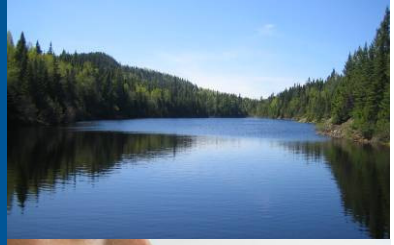
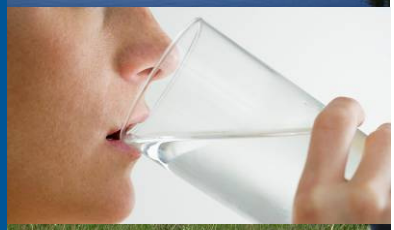






# Real Time Water Quality Report
# VALE, Voisey's Bay Stations

## Deployment Period 2010-07-21 to 2010-08-16

**2010-09-29**

Newfoundland Labrador


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

# Real Time Water Quality Monthly Report for VALE Newfoundland and Labrador Ltd. July & August 2010

## General

- On July 21, 2010 ENVC and VALE environmental staff deployed the 4 DataSondes® following the appropriate procedures.
- The real-time data (and subsequently the water quality graphs) logged, transmitted and graphed successfully for all four stations over the deployment period.
- Water Resources Management Division (WRMD) staff monitors the real-time web page on a daily basis.
- This report interprets the real-time data collected over the deployment period from July 21 until the instruments were removed on August 16 for calibration/cleaning. Instruments were redeployed on August 17.

## Maintenance and Calibration of Instrumentation

- After being cleaned and freshly calibrated the **DataSondes®** were installed on July 21, 2010, and remained deployed continuously until August 16, 2010, a 27 day period. On August 16, 2010, the instrument was checked *in situ* against a freshly calibrated **MiniSonde®** to verify that it was functioning properly, and had no significant drift.

## Quality Assurance / Quality Control (QAQC) Measures

- As part of the QAQC (Quality Assurance, Quality Control) protocol, 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. See **Table 1**.

**Table 1: Ranking limits for Parameters**

| | 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 |

- Upon deployment, a QAQC **MiniSonde®** is temporarily deployed along side the Field **DataSonde®**. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the difference between parameters recorded by the Field **DataSonde®**, QAQC **MiniSonde®** a qualitative statement is made on the data quality upon deployment.
- At the end of a deployment period, readings are taken in the water body from the Field **DataSonde®** before and after a thorough cleaning in order to assess the degree of biofouling. During calibration in the laboratory, an assessment of calibration drift is made and the two error values are combined to give Total Error ($T_e$). If $T_e$ exceeds a predetermined data correction criterion, a correction based on $T_e$ is applied to the dataset using linear interpolation. Based on the value for $T_e$, a qualitative statement is also made on the data quality upon removal.
- The rankings at the beginning and end of the deployment period are shown in **Table 2** for the Voisey's Bay Stations.

- The **Reid Brook at Outlet of Reid Pond** data was ranked at installation and removal. Due to the absence of a turbidity probe on the QAQC **MiniSonde®** at installation, there is no ranking for turbidity at that time. During installation all parameters ranked within the applicable ranges of *Good* and *Excellent*. During removal all parameters ranked as *Good* and *Excellent,* except for dissolved oxygen and turbidity which ranked as *Poor* at removal. This result may be a reflection of the performance of the Clark cell dissolved oxygen probe on the instrument.

- There were no major events or disruptions to the maintenance check of **Lower Reid below Tributary** station, during the deployment period or the scheduled site visit. The data was ranked at installation and removal. Due to the absence of a turbidity probe on the QAQC **MiniSonde®** at installation, there is no ranking for turbidity at that time. During installation all parameters ranked within the applicable ranges of *Good* and *Excellent*. During removal all parameters ranked as *Good* and *Excellent,* except for dissolved oxygen which ranked as *Marginal* at removal. This result may be a reflection of the performance of the Clark cell dissolved oxygen probe on the instrument.

- There were no major events or disruptions to the maintenance check of **Tributary to Lower Reid Brook** station, during the deployment period or the scheduled site visit. The data was ranked at installation and removal. Due to the absence of a turbidity probe on the QAQC **MiniSonde®** at installation, there is no ranking for turbidity at that time. During installation all parameters ranked within the applicable ranges of *Good* and *Excellent*, except for pH which ranked as *Poor,* this ranking can be a result of insufficient length of stabilization time for the sensor on the field instrument. During removal all parameters ranked *Excellent.*

- There were no major events or disruptions to the maintenance check of **Camp Pond Brook below Camp Pond** during the deployment period or the scheduled site visit. The data was ranked at installation and removal. Due to the absence of a turbidity probe on the QAQC **MiniSonde®** at installation, there is no ranking for turbidity at that time. During installation all parameters ranked within the applicable ranges of *Good* and *Excellent*. During removal all parameters ranked *Excellent,* except for dissolved oxygen, which ranked as *Poor* at removal. This result may be a reflection of the performance of the Clark cell dissolved oxygen probe on the instrument

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups, temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

- With the exception of water quantity data (stage & stream flow), 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. Where appropriate, corrected data for water quality parameters are indicated.

**Table 2: QAQC Data Comparison Rankings for deployment between July 21 and August 16, 2010**

| Station | Date | Action | Instrument Comparison Ranking | | | | |
|---|---|---|---|---|---|---|---|
| | | | Temperature | pH | Conductivity | Dissolved Oxygen | Turbidity |
| **Reid Brook Outlet (40644)** | **July 21/10** | **Installation** | Good | Excellent | Excellent | Excellent | N/A |
| | **Aug 16/10** | **Removal** | Excellent | Good | Excellent | Poor | Poor |
| **Lower Reid Brook (40643)** | **July 21/10** | **Installation** | Good | Good | Excellent | Excellent | N/A |
| | **Aug 16/10** | **Removal** | Excellent | Good | Excellent | Marginal | Excellent |
| **Tributary to Lower Reid Brook (44175)** | **July 21/10** | **Installation** | Excellent | Poor | Excellent | Good | N/A |
| | **Aug 16/10** | **Removal** | Excellent | Excellent | Excellent | Excellent | Excellent |
| **Camp Pond Brook (40642)** | **July 21/10** | **Installation** | Excellent | Good | Excellent | Excellent | N/A |
| | **Aug 16/10** | **Removal** | Excellent | Excellent | Excellent | Poor | Excellent |

# DATA INTERPRETATION

## REID BROOK AT OUTLET OF REID POND (UPPER REID BROOK)

### TEMPERATURE

- The water temperature (**Figure 1**) ranged from a minimum of 5.95 ˚C to a maximum of 18.17˚C.
- The water temperature ranges depict the steady increase in water temperature from July to August, as air temperature increases with summer weather.
- On July 24, 2010 the water temperature values increase to ~13.8˚C and then drop down to ~6˚C. There is also another occurrence of an increase on August 4 followed by a decrease on August 6, 2010.
- The increase in water temperature may be explained by several precipitation events that occurred during the deployment period. Rainfall can increase the water temperature. The large drops in temperature may be a result of the runoff from the pond – flushing cooler water into the brook.

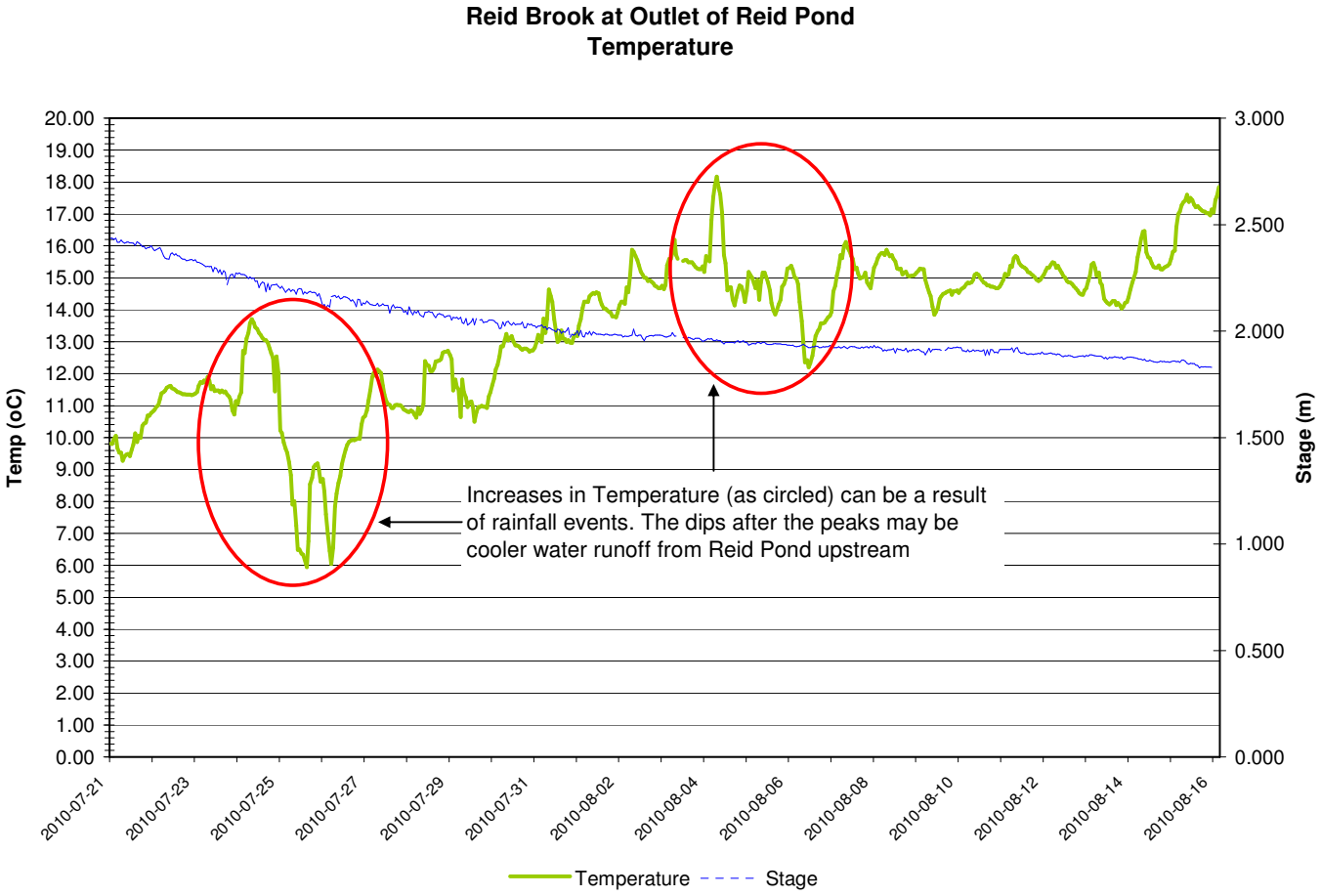


**Figure 1: Water Temperature at Reid Brook at Outlet of Reid Pond**

## pH

- Throughout the deployment period pH values (**Figure 2**) ranged from a minimum of 6.51 to a maximum of 6.90.
- The pH values can be compared to the CCME *Protection for Aquatic Life Guideline.* For Reid Brook Outlet the pH values are slightly higher than that recorded for the previous deployment period. The values sit just above the recommended range (6.5) for the minimum CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. This is not unusual as the background pH for Reid Brook Outlet is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* range.
- A decrease in pH on July 26th, 2010 can be explained by a rainfall event that was recorded in Nain on July 26th, 2010. The remainder of the deployment period had no significant events.

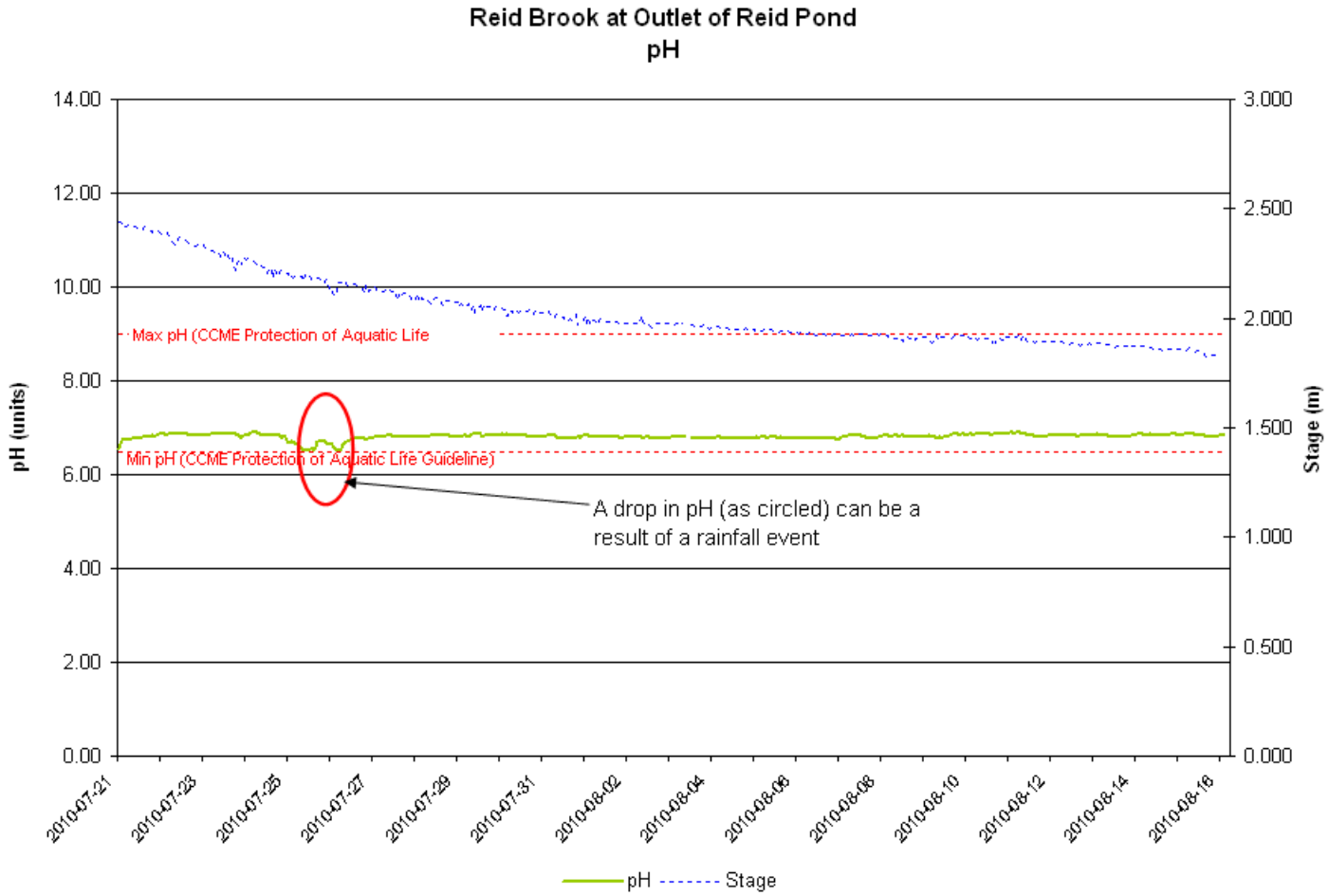


**Figure 2: pH values at Reid Brook at Outlet of Reid Pond**

## SPECIFIC CONDUCTIVITY

- The specific conductivity **(Figure 3)** ranged from a minimum of 7.7 µS/cm to a maximum of 8.6 µS/cm over the deployment period.
- Specific Conductivity remained constant during the deployment period; there are two noticeable events on July 25-27 and August 11, 2010 which corresponds with precipitation events recorded in the area.

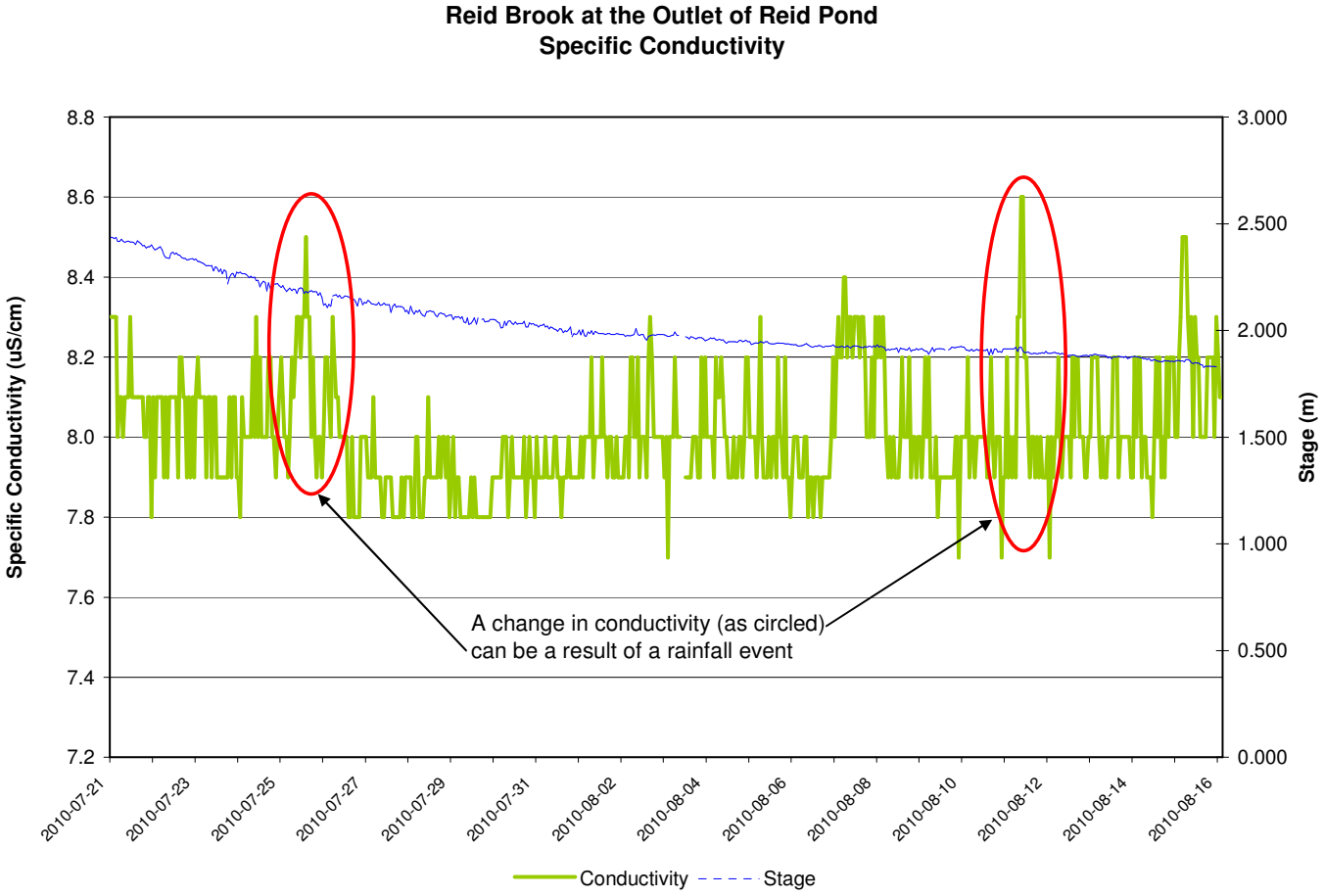


**Figure 3: Specific Conductivity Values at Reid Brook at Outlet of Reid Pond**

## DISSOLVED OXYGEN

- The dissolved oxygen (DO) values ranged from a minimum of 5.99 mg/L to a maximum of 11.48 mg/L over the deployment period (**Figure 4**).
- At installation of the instrument the DO probe ranked at excellent, however at removal the DO probe only ranked as poor.
- Within one week of the deployment on July 21, DO values start to display uncharacteristic trends. By July 29, DO values are decreasing steadily while fluctuating erratically indicating there is something affecting the sensor. While it is expected that there could be a decrease in DO concentrations due to the warming water temperatures and rainfall events in the area, these significant and consistent fluctuations are not normal.
- In the previous deployment period (June 4-July 20), the same trend was explained at both the Upper and Lower Reid Brook stations by a significant rainfall event and increase in flow that likely caused the instrument to become at least partially buried. In this case there are no precipitation events large enough to cause this disturbance. Stage and stream flow steadily decrease throughout the entire deployment period.
- It is unknown what caused this sensor failure. Data recorded between June 25 and July is not accurate.

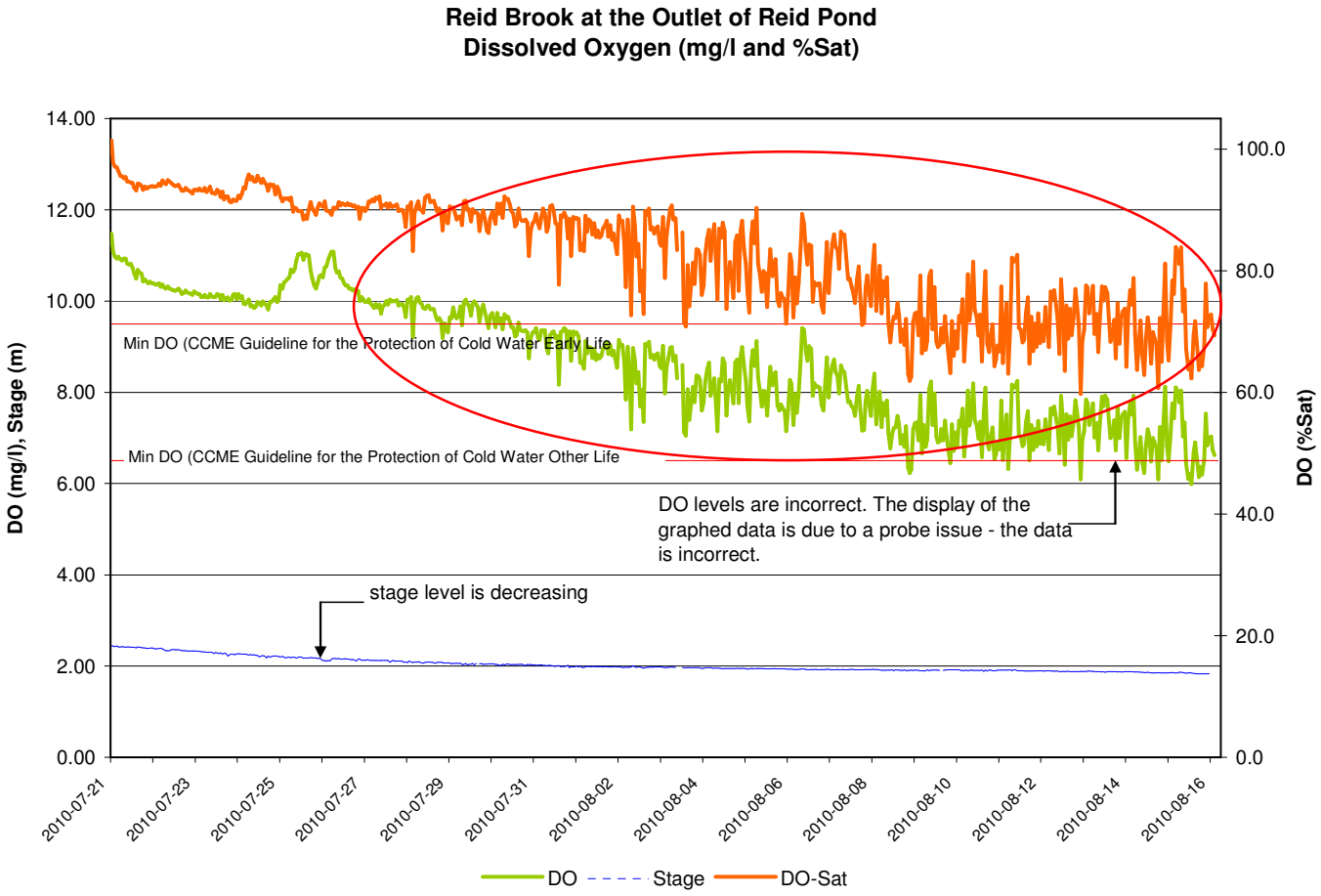


**Figure 4: Dissolved Oxygen (mg/L & % Sat) at Reid Brook at Outlet of Reid Pond**

## TURBIDITY

- The turbidity values ranged from a minimum of 0.00 NTU to a maximum of 90.2 NTU over the deployment period (**Figure 5**).
- There is steady increase in turbidity from July 26, 2010 onwards, with intermittent peaks reaching as high as ~90NTU.
- There is no ranking for turbidity at deployment; therefore it can not be compared to the removal ranking of *Poor*. When compared at removal the QA sonde measured 0.0 NTU at this site, therefore no evidence of turbidity in the water body.
- This data is uncharacteristic for this station and is likely a result of instrument error. This period of incorrect data corresponds with the inaccurate data reported for DO (Figure 4). Like in the previous deployment period (June 4 – July 20), this failure could be attributed to a large rainfall event with caused significant increases in stage and flow leaving the instrument most likely partially buried at two different stations. There is no such rainfall event recorded in the area that could have caused such a disturbance. Stage and flow are decreasing steadily throughout the entire deployment period. This type of disturbance is not clearly evident at any of the other station sin the network.
- Data recorded between July 25 and August 16 is not accurate.

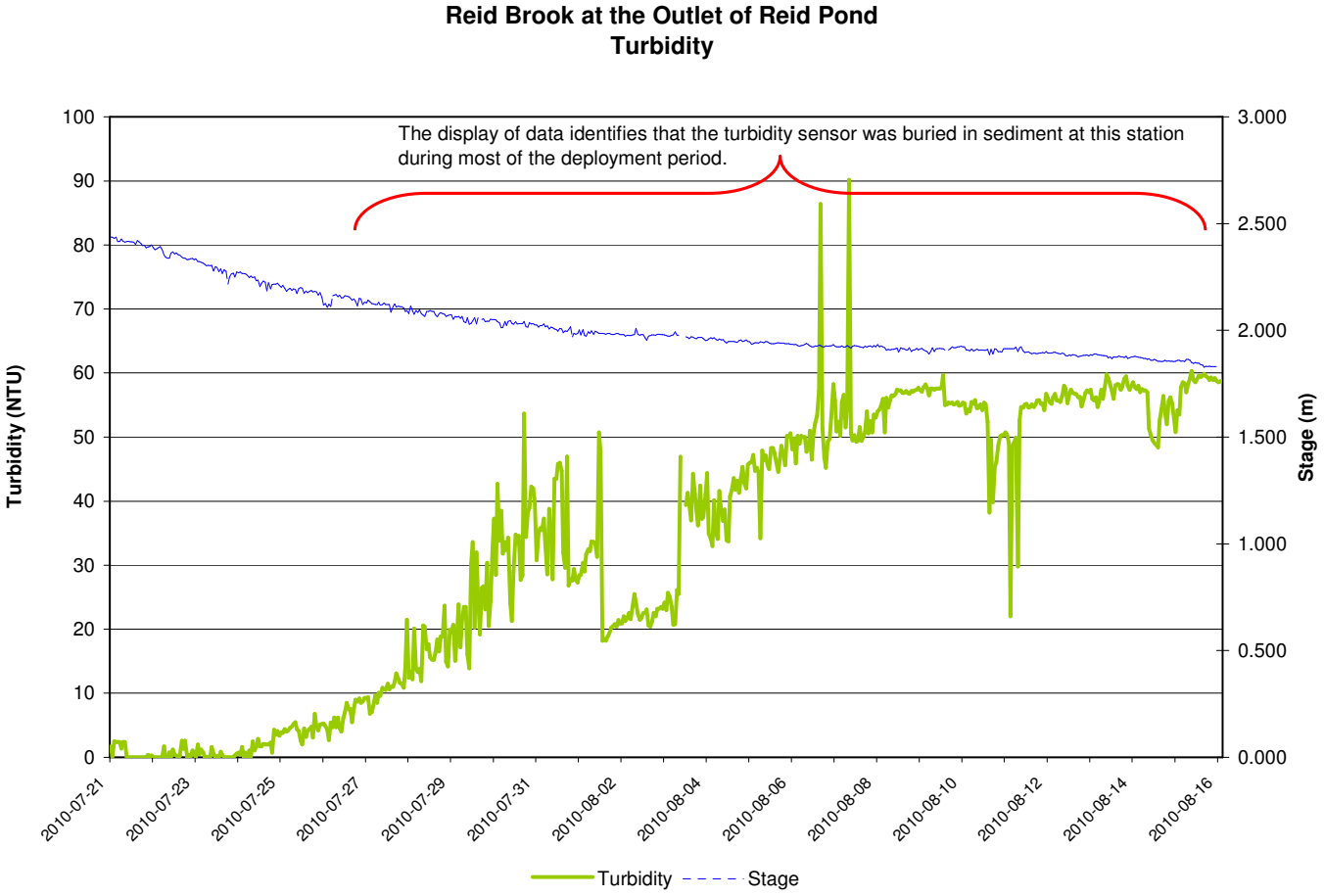


**Figure 5: Turbidity Values for Reid Brook at Outlet of Reid Pond**

## STAGE AND STREAM FLOW

- The stage (**Figure 6)** or water level ranged from a minimum of 1.827 m to a maximum of 2.437 m.
- The stream flow ranged from minimum of 1.64 m³/s to a maximum of 12.1 m³/s.
- There is a gradual and steady decrease in both stage and stream flow during the deployment period.
- The graph (Figure 6) does not indicate, that the precipitation that occurred, had any effect on the stage and stream flow for the deployment period.

## PRECIPITATION

- The closest recorded rainfall to Reid Brook at Outlet to Reid Pond is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID=10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (**Figure 6)** ranged from a minimum of 0.0 mm to a maximum of 19.6 mm.
- Nain had two substantial rainfall events, the first on August 4th, 2010 to 19.6 mm and the second on August 8th, 2010 to 7.4mm.

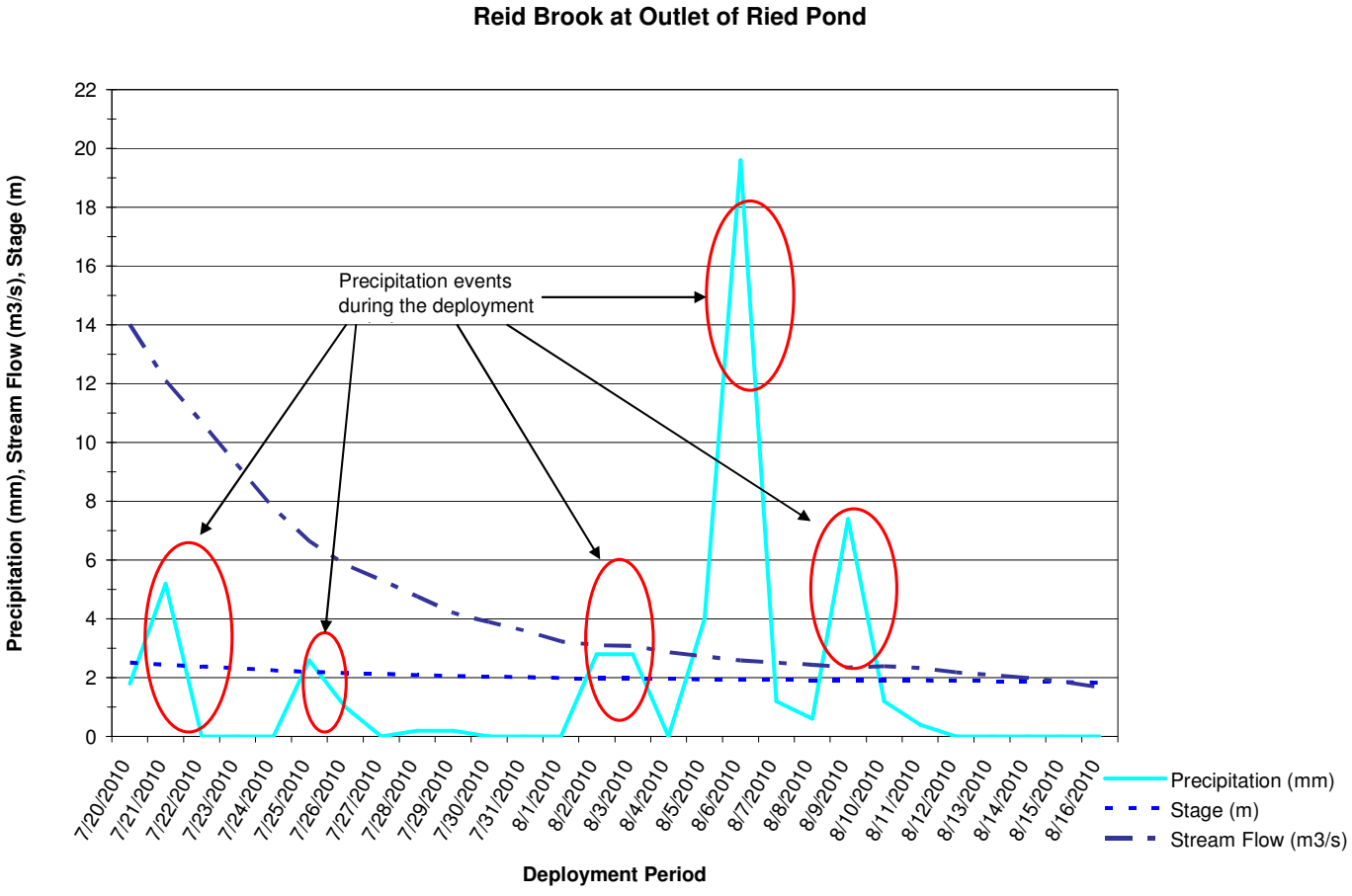


**Figure 6: Reid Brook at Outlet of Reid Pond stream flow and stage**

## CONCLUSION

The water quality monitoring instrument was deployed at the station at Reid Brook at Outlet of Reid Pond between July 21st and August 16th, 2010. During this deployment period, several water quality events were recorded at Reid Brook at Outlet of Reid Pond Station. There was an indication of rainfall occurrences throughout this deployment period. Precipitation may be the source of the events on some of the graphs, as the events coincide with the day of the rainfall.

DO and turbidity data recorded during the majority of the deployment period is compromised by instrument error. There is no evidence to explain why the sensor failure occurred. Data recorded between July 25 and Aug 16 is inaccurate. Typical seasonal patterns are still evident in temperature, pH, conductivity and stage.

## DATA INTERPRETATION

- There were no technical difficulties with the instrument at Tributary to Lower Reid Brook. All calculations and readings were able to be completed.

### TRIBUTARY TO LOWER REID BROOK

### TEMPERATURE

- The water temperature (**Figure 7**) ranged from a minimum of 8.50 ˚C to a maximum of 18.30˚C.
- The water temperatures rise and fall throughout the deployment period.
- The two larger peaks (outlined on Figure 7) may be caused by corresponding rainfall events, and the dips in water temperature directly after could be the water body stabilizing after an influence such as, rainfall.
- There is no significant correlation between stage (m) and temperature during the deployment period.
- The diurnal cycling of temperature is a natural process which will also have an effect on other parameters.

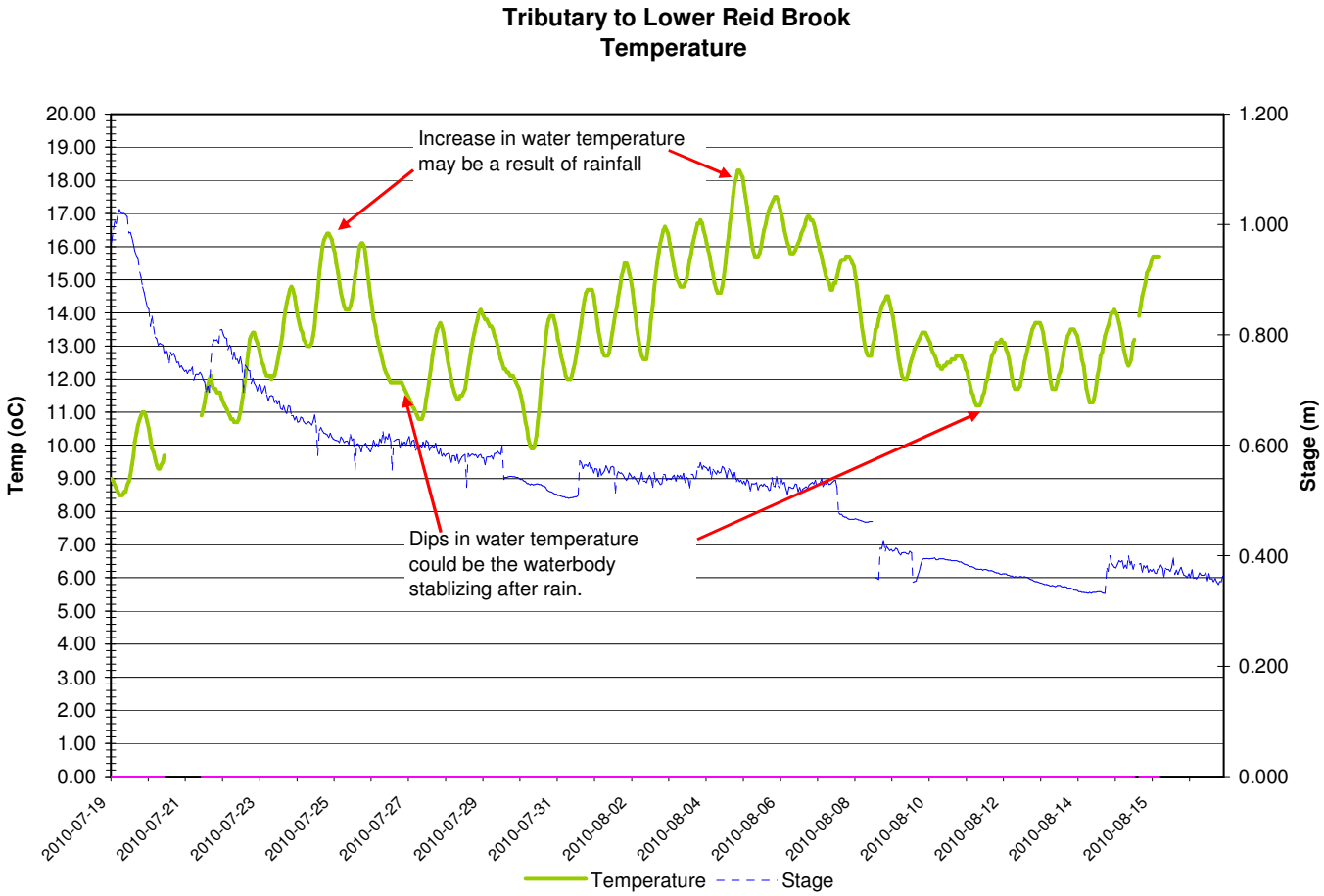


**Figure 7: Water Temperature at Tributary to Lower Reid Brook**

## pH

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.08 to a maximum of 6.76
- The pH values can be compared to the CCME *Protection for Aquatic Life Guideline.* For Tributary to Lower Reid Brook the pH values sit slightly below the recommended range (6.5 – 9.0 for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life)* for the start of the deployment period. As the deployment period continues the pH values gradually increase to just above the guideline. This is not unusual as the background pH for Tributary to Lower Reid Brook, is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- At installation pH was ranked as *poor,* however it takes considerable time to stabilize this probe. When this reading was compared against the pH value an hour later (11:30am) the pH was 6.23 much closer to the initial pH reading. At removal pH was ranked *excellent*. It appears that pH had no significant events during the deployment period.

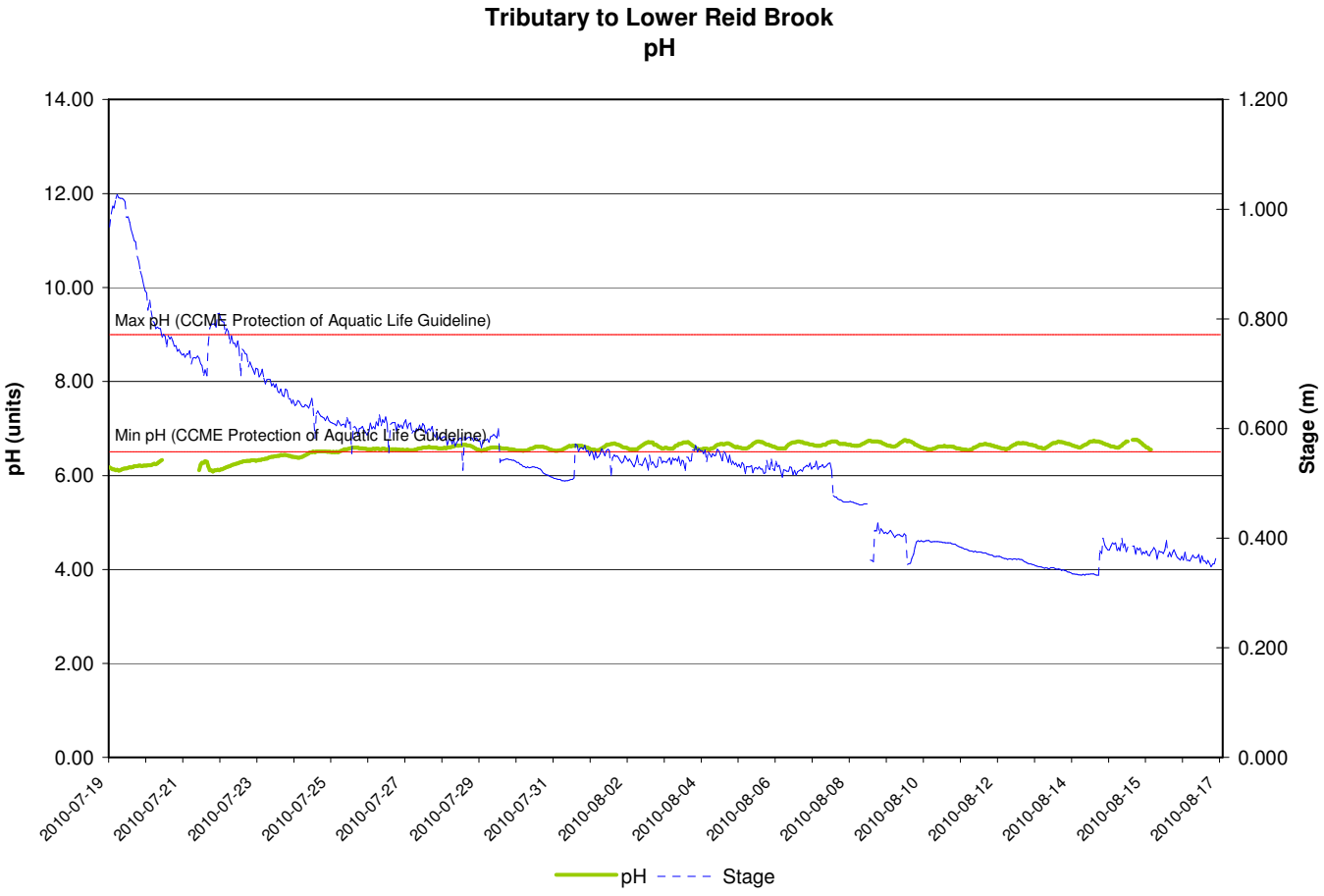


**Figure 8: pH values at Tributary to Lower Reid Brook**

## SPECIFIC CONDUCTIVITY

- The specific conductivity **(Figure 9)** ranged from a minimum of 15.4 µS/cm to a maximum of 33.0 µS/cm over the deployment period.
- There appears to be a correlation between specific conductivity and stage, it is displayed on the graph (Figure 9) as stage decreases, conductivity responds by increasing.
- The increasing of conductivity values is not uncommon as lower water levels concentrate the presence of dissolved substances (salts) in the water body.

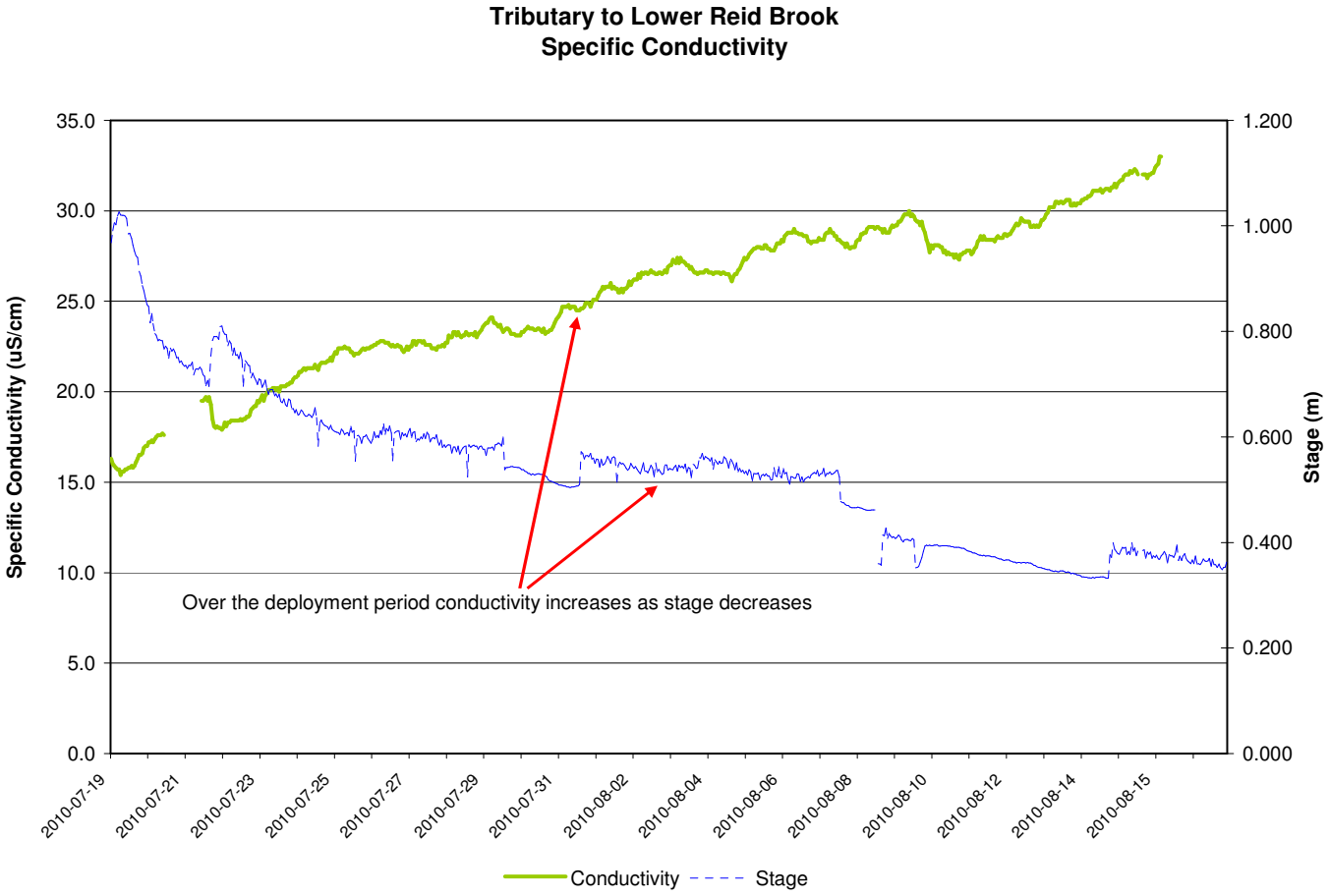


**Figure 9: Specific Conductivity Values at Tributary to Lower Reid Brook**

## DISSOLVED OXYGEN

- The dissolved oxygen (DO), values ranged from a minimum of 9.19 mg/L to a maximum of 13.43 mg/L over the deployment period (**Figure 10**).
- Throughout the deployment period, the DO values were within the limits recommended by CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Cold Water/Early Life Stages – above 9.5 mg/L) and (Cold Water/Other Life Stages – above 6.5 mg/L).
- There was a small drop in DO (mg/L) on August 4, 2010 to below the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Cold Water/Early Life Stages – above 9.5 mg/L). This decrease occurred during a period of warm water temperatures. The data values returned to levels above the minimum guideline within a few days.
- At removal the dissolved oxygen probe ranked as *excellent* against the QA sonde.

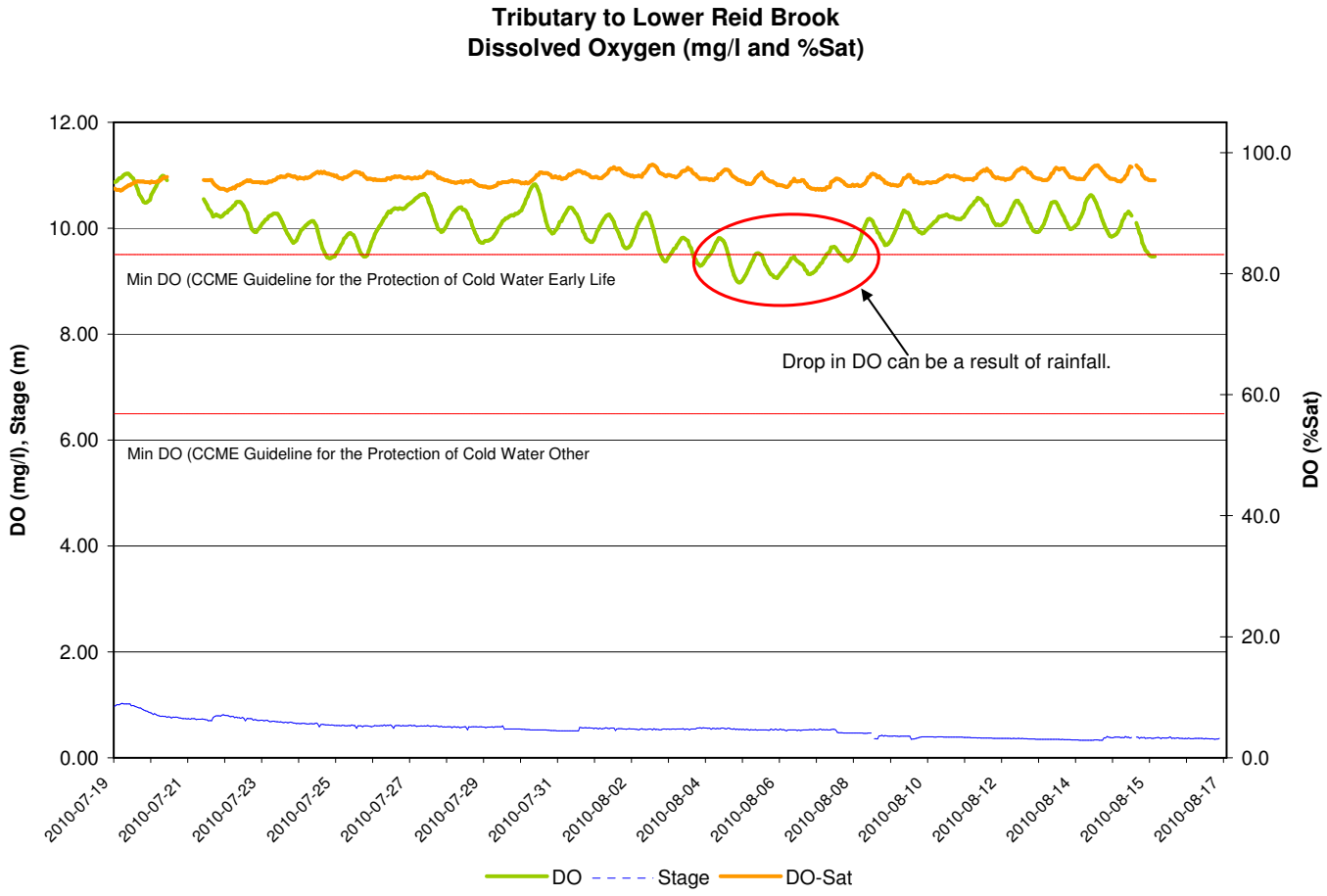


**Figure 10: Dissolved Oxygen (mg/L & % Sat) at Tributary to Lower Reid Brook**

## TURBIDITY

- The turbidity values ranged from a minimum of 0.00 NTU to a maximum of 22.6 NTU over the deployment period (**Figure 11**).
- There is evidence that the turbidity events throughout the deployment period coincide with several increases in stage. Stage may have been influenced by rainfall during these times.
- Rainfall and subsequent runoff can adjust the levels of suspended material in the water body, causing the sensor to read higher than normal turbidity. Generally within 24-48 hours after a rainfall event the turbidity levels will increase and over a period of days or even weeks (in high precipitation season) the turbidity levels will return to normal.

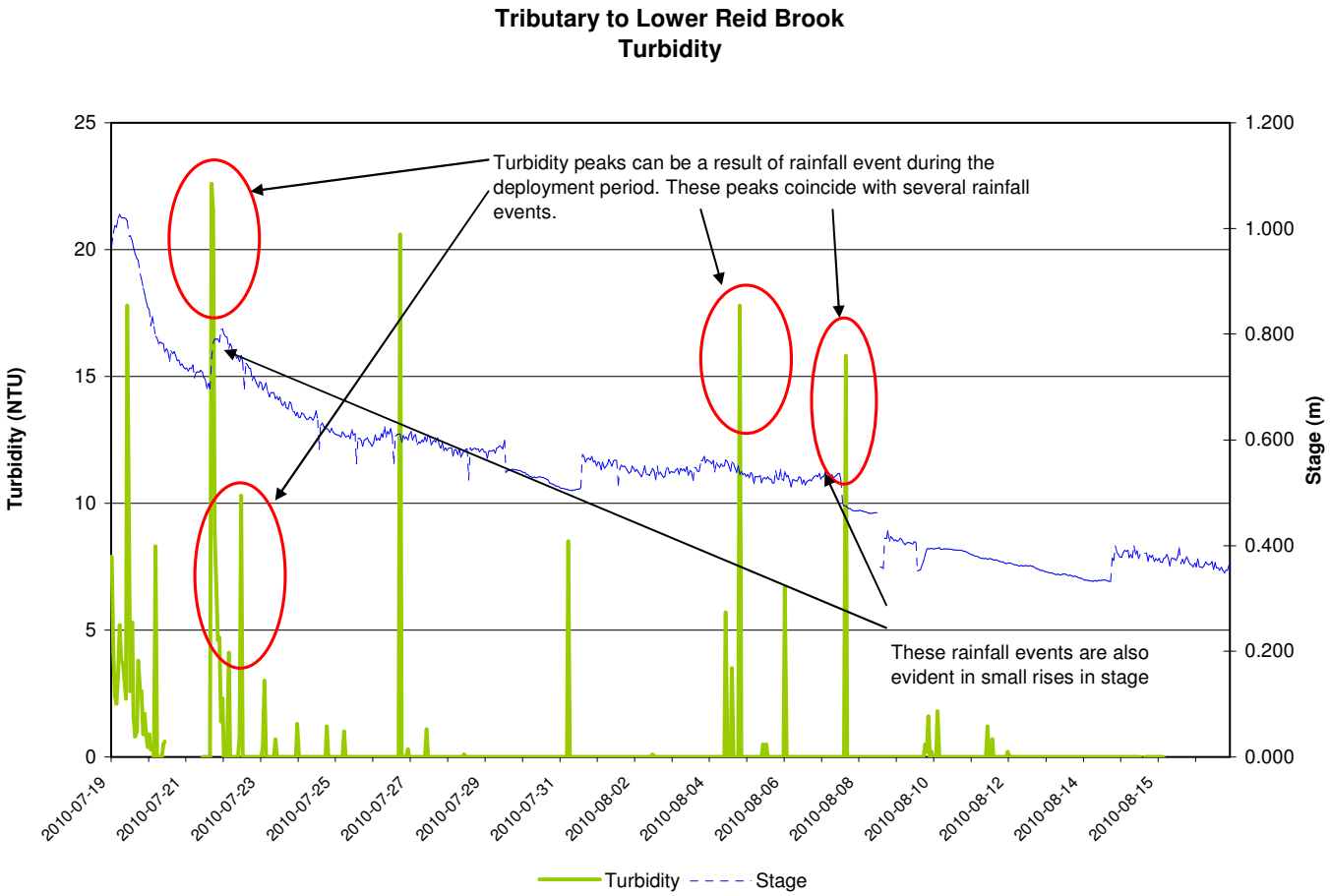


**Figure 11: Turbidity Values for Tributary to Lower Reid Brook**

## STAGE AND STREAM FLOW

- The stage (**Figure 12)** or water level ranged from a minimum of 0.332 m to a maximum of 1.027 m.
- There was no data for stream flow.
- There is a gradual decrease in stage during the deployment period, this may be a result of the increase in temperatures, hence evaporation during the summer season.
- Rainfall events had a slight impact on the stage readings during this deployment period, however it did not dramatically adjust the stage levels.

## PRECIPITATION

- The closest recorded rainfall to Tributary to Lower Reid Brook is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID=10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (**Figure 12)** ranged from a minimum of 0.0 mm to a maximum of 19 mm.
- There were several small precipitation events under 5mm and one large rainfall on August 4th, 2010 to ~ 19mm.

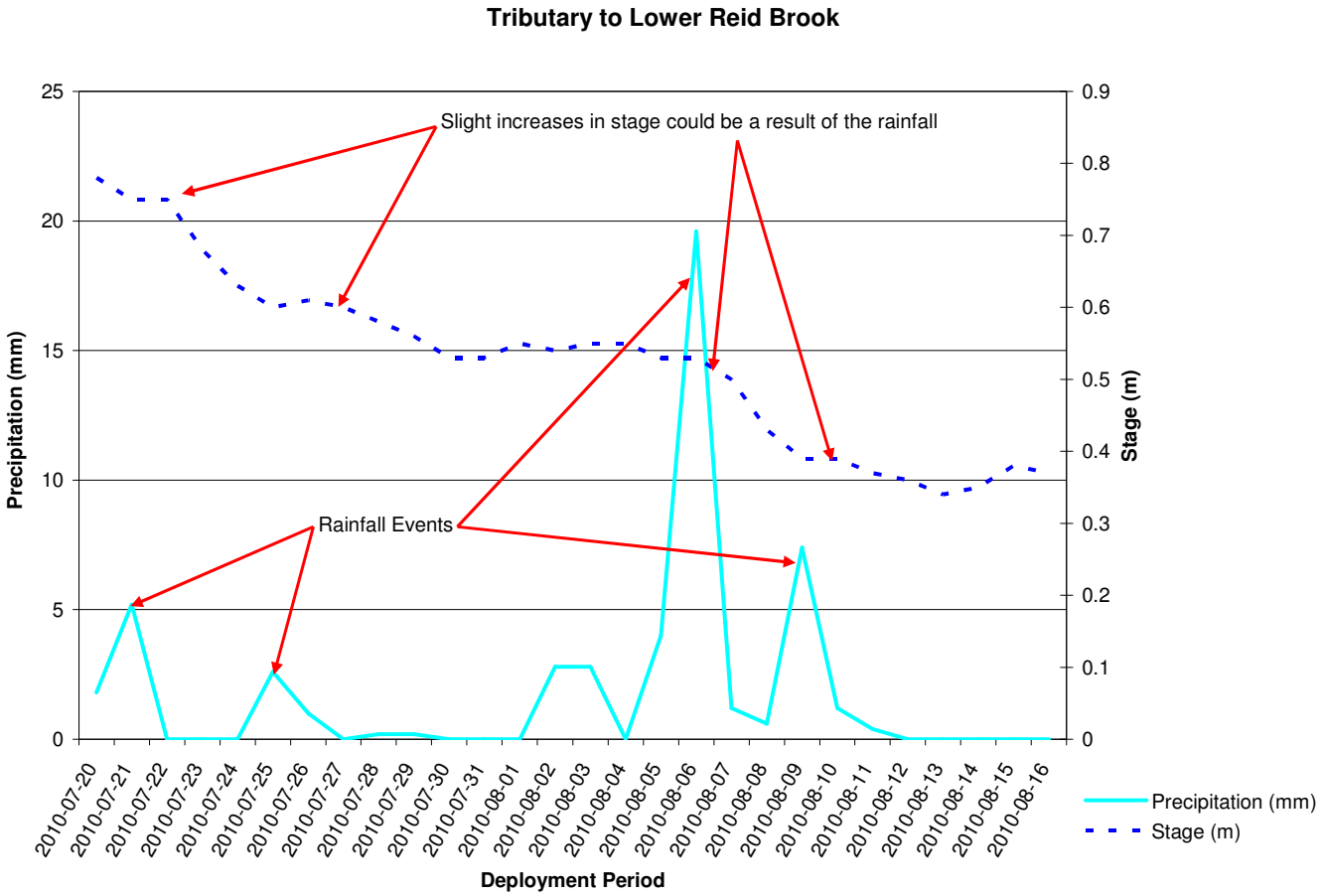


**Figure 12: Tributary to Lower Reid Brook precipitation and stage**

## CONCLUSION

The water quality monitoring instrument was deployed at the station at Tributary to Lower Reid Brook between July 21, and August 16 2010. There were no large disturbances on any of the parameters graphs. While there was an indication of possible rainfall, it did not seem to dramatically affect the sensors.

The peaks of high turbidity at Tributary to Lower Reid Brook are evident on the graph. However, the values settled almost immediately after indicating turbidity values were slightly affected by rainfall.

There were five days where the dissolved oxygen (mg/L) levels dropped below CCME guidelines. The drop in DO may have been a result of the rainfall and subsequent increase in water temperature at that time. During the remainder of the deployment period DO was consistent. Typical seasonal patterns are evident in temperature, pH, conductivity and stage.

## DATA INTERPRETATION

- There were no technical difficulties with the instrument at Lower Reid below Tributary. All calculations and readings were able to be completed.

### LOWER REID BELOW TRIBUTARY

### TEMPERATURE

- The water temperature (**Figure 13**) ranged from a minimum of 9.79 ˚C to a maximum of 18.02˚C.
- The water temperature ranges depict the diurnal changes in water temperature, during each day (increase) and night (decrease).
- The higher water temperature days, coincide with several rainfall events. On August 4th, 2010 there was the largest rainfall event for the deployment period; this may explain the increase in water temperature on August 4th, 2010.

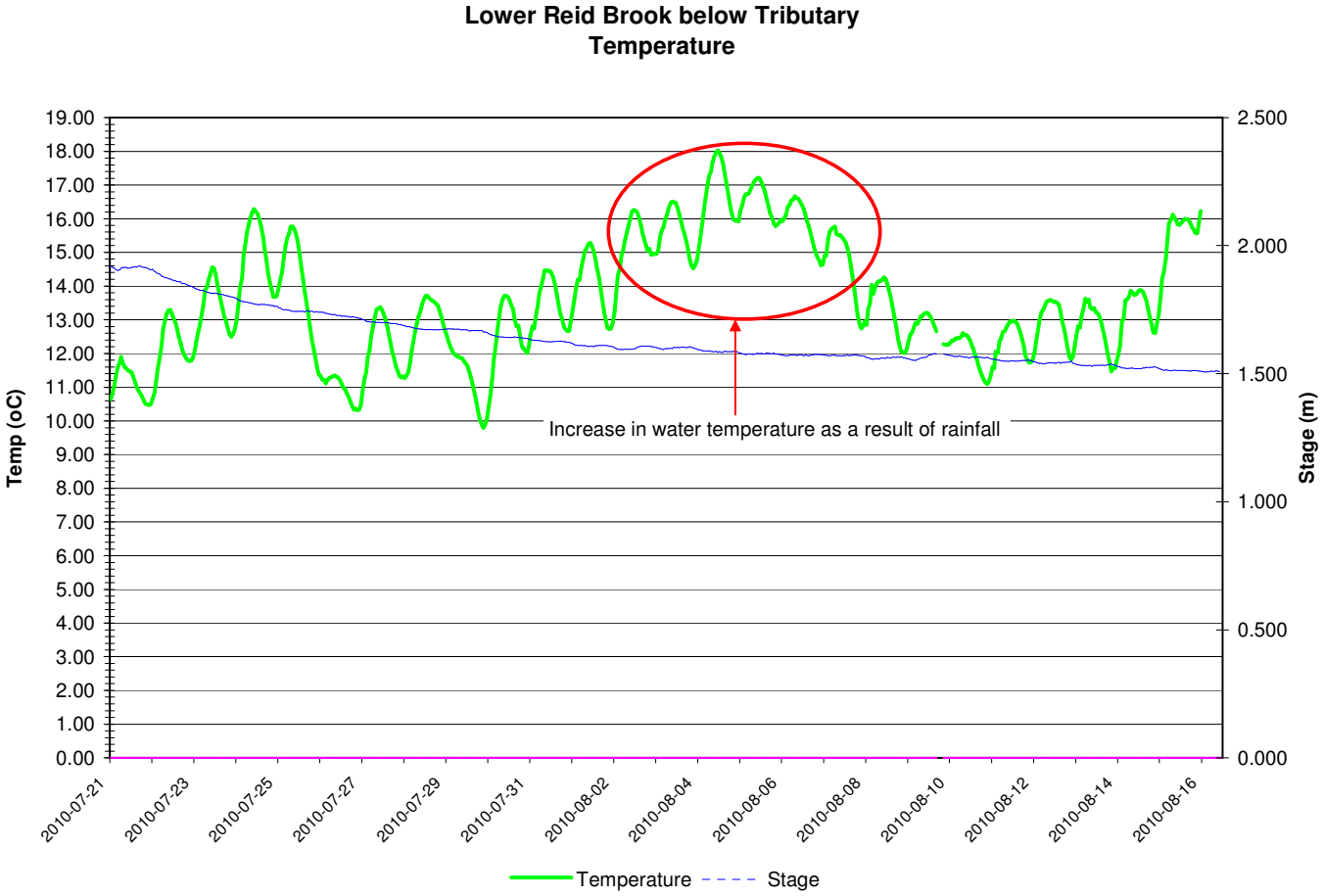


**Figure 13: Water Temperature at Lower Reid below Tributary**

## pH

- Throughout the deployment period pH values (**Figure 14**) ranged from a minimum of 6.39 to a maximum of 6.72.
- The pH values can be compared to the CCME *Protection for Aquatic Life Guideline.* For Lower Reid below Tributary the pH values sit slightly above the lower recommended range (6.5) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. This is not unusual as the background pH for Lower Reid below Tributary is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* range.

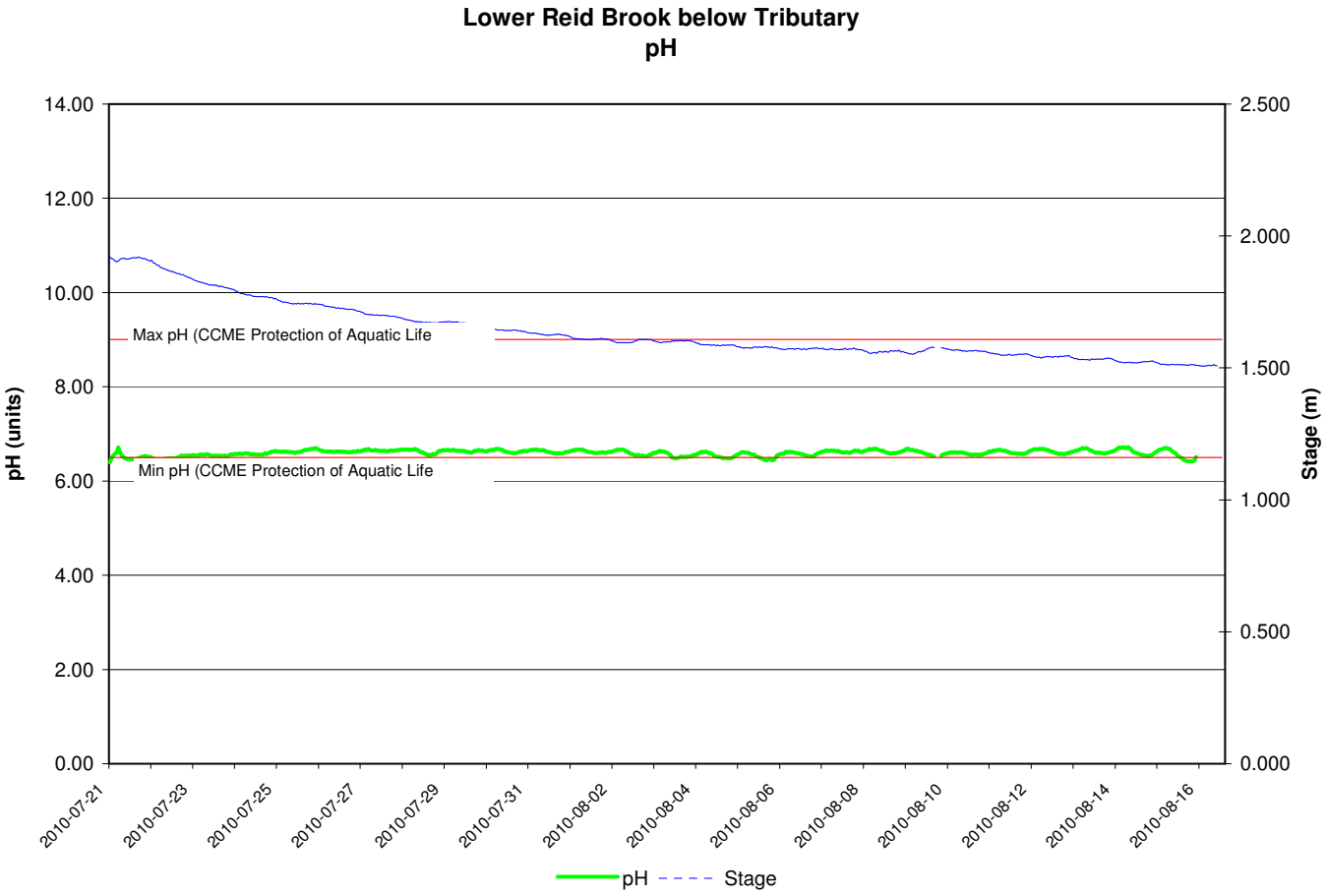


**Figure 14: pH values at Lower Reid below Tributary**

## SPECIFIC CONDUCTIVITY

- The specific conductivity **(Figure 15)** ranged from a minimum of 16.0 µS/cm to a maximum of 31.0 µS/cm over the deployment period.
- There appears to be a correlation between specific conductivity and stage, as stage decreases, conductivity responds by increasing.
- This relationship is not unusual as water levels lower (through evaporation, absorption); it concentrates the presence of dissolved substances (salts) in the water body.

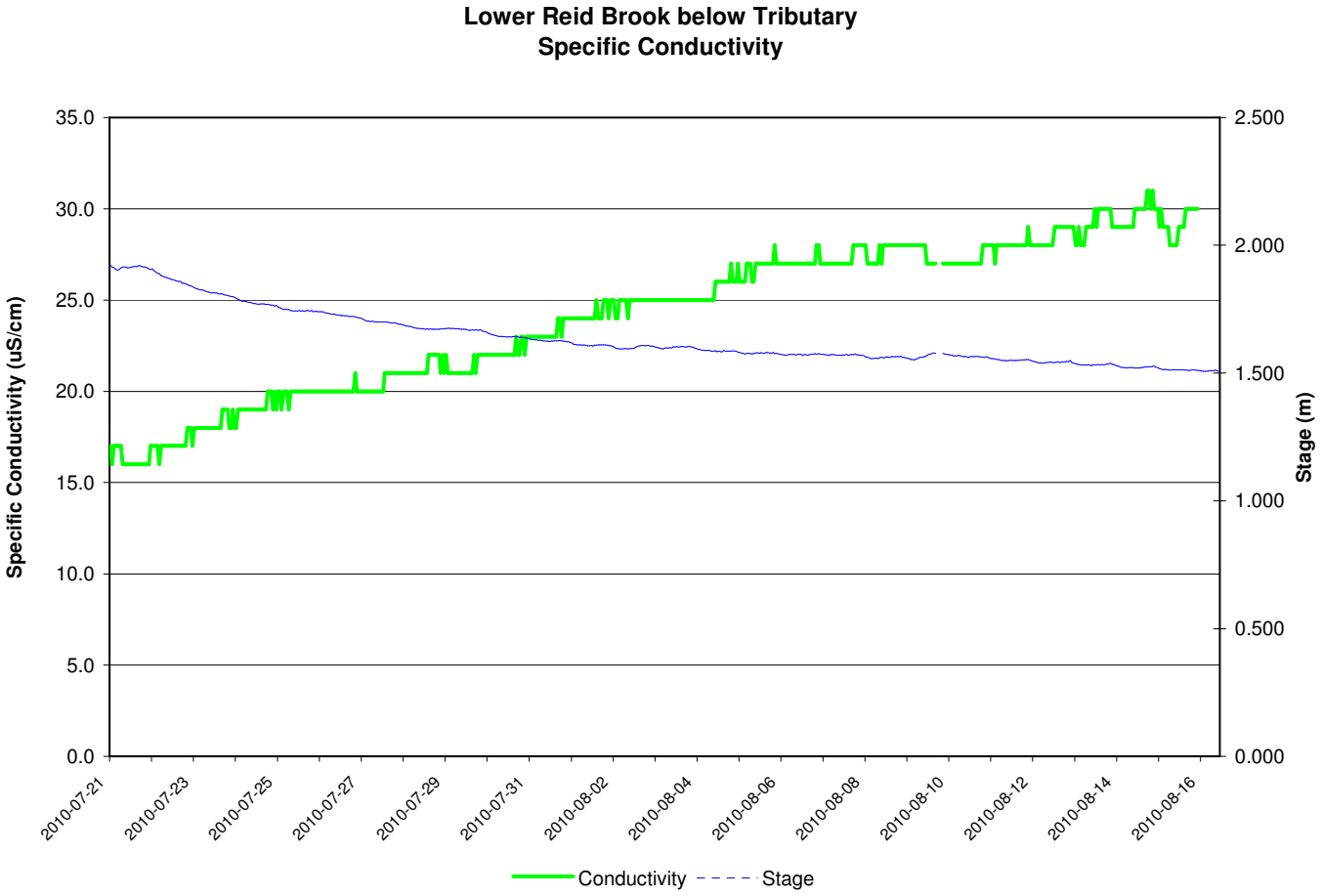


**Figure 15: Specific Conductivity Values at Lower Reid below Tributary**

## DISSOLVED OXYGEN

- The dissolved oxygen (DO), values ranged from a minimum of 8.19 mg/L to a maximum of 10.93 mg/L over the deployment period (**Figure 16**).
- On August 4th, 2010 the DO values (mg/L & % Sat) dropped below the limits recommended by *CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life* (Cold Water/Early Life Stages – above 9.5 mg/L).
- The slight decrease corresponds with a rainfall event on August 4th, 2010. Rainfall can increase the temperature periodically in a water body. Higher water temperatures decrease the level of dissolved oxygen in a stream. The water temperature was at its warmest for the season during this time.
- The DO levels (mg/L and %Sat) drop slightly over the graphed period. When factored in with the ranking from *Excellent* to *Marginal* – it is possible that the Clark cell DO probe had performance issues after some disturbance.

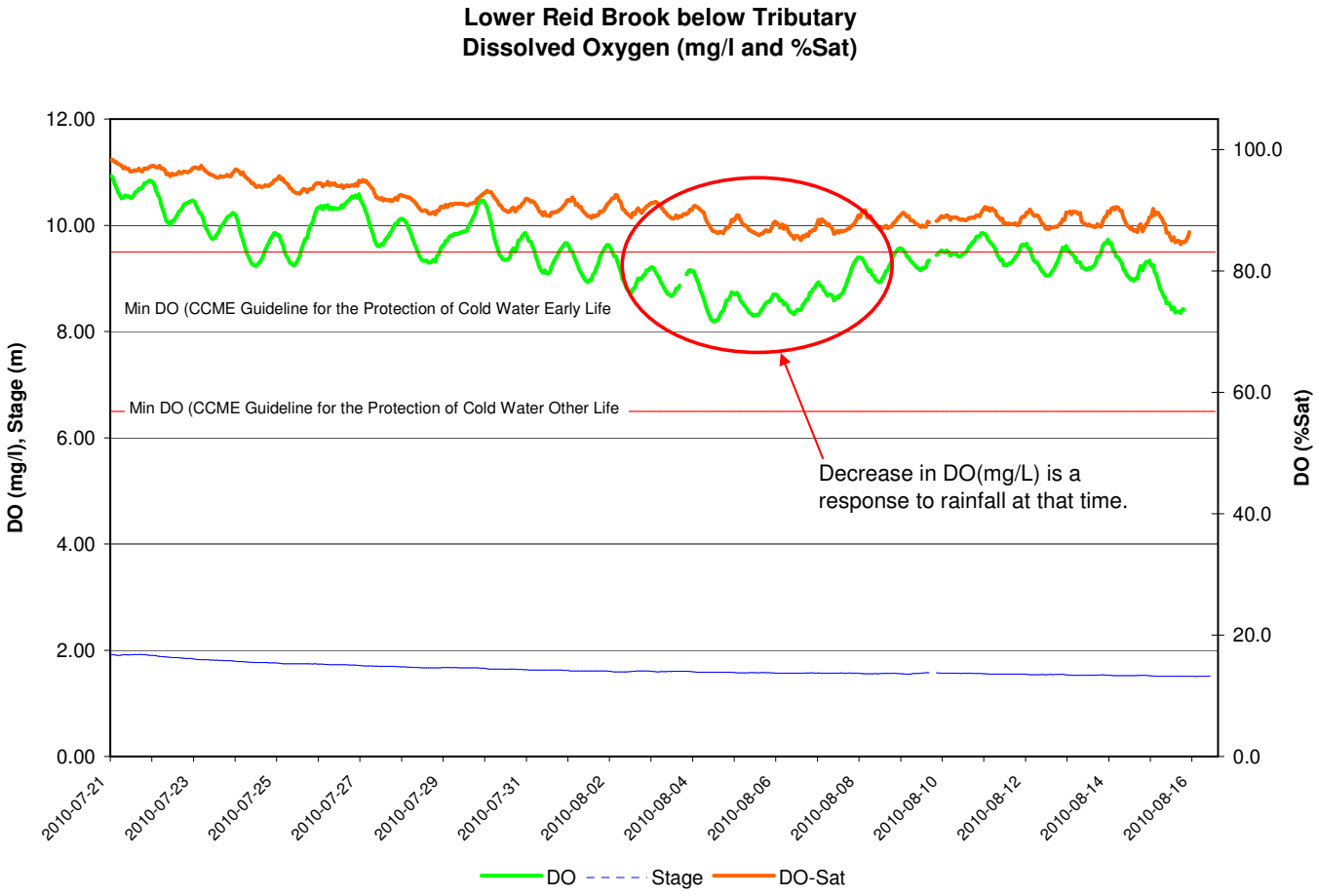


**Figure 16: Dissolved Oxygen (mg/L & % Sat) at Lower Reid below Tributary**

## TURBIDITY

- The turbidity values ranged from a minimum of 1.3NTU to a maximum of 24.8NTU over the deployment period (**Figure 17**).
- Two events stand out from the graphed data. One on July 21, 2010 to ~ 24NTU and the other on August 3, 2010 to ~11 NTU. Both peaks can be matched to rainfall events that occurred on those dates.
- The rest of the deployment period turbidity range remained constant under 5NTU. This is a typical trend for this station.

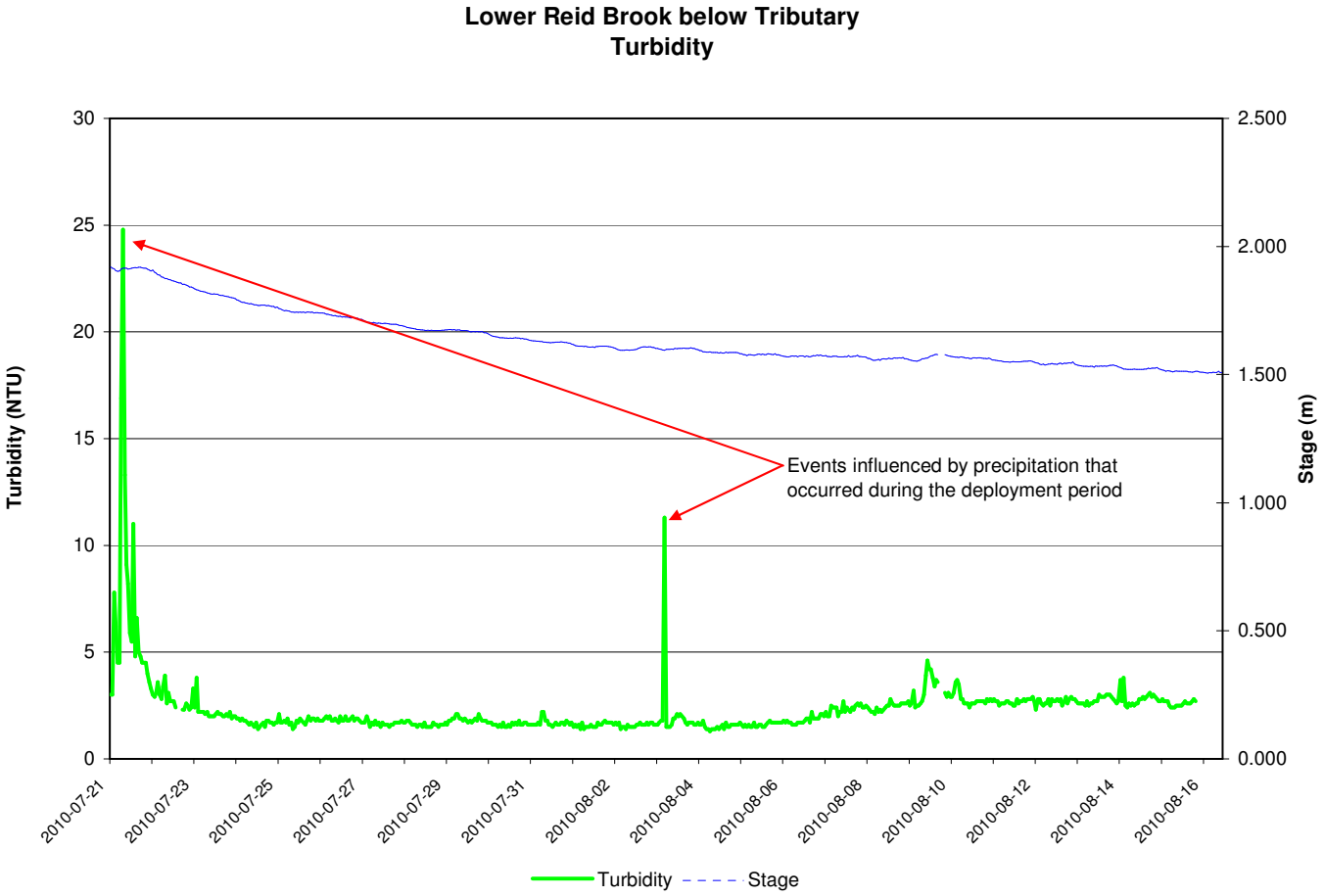


**Figure 17: Turbidity Values for Lower Reid below Tributary**

## STAGE AND STREAM FLOW

- Stage can be defined as the height of the surface of a river or other fluctuating body of water above a set point. The set point is the bottom axis of this graph.
- The stage (**Figure 18)** or water level ranged from a minimum of 1.506 m to a maximum of 1.921 m.
- The stream flow ranged from minimum of 2.23 m³/s to a maximum of 18.9m³/s.
- From July 21 onwards stream flow decreased. Stage also dropped however not considerably (about ~ 0.5m). These decreases are a result of increasing summer temperatures and decreased precipitation.

## PRECIPITATION

- The closest recorded rainfall to Lower Reid below Tributary is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID=10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (**Figure 18)** ranged from a minimum of 0.0 mm to a maximum of 19.4 mm.
- Nain had several rainfall events, the largest on August 4, 2010 to ~ 19mm. The rainfall events did not alter stream flow and stage greatly. However the rainfall did influence several parameters.

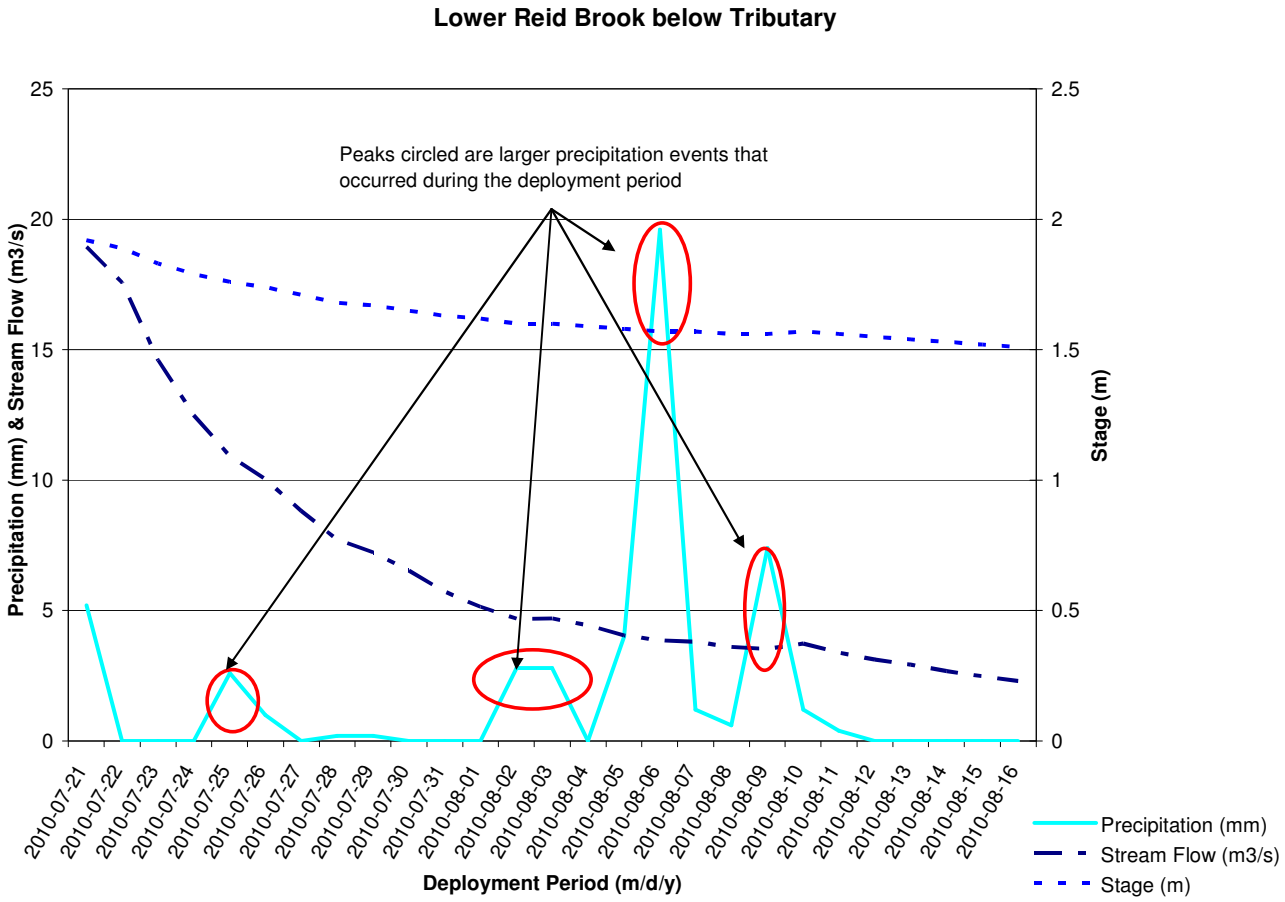


**Figure 18: Lower Reid below Tributary stream flow and stage**

## CONCLUSION

The water quality monitoring instrument was deployed at the station at Lower Reid below Tributary between July 21 to August 17, 2010. During this deployment period, no water quality events were recorded at Lower Reid below Tributary station.

There was an indication of rainfall occurrences throughout this deployment period. Precipitation may be the source of the events on the graphs for water temperature, dissolved oxygen and turbidity. However all other parameters (pH, conductance, stage and stream flow) displayed common water quality outlines for the Lower Reid below Tributary station.

## DATA INTERPRETATION

- There were no technical difficulties with the instrument at Camp Pond Brook below Camp Pond. All calculations and readings were completed.

### CAMP POND BROOK BELOW CAMP POND

### TEMPERATURE

- The water temperature (**Figure 19**) ranged from a minimum of 13.10˚C to a maximum of 22.80˚C.
- The water temperature values depict the steady increase in air temperature from July onward.
- On August 4th, 2010 the water temperature increases to ~21˚C, this change in water temperature can be explained by a precipitation event that occurred at this time.

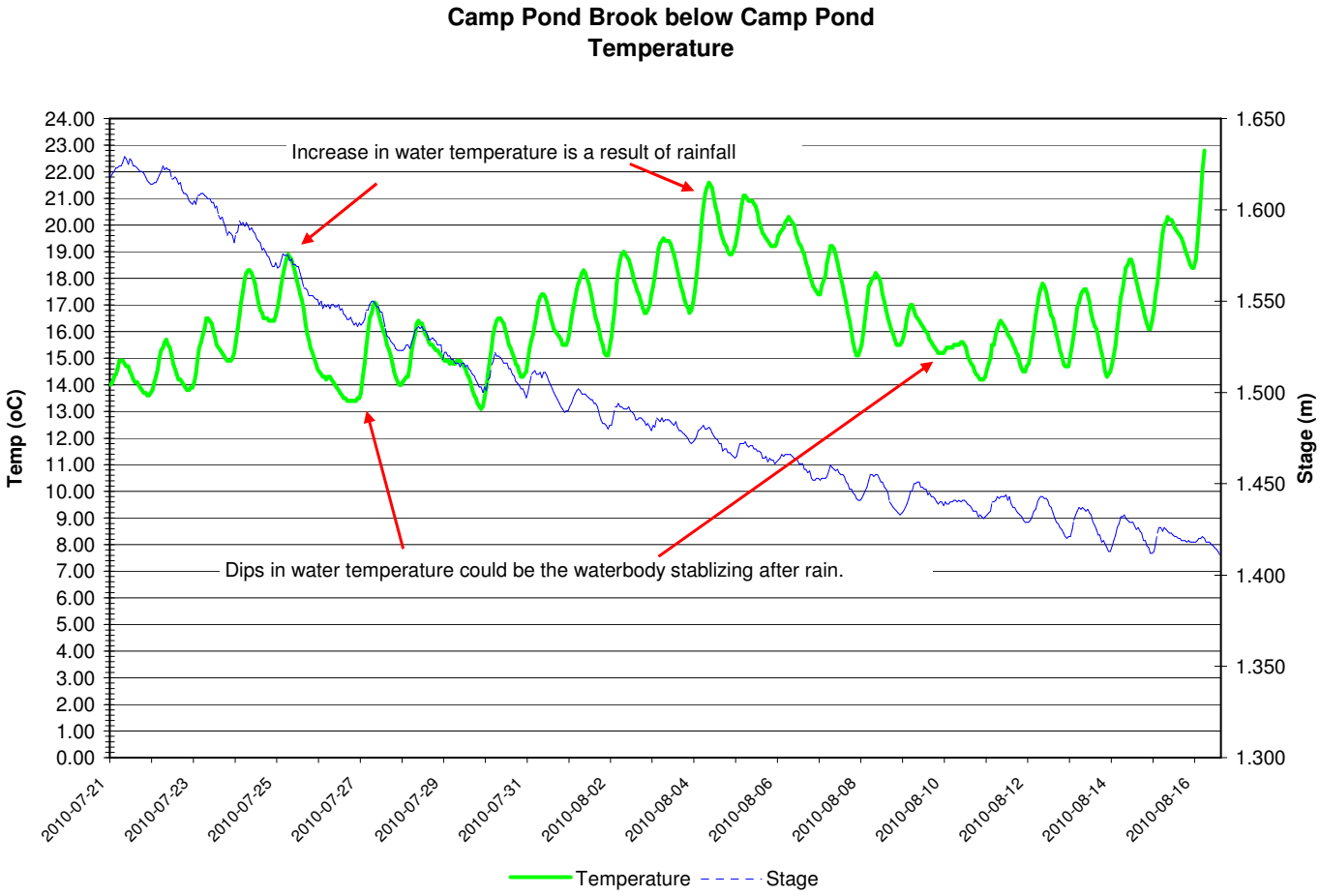


**Figure 19: Water Temperature at Camp Pond Brook below Camp Pond**

## pH

- Throughout the deployment period pH values (**Figure 20**) ranged from a minimum of 6.18 to a maximum of 6.72.
- The pH values can be compared to the *CCME Protection for Aquatic Life Guideline.* For Camp Pond Brook below Camp Pond the pH values sit slightly above the lower recommended range (6.5) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. This is not unusual as the background pH for Camp Pond Brook below Camp Pond is historically at the lower end of the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* range.

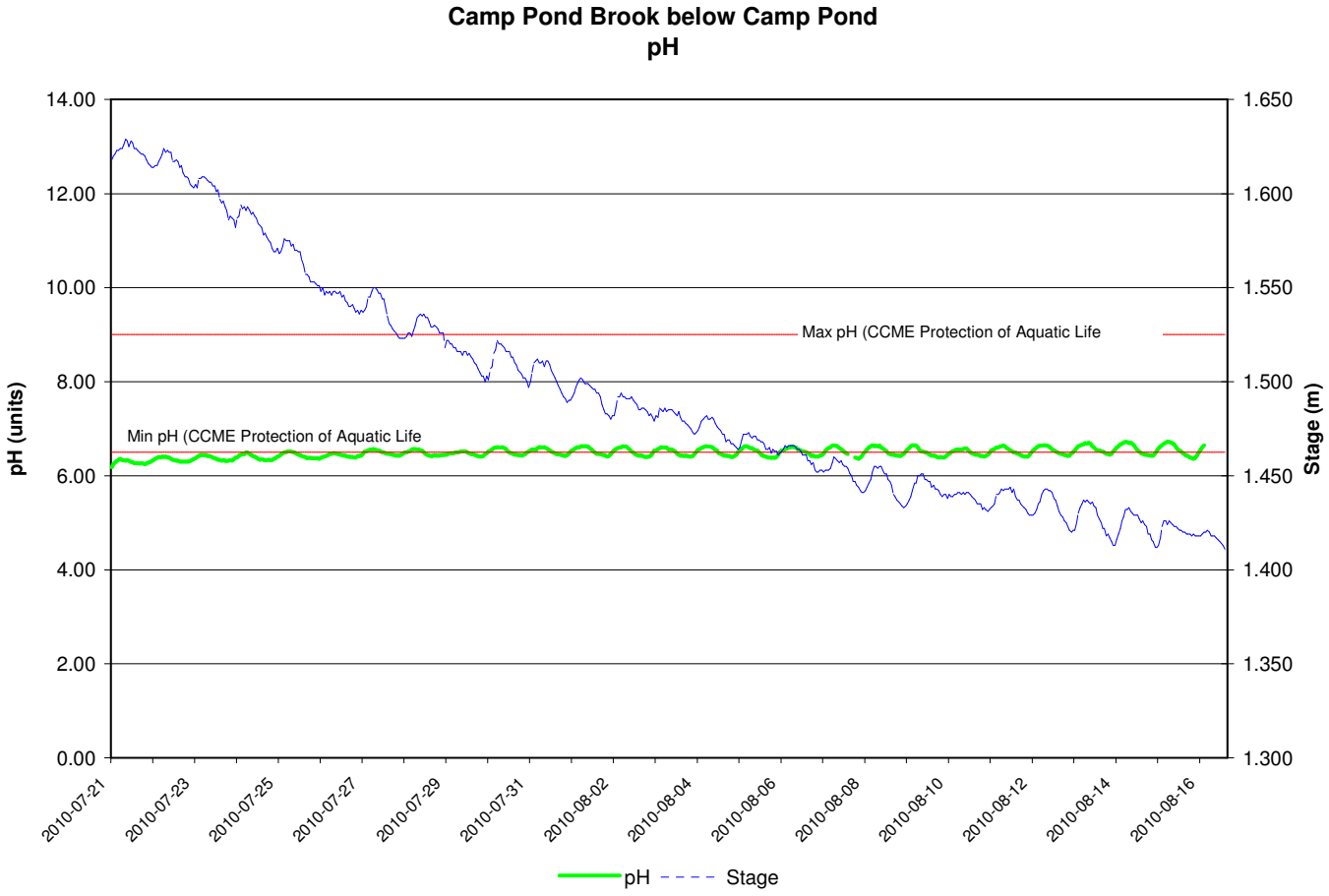


**Figure 20: pH values at Camp Pond Brook below Camp Pond**

## SPECIFIC CONDUCTIVITY

- The specific conductivity **(Figure 21)** ranged from a minimum of 22.8 µS/cm to a maximum of 29.1 µS/cm over the deployment period.
- Specific Conductivity remained relatively constant during the deployment month with several small jumps in values. On August 4, 9 and 14, conductivity increased in value and then returned to lower readings.
- These changes in conductivity coincide with rainfall events on those dates.

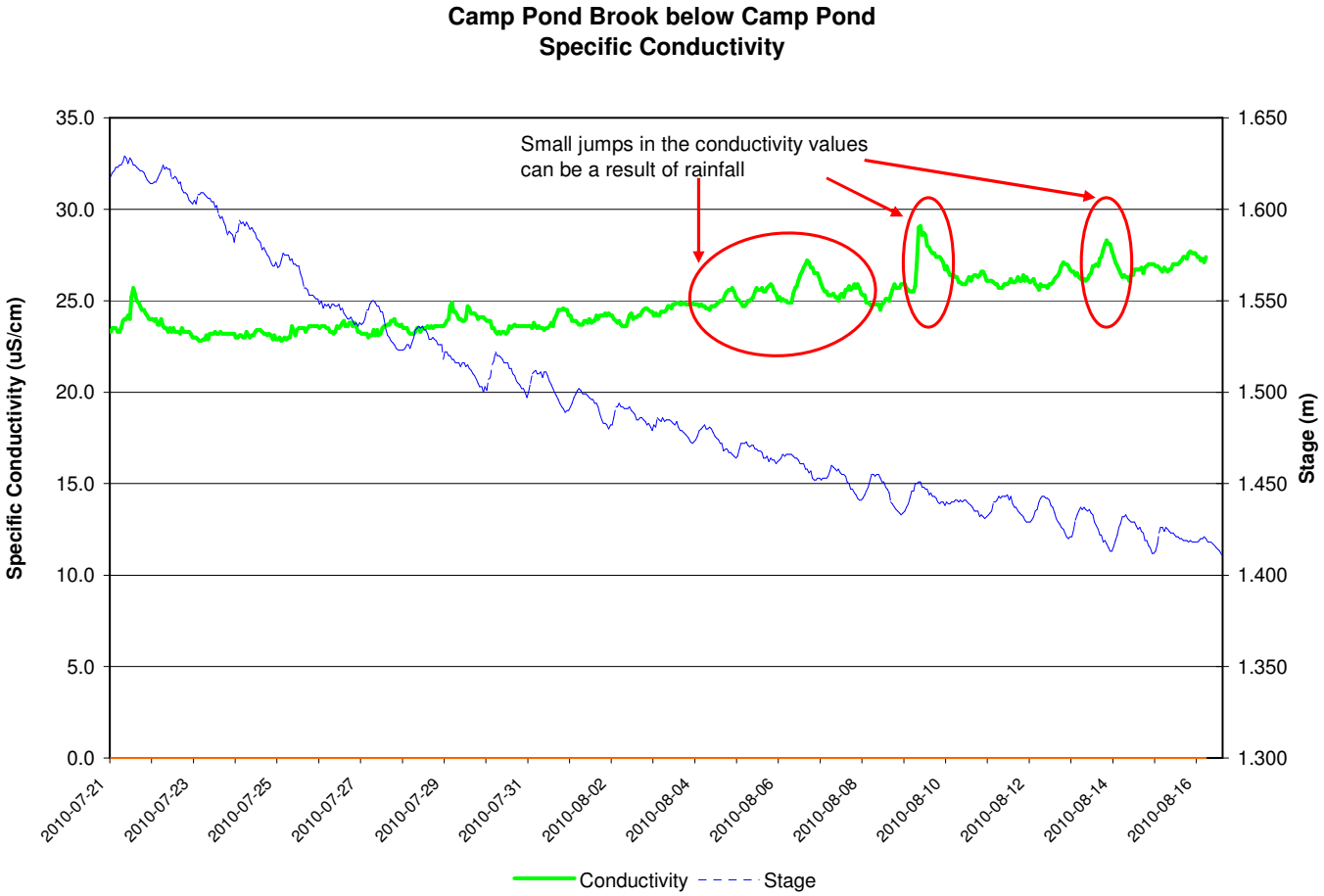


**Figure 21: Specific Conductivity Values at Camp Pond Brook below Camp Pond**

## DISSOLVED OXYGEN

- The dissolved oxygen (DO mg/L), values ranged from a minimum of 6.97 mg/L to a maximum of 9.19 mg/L over the deployment period (**Figure 22**).
- During the deployment period the DO (mg/L and % Sat) values drop consistently.
- At installation the DO values ranked as *Excellent*, however at the end of the deployment period (at removal) the DO values ranked as *Poor*.
- At removal the field reading for DO (mg/L) was 6.82mg/L. This reading was considerably lower than that of the QAQC instrument's DO value of 8.67mg/L.
- The probe not reading accurately was likely a result of rainfall disturbing the Clark cell and interfering with the performance of the membrane. The membrane on the Clark cell DO probe is very susceptible to fouling from oil, biologic growth, silt and dirt. It is not clear how long the sensor may have been affected.

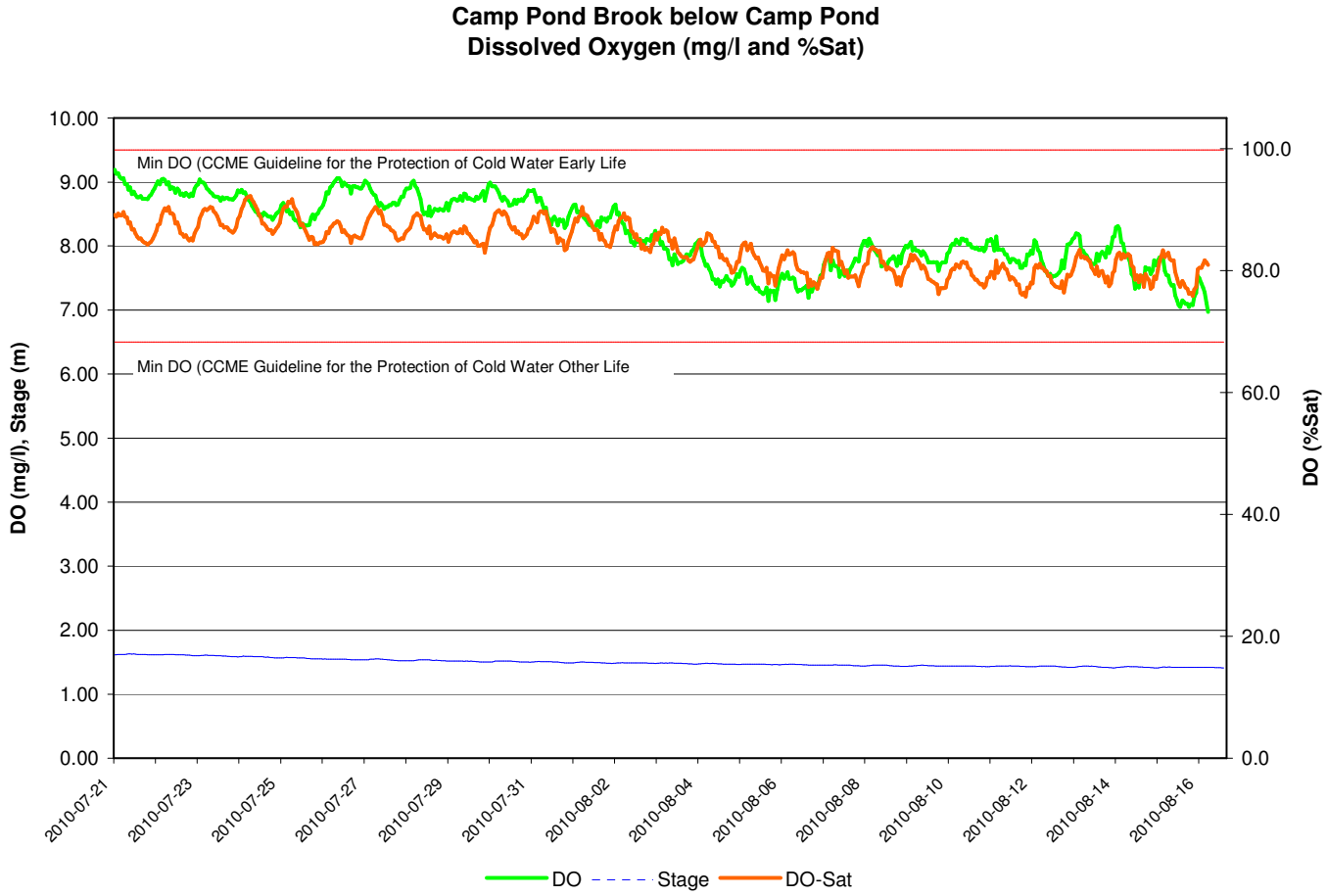


**Figure 22: Dissolved Oxygen (mg/L & % Sat) at Camp Pond Brook below Camp Pond**

## TURBIDITY

- The turbidity values ranged from a minimum of 1.6 NTU to a maximum of 52.5 NTU over the deployment period (**Figure 23**).
- There is an overall increase in turbidity over the deployment period. There are several peaks to ~50NTU. These turbidity values may be a result of the mix up in sediment during rainfall.
- After a small precipitation event, on July 25th, 2010, turbidity starts to increase and it does not completely settle for the remainder of the deployment period. As precipitation events continue turbidity levels do not get a chance to settle down. Data recorded during this period should be used with caution.

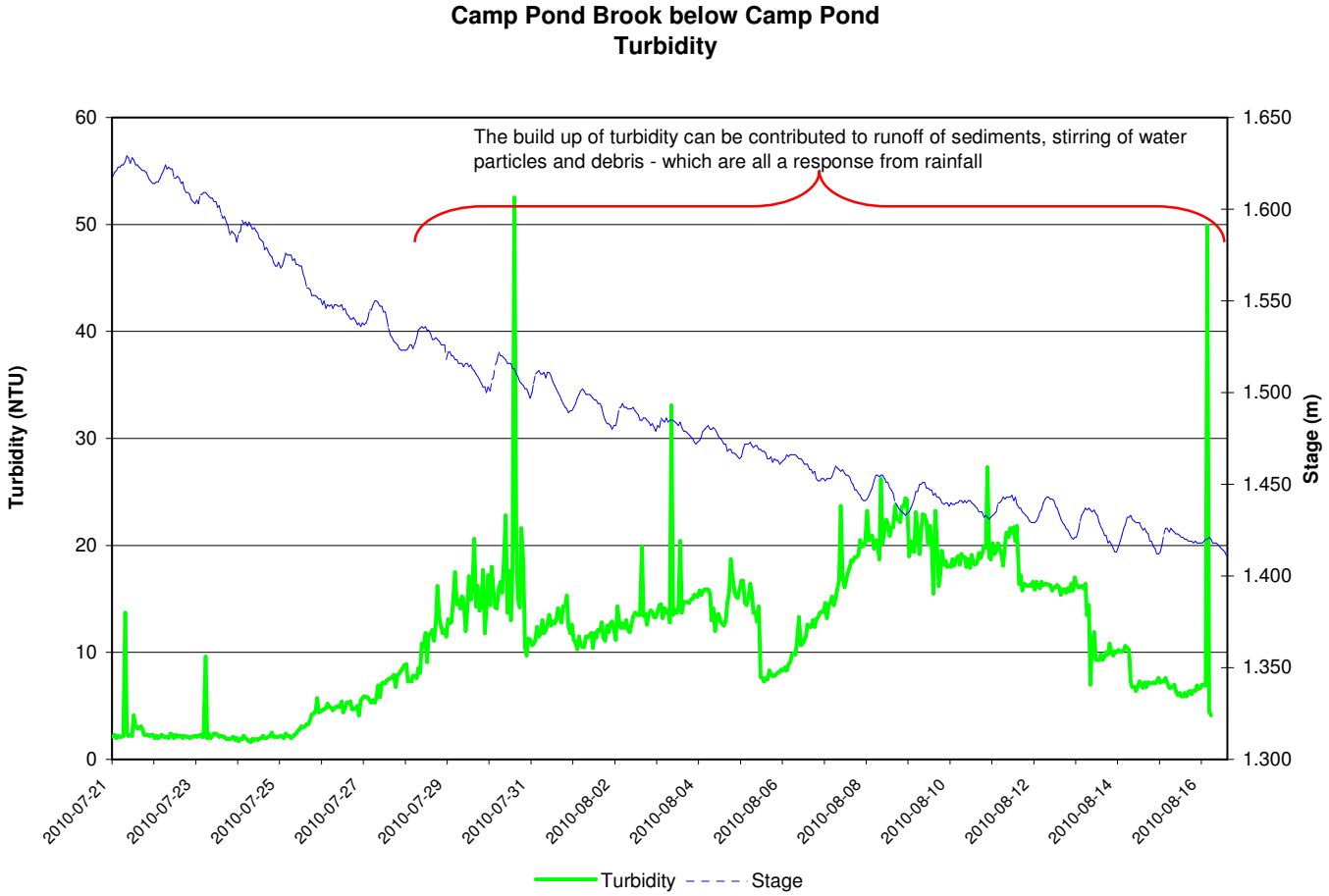


**Figure 23: Turbidity Values for Camp Pond Brook below Camp Pond**

## STAGE AND STREAM FLOW

- Stage can be defined as the height of the surface of a river or other fluctuating body of water above a set point. The set point is the bottom axis of this graph.
- The stage (**Figure 24**) or water level ranged from a minimum of 1.269 m to a maximum of 1.411 m.
- The stream flow ranged from minimum of 0.38 m³/s to a maximum of 1.85 m³/s.

## PRECIPITATION

- The closest recorded rainfall to Camp Pond Brook below Camp Pond is at a weather station in Nain. This station is monitored by Environment Canada, and the data is available at http://climate.weatheroffice.gc.ca/climateData/dailydata_e.html?Prov=XX&timeframe=2&StationID=10813&Day=1&Month=6&Year=2010&cmdB1=Go
- The precipitation (**Figure 24**) ranged from a minimum of 0.0 mm to a maximum of 19.4 mm.
- There are no significant differences in either stage or stream flow after the rainfall.

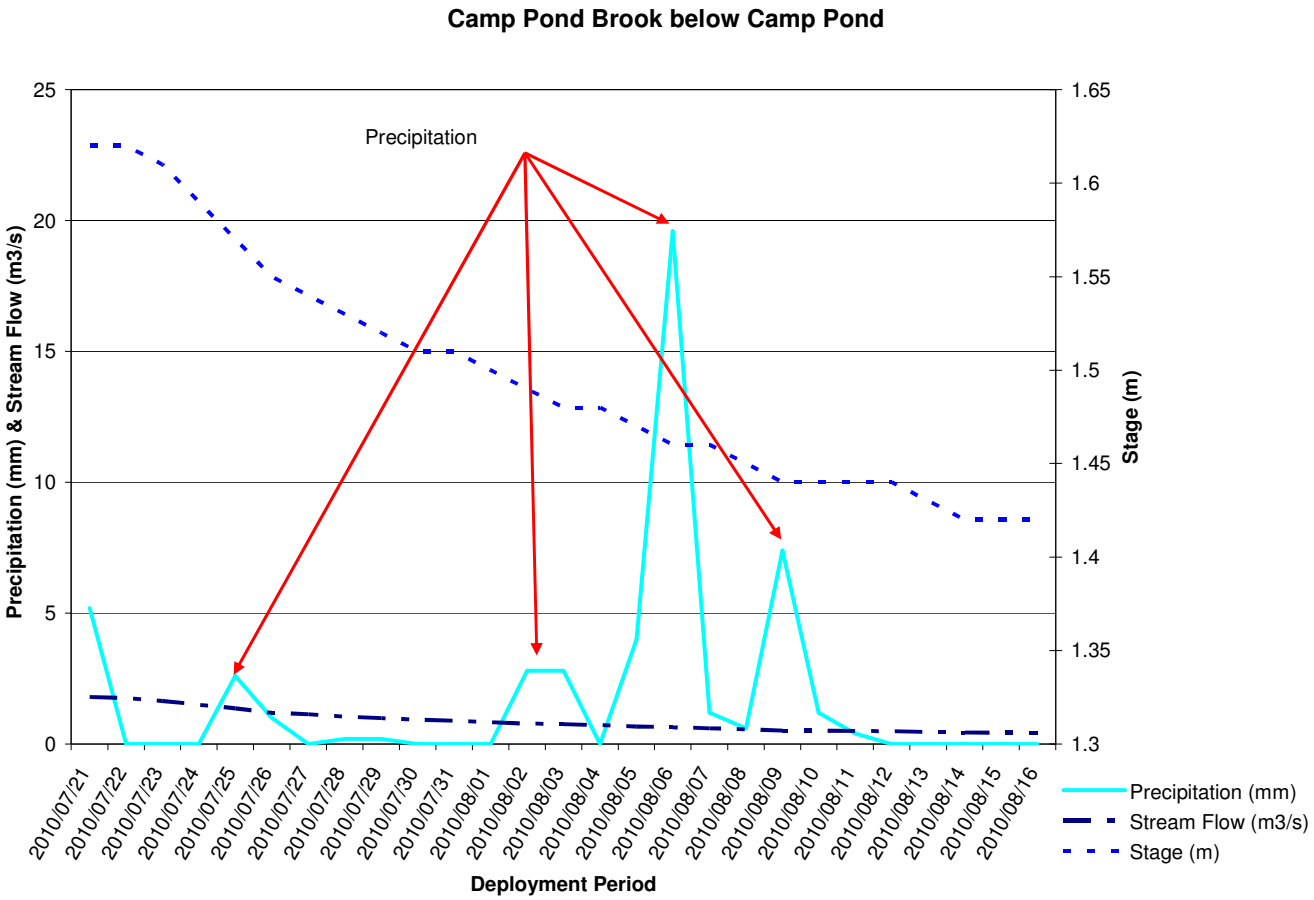


**Figure 24: Camp Pond Brook below Camp Pond Tributary stream flow and stage.**

## CONCLUSION

The water quality monitoring instrument was deployed at the station at Camp Pond Brook below Camp Pond Tributary between July 21 and August 16, 2010. There was an indication of possible rainfall occurrences throughout this deployment period. Precipitation may be the source of the events on the graphs for temperature, dissolved oxygen, conductance and turbidity. Typical seasonal patterns are evident in pH and stage.

It is likely that rainfall disturbed the soil and sediment around the brooks, increasing the amount of debris and material present in the brooks. This debris could have been the factor that interfered with the turbidity and dissolved oxygen readings.

## COMPARISONS BETWEEN STATIONS

Water Temperature

The water temperature readings for all four stations at Voisey's Bay stay within the ranges of 8˚C – 19˚C. All water temperatures indicate increases over the duration of the deployment period. Tributary to Lower Reid Brook, Lower Reid below Tributary and Camp Pond Brook below Camp Pond all have similar water temperature outlines. For example, the graphs (Figures 7, 13, 19) display slight increases in water temperature on August 4th, 2010. When compared to that of the precipitation graph (Figures 12, 18, 24) there is evidence of a rainfall event on that date. Reid Brook at outlet of Reid Pond has a slightly different water temperature graph; the graph presents larger peaks and dips in the data. This particular station is situated at the outflow of a large pond; thus the flowing water from the pond influences the water temperature of the brook. As rain falls, water temperature increases (displayed in the peaks) then following the rainfall, water temperature decreases (displayed in the dips) as the water flow increases from Reid Pond (water temperatures in the pond may be lower due to the depth or size of the water body).

pH

Over the course of the deployment period the pH values did not deviate too far from the minimum CCME guideline for all Voisey's Bay stations. Reid Brook at outlet of Reid Pond displays one small dip in pH on July 26th, 2010 however on July 27th, 2010 the data resumed a constant measurement and maintained that for the remainder of the deployment period.

Specific Conductance

Tributary to Lower Reid Brook and Lower Reid Brook below Tributary maintain similar specific conductance values. Both brooks are free flowing waterways with fluctuating water levels during the warmer months. As water levels drop over the summer the levels of partial matter and minerals can increase and in turn provide slightly higher Specific Conductance levels. The specific conductance levels at Reid Brook at outlet of Reid Pond, remained constant throughout the deployment period. The levels ranged from 7.8 µS/cm to 8.4 µS/cm with two small events that seem to coincide with rainfall. While there was evidence of a slight increase in conductance levels at Camp Pond Brook below Camp Pond, the values did not vary greatly and generally remained constant during deployment.

Dissolved Oxygen

Tributary to Lower Reid Brook and Lower Reid Brook below Tributary resemble each other in the graphed data. Both stations had a reasonably constant DO reading throughout the deployment period. Both stations had DO (mg/L) levels that dropped below the cold water guidelines for CCME. During the six days that the DO (mg/L) readings dropped, the water temperatures were the highest for the deployment period. Water temperature is inversely related to DO concentrations.

Reid Brook at outlet of Reid Pond displays irregular DO (mg/L and % Sat) readings for the deployment period. The values decrease to below the CCME guidelines for cold water. This occurrence can be a result of turbidity (due to rainfall) blocking or fouling the Clark cell membrane causing the instrument to read inaccurate values. This interference may also reflect at Camp Pond Brook below Camp Pond, the DO readings for Camp Pond start to decrease around the same time frame as those values at Upper Reid Brook.

Turbidity

Turbidity graph for Reid Brook at outlet of Reid Pond indicates a disturbance in the water way that affected the reading of the turbidity sensor for the majority of the deployment period. This display is also evident in Camp Pond below Camp Pond Brook graphed data. On both stations turbidity levels start to increase around July 27-28th, 2010. It is possible that runoff from an earlier precipitation event (precipitation event recorded on July 25th, 2010) started the initial increase in turbidity. Then throughout the deployment period additional rainfall events prevented the turbidity levels to settle. It is possible the sensor became blocked or obstructed by debris which can cause an incorrect reading. Turbidity sensors can be affected by direct sunlight, if the water levels are low enough and the sensor is not protected from the direct sunlight (below < 1 meter of water) it can be influenced by infrared light.
Tributary to Lower Reid Brook displays straight up and down turbidity peaks which can indicated small/short windows of turbidity that are flushed quickly through the system. The turbidity for Tributary to Lower Reid Brook settles down towards the end of deployment. Lower Reid below Tributary had two turbidity events reading ~25NTU and ~12NTU possibility in response to rainfall events. For the remainder of the deployment period the station had consistent readings.

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