Real-Time Water Quality Report

Outer Cove Brook Network

Deployment Period
June 17, 2014 to August 22, 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 period from deployment on June 17, 2014 until removal on August 22, 2014.

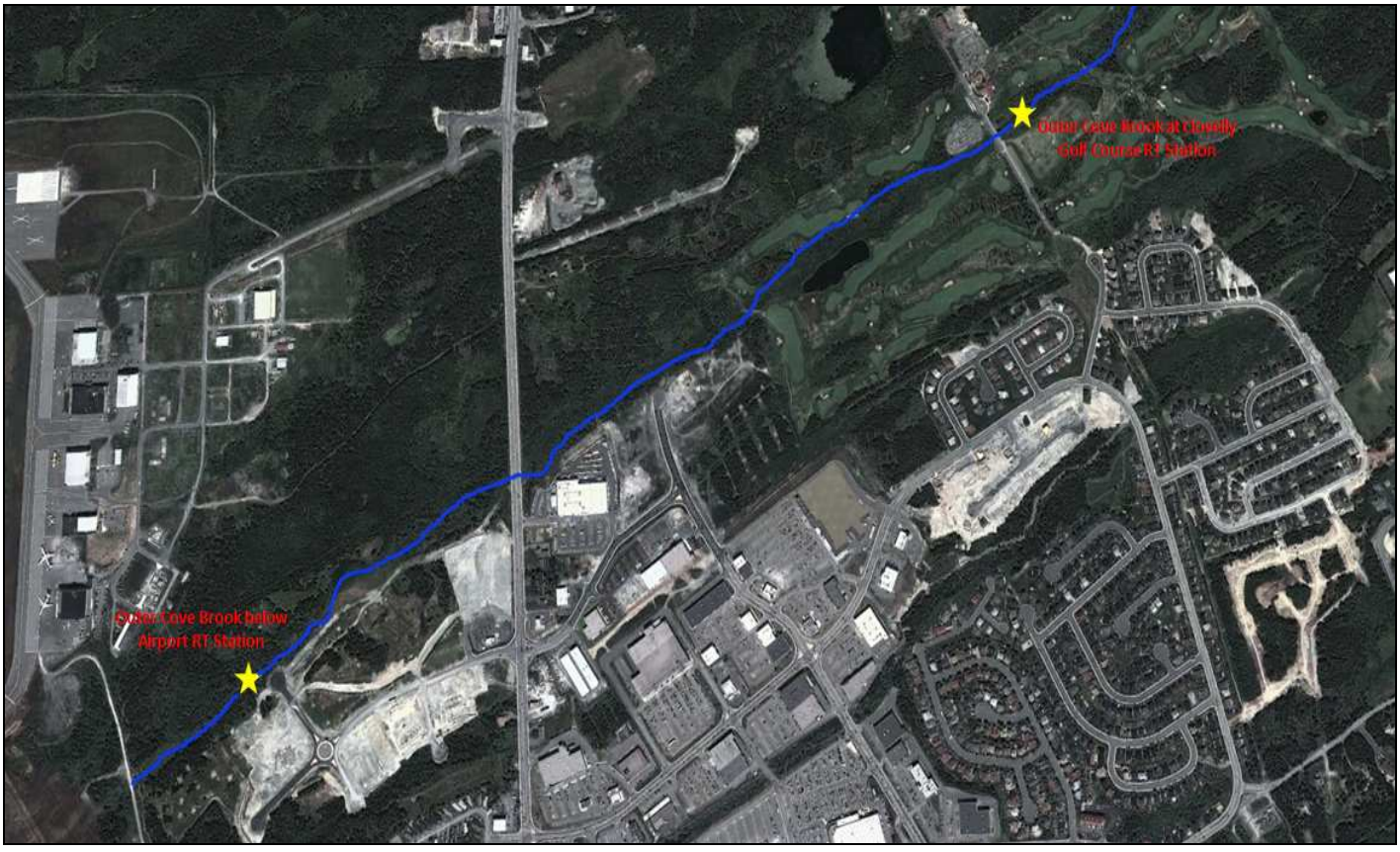

Figure 1: Outer Cove Brook Real-Time Water Quality and Quantity Stations.

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** 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 17 2014**	**Deployment**	Fair	Excellent	Excellent	Fair	Excellent
	Aug 22 2014	**Removal**	Excellent	Excellent	Excellent	Excellent	Fair

- During the Outer Cove Brook below Airport station deployment, water temperature and dissolved oxygen ranked as 'fair'. The 'fair' ranking for water temperature may be a result of the QAQC instrument not being left to stabilize long enough before a reading was taken. This also would explain the 'fair' ranking for the dissolved oxygen probe as the dissolved oxygen content is dependent upon water temperature. All other parameters at the time deployment ranked as 'excellent'.

- At removal, water temperature, pH, conductivity and dissolved oxygen values all ranked as 'excellent', while turbidity ranked as 'fair'. The turbidity probe was completely covered with algae. The lower ranking was likely a result of the fouling that was present on the probe at the time of removal. The turbidity self-cleaning arm was unable to clean the sensors due to the amount of algae that was present.

- Deployment and removal instrument performance rankings for **Outer Cove Brook at Clovelly Golf Course** for the period of June 17, 2014 to August 22, 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	June 17 2014	Deployment	Good	Good	Marginal	Excellent	Excellent
	Aug 22 2014	Removal	Excellent	Excellent	Good	Excellent	Excellent

- Comparison of the field sonde and QAQC data during the deployment at Outer Cove Brook Clovelly Golf Course indicated the following: temperature and pH values were ranked as 'Good'; conductivity ranked as 'marginal' and dissolved oxygen and turbidity data ranked as 'Excellent'. The ranking of 'Marginal' for conductivity may have been a result of an air bubble caught between the sensors; air bubbles can influence a reading on any sensor.

- At removal the comparison between the sondes indicated that, temperature, pH, dissolved oxygen and turbidity all ranked 'excellent', while conductivity data ranked as 'good'. These ranks are reasonably good for an instrument that has spent 67 days in the water.

Issues or Concerns during deployment

During this deployment there was a large amount of fouling at both stations but primarily at Outer Cove Brook below Airport. When the instrument was removed for calibration and maintenance it was covered in slime like algae growth that prevented the turbidity self-cleaning arm from turning and cleaning the tops of the sensors off. Due to the algae, some of the data for turbidity and dissolved oxygen (%sat and mg/L) had to be removed as it was not accurate at that time.

It should also be noted that this is a longer than normal deployment period for these stations. The reason for the extended deployment is that on July 4th, Outer Cove Brook below Airport was changed out with another instrument (freshly calibrated) to see if the dissolved oxygen levels could be improved. The dissolved oxygen was lower than expected for the brook. However, even with the new freshly calibrated instrument the dissolved oxygen remained low for the remainder of the deployment.

During the site visit on July 4th, it was discovered that a large amount of sediment from the construction parallel with the brook, was flowing into the brook causing the discolouration at that time (Appendix A).

Due to the excessive amount of unidentified slime-like algae present in Outer Cove Brook during spring and early summer, Outer Cove Brook below Airport is being considered for bi-weekly cleaning visits to remove as

much of the algae from the instrument as possible. This will allow the instrument to provide as accurate and correct water quality data as possible during these high algae times.

There were several short transmission errors during this deployment period at the Outer Cove Brook below Airport station. Due to the nature of the data transmission, it is not uncommon to have the data drop out for period at a time. This station sits among a large cover of trees, which may interfere with transmission as well.

Data Interpretation

The following graphs and discussion illustrate water quality-related events from June 17, 2014 through to August 22, 2014 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.

Outer Cove Brook below Airport

Water Temperature

Water temperature ranged from 8.10°C to 21.90°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.

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.

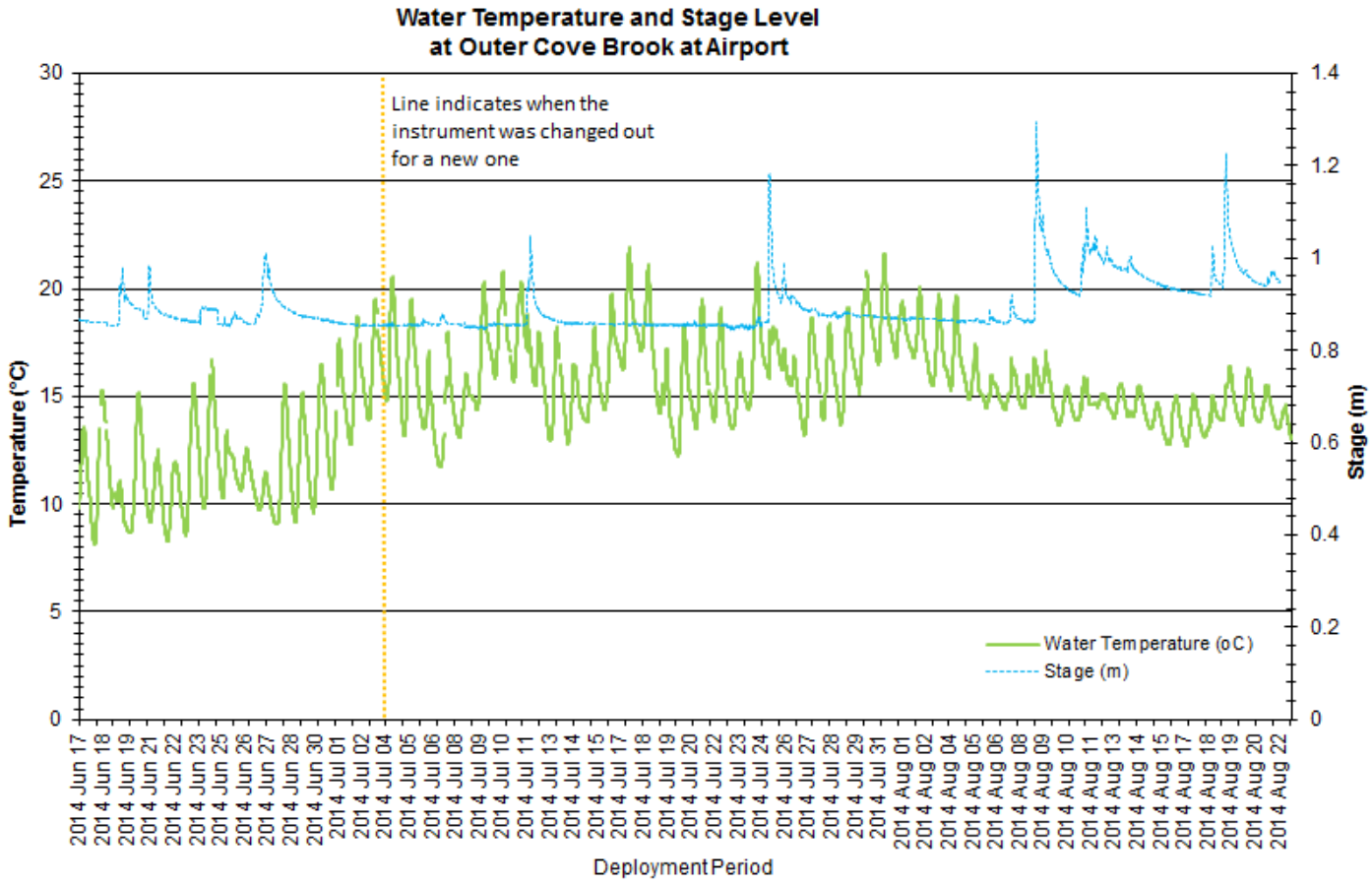

Figure 2: Water temperature (°C) and stage level (m) values at Outer Cove Brook below Airport.

pH

Throughout this deployment period pH values ranged between 5.57 pH units and 6.84 pH units (Figure 3).

During this deployment, the pH values at this station sat above the minimum CCME Guideline for the Protection of Aquatic Life (between 6.5 and 9 pH units) for the beginning of the deployment period, however for the remainder of the deployment period pH fluctuates around the lower guideline range.

The events on June 19th, July 13th, July 25th, August 8th and August 18th displaying the slight dips in pH levels also correspond with stage level increases. This can be explained by the natural correlation 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 6.42 units, which was slightly lower than last month of 6.84 (pH units).

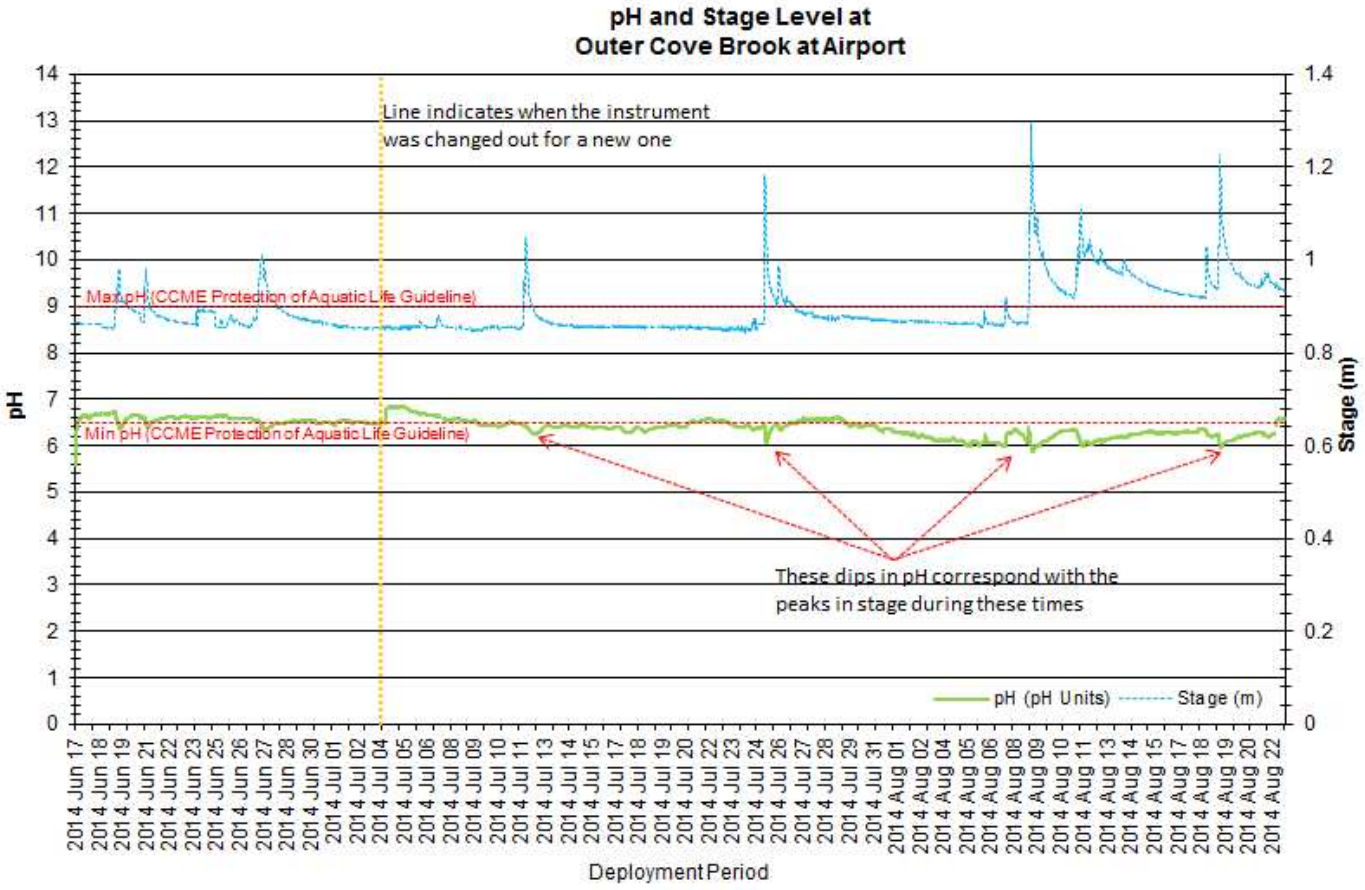

Figure 3: pH (pH units) and stage level (m) values at Outer Cove Brook below Airport

Specific Conductivity & TDS

The conductivity levels were within 92.5 µS/cm and 719.0 µS/cm during this deployment period. TDS ranged from 0.0593 g/L to 0.4600 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 present. This is evident on Figure 4 as the conductivity (green) drops in concentration as the stage level (blue) increases.

Towards the end of the deployment the conductivity levels start to decline, this may be a result of higher stage levels close together from August 8th onwards. As stage increases there is a dilution of the dissolved substances present in the brook and therefore the conductivity levels decline.

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.

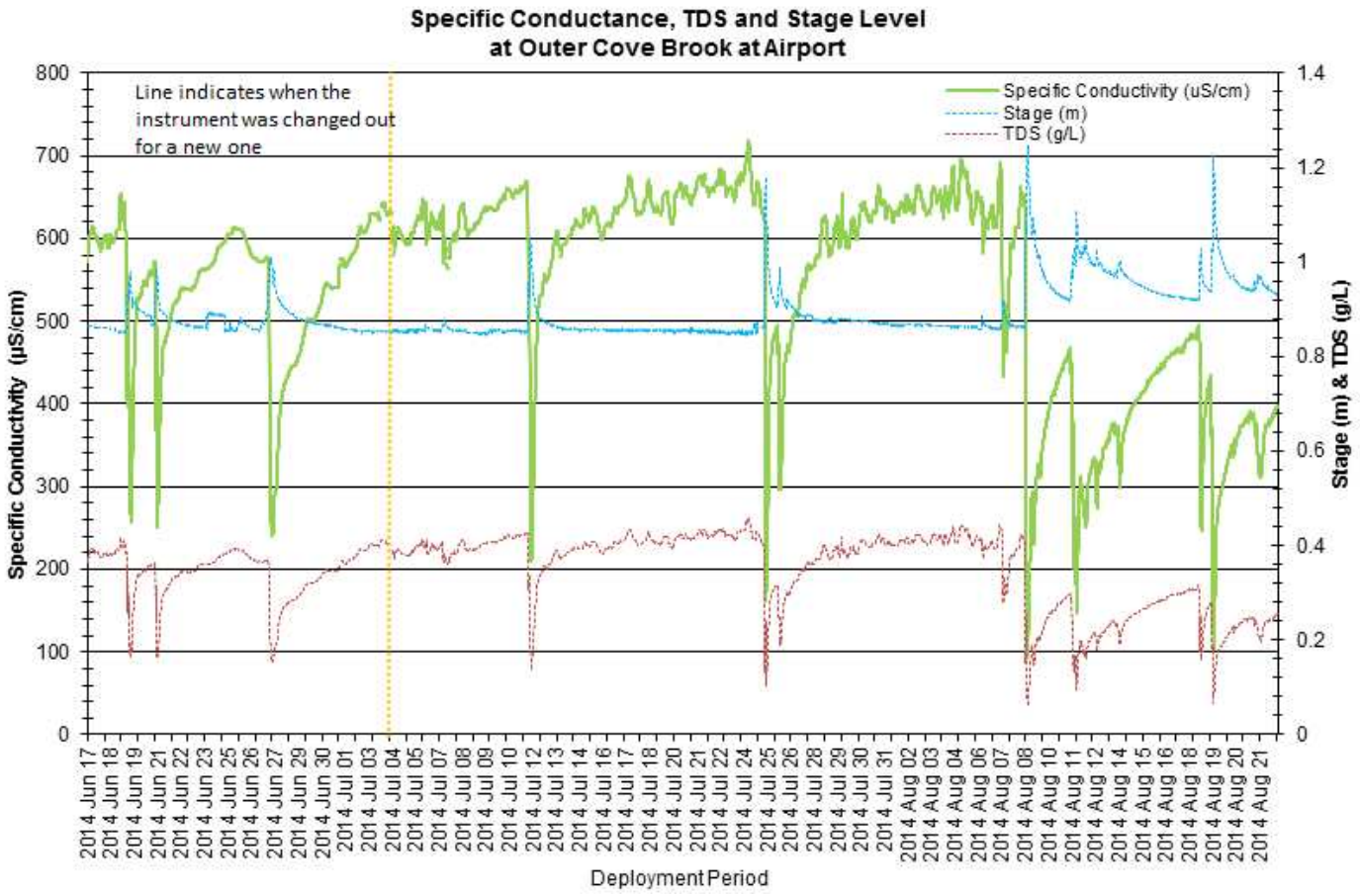

Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook below Airport.

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 7.5% Sat to 92.2% Sat. Dissolved Oxygen (mg/L) measured 0.75 mg/L to 9.90 mg/L.

During this deployment period there are several very low ranges in dissolved oxygen. It was assumed that the instrument had failed for dissolved oxygen and a replacement was put in the brook on July 4th. However the low dissolved oxygen readings continued for the remainder of the deployment period.

It is undetermined what could cause the dissolved oxygen levels to decrease. The event on June 26th -27th, July 13th and the large event on August 7th- 9th, all correspond with high stage levels and precipitation. Although rainfall can have some effect on dissolved oxygen levels, it would not likely cause such low levels as seen on Figure 5.

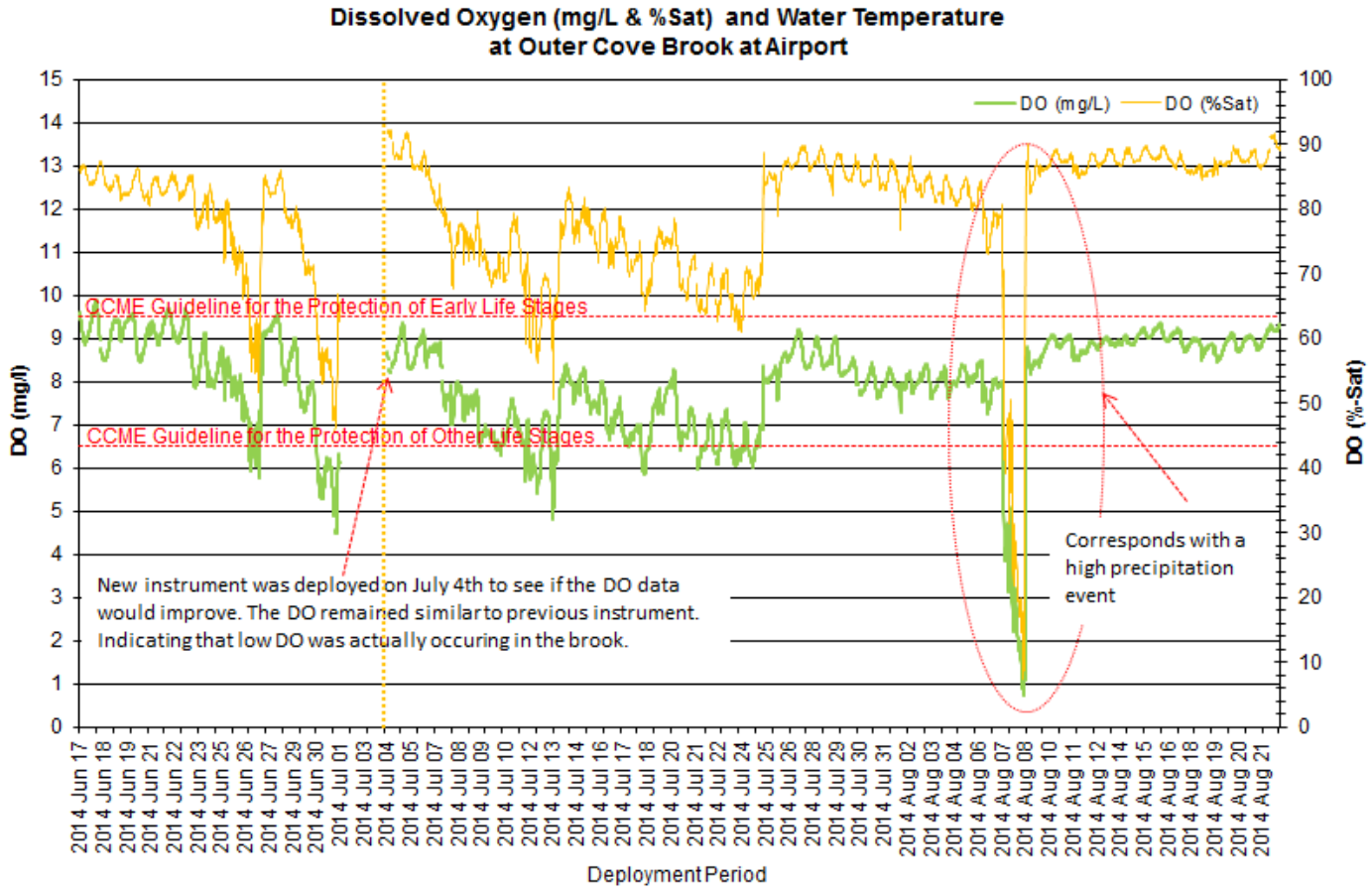

Figure 5: Dissolved oxygen (mg/L & % sat) and water temperature (°C) values at Outer Cove Brook below Airport.

Turbidity

Turbidity levels during this deployment period ranged within 0.1 NTU and 153.9 NTU (Figure 6).

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 value 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 June 21st, July 27th -28th and August 10th and onward toward the end of deployment.

The event on July 4th is a result of land clearing upstream from the station (see Appendix A). During the change out of the instrument, high turbidity was evident in the brook. It was determined after following the stream the turbidity was related to the land clearing activities ongoing upstream from the station.

During this deployment period the display of data indicated fouling on the sensor so the data was removed as it could not be used in any statistical analysis.

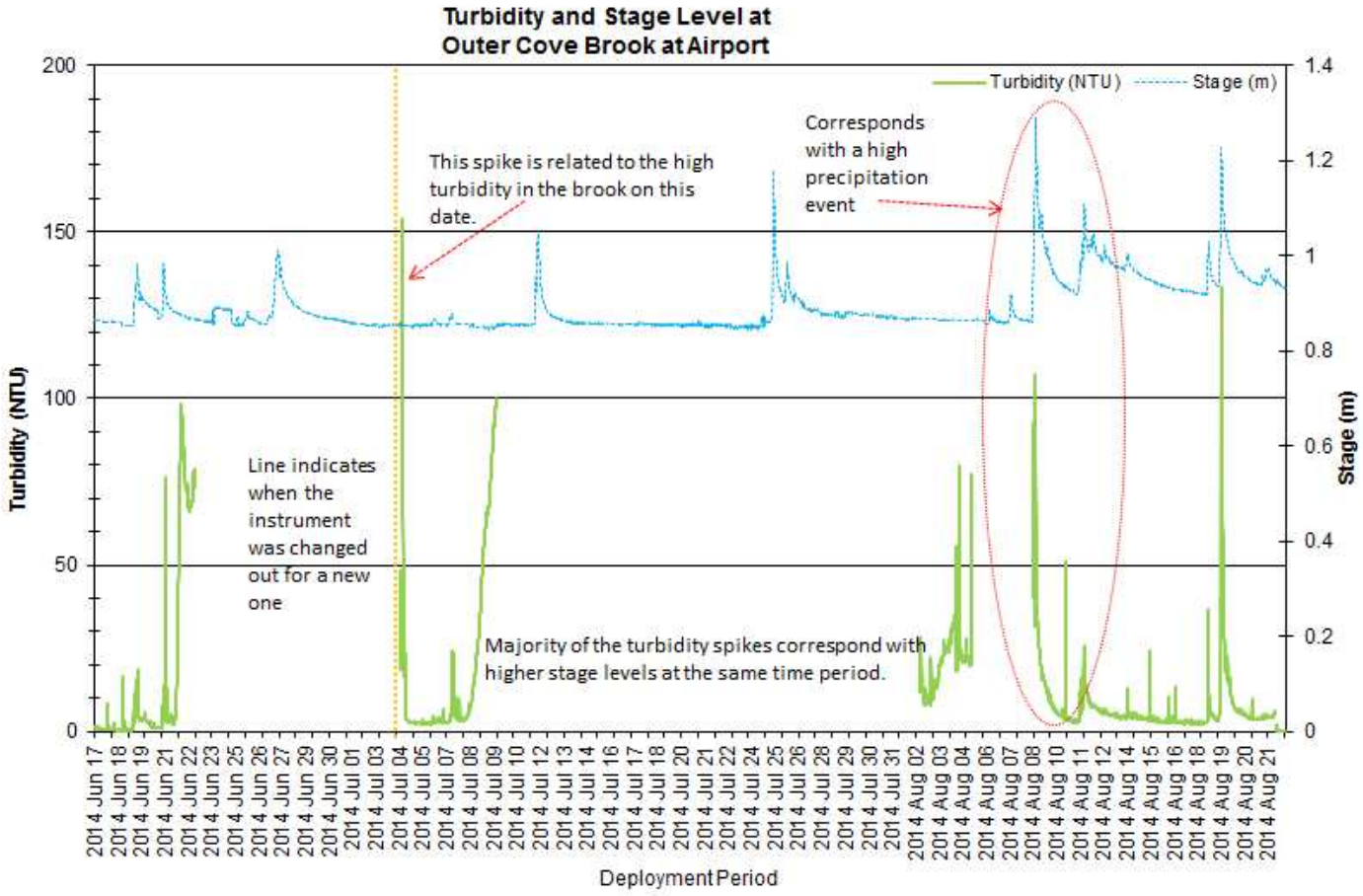

Figure 6: Turbidity (NTU) and stage level (m) values at Outer Cove Brook below Airport.

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.

During the deployment period, the stage values ranged from 0.84m to 1.29m. The larger peaks in stage do correspond with substantial rainfall events as noted on Figure 7.

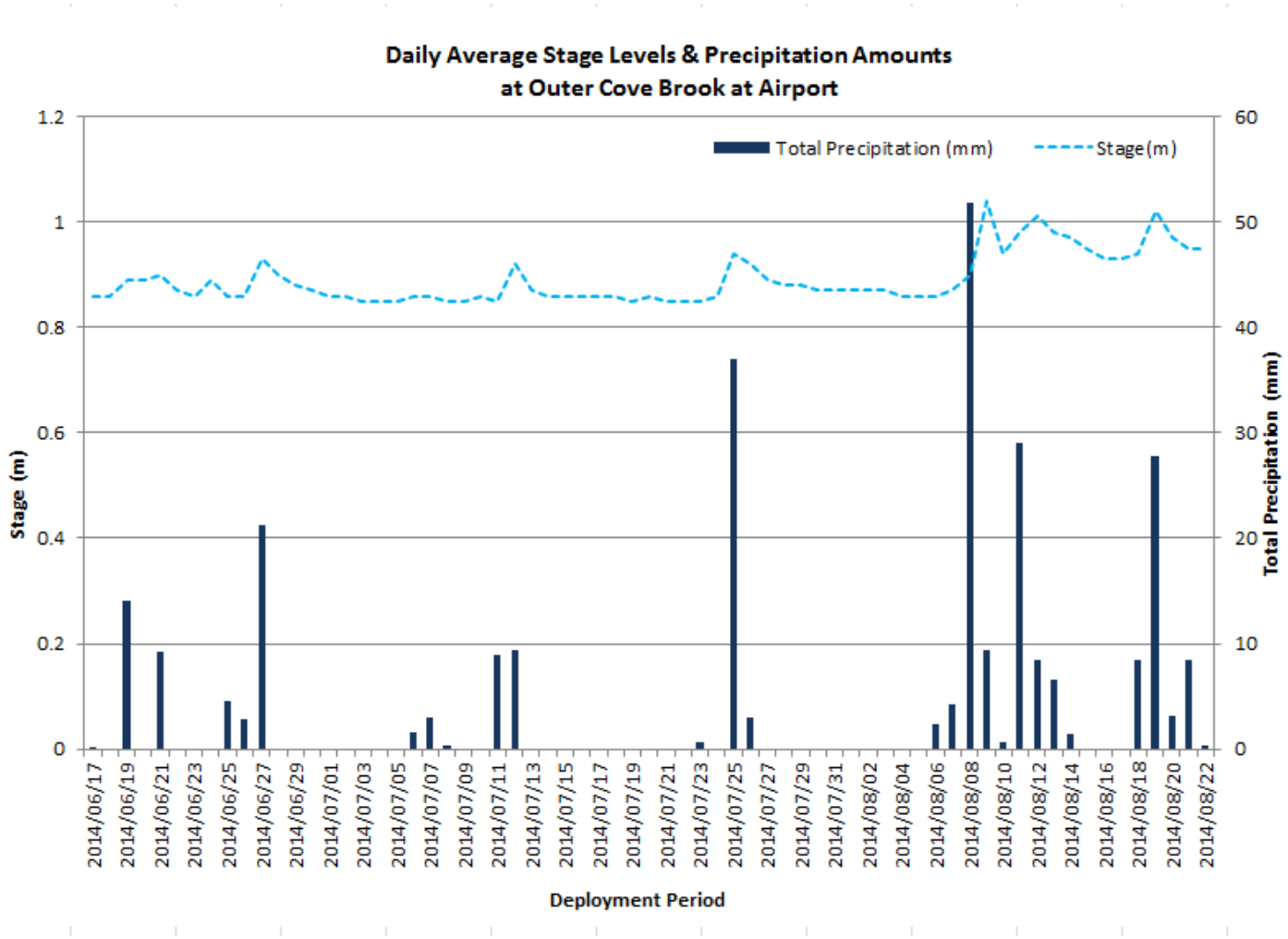

Figure 7: Daily average stage values (m) at Outer Cove Brook below Airport and daily total precipitation values (mm) from Environment Canada's St. John's Airport Weather Station.

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.

- This brook is currently impacted from the surrounding construction and earth movement for development. During this deployment period there were some evident influences from the construction. The runoff of sediment during land clearing was evident on the turbidity and even DO graphs (see pictures in Appendix A).

- 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 June 19th and August 10th caused 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 increased it caused the water temperature to increase. Water temperature directly affects the amount of dissolved oxygen present in the brook during those times and it is natural to see a slight decrease in dissolved oxygen levels with warmer water temperatures.

- Toward the end of this deployment the level of biofouling present on the instrument affected the raw data being transmitted. At removal of the instrument, there was a large amount of slime-like algae present in the brook that is not evident all year round. Environment Canada was notified of the presence of this alga. Environment Canada will also be forwarded the grab sample results taken on deployment for additional investigation.

Outer Cove Brook at Clovelly Golf Course

Water Temperature

Water temperature ranged from 8.48 ^{o}C to 23.76 ^{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 can be influenced by high stage levels; this is evident on the graph on June 18th -20th, June 26th – 28th, July 23rd to 25th to just point out a few events. Air temperatures in August were considerably cooler than previous months and this is evident on the graph towards the end of the deployment period.

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

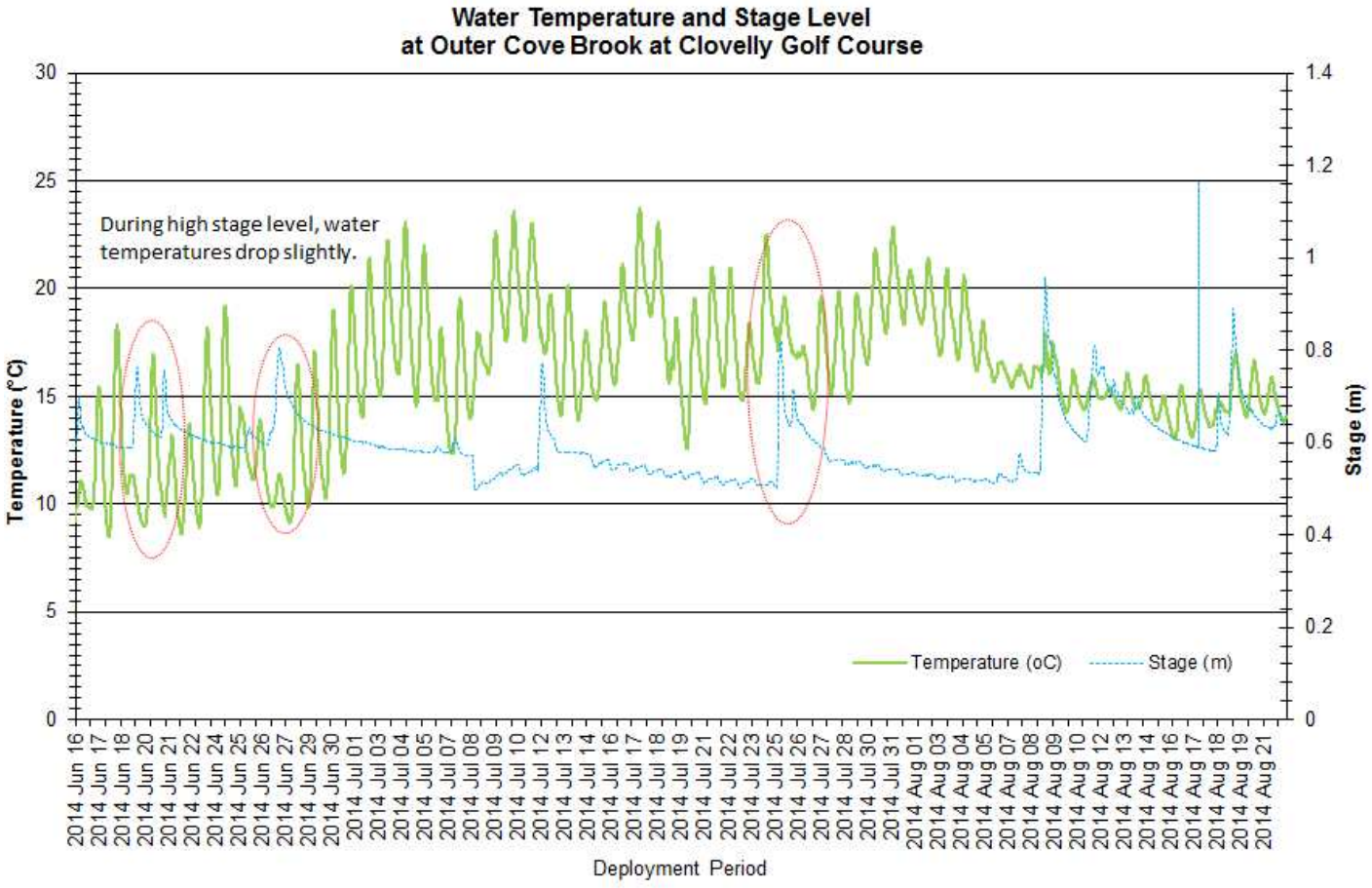

Figure 8: Water temperature (℃) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

pH

Throughout this deployment period pH values ranged between 5.77 pH units and 6.74 pH units (Figure 9).

During the deployment, the pH values at this station were generally situated within the range of the minimum CCME Guideline for the Protection of Aquatic Life. As the deployment period continues the pH level drops to just below the guideline.

There are several pH events on June 26th-27th, July 9th–10th, July 26th-27th as well as August 9th and 12th. All of these dips in pH correspond with higher stage times, likely a result of precipitation.

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 6.30 units.

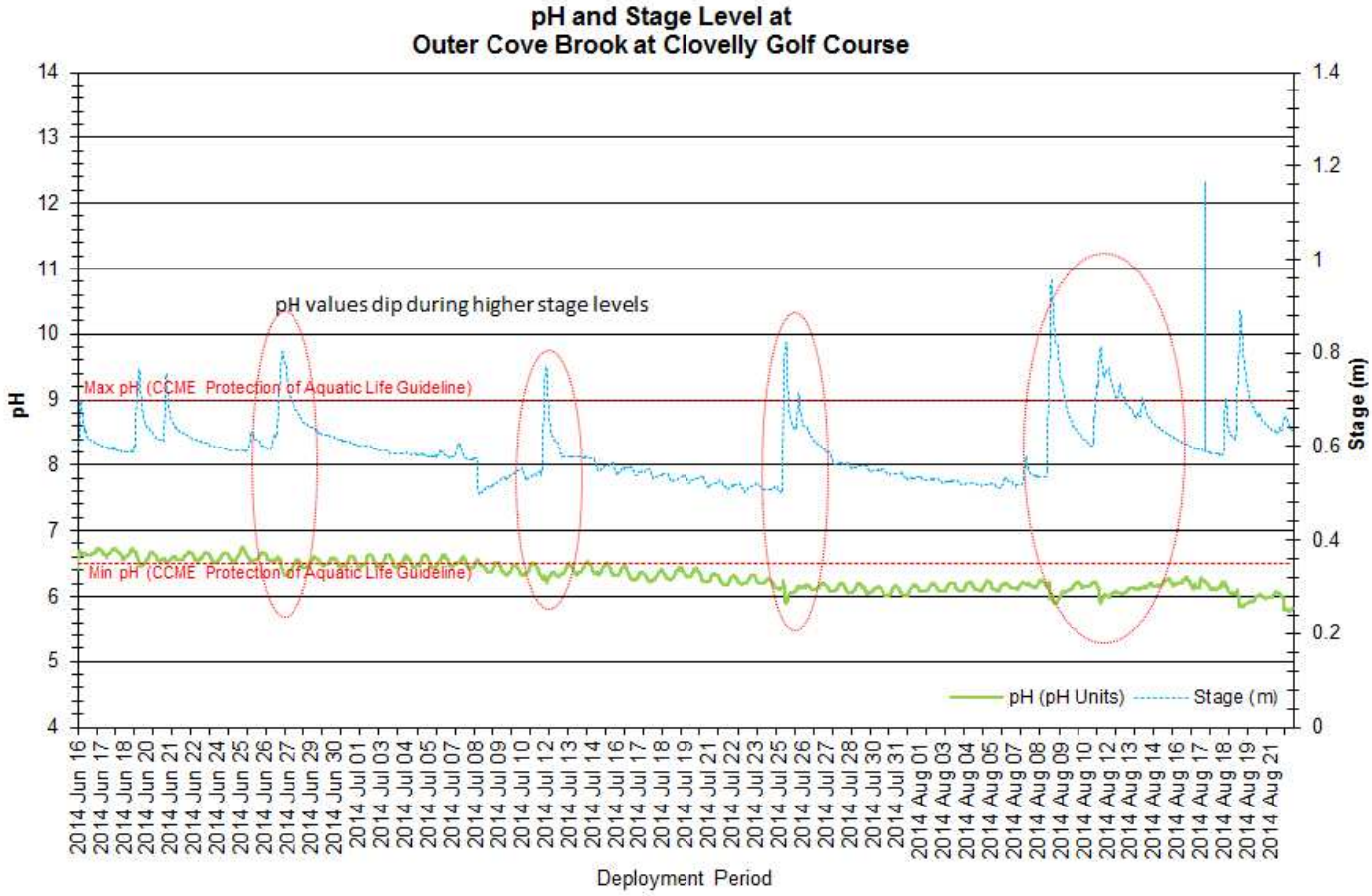

Figure 9: pH (pH units) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

Specific Conductivity & TDS

The conductivity levels were within 183.7.0 µS/cm and 647.0 µS/cm during this deployment period. TDS ranged from 0.1176 g/L to 0.4140 g/L.

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. All of the dips in conductivity present on the graph (Figure 10) can be linked with a high stage level.

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.

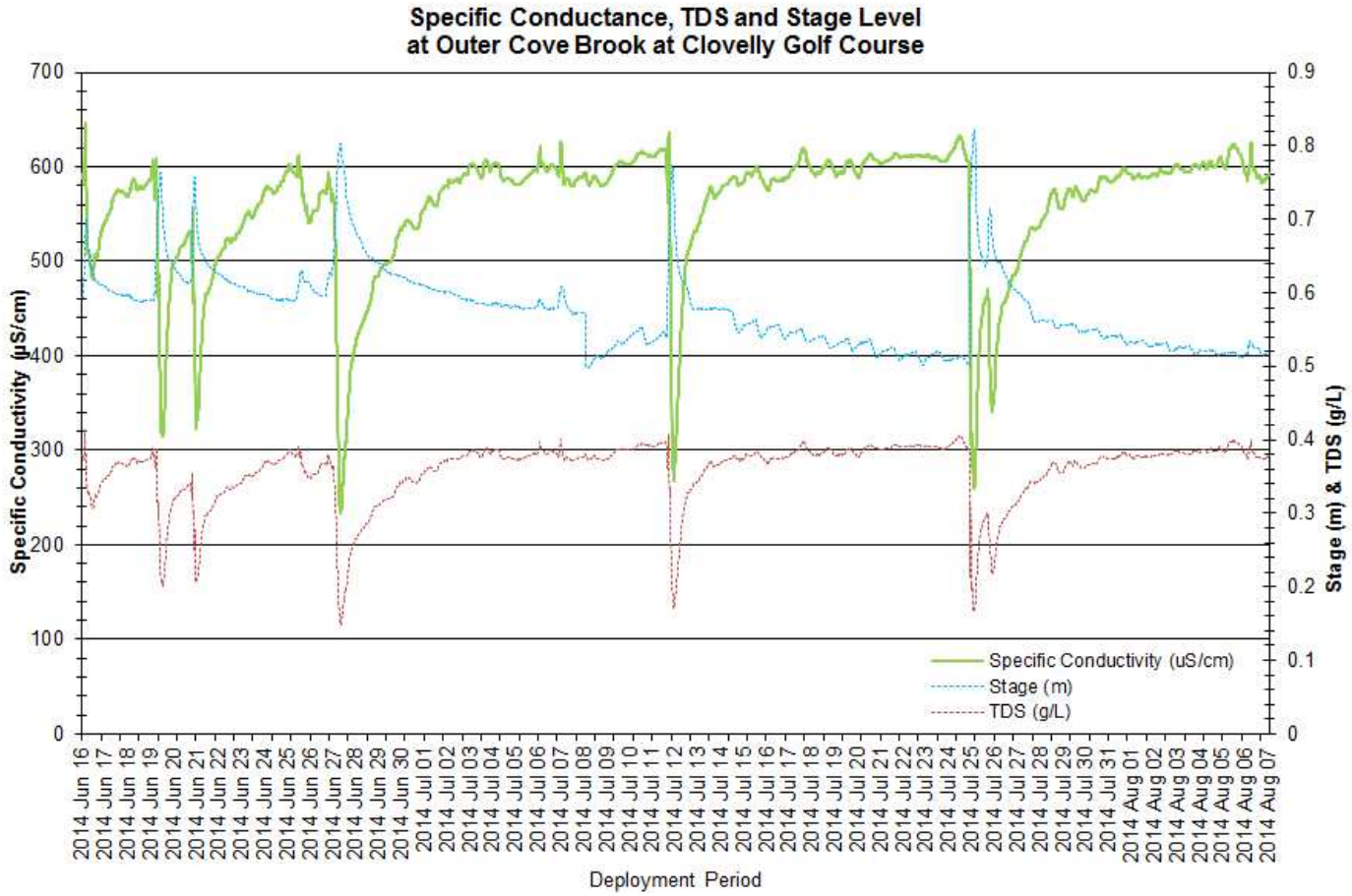

Figure 10: Specific conductivity (uS/cm), TDS (g/L) and stage (m) values at Outer Cove Brook at Clovelly Golf Course.

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 59.8 %Sat to 101.8 %Sat. Dissolved Oxygen (mg/L) measured 5.62 mg/L to 9.97 mg/L. Dissolved oxygen levels at this brook can be lower than would be expected; there is a possibility that coupled with the high amount of algae and the warmer water temperatures a higher amount of Dissolved Oxygen is being consumed (Figure 11).

The circled Dissolved Oxygen events on the graph correspond with higher stage levels and rainfall. Rainfall can disrupt the balance of dissolved oxygen in the brook which is seen in the lower values highlighted.

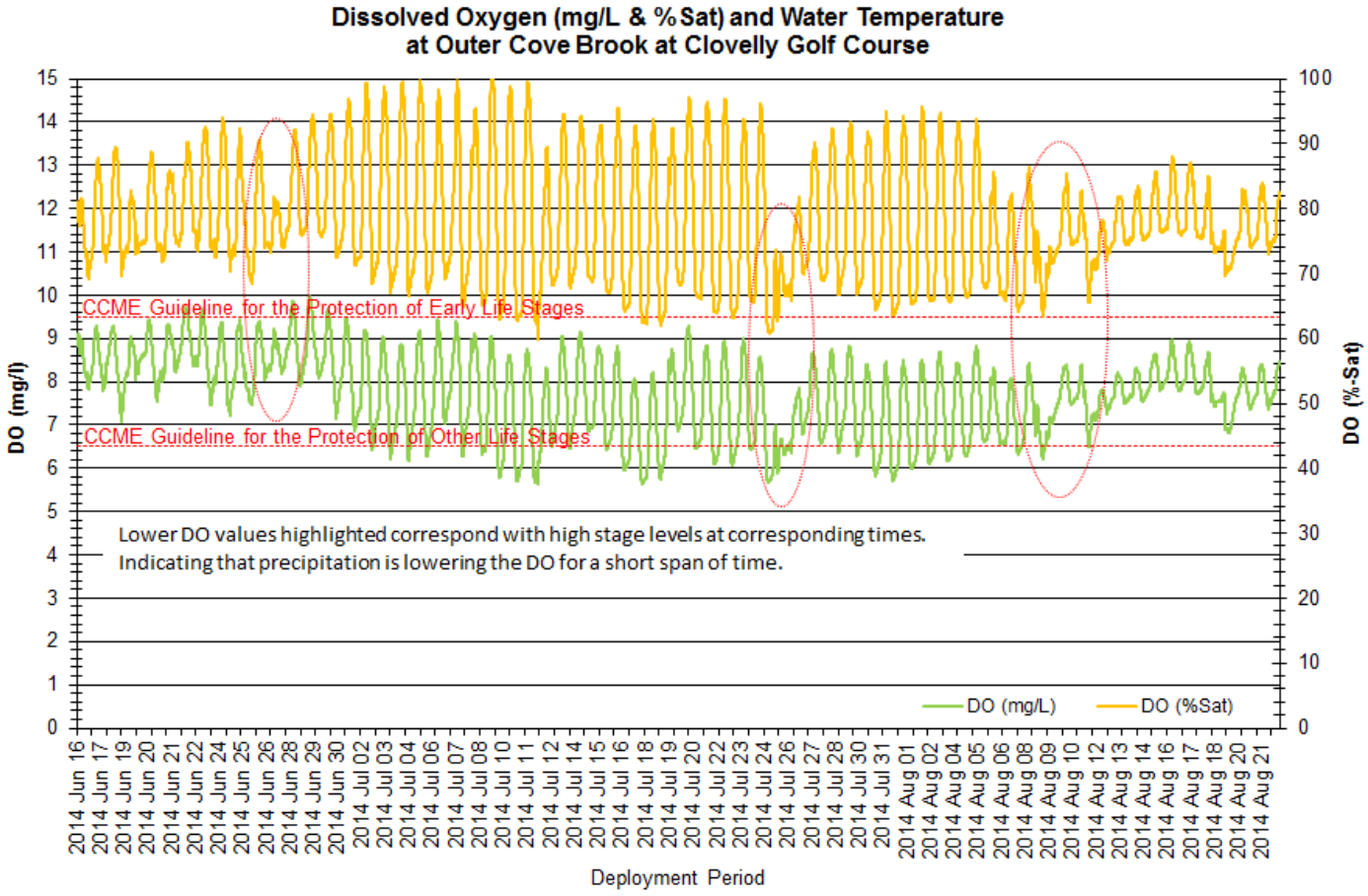

Figure 11: Dissolved oxygen (mg/L & % sat) and water temperature (℃) values at Outer Cove Brook at Clovelly Golf Course.

Turbidity

Turbidity levels during this deployment period ranged within 0.0 NTU and 270.7 NTU (Figure 12).

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 to ensure it is not included in any statistical analysis.

As depicted on the graph there were several turbidity events during deployment. The events on June 19th - 21st, June 27th, July 12th and July 25th – 27th can all be linked to the high stage levels and hence precipitation. The event on July 10th may have been a result of lower stage levels during the warmer part of the summer.

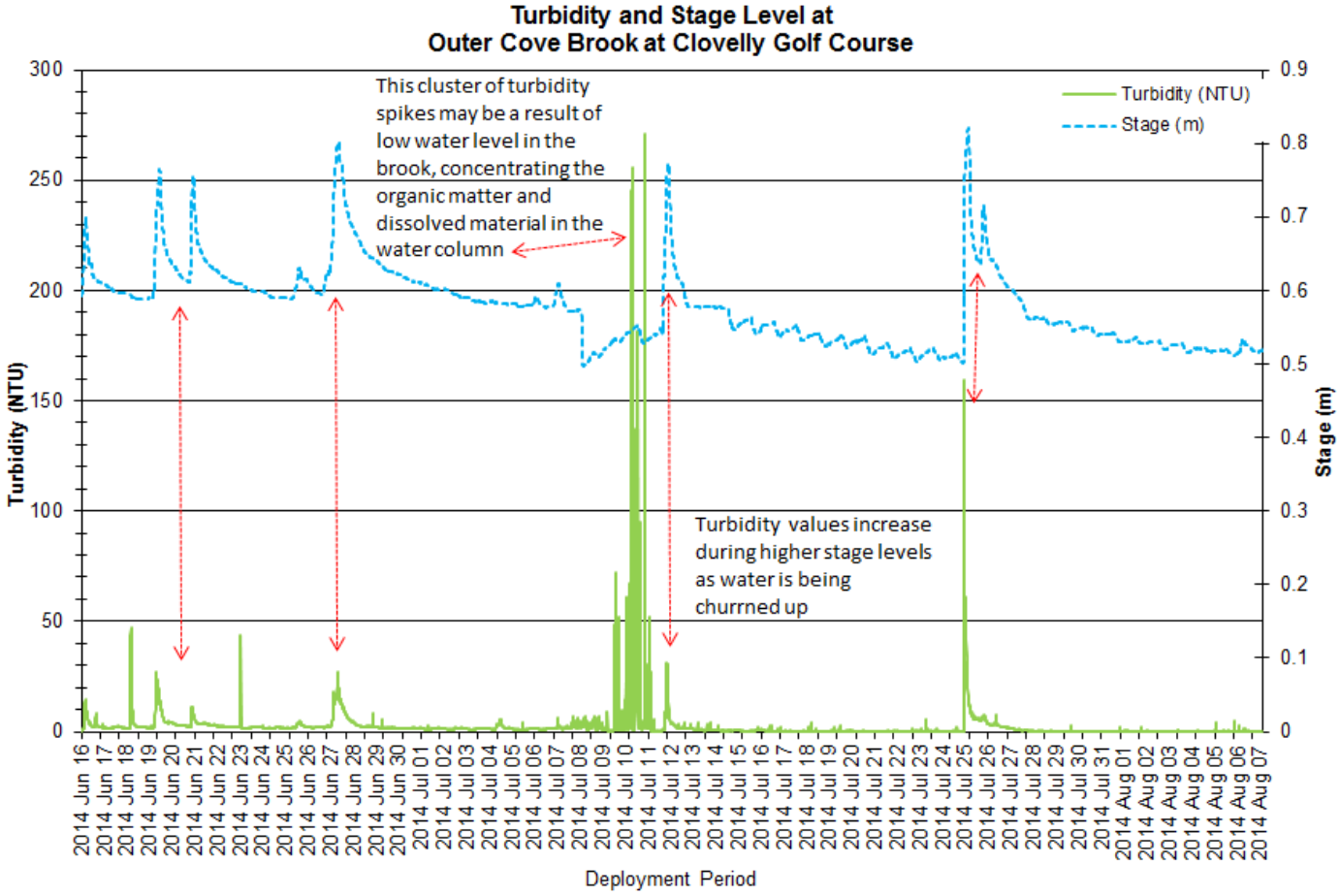

Figure 12: Turbidity (NTU) and stage level (m) values at Outer Cove Brook at Clovelly Golf Course.

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 with the majority of stage peaks over the deployment period.

Stage levels during this deployment ranged within a minimum of 0.50m and a maximum of 1.17m.

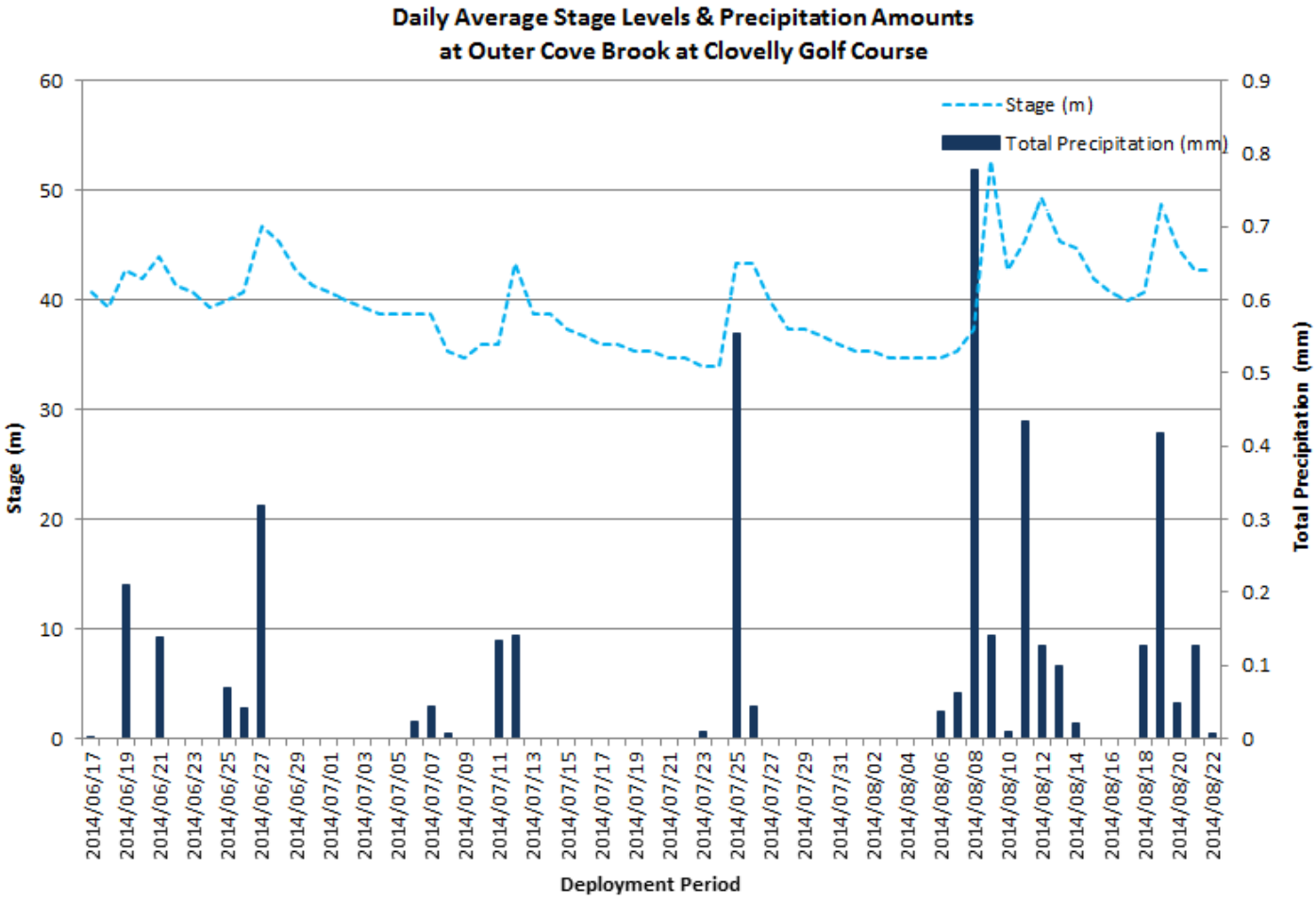

Figure 13: Daily average stage values (m) at Outer Cove Brook at Clovelly Golf Course and daily total precipitation values (mm) from Environment Canada's St. John's Airport Station.

Conclusion

- 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 will reflect in the water temperature. The water temperature is highest during the end of June and beginning of July then starts to cool down towards the end of August.

- All events noted on the parameter graphs during this deployment period can be linked back to precipitation. Over the course of this deployment period there was a total amount of 278 mm (averaged) of rainfall which is a considerable amount during the summer months.

- The unexplained turbidity event on July 9th to July 11th may be a result of the lower stage level at that time. There is the possibility that debris and organic matter increased during this time frame and caused higher turbidity levels.

Outer Cove Brook, Newfoundland and Labrador

APPENDIX A

Outer Cove Brook, Newfoundland and Labrador

Figure A1: Outer Cove Brook below Airport

Figure A2: Downstream from Station

Figure A3: Upstream from Station

Outer Cove Brook, Newfoundland and Labrador

Figure A4: Walking toward Airport boundary

Figure A5: Location of sediment runoff

Figure A6: Looking downstream toward Station

Figure A7: Land Clearing