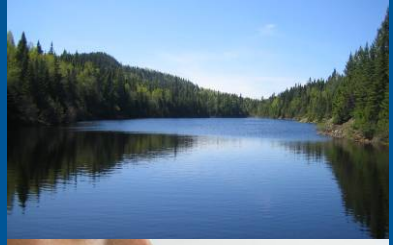







Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
November 13, 2015 to January 12, 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 November 13, 2015 until removal on January 12, 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	November 13	Deployment	Fair	Excellent	Good	Marginal	Good
	January 12	Removal	Excellent	Excellent	Excellent	Excellent	Poor

On deployment the rankings of the field data against the QAQC data was as follows; water temperature ranked as 'Fair'. pH data ranked as 'Excellent' with dissolved oxygen data ranking as 'Marginal' and conductivity and turbidity data ranked as 'Good'. The low water temperature ranking of 'Fair' likely also contributed to the 'Marginal' ranking for dissolved oxygen. It is likely that the QAQC instrument had not stabilized before the readings were taken hence the 'Fair' & 'Marginal' rankings.

At removal of the instrument, the rankings for parameters water temperature, pH, conductivity and dissolved oxygen were all 'Excellent'. Turbidity ranked as 'Poor'. During removal it was determined that there was leaf litter and sediment in the sensor cage which likely caused the higher values for turbidity from the field instrument.

Waterford River at Kilbride

Water Temperature

Water temperature ranged from -1.29°C to 6.22°C during this deployment period (Figure 2). There were noticeable increases and decreases in the water temperature. This would likely be consistent with ambient air temperatures over this time period, generally temperatures will increase during daylight hours and cool overnight.

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 subtlety by natural diurnal variations in air temperatures (Appendix I).

The water temperatures decrease across the deployment period. During the higher stage events the water temperatures do increase briefly before settling back down.

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.

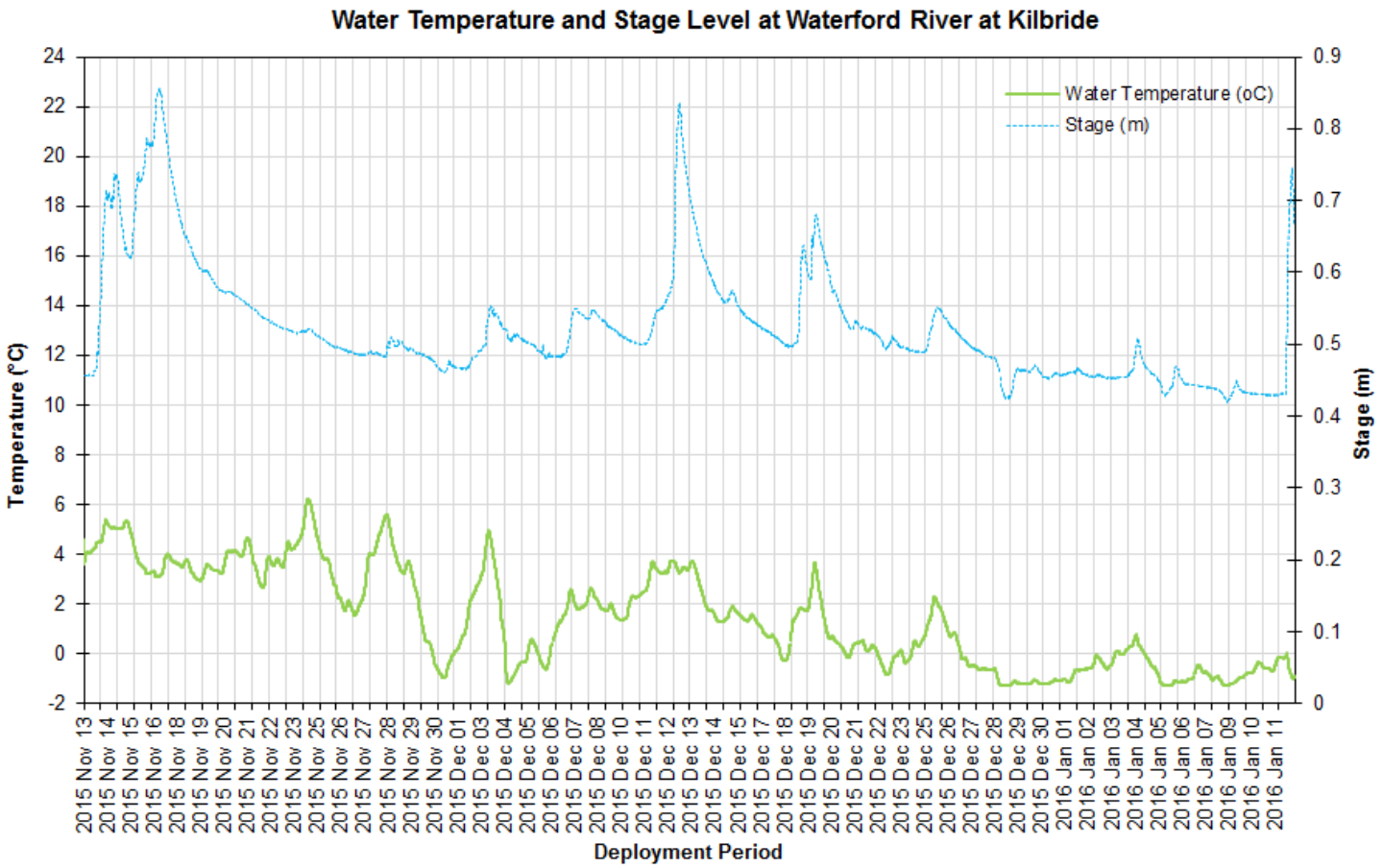


Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH values ranged between 7.15 pH units and 7.66 pH units (Figure 3).

The pH levels at the beginning of deployment were slightly higher than would be expected for Waterford River, it is not clear what may have influence pH at that time. Throughout the remainder of the deployment the pH data was reasonably consistent. The pH values at this station were above the minimum CCME Guideline for the Protection of Aquatic Life (above 6.5 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. During the deployment period the median pH level was 7.26 pH units.

During the higher stage periods the pH values flattening slightly before returning to its previous values. 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.

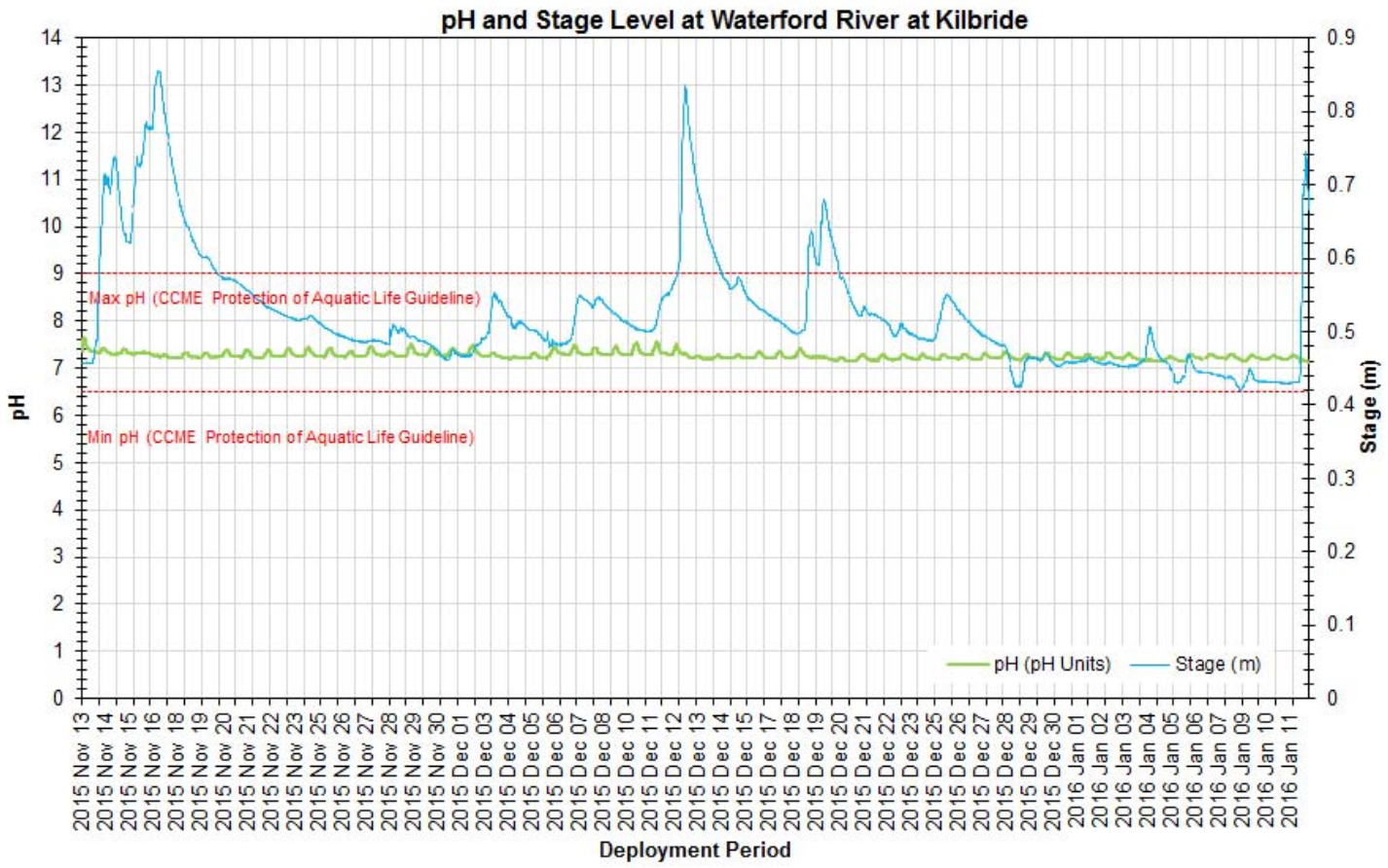


Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride

Specific Conductivity & Total Dissolved Solids

The conductivity levels were within 342 µS/cm and 3010.0 µS/cm during this deployment period. TDS (a calculated value) ranged from 0.2230 g/L to 1.9570 g/L (Figure 4).

The spikes in conductivity can be a result of road salting or runoff into the brook. At this time of year road salting is frequent to break down the ice and snow. The high conductivity spikes are likely a direct result of road salting. The additional material and dissolved salt in the brook is captured by the conductivity probe however after each peak conductivity event the levels drop back down.

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.

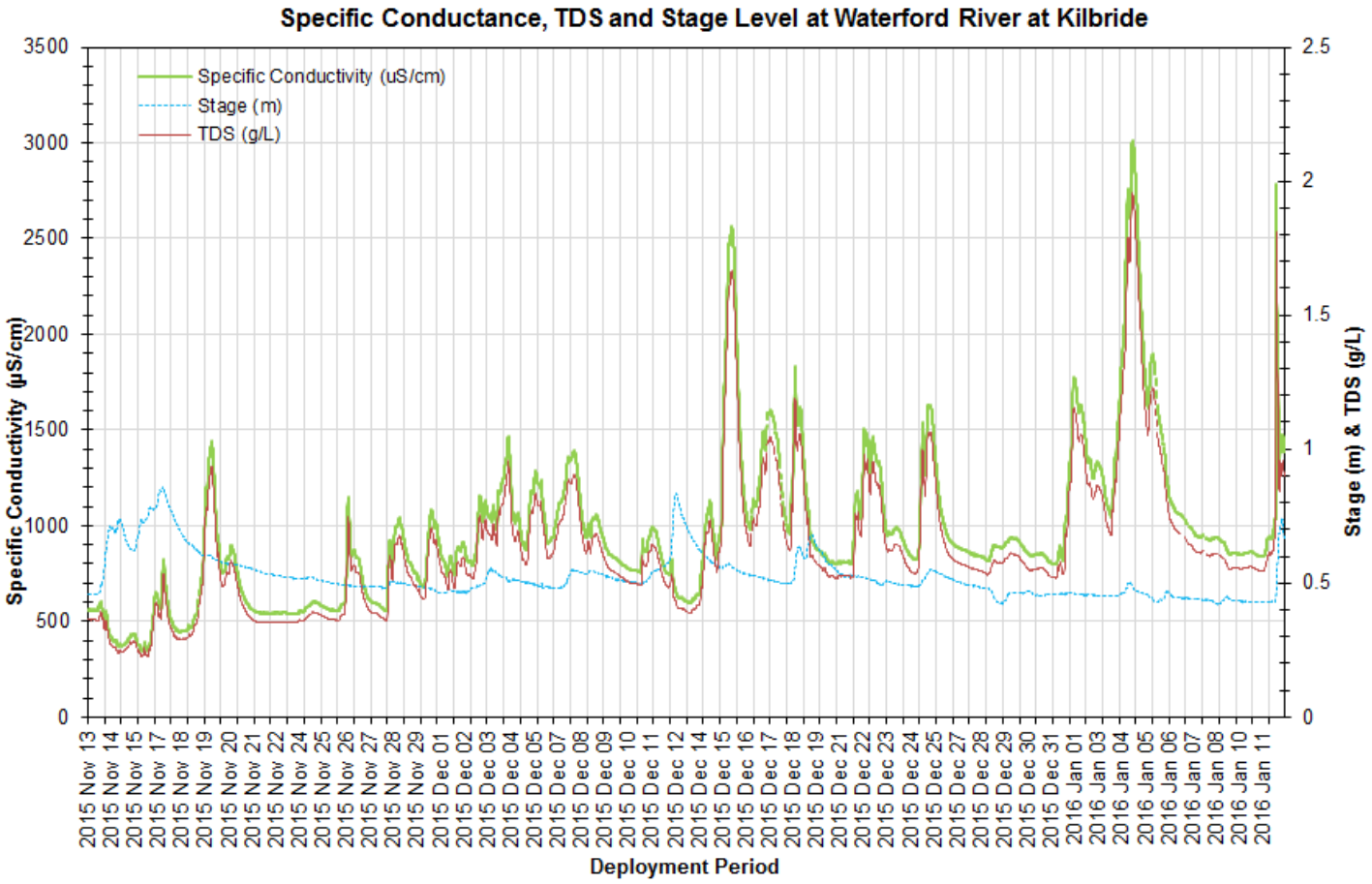


Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

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 12.11mg/L to a maximum of 15.56mg/L. The percent saturation levels for dissolved oxygen ranged within 95.8 %Sat to 105.5 %Sat (Figure 5).

Dissolved oxygen remained about the CCME guideline for the Protection of Early Life Stages for the duration of the deployment period.

The sharp dips in dissolved oxygen (mg/L) match the increases in water temperature (Figure 2). Warmer water temperatures will decrease the dissolved oxygen levels.

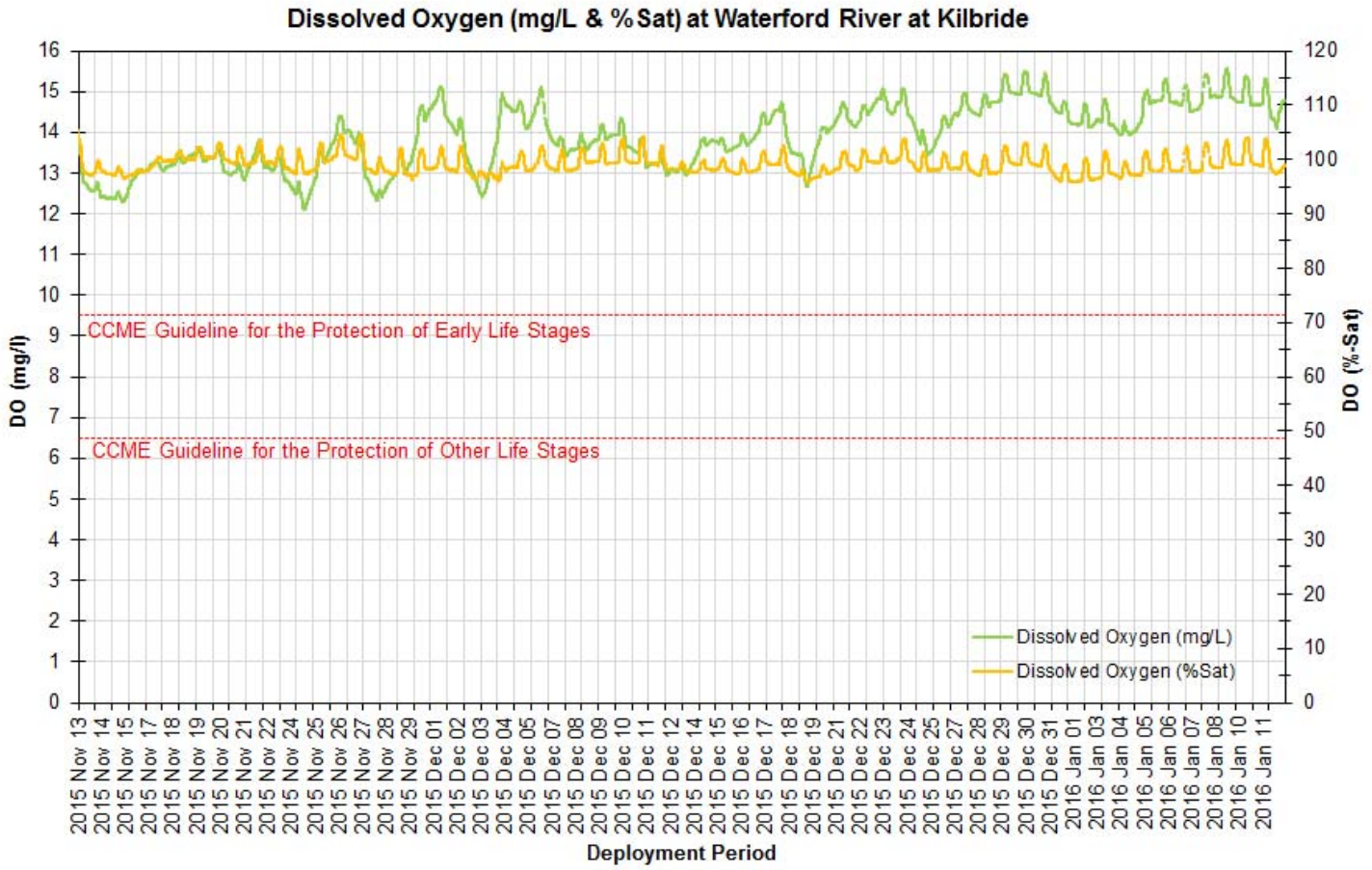


Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment ranged within 1.0 NTU and 328.7 NTU (Figure 6). The deployment data had a median of 5.9 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.

At the end of deployment there is a turbidity peak, this would coincide with the state of the instrument when it was removed from the protective deployment casing. The turbidity sensor was inundated with debris, blocking the sensor. The ranking at removal was 'Poor' for the turbidity data due to the interference by the debris. The data from January 12th will not be used in any statistical analysis.

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.

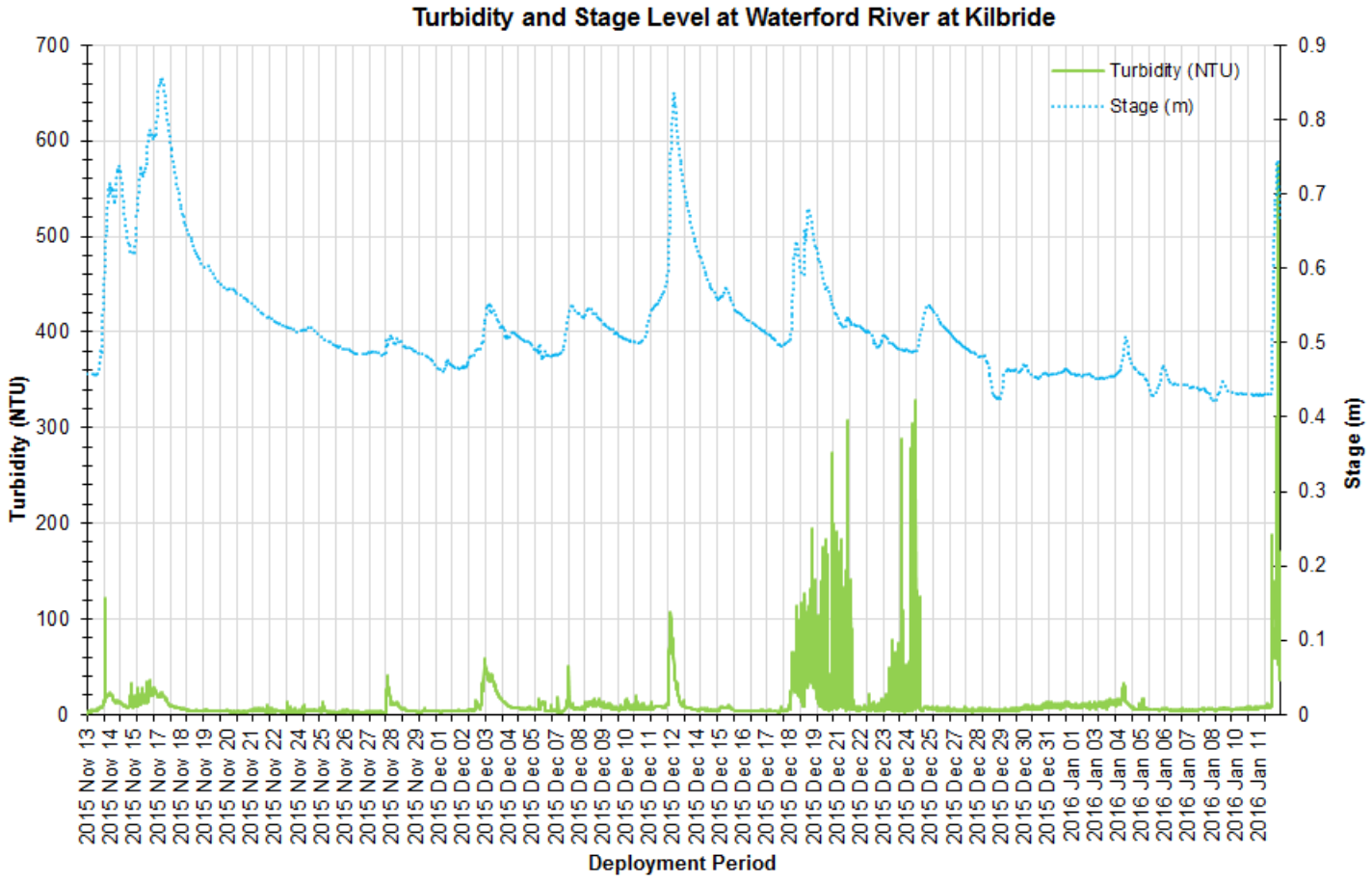


Figure 6: Turbidity (NTU) and stage level (m) values at Waterford River at Kilbride.

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 0.42m to 0.86m. 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 24 mm on November 14th, 2015.

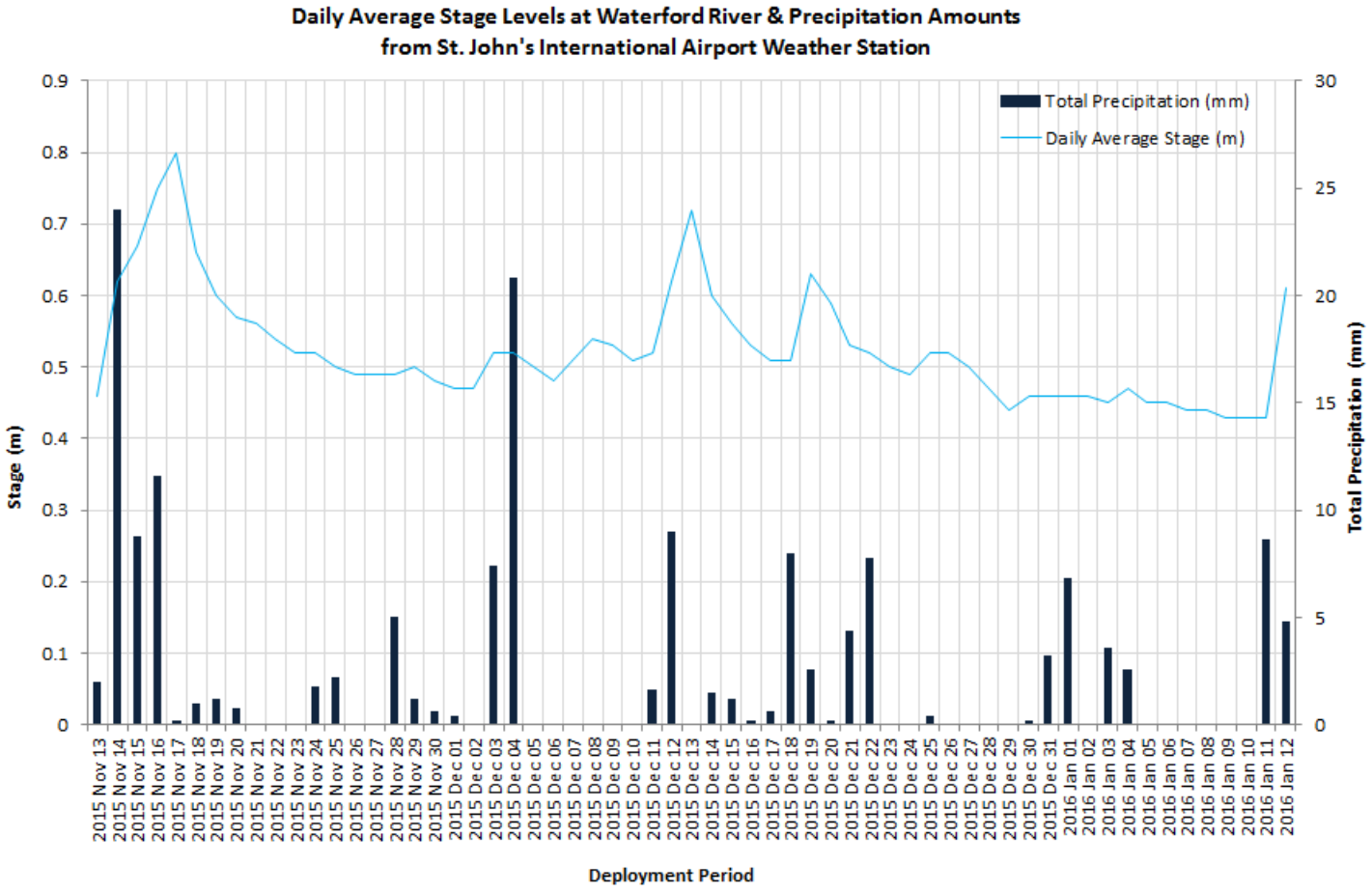


Figure 7: Daily average stage values at Waterford River at Kilbride and daily total precipitation from St. John's Airport Weather Station.

Conclusion

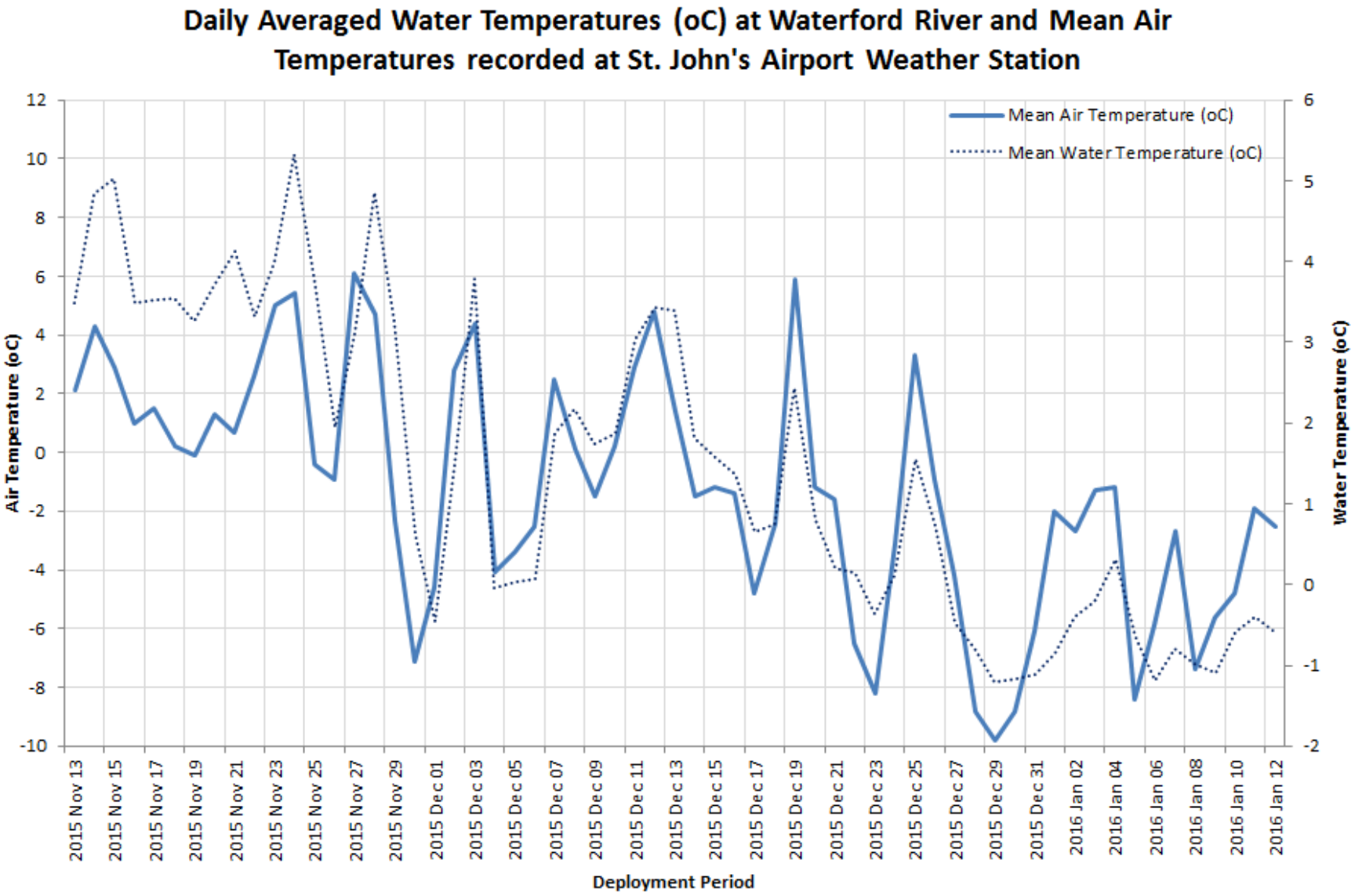
As with many urban brooks and streams, precipitation and runoff events play a role in influencing the water quality within the water body. Waterford River flows through significant developed areas, including residential and industrial zones, the brook can also be found along the boundaries of heavily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

It is evident by the recorded data that precipitation events have influenced fluctuations in stage. 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 high pH values during deployment are consistent; despite stage level changes throughout the deployment the pH values remained steady. Rainfall also played a part in the conductivity values. High peaks can be matched to rainfall during those same timeframes. Dissolved oxygen concentration (mg/L) was influenced by the water temperature; there were several dips in dissolved oxygen during deployment. Turbidity had a several events but they were 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 recorded at St. John's Airport Weather Station
Mean Air Temperature (oC)
Mean Water Temperature (oC)
Air Temperature (oC)
Water Temperature (oC)
Deployment Period
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
6
5
4
3
2
1
0
-1
-2
2015 Nov 13
2015 Nov 15
2015 Nov 17
2015 Nov 19
2015 Nov 21
2015 Nov 23
2015 Nov 25
2015 Nov 27
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2016 Jan 02
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2016 Jan 12