Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
June 2, 2015 to July 22, 2015

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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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 mitigated measures can be taken.

The purpose of these real-time stations is to monitor, process and publish 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 deployment period of June 2, 2015 until removal on July 22, 2015.

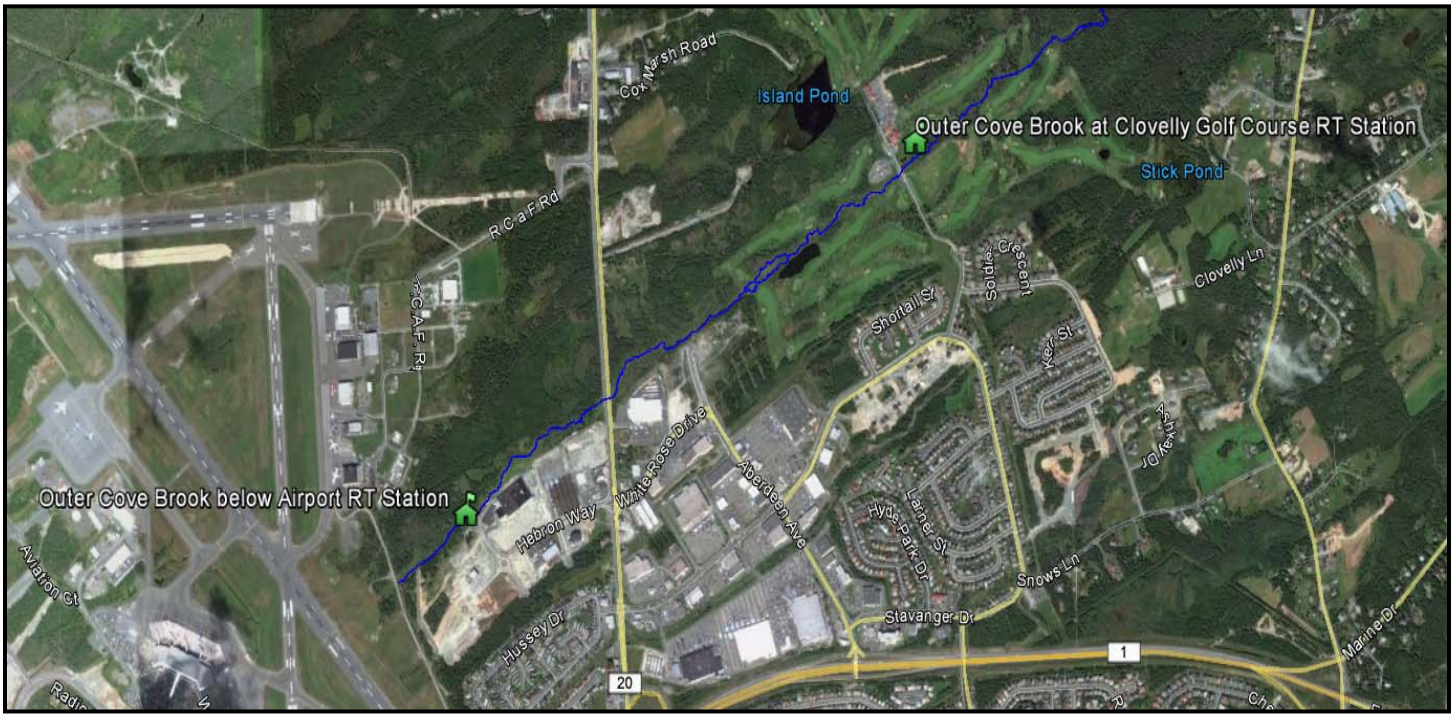

Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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).

Water Resources Management Division (WRMD) staff (Environment and Conservation (ENVC)) is responsible for maintenance of the real-time water quality monitoring equipment, as well as recording and managing the water quality data. Tara Clinton, under the supervision of Renee Paterson, is ENVC's main contact for the real-time water quality monitoring operations at Outer Cove Brook, and is responsible for maintaining and calibrating water quality instruments, as well as grooming, analyzing and reporting on water quality data recorded at the stations during the deployment year.

Water Survey of Canada (WSC) staff (Environment Canada (EC)) under the management of Howie Wills, play an essential role in the data logging/communication aspect of the network and the maintenance of the water quantity monitoring equipment. EC-WSC staff visit the sites regularly to ensure the data logging and data transmitting equipment are working properly. WSC is responsible for handling stage and streamflow issues. The quantity data is raw data that is transmitted via satellite and published online with the quality data on the Real-Time Stations website. Quantity data has not been corrected or groomed when published online or used in the monthly reports for the stations. WSC is responsible for QA/QC of water quantity data. Corrected stage and streamflow data can be obtained upon request to WSC.

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.

Concerns or Issues during the deployment period

Aside from several spotty data periods during the beginning of the deployment period, there were no other transmission issues or problems at these stations during deployment.

The Outer Cove Brook stations during the winter months are coated in a brown-grey slime like algae that will coat whatever is present in the brook during this time. As the water temperatures increase the slime like algae starts to sloth off and can cause disturbance in the turbidity levels of the brook as well as the dissolved oxygen levels (Appendix I).

Deployment and removal instrument performance rankings for **Outer Cove Brook below Airport** 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	June 2	Deployment	Excellent	Excellent	Excellent	Good	Excellent
	July 22	Removal	NA	NA	NA	NA	NA

During the Outer Cove Brook below Airport station deployment, the water quality parameter data ranked as 'Excellent' for water temperature, pH, conductivity and turbidity. The Dissolved oxygen data ranked as 'Good'.

There were no removal rankings during this deployment period. The QAQC sonde that was used to compare against the field sonde would not connect.

Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** 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	June 2	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	July 22	Removal	Excellent	Marginal	Excellent	Good	Good

Comparison of the field sonde and QAQC sonde 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 and conductivity data ranked as 'Excellent', while the data for dissolved oxygen and turbidity ranked as 'Good'. pH data when compared against the QA sonde ranked as 'Marginal' at the time of removal.

Outer Cove Brook below Airport

Water Temperature

Water temperature ranged from 6.00°C to 16.80°C during this deployment period (Figure 2). There were noticeable increases and decreases in the water temperature. This is consistent with ambient air temperatures over this time period, generally increasing during daylight hours and cooling overnight (Appendix II).

As the deployment period came to an end, the water temperature starts to increase with the warmer air temperatures. The water temperatures at this station do display diurnal variations although slightly exaggerated due to the climatic conditions during this deployment period. Shallow streams and ponds are highly influenced by natural diurnal variations in the surrounding air temperatures and precipitation events.

Please note the stage data is raw data that is published on our web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

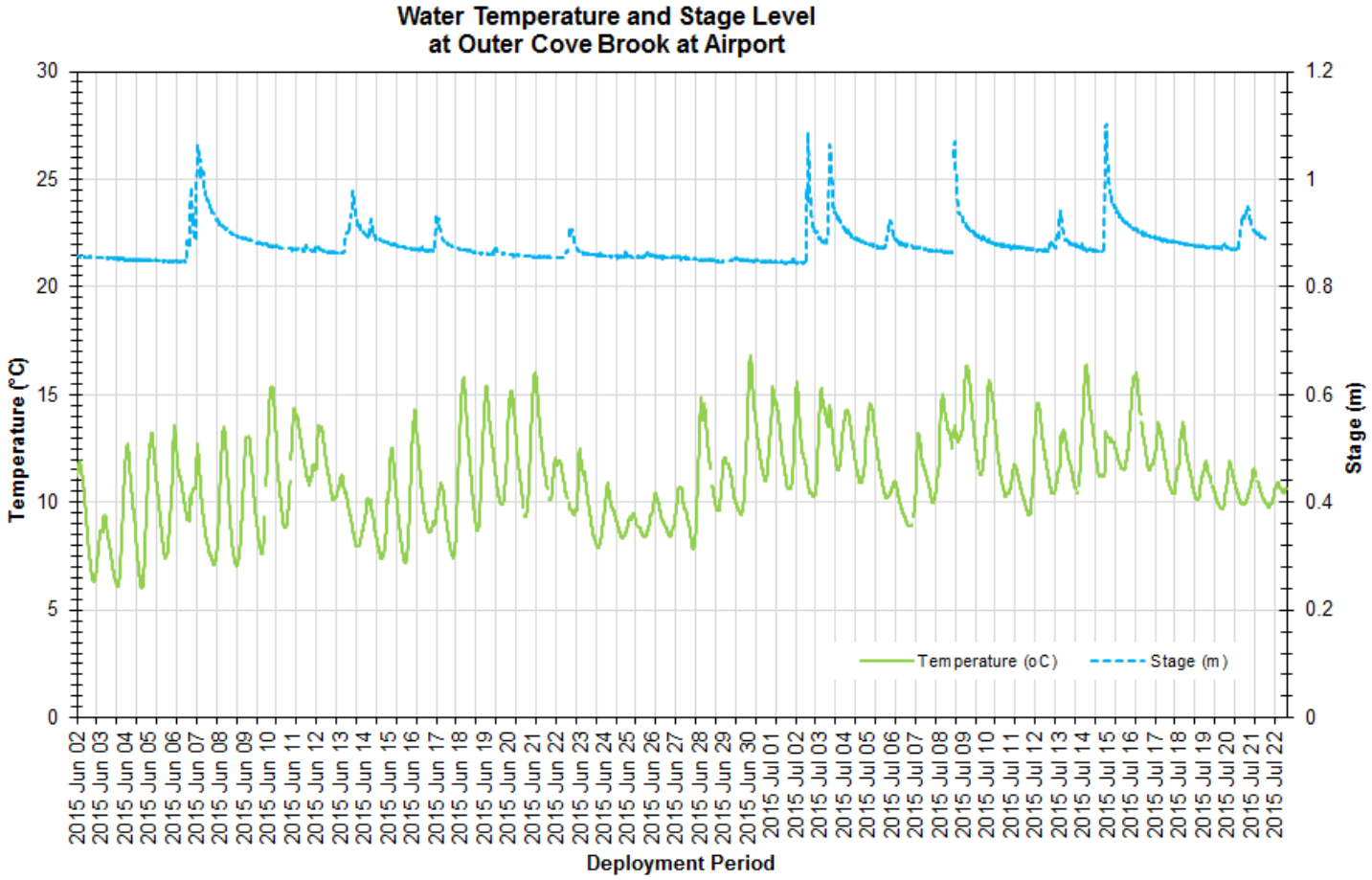

Figure 2: Water temperature (°C) and Stage (m) values at Outer Cove Brook below Airport

pH

Throughout the deployment period, pH values ranged between 6.21 pH units and 7.75 pH units (Figure 3).

During this deployment, the majority of the pH values at this station were within the CCME Guidelines for the Protection of Aquatic Life (6.5 pH units and 9.0 pH units). The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different.

The graph indicates that as the stage level increases the pH data decreases. During the deployment period the median pH level was 7.03 pH units. The pH data increases gradually over the deployment period. This could be due to the fouling on the sensor.

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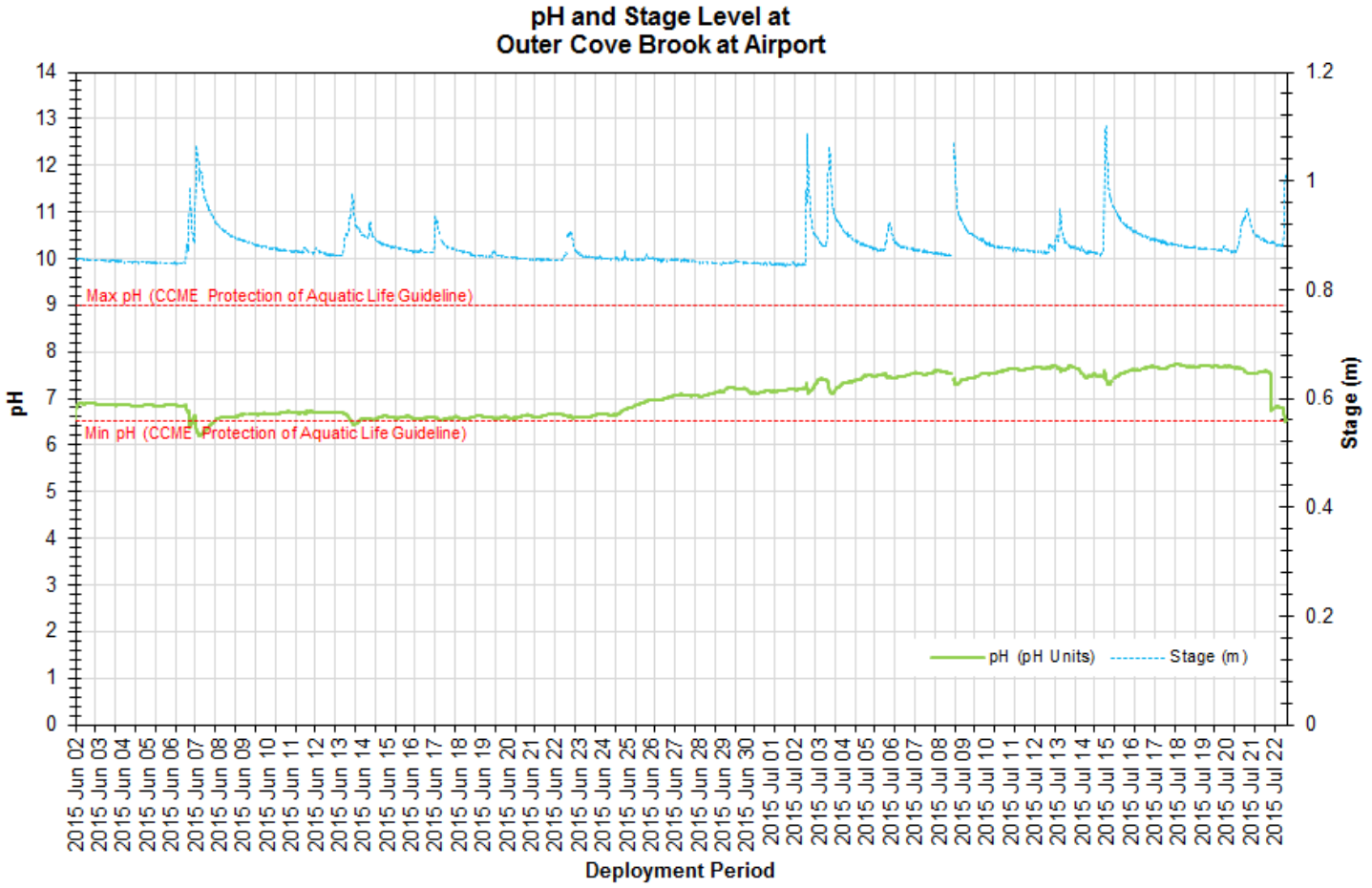

Figure 3: pH (pH units) and stage level (m) values at Outer Cove Brook below Airport

Specific Conductivity

The conductivity levels were within 150.6 µS/cm and 705.0 µS/cm during this deployment period.

Commonly the relationship between conductivity and stage level is inversed. 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 evident on Figure 4.

The dips in conductivity data after increases in stage indicate that the brook is being flushed naturally, the suspended matter and dissolved substances in the brook are flushed for a short period of time with the higher flow. This is evident on several occasions during this deployment.

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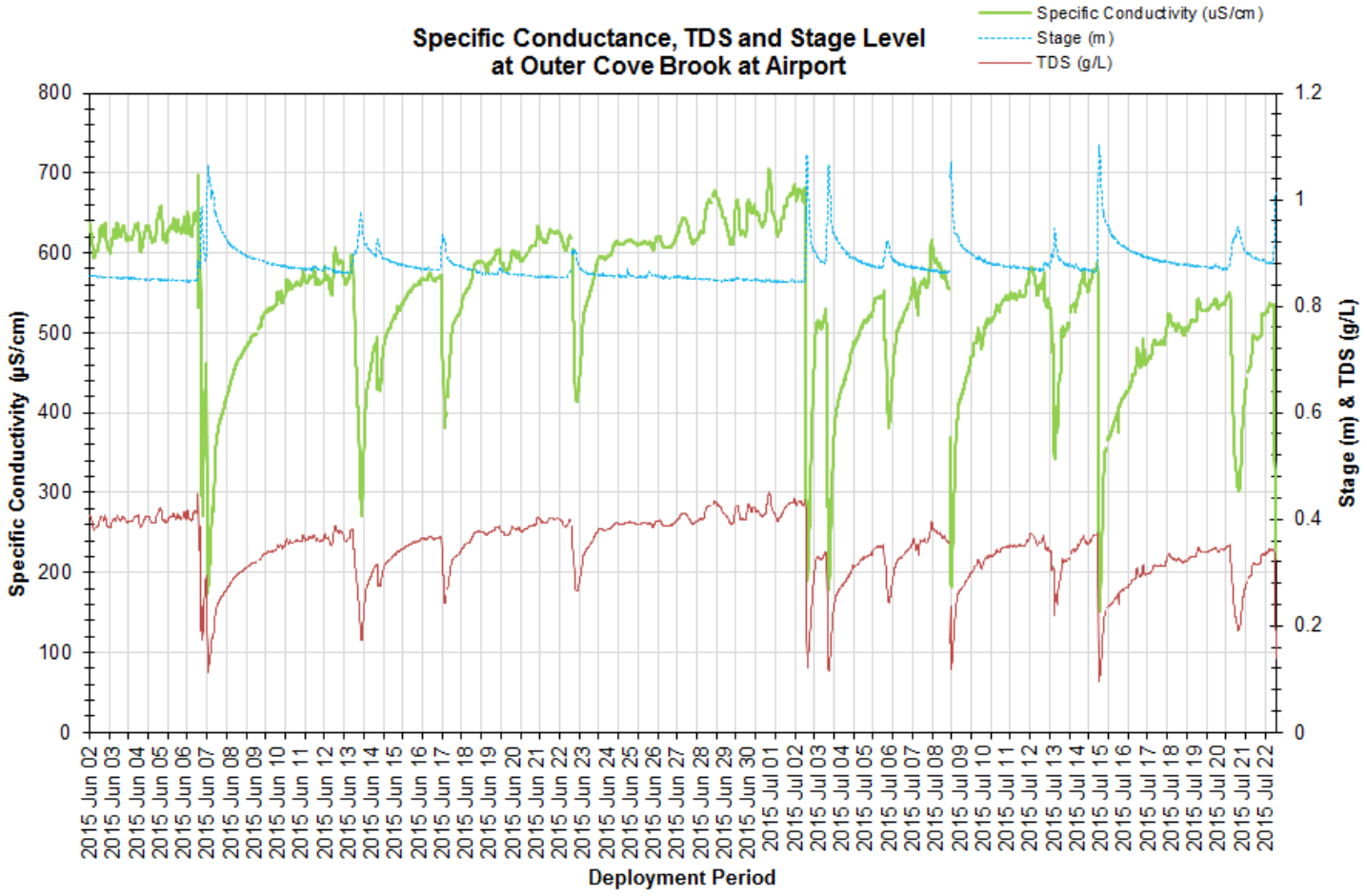

Figure 4: Specific conductivity (µS/cm) and stage (m) values at Outer Cove Brook below Airport.

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 were within 75.7 %Sat to 92.4 %Sat. Dissolved Oxygen (mg/L) measured 8.06 mg/L to 10.55 mg/L (Figure 5).

At the end of the deployment the dissolved oxygen data was inconsistent; therefore the data was removed from the statistical analysis as it did not represent the brook at that time. There is no ranking of the data during removal however there was evidence of fouling on the sensor when the instrument was taken from the brook. This fouling could have inhibited the sensors ability to read accurately.

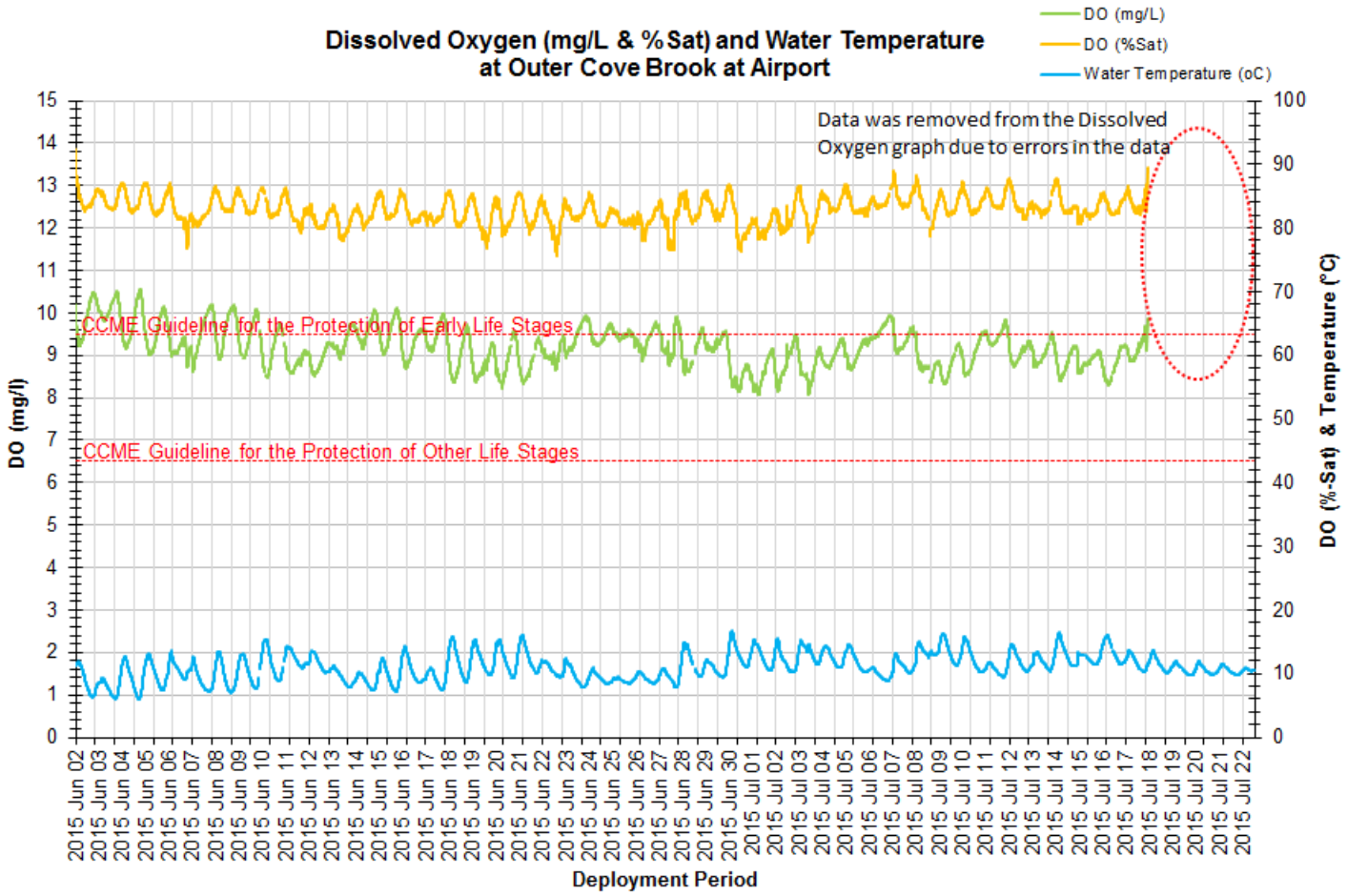

Figure 5: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport.

Turbidity

Turbidity levels during the deployment ranged between 0.0 NTU and 1206.0 NTU (Figure 6). The deployment data had a median of 2.1 NTU.

Most of 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.

The turbidity spikes that do not correlate with stage may be a result of the algae die-off that occurs as the water temperatures increases (circled in red). The turbidity sensor could be capturing the algae shedding as it dies and passes through the brook (Appendix I).

Please note the stage data is raw data that is published on our web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

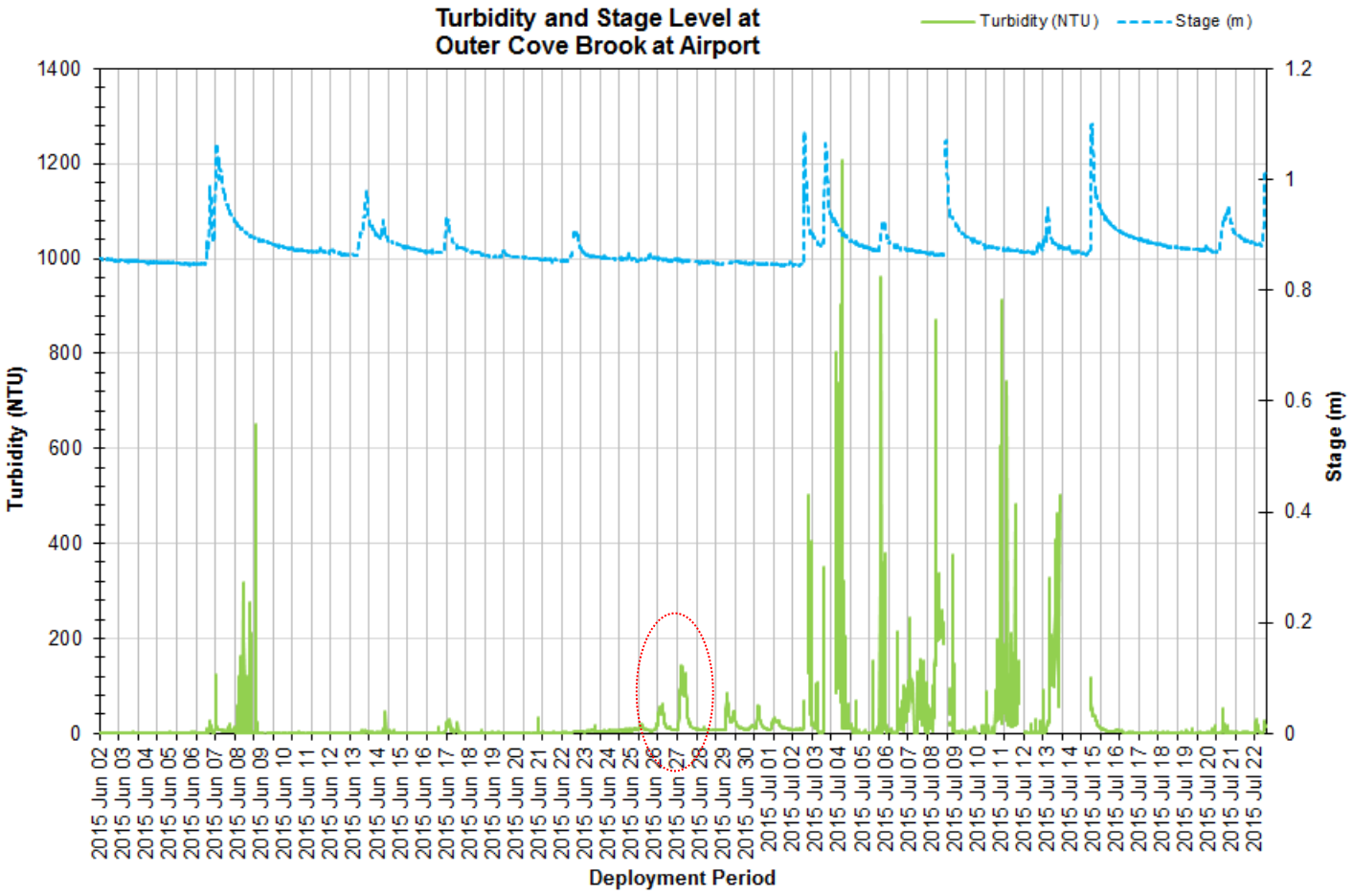

Figure 6: Turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport.

Stage, Stream Flow & Precipitation

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).

During the deployment period, the daily averaged stage data ranged from 0.84m to 1.10m. The larger peaks in stage correspond with substantial rainfall events as noted on Figure 7.

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 37.2 mm on June 7th which increased both stage and stream flow at that time.

Please note the stage and stream flow data graphed below is raw data that is published on WRMD web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

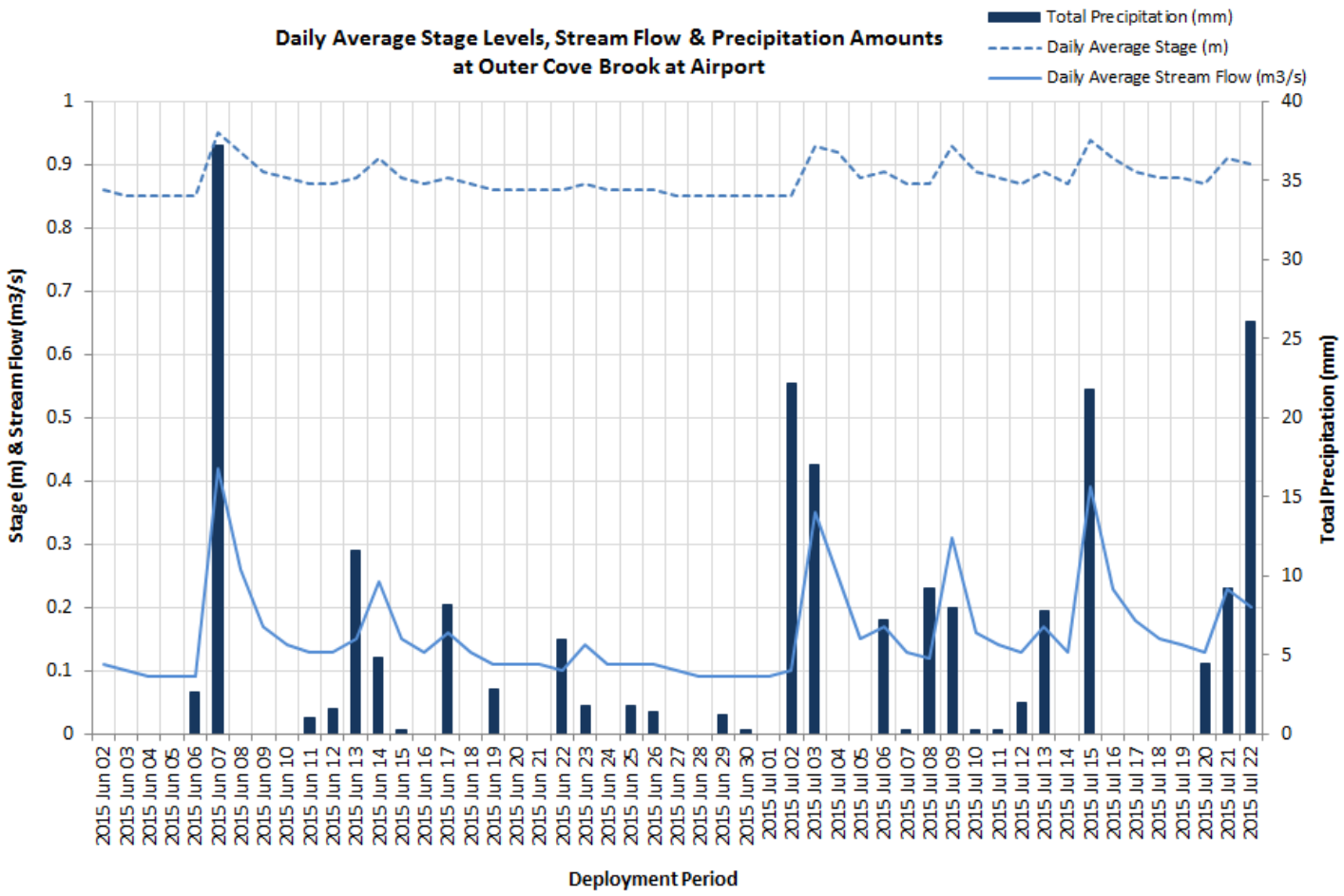

Figure 7: Daily average Stage & Stream Flow values at Outer Cove Brook below Airport and daily total precipitation values from Environment Canada's St. John's Airport Station.

Conclusion

As with many shallow brooks and streams, precipitation events play a role in influencing the parameters within the water body. Outer Cove Brook at Airport 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.

Rainfall events decreased conductivity for short periods of time flushing the dissolved material through the brook. High stage levels reflecting rainfall, also contributed to bursts in turbidity readings for short periods of time. During the deployment there was significant algae cover of the brook, it seems with the warmer water temperatures the algae begins to die off and during this process can cause interference with some of the sensors.

The warmer ambient air temperatures (Appendix II) resulted in a slight increase in water temperature over this deployment period. In turn, water temperature directly affects the amount of dissolved oxygen present in the brook and it is common to see mirroring trends in dissolved oxygen. During the deployment there were inaccuracies with the dissolved oxygen data from July 18th onwards, this data was removed to ensure it was not used in any statistical analysis.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

Water temperature ranged from 6.20°C to 18.51°C during this deployment period (Figure 8).

During this deployment period the water temperature remains reasonably consistent. Water temperatures dip slighting during higher stage levels circled in red on Figure 8.

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

Please note the stage data graphed below is raw data that is published on WRMD web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

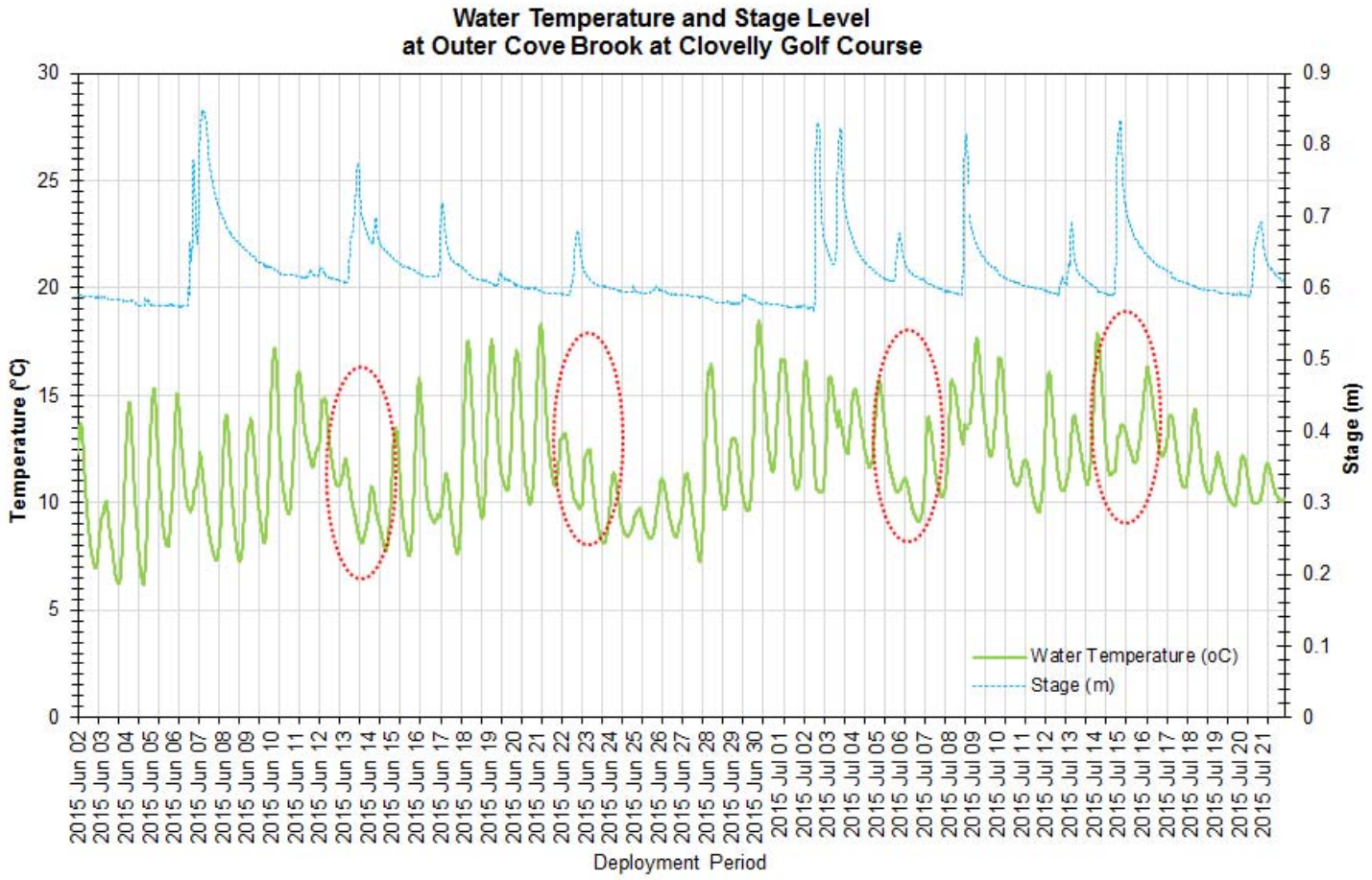

Figure 8: Water temperature (°C) and Stage (m) levels at Outer Cove Brook at Clovelly Golf Course.

pH

Throughout this deployment period pH values ranged between 5.93 pH units and 6.82 pH units (Figure 9).

The pH data that did dip below the minimum guideline corresponded with increases in stage level. Increases in stage resulted in increases and then decreases in pH values.

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 6.40 units (a slightly lower pH median from last deployment).

Please note the stage data graphed below is raw data that is published on WRMD web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

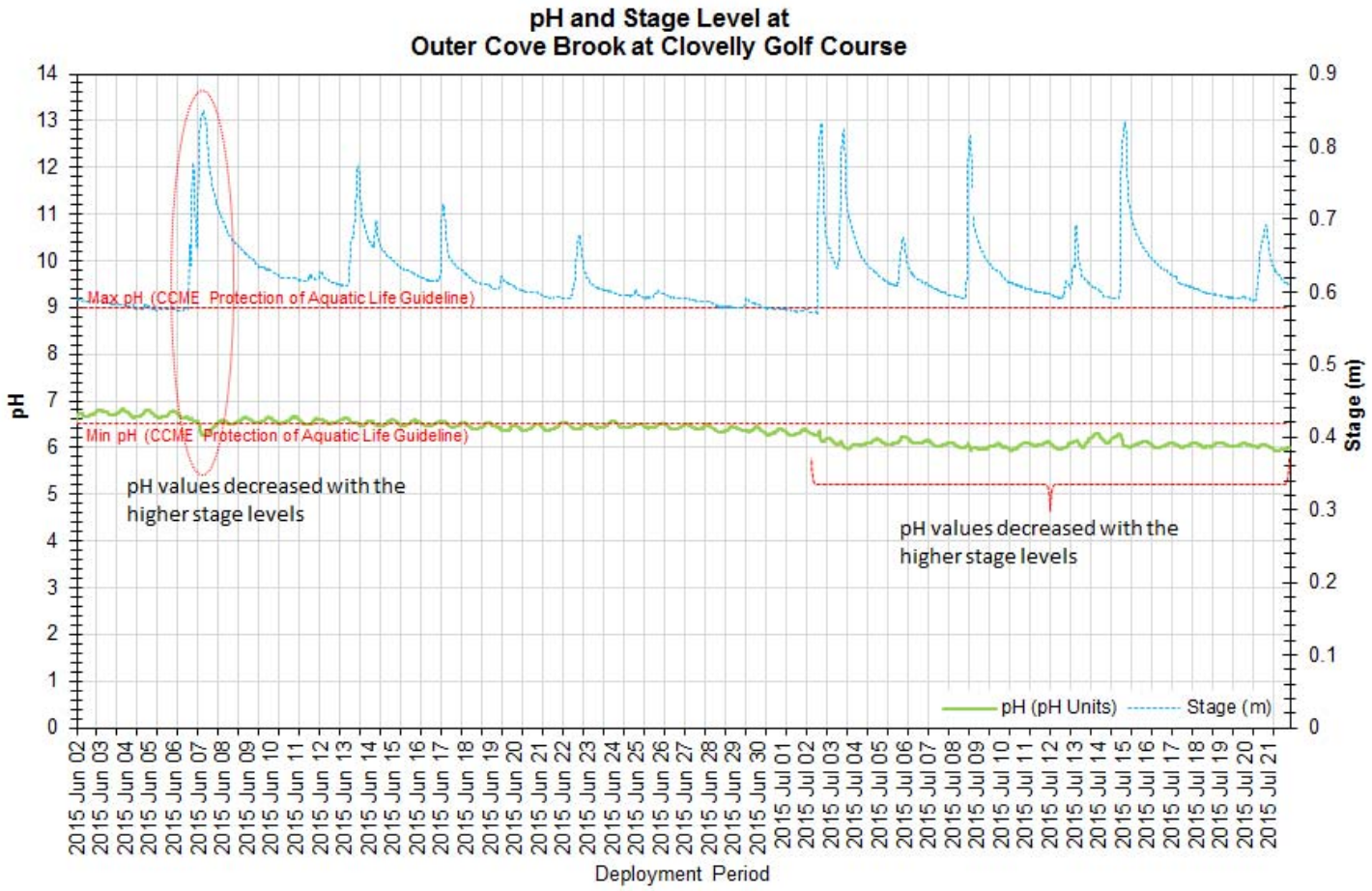

Figure 9: pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Specific Conductivity & TDS

The conductivity levels were within 190.7µS/cm and 731.0µS/cm during this deployment period. TDS ranged from 0.1220g/L to 0.4680g/L (Figure 10)

Generally, rainfall saturates the brook and flushes the dissolved particles from the water column diluting the conductivity levels for a short period of time. This is evident on Figure 10, as the stage increases in the brook the conductivity levels dip for short periods 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.

Please note the stage data graphed below is raw data that is published on WRMD web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC

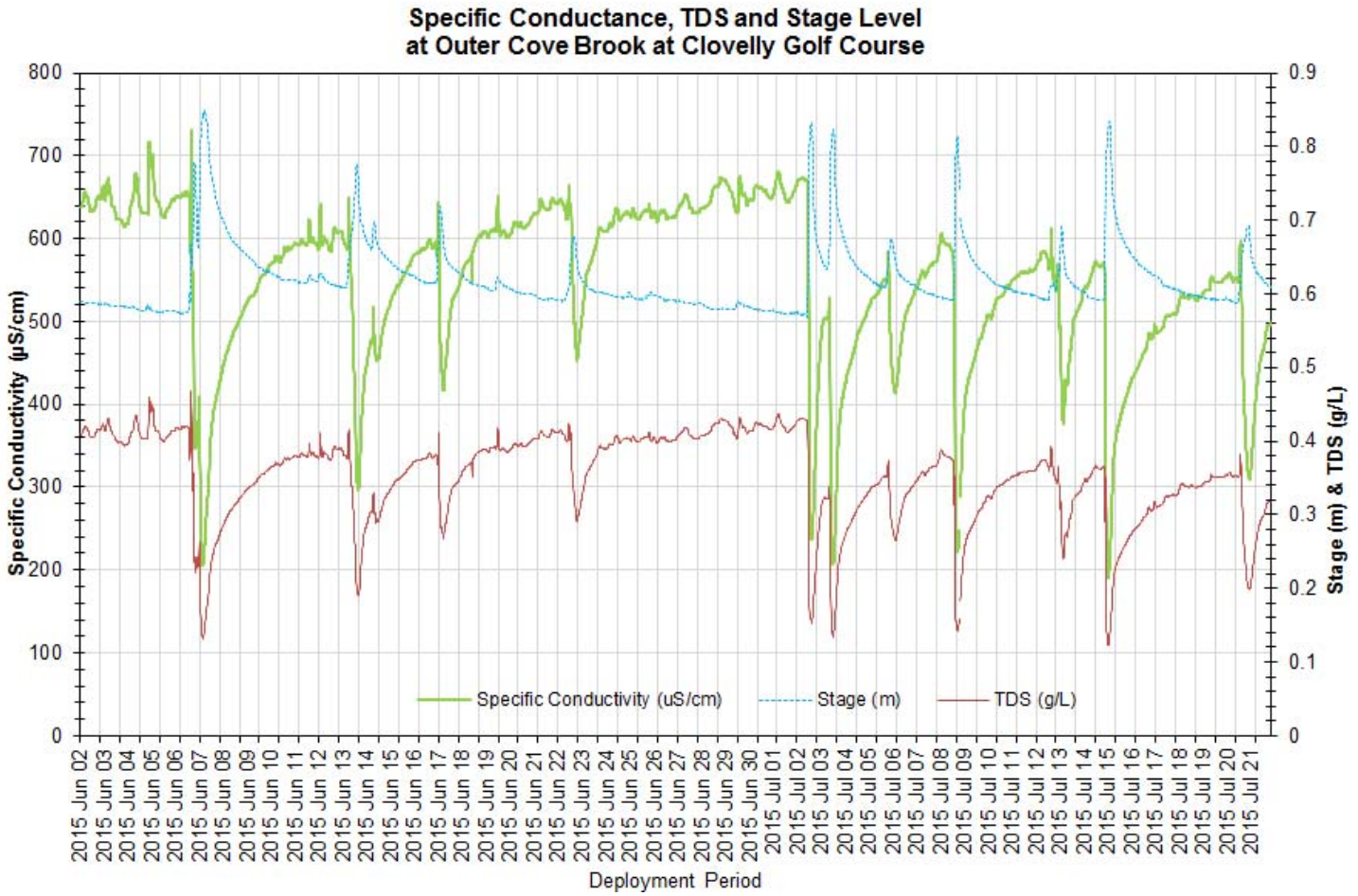

Figure 10: Specific conductivity (uS/cm) and stage (m) values at Outer Cove Brook at Clovelly Golf Course.

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 64.5 %Sat to 98.7 %Sat. Dissolved Oxygen (mg/L) measured 7.04 mg/L to 10.66 mg/L (Figure 11).

The dissolved oxygen (mg/L) level remained above the CCME Guideline for the Protection of Other Life Stages for the duration of the deployment period.

It should be noted that the warmer water temperatures decrease the amount of dissolved oxygen a water body can hold. As water temperatures increase (most likely during the day) the dissolved oxygen levels in the water decrease with consumption from the aquatic organisms and vegetation present in the brook.

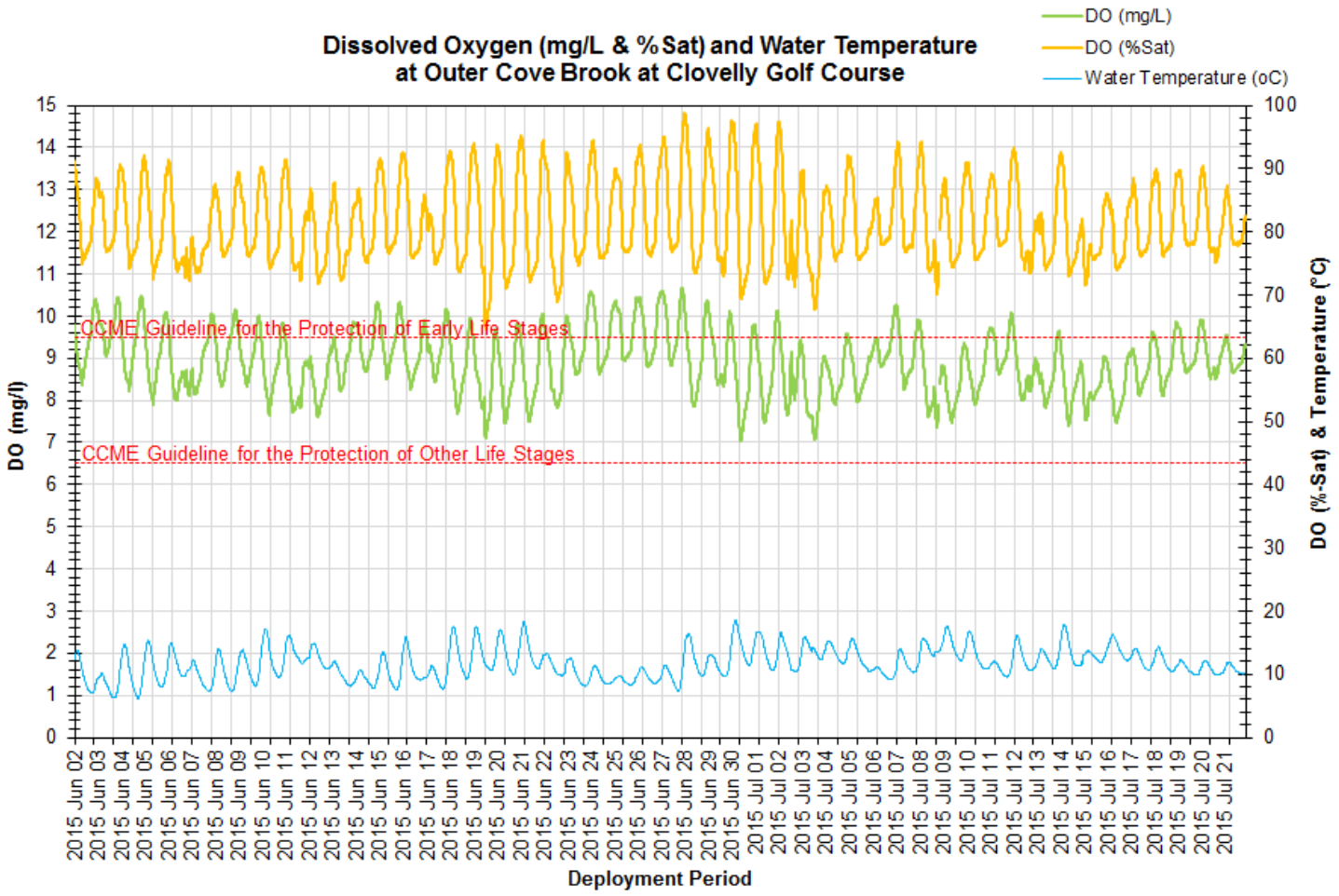

Figure 11: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook at Clovelly Golf Course.

Turbidity

Turbidity levels during the deployment period ranged from 0.0 NTU to 133.4 NTU (Figure 12), with a median of 0.8 NTU.

As depicted on the graph there were several turbidity spikes during deployment. The majority of turbidity increases on the turbidity graph correspond with stage increases at the same time. The largest turbidity event was recorded on July 13th 2015. The total precipitation data indicates that there was 7.8mm of rainfall on July 13th, 2015 which likely contributed to the turbidity.

The turbidity event circled in red was also represented on the turbidity graph for Outer Cove Brook below Airport. It is not determined what may have caused the turbidity to increase during this time. However previous findings have indicated a die off of the algae as the water temperatures rise may be responsible for the turbidity increase. The turbidity event on June 26th to June 28th may be a result of this die off occurring (Appendix I).

Please note the stage data graphed below is raw data that is published on WRMD web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC

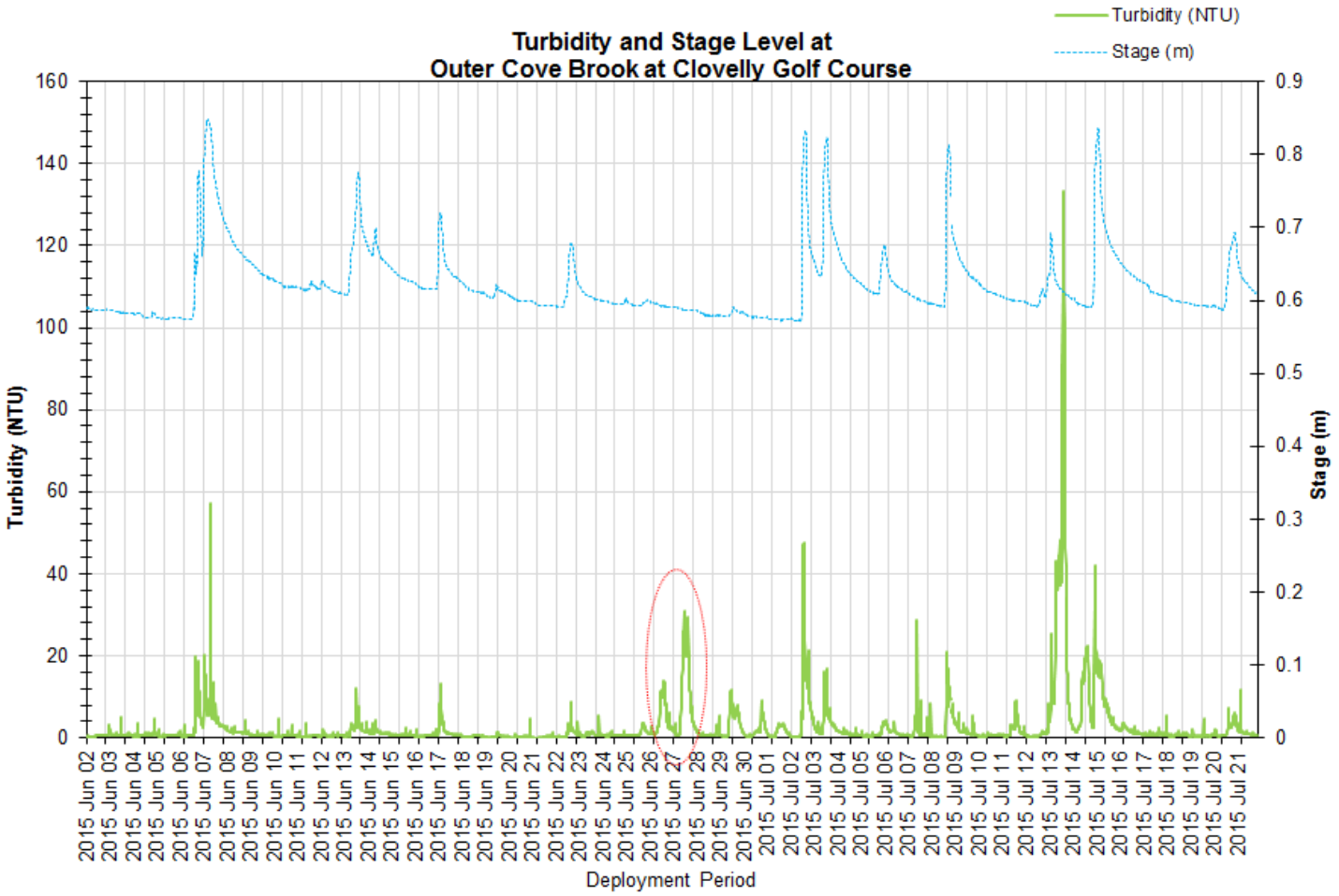

Figure 12: Turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Stage, Stream Flow and Total Precipitation

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).

Stage levels during this deployment ranged from a minimum of 0.57m to a maximum of 0.85m. Stream flow levels ranged from a minimum of 0.07m^3/s to a maximum of 0.90m^3/s. The precipitation ranged from a minimum of 0.0 mm a day to a maximum of 37.2mm which was on June 7th, 2015. This rainfall event increased stage and stream flow at Outer Cove Brook at Clovelly Golf Course for a short period of time (Figure 13).

Precipitation data was obtained from Environment Canada's St. John's Airport weather station. Please note the stage and stream flow data graphed below is raw data that is published on WRMD web page. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

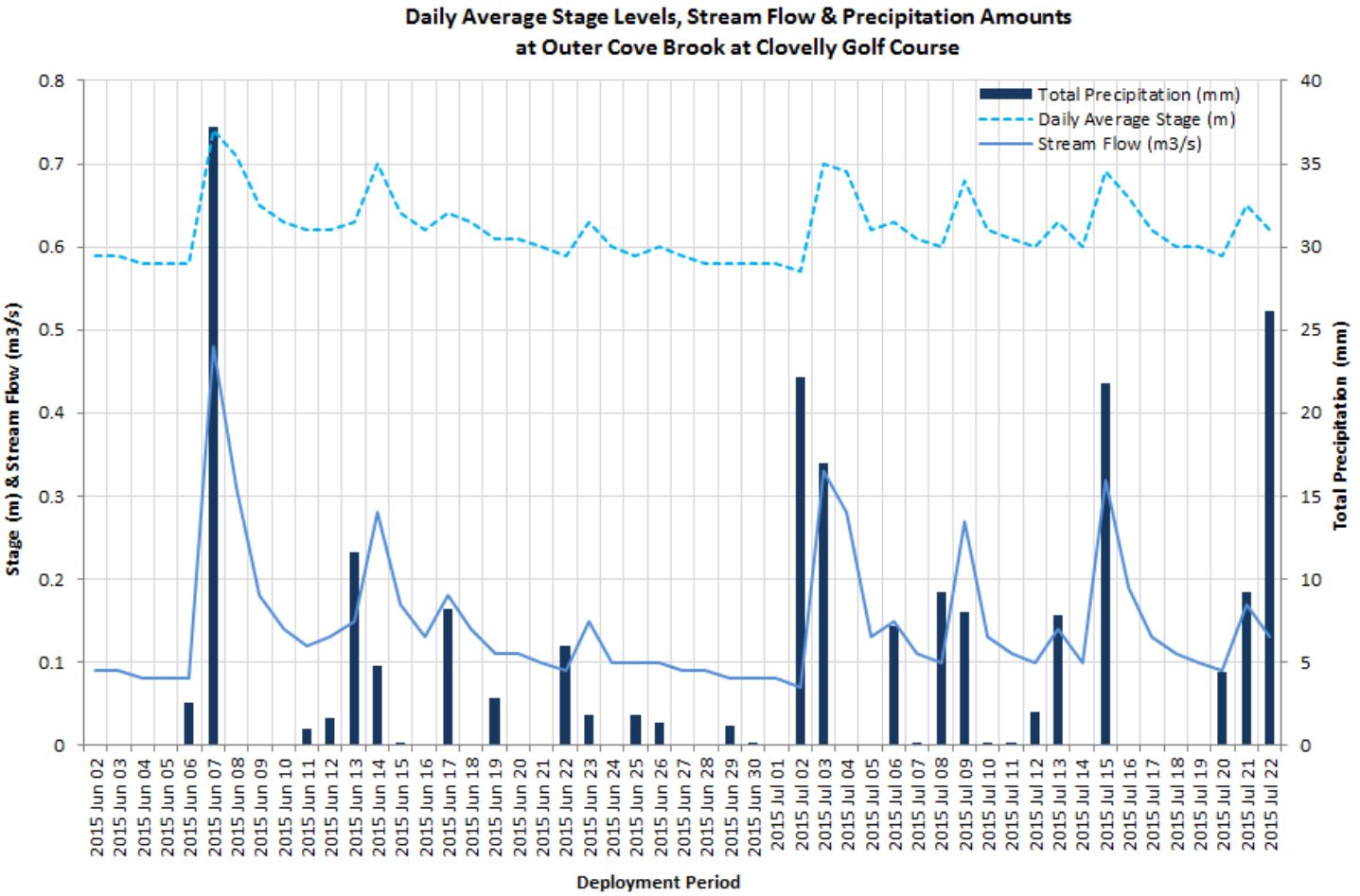

Figure 13: Daily average stage & stream flow values at Outer Cove Brook at Clovelly Golf Course and daily total precipitation values (mm) from Environment Canada's Weather Station at St. John's International Airport.

Conclusion

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.

Outer Cove Brook at Clovelly Golf Course station is the second station along Outer Cove Brook. During water quality changes or evident it is sometimes evident at both stations. Appendix III displays the water quality parameters graphed together for this deployment period.

Water temperature displayed data representative of an urban brook, with examples of small dips in water temperature during higher stage events. pH data indicated influences from higher stage events. High stage events on July 2nd, 2015 influenced the pH levels to drop below the minimum CCME guideline for the Protection of Aquatic Life. During these increases in stage the conductivity levels also adjusted by decreasing as the suspended minerals are flushed from the brook for a short period of time.

Dissolved oxygen levels remained relatively constant. The concentration levels of dissolved oxygen had a median of 8.87mg/L during deployment. The dissolved oxygen levels didn't drop below the CCME guideline for the Protection of Other Life Stages.

Turbidity levels fluctuated during deployment, with the majority of the higher turbidity values linked with high stage levels. An event on June 26th, June 27th and June 28th corresponds with turbidity increases at Outer Cove Brook below Airport during the same time frame (Appendix III). It is likely these turbidity readings are a result of algae die-off that occurs as the water temperatures start to warm up.

APPENDIX I

Figure 14: QAQC sonde in Outer Cove Brook below Airport. Evidence of the algae present on the brook floor.

Figure 15: Outer Cove Brook below Airport. A closer look at the algae present in the brook.

Figure 16: Field Instrument in Outer Cove Brook below Airport. Algae is present on everything in the water

Figure 17: Field Instrument from Outer Cove Brook below Airport removed after a deployment period. Algae are present on the instrument however the wiper has managed to keep majority of the fouling away from the tops of the sensors.

APPENDIX II

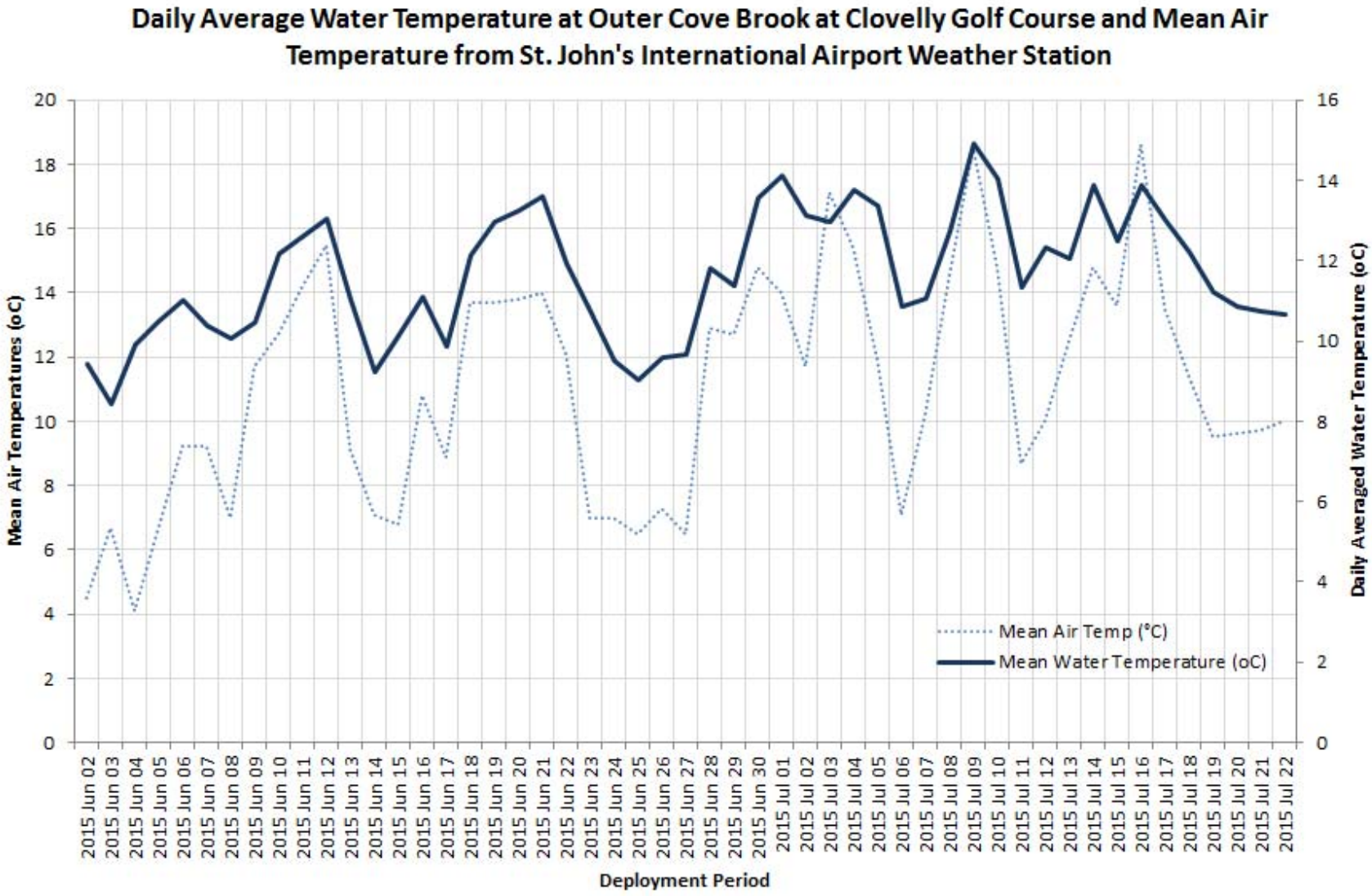

Figure 18: Daily average water temperature values from Outer Cove Brook at Clovelly Golf Course and air temperature values from Environment Canada's Weather Station at St. John's International Airport.

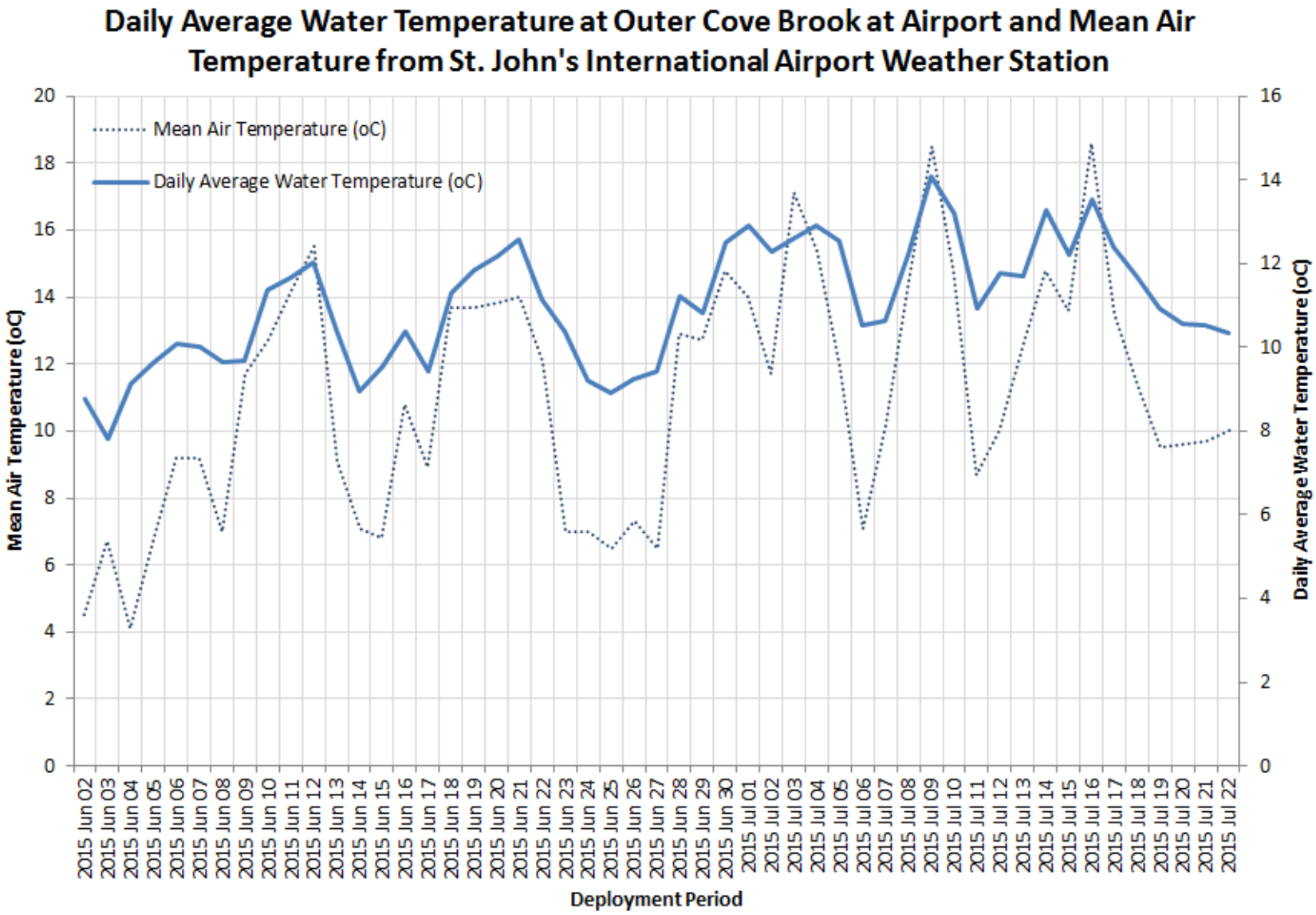

Figure 19: Daily average water temperature values from Outer Cove Brook below Airport and air temperature values from Environment Canada's Weather Station at St. John's International Airport.

APPENDIX III

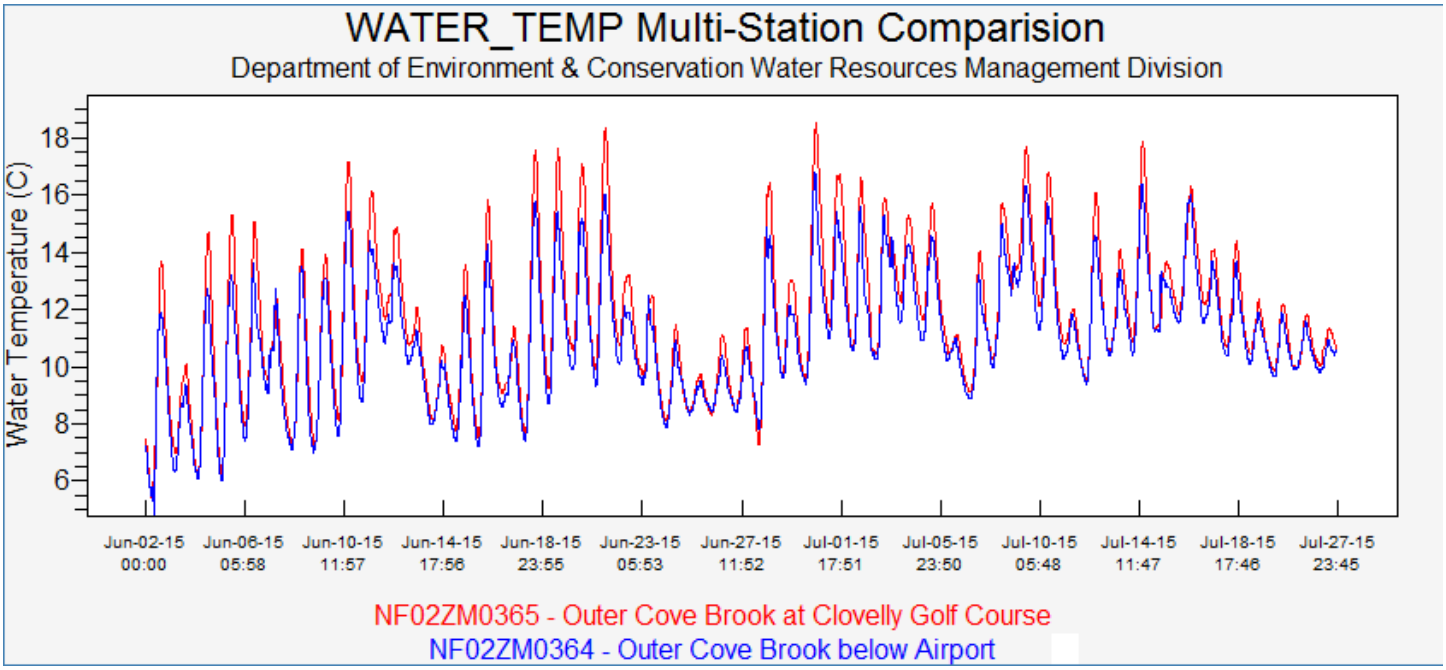

Figure 20: Comparison Water Temperature at the Outer Cove Brook Stations

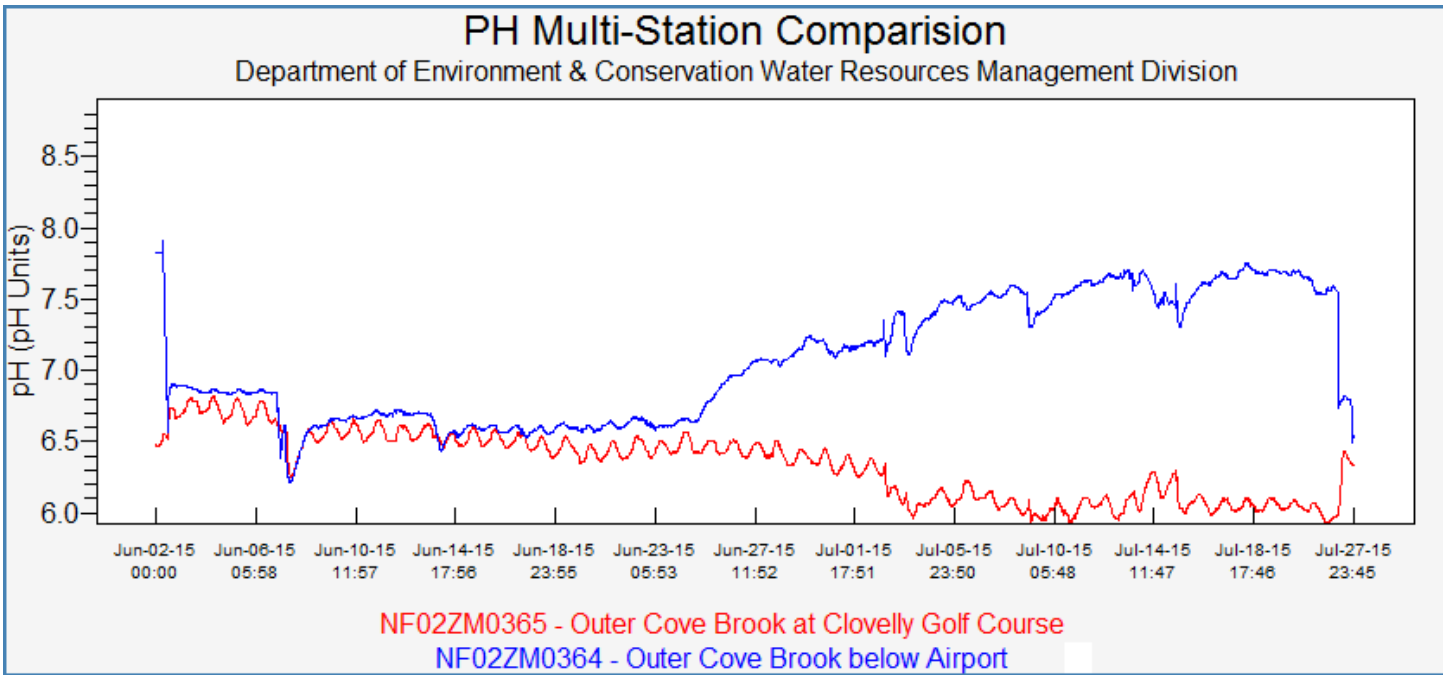

Figure 21: Comparison of pH units at the Outer Cove Brook Stations

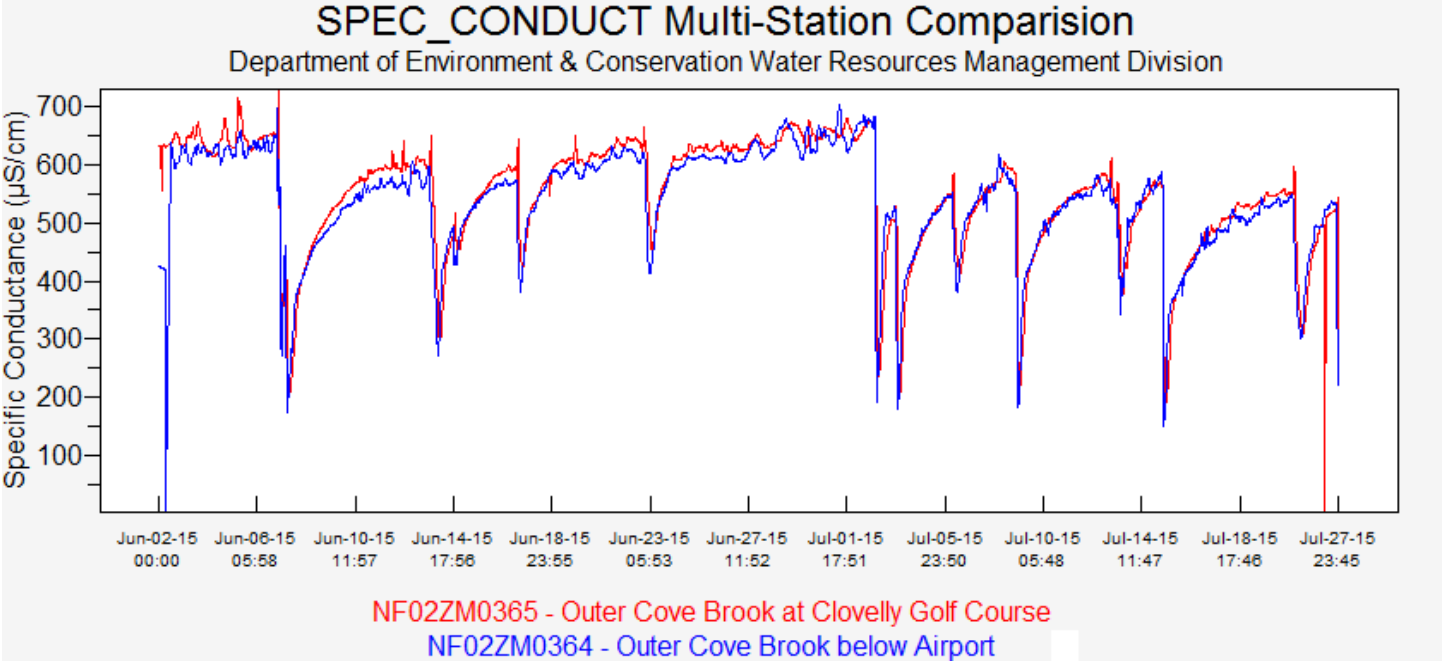

Figure 22: Comparison Specific Conductivity at the Outer Cove Brook Stations

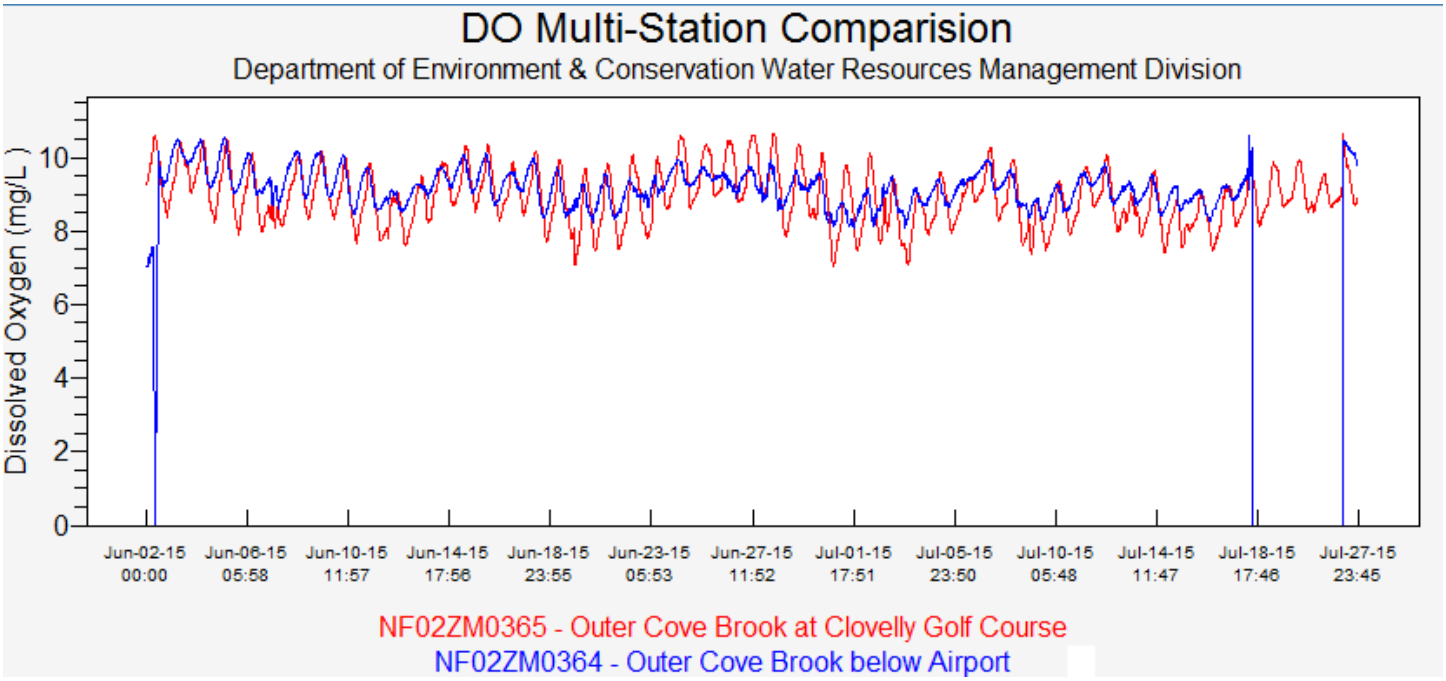

Figure 23: Comparison of Dissolved Oxygen (mg/L) at the Outer Cove Brook Station

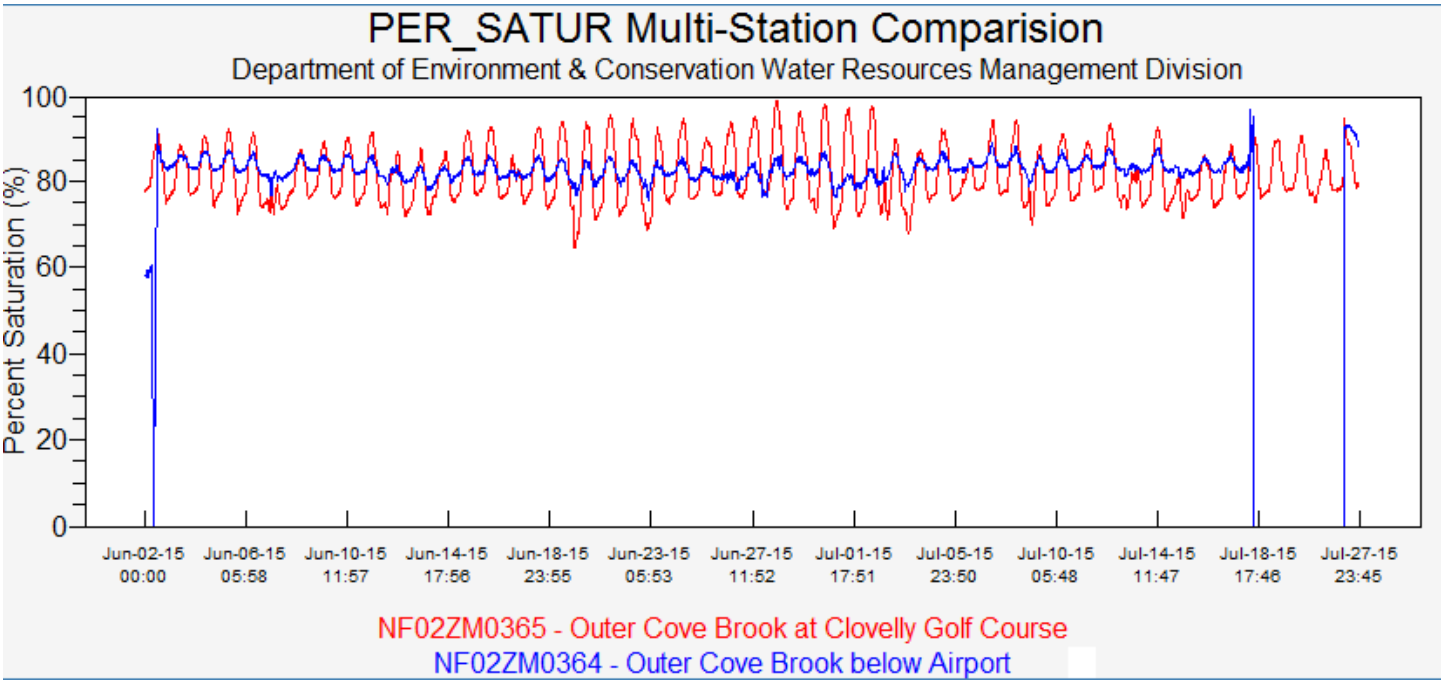

Figure 24: Comparison of Dissolved Oxygen (%Sat) of the Outer Cove Brook stations

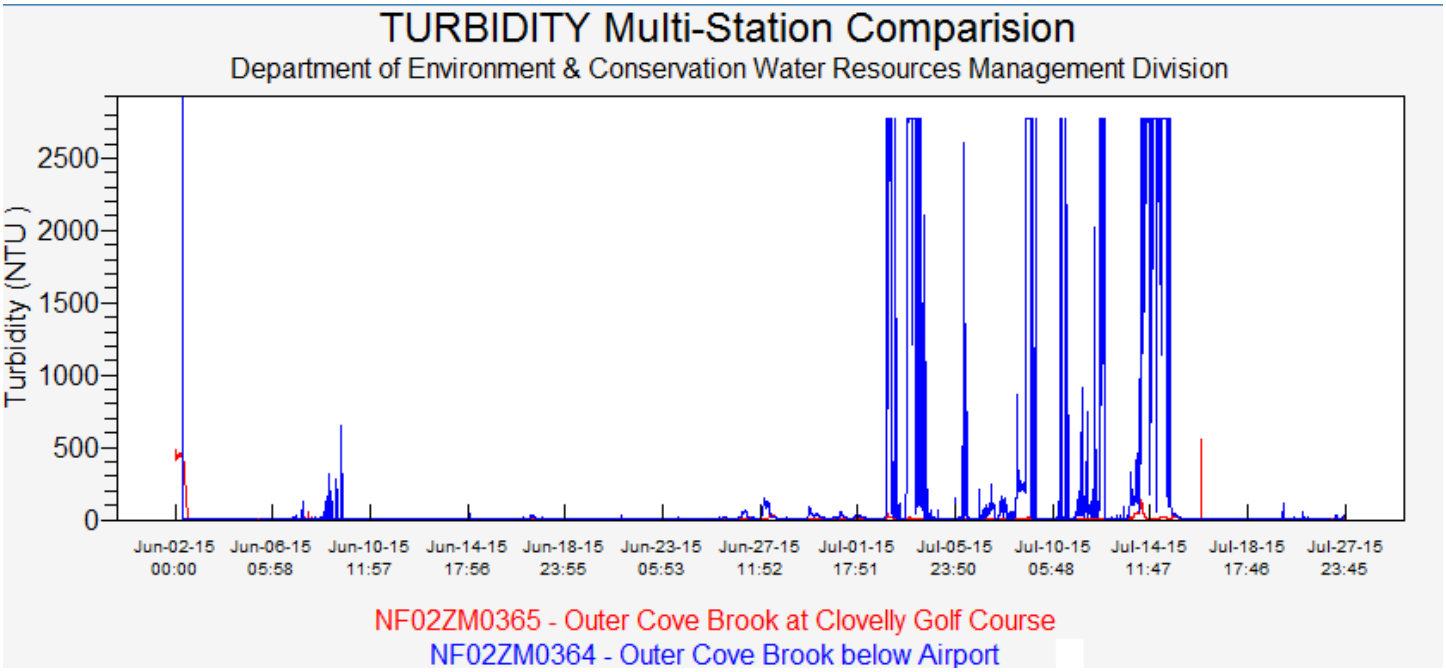

Figure 25: Comparison of Turbidity at the Outer Cove Brook stations

*Please note: Turbidity data that was removed for the report is evident in the graph above; this data does not represent the water body.