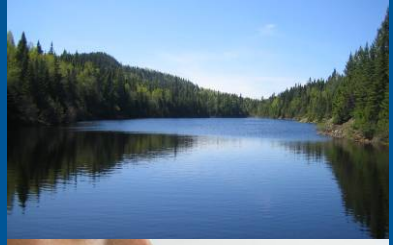







Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
May 12, 2016 to July 13, 2016

Newfoundland Labrador

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

Waterford River at Kilbride, Newfoundland and Labrador

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General

The Water Resources Management Division (WRMD), in partnership with Water Survey of Canada - Environment Canada (WSC-EC), maintain a real-time water quality and water quantity monitoring station on Waterford River at Kilbride.

This deployment report discusses water quality related events occurring at this station.

The purpose of the real-time water quality station is to monitor process and publish real-time water quality data.

This report covers the period from deployment on May 12, 2016 to July 13, 2016.

Figure 1: Waterford River at Kilbride Real-Time Water Quality and Quantity Station.

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).

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 operation at Waterford River station, and is responsible for maintaining and calibrating the water quality instrument, as well as grooming, analyzing and reporting on water quality data recorded at the station.

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. WSC-EC staff visit the site 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 along with the water 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.

Table 2: Instrument performance rankings for Waterford River at Kilbride

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Waterford	May 12	Deployment	Good	Good	Excellent	Excellent	Excellent
	July 13	Removal	Fair	Excellent	Excellent	Excellent	Good

On deployment the rankings of the field data against the QAQC data was: water temperature and pH data ranked as 'Good', conductivity, dissolved oxygen and turbidity data ranked as 'Excellent'. All rankings for the water quality parameters were acceptable for the initial deployment of the field instrument.

At removal of the instrument, the ranking for water temperature ranked as 'Fair'. The ranking for pH, conductivity and dissolved oxygen was 'Excellent'. Turbidity data at removal ranked as 'Good'. These were reasonable rankings after the instrument was in the brook for approximately 60 days.

Concerns or Issues during the Deployment Period

During this deployment period there was a failure with the temperature and conductivity probe on the instrument. Therefore on June 2, 2016 the instrument was switched out with a functioning instrument and repaired. The temperature and conductivity data was removed for the time frame of May 30th to June 2nd, 2016. This data did not represent the water body during that time due to the failure in the temperature and conductivity probe.

Waterford River at Kilbride

Water Temperature

Water temperature ranged from 3.94 °C to 22.71°C during this deployment period (Figure 2).

The water temperature at this station displays diurnal variations although slightly elongated due to the depth of water at this station. Deeper streams are influenced more subtly by natural diurnal variations in air temperatures (Appendix I). This time of the year there is more influence on the water quality parameters as air temperatures increase and stream levels dip.

Over the duration of the deployment period the water temperature gradually increases as the air temperatures increase with the summer weather approaching. There are several peaks in water temperature on May 24th and May 25th and again on June 28th to June 30th, 2016 during periods of noticeably warmer air temperatures (Appendix I).

Please note the stage data is raw data that is published on the ENVC 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.

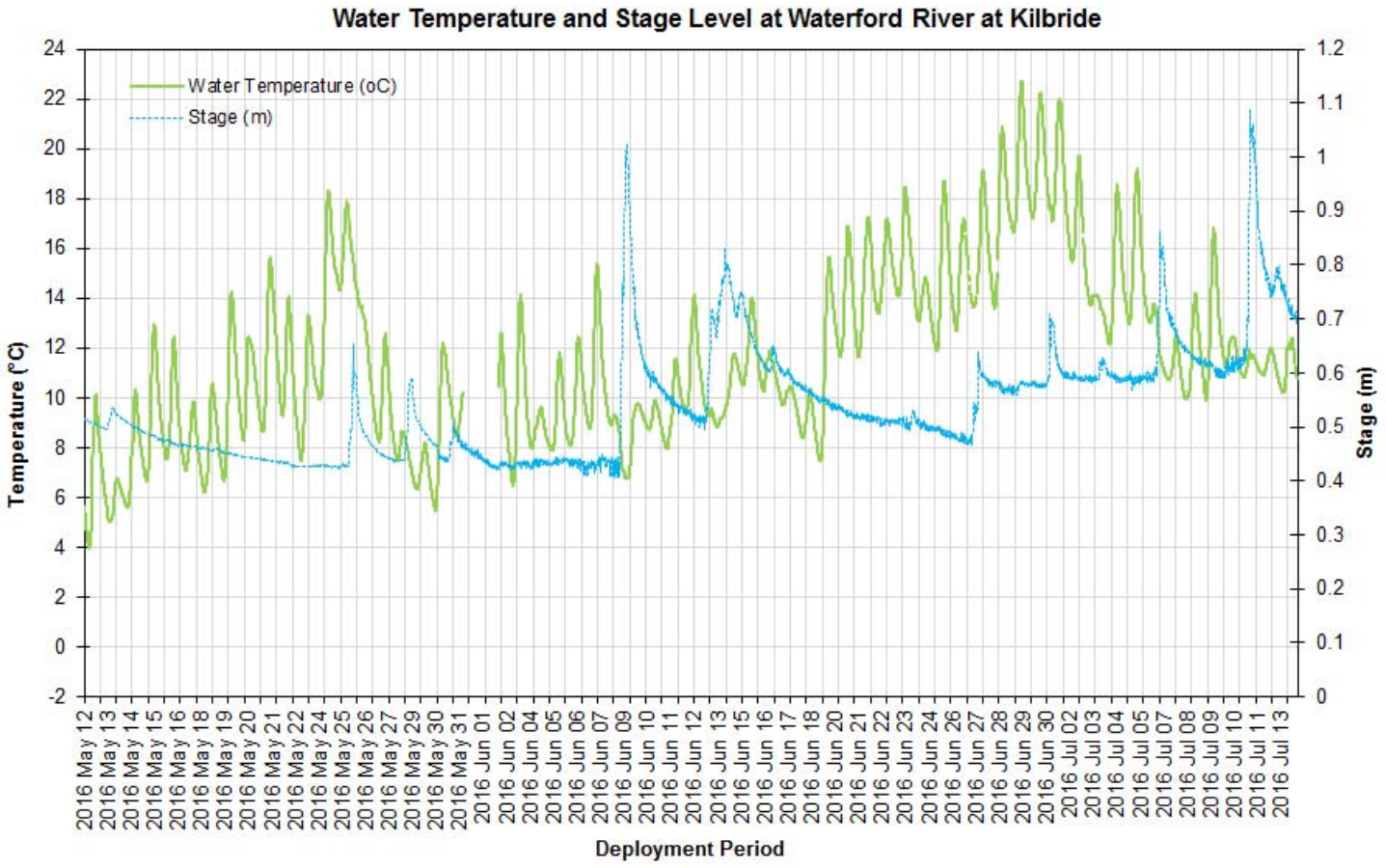

Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH values ranged between 6.60 pH units and 8.02 pH units (Figure 3).

The pH levels are consistent; however during high stage levels the pH data decreases slightly for short period of times. The pH values only dip slightly on July 10th, 2016; this dip in pH was during a drop in stage level.

The CCME guideline provides a basis by which to judge the overall health of the brook. Naturally, all streams and brooks are different. During the deployment period the median pH level was 7.26 pH units.

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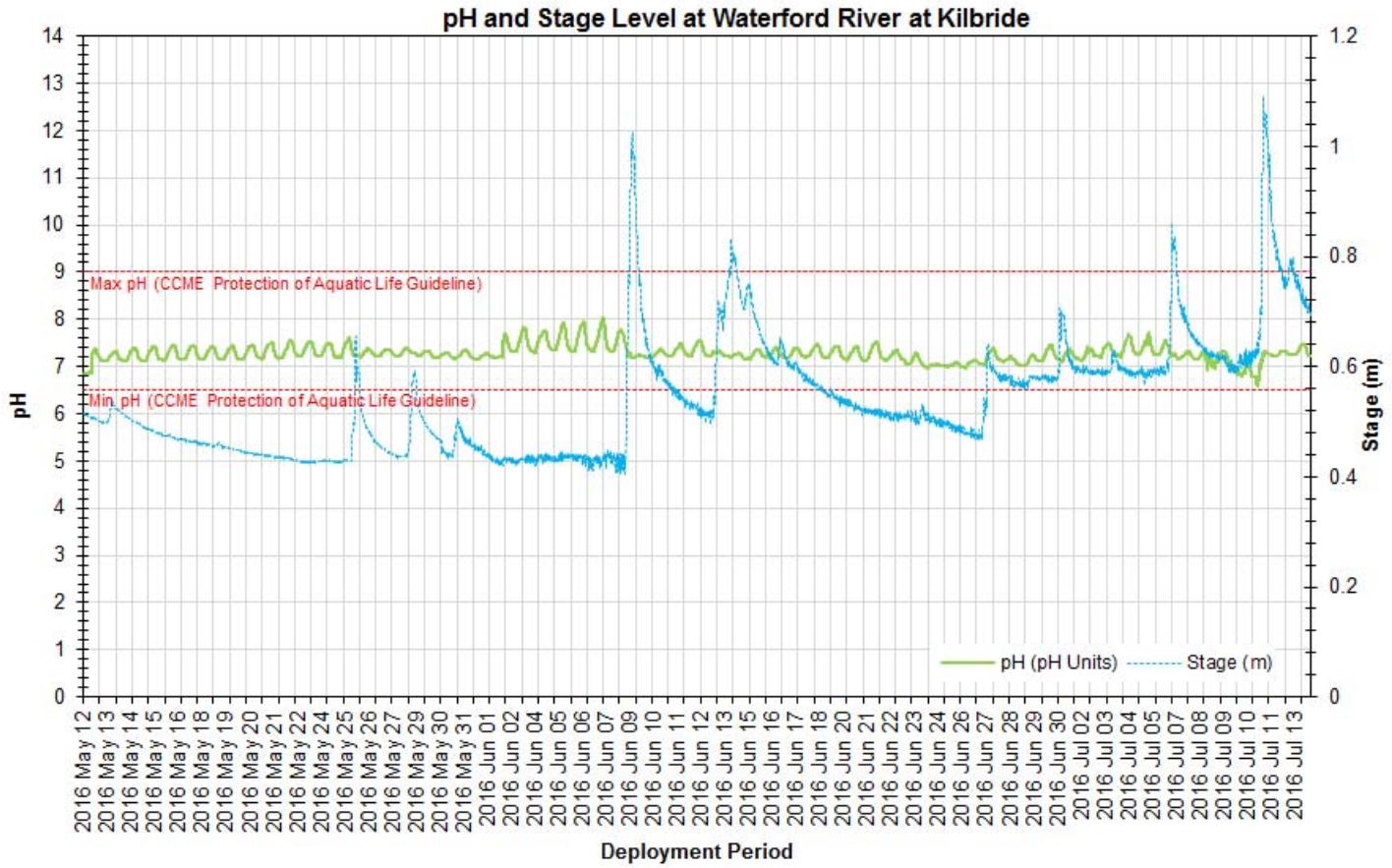

Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride

Specific Conductivity & Total Dissolved Solids

The conductivity levels were within 240.0 µS/cm and 1295.0 µS/cm during this deployment period. TDS (a calculated value) ranged from 0.02520 g/L to 0.8420 g/L (Figure 4).

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 May 25th, May 28th June 8th, June 14th and several other times toward the end of deployment (as noted on Figure 4).

Any additional material and dissolved substances present in the brook are captured by the conductivity probe. On May 13th, there is a spike in conductivity. This spike may be a result of runoff into the brook from surrounding roadways after rainfall. The conductivity level settles down shortly after.

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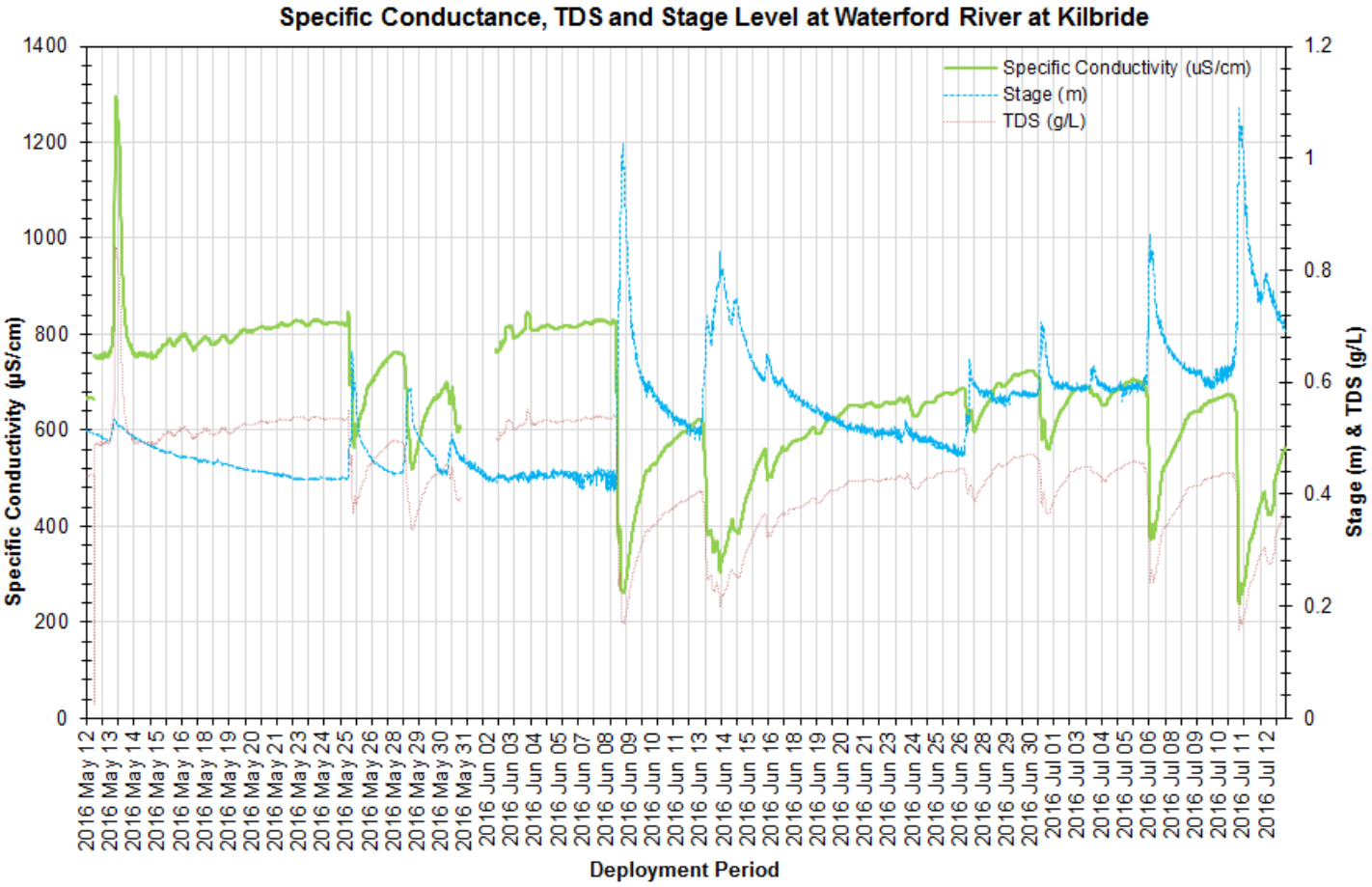

Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

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.

During the deployment the dissolved oxygen concentration levels ranged within a minimum of 8.46 mg/L to a maximum of 13.05 mg/L. The percent saturation levels for dissolved oxygen ranged within 89.9 % Saturation to 111.9 % Saturation (Figure 5).

Dissolved oxygen concentration dipped below the Guideline for the Protection of Early Life Stages on May 24th and May 25th, and again on June 19th through to July 4th, 2016 likely a result of the warmer water conditions at this time (Figure 2). It is not unusual to see the dissolved oxygen concentration in the brook drop during the warmer water temperatures. As the summer weather improves there will be a gradual decrease of the dissolved oxygen present in the brook. The growth of aquatic flora and fauna will use up the dissolved oxygen in the warmer temperatures. This is a natural occurrence.

Dissolved Oxygen data was removed from the data set covering the dates July 5th to July 11th. The data was removed as it was inaccurate and likely a result of something blocking the sensor for that period of time.

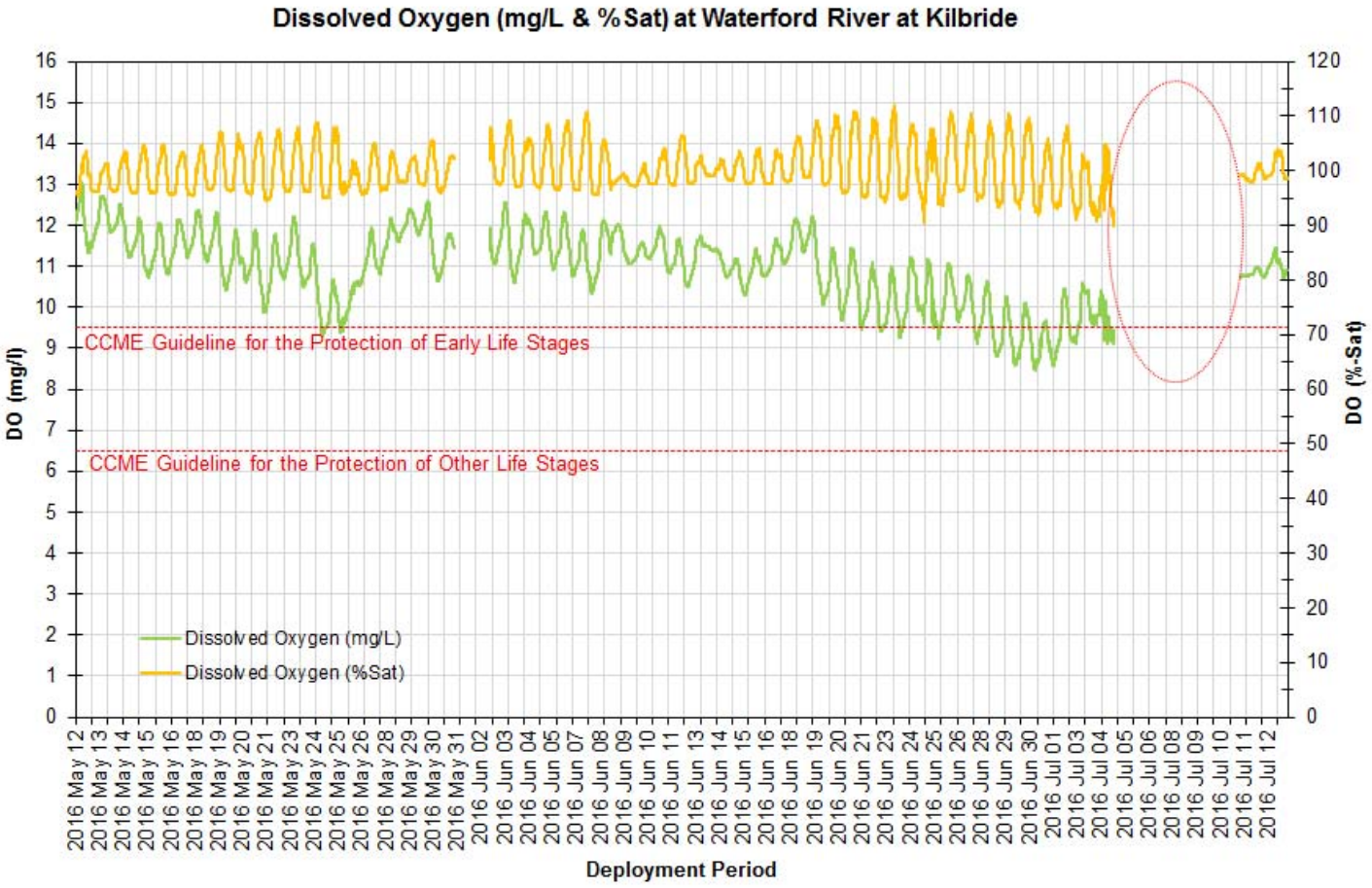

Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment ranged within 0.8 NTU and 904.6 NTU (Figure 6). The deployment data had a median of 3.5 NTU.

The higher turbidity events in the deployment period correlate with increases in stage potentially from precipitation. Precipitation can increase the presence of suspended material in water. The turbidity data does return to lower levels after the high peaks.

The highest turbidity value of 904.6 NTU was recorded during a high stage event. The turbidity data did return to a lower value as the stage level decreased. Turbidity levels can change quickly at Waterford River. This brook has a significant streamflow rate which can flush the turbid water or sediments from the brook. Being an urban brook in the heart of the City of St. John's the turbidity values in this brook can be heavily influenced by its surroundings.

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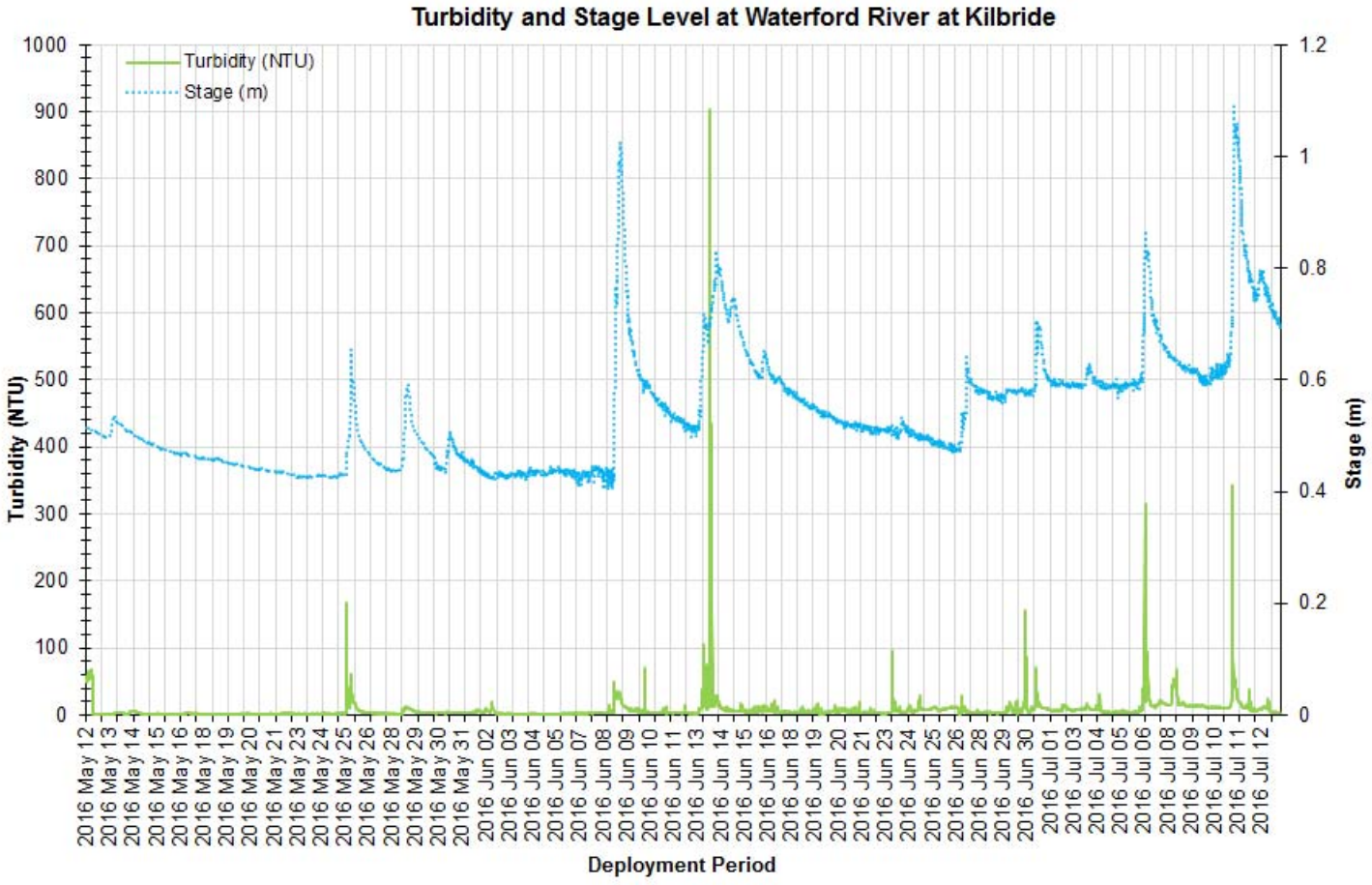


Figure 6: Turbidity (NTU) and stage level (m) values at Waterford River at Kilbride.

Stage and Precipitation

Please note the stage data graphed below is raw data. 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.

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 them to rise significantly.

During the deployment period, the stage values ranged from 0.41m to 1.09m. The larger peaks in stage do 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 43.4 mm on July 11th, 2016.

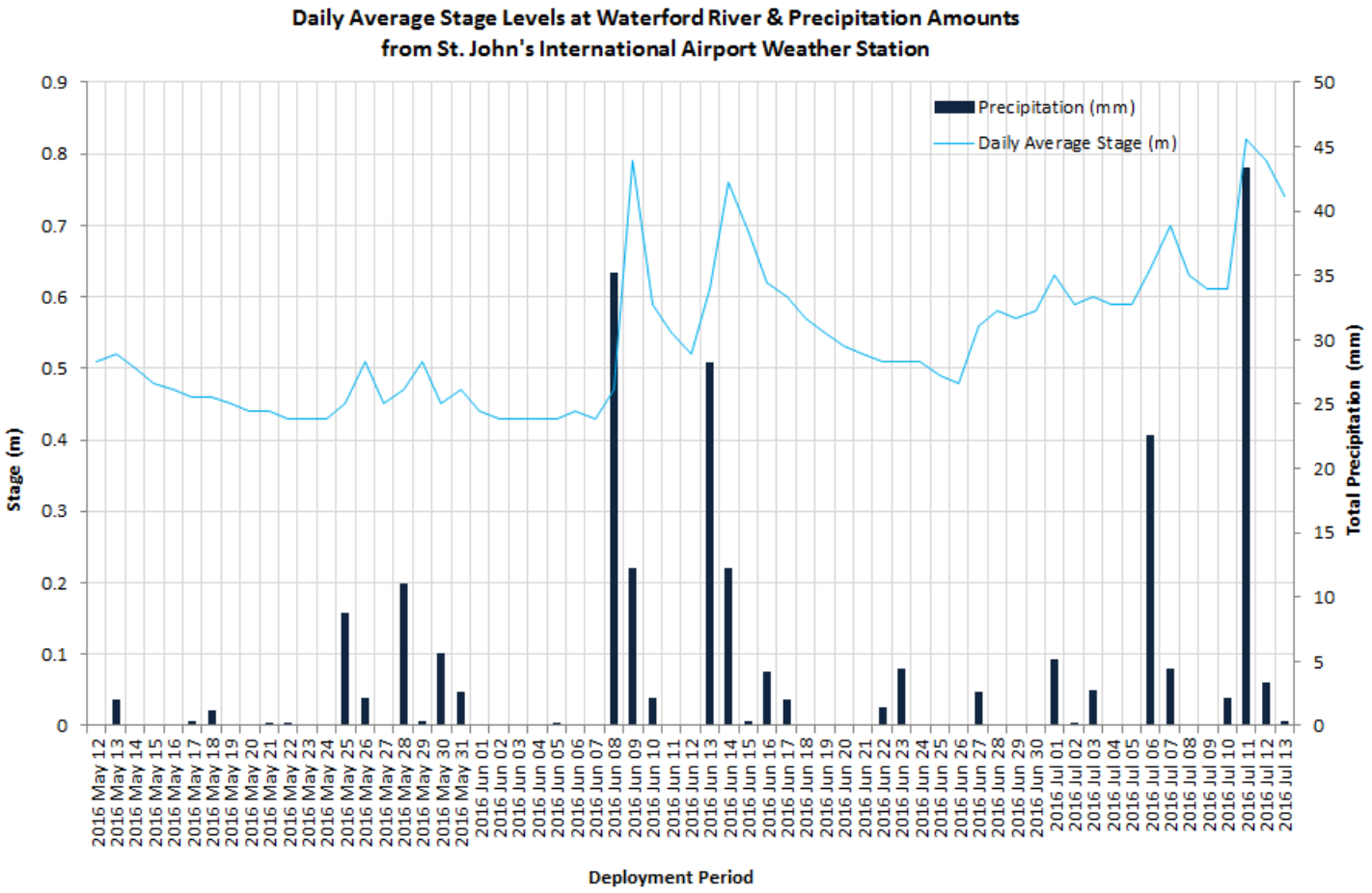


Figure 7: Daily average stage values at Waterford River at Kilbride and daily total precipitation from St. John's Airport Weather Station.

Conclusion

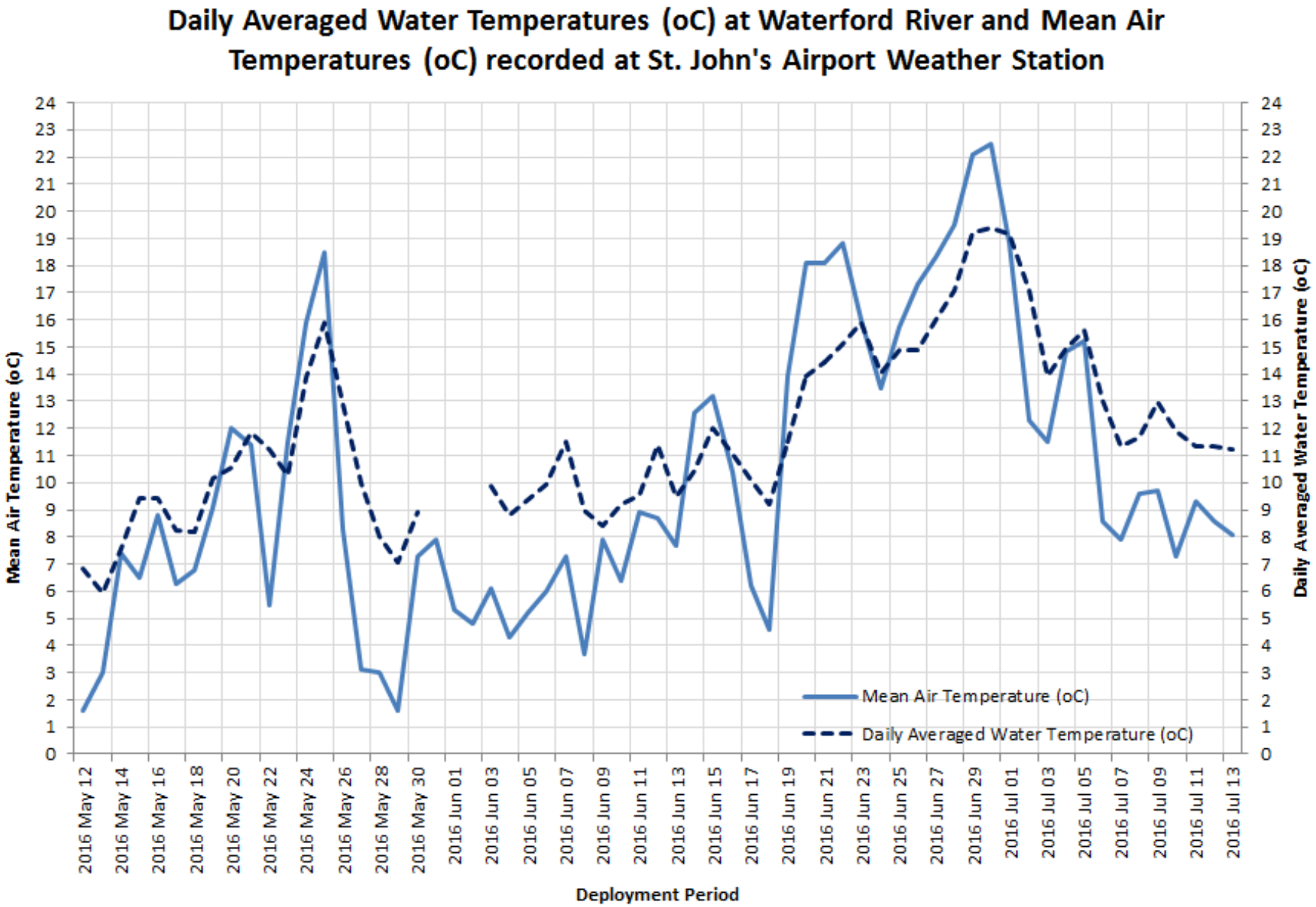
As with many urban brooks and streams, precipitation and runoff events play a role in influencing the water quality within the water body. Waterford River at Kilbride flows through significant developed areas, including residential and industrial zones, the brook can also be found along the boundaries of heavily used road ways, all these factors can influence the parameters that are recorded by the water quality instrument.

When reviewing the graphs as a whole it is evident that the larger precipitation events did create varying effects with the water quality parameters pH, conductivity, dissolved oxygen and turbidity. The movement in the water temperature data indicates the warmer air temperatures increased the water temperature which in turn influenced the dissolved oxygen concentration in the brook.

The pH values during deployment are consistent with slight changes in the stage level. Conductivity dips were a result of high stage levels and likely rainfall events. Turbidity had several events but they were also during high stage levels and rainfall periods. After stage settled down the turbidity returned to normal.

Despite some changes in the water quality parameters during the higher stage events, the data was as expected of an urban brook during this time of the year. After each event the data for all the parameters returned to its previous levels. Overall the water quality parameters recorded at Waterford River at Kilbride displayed natural events expected of a brook in an urbanized environment.

APPENDIX I


Daily Averaged Water Temperatures (oC) at Waterford River and Mean Air Temperatures (oC) recorded at St. John's Airport Weather Station
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)
Deployment Period
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)