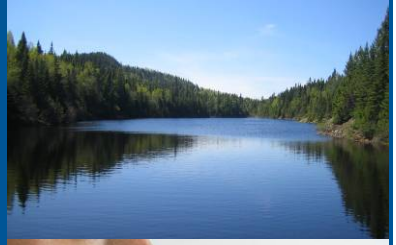







Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
October 18, 2016 to January 11, 2017

Newfoundland Labrador

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

Waterford River at Kilbride, Newfoundland and Labrador

Prepared by:

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General

The Water Resources Management Division (WRMD), in partnership with Water Survey of Canada - Environment and Climate Change Canada (WSC-ECCC), 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 October 18, 2016 to removal on January 11, 2017

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 Climate Change (ECC)) 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 ECC'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 and Climate Change Canada (ECCC)) 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-ECCC 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	Oct 18	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Jan 11	Removal	Good	Excellent	Marginal	Poor	Poor

On deployment the ranking of the field data against the QAQC data was: water temperature, conductivity, dissolved oxygen and turbidity data ranked as 'Excellent', with the pH data ranked as 'Good'. All rankings for the water quality parameters were acceptable for the initial deployment of the field instrument. However early November month the instrument was providing erratic readings, therefore it was removed and replaced with a new freshly calibrated instrument for the reminder of deployment.

At removal of the instrument, the ranking for water temperature was 'Good', pH data was ranked as 'Excellent'. Specific Conductivity data ranked as 'Marginal', with dissolved oxygen and turbidity data ranking as 'Poor'. During the physical removal of this instrument it was noted that the sensor end of the instrument had a large amount of debris, grit and leaf litter built up around the probes. This material would have disrupted the conductivity, dissolved oxygen and turbidity sensors ability to take accurate readings.

Concerns or Issues during the Deployment Period

There were no detected issues with the instrument or any problems with the data being transmitted from the station during this deployment period.

On November 23rd, 2016 the instrument was switched out with a new freshly calibrated instrument due to erratic data with the dissolved oxygen and turbidity sensors. When the instrument was removed from the brook it was observed that there was a large amount of debris and grit built up within the sensors, this was likely prohibiting the sensors from self-cleaning between readings.

It was determined due to the buildup of debris that the erratic data will be removed and not used in this report on Waterford River. The erratic data does not represent the Waterford River.

This deployment period was an extended deployment. This was a result of the buildup of ice around the instrument during the month of December. It wasn't until January that the instrument was able to be removed from the protective casing.

Waterford River at Kilbride

Water Temperature

Water temperature ranged from -0.04°C to 14.19°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).

Over the duration of the deployment period the water temperature gradually decreases as the air temperatures decrease with the cooler temperatures approaching. During high stage events there is a slight increase in the water temperatures for a short period of time until the temperatures start to dip again.

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

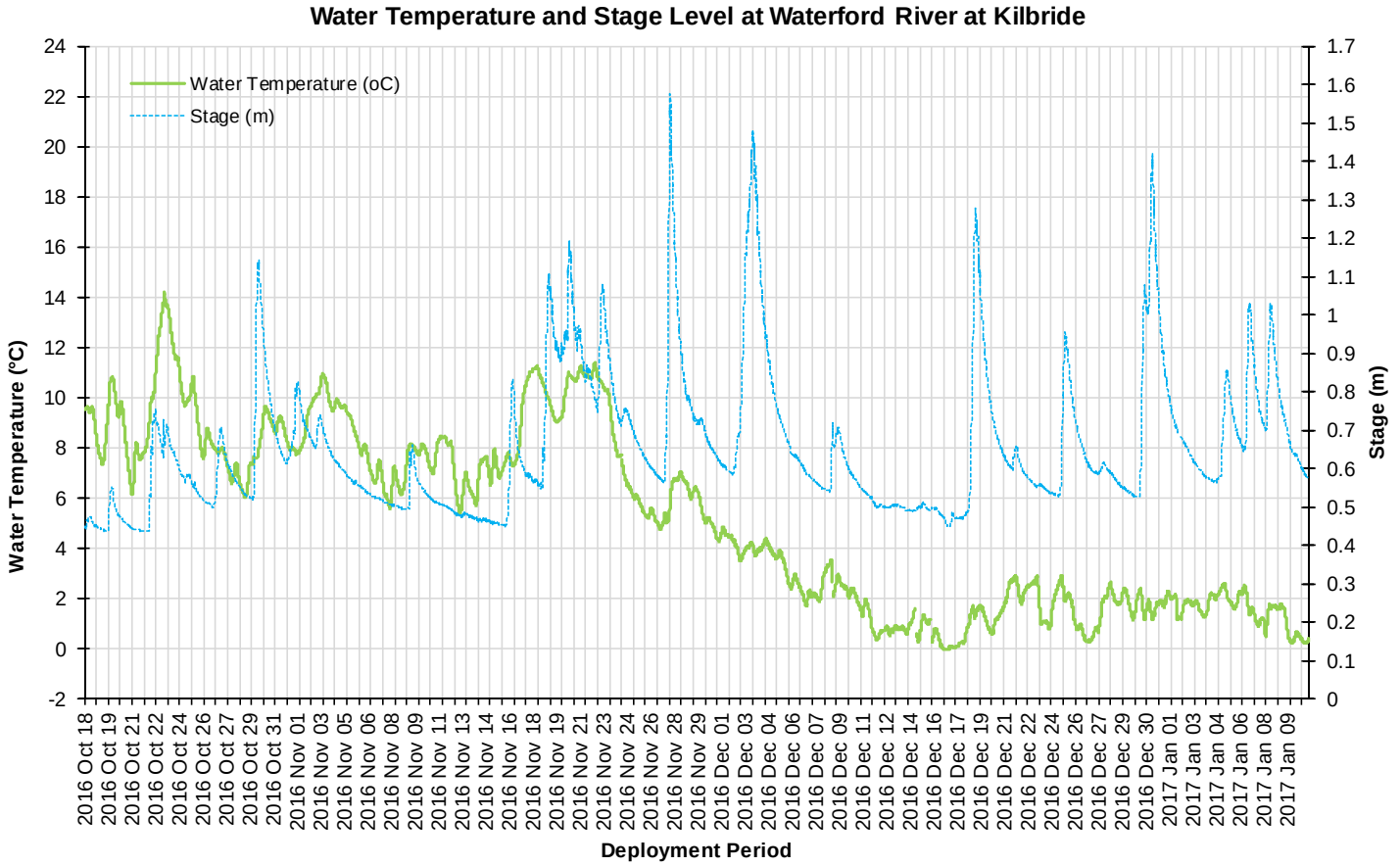

Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH values ranged between 7.11 pH units and 8.08 pH units (Figure 3).

The pH levels are reasonably consistent and remained within the guidelines indicated on the graph; however during and after high stage levels the pH data decreases slightly for short periods of time and is a natural occurrence. In this stream the CCME guideline provides a basis by which to judge the overall health of the brook. pH levels did not indicate that there were any immediate issues with water quality in Waterford River during this deployment. The median pH level was 7.30 pH units.

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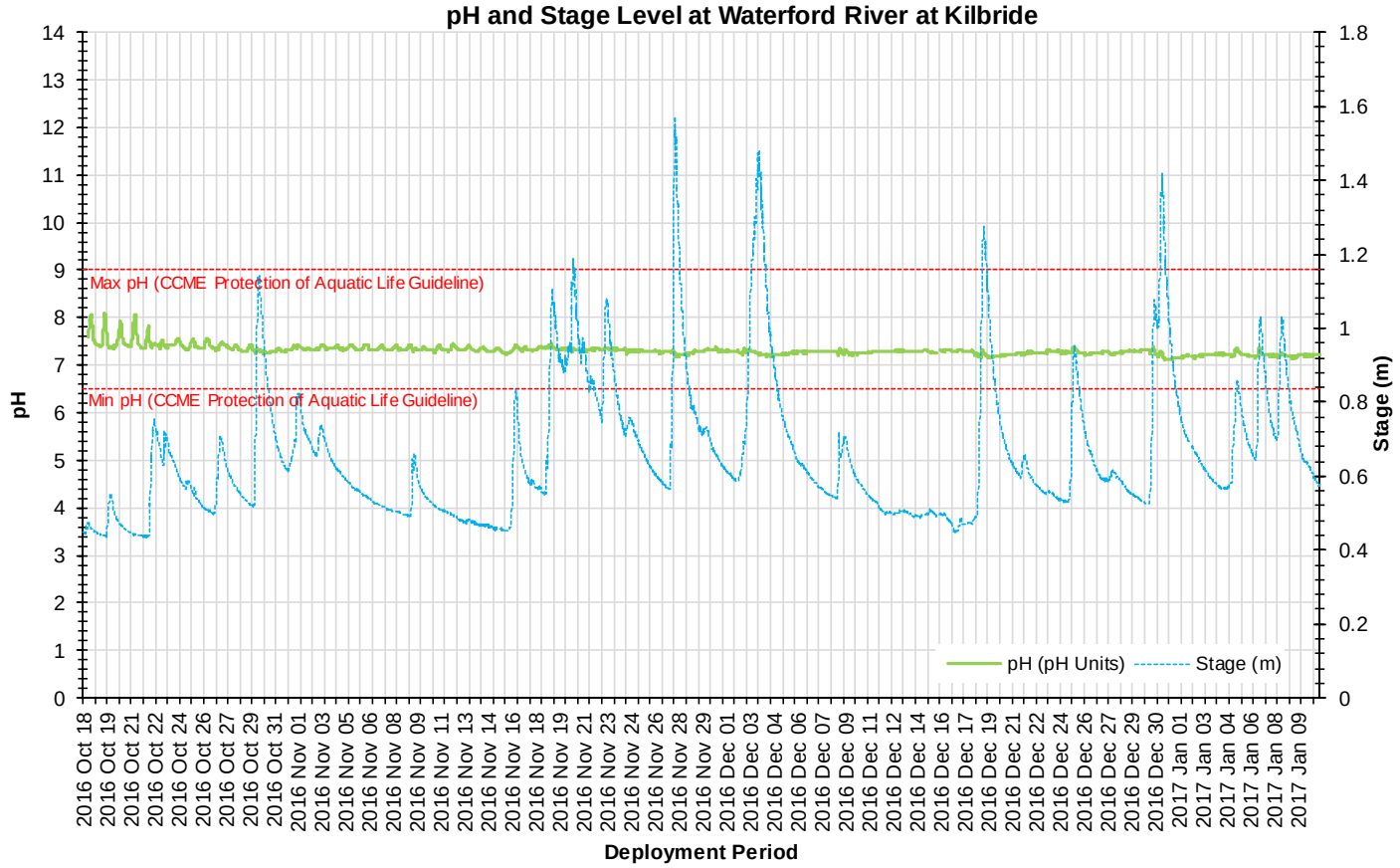

Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride

Specific Conductivity & Total Dissolved Solids

The conductivity levels were within 130.0 µS/cm and 2605.0 µS/cm during this deployment period. TDS (a calculated value) ranged from 0.0840 g/L to 1.6930 g/L (Figure 4).

The relationship between conductivity and stage level is inversed at the beginning of the deployment. 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 (as noted on Figure 4). This is evident on the graph until December 2, 2016.

After December 2, 2016 the stage and conductivity levels mirror each other in the increases. It is likely that road salting was started on the surrounding roads and it was being flushed into the brook to provide higher than normal conductivity levels.

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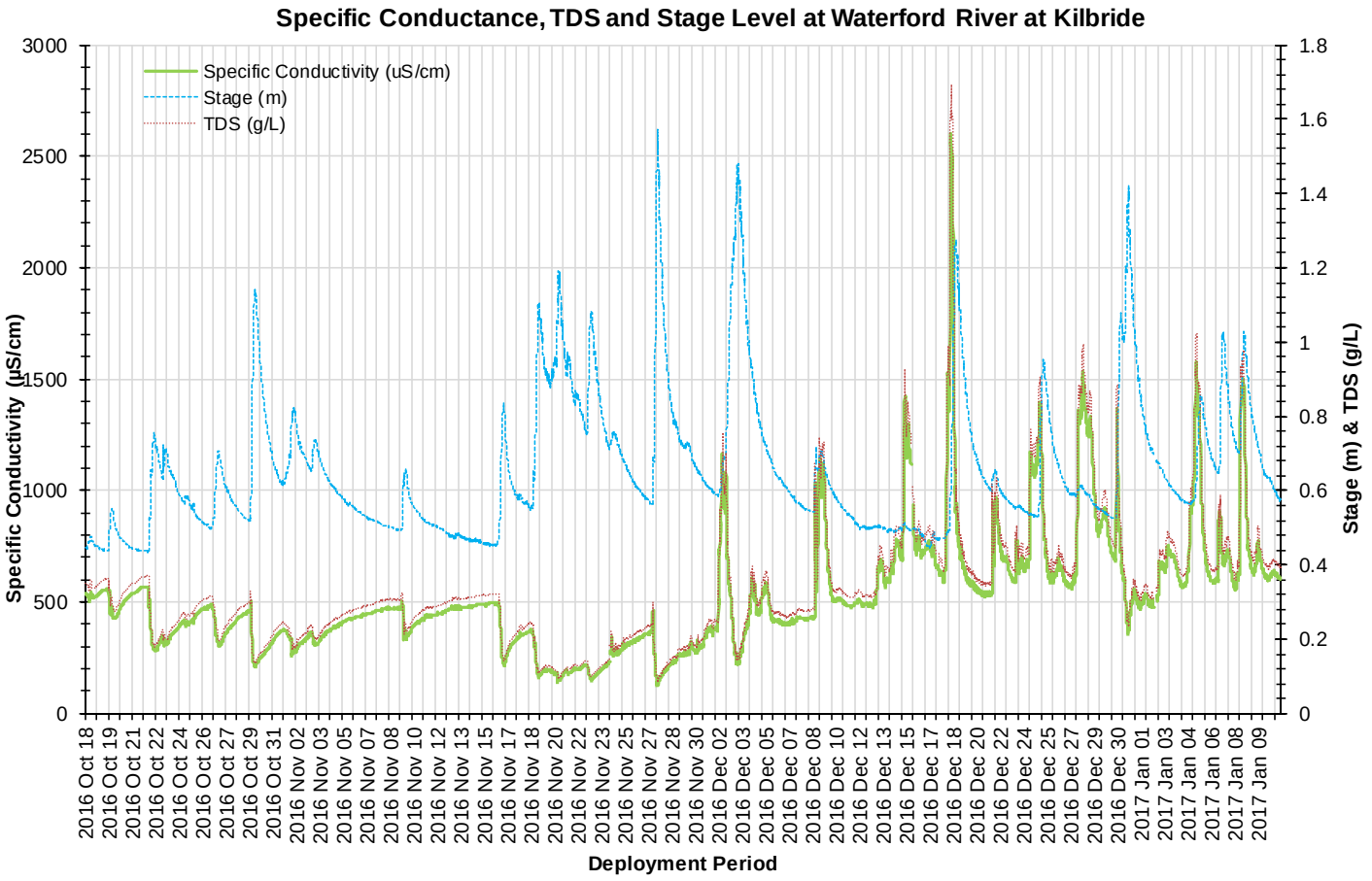


Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

Dissolved Oxygen

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

During the deployment the dissolved oxygen concentration levels ranged within a minimum of 10.15 mg/L to a maximum of 13.14 mg/L. The percent saturation levels for dissolved oxygen ranged within 86.8% Saturation to 108.5% Saturation (Figure 5).

The dissolved oxygen concentration remained above the Guideline for the Protection of Early Life Stages (9.5mg/L). It was determined that the dissolved oxgyen data was not representing the brook from October 29th to November 23rd, 2016 and a new instrument was installed on November 23rd, 2016. The erratic data was removed from this statistical analysis.

The dip in dissolved oxygen concentration on October 23rd corresponds with a higher water temperature for that timeframe. This data is representing the natural relationship between temperature and dissolved oxygen.

As the fall season moves into winter with a decrease in water temperature, there will be a gradual increase of the dissolved oxygen present in the brook. The reduction in aquatic flora and fauna growth will increase the amount of dissolved oxygen present in the brook as the dissolved oxygen is not being used. This is a natural occurrence.

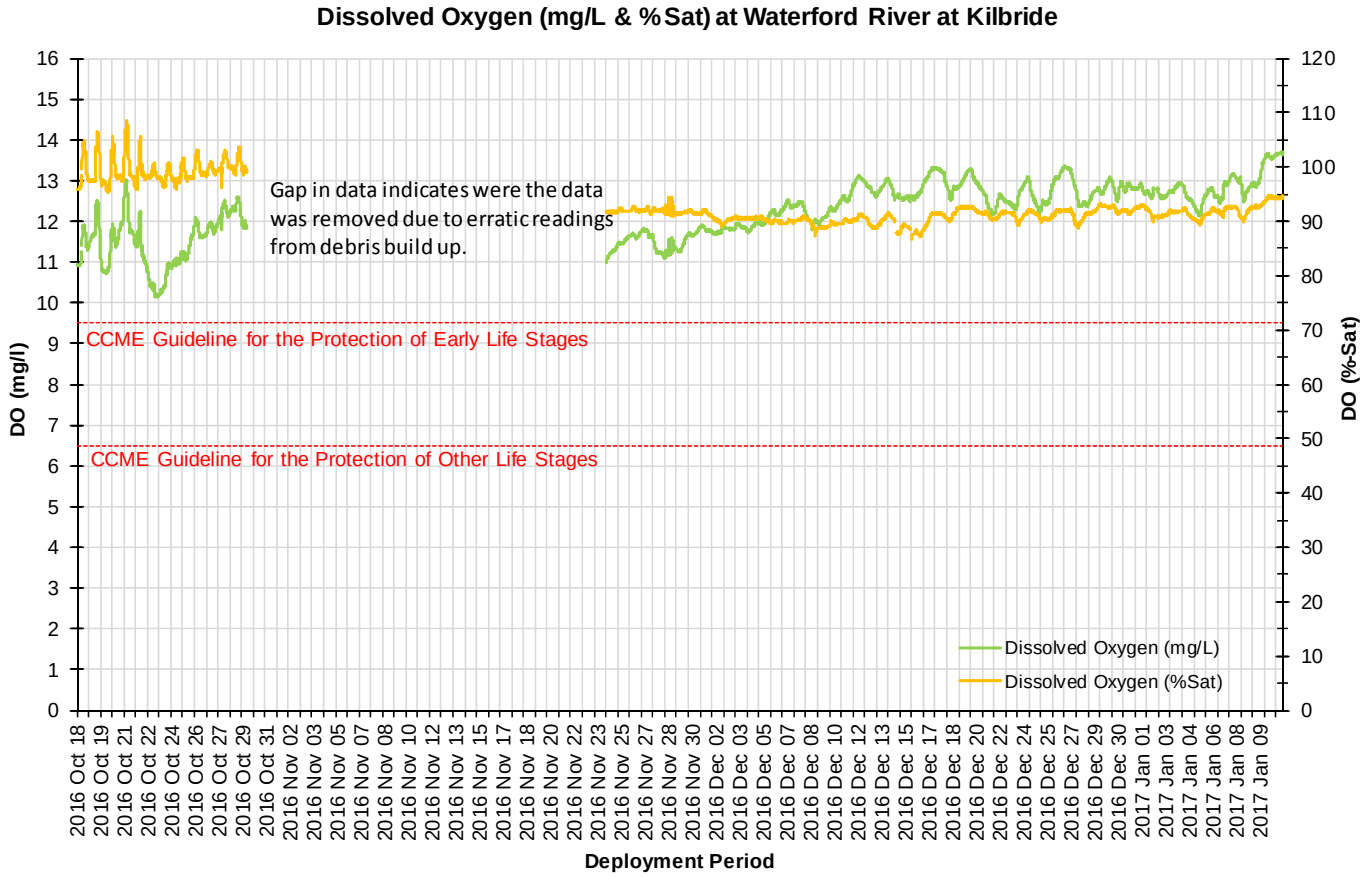


Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment ranged within 0.8 NTU and 94.9 NTU (Figure 6). The deployment data had a median of 3.4NTU.

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

It was determined that the turbidity data was not representing the brook from October 29th to November 23rd, 2016 and a new instrument was installed on November 23rd, 2016. The erratic data was removed from this statistical analysis.

Turbidity levels can change quickly at Waterford River. This site has a significant streamflow rate which can flush turbid water or sediments quickly through the brook. As this brook is in the heart of the City of St. John's the turbidity values can be heavily influenced by its surroundings.

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

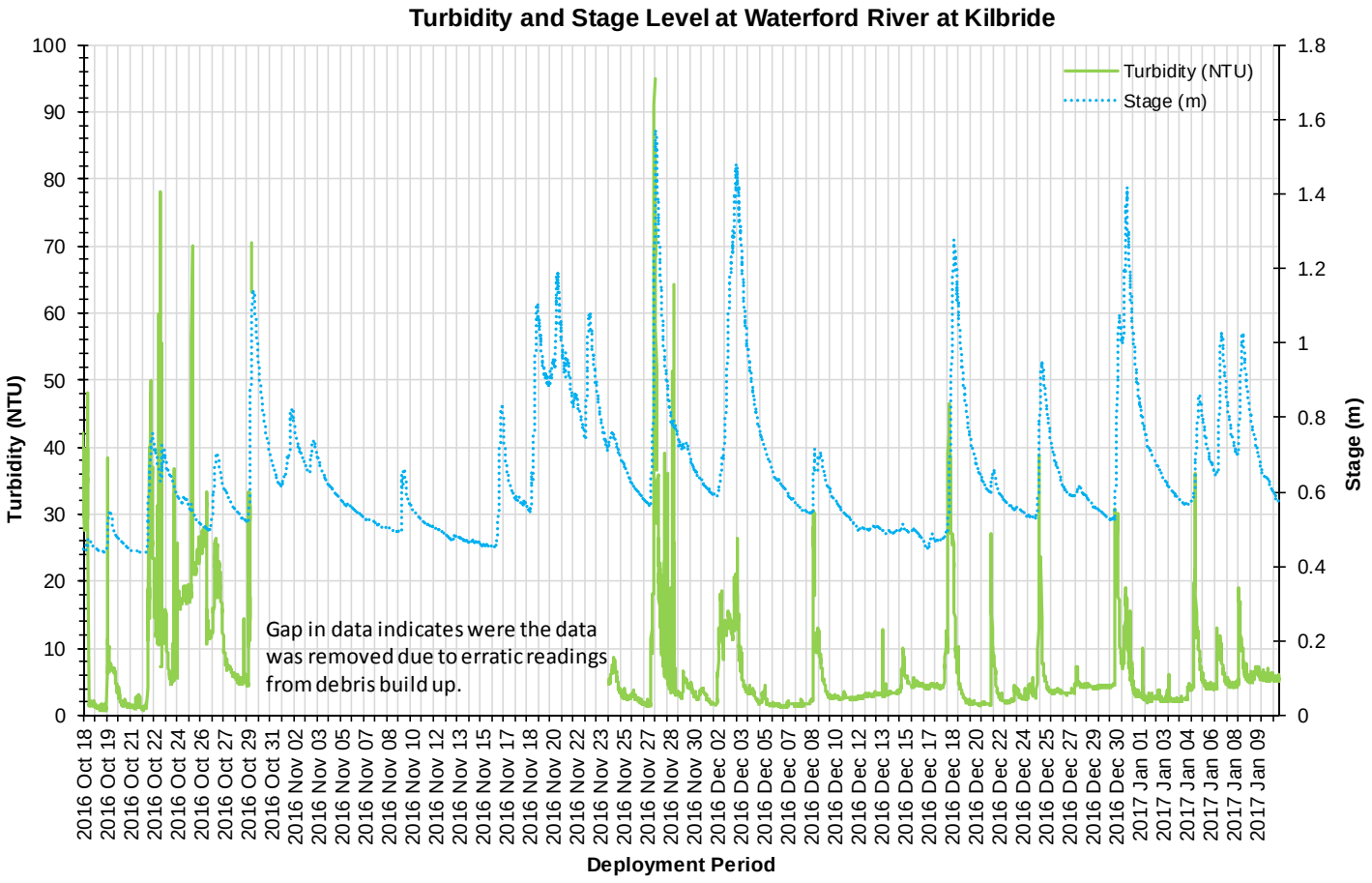


Figure 6: Turbidity (NTU) and stage level (m) values at Waterford River at Kilbride.

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 stage to rise significantly.

During the deployment period, the stage values ranged from 0.4m to 1.57m. 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 46.4 mm on November 27th, 2016.

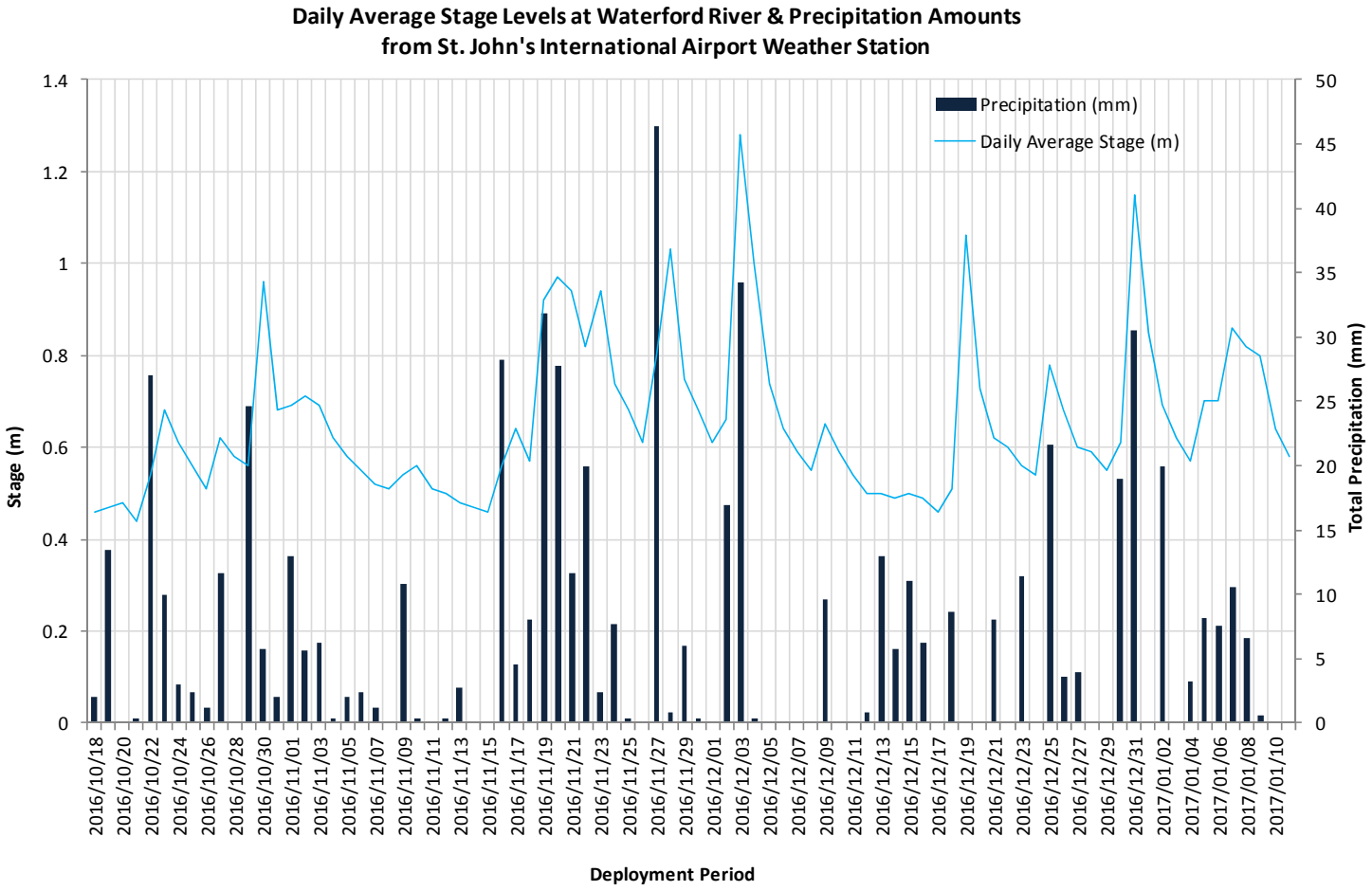


Figure 7: Daily average stage values at Waterford River at Kilbride and daily total precipitation from St. John's Airport Weather Station.

Conclusion

Waterford River at Kilbride flows through significant developed areas, including residential and industrial zones. Waterford River also borders along several heavily used urban road ways and thoroughfares. The proximity to these factors, combined with precipitation and runoff, can influence and adjust the parameters that are recorded by the water quality instrument.

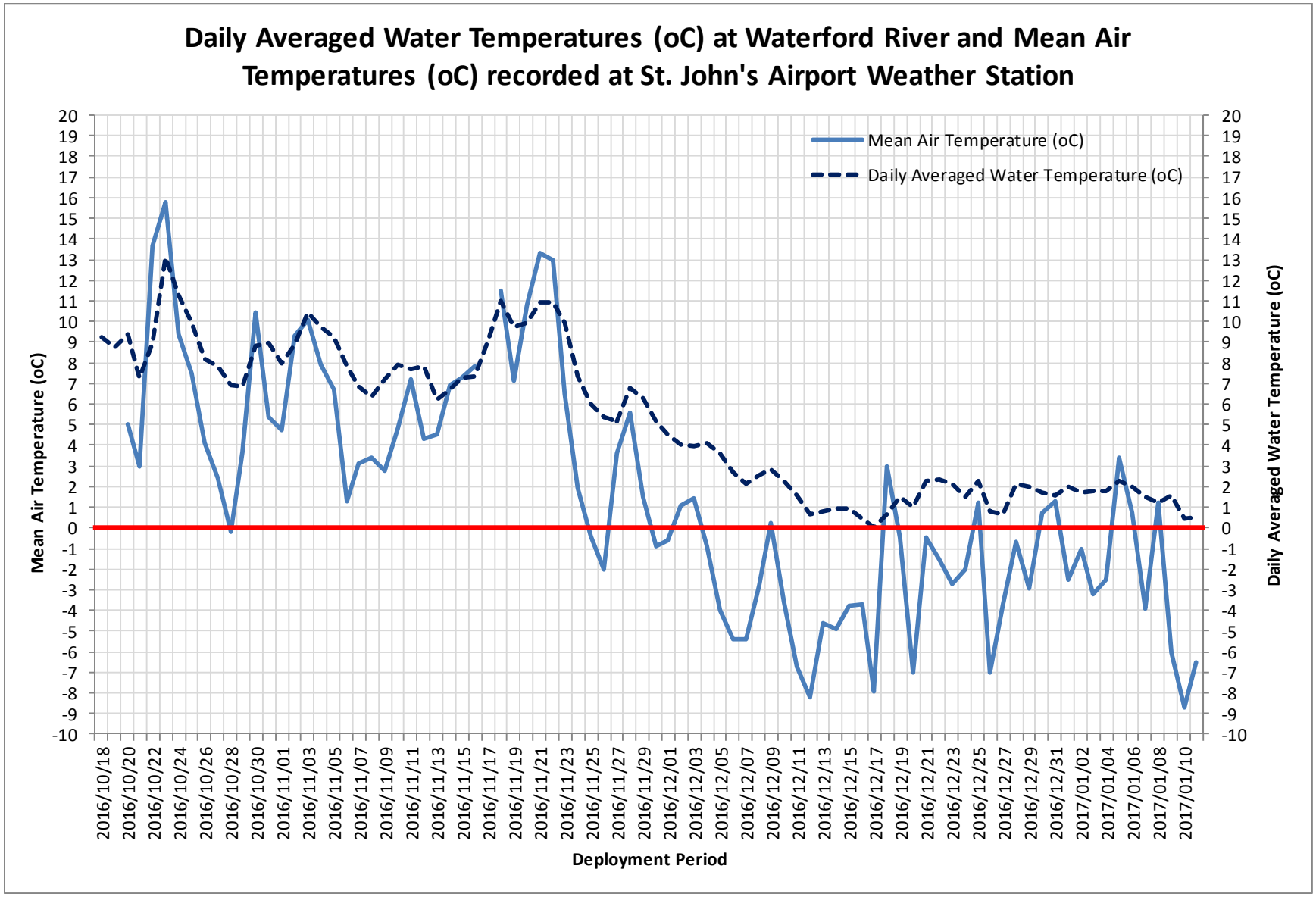
When reviewing the graphs as a whole it is evident that the larger precipitation events did create varying effects with the water quality parameters pH, conductivity, dissolved oxygen and turbidity. The movement in the water temperature data indicates that air temperatures caused a decrease in the water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

There were visible changes in the pH, whereby at several periods during deployment, the pH levels dip during high stage events. However for most of the deployment, the pH values were reasonably consistent. Conductivity dips were a result of high stage levels and likely rainfall events. There was movement in the turbidity data over the deployment, whereby several events were related to high stage levels and rainfall periods.

This instrument sits on the riverbed to record data. There can be significant interference from the silty brook bottom or any debris that might snag on the protective casing that the instrument is in. During this deployment there were several days where the turbidity and the dissolved oxygen data did not represent accurate water quality. It was determined after an inspection that river debris was the cause and the instrument was changed out with a freshly cleaned and calibrated one for the remainder of deployment.

The water quality data displayed in this report is as expected of an urban brook. After each significant change in the data, the parameters returned to the 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)
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)
Deployment Period

Waterford River at Kilbride, Newfoundland and Labrador