Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
August 22, 2014 to September 30, 2014

Newfoundland Labrador

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

Outer Cove Brook, Newfoundland and Labrador

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Outer Cove Brook, Newfoundland and Labrador

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 38-day period from deployment on August 22, 2014 until removal on September 30, 2014.

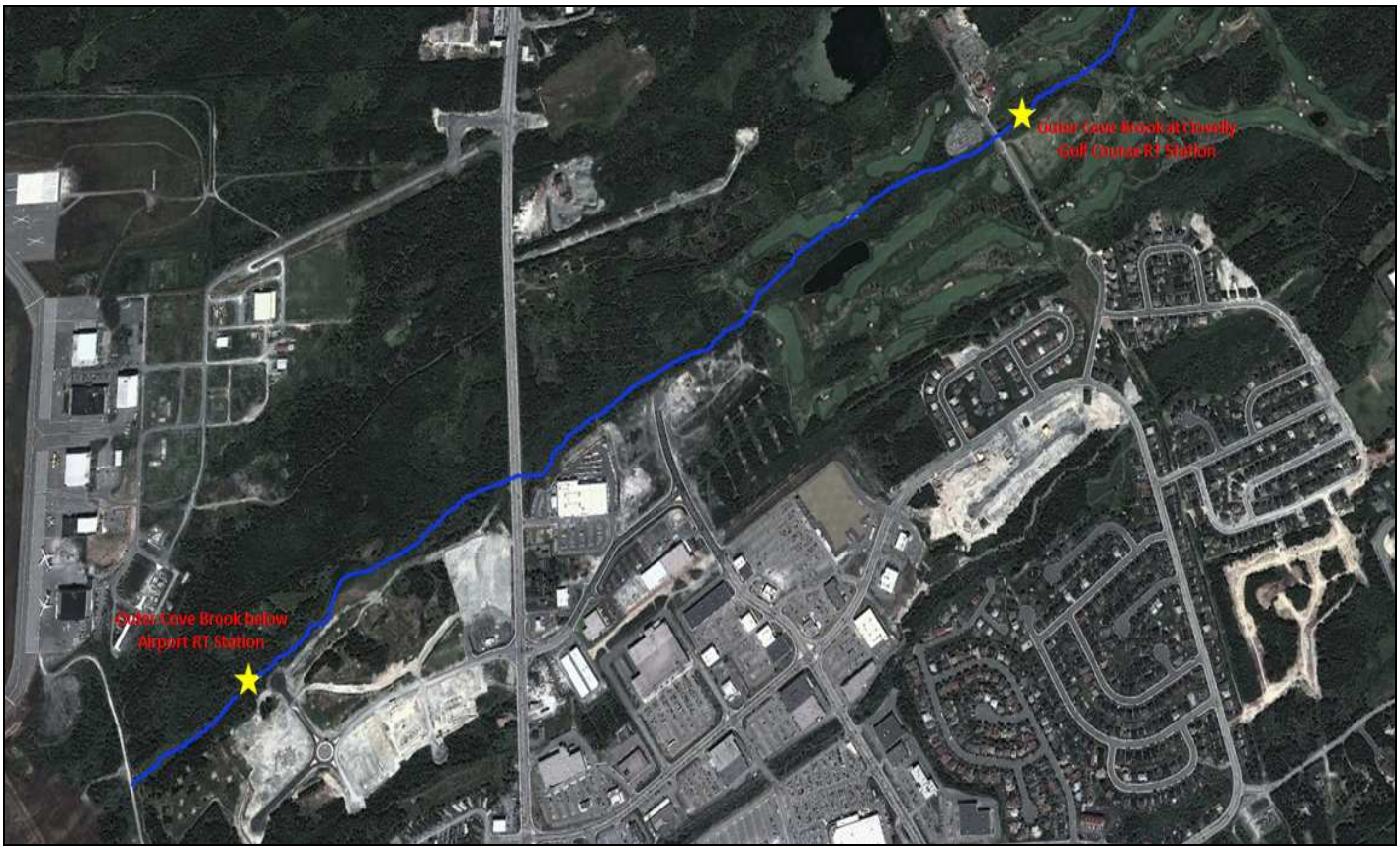

Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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 August 22, 2014 to September 30, 2014 are summarized in Table 2.

Table 2: Instrument performance rankings for Outer Cove Brook below Airport

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Below Airport	**Aug 22 2014**	**Deployment**	Excellent	Excellent	Excellent	Excellent	Fair
	Sept 30 2014	**Removal**	Excellent	Fair	Good	Excellent	Excellent

- During the Outer Cove Brook below Airport station deployment, water temperature, pH, conductivity and dissolved oxygen all ranked as 'excellent'. Turbidity ranked as 'fair', this ranking may have been a result of debris and/or an air bubble interfering with the small window on the sensor that takes the reading.

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- At removal, water temperature, dissolved oxygen and turbidity ranked as 'excellent'. Conductivity ranked as 'good', while pH ranked as 'fair'. The lower pH ranking was likely a result of the QAQC instruments' pH sensor not stabilizing before the reading was taken. The pH sensor does take anywhere from 2 minutes to 5 minutes to stabilize. The 'fair' ranking for conductivity may have been a result of an air bubble being trapped within the sensors window.

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of August 22, 2014 to September 30, 2014 are summarized in Table 3.

Table 3: Instrument performance rankings for Outer Cove Brook at Clovelly Golf Course

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Clovelly Golf Course	Aug 22 2014	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Sept 30 2014	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

- Comparison of the field sonde and QAQC data during the deployment at Outer Cove Brook Clovelly Golf Course indicated the following: water temperature, pH, conductivity, dissolved oxygen and turbidity comparison data all ranked as 'excellent'.

- At removal the comparison between the field sonde and QAQC sonde indicated that, water temperature, pH and conductivity, dissolved oxygen and turbidity data all ranked as 'excellent' at the end of the deployment period. Indicating that the data set for this deployment period represents the brook as good as possible.

Outer Cove Brook below Airport

Water Temperature

Water temperature ranged from 8.8°C to 17.20°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.

The lower water temperatures indicated on the graph also correspond with increases in stage. This can indicate that there was a rainfall event during those particular times that slightly decreases the water temperature for a short period of time.

A cluster of warmer temperatures, such as what is displayed from September 21st through to September 23rd, is likely a related to higher air temperature during that time frame.

The water temperatures at this station display diurnal variations. Shallow streams and ponds are highly influenced by natural diurnal variations in the surrounding air temperatures.

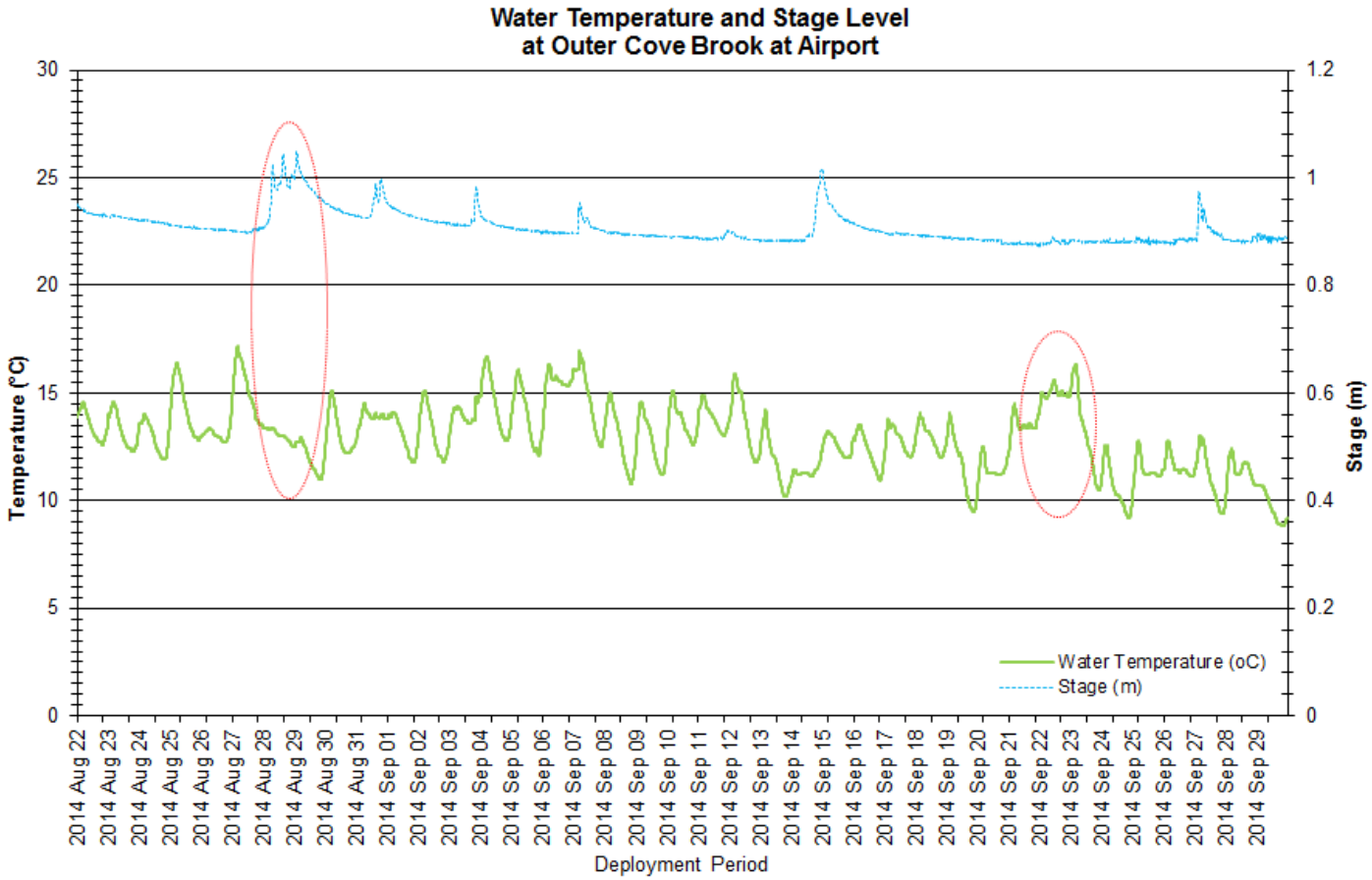

Figure 2: Water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport.

pH

Throughout this deployment period pH values ranged between 6.43 pH units and 7.47 pH units (Figure 3).

During this deployment, the majority of the pH values at this station remained above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units).

The small dips in pH on August 29th, September 1st, 3rd and 7th as well as September 15th all correspond with peaks in stage for the same time frames. Rainfall will drop the pH value for a short period of time.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. During this deployment period the median pH level was 7.25 units, which was slightly higher than last month.

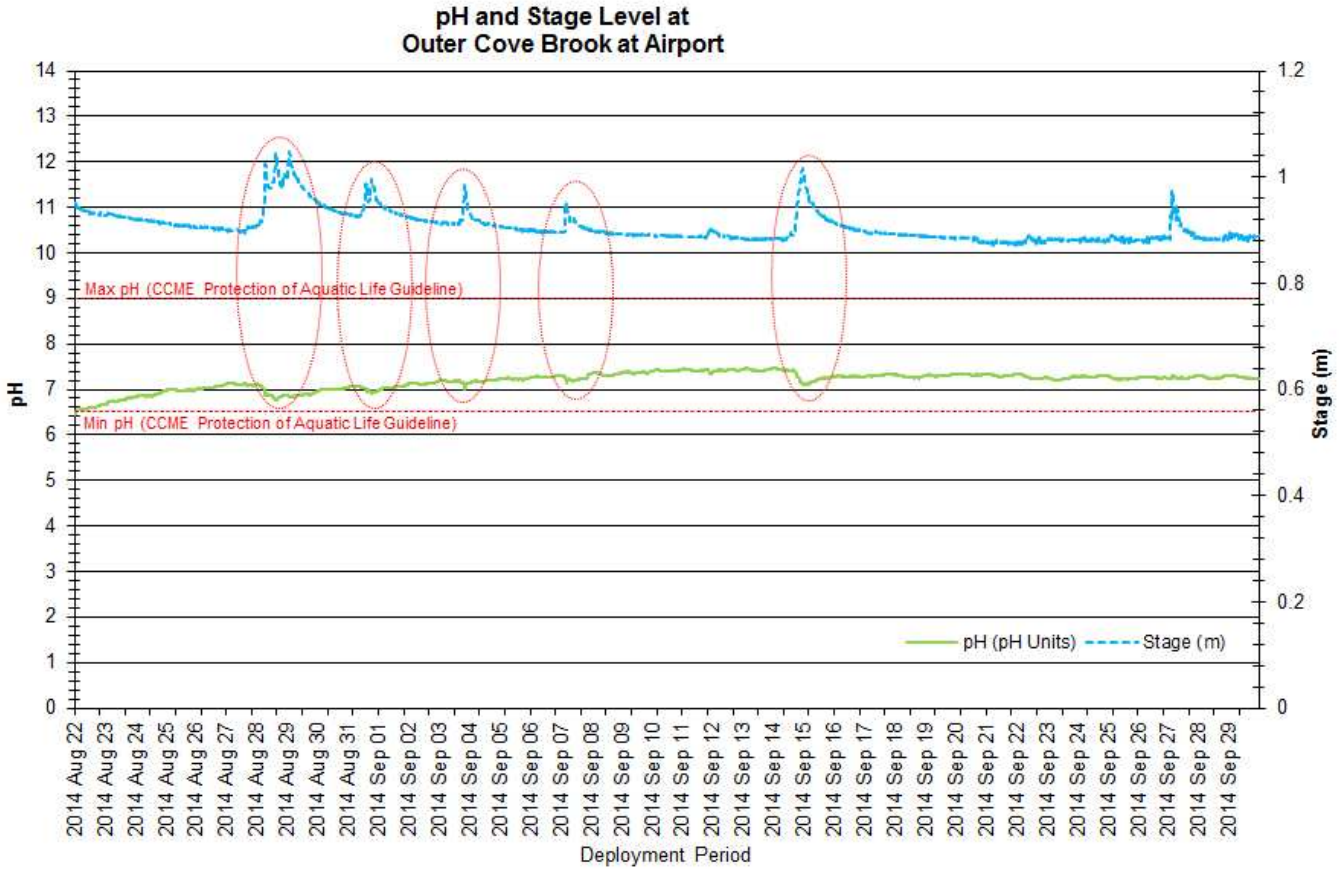

Figure 3: pH (pH units) and stage level (m) values at Outer Cove Brook below Airport

Specific Conductivity & TDS

The conductivity levels were within 202.0 µS/cm and 561.0 µS/cm during this deployment period. TDS ranged from 0.1290 g/L to 0.3590 g/L.

When stage levels rise, the specific conductance levels drop in response as the increased amount of water in the river system dilutes the solids that are present. This is displayed by the dips in conductivity on Figure 4.

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. TDS generally always mirrors specific conductivity.

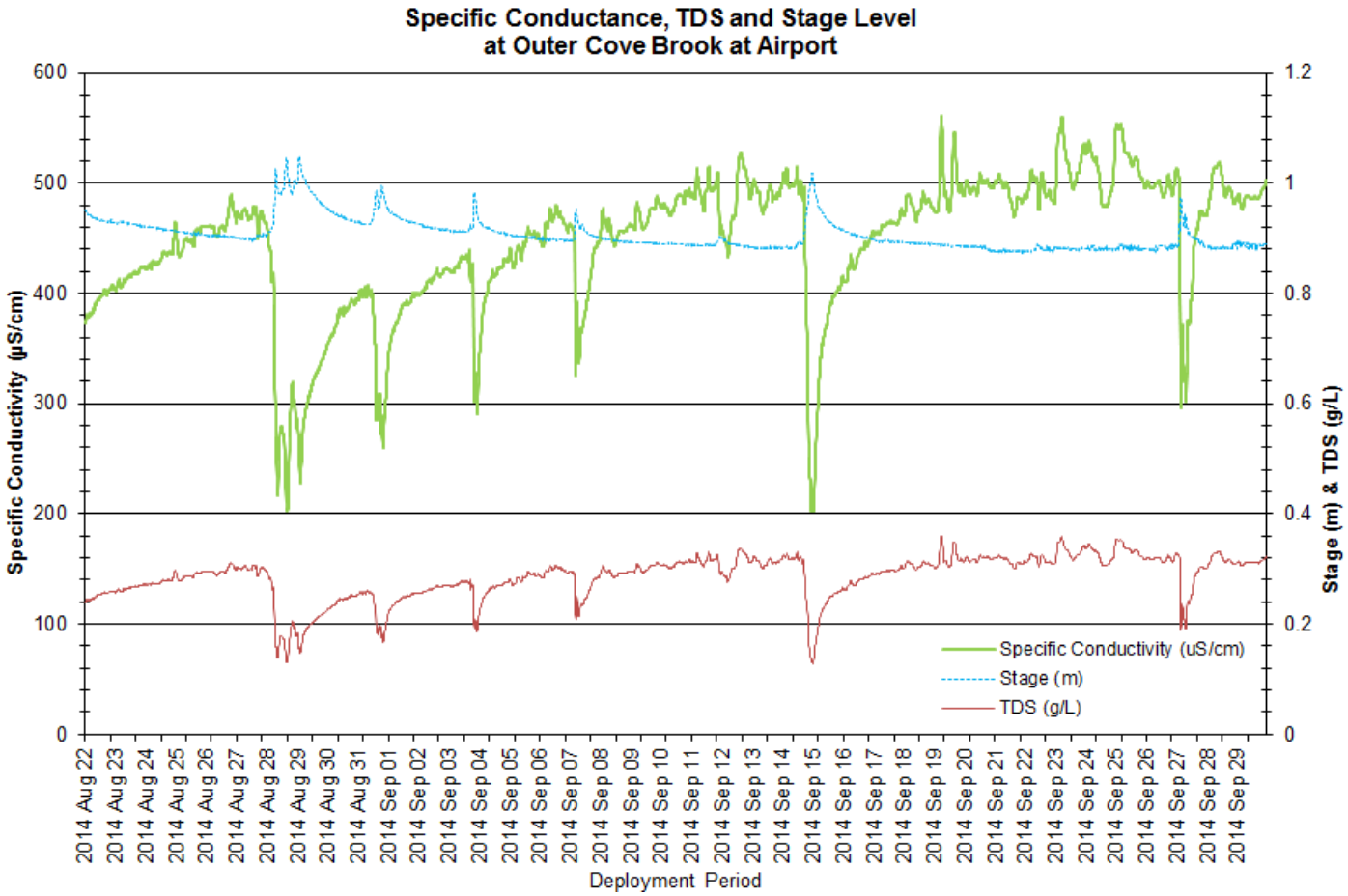

Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport.

Dissolved Oxygen

The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe and then the instrument calculates percent saturation (% Sat) with water temperature.

The Dissolved Oxygen % Sat levels within this deployment period were within 86% Sat to 93.9% Sat. Dissolved Oxygen (mg/L) measured 8.31 mg/L to 10.44 mg/L.

During this deployment the dissolved oxygen levels remained consistent. The circled data on Figure 5 indicates the relationship between water temperature and dissolved oxygen. As water temperature increases the level of dissolved oxygen consumed increases, which means there is less dissolved oxygen in the brook during these temperatures. This is the opposite with cooler water temperatures.

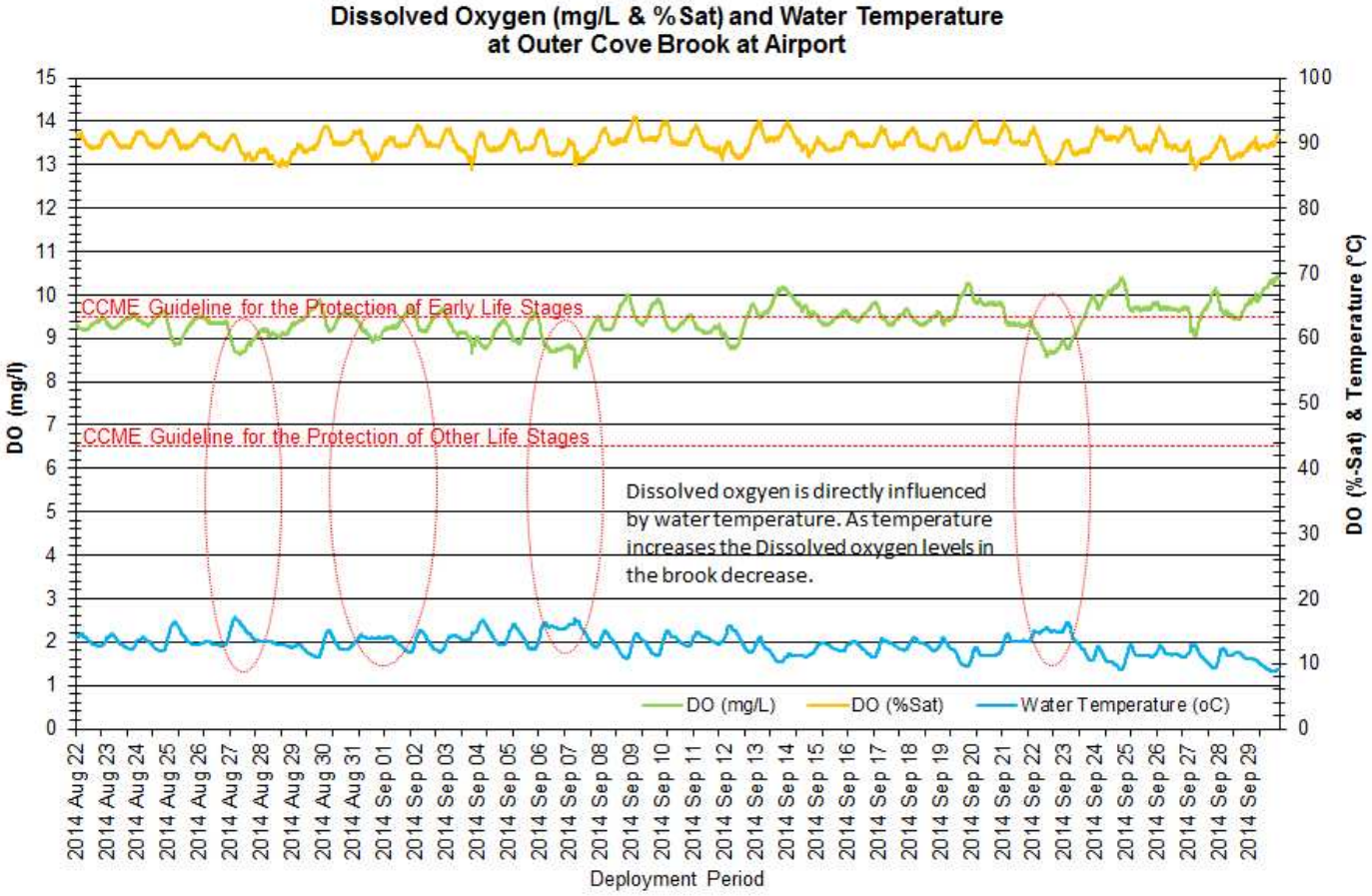

Figure 5: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport.

Turbidity

Turbidity levels during this deployment period ranged within 0.0 NTU and 147.2 NTU (Figure 6). With a median of 0.0 NTU.

The turbidity sensor on this instrument can read turbidity values between 0 NTU and 3000 NTU. However a turbidity reading of 3000 NTU is always identified as an error reading and should not be used as a valid reading or included in any statistical analysis.

The turbidity events in the deployment period correlate with increases in stage potentially from precipitation (Figure 6). Precipitation can increase the presence of suspended material in water as seen on August 28th to 30th, September 1st, 4th, 8th, 15th and September 27th. The turbidity peaks on September 10th and September 14th are likely a result of debris blocking the sensor at the exact moment the instrument took a reading.

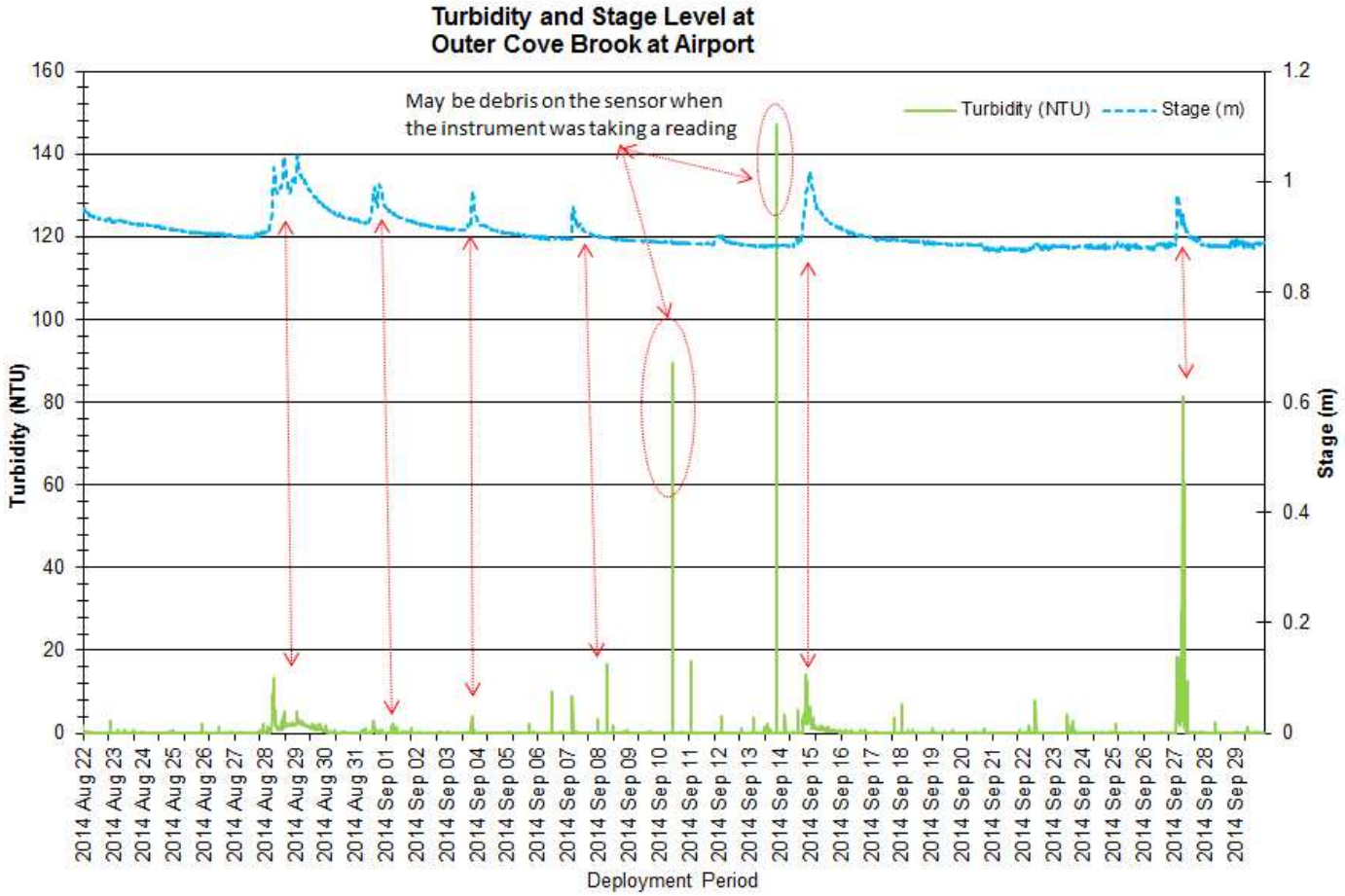

Figure 6: Turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport.

Stage

Stage can be defined as the height or elevation of the stream's water surface above a reference elevation (sea level, gage level)**.** Stage is important to display as it 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 will increase during rainfall events (Figure 7) and during any surrounding snow or ice melt as runoff will collect in the brooks. However, direct snowfall will not cause stage to rise significantly.

Precipitation data was obtained from Environment Canada's St. John's Airport weather station. Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 21.4 mm on August 28th.

During the deployment period, the stage values ranged from 0.87m to 1.05m. The larger peaks in stage do correspond with substantial rainfall events as noted on Figure 7.

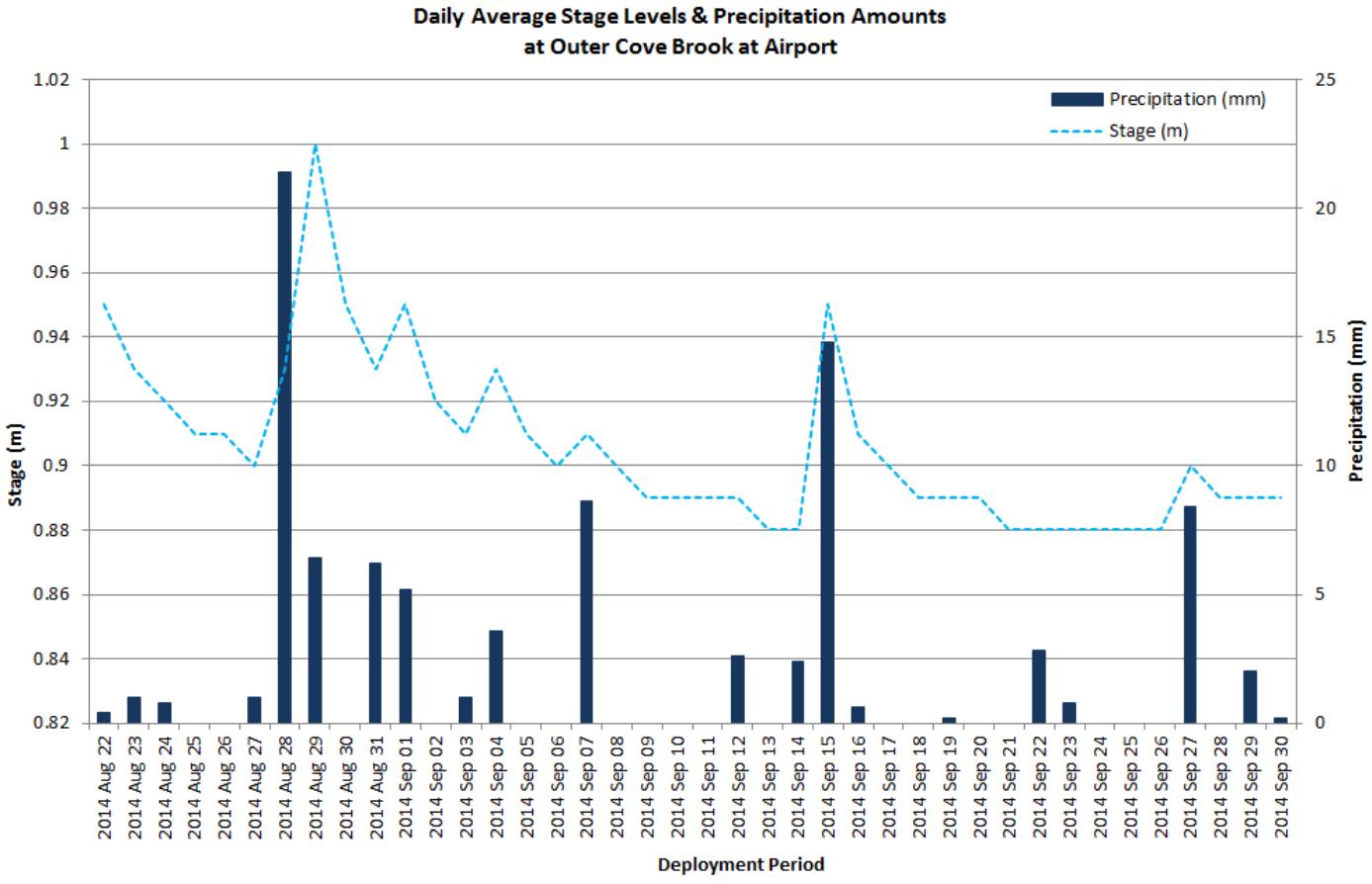

Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

Conclusion

- As with many shallow brooks and streams, precipitation events play a role in influencing the parameters within the water body. This brook also flows through significant developed areas, including residential zones and within the boundaries of heavily used road ways, which can influence the parameter levels that are recorded.

- It is evident by the parameter data recorded that precipitation events during this deployment period have influenced fluctuations in stage. When reviewing the graphs as a whole it is evident that the precipitation events on August 28th-29th, August 30th to September 1st, September 15th and September 27th created varying effects with the water quality parameters. An influx of rainfall will dilute conductivity and TDS, and increase turbidity. pH values dropped (acidity increases) potentially with an increase in runoff from the surrounding environment with higher dissolved substances present.

- As ambient air temperatures decreased toward the end of August it caused the water temperature to decrease. Water temperature directly affects the amount of dissolved oxygen present in the brook during those times and it is common to see such a trend.

- No event to note during this deployment period. The data is easily explained and represents a likely natural, urban influenced brook.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

Water temperature ranged from 8.04 ^{o}C to 17.73 ^{o}C during this deployment period (Figure 8).

Water temperature in this brook displays a typical variation in pattern over the deployment period. Water temperature is influenced by air temperature. This deployment period has higher water temperature values than the previous month. This is expected as the air temperature increases with natural climatic changes.

Water temperature on these water quality instruments is a very important parameter and it has the ability to influence other parameters.

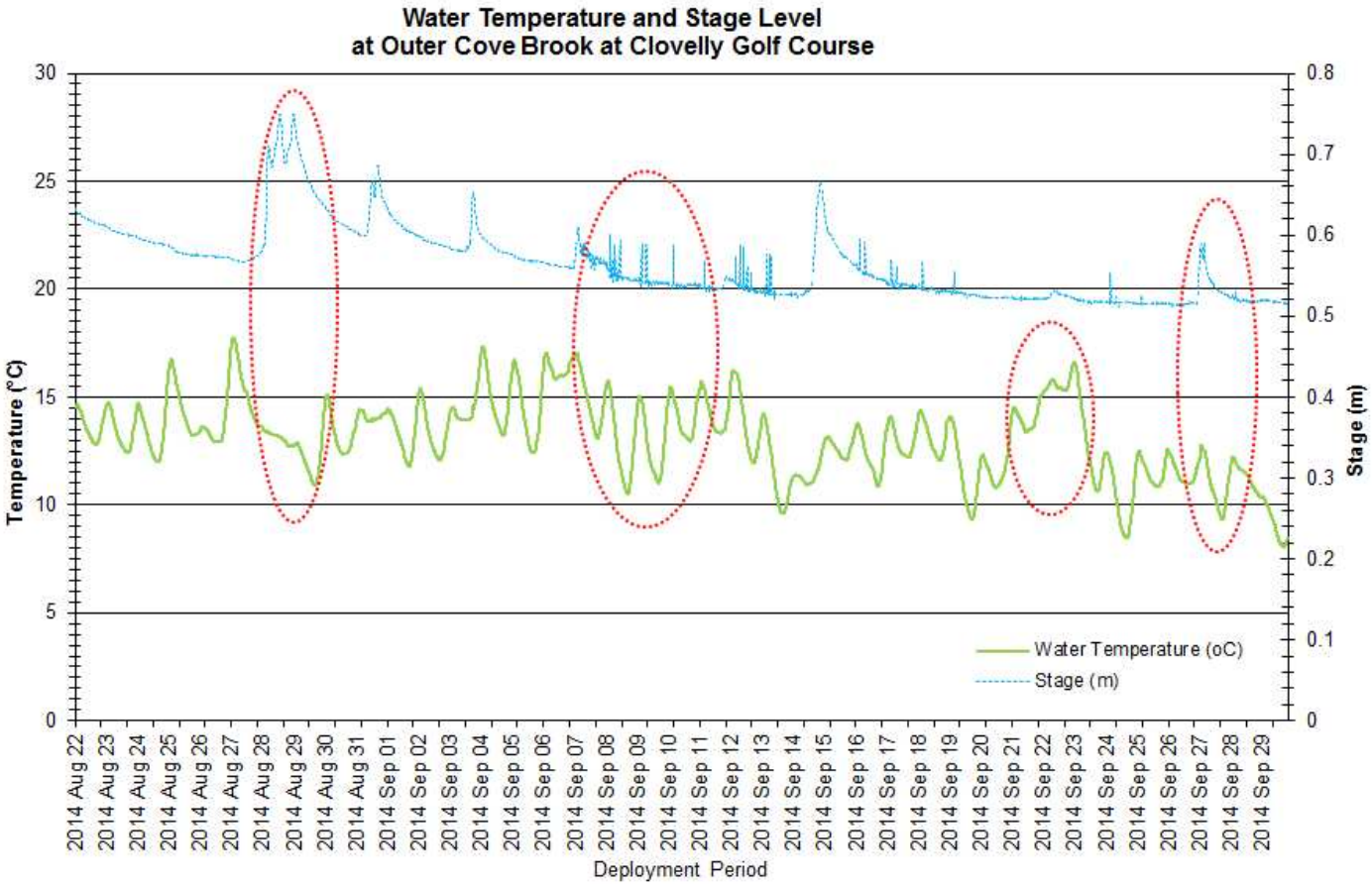

Figure 8: Water temperature (℃) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

pH

Throughout this deployment period pH values ranged between 5.74 pH units and 6.68 pH units (Figure 9).

During the deployment, the pH values at this station were generally along the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) for the majority of deployment period.

The pH levels dip slightly on August 28th and September 1st. This corresponds with stage increases during the same time period. This is a natural occurrence and can be explained by the natural relationship 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. During this deployment period the median pH level was 6.45 units.

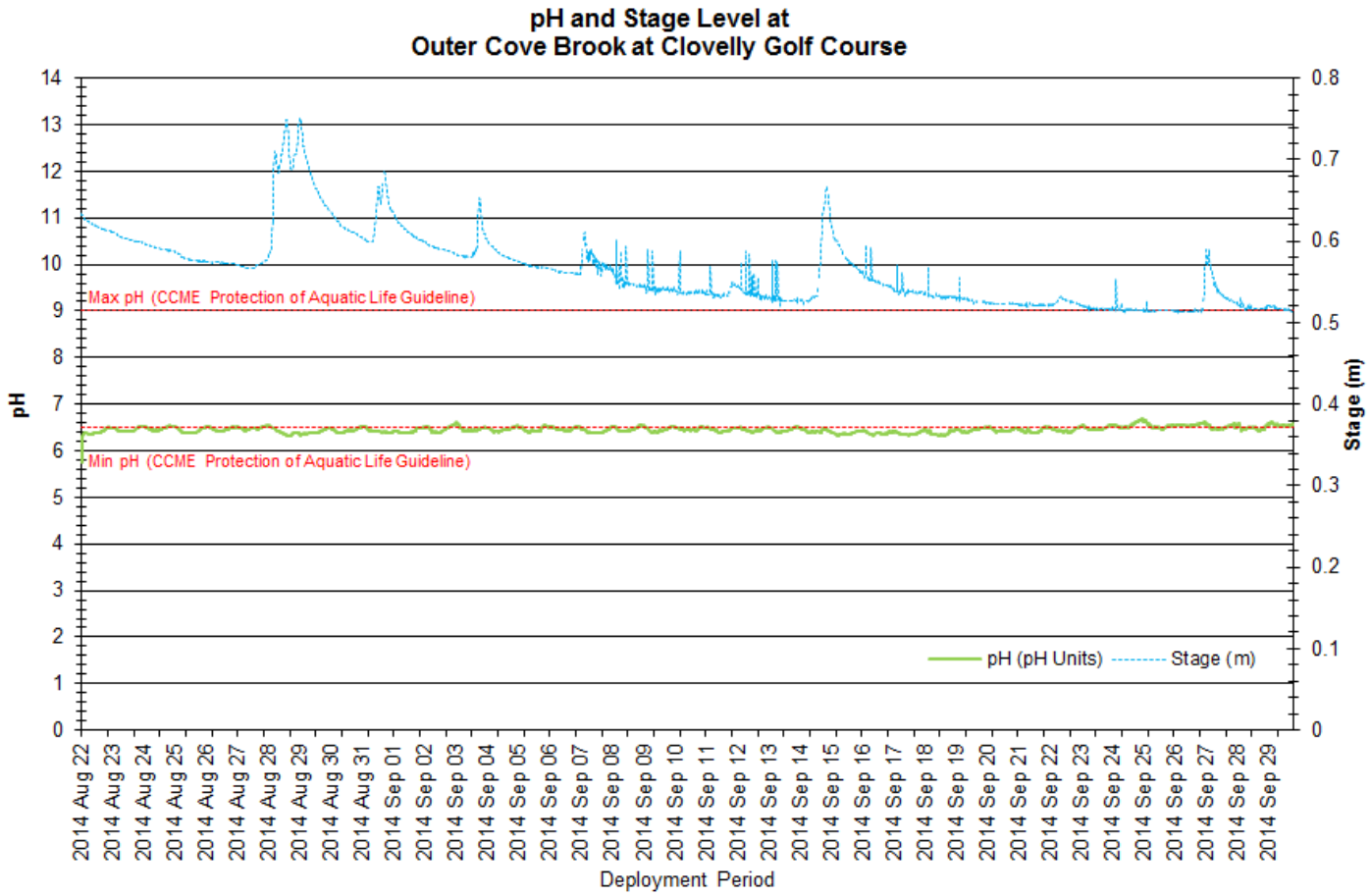

Figure 9: pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Specific Conductivity & TDS

The conductivity levels were within 232.0 µS/cm and 536.0 µS/cm during this deployment period. TDS ranged from 0.1480 g/L to 0.3430 g/L.

The dips in conductivity during the deployment period (see Figure 10) all correspond with a increase in stage level. The conductivity probe measures the dissolved particles present in a water body, when there is an increase in stage it can indicate that there was rainfall. Rainfall saturates the brook and flushes the dissolved particles from the water column diluting the conductivity levels for a short period of time.

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.

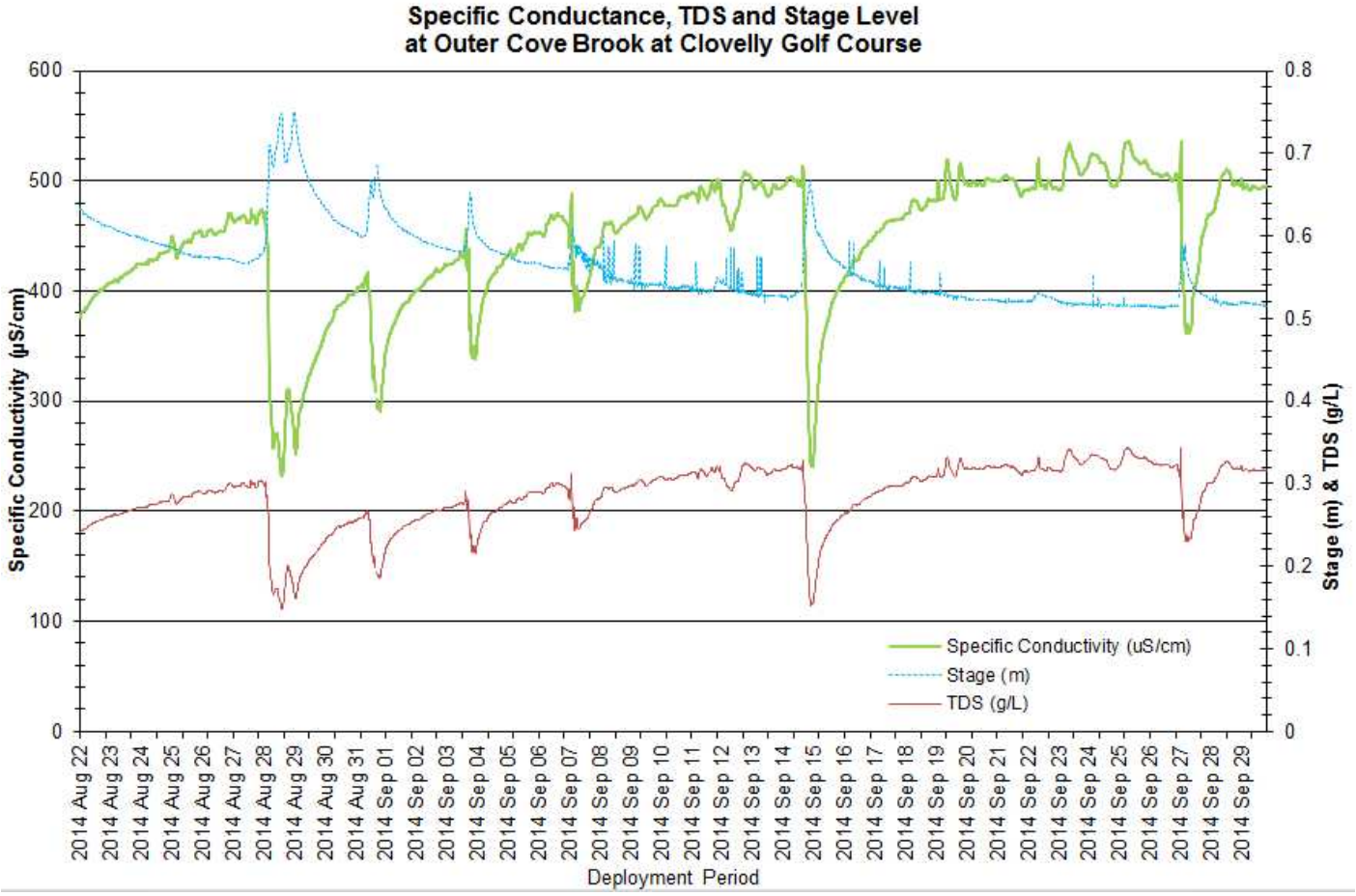

Figure 10: Specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course.

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 72.4 %Sat to 98.4 %Sat. Dissolved Oxygen (mg/L) measured 7.14 mg/L to 10.67 mg/L.

It should also be noted that the warmer water temperatures reduce the amount of dissolved oxygen a water body can hold. It can be seen on August 27th to 29th, September 6th-7th and September 22nd -23rd, as the water temperatures increases (probably at the hottest time of the day) the water dissolved oxygen levels dip.

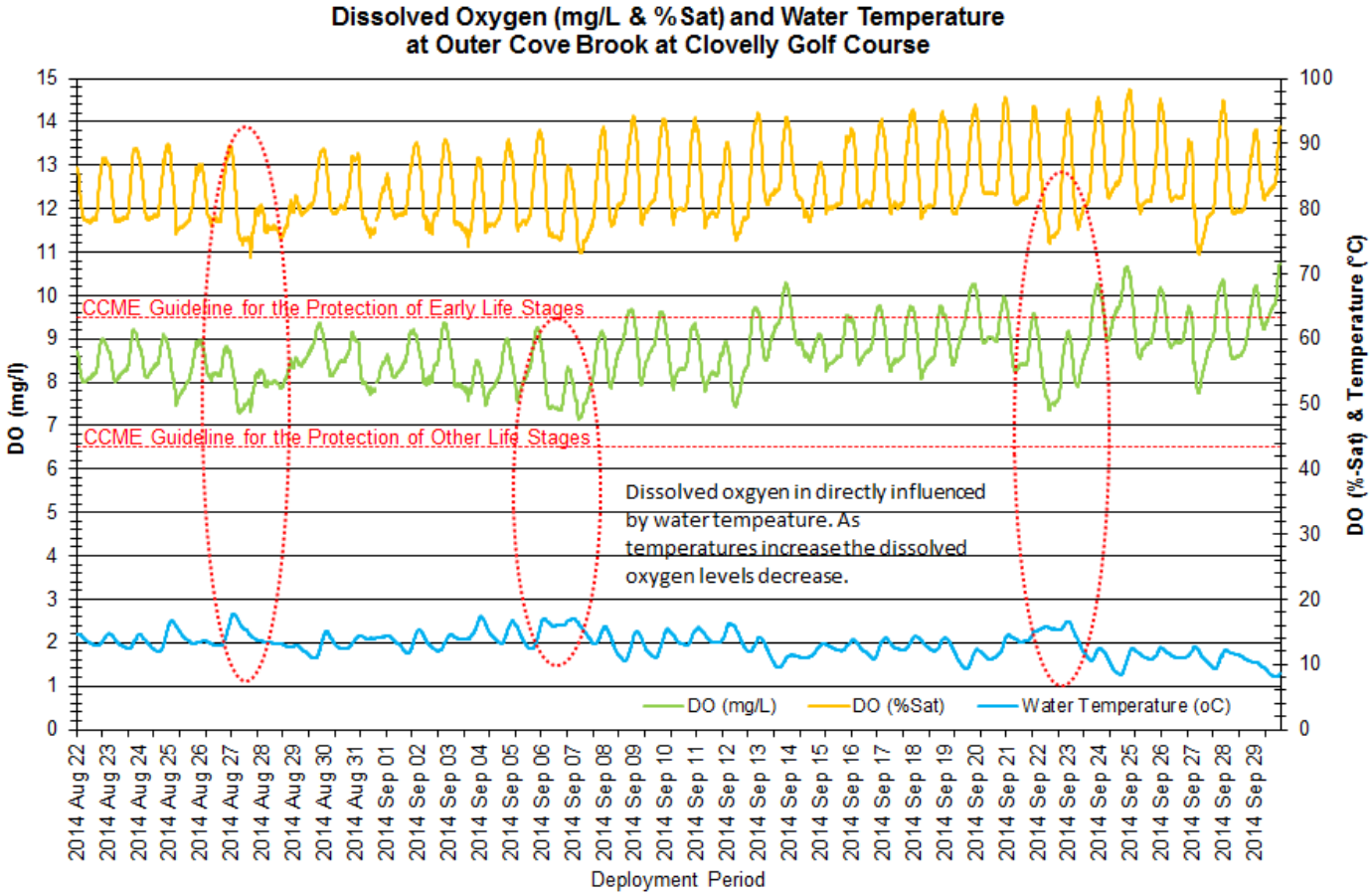

Figure 11: Dissolved oxygen (mg/L & % sat) and water temperature (℃) values at Outer Cove Brook at Clovelly Golf Course.

Turbidity

Turbidity levels during this deployment period ranged within 0.5 NTU and 27.8 NTU (Figure 12), with a median of 2.0 NTU.

At particular times in the year, Outer Cove Brook can contain significant amounts of algae. High algal growth, biofouling, or leaf and grass debris can interfere with a turbidity sensor as particles block the sensor and affect the turbidity value.

The turbidity sensor on this instrument can read turbidity values between 0.0 NTU and 3000 NTU. However a turbidity reading of 3000 NTU is always identified as an error reading and during data grooming will be removed from the data set so to ensure it is not included in any statistical analysis.

As depicted on the graph there were several turbidity events during deployment. The highest turbidity reading on August 28th corresponds with a large stage increase at the same time. The turbidity events on August 31st, September 4th and 8th, as well as September 15th and September 27th also correspond with the high stage levels.

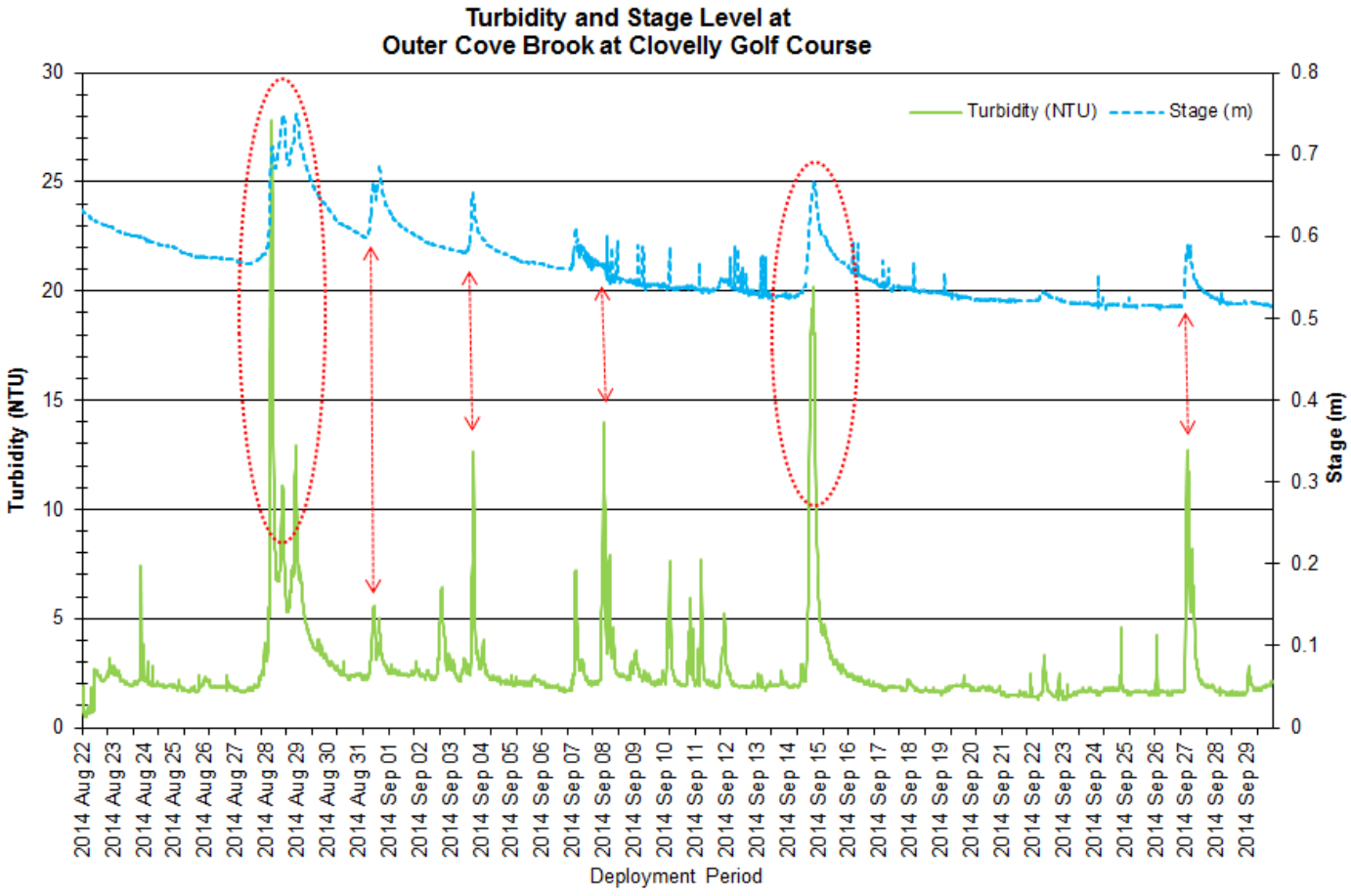

Figure 12: Turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Stage

The below graph includes precipitation data from St. John's International Airport weather station.

Stage can be defined as the height or elevation of the stream's water surface above a reference elevation (sea level, gauge level)**.** Stage is important to display as it 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).

It is not unusual to see Stage vary throughout the deployment period (Figure 13). Stage is directly influenced by rainfall and subsequent runoff from the surrounding environment. This is evident on August 28th, August 31st, September 1st, 7th and again on September 15th as both stage and turbidity have spikes in the data.

Stage levels during this deployment ranged within a minimum of 0.51m and a maximum of 0.75m. The precipitation averaged a minimum of 0.0 mm a day to a maximum of 21.4 mm which was on August 28th, 2014.

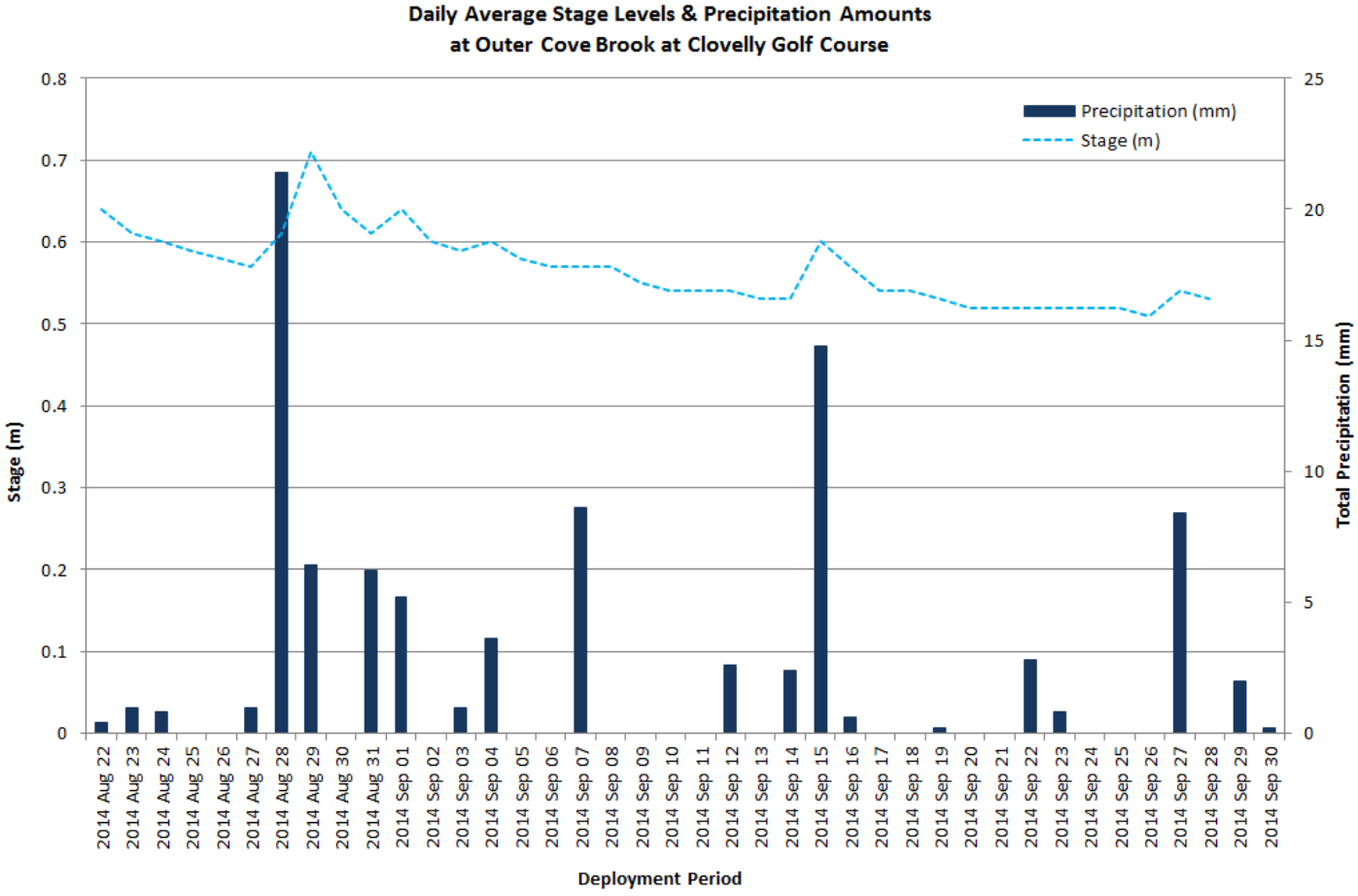

Figure 13: Daily average stage values (m) at Outer Cove Brook at Clovelly Golf Course and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

Conclusion

Outer Cove Brook, Newfoundland and Labrador

- There is visual evidence that the large spikes in stage level were a result of several rainfall events as displayed on Figure 13. Rainfall events such as those displayed on Figure 13 can influence changes in water temperatures, conductivity, dissolved oxygen and turbidity in the water column.
- This brook flows through significant developed areas, including residential zones, golf courses and within the boundaries of heavily used road ways, which can influence the water quality parameters in the areas of turbidity increases or conductivity increases when runoff from residential areas is a factor.
- As ambient air temperatures increase with the seasonal changes it should reflect in the water temperature. Water temperature directly affects the amount of dissolved oxygen present in the brook