Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
May 3 to June 4, 2013

Newfoundland Labrador

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

Outer Cove Brook, Newfoundland and Labrador

Prepared by:

Kyla Brake
Environmental Scientist
Water Resources Management Division
Department of Environment & Conservation
4th Floor, Confederation Building, West Block
PO Box 8700, St. John's NL A1B 4J6
Ph. No.: (709) 729 - 3899
Fax No.: (709) 729 - 0320
kbrake@gov.nl.ca

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 31-day period from deployment on May 3, 2013 until removal on June 4, 2013.

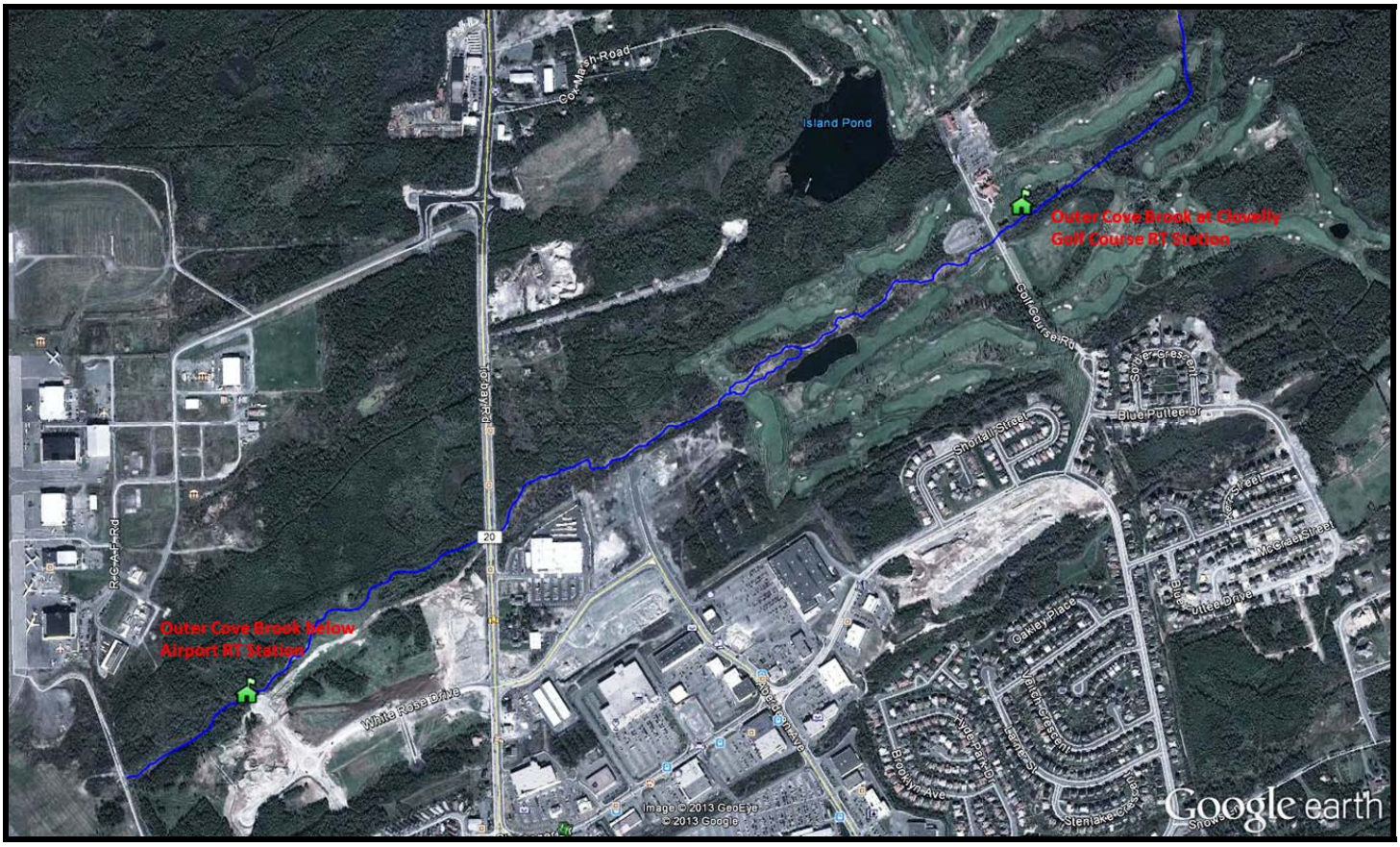


Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be 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 May 3, 2013 through to June 4, 2013 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport May 3, 2013 – June 4, 2013

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	May 3 2013	Deployment	Good	Excellent	Fair	Excellent	Excellent
	June 4 2013	Removal	Good	Fair	Poor	Poor	Poor

- At the Outer Cove Brook below Airport station at the point of deployment, the turbidity, pH and dissolved oxygen sensors ranked 'excellent' while temperature ranked 'good'. The conductivity sensor ranked 'fair', likely due to the QA/QC sonde or field sonde reading being taken before the probe had stabilized or sediments being resuspended between the QAQC and field readings.

- At removal, temperature ranked as 'good'. pH ranked as 'fair' while conductivity, dissolved oxygen and turbidity ranked as 'poor', as was to be expected after observing a constant rise in turbidity values over the month, reaching the maximum and error value of 3000#, indicative of sensor blockage. When the sonde was removed, heavy growth of a brown 'fur-like' slime substance again coated the sonde casing and the sensors, as in the previous deployment periods.

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of May 3, 2013 through to June 4, 2013 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course May 3, 2013 – June 4, 2013

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	May 3 2013	Deployment	Good	Excellent	Good	Excellent	Good
	June 4 2013	Removal	Excellent	Excellent	Good	Good	Poor

- During the Outer Cove Brook Clovelly Golf Course station deployment, all sensors ranked 'excellent' or 'good' when compared to the freshly calibrated QA/QC sonde.

- At removal, temperature and pH ranked 'excellent', while conductivity and dissolved oxygen ranked 'good'. The turbidity sensor ranked as 'poor', as was expected after the values jumped around constantly during the deployment. Analysis of the turbidity data at this site shows that biofouling is an issue. The presence of grass wrapped around the turbidity sensor indicates the tall grasses growing in this area are an issue, and may be what caused the turbidity wiper to stop working, as was noticed during the calibration attempt after removal. This sonde will now undergo performance testing.

- 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 were no transmission errors during this deployment period at either the below airport station or the Clovelly Golf Course station.
- At the end of this deployment period, the prolific 'slime' substance first noted on April 9th was still present in the river, and thus would have affected the sensors during deployment, in particular DO and turbidity.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from May 3 to June 4, 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 4.5°C to 16.4°C during this deployment period (Figure 2).
- Water temperatures rise when air temperatures are warm, and fall again when ambient air temperatures decrease. A notable decrease in water and air temperature occurred May 15-20th (Figure 2) due to a 'cold snap'.
- 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.

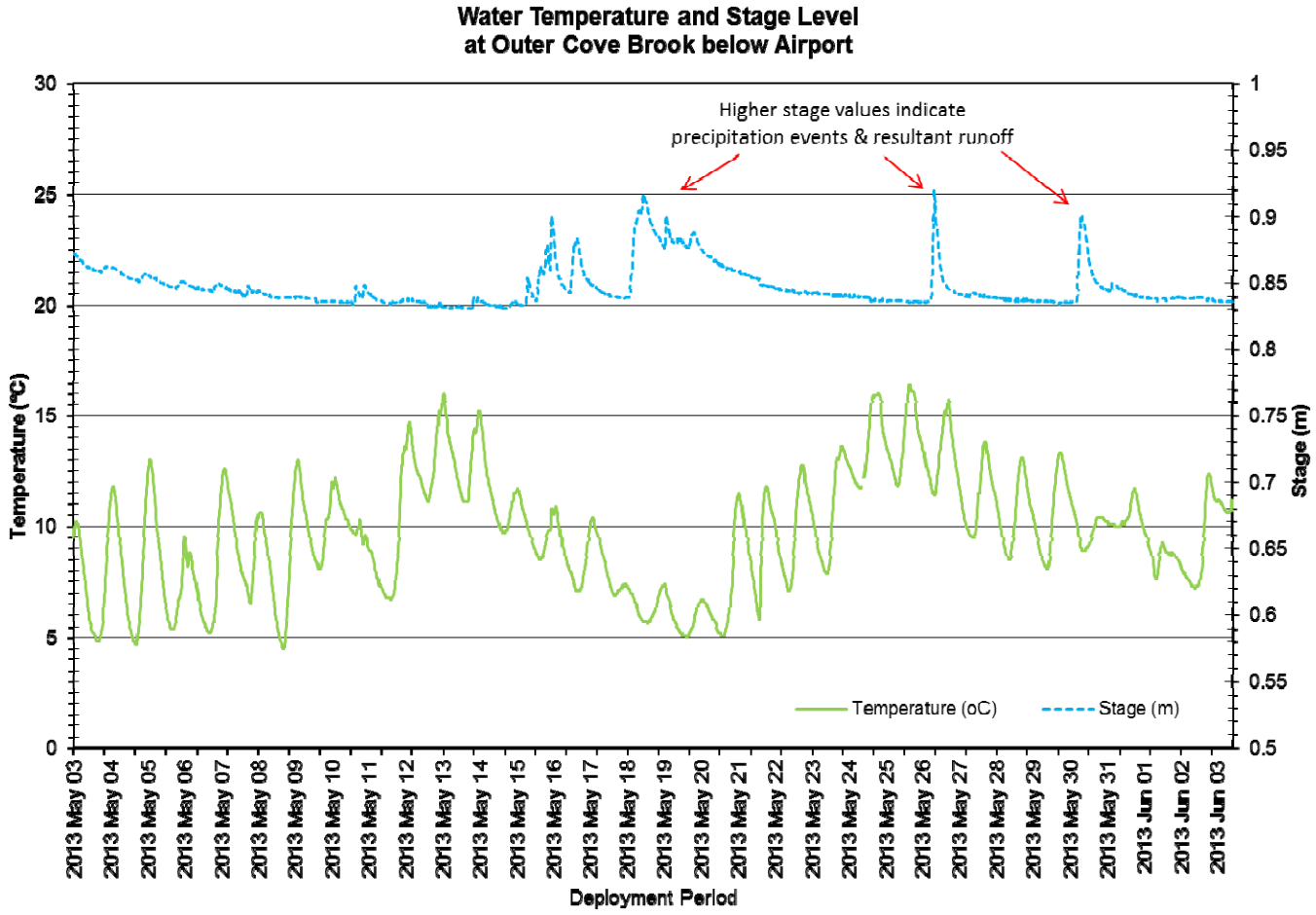


Figure 2: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport for the deployment period May 3, 2013 to June 4, 2013.

pH

- Throughout this deployment period pH values ranged between 6.22 pH units and 6.82 pH units (Figure 3). The maximum value is lower than the maximum values from previous months (7.02; 7.29; 7.34)
- During the deployment, the pH values decreased constantly over time, dropping below the minimum CCME Guideline for the Protection of Aquatic Life during the last two weeks of deployment. There is a notable drop in pH on May 19, related to a precipitation event (Figure 3). This is a natural occurrence between rainfall and pH levels. The pH stays low after this precipitation event, compared to the beginning of the deployment period.
- 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.

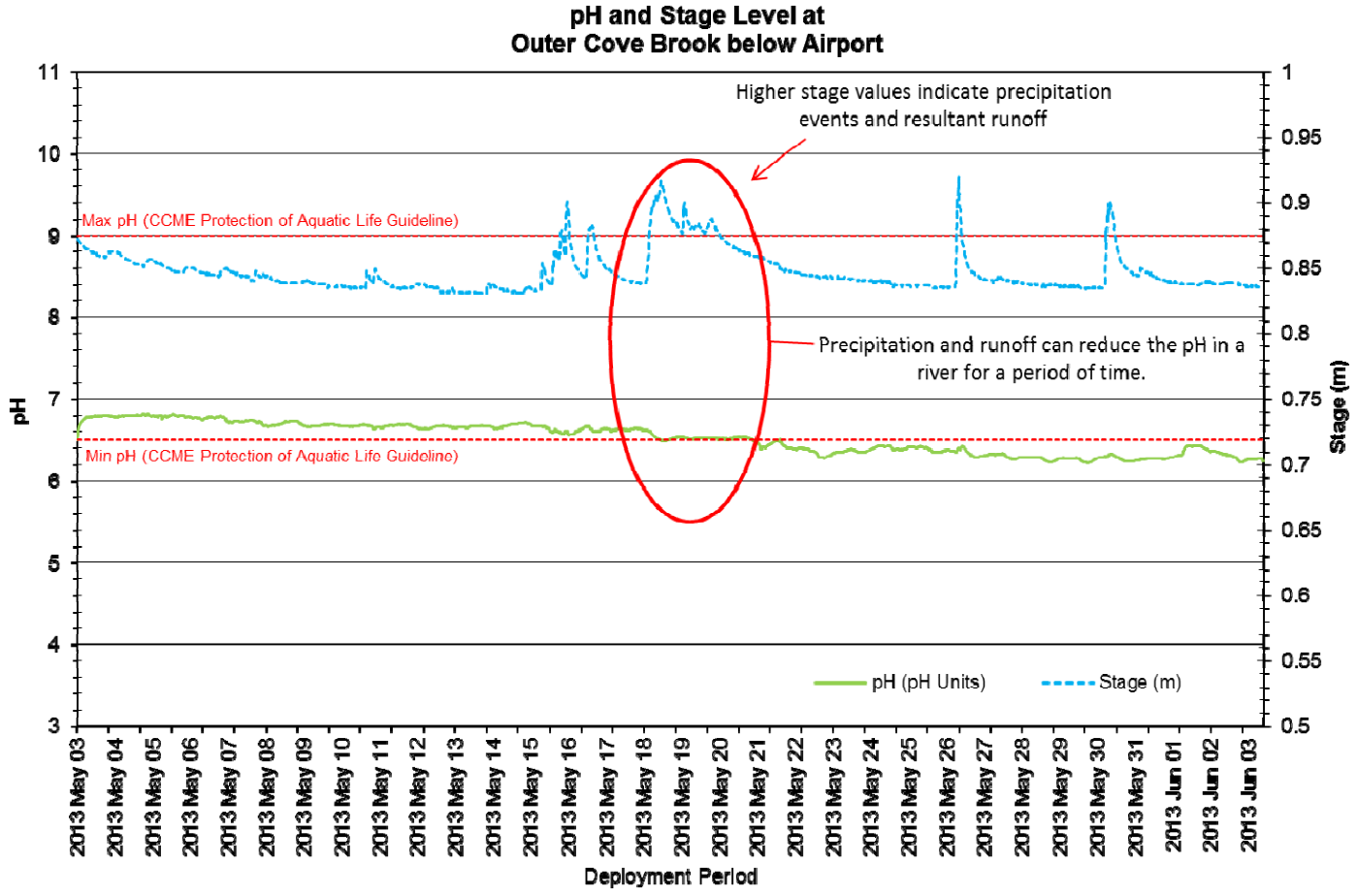


Figure 3: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook below Airport for the deployment period May 3, 2013 to June 4, 2013.

Specific Conductivity & TDS

- The conductivity levels were within 305 µS/cm and 492 µS/cm during this deployment period. TDS ranged from 0.1950 g/L to 0.3150 g/L.
- Generally, rainfall events, such as that which occurred on May 26 (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 algothrim that utilizes the data from specific conductivity and water temperature to produce a TDS value and generally always mirrors specific conductivity.

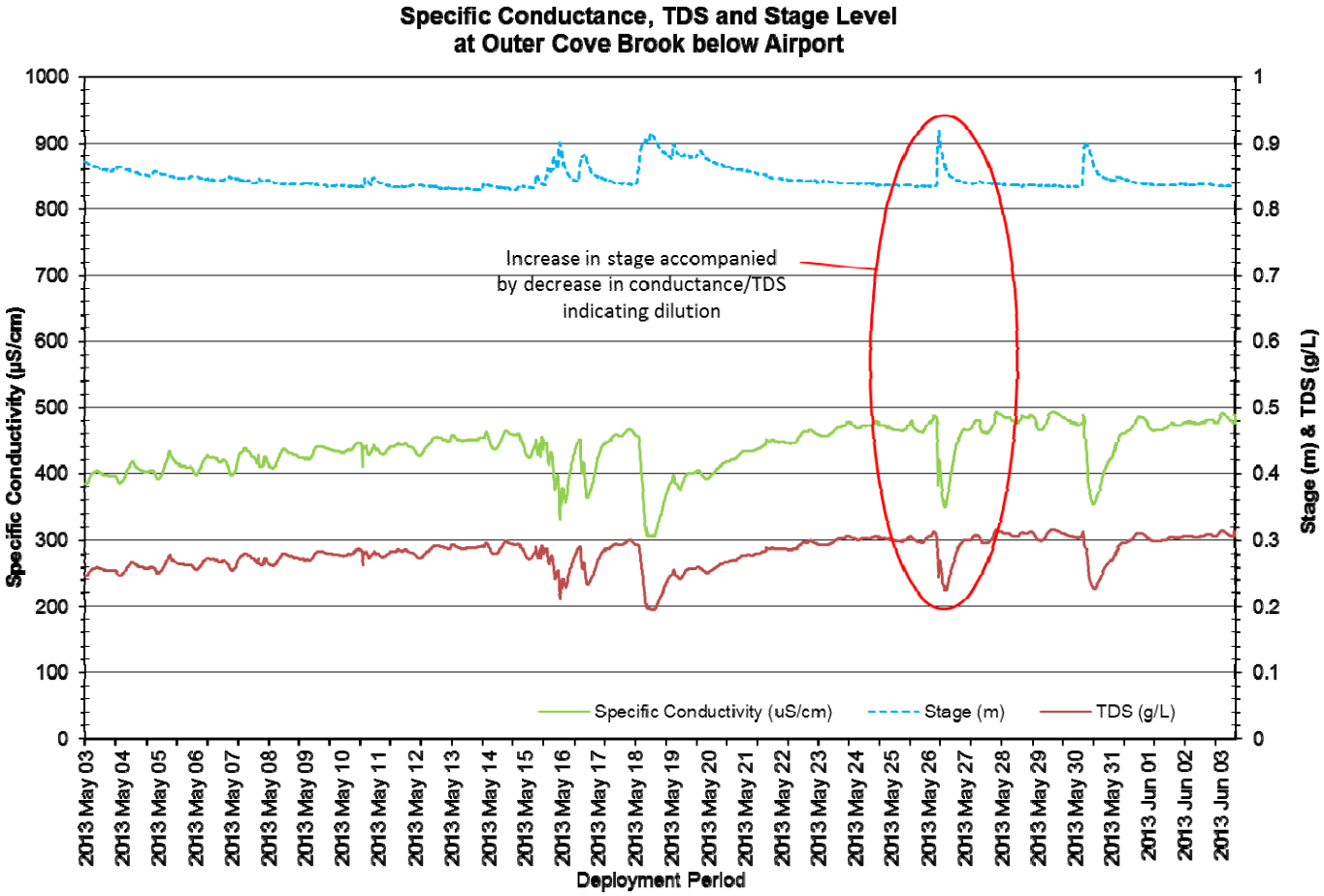


Figure 4: Quarter-hourly specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport for the deployment period May 3, 2013 to June 4, 2013.

Dissolved Oxygen

- The instrument measures dissolved oxygen (mg/L) then calculates percent saturation.
- During this deployment, DO values were inaccurate due to the presence of a large amount of brown 'slime' thickly coating the instrument (Figure 5), which led to DO values which did not reflect the actual oxygen content of the water. This caused the 'poor' sensor performance ranking upon removal, as only the QA/QC reading was an accurate reflection of the DO in the water. As this field data was inaccurate, it will be removed from the dataset for the duration of the deployment.

Figure 5: Thick brown 'slime' growth covering river bottom at deployment location.

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.
- Turbidity readings during this deployment period were inaccurate due to the large amount of brown 'slime' which quickly attached to the sonde casing after deployment, blocking the turbidity sensor and giving inaccurate water quality values. This biofouling is what caused the 'poor' performance ranking at removal. Methods to combat this biofouling will be investigated.

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 6) 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 0.83m to 0.92m. There was very low flow during sonde removal.

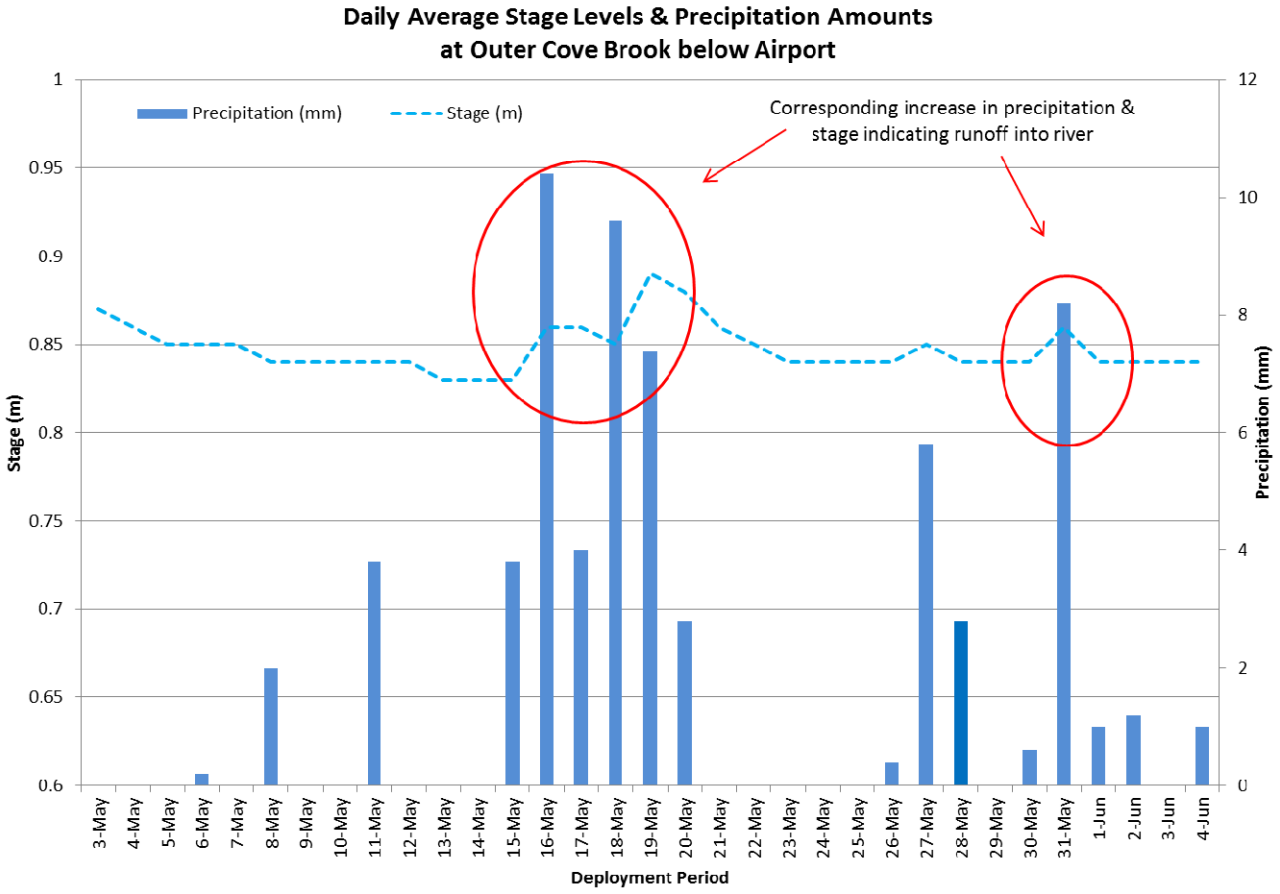


Figure 6: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period May 3, 2013 to June 4, 2013.

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 increases).
- Precipitation events during the deployment period led to related fluctuations in stage, which thus influenced the values of pH, specific conductance, and TDS.
- Due to the presence of a thick coating of 'slime' covering the sonde, the turbidity and DO sensors yielded inaccurate data, which was consequently removed from the dataset. The presence of this thick biofouling growth may impact other water quality parameters, but to a lesser extent.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from 4.79°C to 18.87°C during this deployment period (Figure 7).
- Water temperatures rise when air temperatures are warm, and fall again when ambient air temperatures decrease. A notable decrease in water and air temperature occurred May 15-20th (Figure 7) due to a 'cold snap'.
- 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.

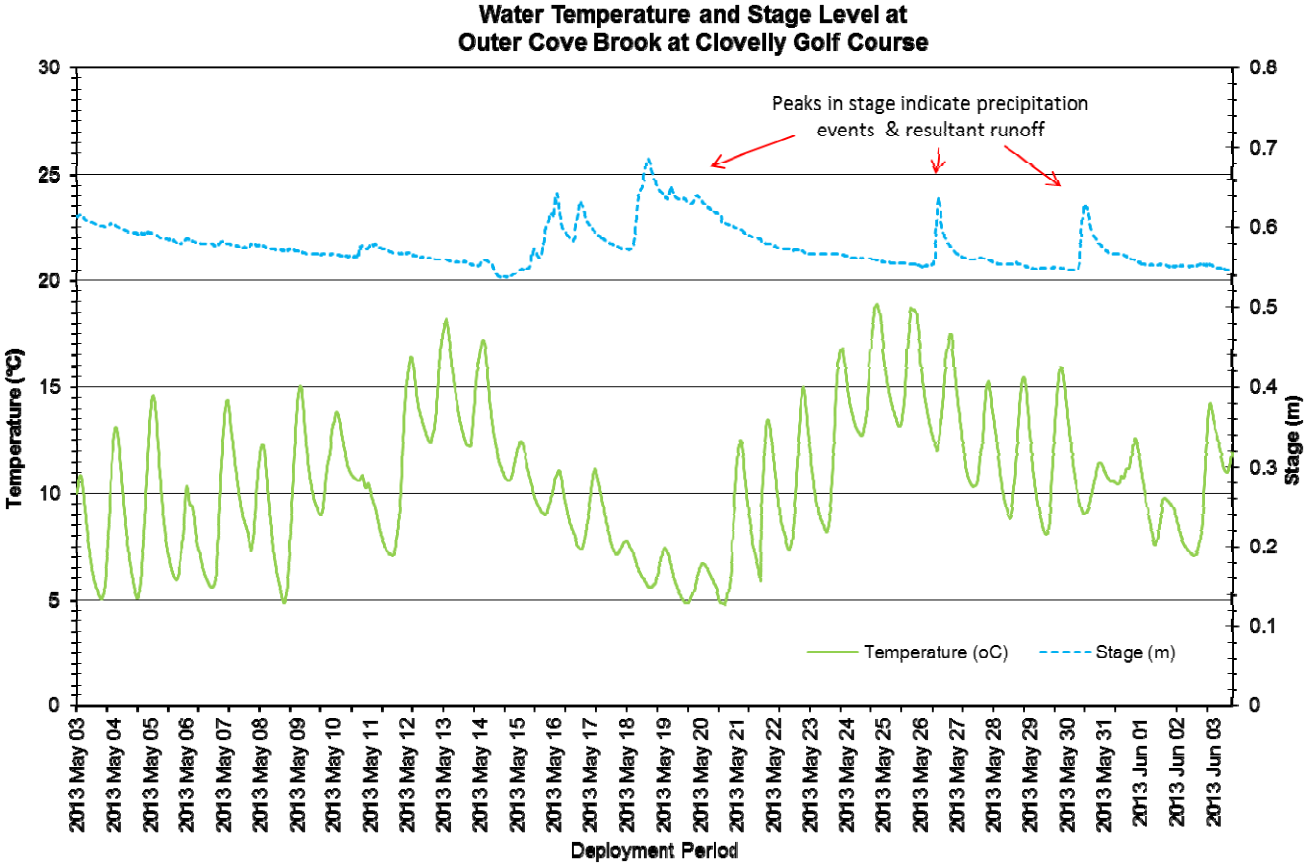


Figure 7: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period May 3, 2013 to June 4, 2013.

pH

- Throughout this deployment period pH values ranged between 6.40 pH units and 6.80 pH units (Figure 8).
- During the deployment, the pH values at this station hover around the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) dipping below occasionally after precipitation events.
- There are notable drops in pH on May 21 and May 31, 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.

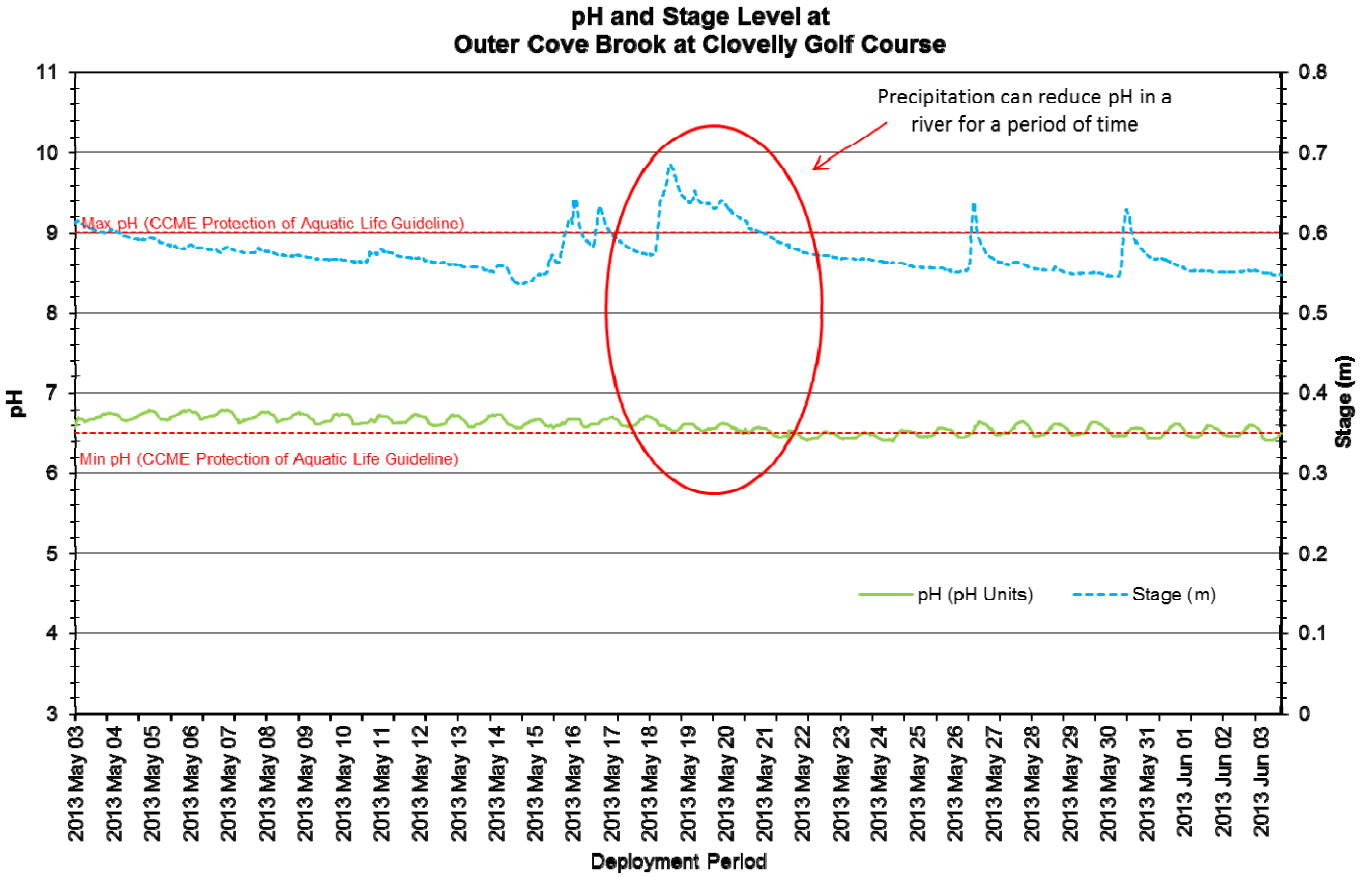


Figure 8: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period May 3, 2013 to June 4, 2013.

Specific Conductivity & TDS

- The conductivity levels were within 305 µS/cm and 522 µS/cm during this deployment period. TDS ranged from 0.1950 g/L to 0.3340 g/L.
- Generally, rainfall events, such as that which occurred on May 18th (see Figure 9), 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.
- There is a significant spike in conductivity and TDS on May 11th, accompanied by a small increase in stage. This increase was not evident at the below airport station, indicating some possible input or disturbance in the river at this time between the two stations which may have led to resuspension of solids and salts. This river has been under investigation by Environment Canada, and this spike may result from disturbance due to sampling upstream or near the station. Other possible causes of the river disturbance include construction occurring upstream and ATV usage cutting through the river.
- Total Dissolved Solids (TDS), is a parameter that the instrument calculates by an algothrim that utilizes the data from specific conductivity and water temperature to produce a TDS value and generally always mirrors specific conductivity.

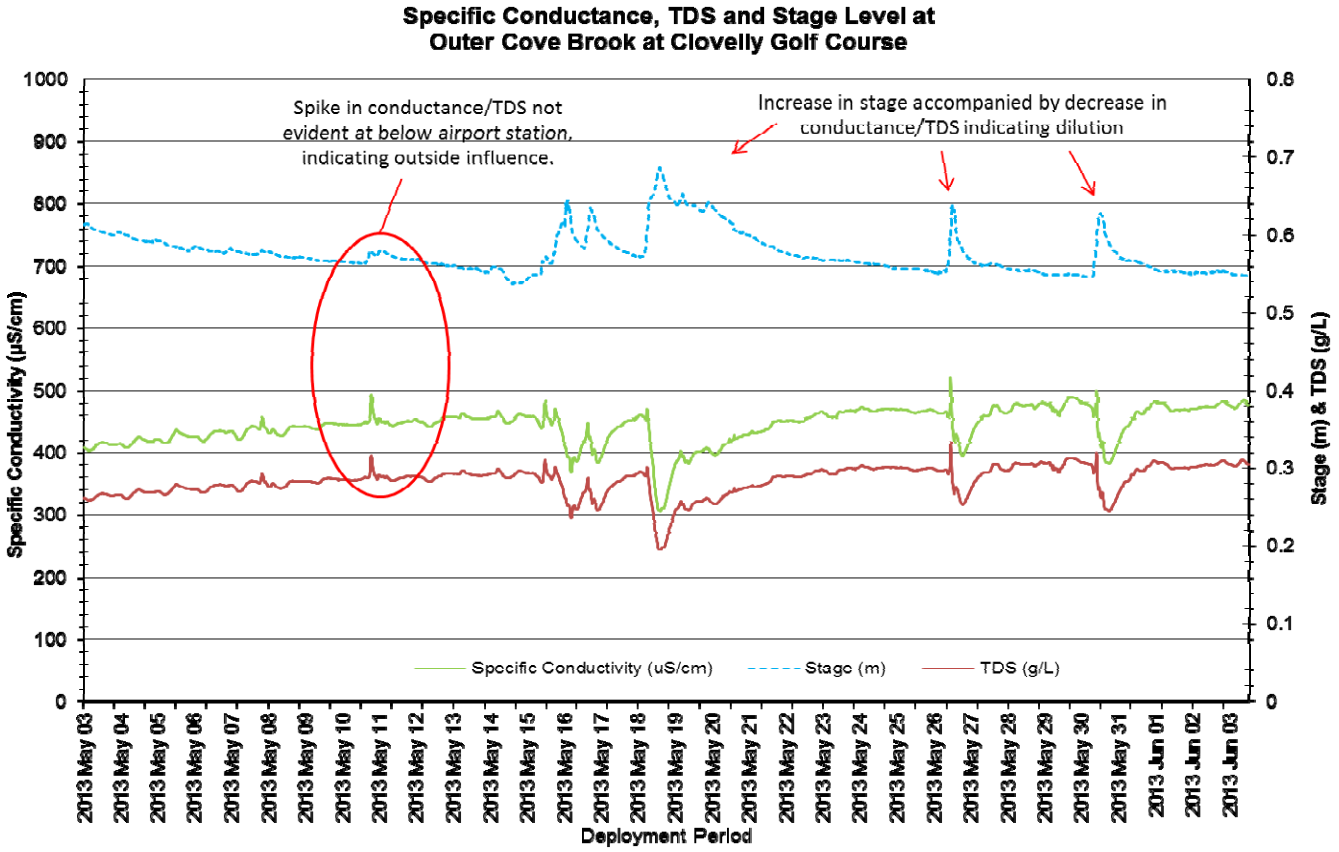


Figure 9: Quarter-hourly specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period May 3, 2013 to June 4, 2013.

Dissolved Oxygen

- The instrument measures dissolved oxygen (mg/L) then calculates percent saturation.
- The Dissolved Oxygen % Sat levels within this deployment period were within 57.4% Sat–99.0% Sat. Dissolved Oxygen (mg/L) measured 6.07 mg/L to 10.90 mg/L. The DO mg/L values hover around the minimum DO CCME guideline for early life stages, varying in relation to water temperature. Notably, the water temperature decrease May 15-20 resulted in an increase in DO mg/L during this period (Figure 10).
- Large fluctuations in DO values between day and night are due to the presence of vast amounts of algae and grass at the deployment site, which can only produce oxygen during daylight hours.
- 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.

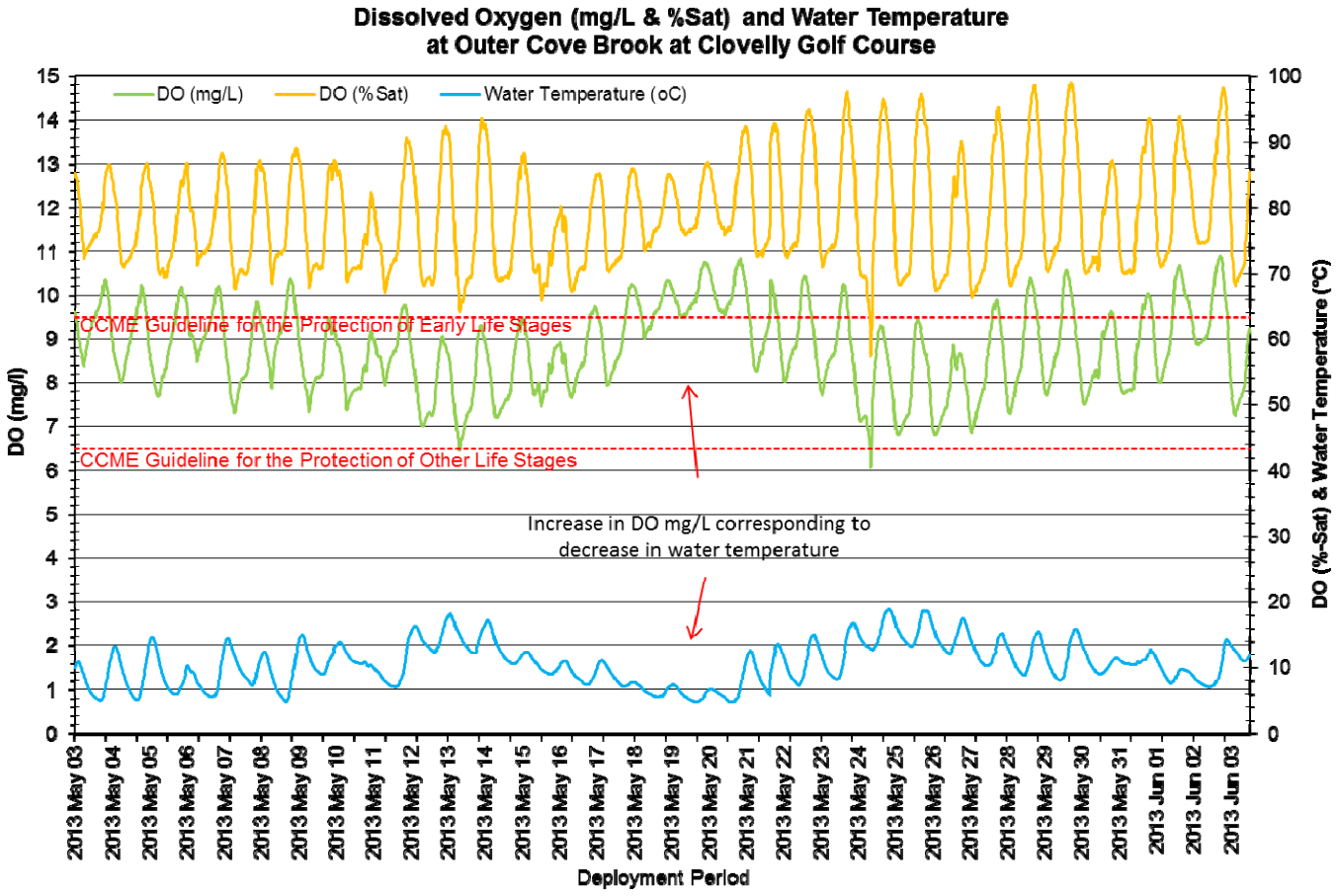


Figure 10: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook at Clovelly Golf Course for the deployment period May 3, 2013 to June 4, 2013.

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, this is not a valid turbidity reading.
- During this deployment, the turbidity sensor did not function properly, likely due to long grass wrapping around the turbidity wiper, which then could not remove any biofouling or debris from the sensor, thus providing erroneous data, which has been removed from the dataset.
- As this instrument was not functioning properly during removal, the sonde will undergo repairs during June, and will be replaced by another fully functional sonde for the next deployment period.

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 11).
- 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 0.54m to 0.69m.

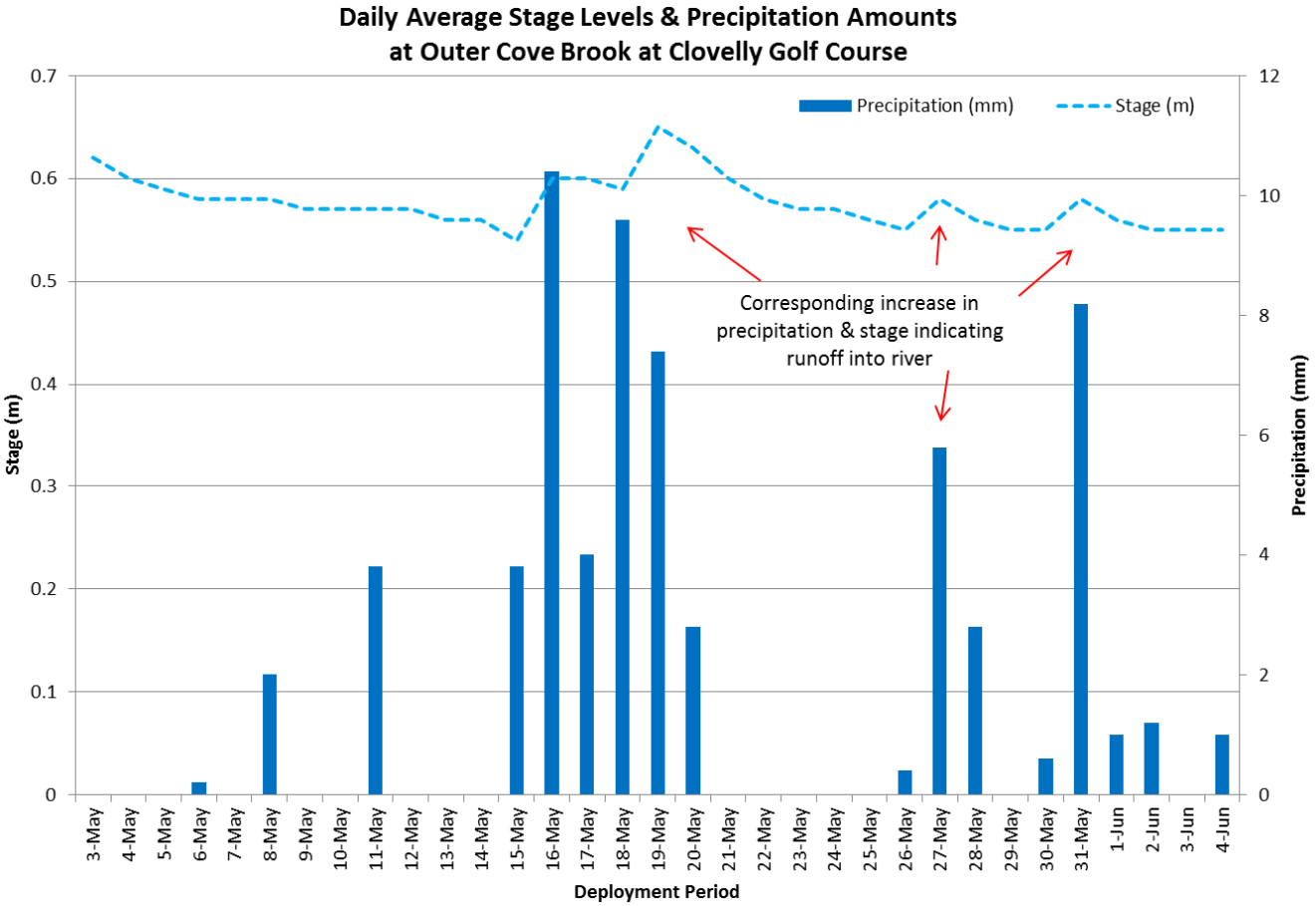


Figure 11: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period May 3 to June 4, 2013.

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 pH, specific conductance, and TDS. As ambient air temperatures warm up, in turn the amount of dissolved oxygen in the water decreases.
- High turbidity values at removal and a 'poor' sensor ranking along with erratic values during deployment are explained by the presence of a layer of brownish slime coating the sensors and the presence of long strands of aquatic grass around the sonde which likely interfered with the readings.
- Dissolved oxygen levels at this station fluctuate greatly between day and night, with lowest values occurring consistently at night, indicating a diurnal pattern. It is likely that the large amount of aquatic grass and brown algae at this station is unable to produce oxygen without sunlight through the process of photosynthesis, and thus oxygen is replenished only during daylight hours.

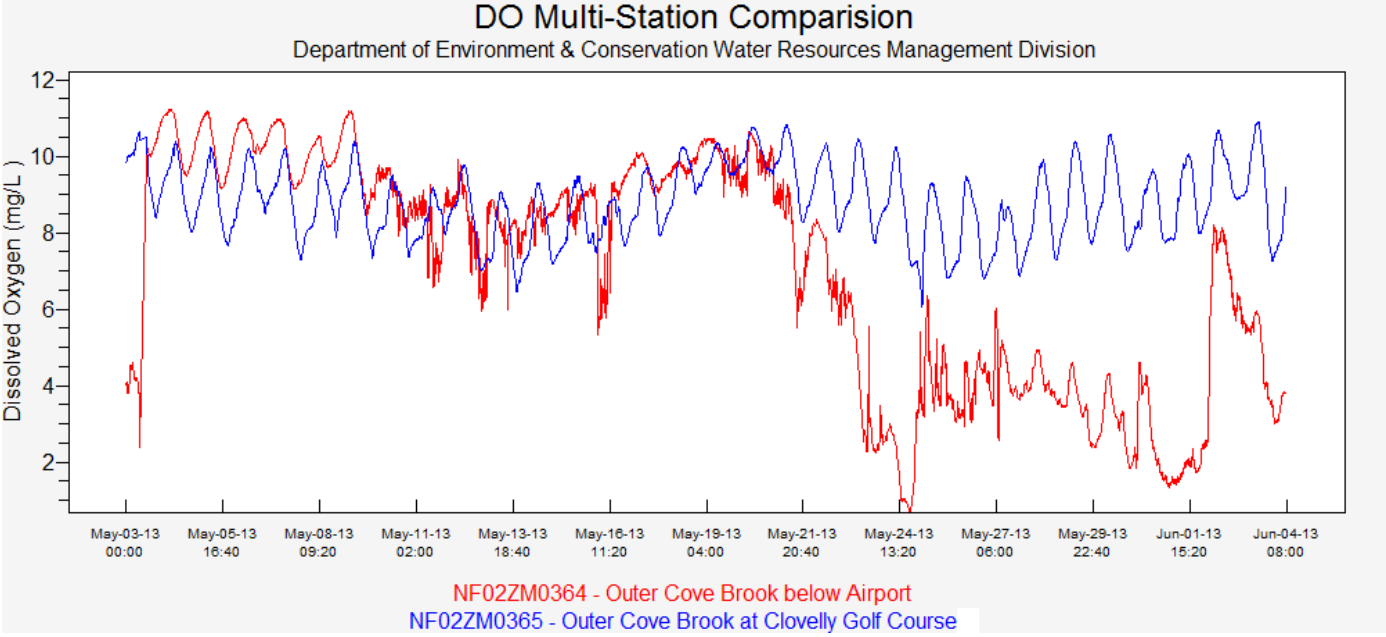
Conclusions – Outer Cove Brook Network

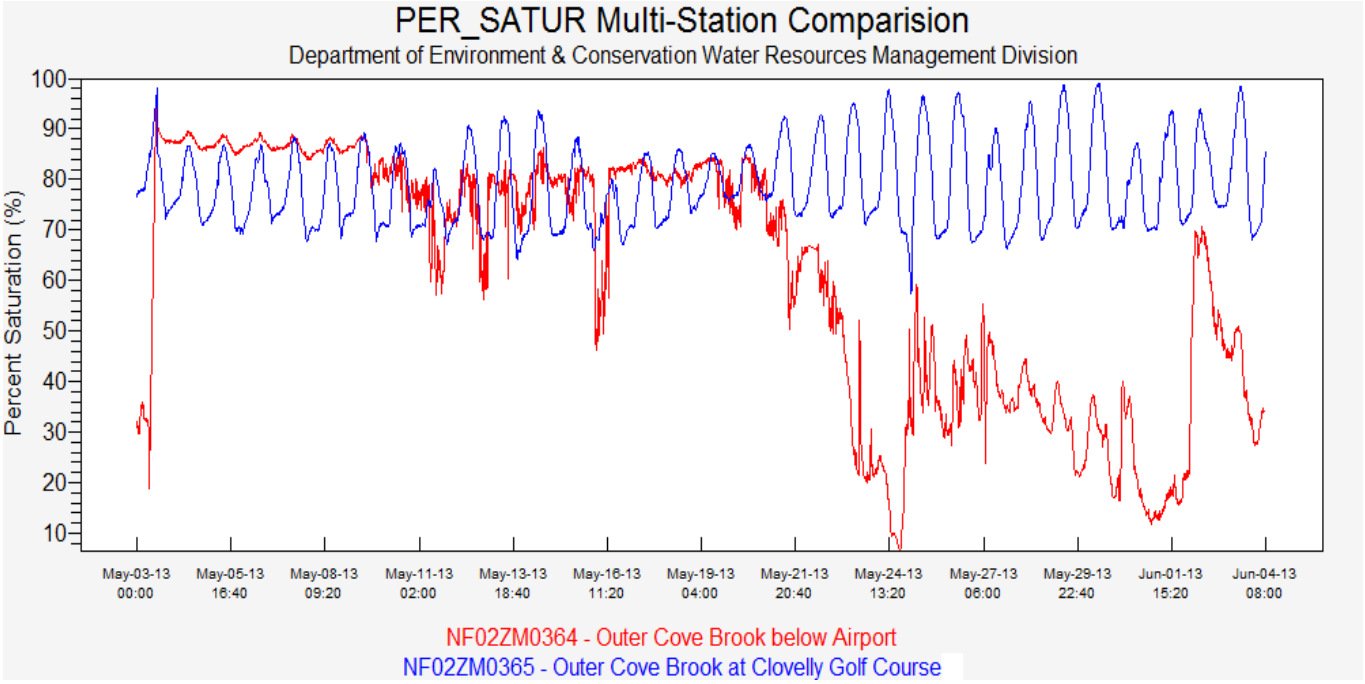
During this deployment period, the median water temperature at the upstream station (below Airport) of 9.80°C was very similar to that of the downstream station (at Clovelly Golf Course) of 10.50°C. The median pH values for both were also comparable with below Airport's median at 6.53 and Clovelly Golf Course reading 6.60, and thus no significant change in pH from the upstream to the downstream station. The specific conductivity medians were similar at both stations with 442 uS/cm reported below the airport and 449 uS/cm reported at the golf course. These values are approximately 100 uS/cm higher than during the previous deployment period. The highest value of 522 uS/cm occurred at Clovelly Golf Course. Comparisons of dissolved oxygen (% Sat and mg/L) could not be made as the data associated with these parameters at the below airport station were erroneous. The median dissolved oxygen values at Clovelly Golf Course were 76.9 % Sat and 8.79 mg/L. Issues with turbidity sensors at both stations (biofouling and sensor failure) prevent comparisons of this data between stations. The appendix provides further information as well as a visual comparison of all raw data collected at both stations.

Appendix

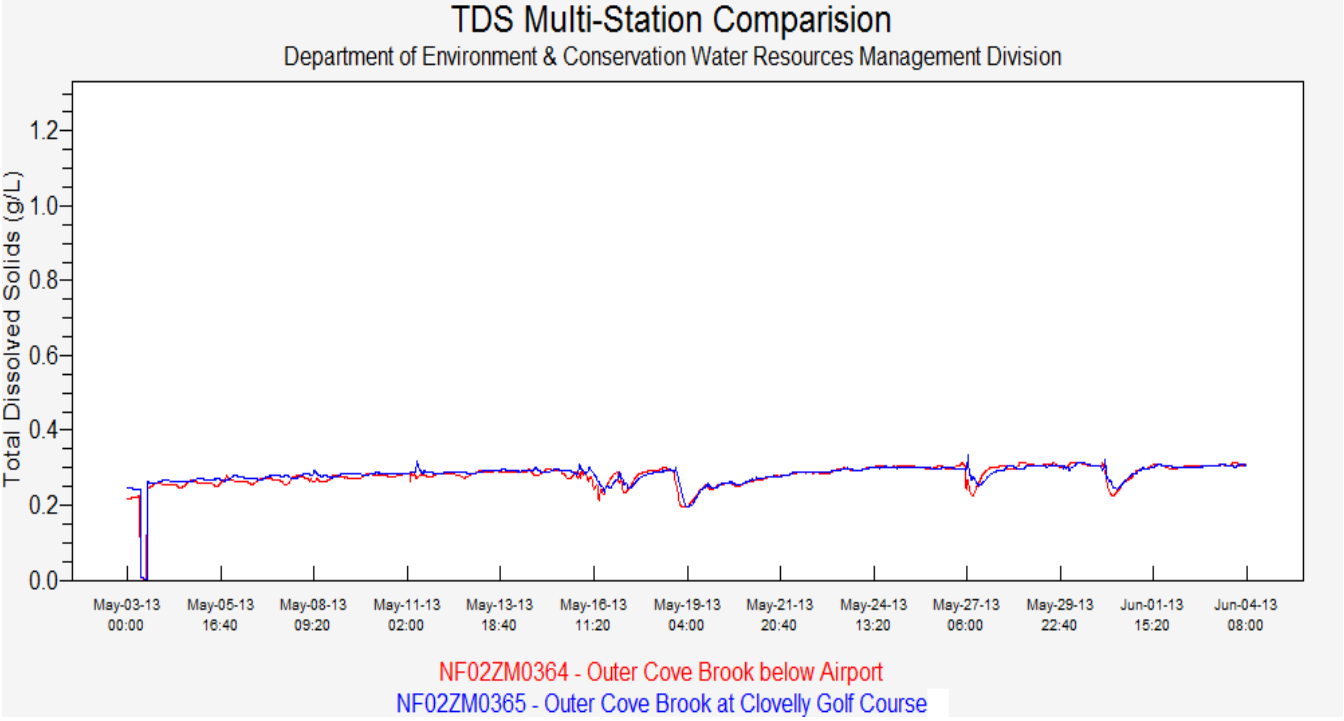
Parameter Station Comparison Graphs

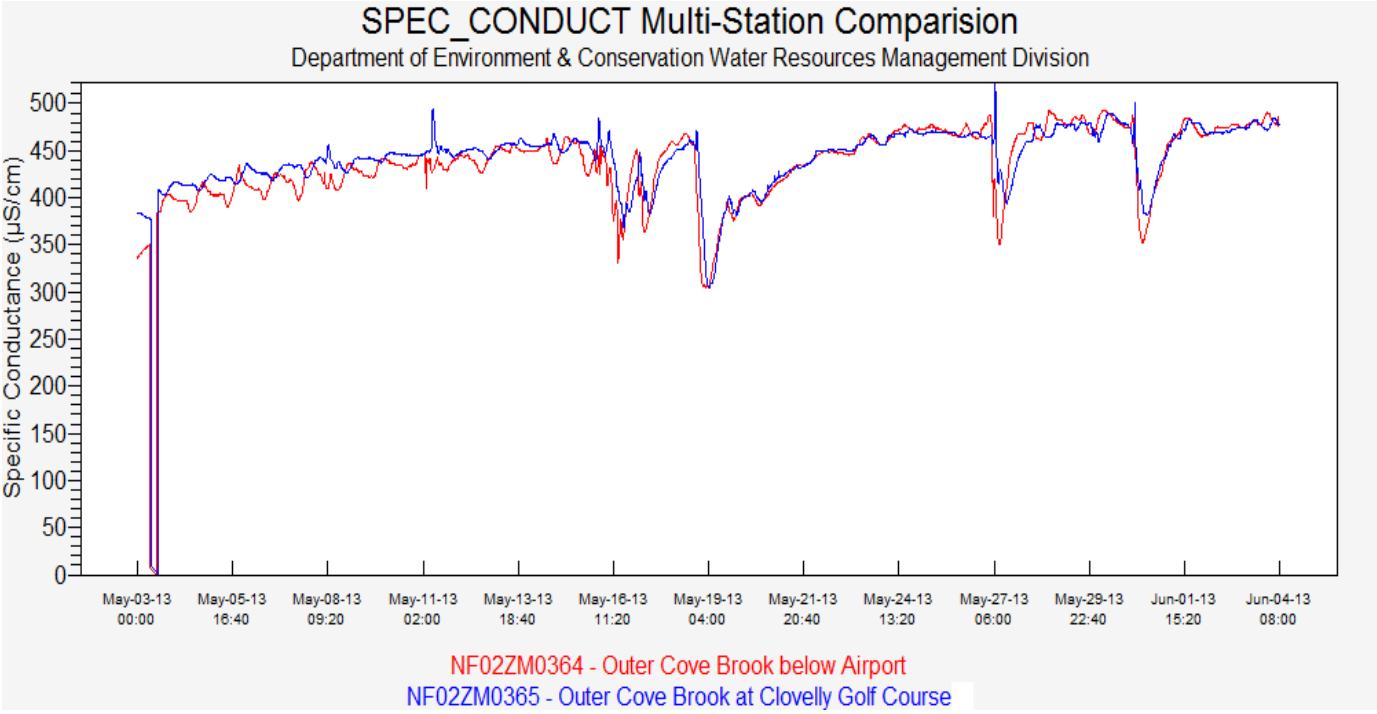
***Note: These graphs include erroneous data which will be removed from the dataset.**



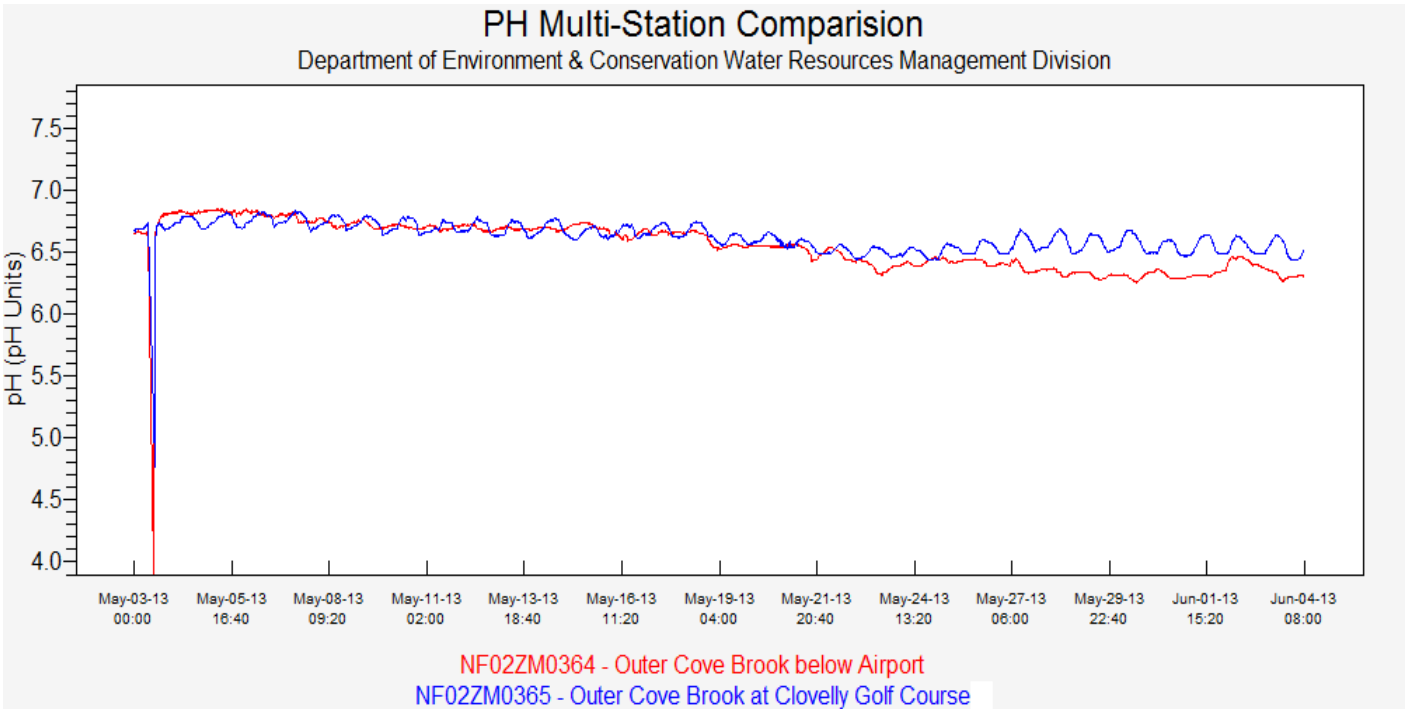


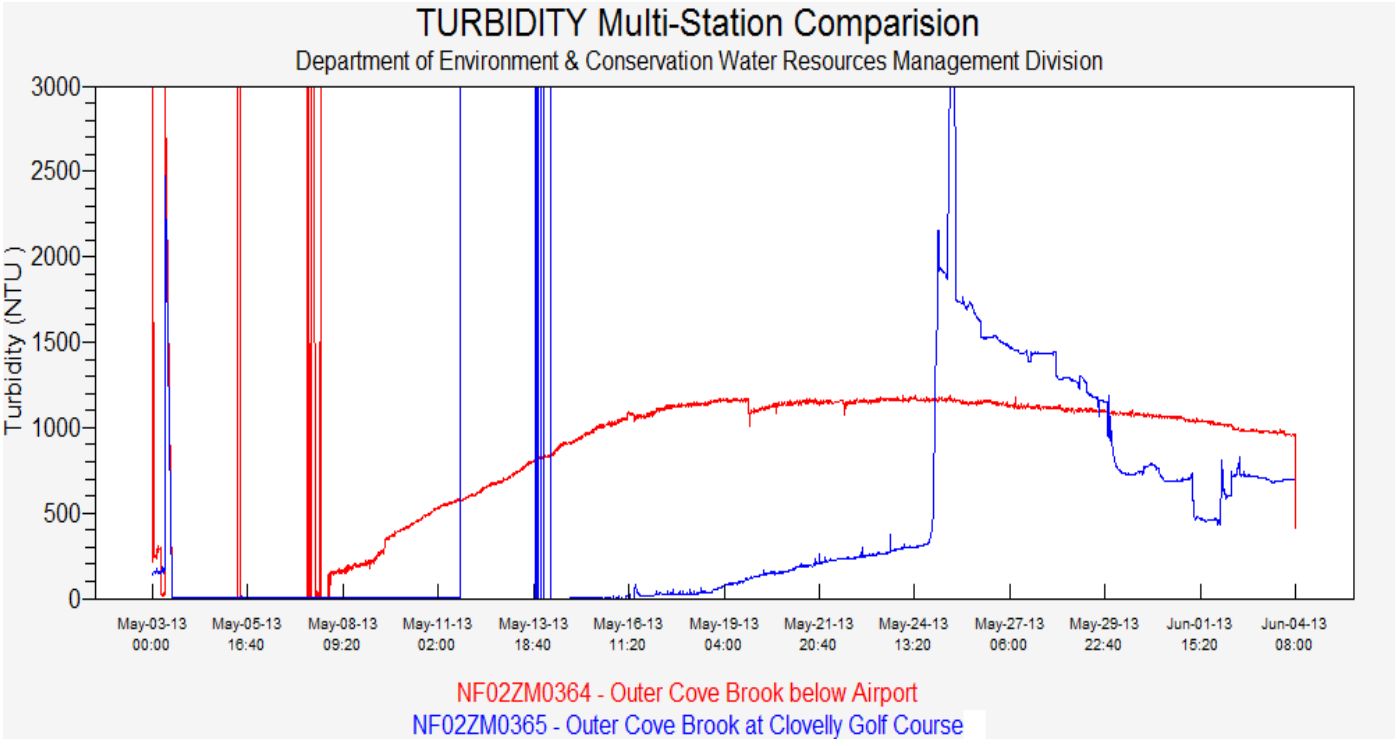
Outer Cove Brook, Newfoundland and Labrador





Outer Cove Brook, Newfoundland and Labrador





Outer Cove Brook, Newfoundland and Labrador