



# Real-Time Water Quality Report

## Outer Cove Brook Network

Deployment Period  
October 8 to November 6, 2013



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

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## General

- The Water Resources Management Division (WRMD), in partnership with the City of St. John's and Environment Canada, maintain two real-time water quality and water quantity monitoring stations along Outer Cove Brook.
- This deployment report discusses water quality related events occurring at the stations: Outer Cove Brook below Airport and Outer Cove Brook at Clovelly Golf Course in St. John's.
- WRMD staff monitors the real-time web pages regularly. The City of St. John's will be notified of any water quality issues that arise so mitigative measures can be taken.
- The purpose of these real-time stations is to monitor, process and publish hydrometric (water quantity) and real-time water quality data at the real-time stations. Outer Cove Brook is in the vicinity of the Torbay Road North Commercial Development Area and the real-time stations allow for assessment and management of the water body.
- This report covers the 28-day period from deployment on October 8, 2013 until removal on November 6, 2013.

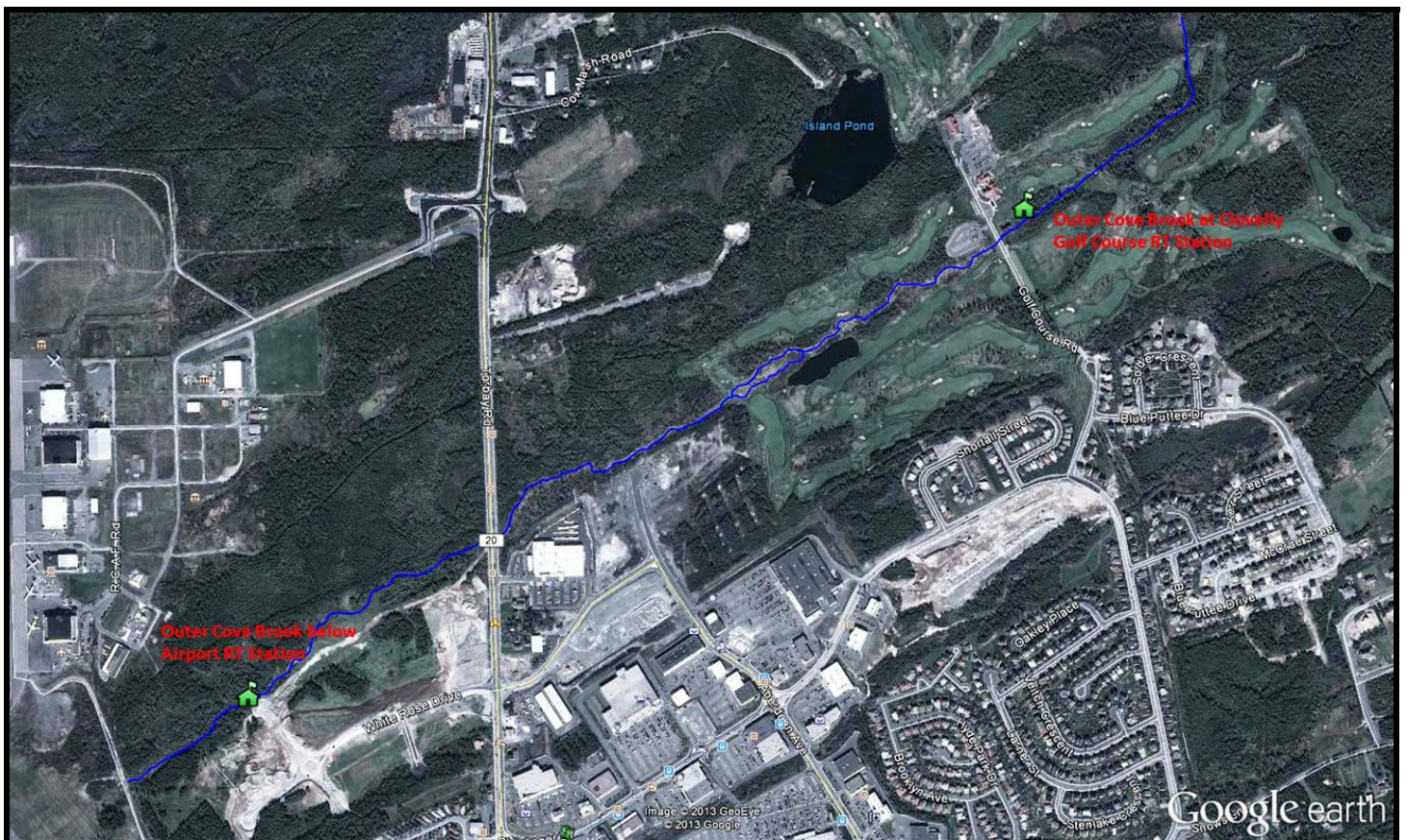


Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.



## Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
- At deployment and removal, a QA/QC Sonde is temporarily deployed alongside the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the degree of difference between the parameters on the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

**Table 1: Instrument Performance Ranking classifications for deployment and removal**

Parameter	Rank				
	Excellent	Good	Fair	Marginal	Poor
Temperature (°C)	$\leq \pm 0.2$	$> \pm 0.2$ to 0.5	$> \pm 0.5$ to 0.8	$> \pm 0.8$ to 1	$< \pm 1$
pH (unit)	$\leq \pm 0.2$	$> \pm 0.2$ to 0.5	$> \pm 0.5$ to 0.8	$> \pm 0.8$ to 1	$> \pm 1$
Sp. Conductance ( $\mu\text{S}/\text{cm}$ )	$\leq \pm 3$	$> \pm 3$ to 10	$> \pm 10$ to 15	$> \pm 15$ to 20	$> \pm 20$
Sp. Conductance $> 35 \mu\text{S}/\text{cm}$ (%)	$\leq \pm 3$	$> \pm 3$ to 10	$> \pm 10$ to 15	$> \pm 15$ to 20	$> \pm 20$
Dissolved Oxygen (mg/L) (% Sat)	$\leq \pm 0.3$	$> \pm 0.3$ to 0.5	$> \pm 0.5$ to 0.8	$> \pm 0.8$ to 1	$> \pm 1$
Turbidity $< 40$ NTU (NTU)	$\leq \pm 2$	$> \pm 2$ to 5	$> \pm 5$ to 8	$> \pm 8$ to 10	$> \pm 10$
Turbidity $> 40$ NTU (%)	$\leq \pm 5$	$> \pm 5$ to 10	$> \pm 10$ to 15	$> \pm 15$ to 20	$> \pm 20$

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be divided into subgroups of: temperature dependant, temperature compensated and temperature independent. Due to the temperature sensor's location on the sonde, the entire sonde must be at a constant temperature before the temperature 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 instrument performance rankings for **Outer Cove Brook below Airport** for the period of October 8, 2013 through to November 6, 2013 are summarized in Table 2.

**Table 2: Instrument performance rankings for Outer Cove Brook below Airport Oct 8, 2013 – Nov 6, 2013**

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Airport	Oct 8 2013	Deployment	Good	Good	Excellent	Excellent	Excellent
	Nov 6 2013	Removal	Fair	Excellent	Good	Excellent	Excellent

- At the Outer Cove Brook below Airport station at the point of deployment, the dissolved oxygen, conductivity and turbidity sensors ranked 'excellent' while the temperature and pH sensors ranked 'good'.
- At removal, pH, dissolved oxygen and turbidity on the field sonde ranked 'excellent', while conductivity ranked 'good' when compared with a freshly calibrated QA/QC sonde. The temperature sensor ranked 'fair', reading lower than the field sonde. This may be due to the temperature sensor not having stabilized in the cold environment before the value was recorded.
- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of October 8, 2013 through to November 6, 2013 are summarized in Table 3.

**Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course Oct 8, 2013 – Nov 6, 2013**

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	Oct 8 2013	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Nov 6 2013	Removal	Poor	Good	Good	Good	Good

- During the Outer Cove Brook Clovelly Golf Course station deployment, all sensors ranked 'excellent' when compared to the freshly calibrated QA/QC sonde.
- At removal, pH, conductivity, dissolved oxygen and turbidity ranked 'good', while temperature ranked 'poor'. The QA/QC sonde value was again much lower than the field sonde value. A review of the data obtained by the QA/QC sonde at both stations during this removal and the subsequent installations, shows that the QA/QC temperature was approximately a degree lower than each of the field sondes, indicating a possible issue with the QA/QC temperature sensor.
- Outer Cove Brook has a large amount of algae growing and it was very hard to select a location for the sonde where the probes wouldn't be influenced by the long hair-like algae. The algae may cause issues periodically if it becomes tangled around the turbidity sensor or block the sensors on the conductivity probe.

## **Deployment Notes**

- There was only one short transmission error during this deployment period at the below airport station, while none occurred at the Clovelly Golf Course station.
- The river's substrate and surrounding vegetation at the below Airport station no longer appeared red colored, 'slimy', or 'scaly', likely the result of the large amount of flushing the river experienced during the fall months due to numerous precipitation events. The substrate appeared normal, and the water was very clear.
- Significant construction work occurred at the Torbay Road North Development area in October, just downstream of the below Airport station.

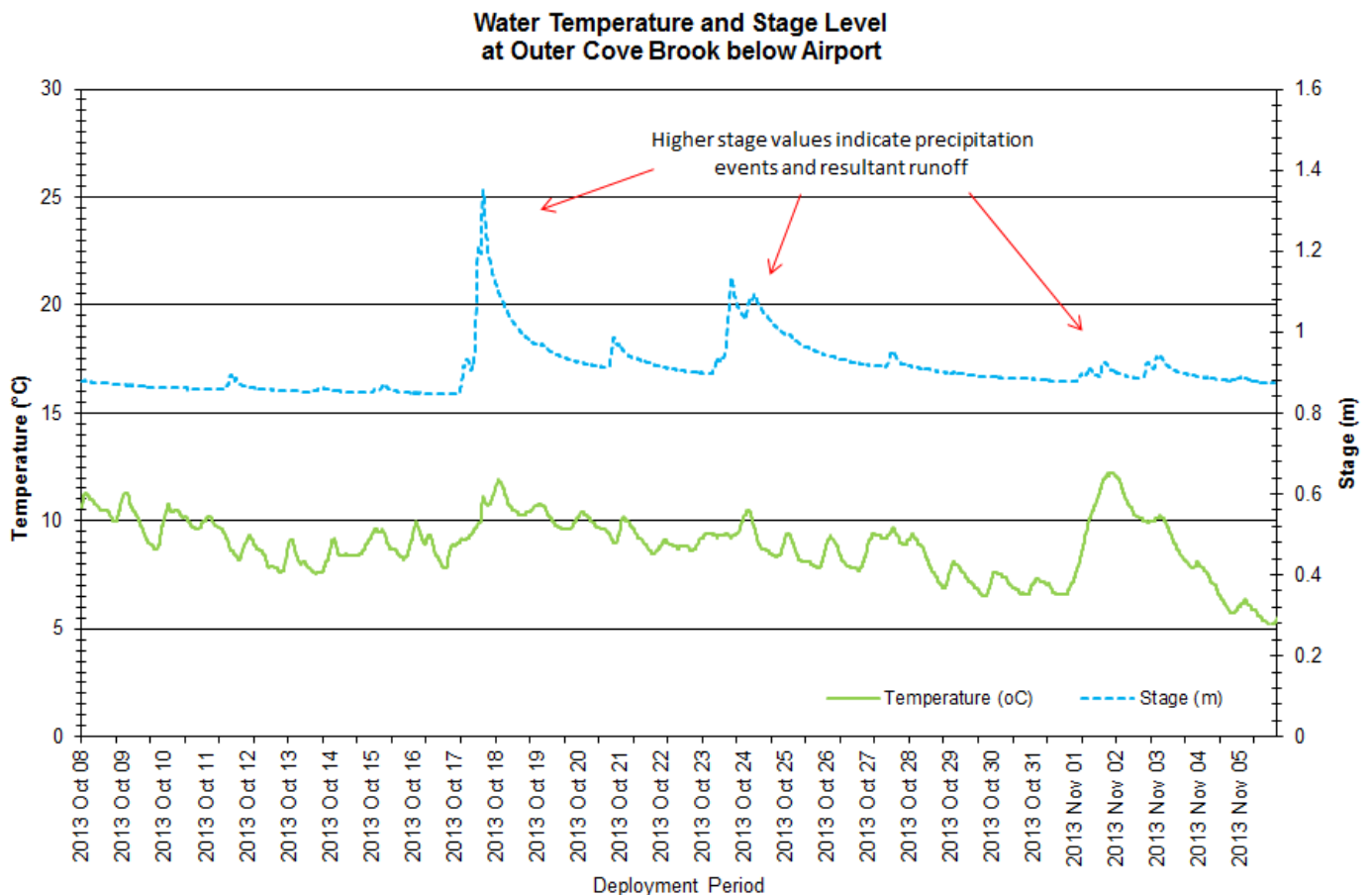
## **Data Interpretation**

- The following graphs and discussion illustrate water quality-related events from October 8, 2013 to November 6, 2013 at the Outer Cove Brook Stations.
- 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 QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request from Water Survey of Canada.
- Precipitation data from the deployment period was retrieved from Environment Canada's weather station at St. John's Airport and supplemented with information from 'The Weather Network' when EC data was not available.

## Outer Cove Brook below Airport

### Water Temperature

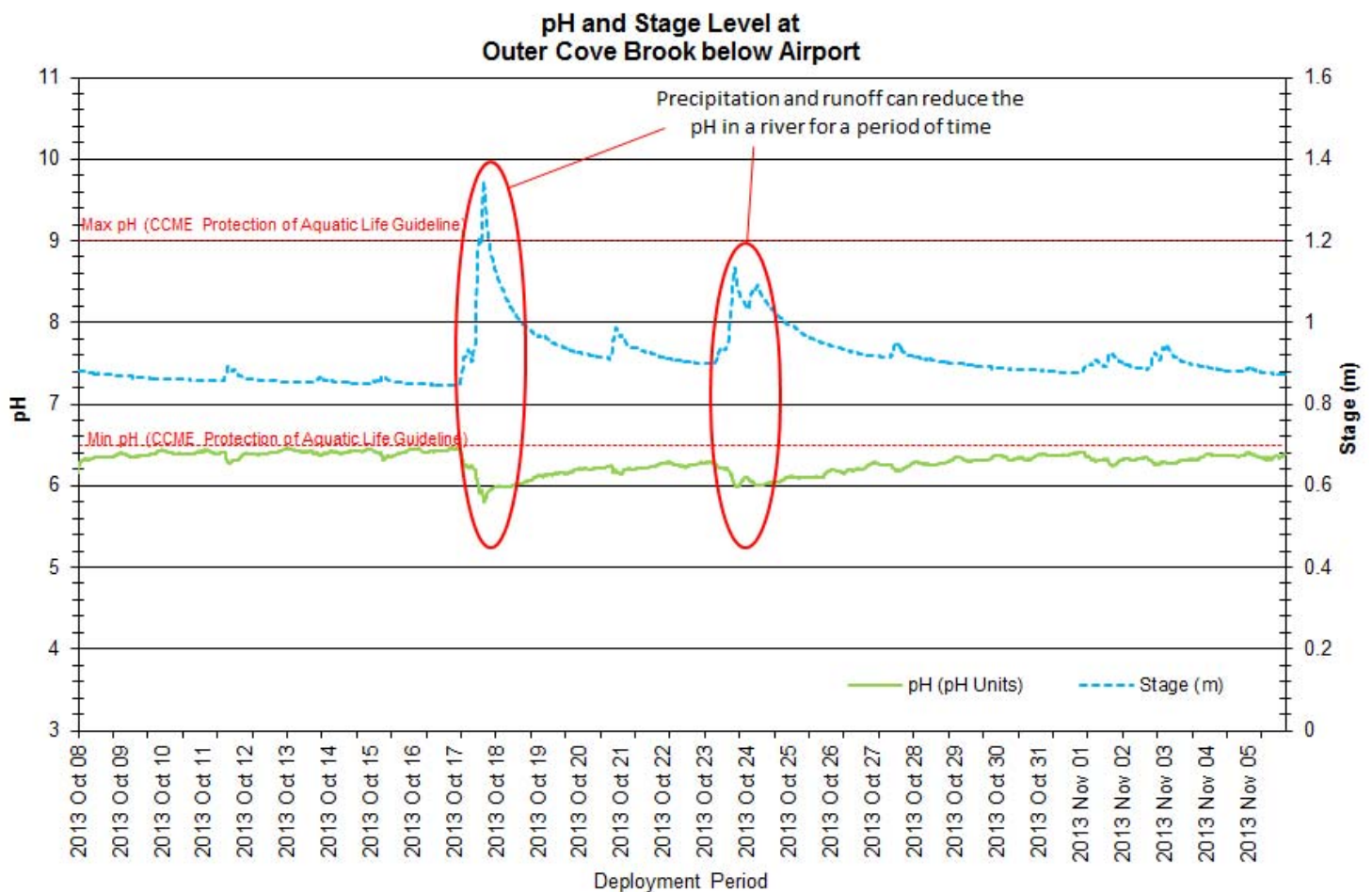
- Water temperature ranged from 5.20°C to 12.20°C during this deployment period (Figure 2).
- There are noticeable increases and decreases in the water temperature during the deployment period. This is consistent with ambient air temperatures over this time period, generally increasing during daylight hours and cooling overnight. Overall, temperature is decreasing as winter approaches.
- Water temperatures display diurnal variations, typical of shallow streams and ponds which are highly influenced by natural diurnal variations in ambient air temperatures.
- Water temperature is a very important parameter and it has the ability to influence other parameters that are measured by the water quality instrument.



**Figure 2: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport for the deployment period October 8, 2013 to November 6, 2013.**

## pH

- Throughout this deployment period pH values ranged between 5.79 pH units and 6.46 pH units (Figure 3).
- During the deployment, the pH values at this station hover near the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units), dropping lower after precipitation events such as those on October 17<sup>th</sup> and 23<sup>rd</sup> (Figure 3). This is a natural occurrence between rainfall and pH levels.
- The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. In the case of Outer Cove Brook below Airport, pH is within the normal range for stream water in St. John's.



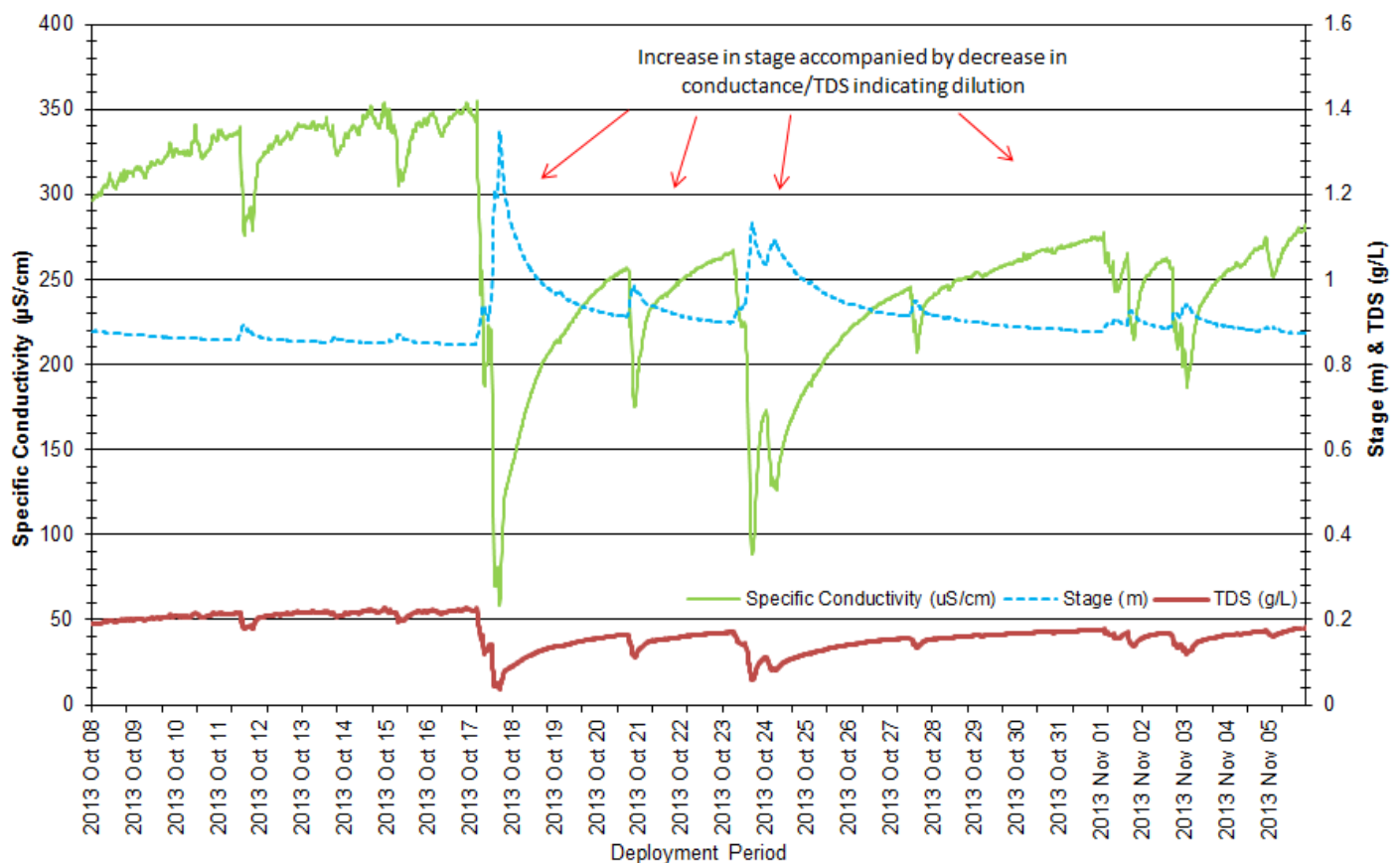
**Figure 3: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook below Airport for the deployment period October 8, 2013 to November 6, 2013.**



### Specific Conductivity & TDS

- The conductivity levels were within 58.6  $\mu\text{S}/\text{cm}$  and 355.0  $\mu\text{S}/\text{cm}$  during this deployment period. TDS ranged from 0.0375 g/L to 0.2270 g/L.
- Generally, rainfall events, such as that which occurred on October 17<sup>th</sup> and 23<sup>rd</sup> (see Figure 4), can have the effect of diluting and lowering conductance levels. When stage levels rise, the specific conductance levels drop in correlation as the increased amount of water in the river system dilutes the solids present there, thus generally decreasing the specific conductivity readings.
- Total Dissolved Solids (TDS), is a parameter that the instrument calculates by an algorithm that utilizes the data from specific conductivity and water temperature to produce a TDS value and generally always mirrors specific conductivity.

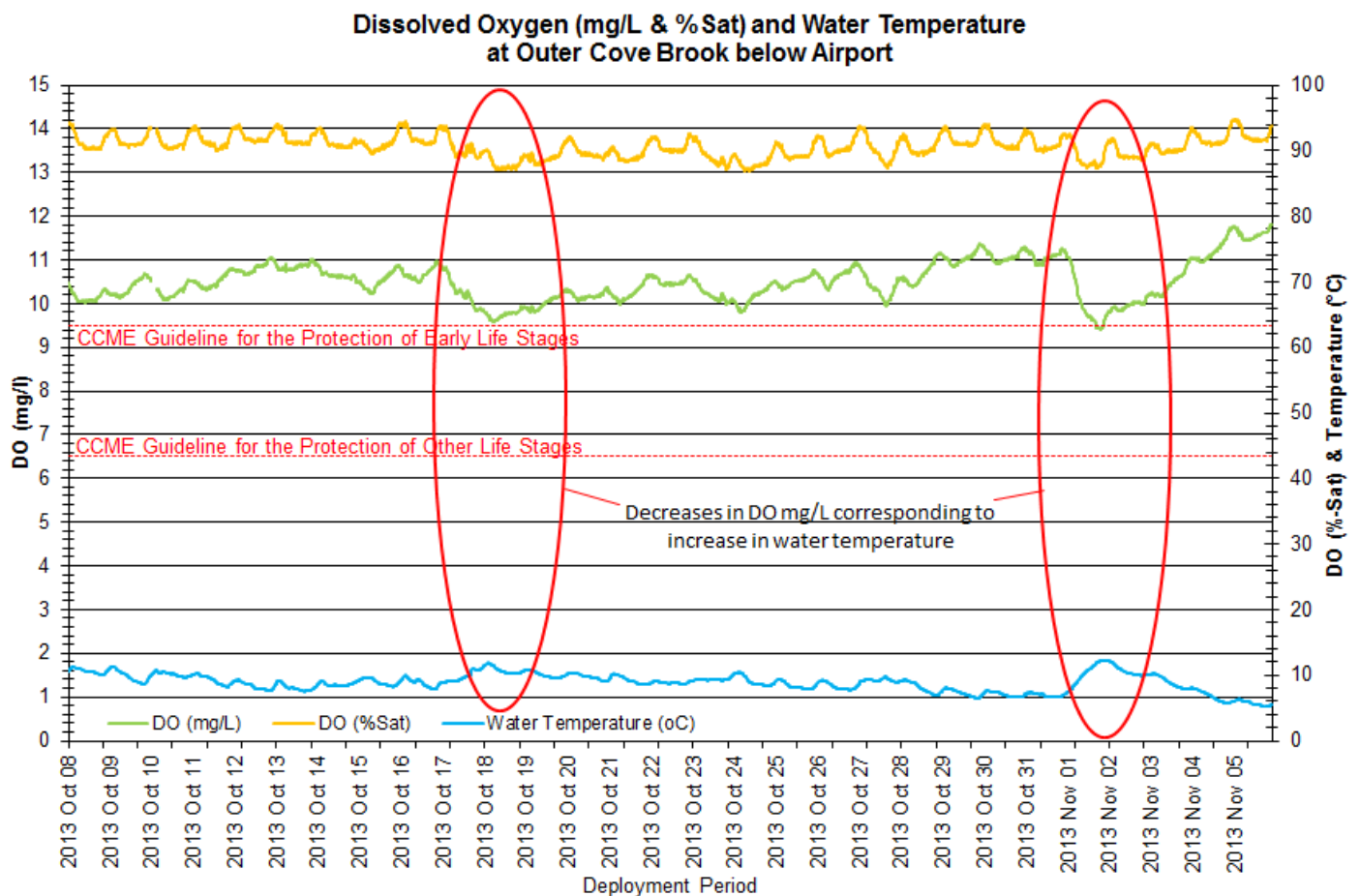
**Specific Conductance, TDS and Stage Level  
at Outer Cove Brook below Airport**



**Figure 4: Quarter-hourly specific conductivity ( $\mu\text{S}/\text{cm}$ ), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport for the deployment period October 8, 2013 to November 6, 2013.**

## Dissolved Oxygen

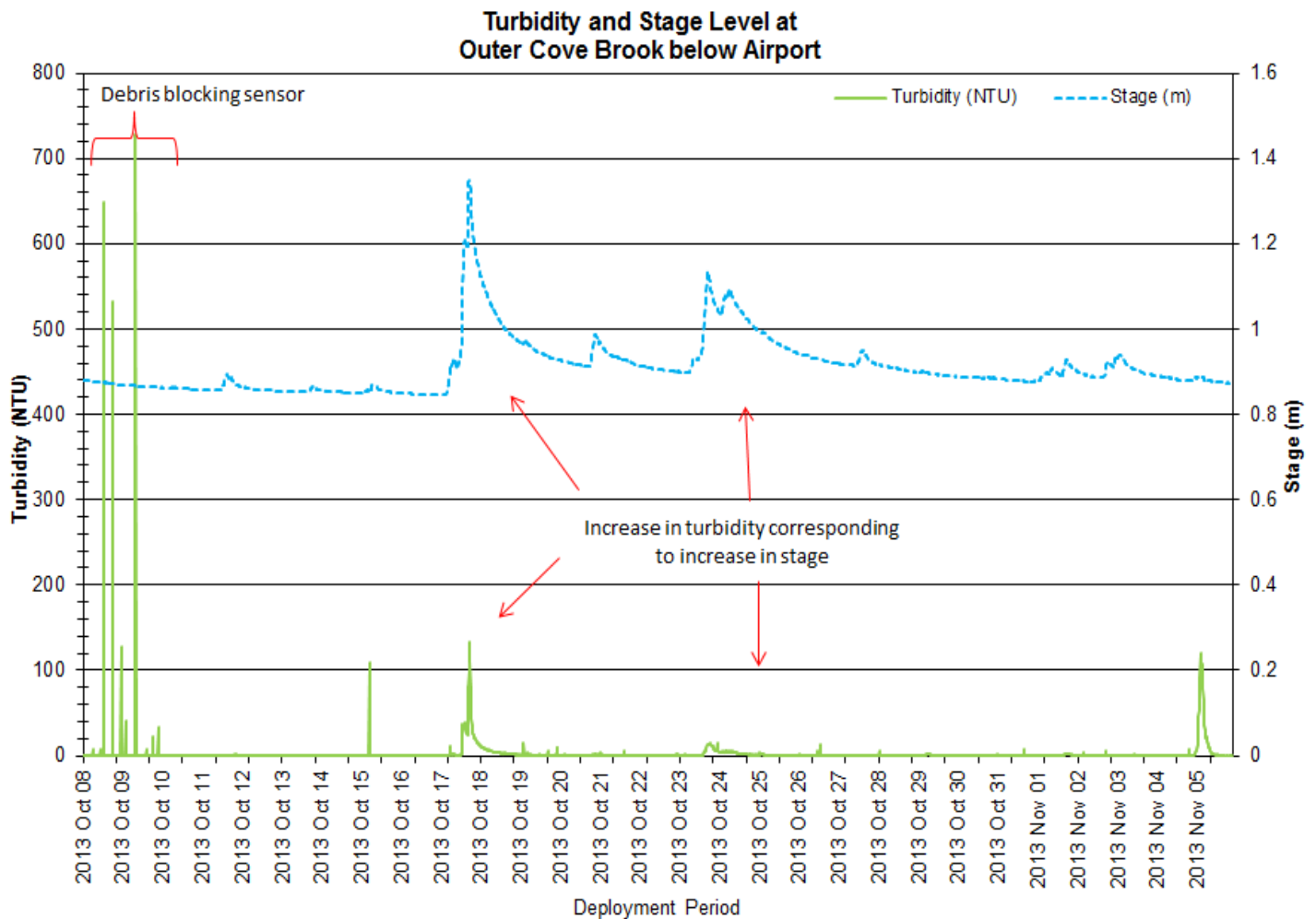
- The instrument measures dissolved oxygen (mg/L) directly then calculates percent saturation (% Sat.).
- The Dissolved Oxygen % Sat levels within this deployment period were within 86.9% Sat–94.8% Sat. Dissolved Oxygen (mg/L) measured 9.39 mg/L to 11.77 mg/L. Water temperatures were cooler during this deployment period, resulting in higher oxygen levels.
- The DO mg/L values are above the minimum DO CCME guideline for early life stages, dropping to near or below the guideline when water temperatures increase as on October 18<sup>th</sup> and November 2<sup>nd</sup> (Figure 5), and rising again when water temperatures decrease.
- Dissolved Oxygen percent saturation remains relatively constant throughout the deployment period. Dissolved oxygen mg/L content fluctuates with the water temperature changes. Small decreases in dissolved oxygen values are inversely related to increases in water temperature as warmer water can hold less oxygen.



**Figure 5: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport for the deployment period October 8, 2013 to November 6, 2013.**

## Turbidity

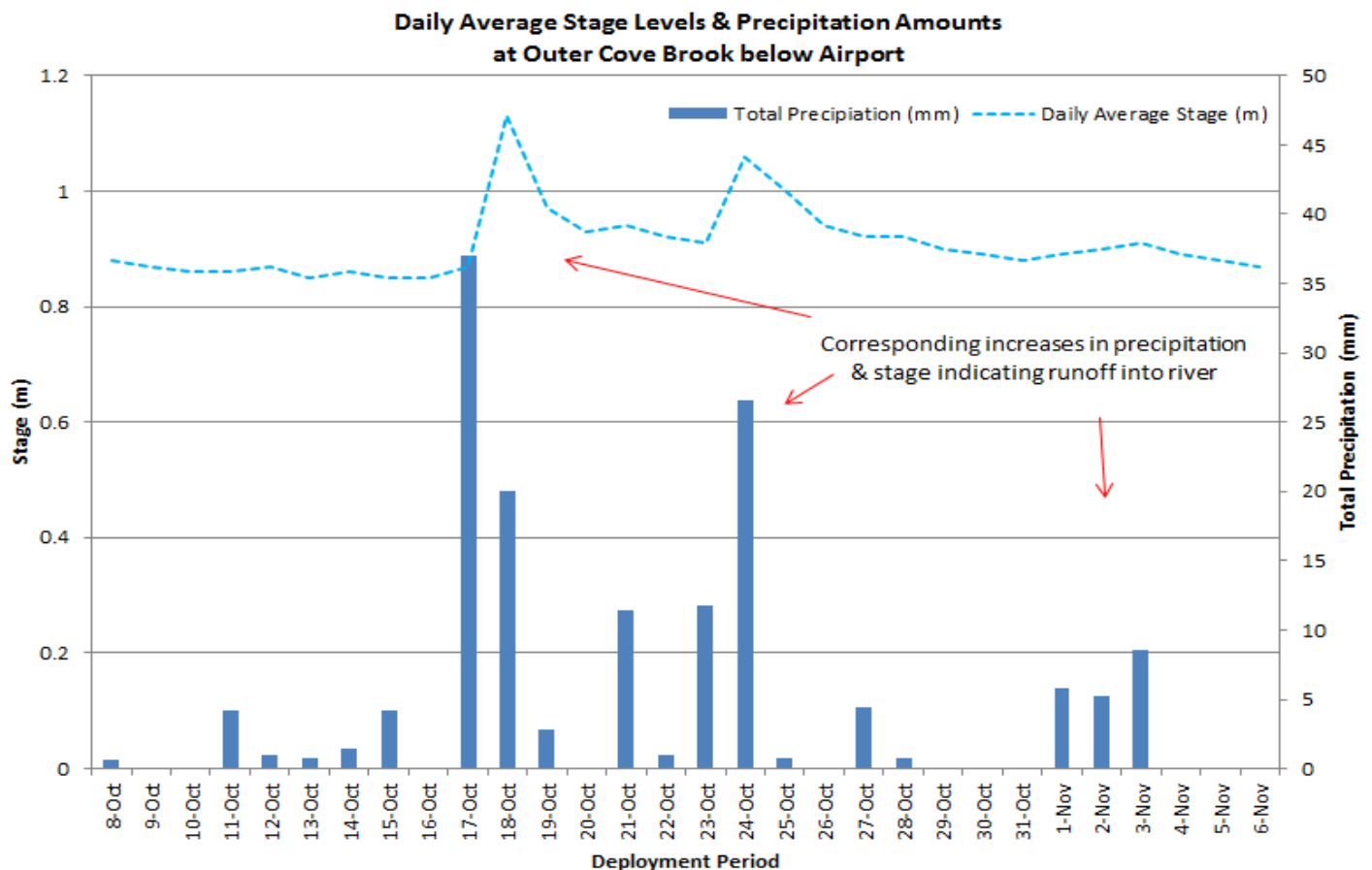
- Outer Cove Brook below Airport contains a significant amount of algae. High algal growth, biofouling, or leaf and grass debris can interfere with turbidity measurements as they block the sensor.
- The turbidity sensor can read a turbidity value between 0 NTU and 3000 NTU. If a reading hits 3000NTU it is identified as an error reading and thus is not a true turbidity value.
- The turbidity readings during this deployment ranged within 0.0 NTU to 728 NTU (Figure 6).
- Several precipitation events and corresponding stage increases led to fluctuating turbidity values (see Figure 6) as sediment and debris were resuspended into the water column. Sudden increases in turbidity for single readings may indicate debris is blocking the turbidity sensor.



**Figure 6: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport for the deployment period October 8, 2013 to November 6, 2013.**

## Stage

- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.
- Stage provides an estimation of water level at the station and can explain some of the changes that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage increases during precipitation events (Figure 7) due to increased runoff from the surrounding area.
- Precipitation data was obtained from Environment Canada's St. John's Airport weather station and supplemented with data from 'The Weather Network' when EC data was unavailable.
- During the deployment period, the stage ranged from 0.85m to 1.35m, with the maximum level being reached after a significant rainfall event of 57mm over 2 days (October 17<sup>th</sup>-18<sup>th</sup>).



**Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period October 8, 2013 to November 6, 2013.**

## Conclusions

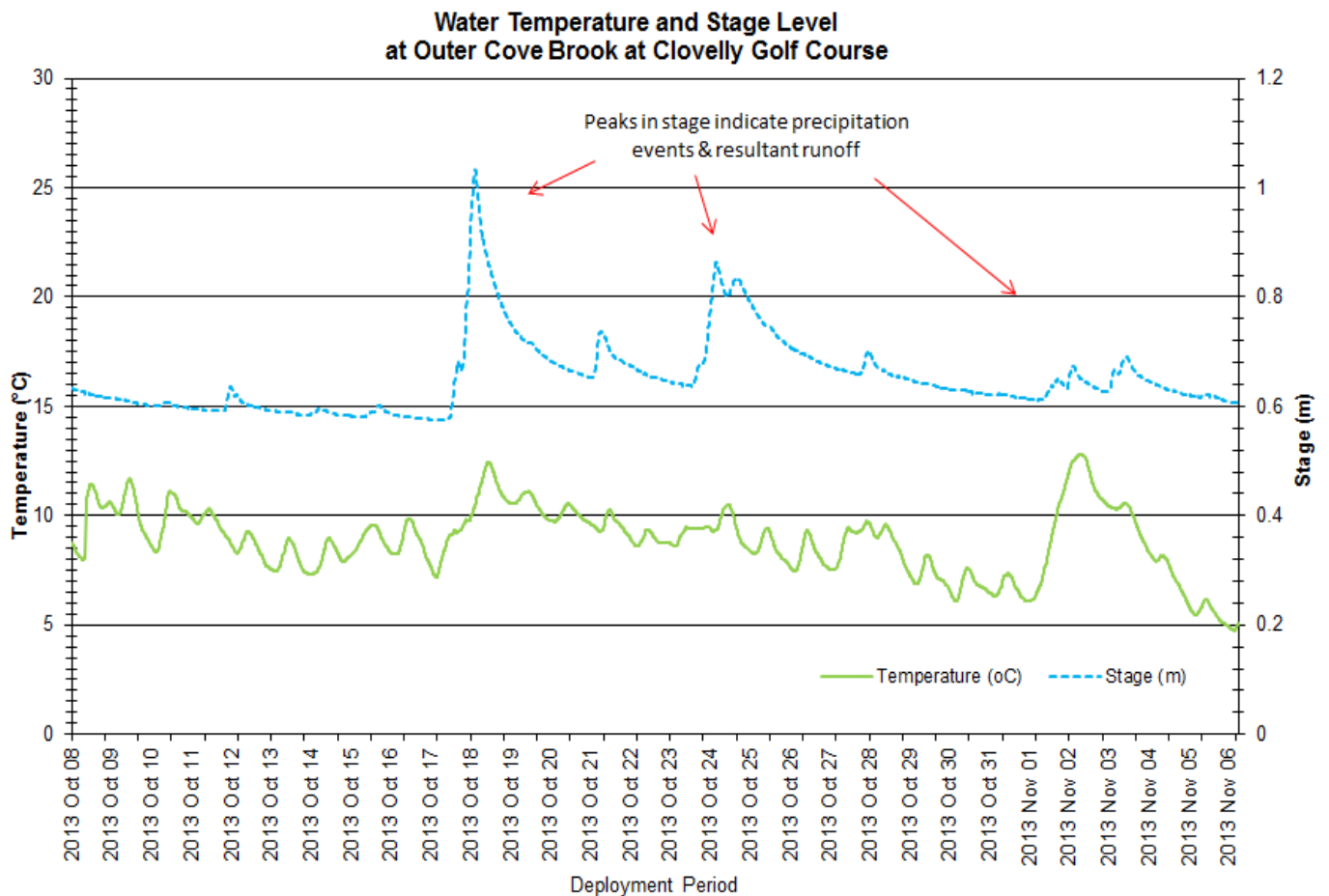
- Generally in natural environments, climate and weather conditions contribute in large part to the variation in water quality parameters. During this deployment it was evident that many of the changes in the parameter data displayed on the graphs, was related to the intermittent precipitation events and small climatic changes of the seasons (i.e. temperature decreases).
- Precipitation events during the deployment period led to related fluctuations in stage, which thus influenced the values of turbidity, pH, specific conductance, and TDS. As ambient air temperatures decreased, there were correspondingly cooler water temperatures, which in turn increased the amount of dissolved oxygen in the water.
- The turbidity sensor may have been influenced by debris in the river October 9<sup>th</sup>, as the values increased at multiple times for single high readings at a time. This is not unusual as the river is full of leaves and grass during this time of the year.
- There do not appear to be any issues with conductivity, TDS, dissolved oxygen or pH at this station during this deployment period.



## Outer Cove Brook at Clovelly Golf Course

### Water Temperature

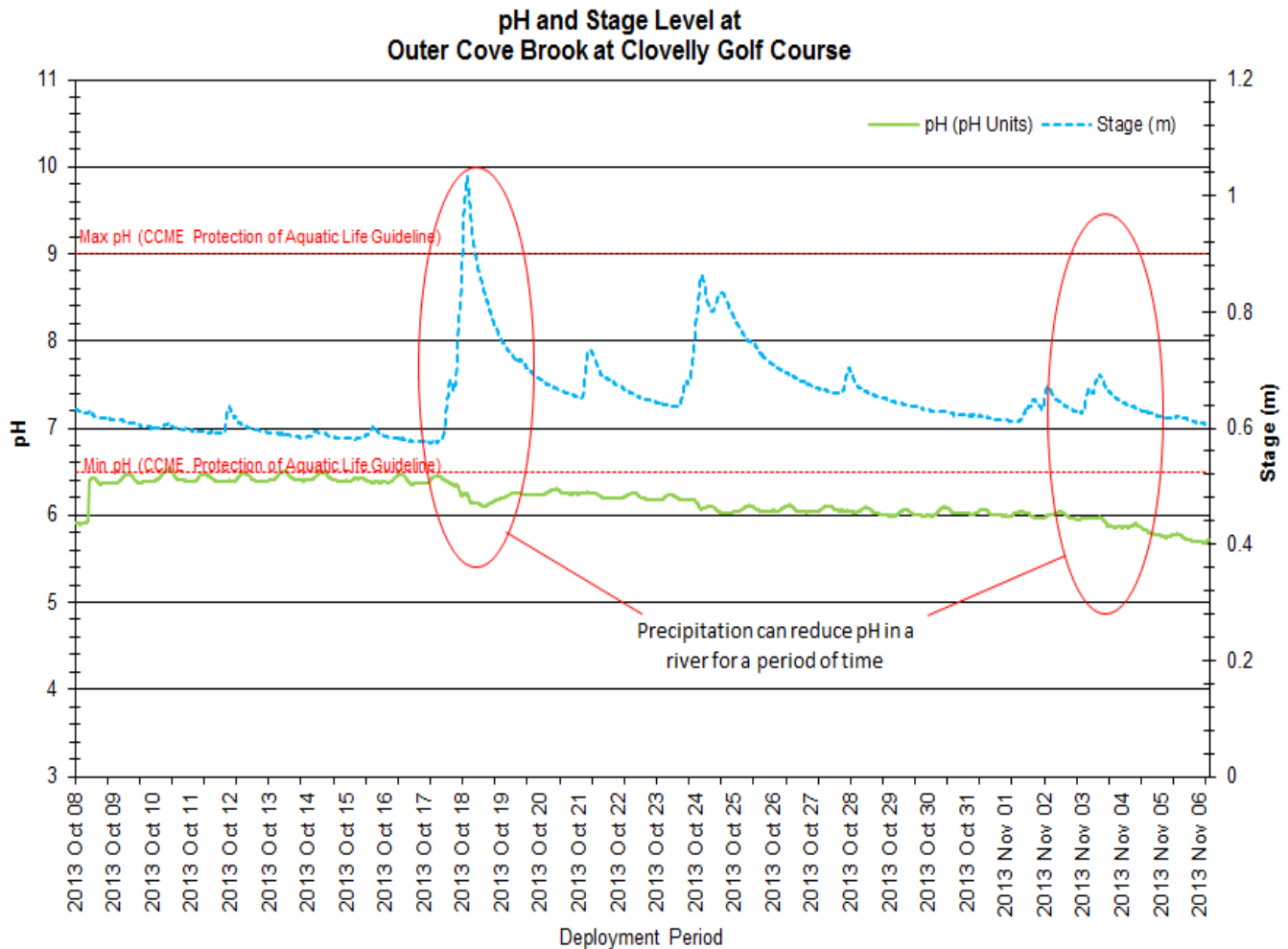
- Water temperature ranged from 4.73°C to 12.79°C during this deployment period (Figure 8). This is notably cooler than the previous deployment, and is normal as winter approaches.
- There are noticeable increases and decreases in the water temperature during the deployment period. This is consistent with ambient air temperatures over this time period, generally increasing during daylight hours and cooling overnight.
- Water temperatures display diurnal variations, typical of shallow streams and ponds which are highly influenced by natural diurnal variations in ambient air temperatures.
- Water temperature is a very important parameter and it has the ability to influence other parameters that are measured by the water quality instrument.



**Figure 8: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period October 8, 2013 to November 6, 2013.**

## pH

- Throughout this deployment period pH values ranged between 5.68 pH units and 6.54 pH units (Figure 9).
- During the deployment, the pH values at this station are below the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) decreasing further at times due to the addition of precipitation. There are notable drops on October 18<sup>th</sup> and November 3<sup>rd</sup>, related to precipitation events. This is a natural occurrence between rainfall and pH levels.
- The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. In the case of Outer Cove Brook at Clovelly Golf Course, pH is within the normal range for stream water in St. John's.



**Figure 9: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period October 8, 2013 to November 6, 2013.**

## Specific Conductivity & TDS

- The conductivity levels were within 100.2  $\mu\text{S}/\text{cm}$  and 341  $\mu\text{S}/\text{cm}$  during this deployment period. TDS ranged from 0.0641 g/L to 0.2180 g/L. This is notably lower than in September, likely due to the large input of freshwater from precipitation during October.
- Generally, rainfall events, such as that which occurred on October 18<sup>th</sup> (see Figure 10), can have the effect of diluting and lowering conductance levels. When stage levels rise, the specific conductance levels drop in correlation as the increased amount of water in the river system dilutes the solids present there, thus generally decreasing the specific conductivity readings.
- Total Dissolved Solids (TDS), is a parameter that the instrument calculates by an algorithm that utilizes the data from specific conductivity and water temperature to produce a TDS value and generally always mirrors specific conductivity.
- A spike in conductivity/TDS is noted on October 10<sup>th</sup>. There is a corresponding smaller spike at this time in the upstream station data, indicating that there may be excessive runoff of sediments into the river between the stations.

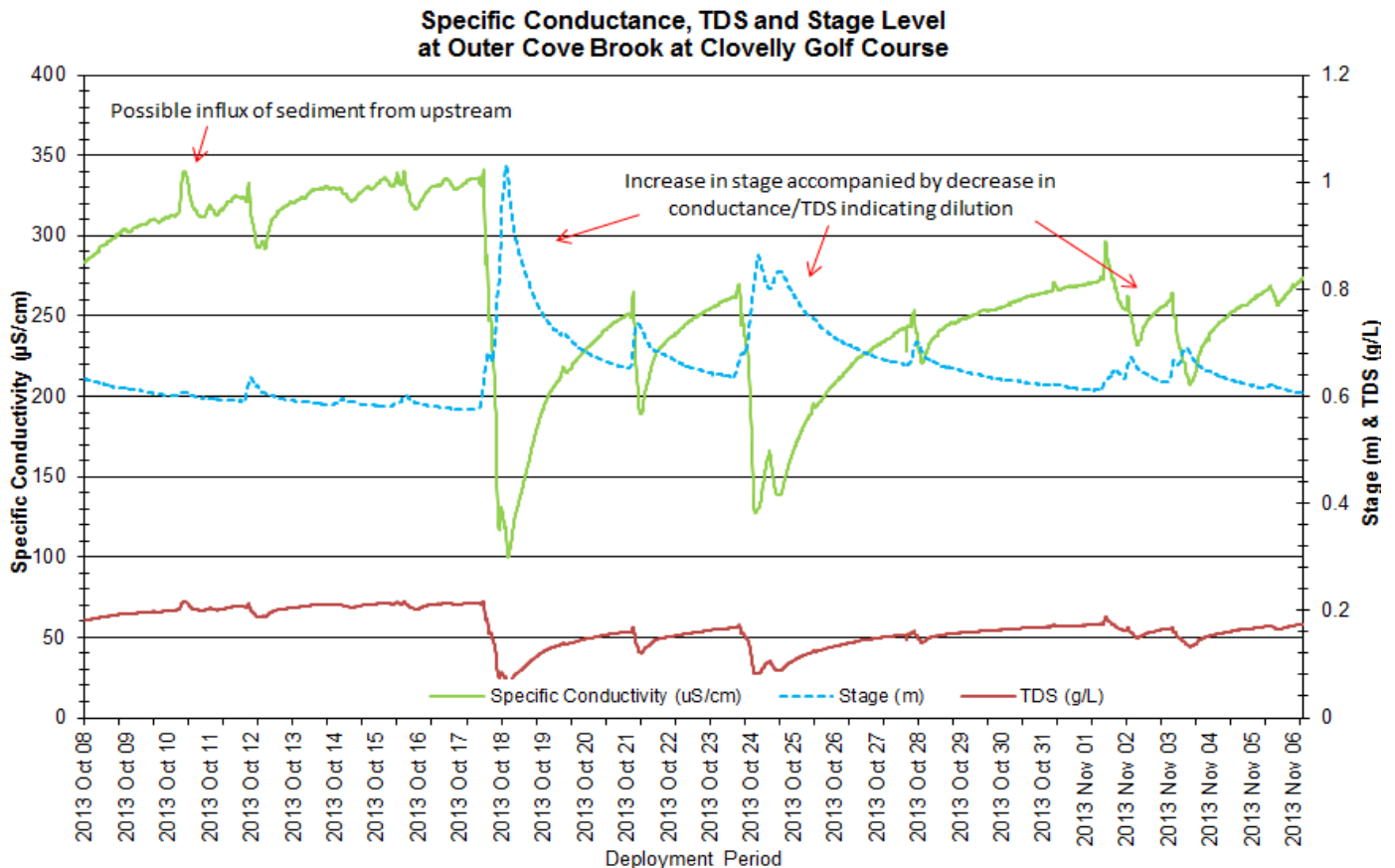
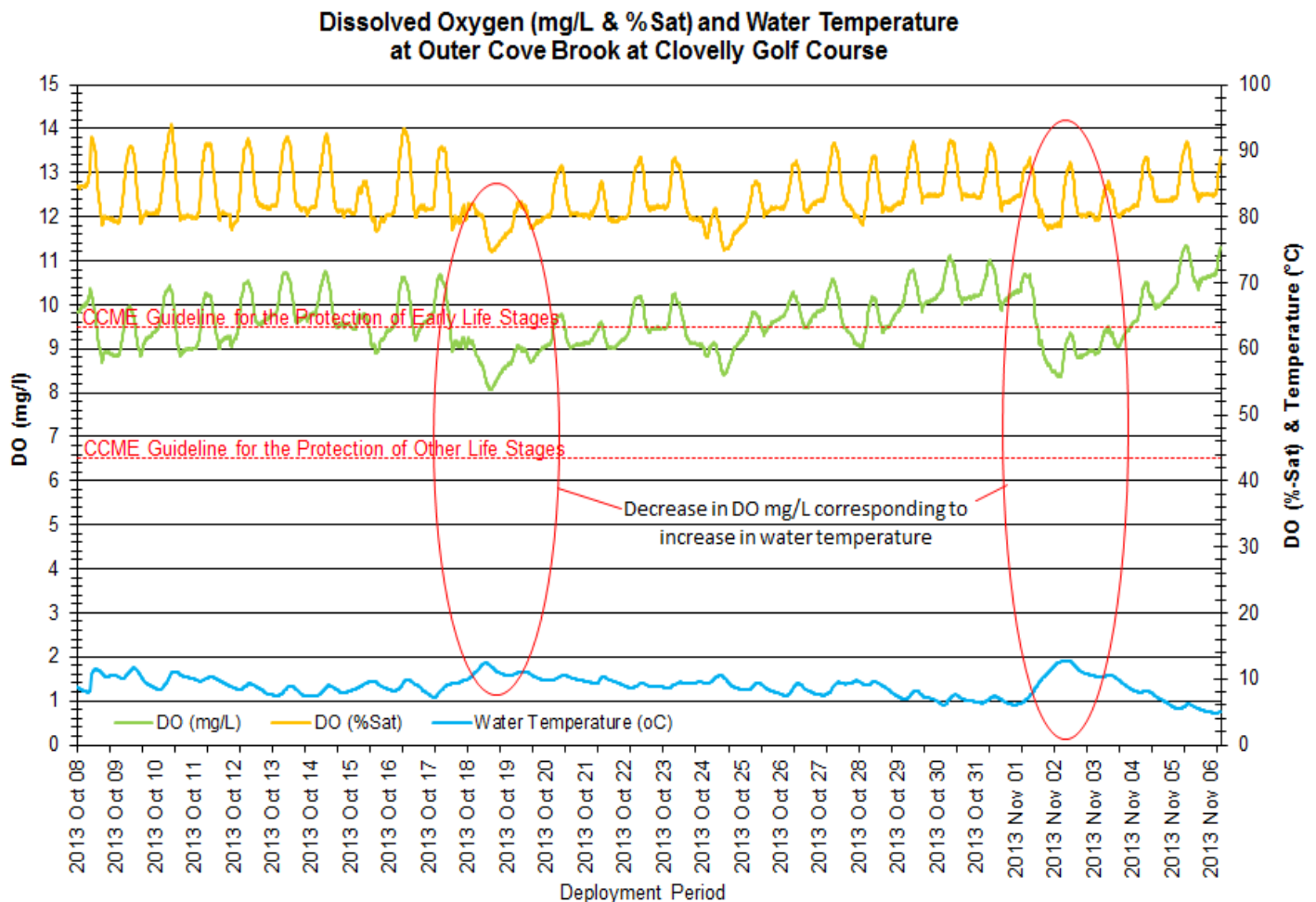


Figure 10: Quarter-hourly specific conductivity ( $\mu\text{S}/\text{cm}$ ), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period October 8, 2013 to November 6, 2013.

## Dissolved Oxygen

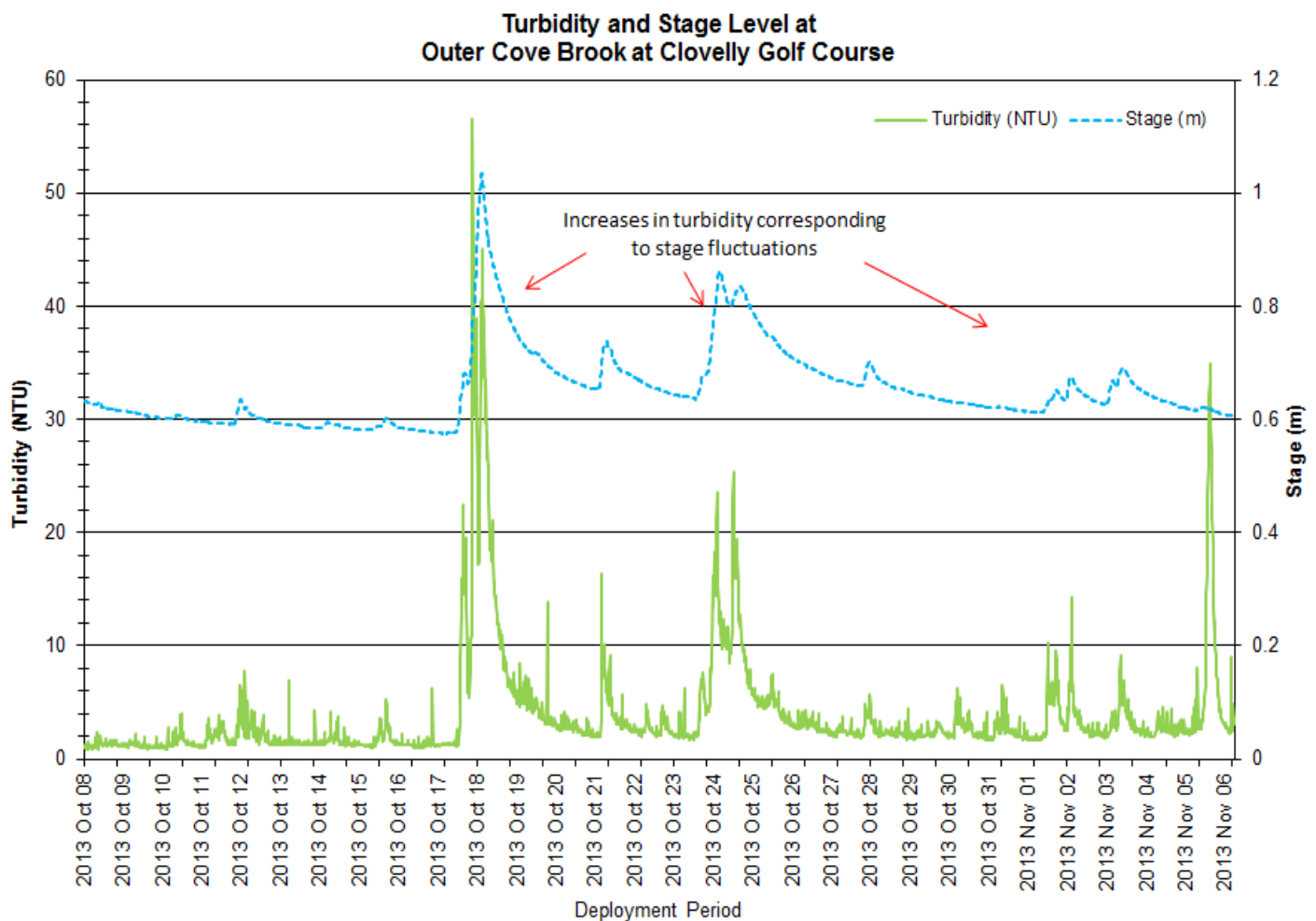
- The instrument measures dissolved oxygen (mg/L) then calculates percent saturation (% Sat).
- The Dissolved Oxygen % Sat levels within this deployment period were within 74.7% Sat–94.0% Sat. Dissolved Oxygen (mg/L) measured 8.06 mg/L to 11.34 mg/L. Water temperatures were cooler during this deployment period, resulting in higher oxygen levels.
- The DO mg/L values dip below the minimum DO CCME guideline for early life stages during warm periods during the deployment. Warm water temperatures October 18<sup>th</sup> and November 2<sup>nd</sup> led to lower oxygen (mg/L) levels in the water at this time (Figure 11).
- Dissolved Oxygen percent saturation remains relatively constant throughout the deployment period, with diurnal fluctuations. Dissolved oxygen mg/L content fluctuates with the water temperature changes. Decreases in dissolved oxygen values are inversely related to increases in water temperature as warmer water can hold less oxygen.



**Figure 11: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook at Clovelly Golf Course for the deployment period October 8, 2013 to November 6, 2013.**

## Turbidity

- Outer Cove Brook contains a significant amount of algae. High algal growth in the summer or leaf debris during all seasons can interfere with turbidity measurements as they block the sensor.
- The turbidity sensor can read turbidity values between 0 NTU and 3000 NTU. If a turbidity reading hits 3000NTU it is always identified as an error reading and thus is not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 0.9 NTU to 56.5 NTU (Figure 12). Fluctuations in turbidity values were correlated with increases in stage and thus precipitation events. Biofouling does not appear to have been an issue during this deployment, even though the sonde was coated in fine organic material during removal.
- Several precipitation events and corresponding stage increases led to fluctuating turbidity values as sediment and debris were resuspended into the water column.

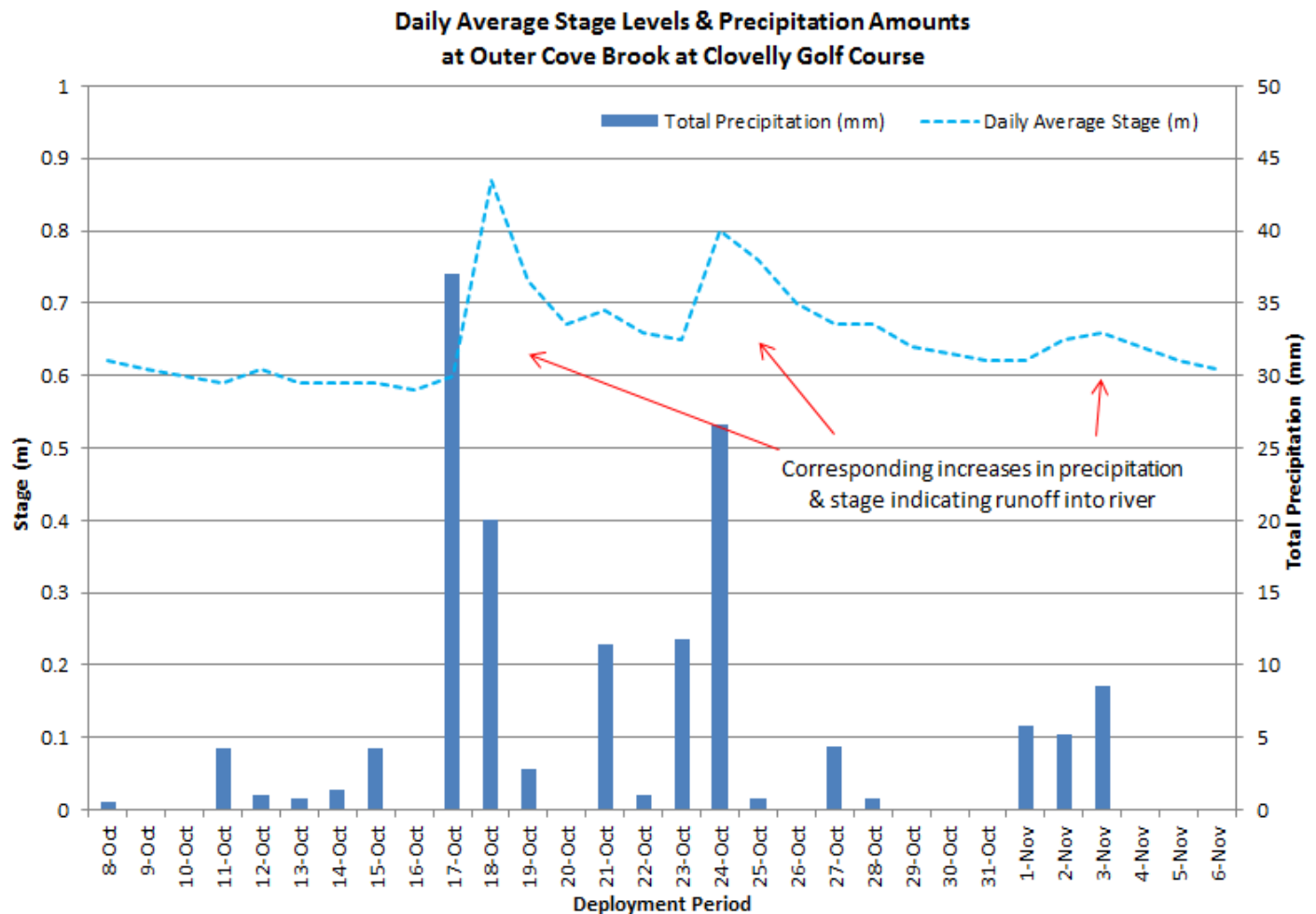


**Figure 12: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period October 8, 2013 to November 6, 2013.**



## Stage

- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.
- Stage provides an estimation of water level at the station and can explain some of the events that are occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage increases during precipitation events due to increased runoff from the surrounding area (see Figure 13).
- Precipitation data was obtained from Environment Canada's St. John's Airport weather station and supplemented with data from 'The Weather Network' when EC data was unavailable.
- During the deployment period, the stage values ranged from 0.58m to 1.03m, with the maximum level being reached after a significant rainfall event of 57mm over 2 days (October 17<sup>th</sup>-18<sup>th</sup>).



**Figure 13: Daily average stage values (m) at Outer Cove Brook at Clovelly Golf Course and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period October 8, 2013 to November 6, 2013.**

## **Conclusions – Outer Cove Brook at Clovelly Golf Course**

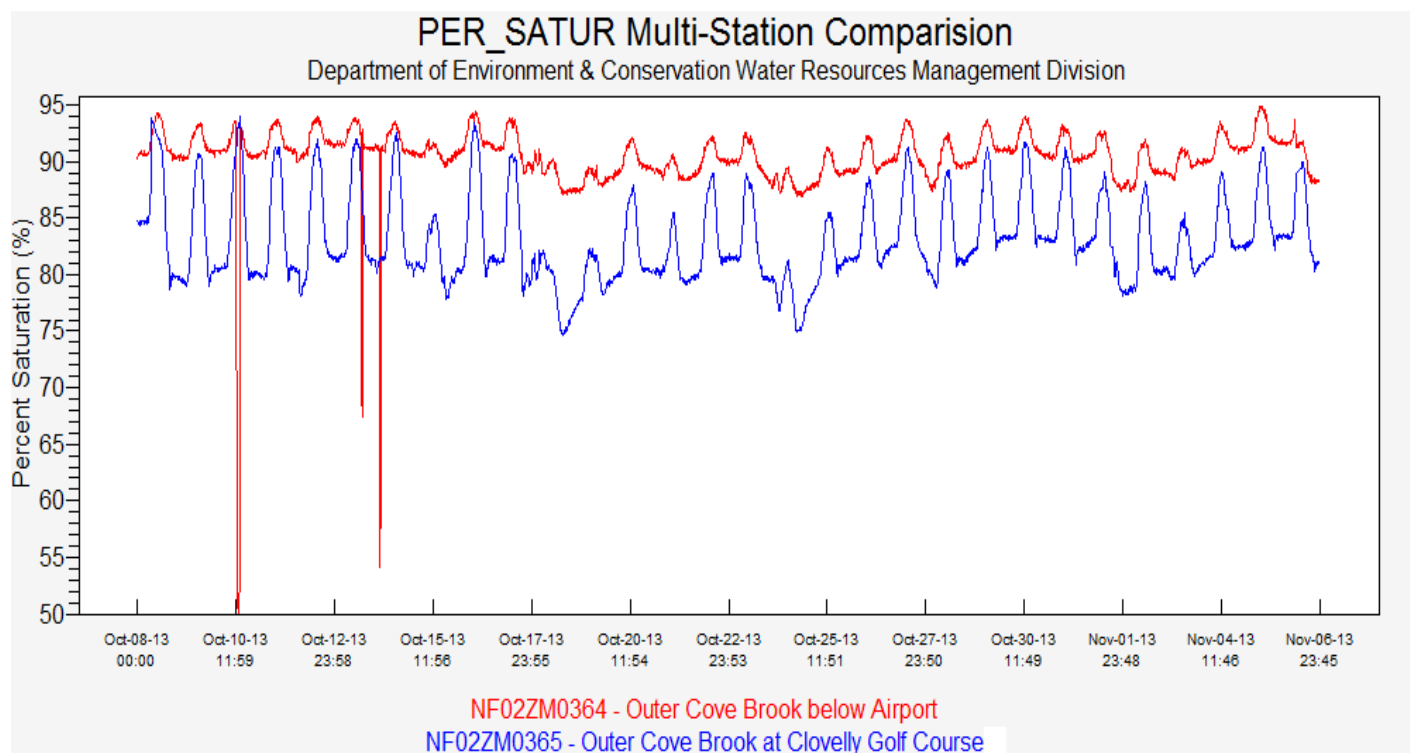
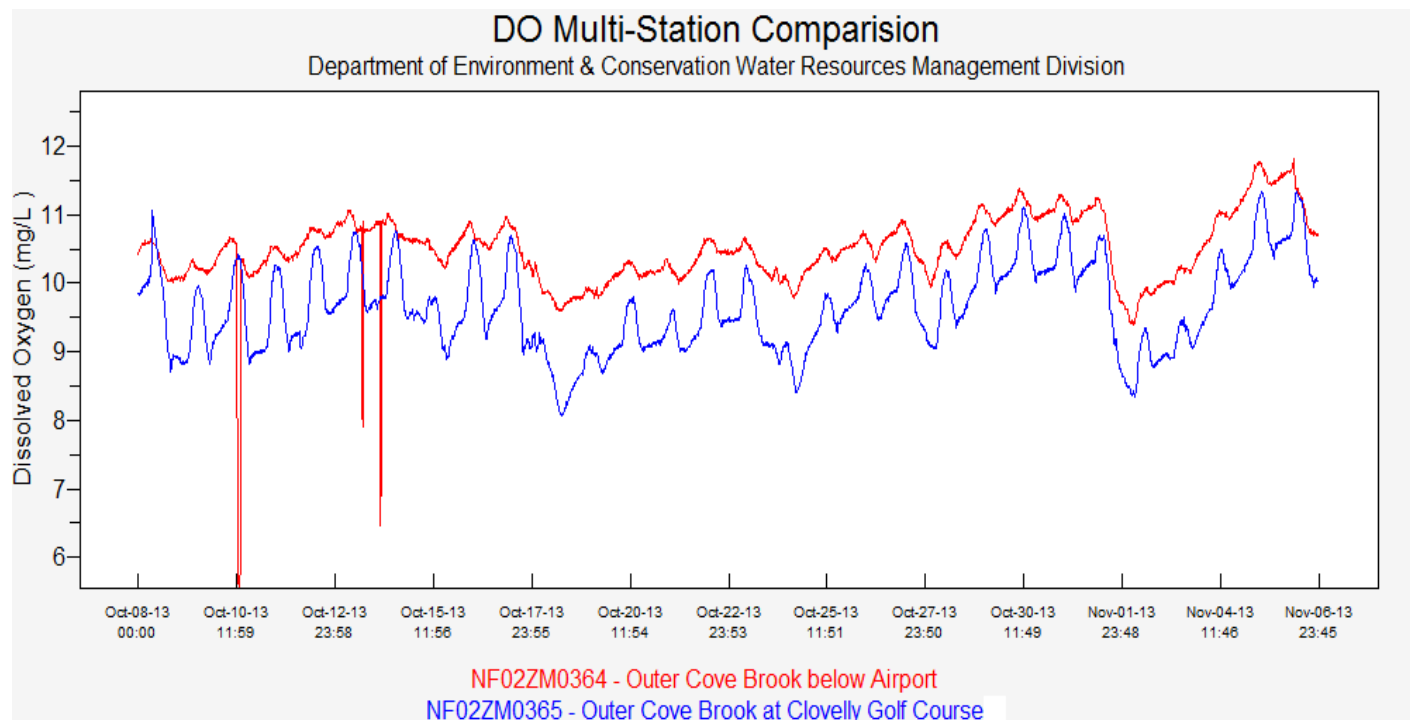
- Precipitation events during the deployment period led to related fluctuations in stage, which thus influenced the values of turbidity, pH, specific conductance, and TDS. As ambient air temperatures decreased, there were correspondingly cooler water temperatures, which in turn increased the amount of dissolved oxygen in the water.
- During this deployment, the turbidity sensor did not suffer from biofouling as it had in previous months, even though the sonde was coated in a layer of black organic material upon removal.
- Dissolved oxygen values at this site fluctuate diurnally, increasing values during the day and decreasing values into the night, indicating a relationship between the oxygen levels and sunlight.
- An increase in conductance on October 10<sup>th</sup> may indicate the addition of sediments to the river upstream of this station. This increase did occur at the below airport station but was smaller in magnitude, indicating possible inputs having occurred between the two stations.
- Generally, dissolved oxygen, pH, conductivity and TDS values are lower while water temperatures are higher at this station than at the below airport station.

## **Conclusions – Outer Cove Brook Network**

During this deployment period, the median water temperature at the upstream station (below Airport) of 9.00°C was slightly higher than that of the downstream station (at Clovelly Golf Course) of 8.96°C. The median pH value of 6.32 below the Airport is higher than the Clovelly station median of 6.17. These values are almost identical to those of the previous deployment. The specific conductivity medians were similar at both stations with 258 uS/cm reported below the airport and 257 uS/cm reported at the golf course. Dissolved oxygen at the upstream station (below Airport) had a median of 90.7%Sat during the deployment period, while the downstream station (Clovelly Golf Course) had a lower median of 81.9%Sat. The lower oxygen levels at the downstream Clovelly station occur at night, indicating an interaction with the prolific aquatic grass growth which cannot synthesize oxygen and replenish the dissolved oxygen in the water at night. The median turbidity value below the airport was 0.0 NTU while at Clovelly Golf Course the median was 2.4 NTU. There does not appear to be any major increase in turbidity from the upstream to the downstream station.

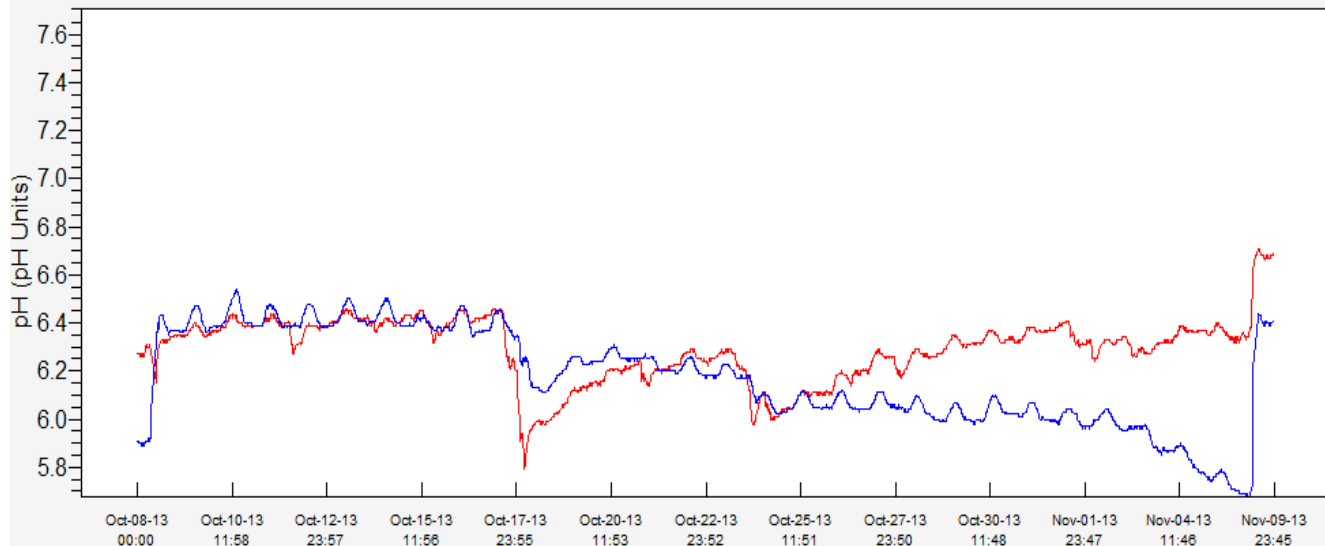
## Appendix

### Parameter Station Comparison Graphs



### PH Multi-Station Comparision

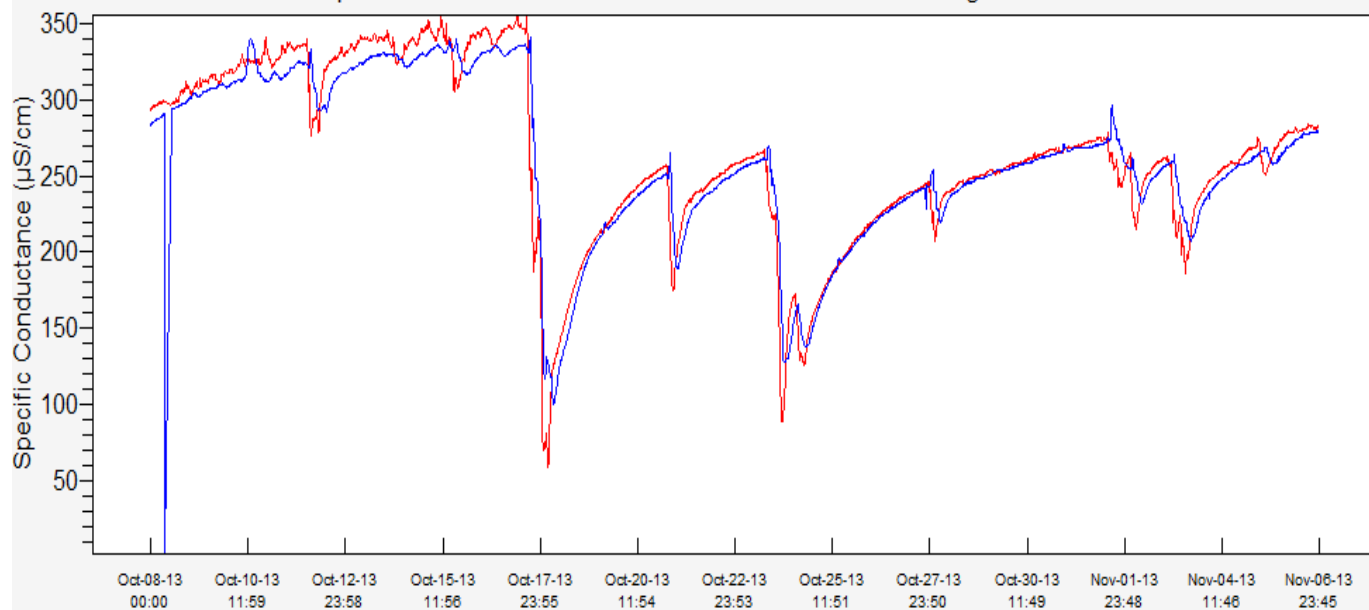
Department of Environment & Conservation Water Resources Management Division



NF02ZM0364 - Outer Cove Brook below Airport  
NF02ZM0365 - Outer Cove Brook at Clovelly Golf Course

### SPEC\_CONDUCT Multi-Station Comparision

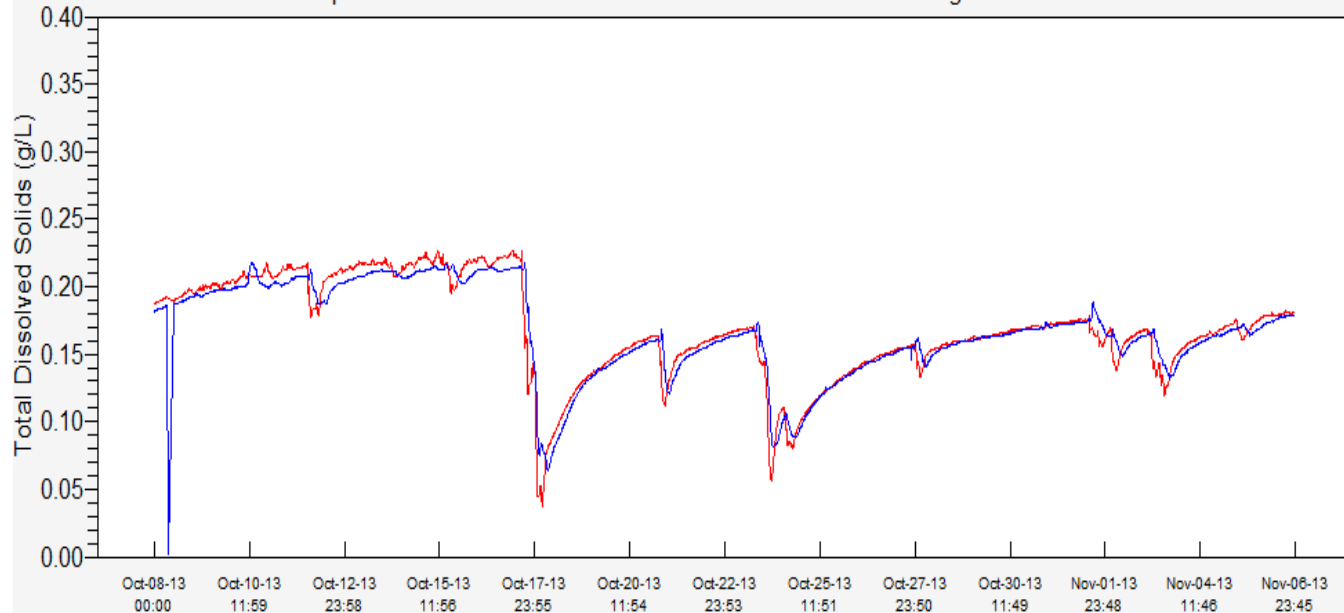
Department of Environment & Conservation Water Resources Management Division



NF02ZM0364 - Outer Cove Brook below Airport  
NF02ZM0365 - Outer Cove Brook at Clovelly Golf Course

### TDS Multi-Station Comparision

Department of Environment & Conservation Water Resources Management Division

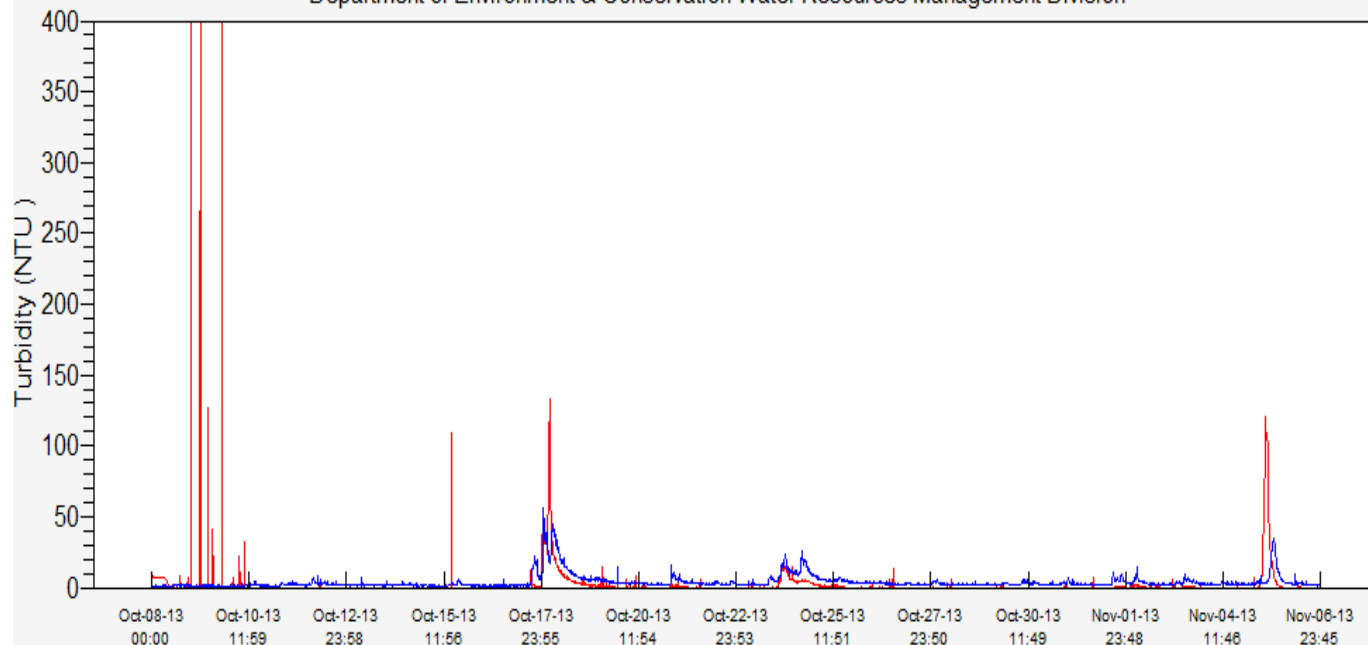


NF02ZM0364 - Outer Cove Brook below Airport

NF02ZM0365 - Outer Cove Brook at Clovelly Golf Course

### TURBIDITY Multi-Station Comparision

Department of Environment & Conservation Water Resources Management Division



NF02ZM0364 - Outer Cove Brook below Airport

NF02ZM0365 - Outer Cove Brook at Clovelly Golf Course



