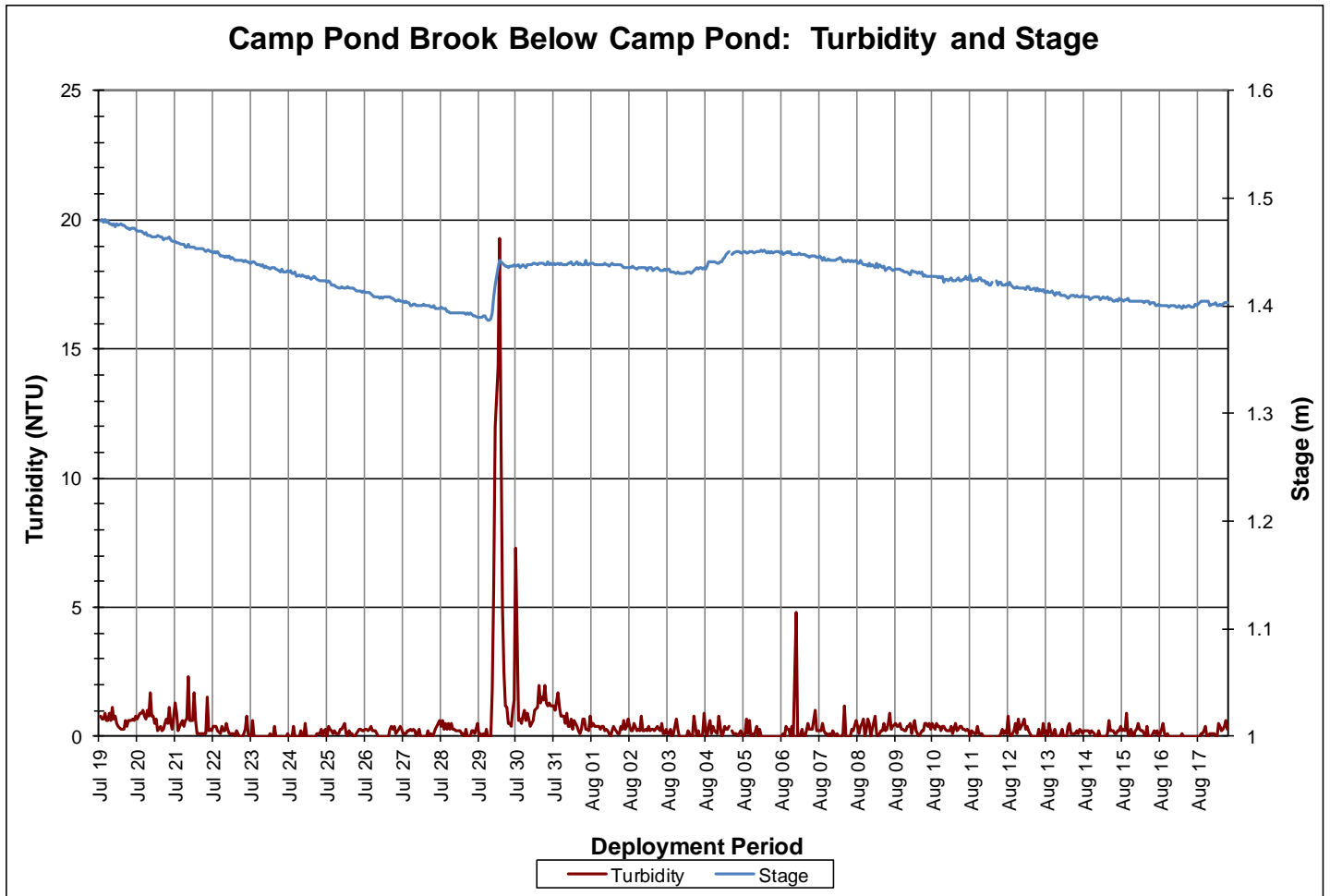


Figure 13: Turbidity & Stage at Camp Pond Brook below Camp Pond

### Stage, Flow and Precipitation

- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.
- Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay (Figure 15).
- Precipitation occurs on 14 days during the deployment period and amounts are small in magnitude, with the exception of the largest on August 17<sup>th</sup> with 22.3mm of rain.
- During the deployment period, the stage values ranged from 1.39m to 1.48m. Streamflow had a minimum amount of 0.29m<sup>3</sup>/s and a maximum flow of 0.69m<sup>3</sup>/s.
- Stage, streamflow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 15).

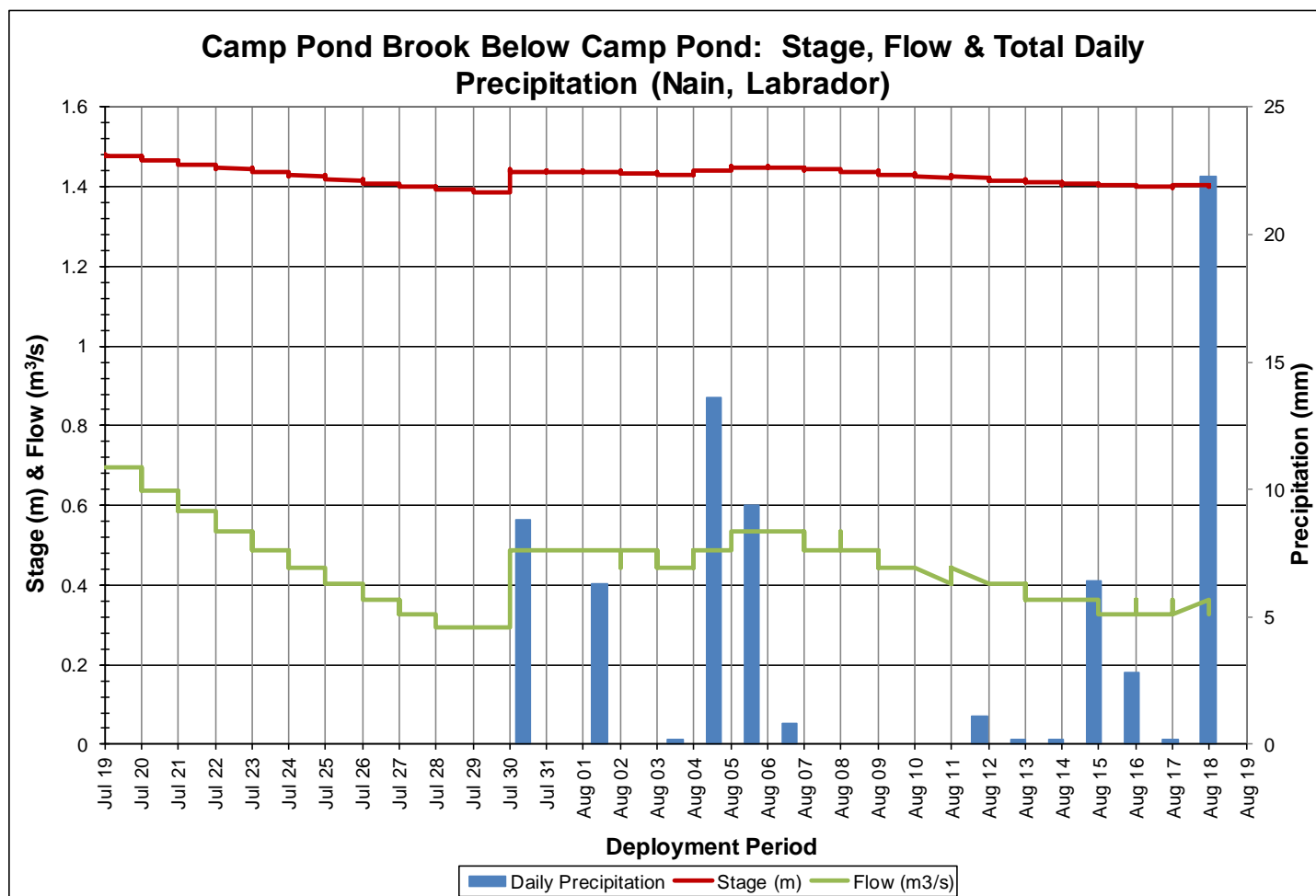


Figure 14: Stage, Flow, and Total Daily Precipitation (Nain, Labrador Weather Station) at Camp Pond Brook below Camp Pond

## Tributary to Lower Reid Brook

### Water Temperature

- Water temperature ranges from 7.80 °C to 15.70 °C, with a median value of 11.50°C (Figure 16).
- Streams and brooks are sensitive to changes in the ambient air temperature and water temperature will fluctuate considerably depending on the weather and the time of day.

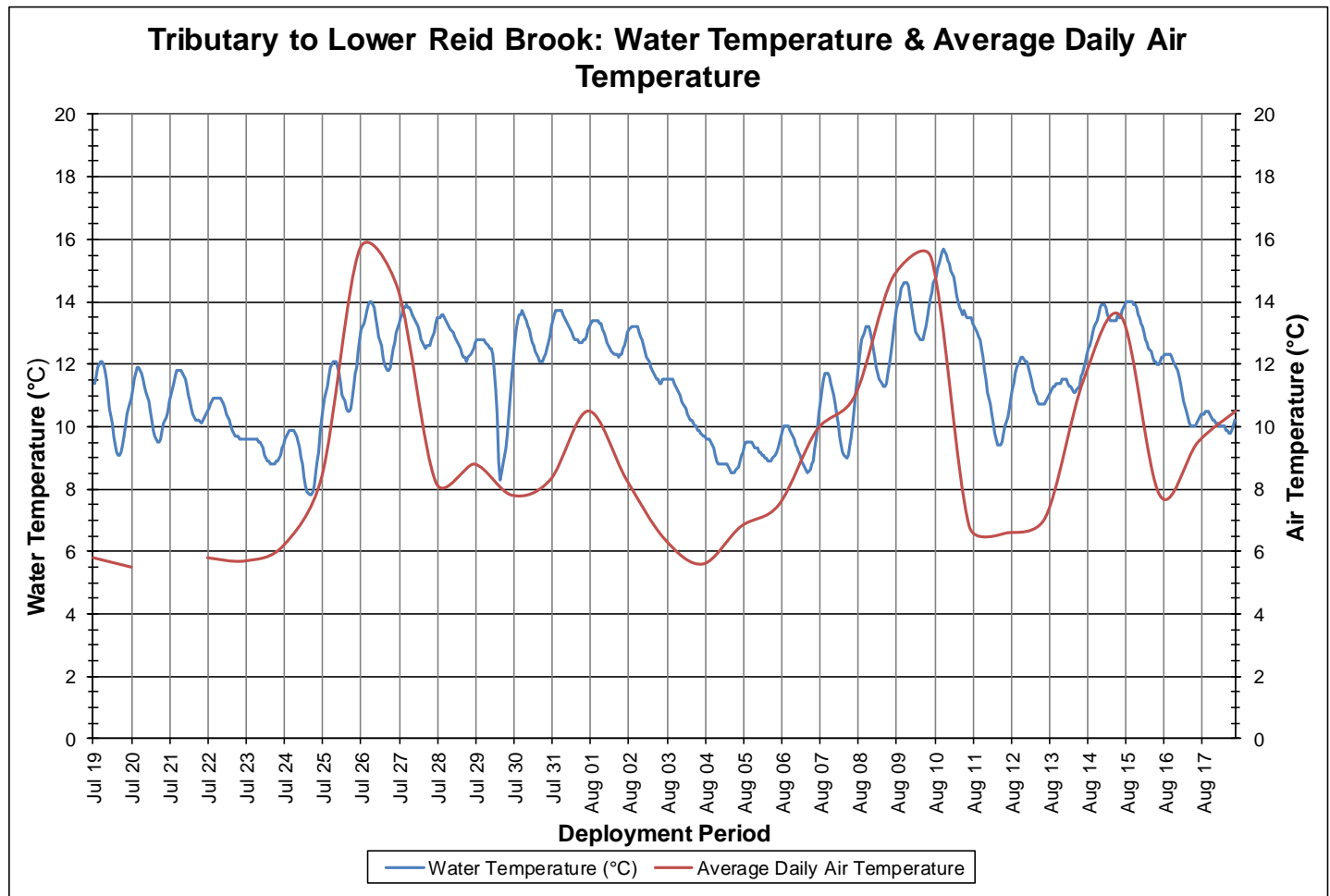


Figure 15: Water Temperature & Average Daily Air Temperature at Tributary to Lower Reid Brook

## pH

- pH ranges from 6.22 to 7.09 pH units, with a median value of 6.87 (Figure 17).
- pH dips below CCME guidelines on a few occasions and these dips are associated with increases in stage due to precipitation events. This addition of rain water causes the water to become more acidic and the pH drops.
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.

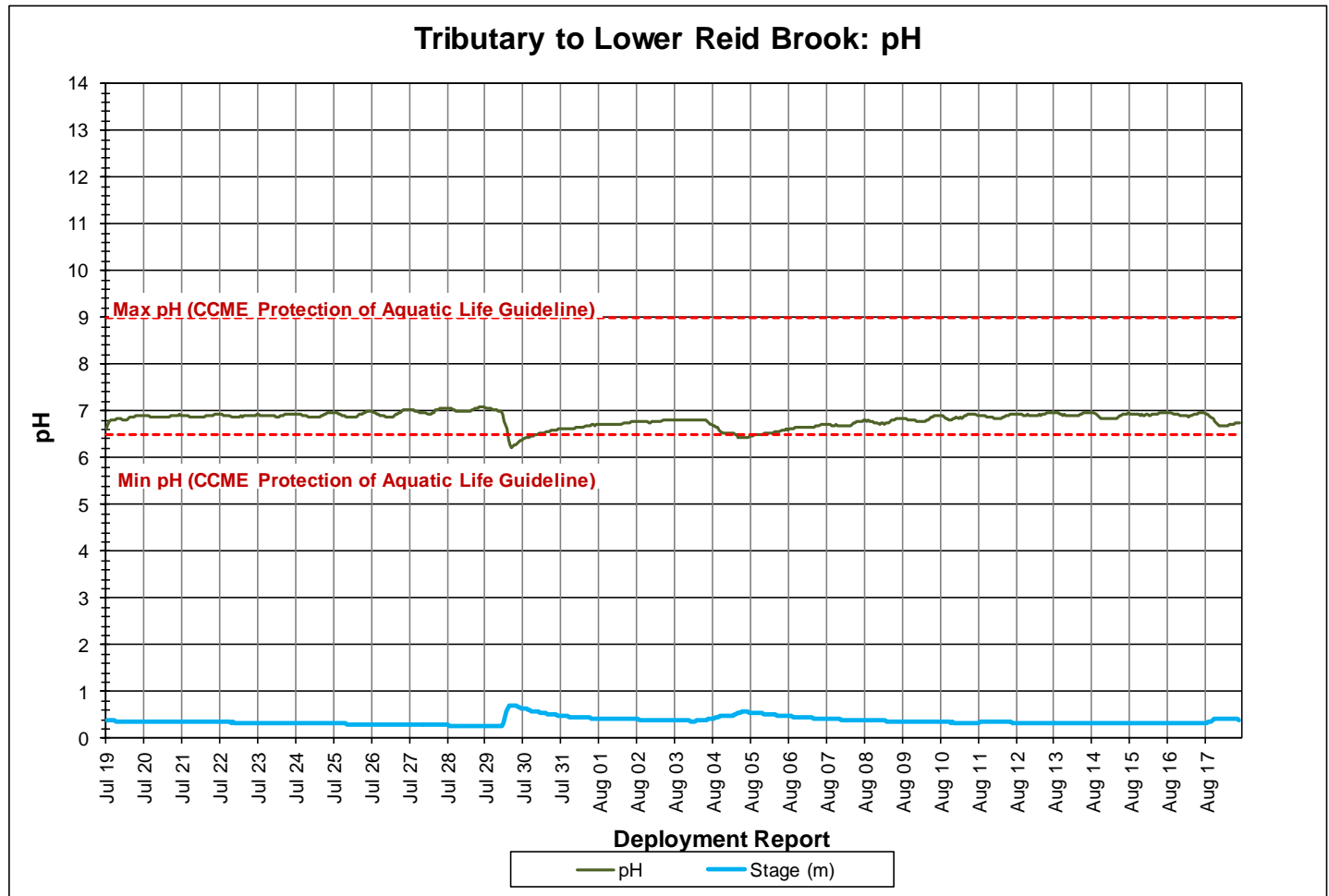


Figure 16: pH & Water Temperature at Tributary to Lower Reid Brook



### Specific Conductivity

- Specific conductivity ranges from 19.9 $\mu$ S/cm to 35.1 $\mu$ S/cm with a median of 29.2 $\mu$ S/cm. (Figure 18).
- TDS ranges between 0.0127 g/mL to 0.0225 g/mL during the deployment period, with a median of 0.0187g/mL (Figure 19).
- Specific conductivity and TDS have a direct relationship but are two separate parameters. Specific conductivity is the ability of the water to conduct electricity. Therefore the value of TDS can be calculated by the conductivity of the water (Figure 19).
- The relationship between conductivity and stage is inversed. When stage level rises, the specific conductance level drops in response as the increased amount of water in the river system dilutes the solids that are present (Figure 18).
- Water Survey of Canada (Environment Canada) is responsible for QA/QC of water quantity data (stage and flow). Corrected data can be obtained upon request.

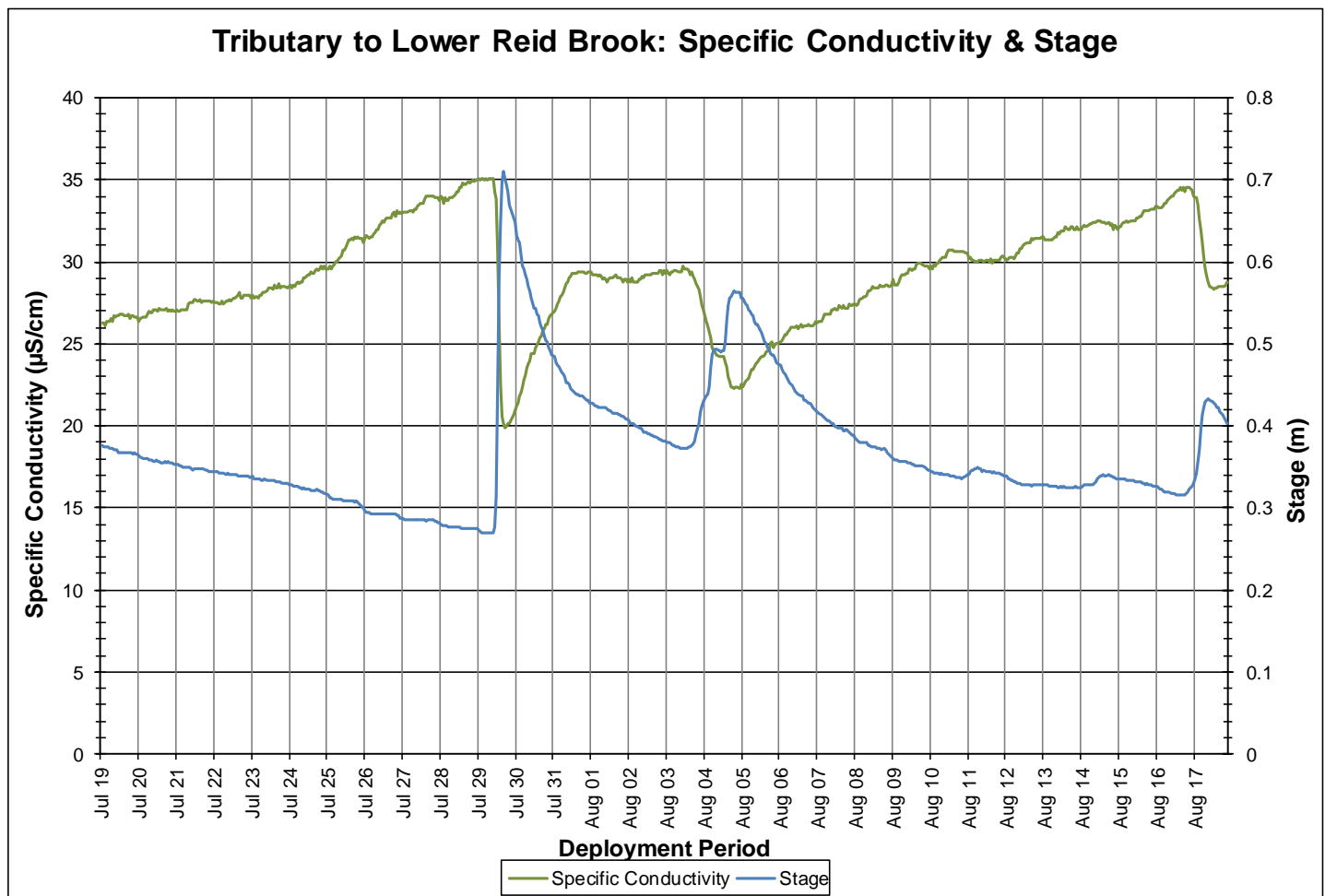


Figure 17: Specific Conductivity & Stage at Tributary to Lower Reid Brook

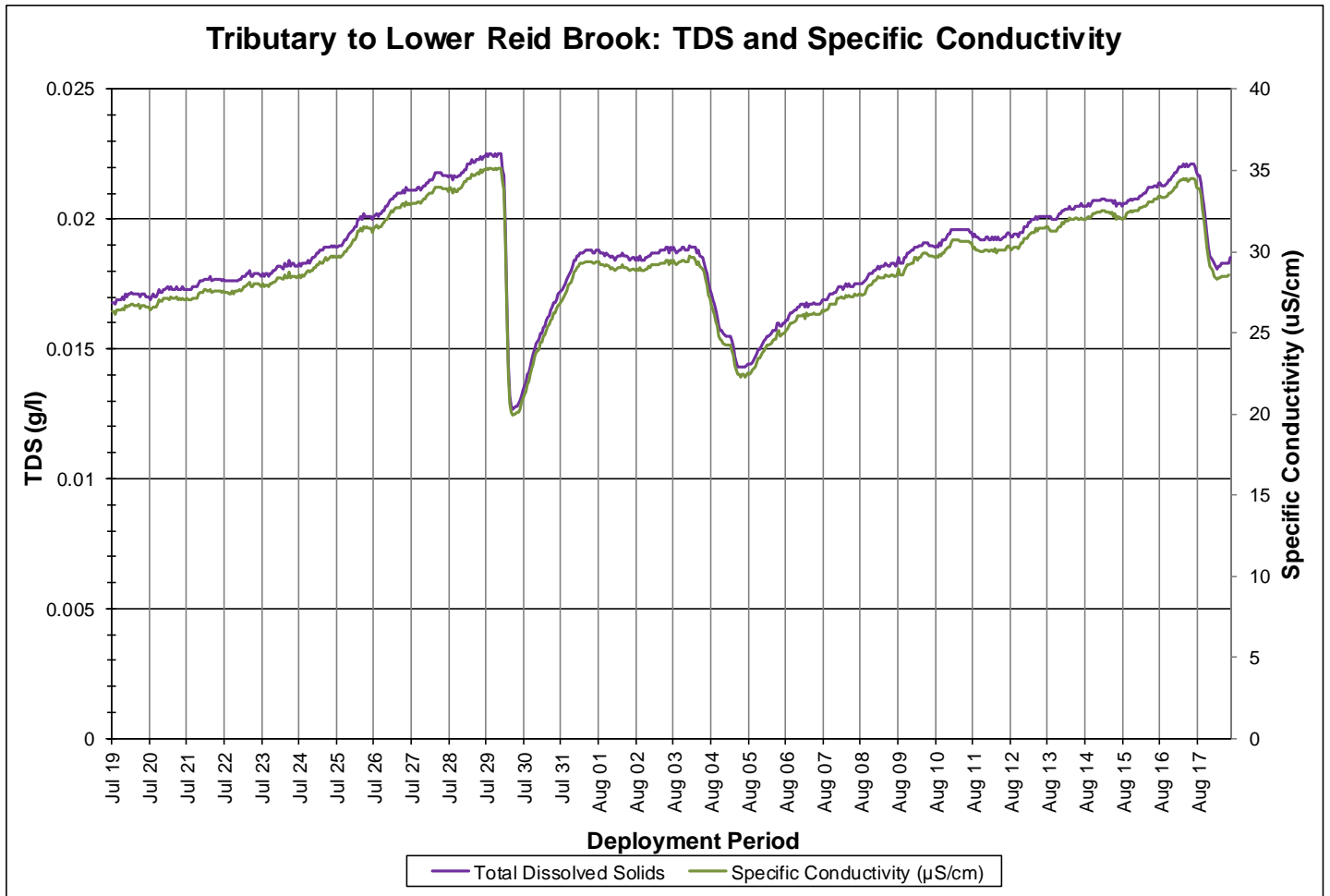


Figure 18: Specific Conductivity & TDS at Tributary to Lower Reid Brook

### **Dissolved Oxygen**

- The dissolved oxygen sensor on this instrument was damaged therefore no dissolved oxygen data is available for this deployment period. When the instrument was retrieved, it was cleaned and recalibrated and checked over for any necessary repairs.

### Turbidity

- Turbidity ranges from 0.0NTU to 99.7NTU during the deployment period, with a median value of 0.0NTU (Figure 20).
- A median value of 0.0 NTU indicates there is very little natural background turbidity at this station during this deployment period.
- There are a number of low - medium turbidity events at this station throughout the duration of this deployment. Some of the larger turbidity events correlate with precipitation causing increase in stage level and mixing of solids into the water column. (Figure 20, 21).
- Water Survey of Canada (Environment Canada) is responsible for QA/QC of water quantity data (stage and flow). Corrected data can be obtained upon request.

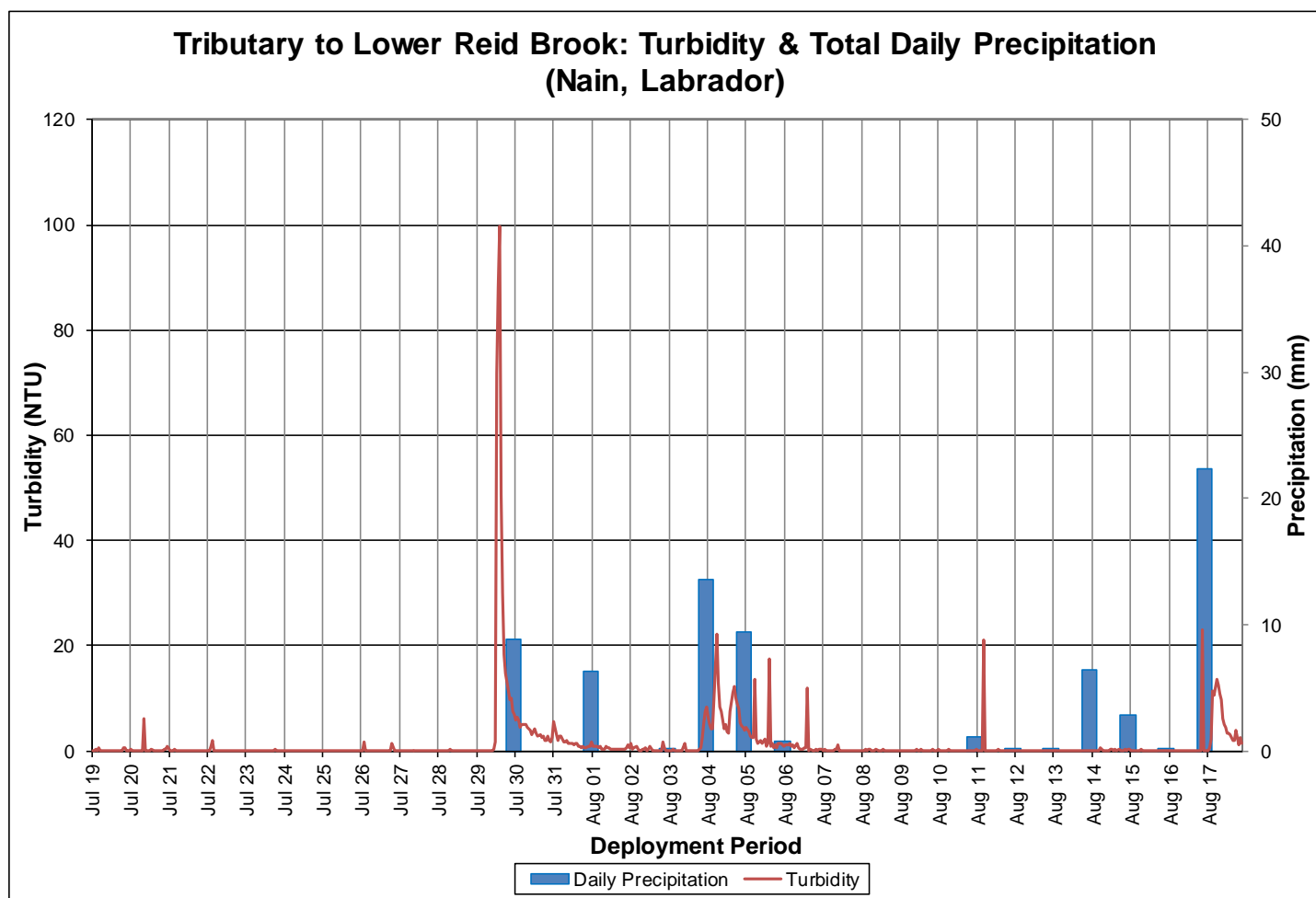


Figure 19: Turbidity & Total Daily Precipitation (Nain, Labrador Weather Station) at Tributary to Lower Reid Brook

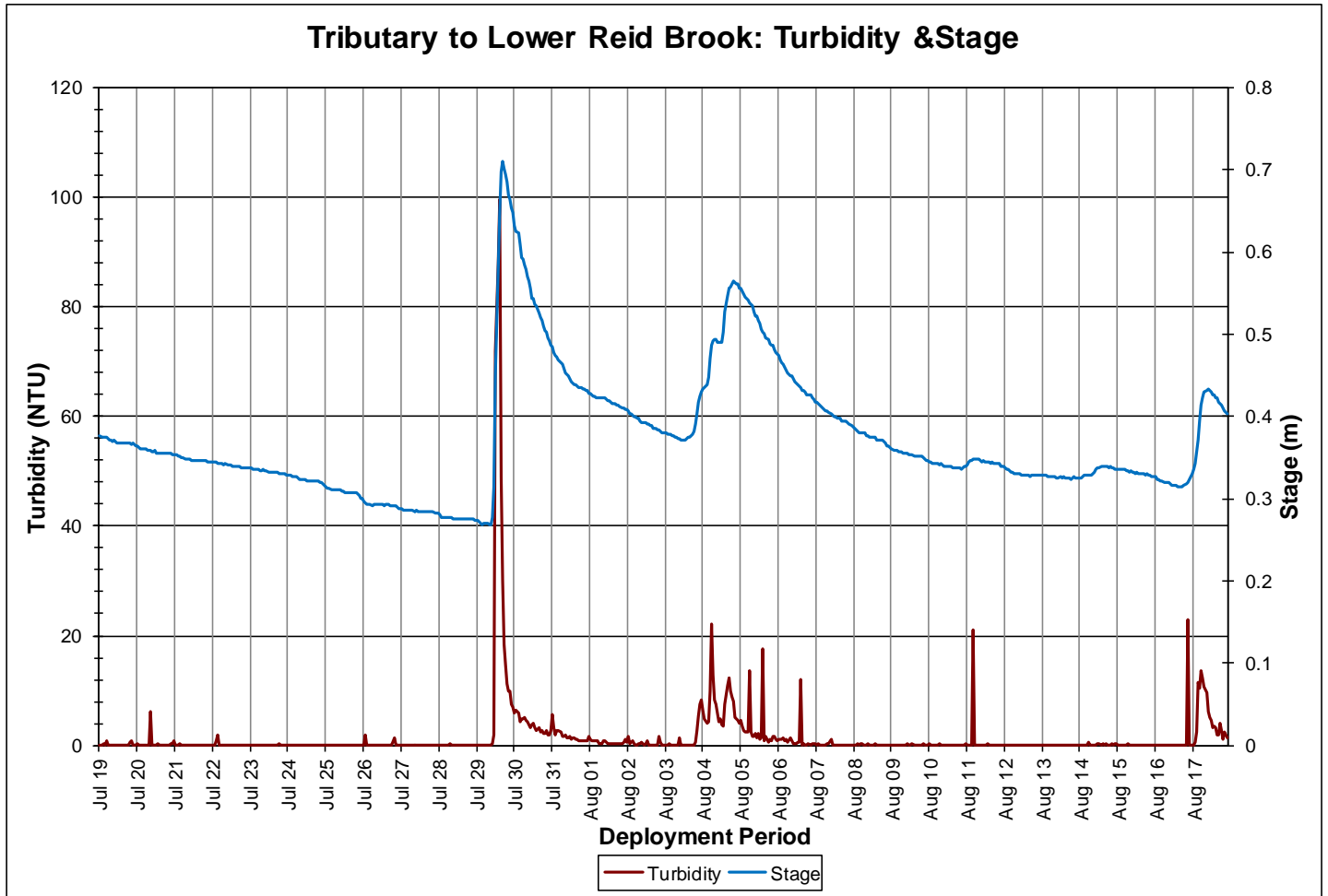


Figure 20: Turbidity & Stage at Tributary to Lower Reid Brook



### Stage, Flow and Precipitation

- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.
- Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay (Figure 22).
- Precipitation occurs on 14 days during the deployment period and amounts are small in magnitude, with the exception of the largest on August 17<sup>th</sup> with 22.3mm of rain.
- During the deployment period, the stage values ranged from 0.27m to 0.71m. Streamflow had a minimum amount of 0.05m<sup>3</sup>/s and a maximum flow of 0.91m<sup>3</sup>/s.
- Stage, Streamflow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). It is evident that the peaks in stage (m) and streamflow data are a result of precipitation.

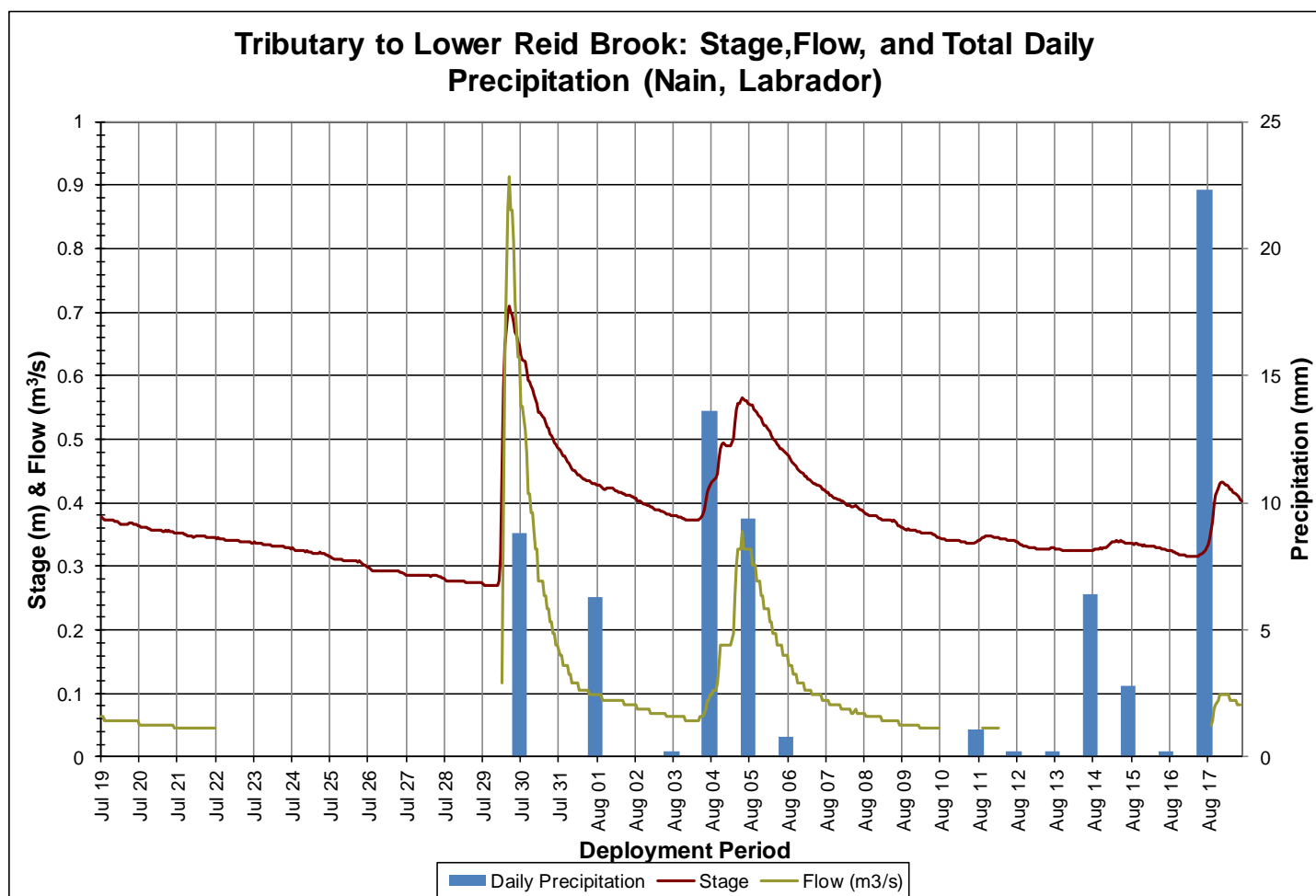


Figure 21: Stage, Flow, and Total Daily Precipitation (Nain, Labrador Weather Station) at Tributary to Lower Reid Brook

## Lower Reid Brook below Tributary

### Water Temperature

- Water temperature ranges from 8.14 °C to 16.09 °C, with a median value of 11.99°C (Figure 23).
- Streams and brooks are sensitive to changes in the ambient air temperature and water temperature will fluctuate considerably depending on the weather and the time of day.

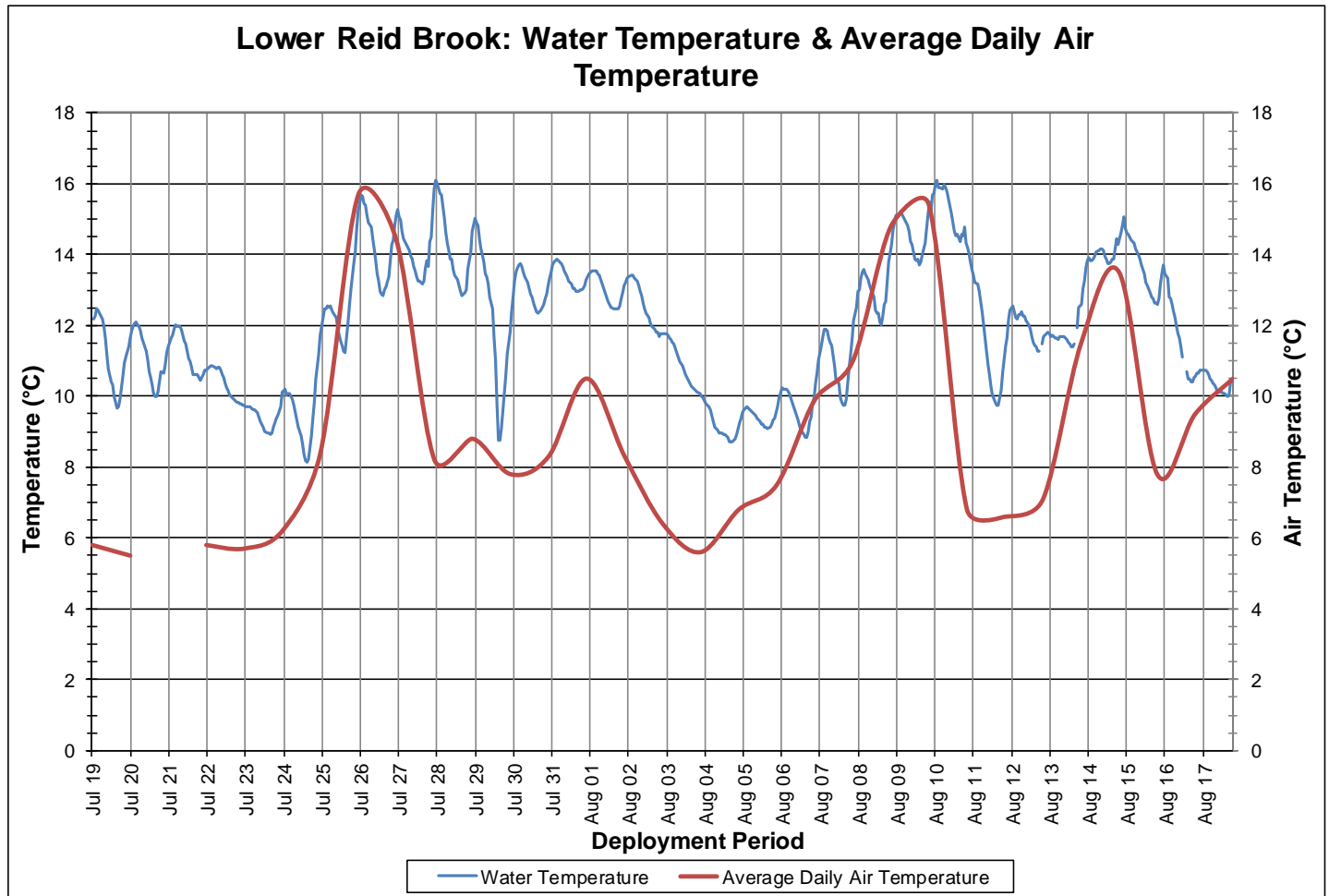


Figure 22: Water Temperature and Daily Average Air Temperature at Lower Reid Brook below Tributary

**pH**

- pH ranges from 5.79 to 6.59 pH units, with a median value of 6.32 (Figure 24).
- The pH hovers just under the CCME guideline for the entire deployment period. A significant rainfall event usually causes a decrease in pH in a waterbody due to the acidic nature of rain. Several rainfall events can cause an increase in stage and an eventual decrease in pH values due to the acidic nature of rainfall events (Figure 24).
- The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different.
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.

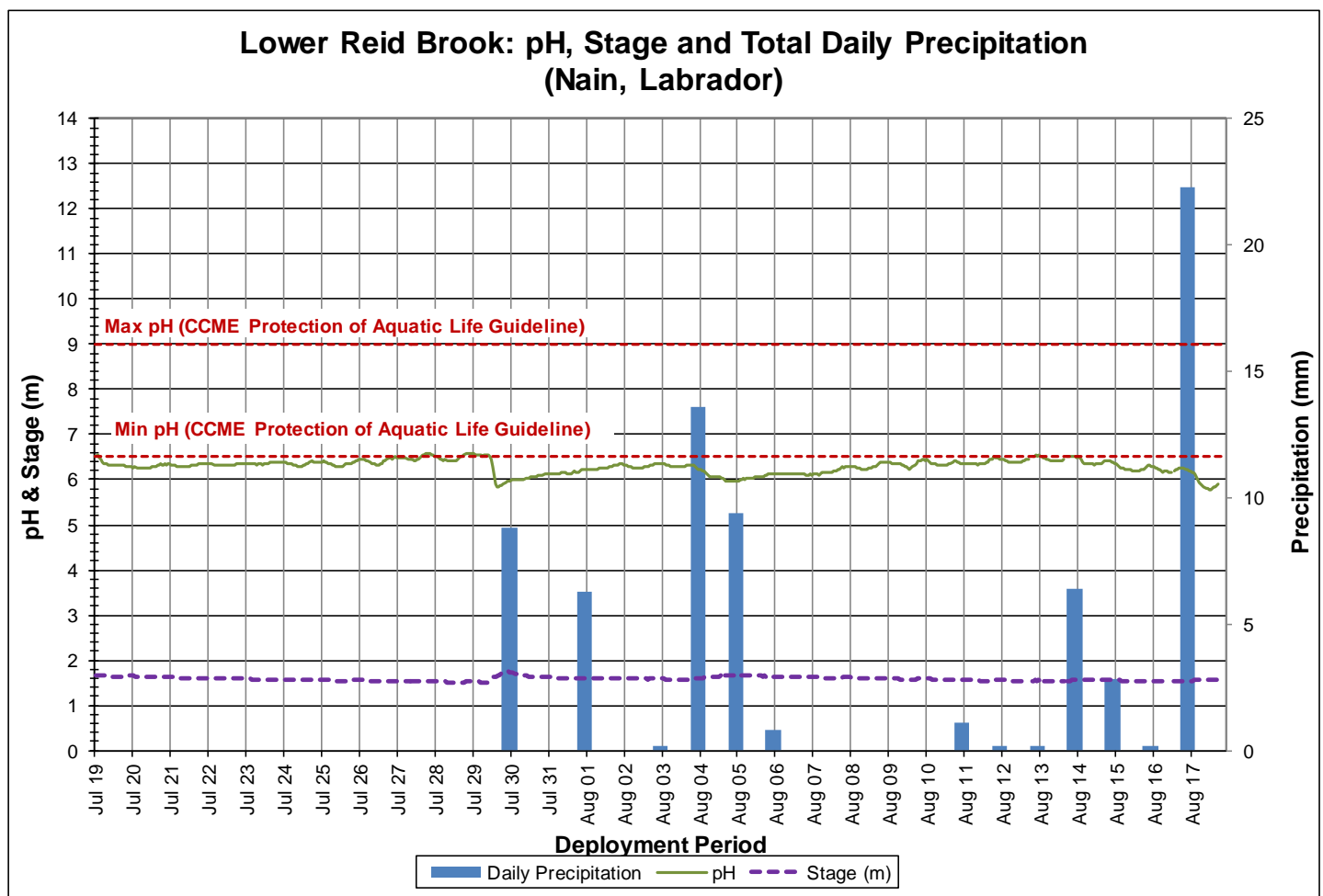


Figure 23: pH, Stage, and Total Daily Precipitation (Nain Labrador) at Lower Reid Brook below Tributary

### Specific Conductivity

- Specific conductivity ranges from 20.6 $\mu$ S/cm to 33.3 $\mu$ S/cm with a median of 28.7 $\mu$ S/cm. (Figure 25).
- TDS ranges between 0.0132 g/mL to 0.0213 g/mL during the deployment period, with a median of 0.0183g/mL (Figure 26).
- Specific conductivity and TDS have a direct relationship but are two separate parameters. Specific conductivity is the ability of the water to conduct electricity. Therefore the value of TDS can be calculated by the conductivity of the water (Figure 26)
- The relationship between conductivity and stage is inversed. When stage level rises, the specific conductance level drops in response as the increased amount of water in the river system dilutes the solids that are present (Figure 25).
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request

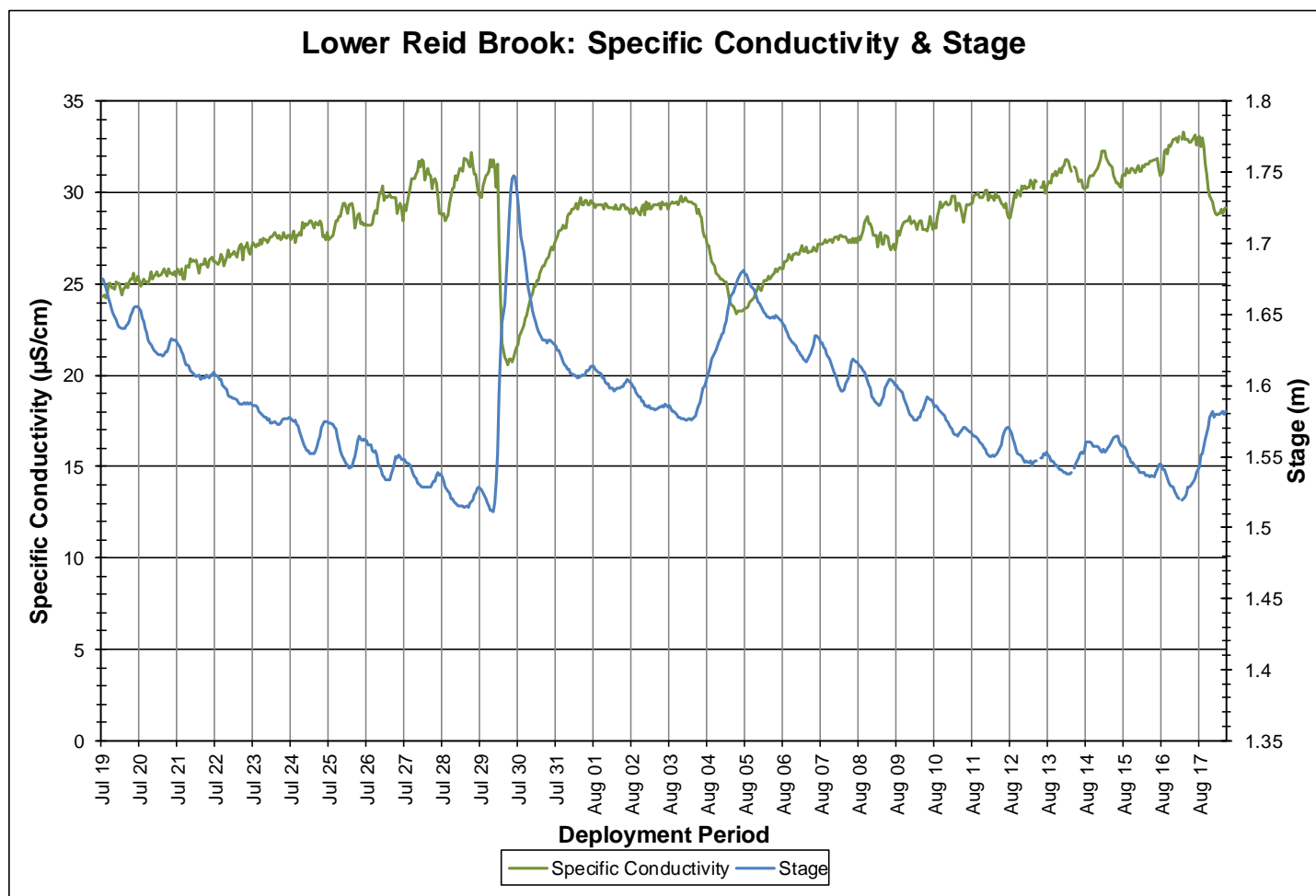


Figure 24: Specific Conductivity & Stage at Lower Reid Brook below Tributary

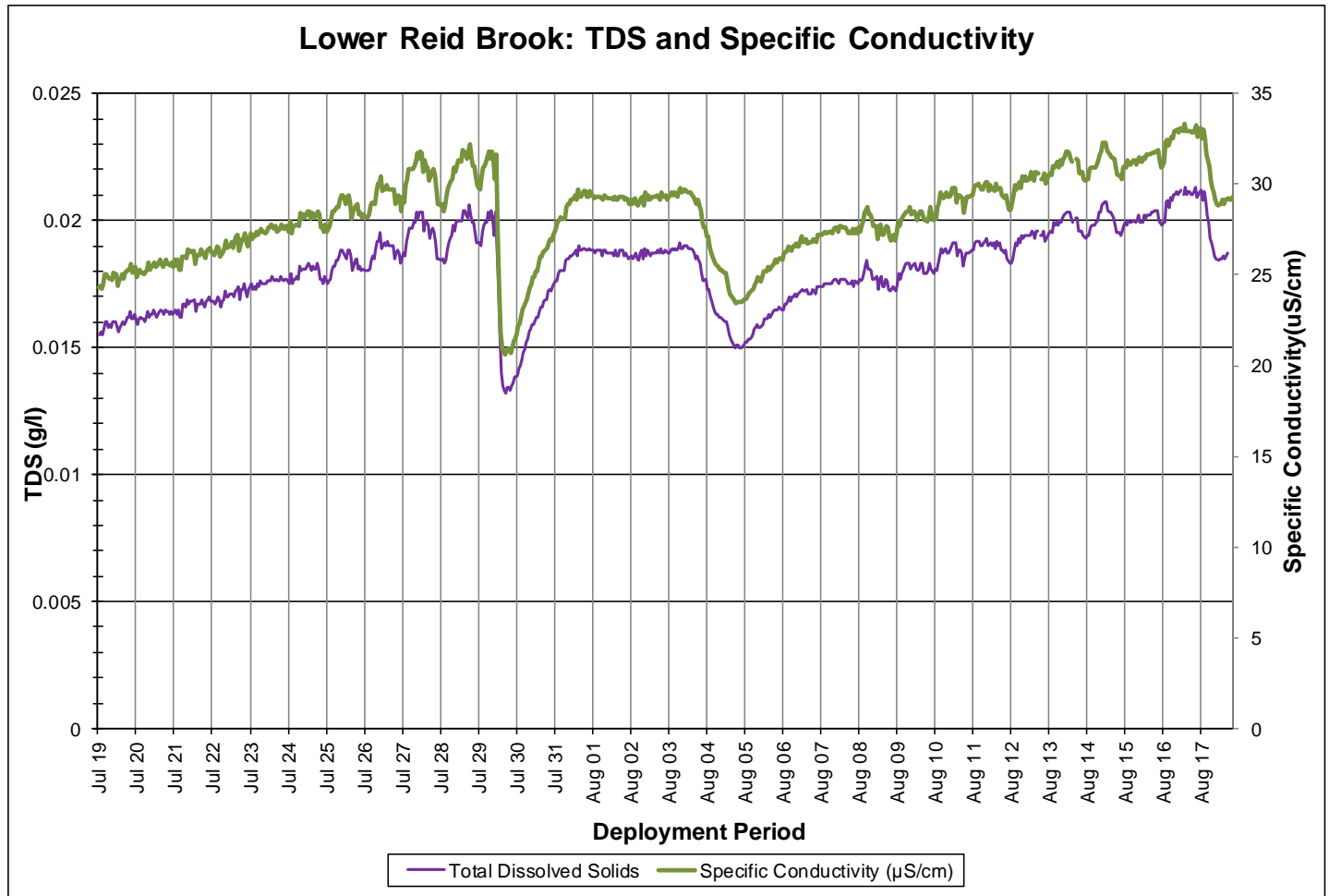


Figure 25: Specific Conductivity & TDS at Lower Reid Brook below Tributary

### Dissolved Oxygen

- Dissolved oxygen content ranges between 9.36mg/l and 11.43mg/l during the deployment period. The saturation of dissolved oxygen ranges from 93.7% to 101.1% (Figure 27).
- The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.
- During this deployment the dissolved oxygen mg/L levels remained near or above the CCME guidelines for the protection of early/other life stages.
- The exception is on August 11th when dissolved oxygen fell below 9.5mg/L. This occurrence corresponds with the warmest water temperature during the deployment period (Figure 27). This is expected as water temperature directly influences the level of dissolved oxygen present in the water column.

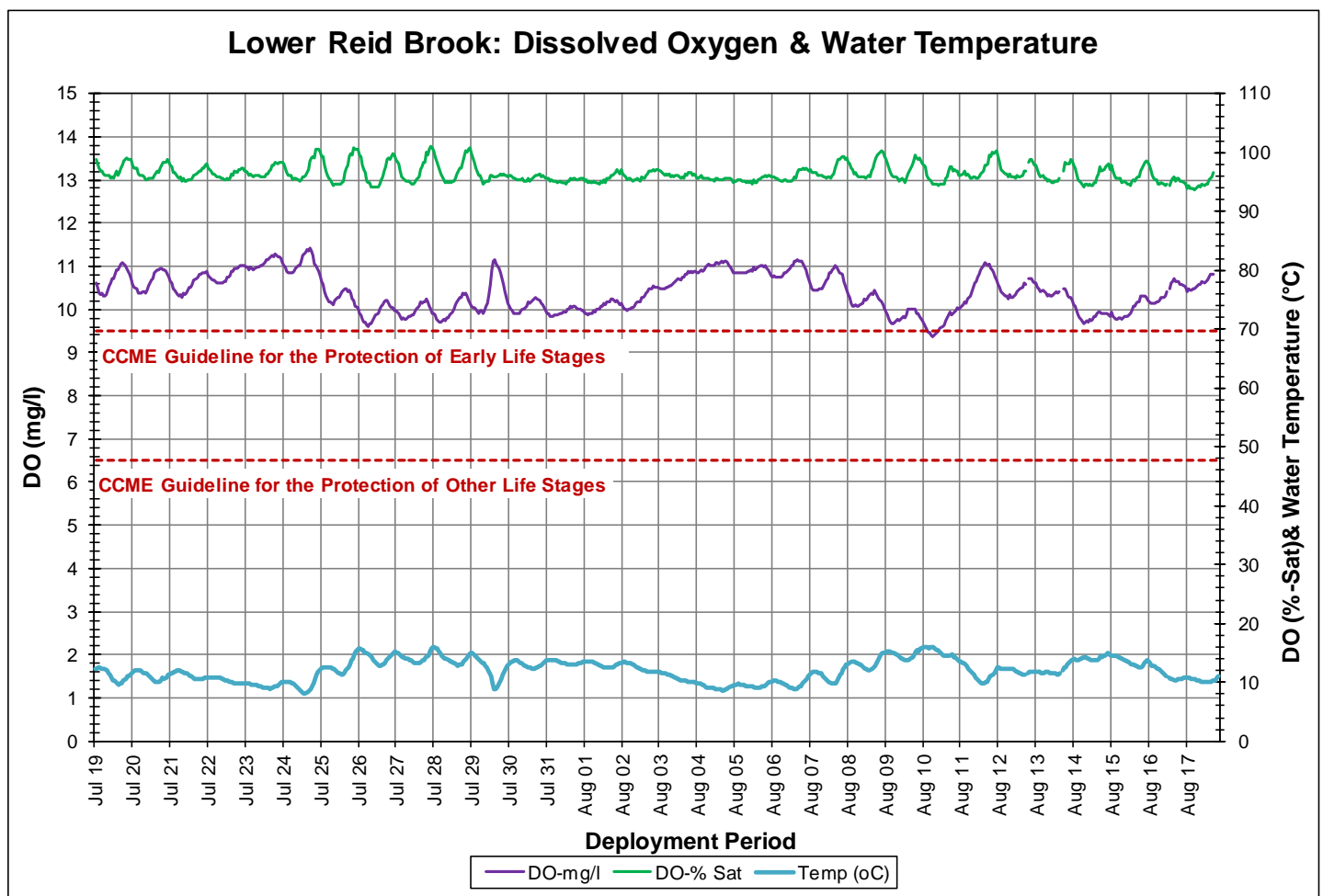


Figure 26: Dissolved Oxygen & Water Temperature at Lower Reid Brook below Tributary

### Turbidity

- Turbidity ranges from 0.0NTU to 101.7NTU during the deployment period, with a median value of 0.0NTU (Figure 28).
- A median value of 0.0 NTU indicates there is very little natural background turbidity at this station during this deployment period.
- There are a number of low and high turbidity events at this station throughout the duration of this deployment. Some of the larger turbidity events correlate with precipitation causing increase in stage level and mixing of solids into the water column. (Figure 28, 29).
- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.

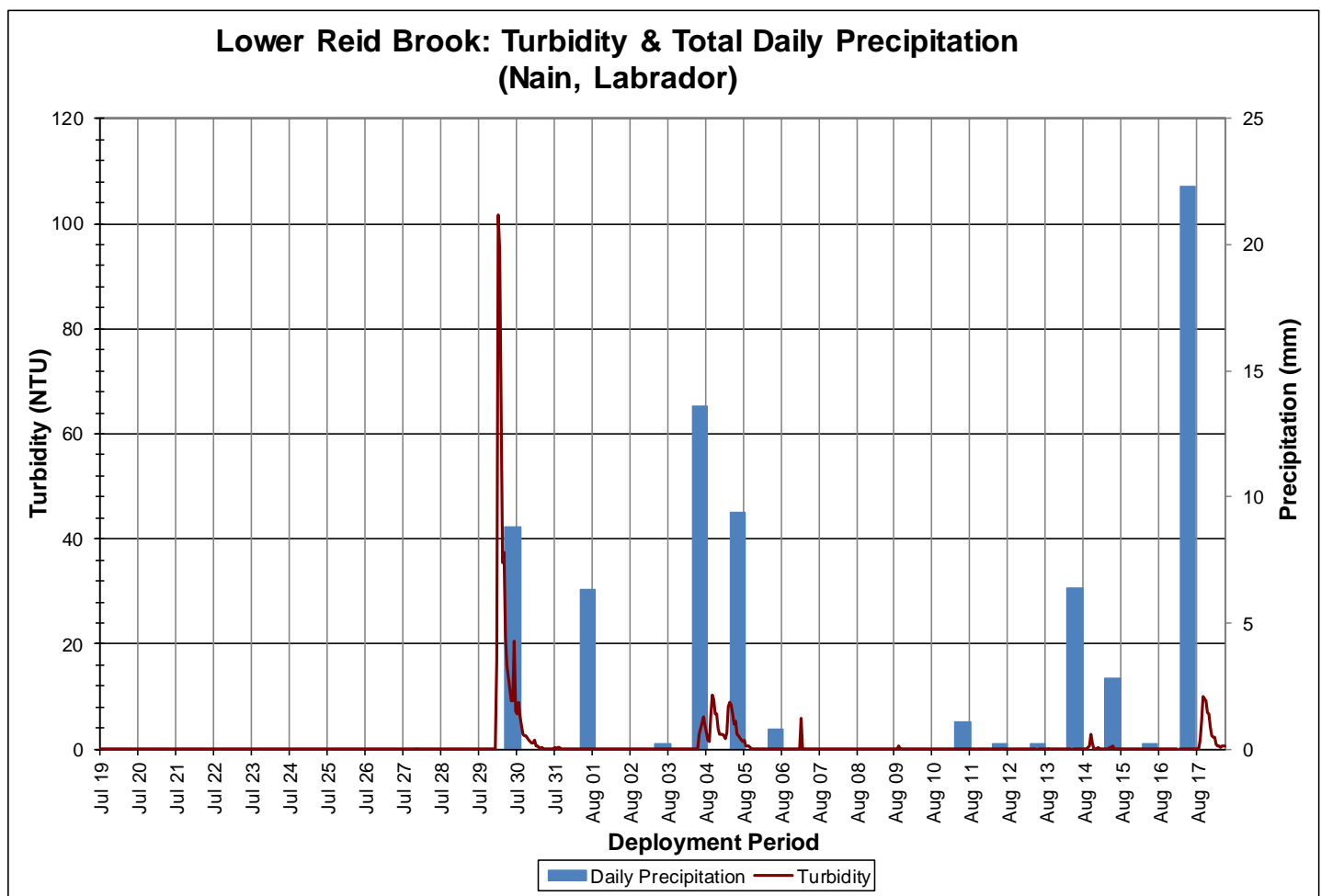


Figure 27: Turbidity & Total Daily Precipitation (Nain, Labrador Weather Station) at Lower Reid Brook below Tributary

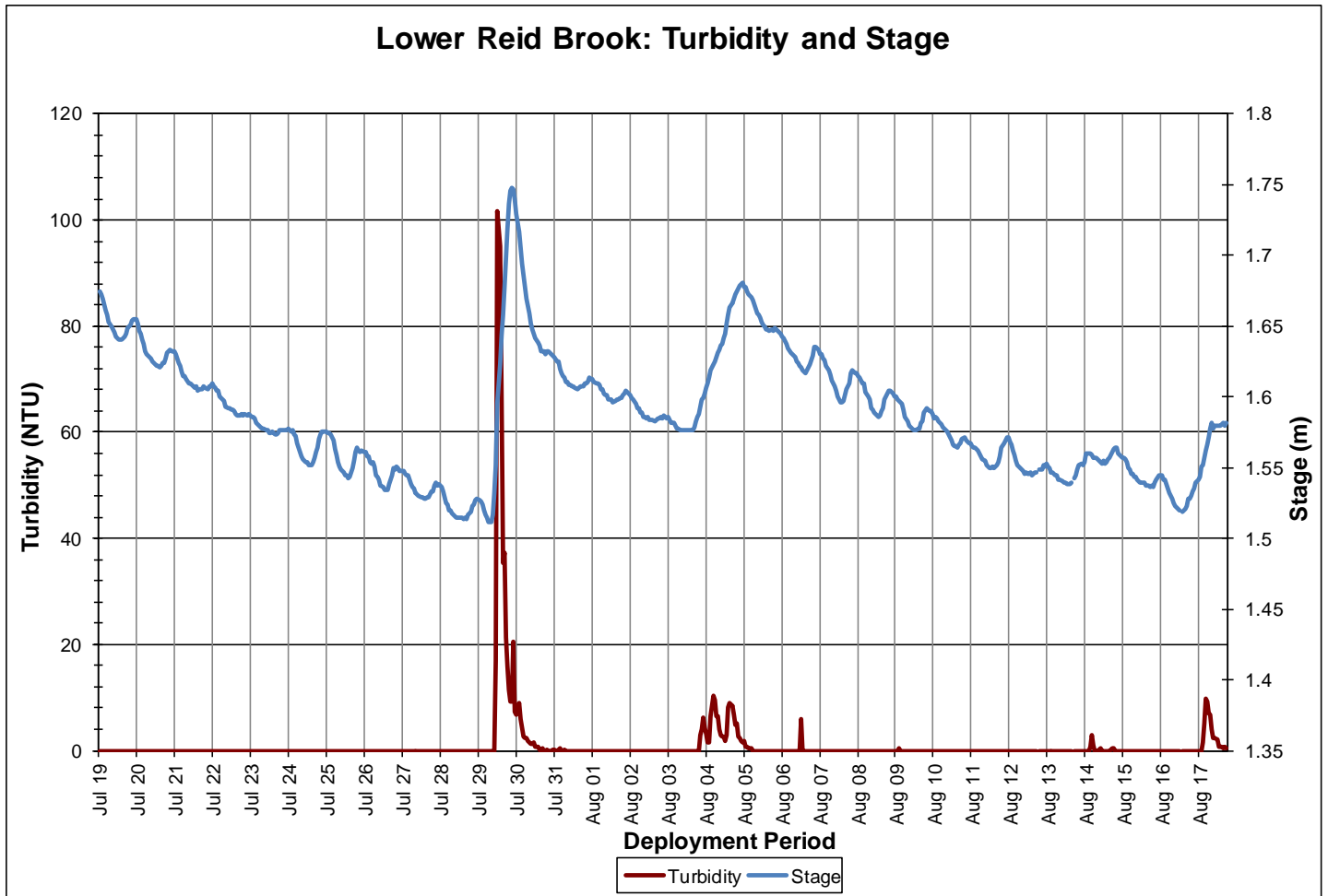


Figure 28: Turbidity & Stage at Lower Reid Brook below Tributary



### Stage, Flow, and Precipitation

- Water Survey of Canada (Environment Canada) is responsible for QAQC of water quantity data (stage and flow). Corrected data can be obtained upon request.
- Precipitation data was obtained from the Environment Canada weather station at Nain. The weather station is 30 km northeast of Voisey's Bay (Figure 30).
- Precipitation occurs on 14 days during the deployment period and amounts are small in magnitude, with the exception of the largest on August 17<sup>th</sup> with 22.3mm of rain.
- During the deployment period, the stage values ranged from 1.51m to 1.75m. Streamflow had a minimum amount of 2.47m<sup>3</sup>/s and a maximum flow of 9.80m<sup>3</sup>/s.
- Stage, Streamflow and precipitation are graphed below to show the relationship between rainfall and water level (Figure 30). It is evident that the peaks in stage (m) and streamflow data are a result of precipitation.

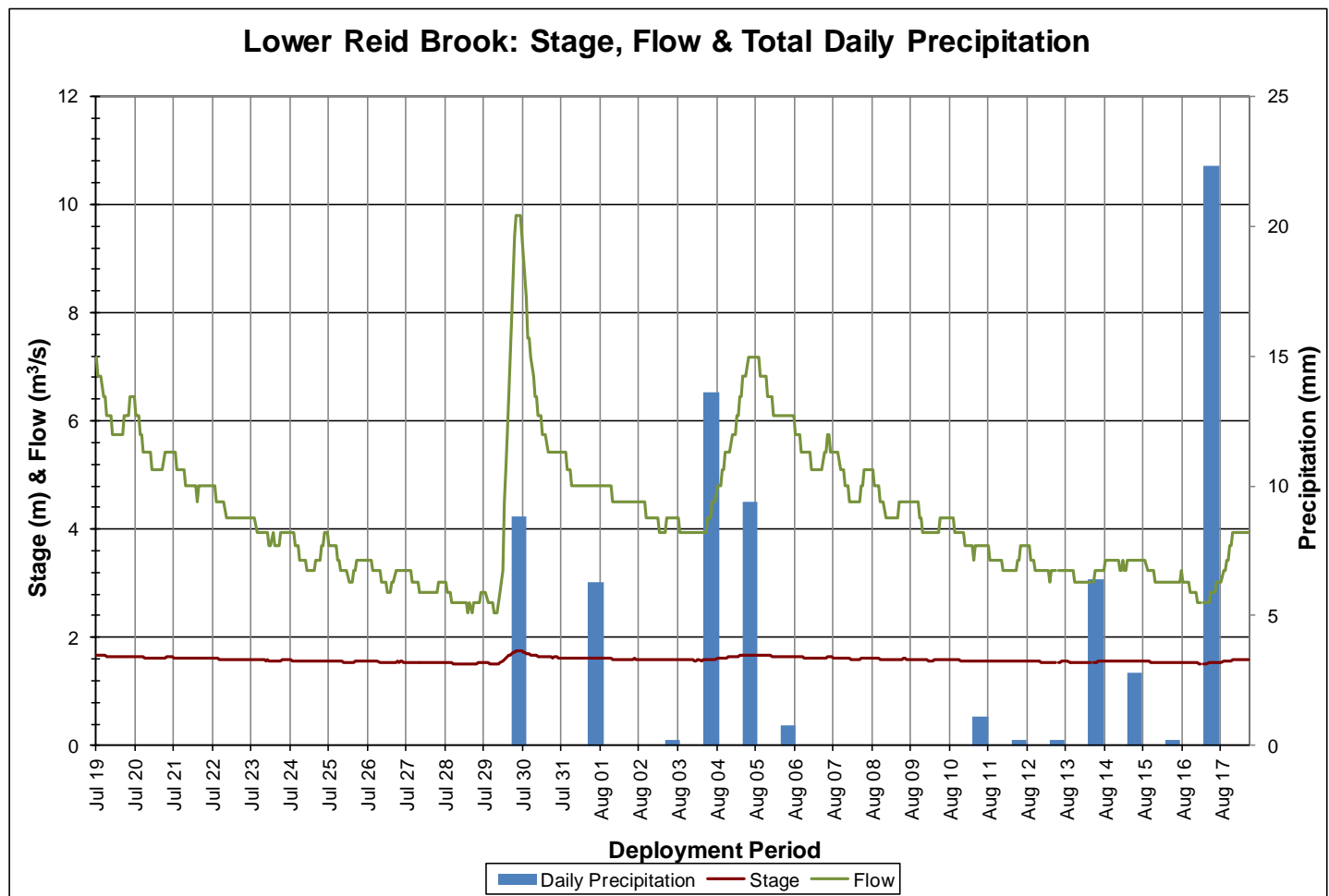
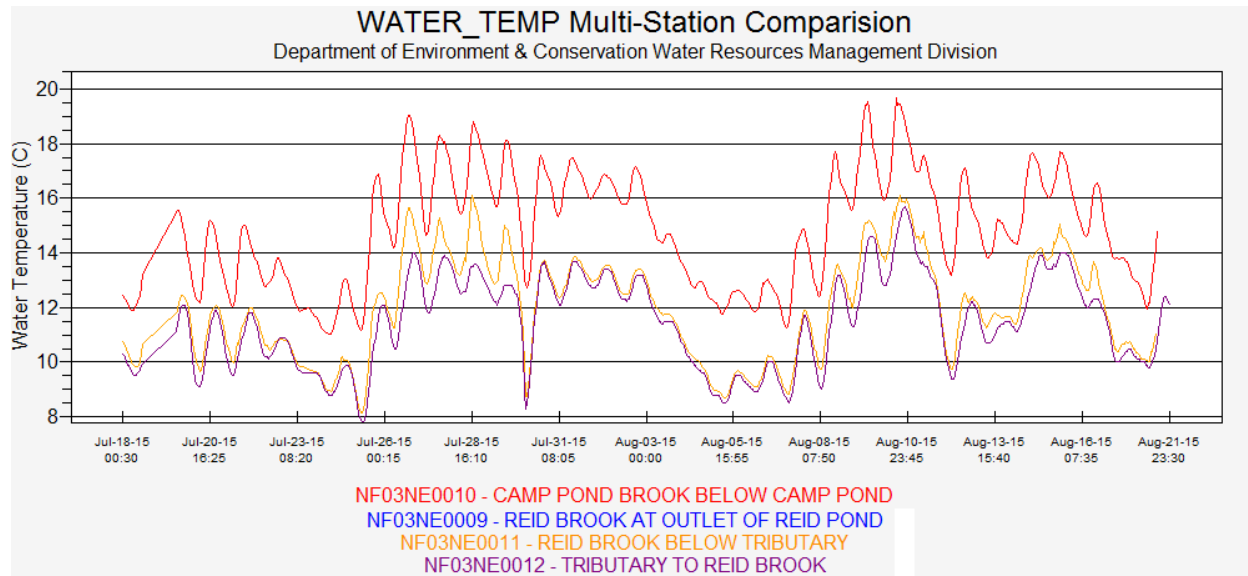


Figure 29: Stage, Flow, and Total Daily Precipitation (Nain, Labrador Weather Station) at Lower Reid Brook below Tributary

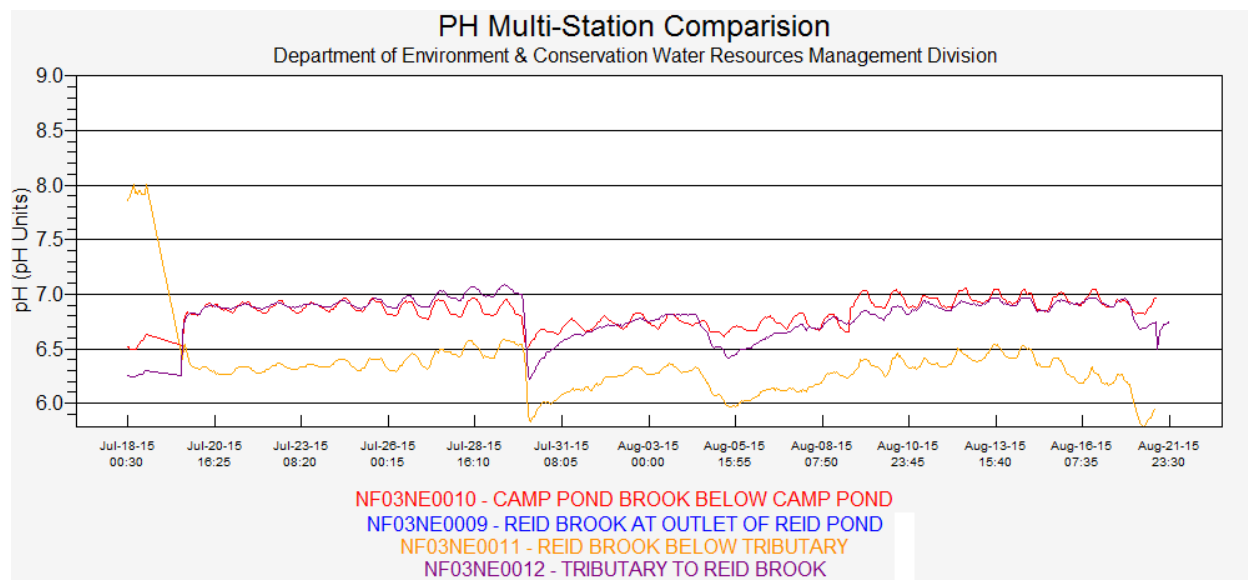
## Conclusions

- The overall water temperatures across all stations were within a minimum of 5.25°C found at Reid Brook at Outlet of Reid Pond and a maximum of 19.66°C recorded at Camp Pond Brook below Camp Pond. Overall the water temperature was increasing across the network of stations. The stations on Camp Pond Brook, Tributary to Lower Reid Brook and Lower Reid Brook are more sensitive to changes in the ambient air temperatures. Reid Brook at Outlet of Reid Pond is a large body of water and takes a longer time to adjust to the ambient air temperatures. Hence Reid Brook at Outlet of Reid Pond having the lowest water temperature during the deployment period.
- The pH values for this deployment ranged between a minimum of 5.79 pH units at Lower Reid Brook below Tributary and maximum of 8.17 pH units at Reid Brook at Outlet of Reid Pond. All of the stations remained within the CCME guidelines for the majority of the deployment period except Lower Reid Brook below Tributary. The pH at Lower Reid Brook below Tributary was lower than the other stations and was influenced by rainfall events.
- The overall conductivity across all stations were within a minimum of 12.0µS/cm at Reid Brook at Outlet of Reid Pond and a maximum value of 55.5µS/cm at Camp Pond Brook below Camp Pond. Conductivity values at Reid Brook at Outlet of Reid Pond have been the lowest all deployment when compared to the other stations. Camp Pond Brook below Camp Pond maintains the highest median at 32.1µS/cm for July to August deployment period. This is to be expected with Camp Pond Brook being closer to the mine site and the increased potential for roadway runoff and other influences.
- Dissolved oxygen levels for the deployment period ranged between a minimum of 8.91mg/l at Camp Pond Brook below Camp Pond and a maximum of 12.31mg/l found at Reid Brook at Outlet to Reid Pond. Dissolved oxygen is lower at this time of year and varies diurnally as water temperature is greatly affected by ambient air temperature.
- Turbidity levels for the four real-time stations ranged within a minimum of 0.0NTU from all stations and a maximum of 101.7NTU at Lower Reid Brook. Tributary to Lower Reid Brook and Camp Pond Brook also have several turbidity events which occurred during and after larger rainfall events.

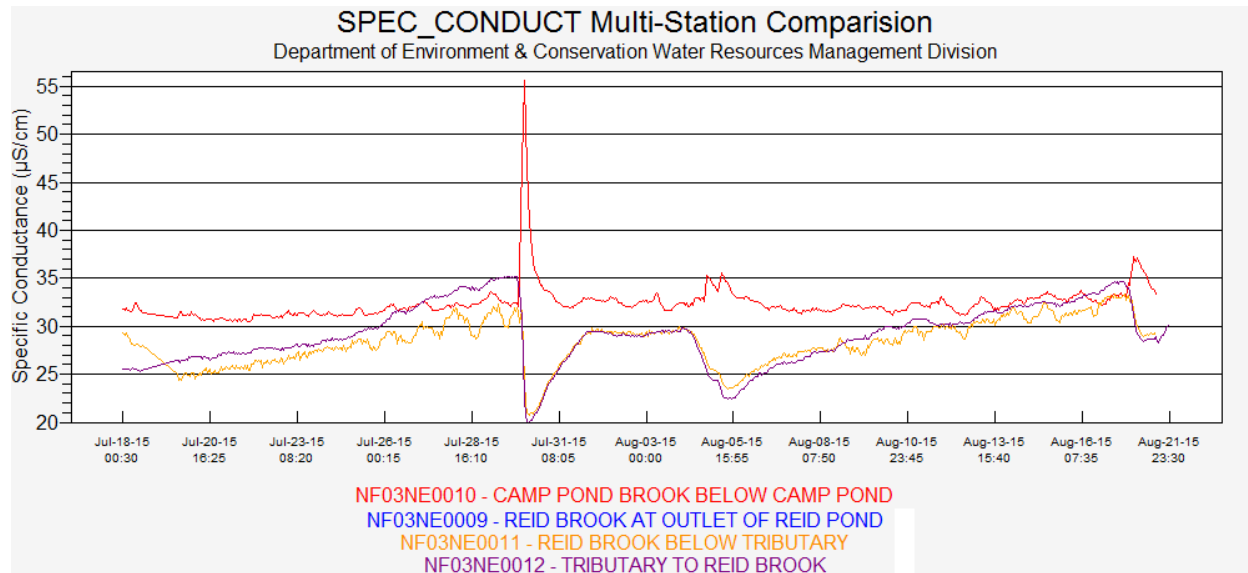
## **APPENDIX A: Comparison Graphs**



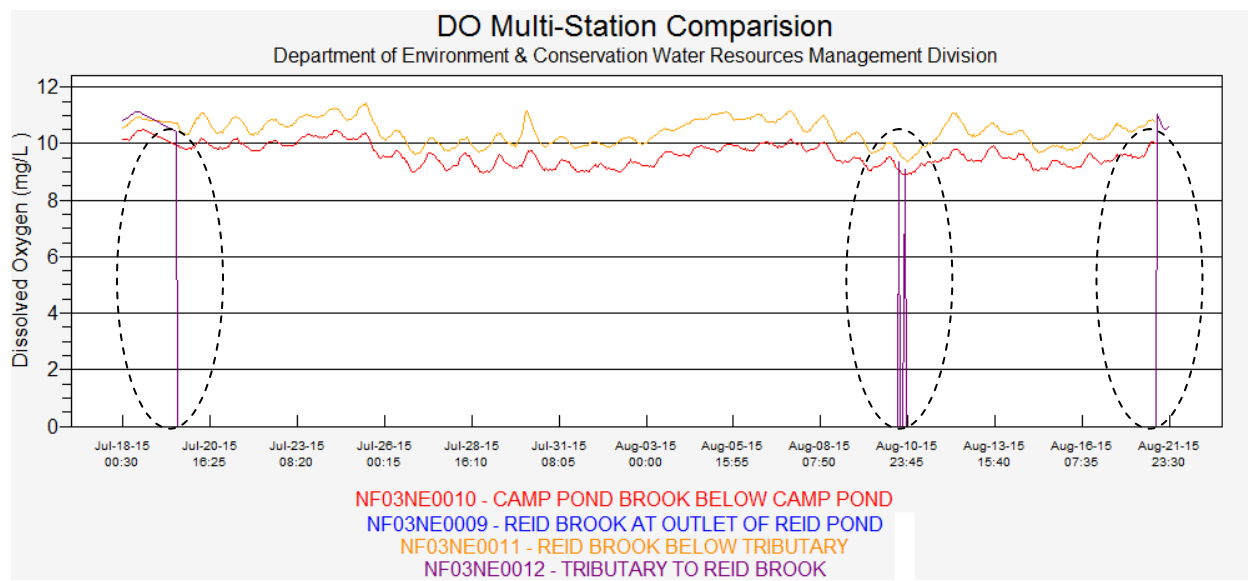
**Figure A1: Comparison of Water Temperature at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph)**



**Figure A2: Comparison of pH at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph)**

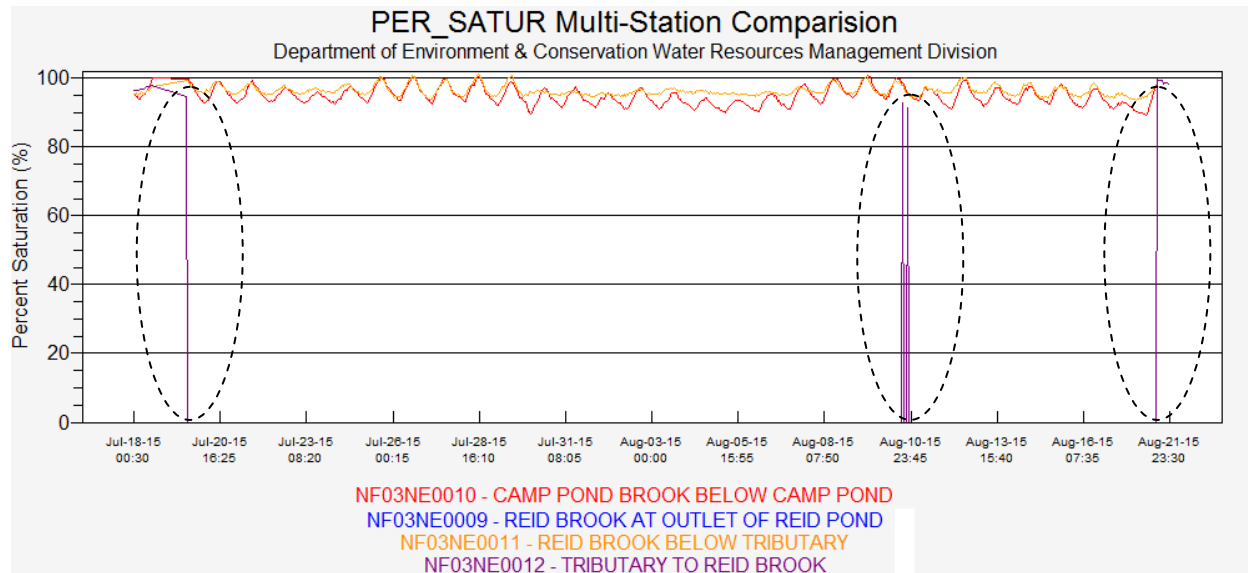


**Figure A3: Comparison of Conductivity at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph)**



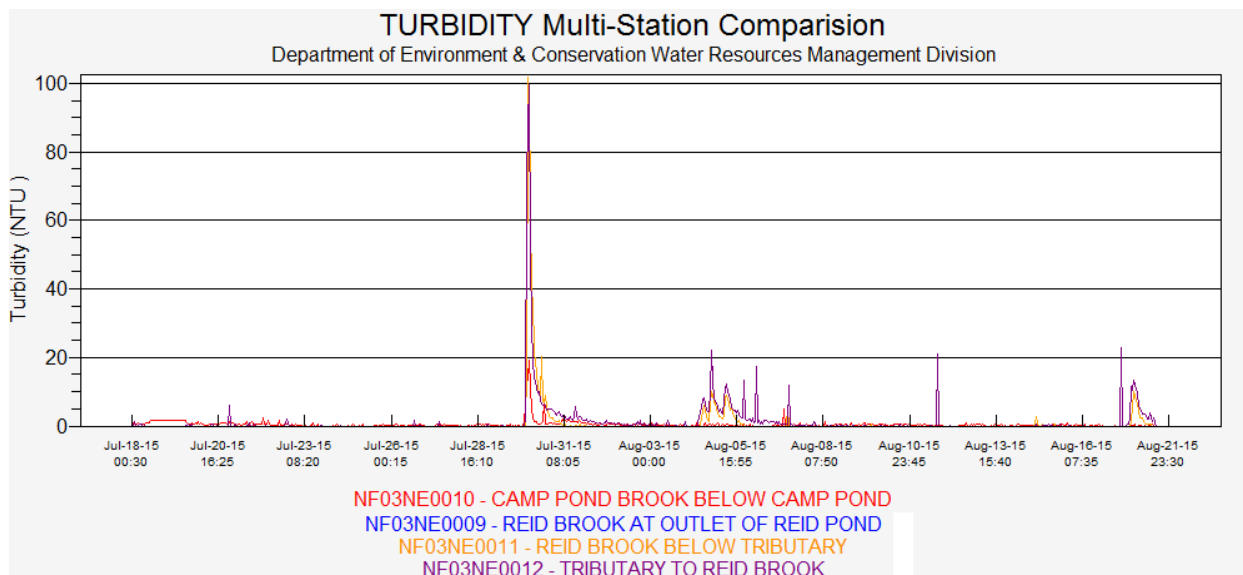
**Figure A4: Comparison of Dissolved Oxygen (mg/L) at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph).**

**\*Sensor issues at Tributary to Reid Brook are circled on the graph.**

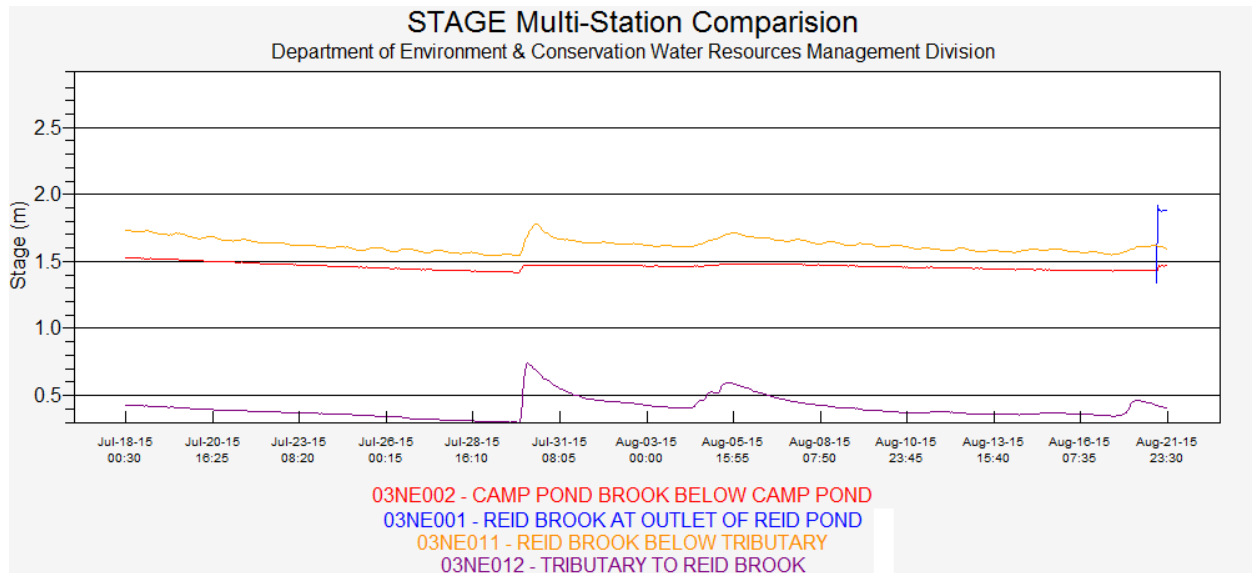


**Figure A5: Comparison of Dissolved Oxygen (%Sat) at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph).**

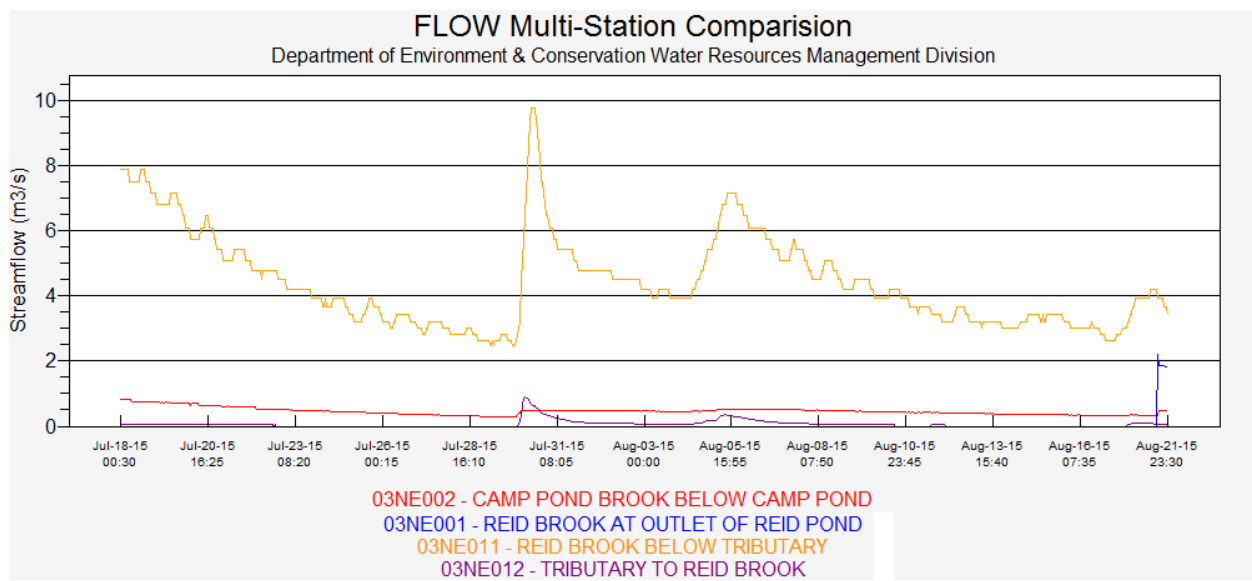
**\*Sensor issues at Tributary to Reid Brook are circled on the graph**



**Figure A6: Comparison of Turbidity at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph)**



**Figure A7: Comparison of Stage (m) at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph)**



**Figure A8: Comparison Flow (m³/s) at the Real-Time Stations in Voisey's Bay (due to transmission issues Reid Brook real time data does not show up on the graph)**

## **APPENDIX B: Grab Sample Data**



**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water

<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190817	WS-S-00000 Reid Brook at Outlet of Reid Pond	2015-6404-00-SI-SP	2015-07-18	Alkalinity as CaCO3	mg/L	5	<5
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	1
				Colour	TCU	2	7
				Conductivity	uS/cm	5	14
				Dissolved Organic Carbon	mg/L	0.5	1.8
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	2
				N-NH3 (Ammonia)	mg/L	0.025	0.206
				N-NO2 (Nitrite)	mg/L	0.10	<0.10
				N-NO3 (Nitrate)	mg/L	0.10	<0.10
				pH		1.00	6.69
				Sulphate	mg/L	1	<1
				Total Dissolved Solids (COND - CALC)	mg/L	1	9
				Total Kjeldahl Nitrogen	mg/L	0.07	0.17
				Total Organic Carbon	mg/L	0.5	1.9
				Total Phosphorus	mg/L	0.05	<0.05
				Turbidity	NTU	0.1	0.2
				Aluminum	mg/L	0.01	0.05
				Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	1
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded. DOC, N-NH3, TKN, TOC, TP, and TSS were subcontracted.

Report comment:



APPROVAL: \_\_\_\_\_  
 Nadine Pinsonneault

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.



# REPORT OF ANALYSIS

Lab Report Number: 1514285

**Cient:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water


<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190817	WS-S-00000 Reid Brook at Outlet of Reid Pond	2015-6404-00-SI-SP	2015-07-18	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	<0.03
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.005
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded. DOC, N-NH3, TKN, TOC, TP, and TSS were subcontracted.

Report comment:

Results relate only to the parameters tested on the samples submitted.  
Methods references and/or additional QA/QC information available on request.

APPROVAL:   
 Nadine Pinsonneault

**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water

<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190818	WS-S-0000 Tributary to Lower Reid Brook	2015-6405-00-SI-SP	2015-07-19	Alkalinity as CaCO3	mg/L	5	9
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	2
				Colour	TCU	2	39
				Conductivity	uS/cm	5	28
				Dissolved Organic Carbon	mg/L	0.5	4.6
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	5
				N-NH3 (Ammonia)	mg/L	0.025	0.099
				N-NO2 (Nitrite)	mg/L	0.10	<0.10
				N-NO3 (Nitrate)	mg/L	0.10	<0.10
				pH		1.00	6.95
				Sulphate	mg/L	1	3
				Total Dissolved Solids (COND - CALC)	mg/L	1	18
				Total Kjeldahl Nitrogen	mg/L	0.07	17.0
				Total Organic Carbon	mg/L	0.5	5.0
				Total Phosphorus	mg/L	0.05	<0.05
				Turbidity	NTU	0.1	0.6
				Aluminum	mg/L	0.01	0.11
				Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded.

Report comment:



APPROVAL: \_\_\_\_\_  
 Nadine Pinsonneault

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water


<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190818	WS-S-0000 Tributary to Lower Reid Brook	2015-6405-00-SI-SP	2015-07-19	Copper	mg/L	0.001	0.001
				Iron	mg/L	0.03	0.20
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.014
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded.

Report comment:

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

APPROVAL:   
 Nadine Pinsonneault

**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water

<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190819	WS-S-0000 Lower Reid Brook below Tributary	2015-6406-00-SI-SP	2015-07-1	Alkalinity as CaCO3	mg/L	5	8
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	2
				Colour	TCU	2	32
				Conductivity	uS/cm	5	27
				Dissolved Organic Carbon	mg/L	0.5	4.3
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	5
				N-NH3 (Ammonia)	mg/L	0.025	0.129
				N-NO2 (Nitrite)	mg/L	0.10	<0.10
				N-NO3 (Nitrate)	mg/L	0.10	<0.10
				pH		1.00	6.95
				Sulphate	mg/L	1	2
				Total Dissolved Solids (COND - CALC)	mg/L	1	18
				Total Kjeldahl Nitrogen	mg/L	0.07	0.22
				Total Organic Carbon	mg/L	0.5	4.4
				Total Phosphorus	mg/L	0.05	<0.05
				Turbidity	NTU	0.1	0.7
				Aluminum	mg/L	0.01	0.10
				Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded.

Report comment:



APPROVAL: \_\_\_\_\_  
 Nadine Pinsonneault

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water


<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190819	WS-S-0000 Lower Reid Brook below Tributary	2015-6406-00-SI-SP	2015-07-1	Copper	mg/L	0.001	0.001
				Iron	mg/L	0.03	0.18
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.012
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded.

Report comment:

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

APPROVAL:   
 Nadine Pinsonneault

**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water

<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190820	WS-S-0000 Camp Pond Brook Below Camp Pond	2015-640700-SI-SP	2015-07-19	Alkalinity as CaCO3	mg/L	5	11
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	2
				Colour	TCU	2	24
				Conductivity	uS/cm	5	38
				Dissolved Organic Carbon	mg/L	0.5	4.1
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	7
				N-NH3 (Ammonia)	mg/L	0.025	0.121
				N-NO2 (Nitrite)	mg/L	0.10	<0.10
				N-NO3 (Nitrate)	mg/L	0.10	<0.10
				pH		1.00	7.27
				Sulphate	mg/L	1	4
				Total Dissolved Solids (COND - CALC)	mg/L	1	25
				Total Kjeldahl Nitrogen	mg/L	0.07	0.42
				Total Organic Carbon	mg/L	0.5	4.3
				Total Phosphorus	mg/L	0.05	<0.05
				Turbidity	NTU	0.1	0.7
				Aluminum	mg/L	0.01	0.08
				Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	3
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded. DOC, N-NH3, TKN, TOC, TP, and TSS were subcontracted.

Report comment:



APPROVAL: \_\_\_\_\_  
 Nadine Pinsonneault

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

**Client:** Department of Environment  
**Attention:** Ms. Annette Tobin  
**Client Project:** Happy Valley-Goose Bay  
**Purchase Order:** 214004545

**COC Number:** 3392  
**Date Reported:** 2015-08-20  
**Date Submitted:** 2015-07-24  
**Sample Matrix:** Water


<u>LAB ID</u>	<u>Supply / Description</u>	<u>Client Sample ID</u>	<u>Sample Date</u>	<u>ANALYTE</u>	<u>UNIT</u>	<u>MRL</u>	<u>RESULT</u>
1190820	WS-S-0000 Camp Pond Brook Below Camp Pond	2015-640700-SI-SP	2015-07-19	Copper	mg/L	0.001	0.003
				Iron	mg/L	0.03	0.11
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.023
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.015
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Sample comment:

Holding time for turbidity analysis was exceeded. Holding time for NO2 and NO3 analysis was exceeded. DOC, N-NH3, TKN, TOC, TP, and TSS were subcontracted.

Report comment:

Results relate only to the parameters tested on the samples submitted.  
 Methods references and/or additional QA/QC information available on request.

APPROVAL:   
 Nadine Pinsonneault



## APPENDIX C: Quality Assurance / Quality Control Procedures

- As part of the Quality Assurance / Quality Control (QA/QC) protocol, the performance of a station's water quality instrument (i.e., Field Sonde) is rated at the beginning and end of its deployment period. The procedure is based on the approach used by the United States Geological Survey (Wagner *et al.* 2006)<sup>1</sup>.
- At the beginning of the deployment period, a newly calibrated QA/QC water quality instrument (i.e., QA/QC Sonde) is temporarily deployed *in-situ* and along side the newly calibrated Field Sonde. A grab sample is also taken from the water body at this time and sent away to a laboratory for analysis. Field Sonde performance ratings for *temperature* (°C) and *Dissolved Oxygen* (% saturation) are based on differences recorded by the Field Sonde and QA/QC Sonde. Field Sonde performance ratings for *specific conductivity* (µS/cm), *pH* (unit) and *turbidity* (NTU) are based on differences between Field Sonde readings and grab sample results.
- At the end of the deployment period, water quality parameters are recorded by the Field Sonde before and after a thorough cleaning of its probes. Error caused by *bio-fouling* ( $E_f$ ) is assessed by comparing these readings with readings made by a newly calibrated QA/QC Sonde, which is temporarily deployed *in-situ* and along side the Field Sonde. An assessment of *instrument drift error* ( $E_d$ ) is made during laboratory calibration of the Field Sonde, and the two error values are added to give an estimate of total error ( $E_t = E_f + E_d$ ). If  $E_t$  exceeds a predetermined data correction criterion, a correction factor is applied to the dataset based on linear interpolation of  $E_t$ . The Field Sonde performance is also rated at the end of the deployment period, based on the  $E_t$  value.
- Performance ratings are based on differences listed in the table below.

Parameter	Rating				
	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

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<sup>1</sup> Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at <http://pubs.water.usgs.gov/tm1d3>

## APPENDIX D: 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 (Allan 2010).
  - **Flow** – Flow (m<sup>3</sup>/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<sub>2</sub> (Allan 2010).
  - **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 (Allan 2010; 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 (Allan 2010; Hach 2006).
  - **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 (Allan 2010; 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 (Allan 2010; Hach 2006; Swanson and Baldwin 1965)

## References

- Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated December, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.
  - Online: <http://st-ts.ccme.ca/en/index.html?chems=154,162&chapters=1>
- Swanson, H.A., and Baldwin, H.L., 1965. A Primer on Water Quality, U.S. Geological Survey.
  - Online: <http://ga.water.usgs.gov/edu/characteristics.html>