Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
February 5 to March 6, 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 February 5, 2013 until removal on March 6, 2013.

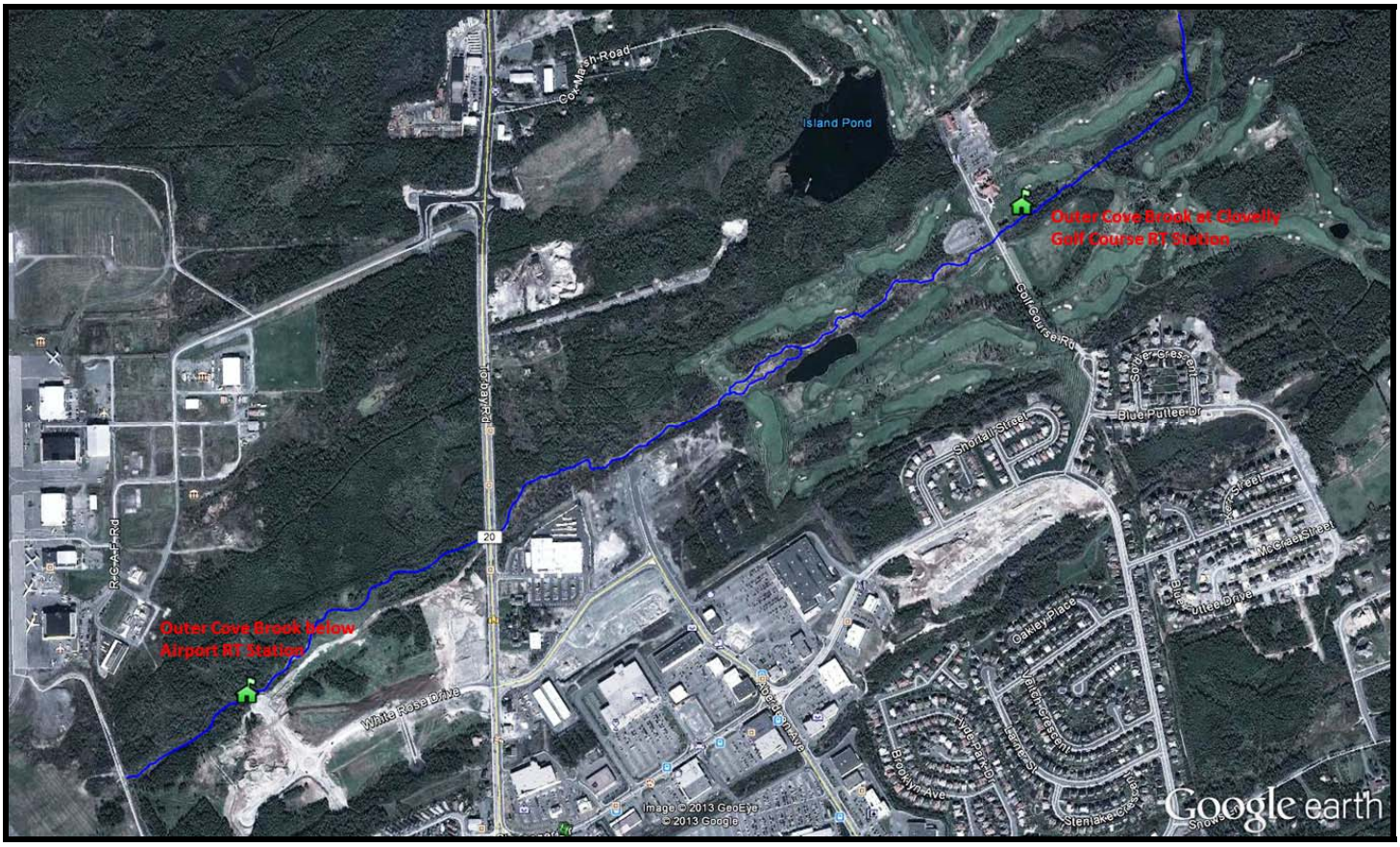

Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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

	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 February 5, 2013 through to March 6, 2013 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport Feb. 5, 2013 – Mar. 6, 2013

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	Dec 7 2012	Deployment	Good	Excellent	Good	Excellent	Excellent
	Jan 8 2013	Removal	Excellent	Fair	Excellent	Excellent	Poor

- At the Outer Cove Brook below Airport station at the point of deployment, all sensors ranked 'good' to 'excellent'. Overall, the data being produced was reliable and accurate at the start of deployment.

- At removal, temperature, conductivity and dissolved oxygen ranked as 'excellent'. The pH sensor ranked as 'fair', indicating that the QA/QC readings may have been taken before the sensor stabilized in the cold environment as the QA/QC reading was lower than expected for this river. The turbidity sensor ranked as 'poor', indicating some possible sensor issues as there was little biofouling material present on the sonde at removal.

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of February 5, 2013 through to March 6, 2013 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course Feb 5, 2013 - Mar 6, 2013

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	Dec 7 2012	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Jan 8 2013	Removal	Excellent	Good	Excellent	Excellent	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, dissolved oxygen and conductivity all ranked 'excellent', while pH ranked as 'good'. The turbidity sensor ranked as 'poor', indicating that there may be an issue with this sensor as no biofouling was present on the sonde during removal. However, there was significant dead grass and debris present in the river which may have affected the sensor readings while in the sonde was in the water.

- 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

- Brief transmission errors occurred during the deployment period at both stations, resulting in data gaps in the graphs shown in this report.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from February 5 to March 6, 2013 at the Outer Cove Brook Stations.
- As the above mentioned transmission errors for the Outer Cove Brook stations were short in duration, the transmitted water quality data and its synchronous stage data were analyzed instead of the internally stored data.
- 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.

Outer Cove Brook below Airport

Water Temperature

- Water temperature ranged from -0.1°C to 3.0°C during this deployment period (Figure 2). No ice was present around the sonde or field cable during removal.
- Water temperatures fluctuate around 0°C, as expected during the winter months, and is consistent with ambient air temperatures over this time period.
- 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.

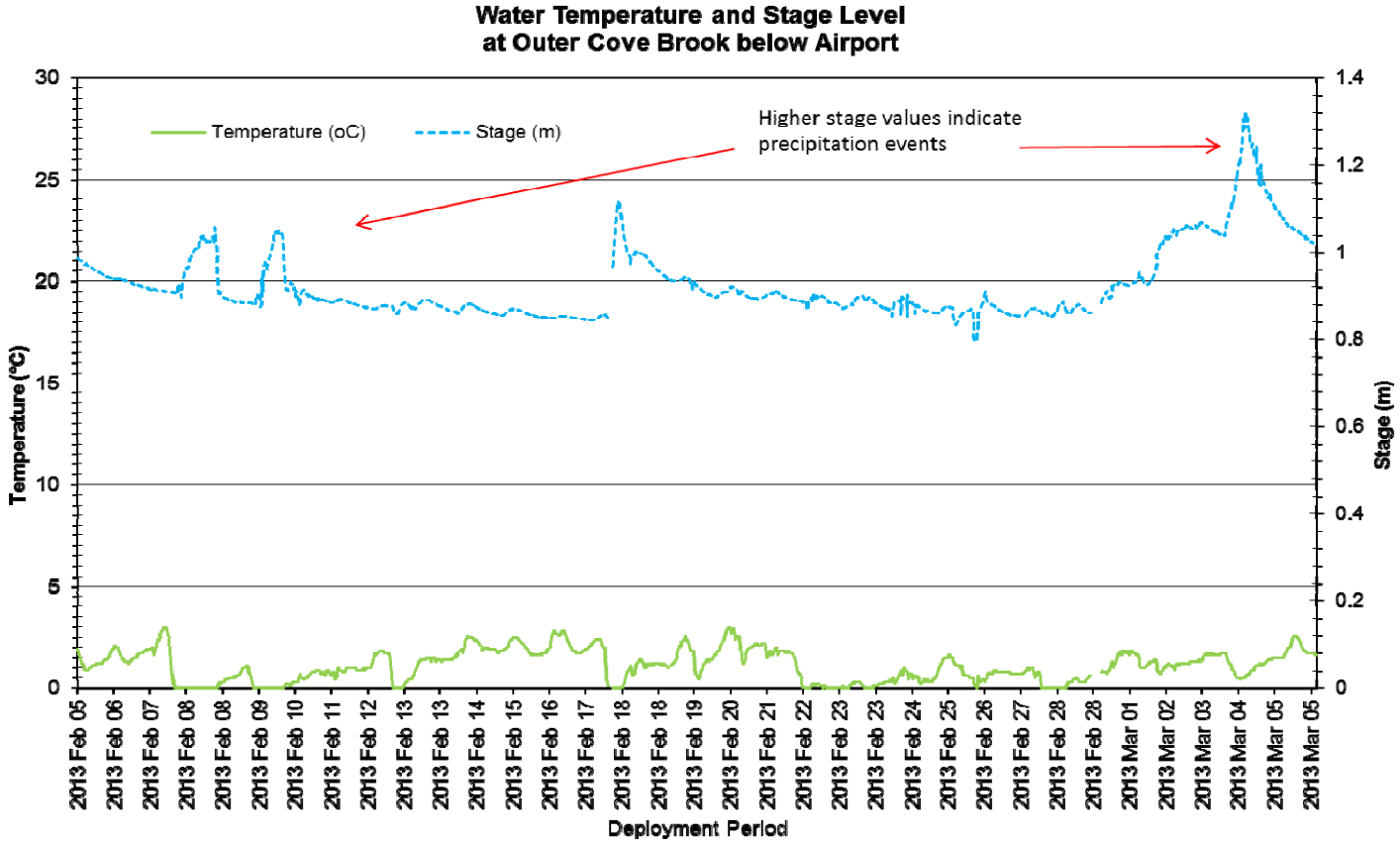

Figure 2: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport for the deployment period February 5, 2013 to March 6, 2013.

pH

- Throughout this deployment period pH values ranged between 6.06 pH units and 7.34 pH units (Figure 3).
- 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). Several precipitation events cause drops in the pH values. 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.

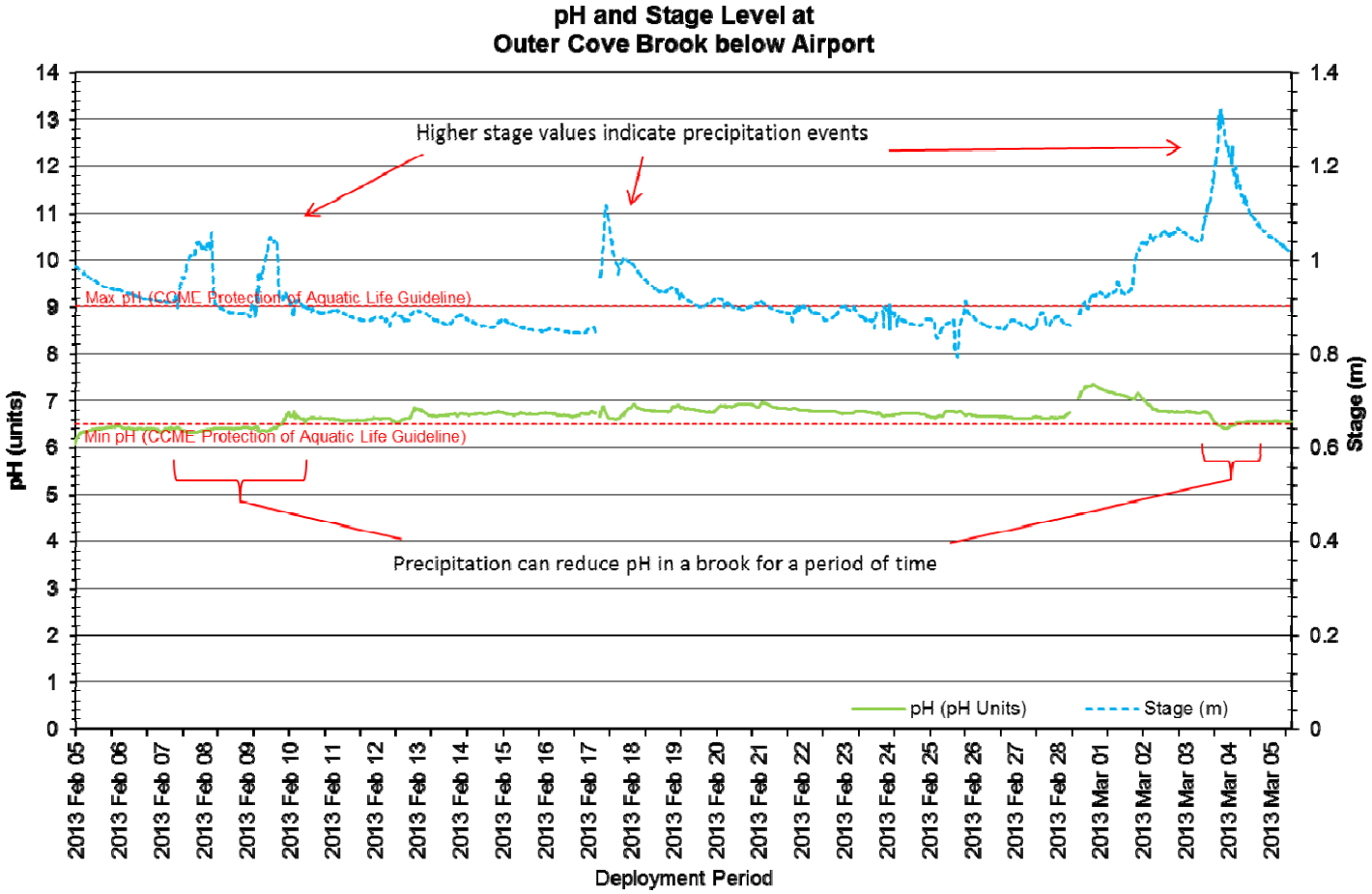

Figure 3: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook below Airport for the deployment period February 5, 2013 to March 6, 2013.

Specific Conductivity & TDS

- The conductivity levels were within 316 µS/cm and 2141 µS/cm during this deployment period. TDS ranged from 0.2020 g/L to 1.3700 g/L.
- Cold temperatures and snowfall events during winter months can have the effect of increasing conductance levels due to the addition of salt to roadways. Through wind, snowmelt and rainfall, these salts are carried into the water system, increasing the specific conductance. The increase on February 18 is in response to a February 17 snowfall event.
- Generally, rainfall events, such as that which occurred on March 4 (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.

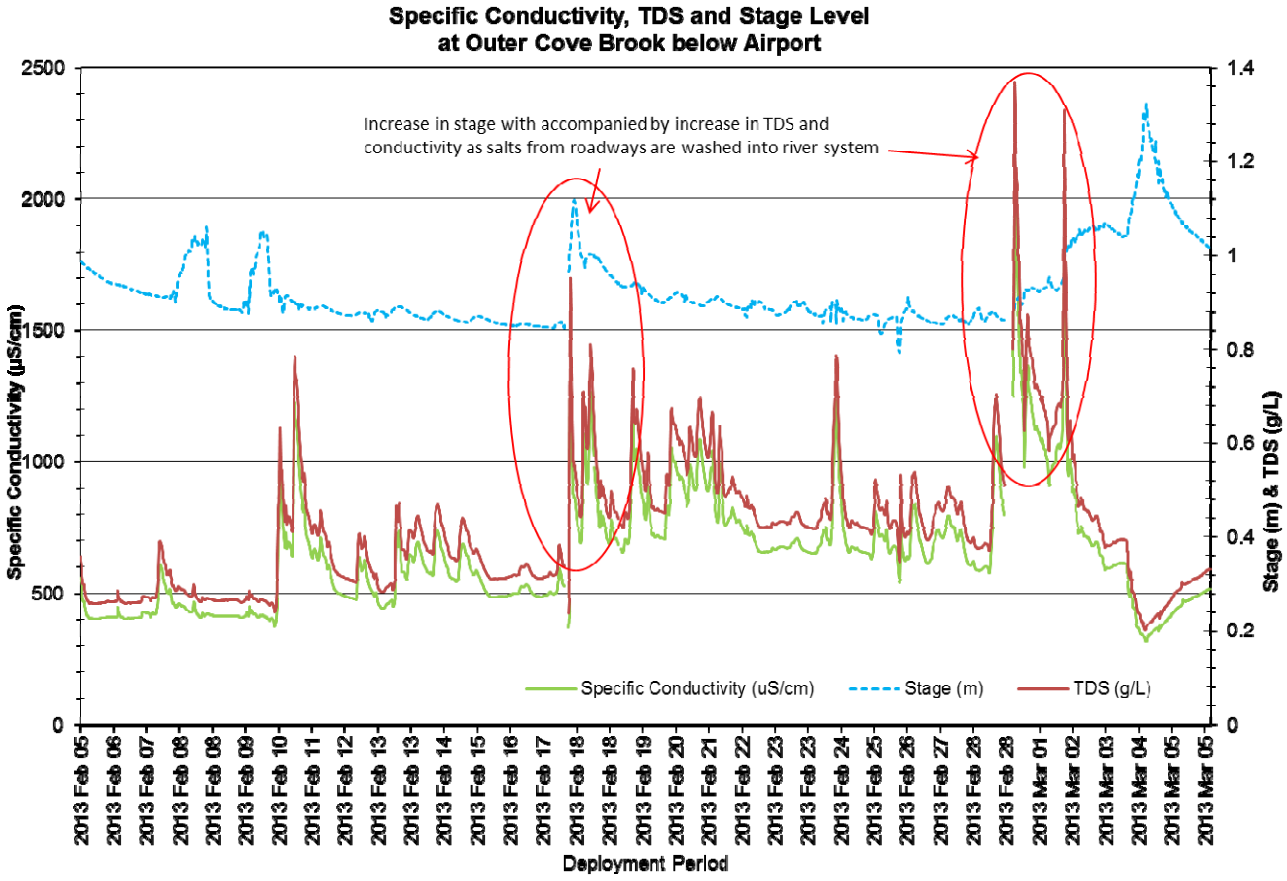

Figure 4: Quarter-hourly specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport for the deployment period February 5, 2013 to March 6, 2013.

Dissolved Oxygen

- The instrument measures percent saturation directly, then calculates dissolved oxygen (mg/L) using the percent saturation and water temperature values.
- The Dissolved Oxygen % Sat levels within this deployment period were within 80.2 % Sat–93.1% Sat. Dissolved Oxygen (mg/L) measured 11.44 mg/L to 13.42 mg/L. The DO mg/L values are above the minimum DO CCME guideline for early life stages and higher than in previous months as the colder water can hold more oxygen.
- Dissolved Oxygen percent saturation fluctuates throughout the deployment period as the presence of dissolved salts in the water influences oxygen saturation. Dissolved oxygen mg/L content fluctuates with the water temperature changes. Increases in dissolved oxygen values are inversely related to decreases in water temperature as colder water can hold more oxygen. This trend was observed during the deployment period as evident in Figure 5 on March 4, 2013.

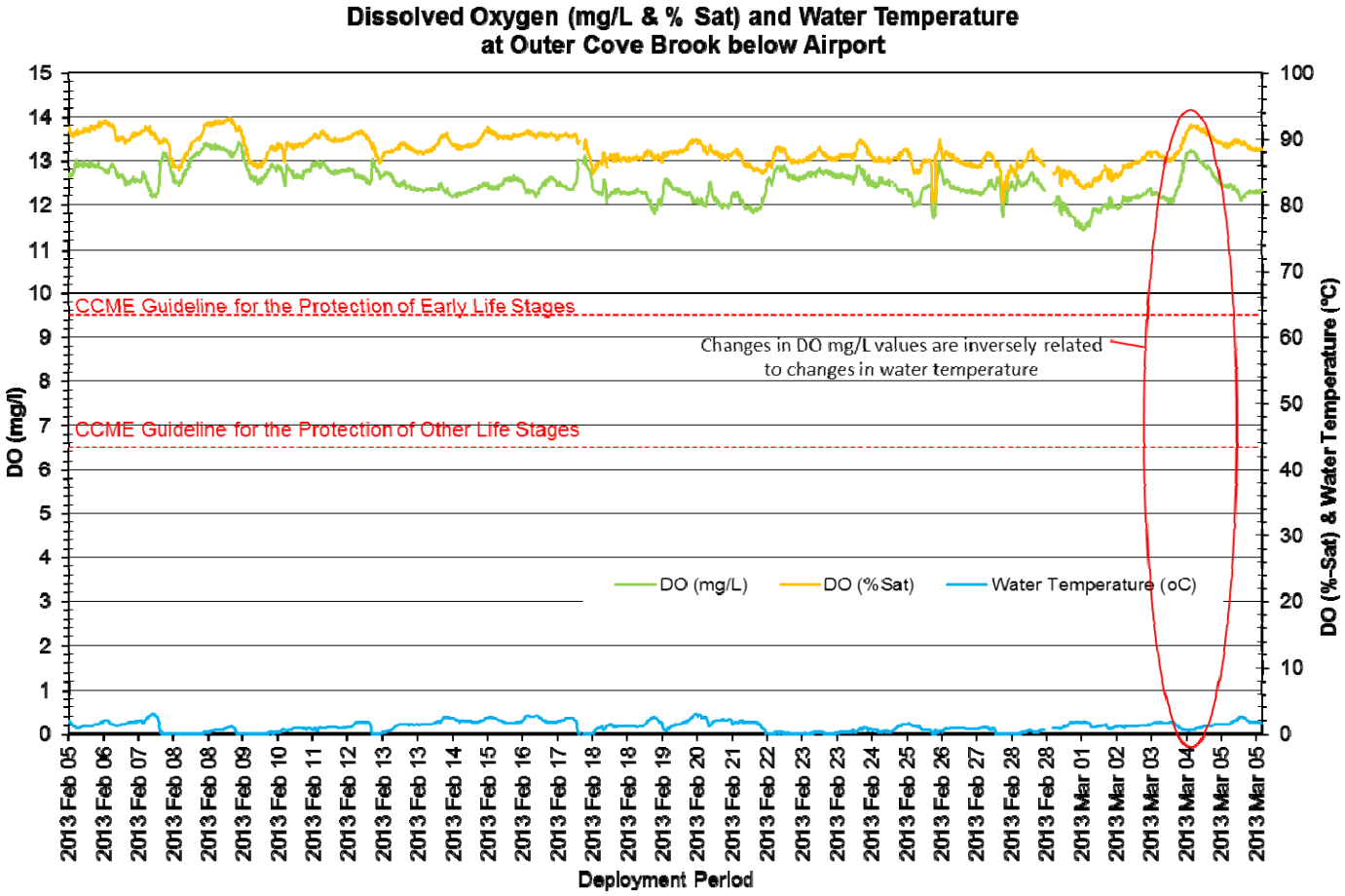

Figure 5: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport for the deployment period February 5, 2013 to March 6, 2013.

Turbidity

- Outer Cove Brook below Airport contains a significant amount of algae. High algal growth 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 NTU to 1447.0 NTU.
- 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.
- As this sensor received a 'poor' performance ranking at removal, and no biofouling or debris were present, it is likely that some sensor drift occurred during the final week of deployment.
- The data from February 28th to March 6th will be removed from the dataset as this may not be 'true data'.

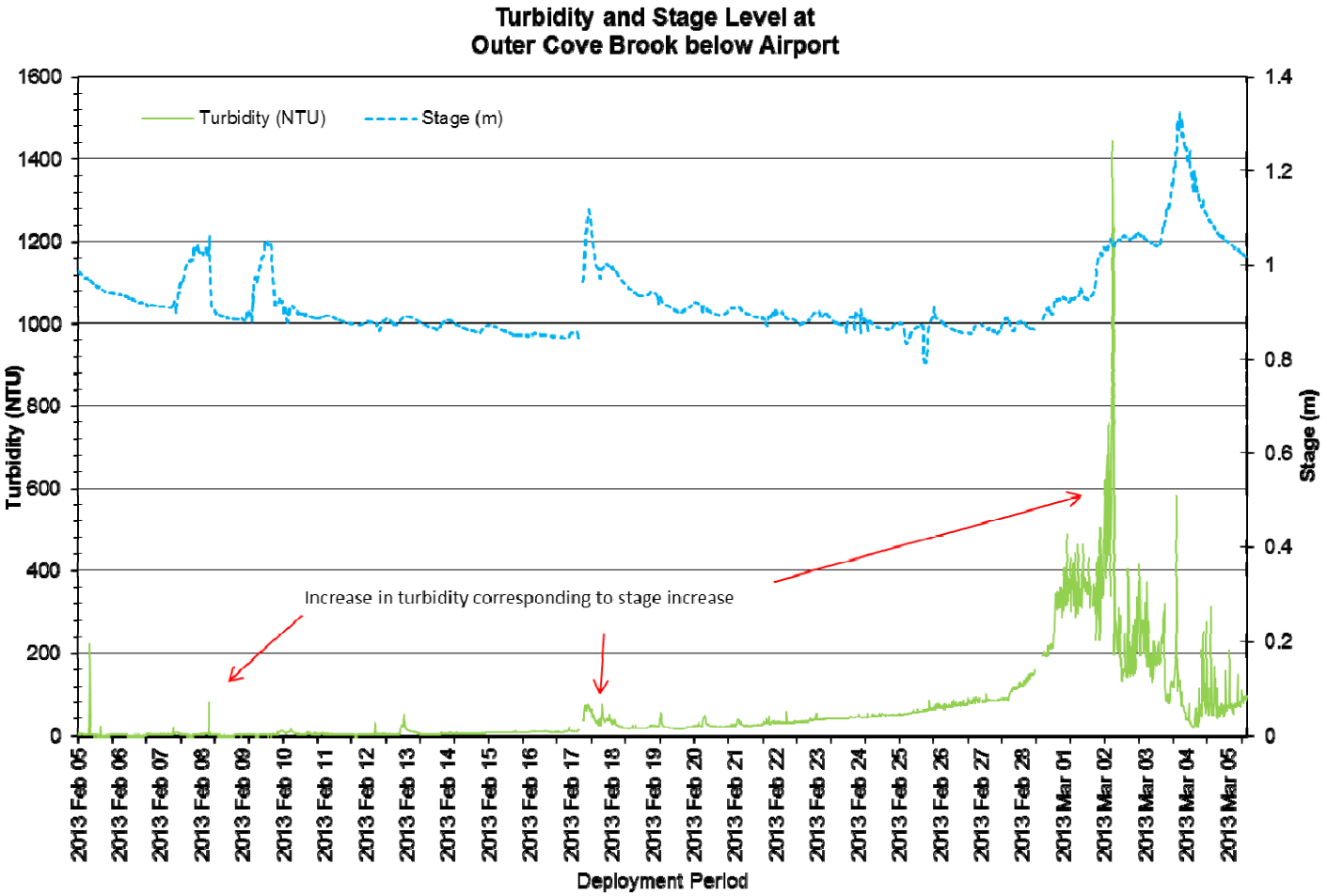

Figure 6: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport for the deployment period February 5, 2013 to March 6, 2013.

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.
- During the deployment period, the stage ranged from 0.79m to 1.32m. During sonde removal, ice was not present in the river at the monitoring station.

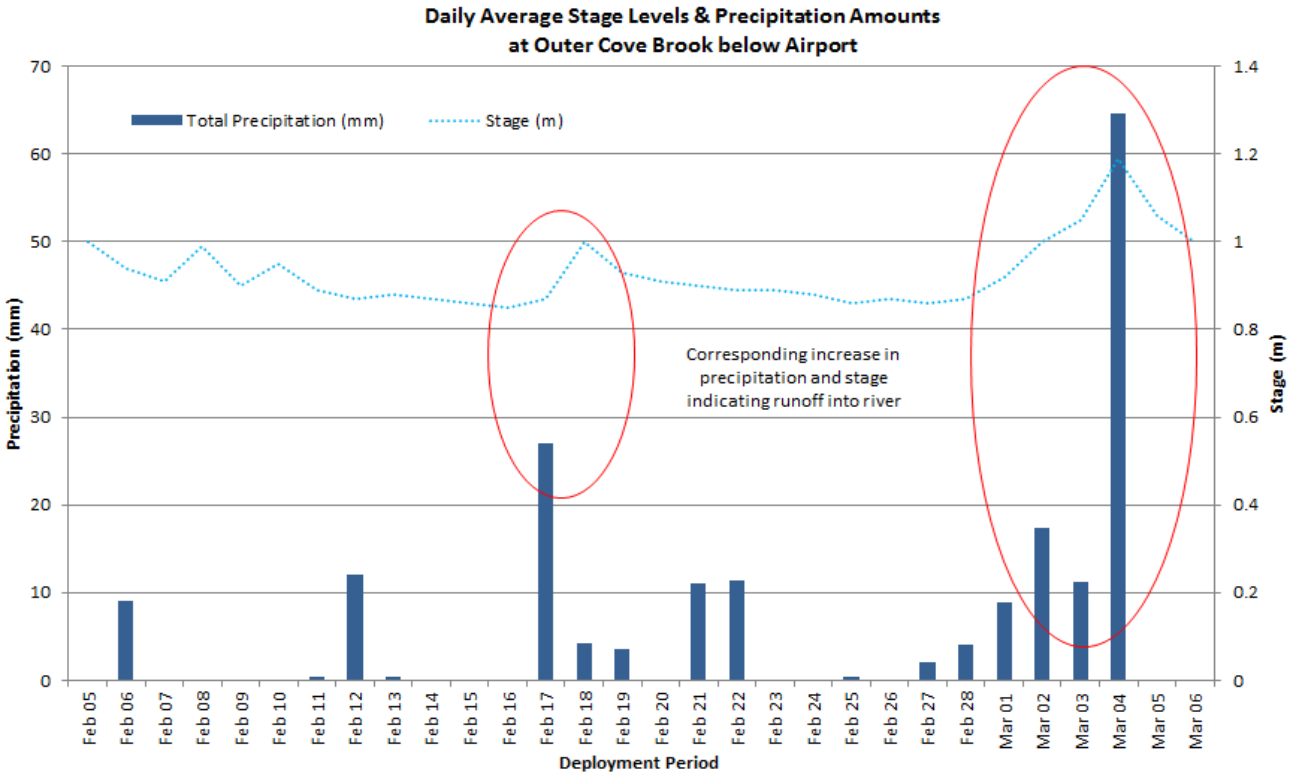

Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period February 5, 2013 to March 6, 2013.

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 were low during the winter months, there were correspondingly low water temperatures, which in turn increased the amount of dissolved oxygen in the water.
- The majority of turbidity events were correlated with increases in stage and thus precipitation events. High turbidity values at removal without the presence of debris or biofouling, and a 'poor' sensor ranking, indicate sensor drift.
- The addition of road salt to roadways and runways during periods of snowfall and low ambient air temperatures led to increases in specific conductance and TDS as the salts were washed into the river system. This indicates that this river is influenced by runoff upstream of the station.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

- Water temperature ranged from -0.04°C to 3.29°C during this deployment period (Figure 8). No ice was present around the sonde or field cable during removal.
- Water temperatures fluctuate around 0°C, as expected during the winter months, and is consistent with ambient air temperatures over this time period.
- 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.

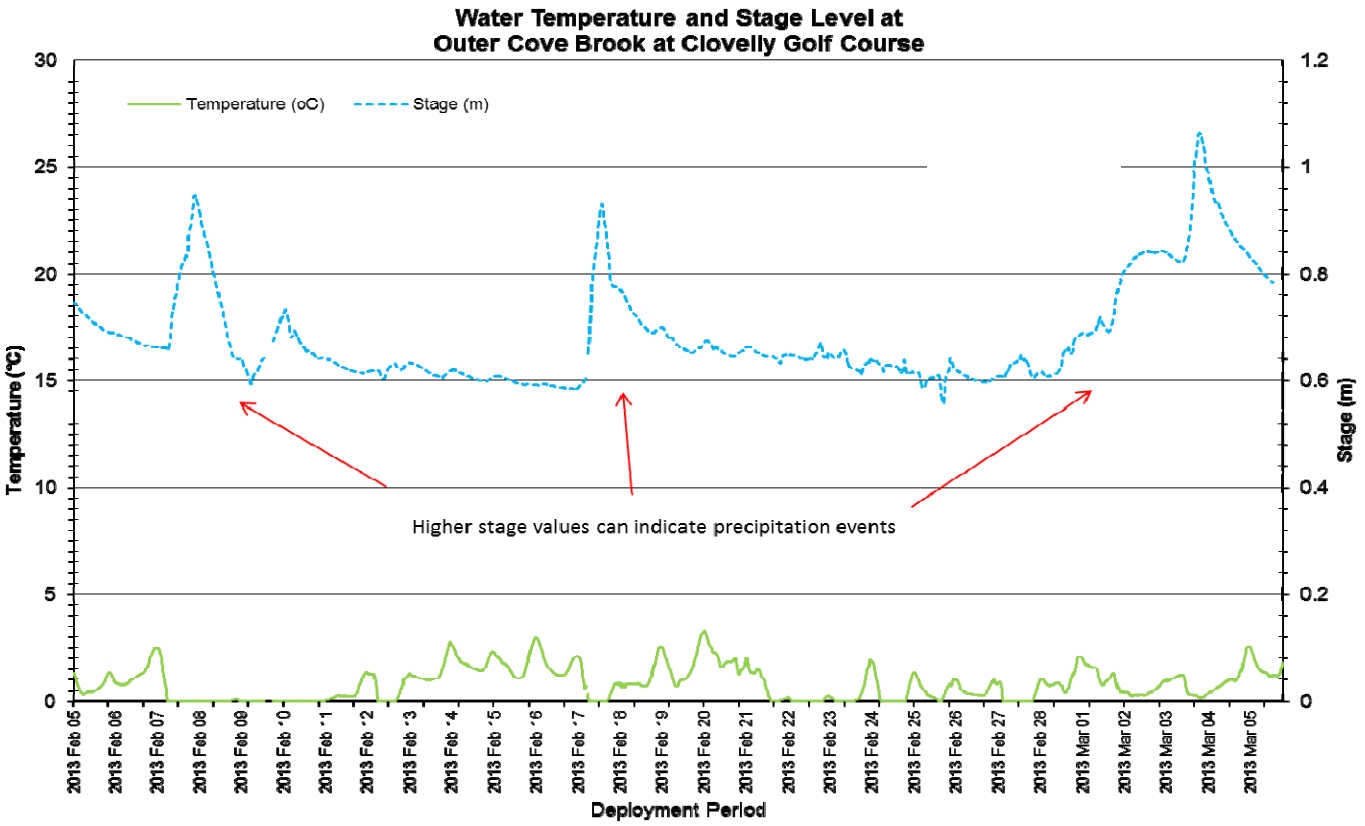

Figure 8: Quarter-hourly water temperature (°C) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period February 5 to March 6, 2013.

pH

- Throughout this deployment period pH values ranged between 6.22 pH units and 7.22 pH units (Figure 9).
- During deployment, the pH values hover just above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units), only falling below as precipitation events increase the stage level, resulting in lower pH values. This is a natural occurrence between precipitation 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.

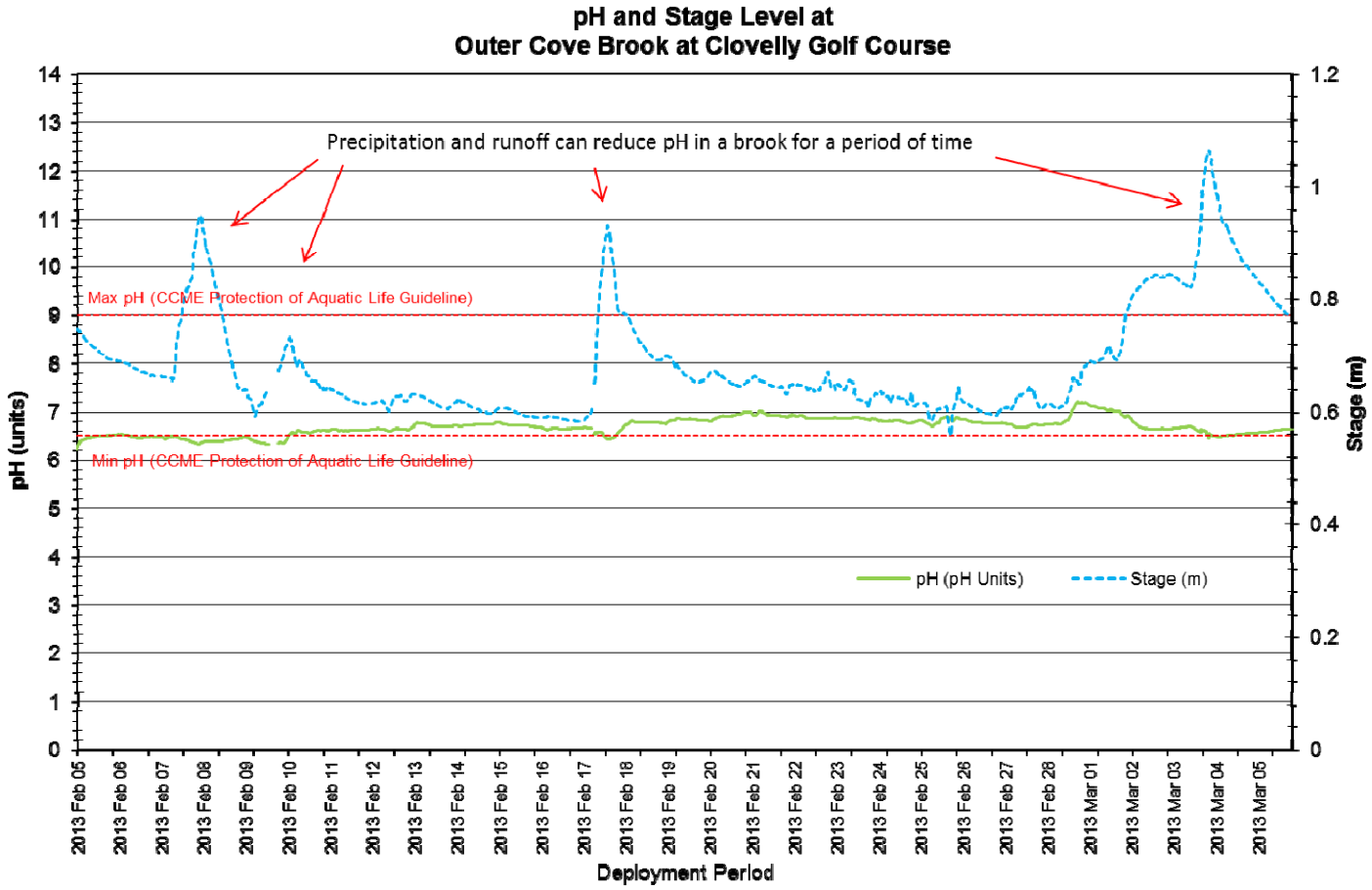

Figure 9: Quarter-hourly pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period February 5 to March 6, 2013.

Specific Conductivity & TDS

- The conductivity levels were within 310 µS/cm and 3896 µS/cm during this deployment period. TDS ranged from 0.1990 g/L to 2.4900 g/L. These values are notably higher than those of the previous deployment period.
- Cold temperatures and snowfall events during winter months can have the effect of increasing conductance levels due to the addition of salt to roadways. Through wind, snowmelt and rainfall, these salts are carried into the water system, increasing the specific conductance. The increase on February 18 (see Figure 10) is in response to a February 17 snowfall event.
- Generally, rainfall events, such as that which occurred on March 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 mirrors specific conductivity.

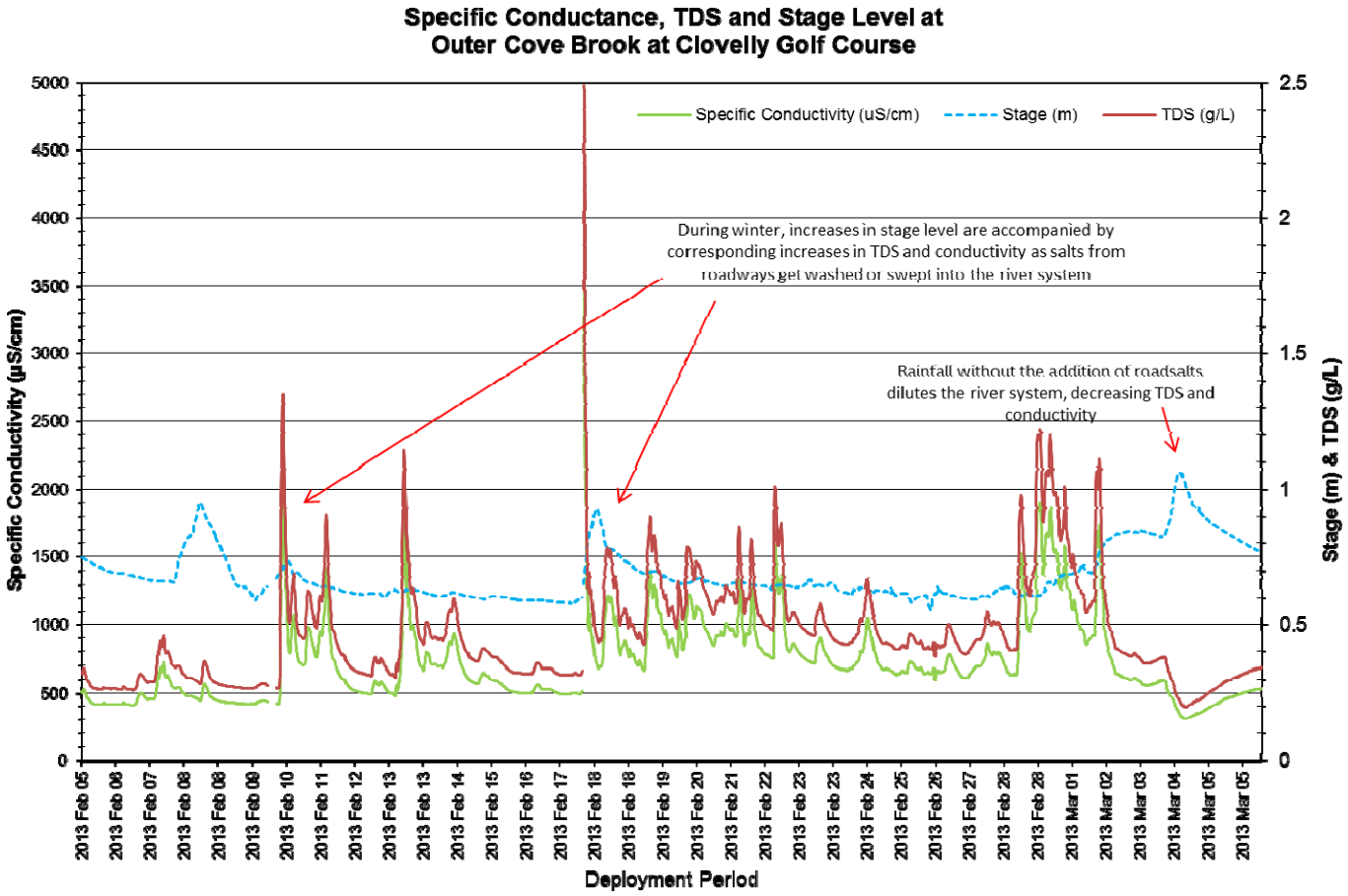

Figure 10: Quarter-hourly specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period February 5 to March 6, 2013.

Dissolved Oxygen

- The instrument measures percent saturation directly, then calculates dissolved oxygen (mg/L) using the percent saturation and water temperature values.
- The Dissolved Oxygen % Sat levels within this deployment period were within 71.4% Sat–88.3% Sat. Dissolved Oxygen (mg/L) measured 10.42 mg/L to 12.69 mg/L. The DO mg/L values are above the minimum DO CCME guideline for early life stages and higher than in previous months as the colder water can hold more oxygen.
- Dissolved Oxygen percent saturation fluctuates throughout the deployment period as the presence of dissolved salts in the water influences oxygen saturation. 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 colder water can hold more oxygen. This trend was observed during the deployment period as evident in Figure 11 on February 16, 2013.

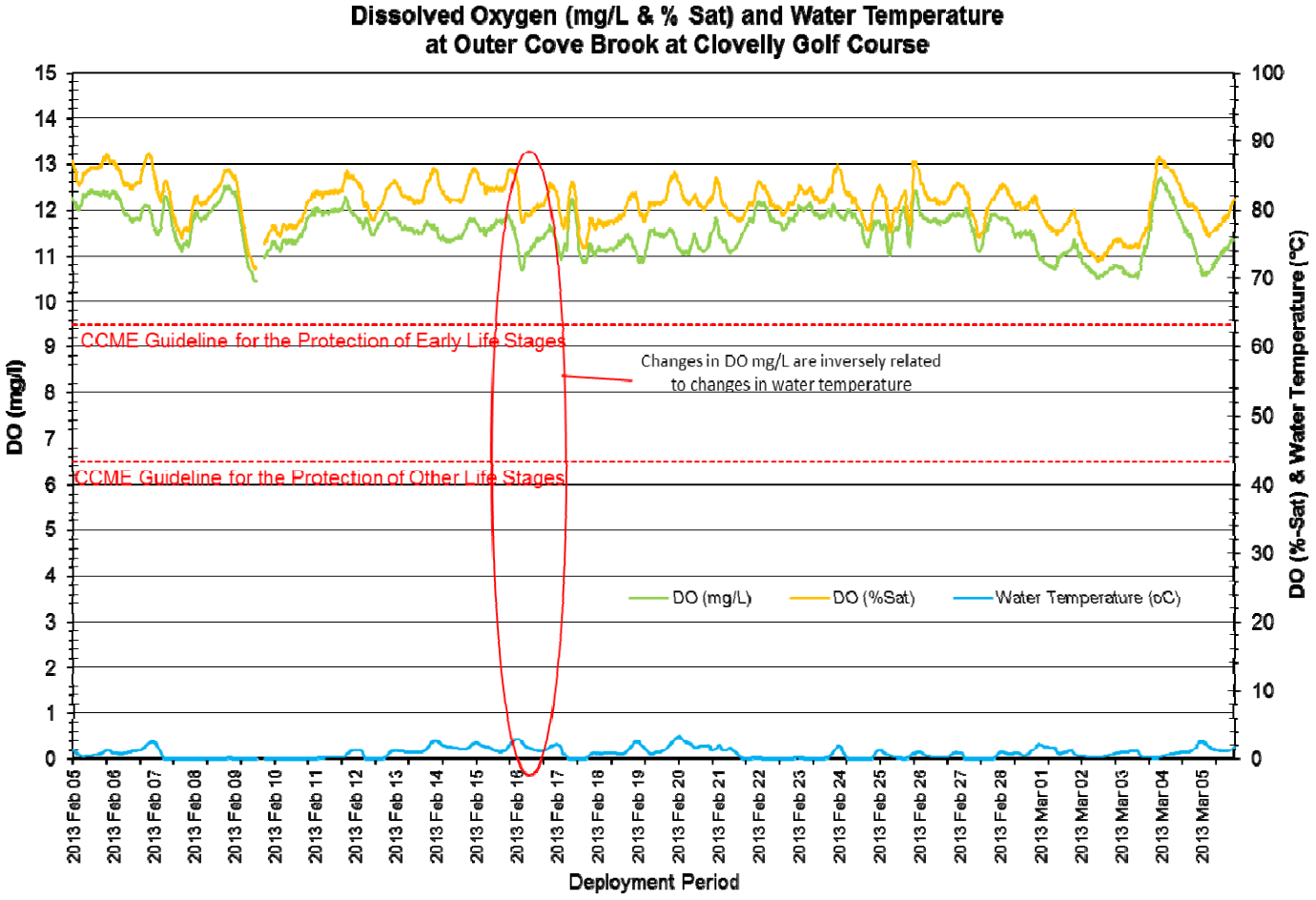

Figure 11: Quarter-hourly dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook at Clovelly Golf Course for the deployment period February 5 to March 6, 2013.

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, this is not a valid turbidity reading.
- The turbidity readings during this deployment ranged within 3.6 NTU to 261.3 NTU (Figure 12).
- Several precipitation events and corresponding stage increases led to fluctuating turbidity values as sediment and debris were resuspended into the water column.
- As this sensor received a 'poor' performance ranking at removal, and no biofouling or debris were present, it is likely that some sensor drift occurred.
- The data from February 28th to March 6th will be removed from the dataset as this may not be 'true data'.

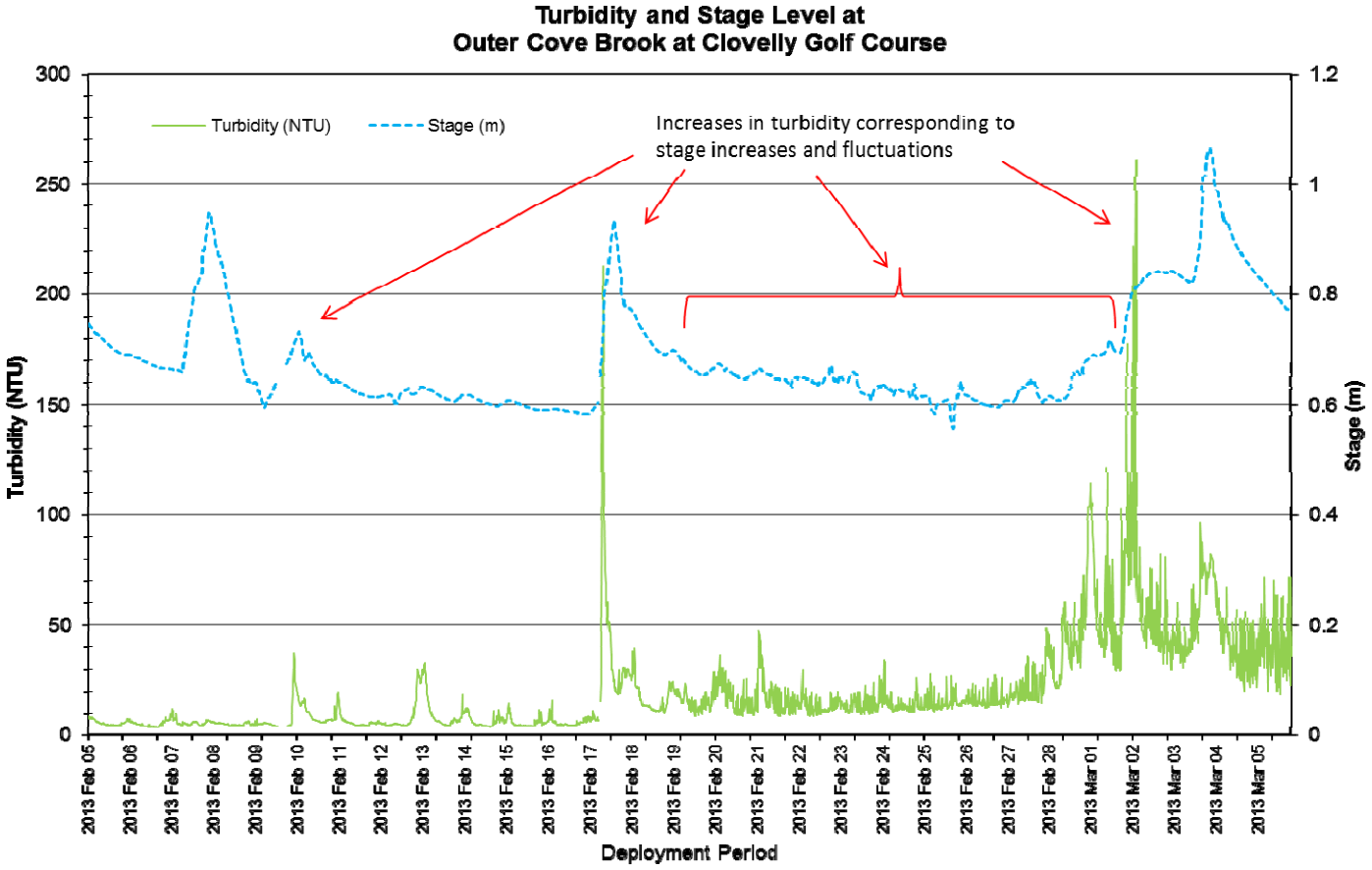

Figure 12: Quarter-hourly turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course for the deployment period February 5 to March 6, 2013.

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.
- During the deployment period, the stage values ranged from 0.56m to 1.06m. During sonde removal, ice was not present in the river at the monitoring station.

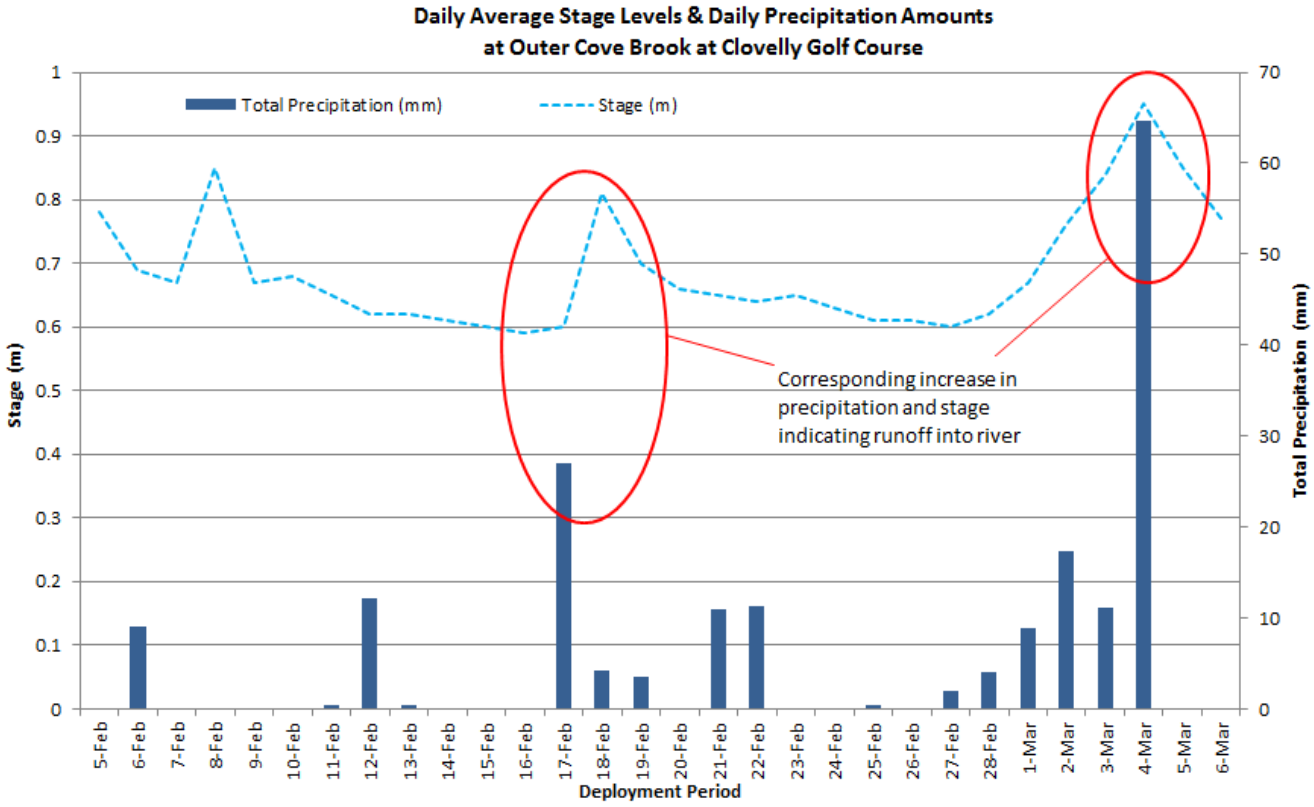

Figure 13: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station for the deployment period February 5 to March 6, 2013.

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 were low during the winter months, there were correspondingly low water temperatures, which in turn increased the amount of dissolved oxygen in the water.
- The majority of turbidity events were correlated with increases in stage and thus precipitation events. High turbidity values at removal without the presence of debris or biofouling, and a 'poor' sensor ranking, indicate sensor drift.
- The addition of road salt to roadways and runways during periods of snowfall and low ambient air temperatures led to increases in specific conductance and TDS as the salts were washed into the river system. This indicates that this river is influenced by runoff upstream of the station.

Conclusions – Outer Cove Brook Network

During this deployment period, the median water temperature at the upstream station (below Airport) of 1.10°C was very similar to that of the downstream station (at Clovelly Golf Course) of 0.77°C. The difference in median temperatures of 0.40°C is the same difference as during the previous deployment period. The median pH values for both were also comparable with below Airport's median at 6.69 and Clovelly Golf Course reading 6.71, and thus no significant change in pH from the upstream to the downstream station. It was noted that both stations reached pH maximum values on March 1, reaching 7.34 pH units and 7.22 pH units, both values which are notably higher than normal for each of these stations. The cause of these corresponding high pH values is unknown. The specific conductivity medians were similar at both stations with 638 uS/cm reported below the airport and 668uS/cm reported at the golf course. The difference in medians of ~30 uS/cm is the same as during the previous deployment. It should be noted that higher specific conductivity values were recorded at the golf course, reaching a maximum value of 3896 uS/cm, compared to the maximum value of 2141 uS/cm below the Airport. This indicates more influence from road salts during snowfall events at the golf course station as it is downstream of a developed commercial development area and roadways. Dissolved oxygen at the upstream station (below Airport) had a median of 88.1%Sat during the deployment period, while the downstream station (Clovelly Golf Course) had a lower median of 81.4%Sat. This lower oxygen content at the downstream station may be due the presence of more salts in water at this station, as indicated by specific conductance values, which lowers the amount of oxygen the water can hold. As both turbidity sensors experienced some drifting near the end of the deployment periods, a comparison of turbidity medians cannot be completed.