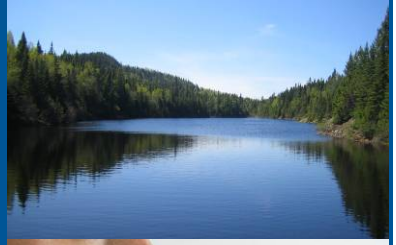







Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
January 11, 2017 to April 7, 2017

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
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 January 11, 2017 to removal on April 7, 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 (Municipal Affairs and Environment (MAE)) 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 MAE'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	January 11	Deployment	Good	Excellent	Good	Good	Excellent
	April 7	Removal	Excellent	Excellent	Good	Good	Excellent

On deployment the ranking of the field data against the QAQC data was: water temperature, specific conductivity and dissolved oxygen data ranked as 'Good', with the pH and turbidity data ranked as 'Excellent'. All valid rankings for the beginning of the deployment.

At removal of the instrument, water temperature, pH and turbidity data ranked as 'Excellent'. Dissolved oxygen and specific conductivity data ranked as 'Good'. All valid rankings for the data at the end of the deployment period.

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.

This instrument was deployed at Waterford River at Kilbride for an extended period of time, the protecting metal casing that houses the instrument in the river had frozen to the river bank and the instrument was unable to be retrieved until a thaw.

At removal of the instrument there was a significant amount of frazzle ice present around the instrument sensors. It is likely that this frazzle ice may have disturbed some of the data that was recorded. The dissolved oxygen data indicated that there may have been interference while some data was being recorded. If the data does not represent Waterford River at Kilbride the data is removed from the graph.

Waterford River at Kilbride

Water Temperature

Water temperature ranged from -0.11°C to 4.12°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 is reasonably consistent, there are several dips and slight increases that correspond with the changes in the stage levels. This is a colder time of the year therefore the water temperature will maintain a lower normal, with the median for this deployment being 0.74°C. During high stage events water temperature decreases for a short period of time.

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

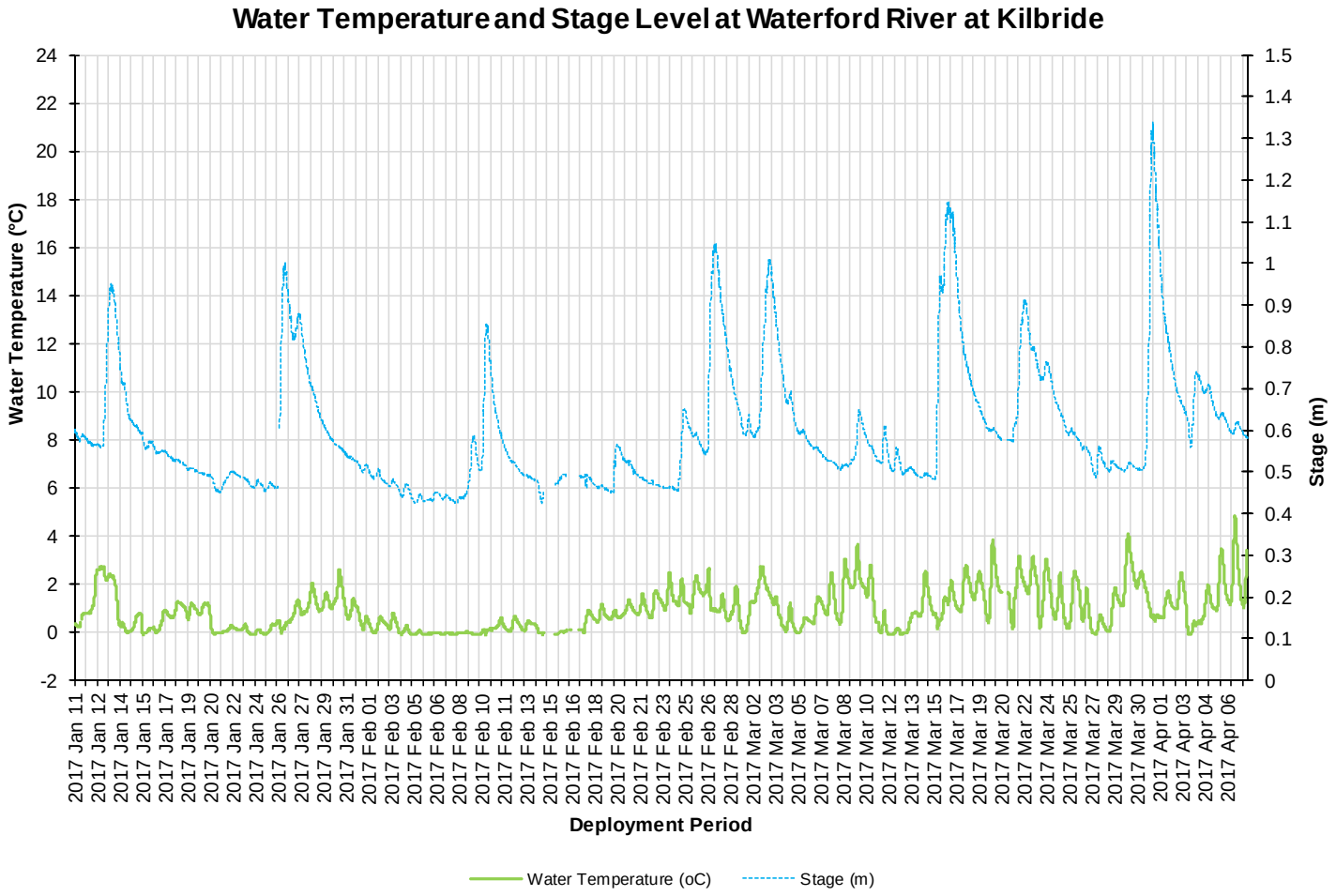

Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH values ranged between 7.02 pH units and 7.92 pH units (Figure 3).

The pH levels are reasonably consistent and remained within the guidelines indicated on the graph. During high stage events there are slight dips in pH data for a short period of time. During lows in stage there are slight increases in the pH levels for that time frame.

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 7.31 pH units.

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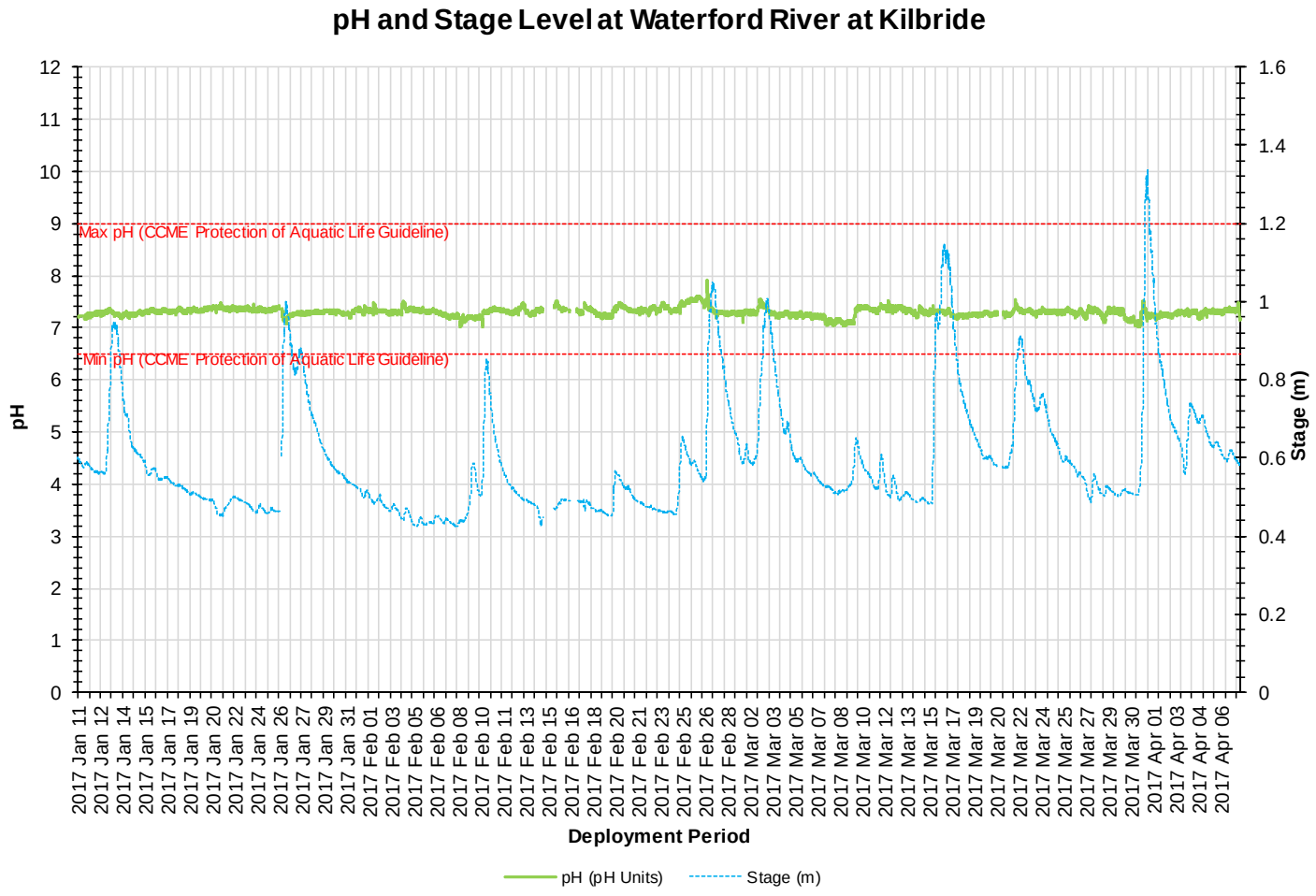

Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride

Specific Conductivity & Total Dissolved Solids

The conductivity levels were within 575.0 µS/cm and 3293.0 µS/cm during this deployment period. TDS (a calculated value) ranged from 0.3730 g/L to 2.1400 g/L (Figure 4).

At this time of the year, there is road salting to prevent ice buildup on the roadways. The salt is subsequently flushed into nearby urban rivers during snow clearing or precipitation events. This is evident on January 26th, and again on February 10th, 2017. The specific conductivity levels are increasing in this deployment during high stage events, as the specific conductivity probe is accounting for the extra suspended material. However throughout most of the year at the Waterford River at Kilbride station, the specific conductance levels drop when the stage levels rise (this is evident on February 27th and April 1st, 2017) as the road salting reduces as the warmer weather approaches. The relationship between stage and conductivity is evident on the graph; during specific times of the year this type of relationship is a normal occurrence in urban brooks.

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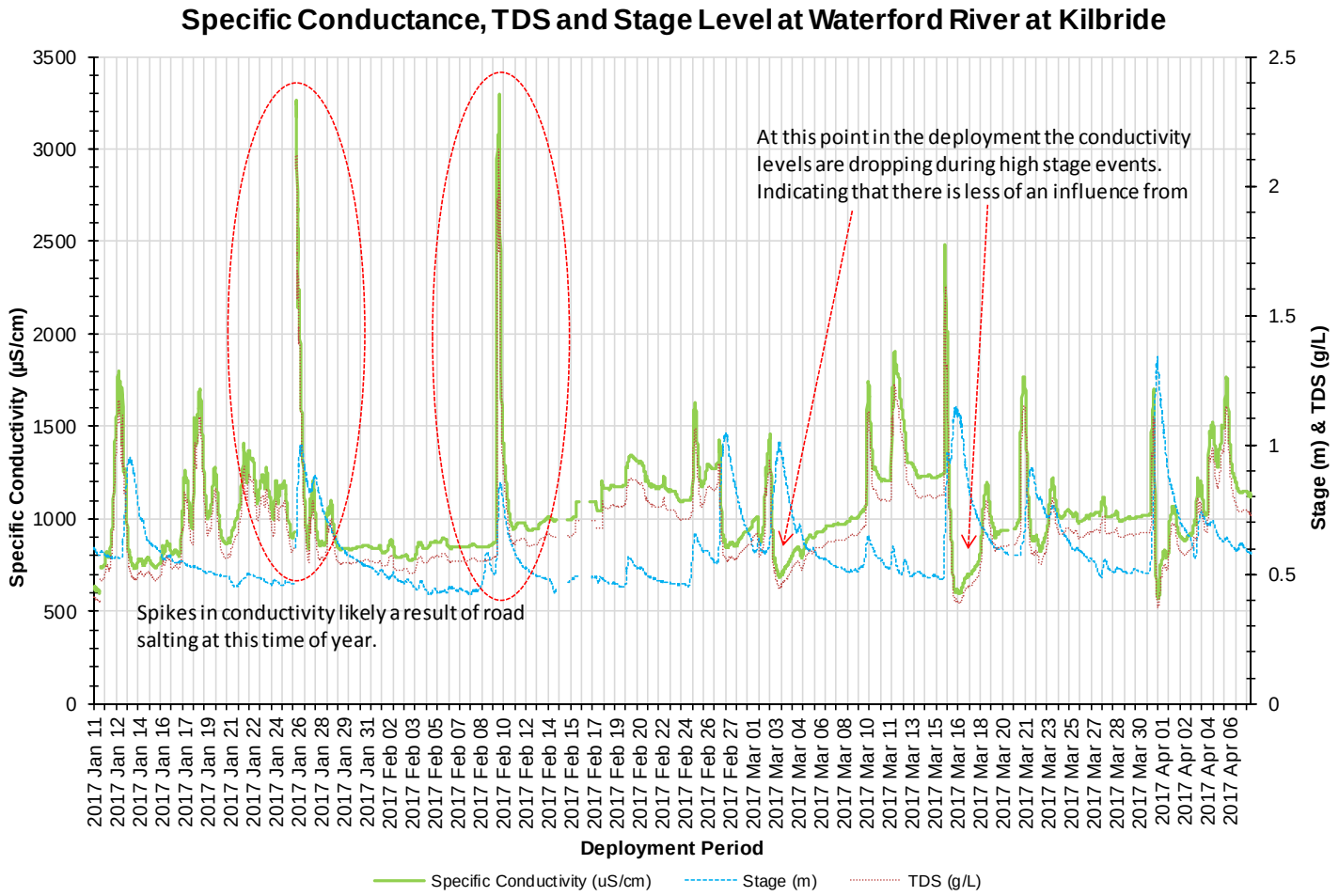

Figure 4: Specific conductivity (µS/cm), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

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 12.10 mg/L to a maximum of 14.80 mg/L. The percent saturation levels for dissolved oxygen ranged within 89.3 % Saturation to 103.2 % Saturation (Figure 5).

Water temperature is graphed with dissolved oxygen as it directly influences the concentration levels of dissolved oxygen in the water column. Cooler water temperatures are going to increase the concentration level of dissolved oxygen being present in the brook.

This deployment period had significant ice buildup around the protective casing for the instrument. The instrument also had frazzle ice present around the probes of the instrument when it was removed. It is assumed that the sharp dips in dissolved oxygen data is a result of inference from the frazzle ice. Dissolved oxygen data was removed from the dataset when it did not represent Waterford River at Kilbride brook.

As the winter season changes into spring there will be an increase in water temperature and a gradual decrease in the dissolved oxygen concentration in the water.

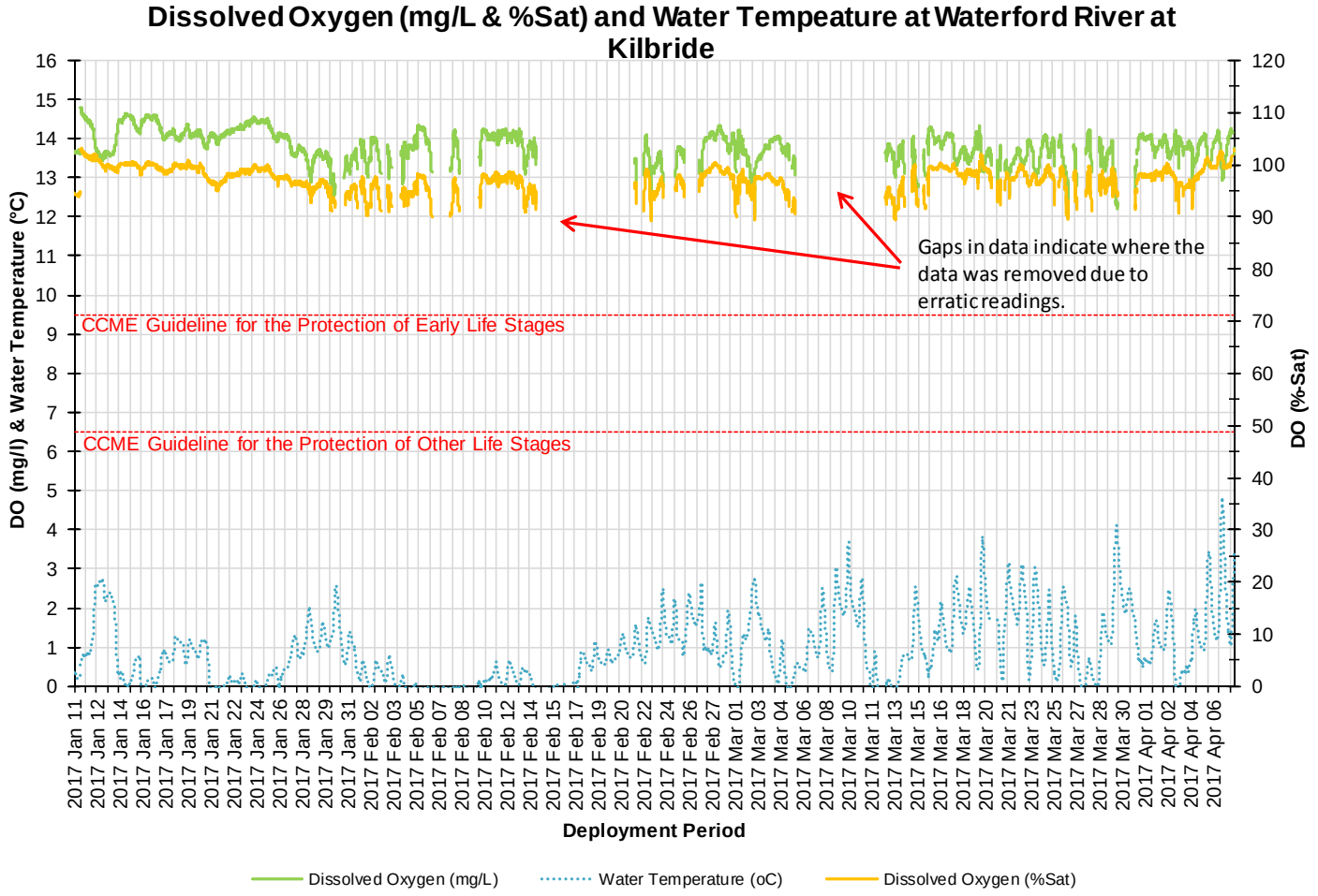

Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment ranged within 0.8 NTU and 95.7 NTU (Figure 6). The deployment data had a median of 15.4 NTU.

The higher turbidity events throughout the deployment period correlate with increases in stage. There was recorded rainfall and/or snowfall on all of the high stage increases (Figure 7). Precipitation can increase the presence of suspended material in water, through the movement of soil and sediment from nearby urban areas. The turbidity data returns to lower levels after the high peaks. 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.

The turbidity median of 15.4 NTU, is slightly higher than normal for this station. This deployment period saw 63 days of rainfall and/or snowmelt out of 87 deployment days. Therefore it is likely that the brook remained turbid for a large portion of this deployment period.

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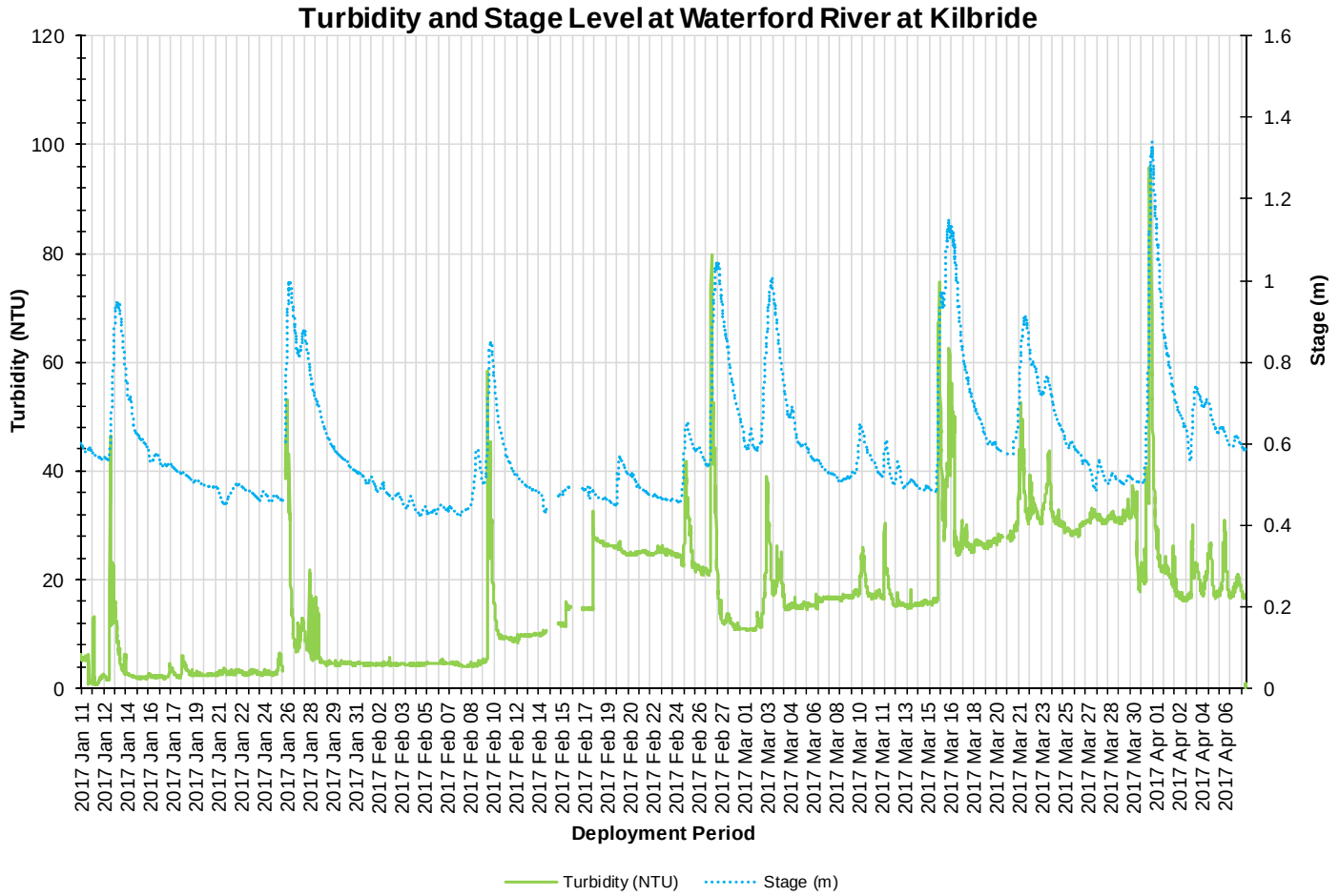


Figure 6: Turbidity (NTU) and stage level (m) values at Waterford River at Kilbride.

Stage and Total 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. The total precipitation data was obtained from Environment Canada's St. John's Airport weather station. Total precipitation includes the sum of the total rainfall and the water equivalent of the total snowfall in millimetres (mm).

During the deployment period, the stage values ranged from 0.42m to 1.34m. The larger peaks in stage do correspond with substantial total precipitation events as noted on Figure 7. Total Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 40.2 mm on January 26th 2017.

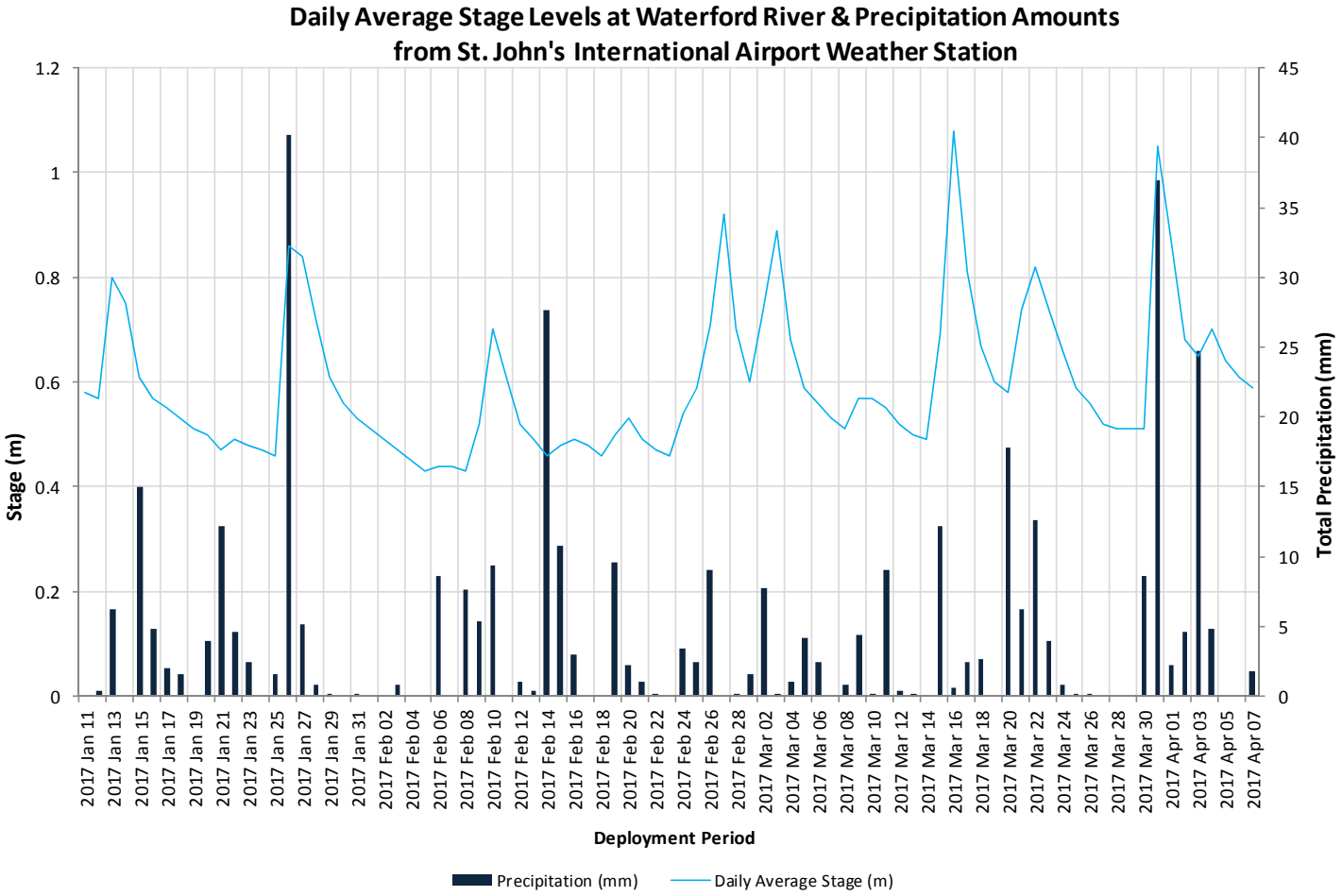


Figure 7: Daily average stage values at Waterford River at Kilbride and daily total precipitation from St. John's Airport Weather Station.

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.

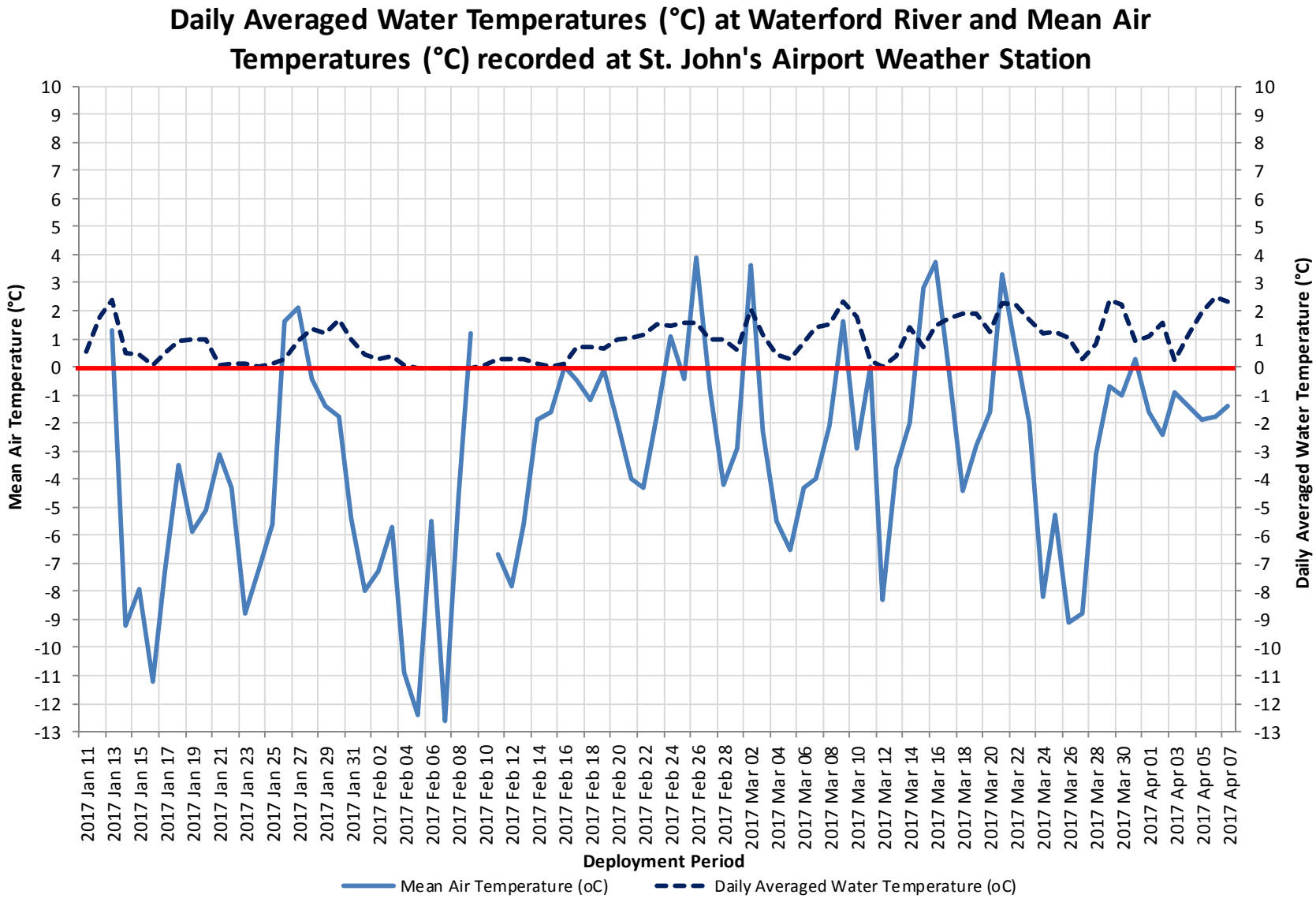
This deployment was extended due to the ice and snow buildup around the bank of the river, the instrument was unable to be removed until the spring thaw. The instrument also had a significant amount of frazzle ice buildup present around the end of the protective casing where the sensors are located. It is assumed that some of this frazzle ice interfered with the dissolved oxygen data. The data that did not represent the brook was removed.

When reviewing the graphs as a whole it is evident that precipitation events did create varying effects with the water quality parameters pH, conductivity, dissolved oxygen and turbidity. It is also likely that the frequency of the rainfall during this deployment period influenced water quality, for instance this is evident with the higher consistent turbidity data. There were evident spikes in specific conductivity, a result of road salt being flushed into the brook during rainfall and/or snowfall events. The pH values were reasonably consistent for this deployment, with slight increases at low stage times. Dissolved oxygen was reasonably constant, with small increases during the lower temperature events.

There was significant movement in the turbidity data over the deployment. The majority of the turbidity levels were directly linked with the high stage levels and frequent rainfall. 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 secured in.

The water quality data displayed in this report is as expected of an urban brook during the winter season. After each significant change in the data, the parameters settled 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 during the winter months.

APPENDIX I


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

Waterford River at Kilbride, Newfoundland and Labrador