Real-Time Water Quality Report

Canada Fluorspar (NL) Inc, Real-Time Water Quality Stations

Deployment Period
October 24th, 2023 to December 11th, 2023

Newfoundland Labrador

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

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General

The Water Resources Management Division (WRMD) maintains real-time water quality and water quantity monitoring stations in John Fitzpatrick Pond and on Outflow of Unnamed Pond south of Long Pond, within the site of Canada Fluorspar (NL) Inc, St. Lawrence, Newfoundland & Labrador.

Decommission of Outflow of Grebes Nest Pond

Due to a change in the water supply for Outflow to Grebes Nest Pond station, it was determined that this brook would not provide consistent water supply to remain a monitoring station. It was decided to decommission Outflow to Grebes Nest station in May 2022. In replacement, a new site was selected and the hut and all the water quality instrumentation was relocated to an area that has a consistent water supply and the capability to provide an overview of the water quality conditions (Figure 1). The new site was named John Fitzpatrick Pond.

John Fitzpatrick Pond

John Fitzpatrick station was established in May 2022. The site was selected based on the location and consistent water supply throughout the year. Despite an expected small decrease in water level during the summer, this station will provide stable and beneficial water quality data for this site (Figure 1).

The Real Time station is established on the northwest bank of John Fitzpatrick Pond, close to the only outflow from the pond. This pond is surrounded by natural habitat on the northeast side, and on the southwest side bordered by the CFI mine (Figure 1). There are two small brooks that periodically flow into this pond. This station will monitor the water quality and the stage level of the pond. The instrument is deployed, at a depth of approximately 1.0 meters. The GPS coordinates for this site are as follows: N 46° 54’ 47.95” W 055° 27’ 46.97” (Figure 1).

Figure 1: Real-Time Station at John Fitzpatrick Pond. Station hut (left) and instrument deployed in pond (right)

Outflow of Unnamed Pond south of Long Pond

The Outflow of Unnamed Pond south of Long Pond is established downstream of the Tailings Management Facility (TMF). This station will provide near real-time water quality and quantity data to ensure emerging issues associated with the TMF are detected, to allow the appropriate mitigation measures to be implemented in a timely manner, thus reducing any adverse effect on the downstream systems.

The location of Outflow of Unnamed Pond south of Long Pond was selected due to accessibility to the brook and the sufficient pool available to place the water quality and quantity instruments (See Figure 2). The stream originates from a small unnamed pond and meanders through a marsh environment alongside the TMF. The stream is approximately 1.0 to 2.0 meters wide. Where the instrument is deployed, there is a depth of approximately 1.0 to 1.5 meters. The GPS coordinates for this site are as follows: **N46° 54' 14.1" W055° 26' 37.5"**. The station hut was placed on the right bank looking downstream approximately 8 meters from the stream (Figure 2).

Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Unnamed Pond south of Long Pond. Station hut (left) and instrument deployed in brook (right).

Quality Assurance and Quality Control

WRMD staff are responsible for maintenance and calibration of the real-time water quality monitoring equipment, as well as recording and managing the water quality data. As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is conducted at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.

During deployment and removal, a QA/QC Sonde is temporarily deployed adjacent to the Field Sonde. 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). Values for temperature, pH, conductivity, dissolved oxygen, and turbidity are compared between the two instruments (Table 2)**.** Additionally, grab samples are collected during deployment to compare pH, specific conductivity and turbidity values between the field instrument and grab samples (Table 3).

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's important to note that the temperature sensor on any sonde is crucial. All other parameters can be categorized into subgroups: temperature-dependent, temperature-compensated, and temperature-independent. Due to the temperature sensor's placement on the sonde, the entire sonde must be at a constant temperature before the temperature sensor stabilizes. The values may take some time to reach the appropriate reading; if a reading is taken too soon, it may not accurately represent the conditions of the water body.

Table 2: QA/QC vs. Field Instrument performance rankings

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
John Fitzpatrick	**Oct. 24th 2023**	**Deployment**	Excellent	Excellent	Excellent	Excellent	Excellent
	Dec. 11th 2023	**Removal**	Good	Good	Excellent	Good	Excellent
Unnamed Pond	**Oct. 24th 2023**	**Deployment**	Good	Excellent	Excellent	Excellent	Excellent
	Dec. 11th 2023	**Removal**	Good	Fair	Excellent	Excellent	Excellent

When compared to the QAQC instrument data, both stations ranked Excellent or Good for all parameters, except for pH upon removal at Unnamed Pond which ranked fair. This could be attributed to the QA/QC instrument not being in the water long enough to fully equilibrate to the waterbody.

Table 3: Grab sample vs. Field Instrument Comparison Rankings

Station	Date	Action	Comparison Ranking		
			pH	Conductivity	Turbidity
John Fitzpatrick	**October 24th, 2023**	**Deployment**	Excellent	Excellent	Excellent
Unnamed Pond	**October 24th, 2023**	**Deployment**	Good	Good	Excellent

When comparing the field instrument to grab sample data, all parameters rank excellent or good.

Hydrometric Data

Water Resources Management Division hydrometric (stage and flow) data is quality controlled on a less frequent basis than water quality data due to differences in protocols. The hydrometric data shown in this report is provisional and has not undergone quality control checks.

John Fitzpatrick Pond

Water Temperature

Water temperature ranged from 0.34°C to 11.46°C during the deployment period (Figure 3). The average water temperature for this deployment was 5.10°C, cooler than the previous deployment period average of 13.66°C. Colder water temperatures are to be expected as the season transitions to Winter. Water temperature displayed a natural diurnal pattern. Water temperatures will be warmer during the daylight hours and then lower during the nighttime (Figure 3).

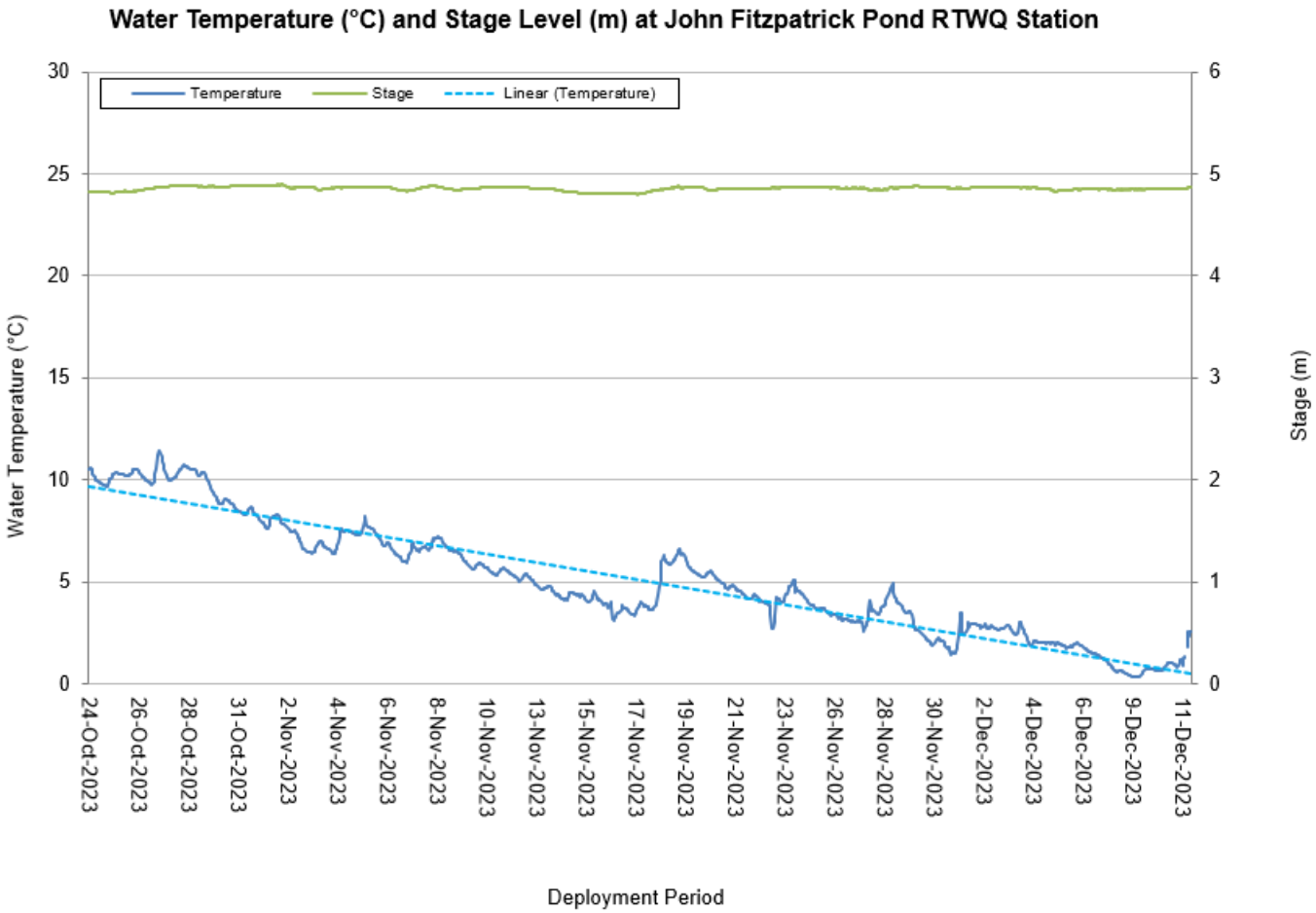

Figure 3: Water temperature at John Fitzpatrick Pond RTWQ Station (°C)

pH

Throughout the deployment period, pH values ranged between 7.71 pH units to 7.99 pH units with an average of 7.93 and remained stable other than small fluctuations (Figure 4).

A pH sensor measures the acidity or alkalinity of a water body. pH is a measure of the concentration of hydrogen ions (H^+) in a solution. pH is a critical parameter because it influences the solubility of minerals and chemicals, the availability of nutrients, and the biological processes that occur in aquatic ecosystems. Most aquatic organisms have a preferred pH range for optimal growth and survival, and deviations from this range can have significant ecological implications. The pH data at John Fitzpatrick Pond remained within the Canadian Council of Ministers of the Environment (CCME) guidelines of 6.5-9.0 pH units for the protection of aquatic life for the duration of the deployment period (Figure 4).

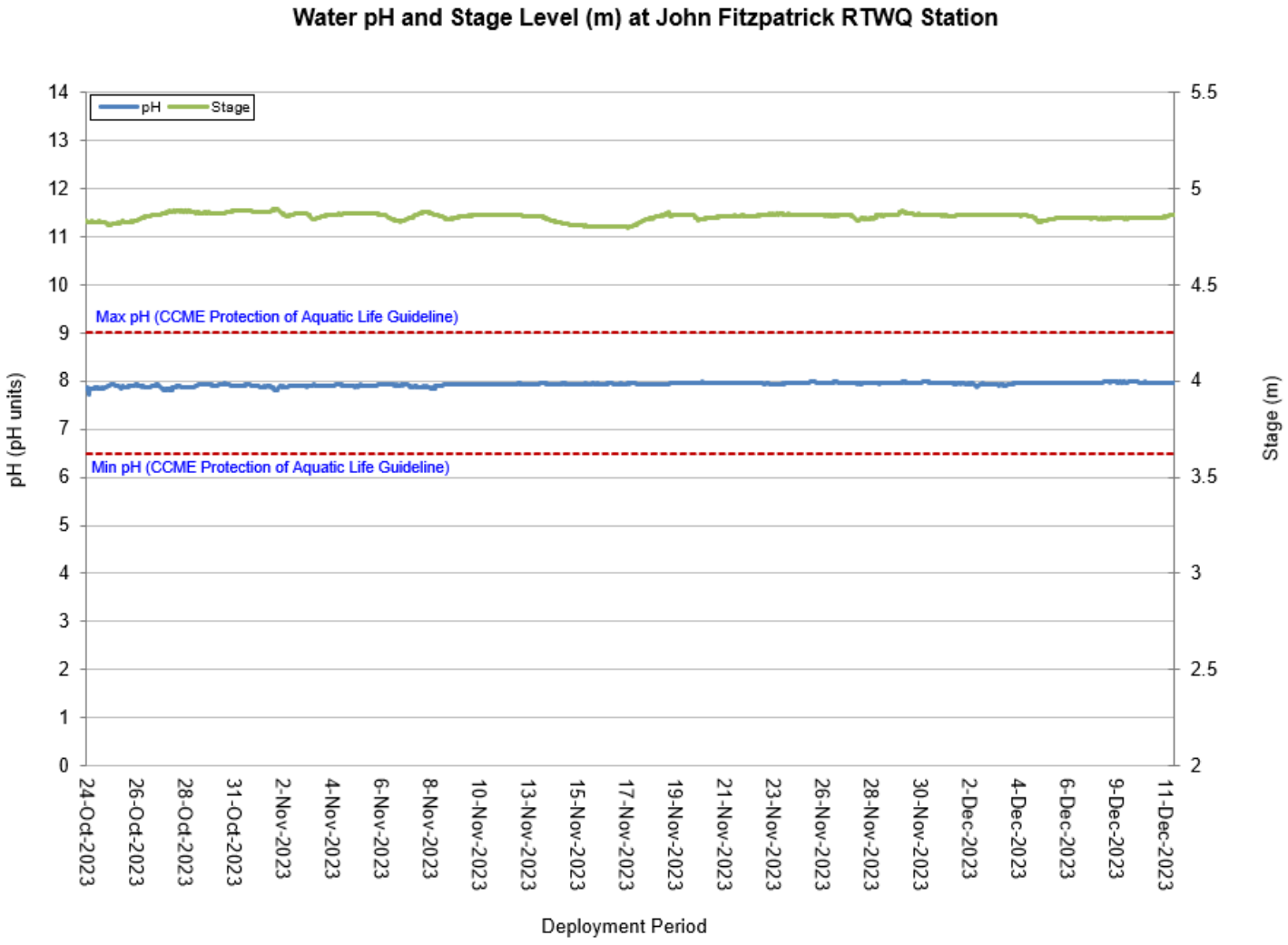

Figure 4: pH (pH units) values at John Fitzpatrick Pond RTWQ Station

Specific Conductivity

The conductivity levels were within 217.56 µS/cm and 272.52 µS/cm during this deployment period, with an average of 246.03 µS/cm (Figure 5). Conductivity was steadily increasing across the deployment period, with several small spikes of higher than normal values, which can be attributed to water getting pumped from the open mine pits. Small dips were likely a result of the rainfall (Appendix I) that was recorded by the weather station in St. Lawrence. The rain dilutes the water column for a short period of time, reducing the concentration of any suspended particles or diluted salts.

Specific conductivity is commonly used as an indicator of the concentration of dissolved ions in water. These ions can include electrolytes like salts, acids, and bases. The higher the concentration of dissolved ions, the higher the specific conductivity of the water.

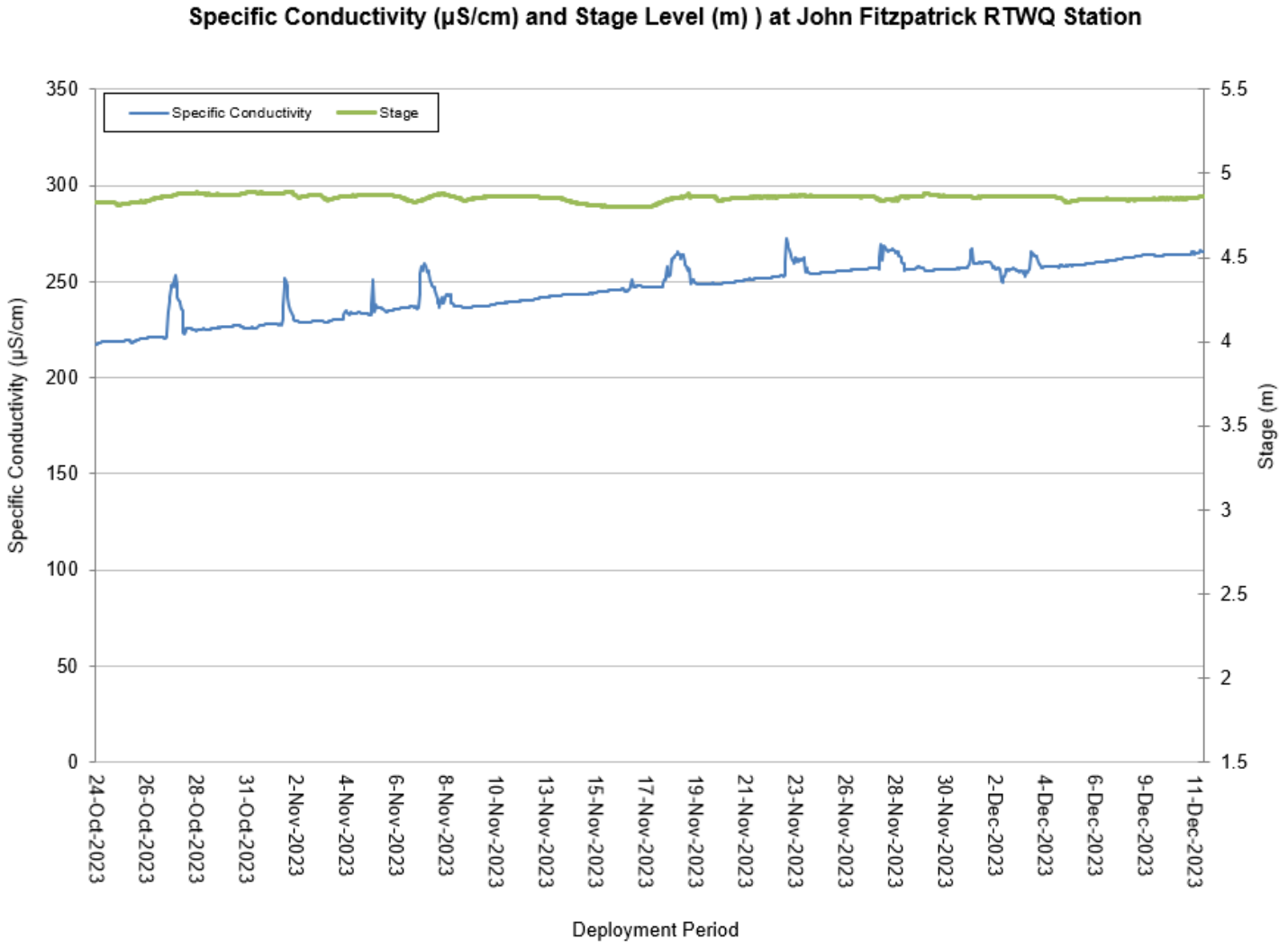

Figure 5: Specific conductivity (µS/cm) values at John Fitzpatrick Pond RTWQ Station

Dissolved Oxygen

Throughout the deployment, dissolved oxygen (DO) concentrations ranged from 10.86 mg/L to 14.62 mg/L, with corresponding DO percent saturation levels varying from 95.7% to 105.4% (Figure 6). All values remained above the CCME Guidelines for the Protection of Aquatic Life throughout the deployment, as was expected due to the cooler water temperatures entering the winter months.

The DO probe measures oxygen directly dissolved in the water in milligrams per liter (mg/L). The instrument then calculates percent saturation (% Sat), taking into account the water temperature. Dissolved oxygen levels can vary based on factors such as temperature, pressure, and the presence of other dissolved substances. Warmer water tends to hold less dissolved oxygen than cooler water. Additionally, the presence of organic matter, pollutants, and certain chemical reactions can influence dissolved oxygen levels**.**

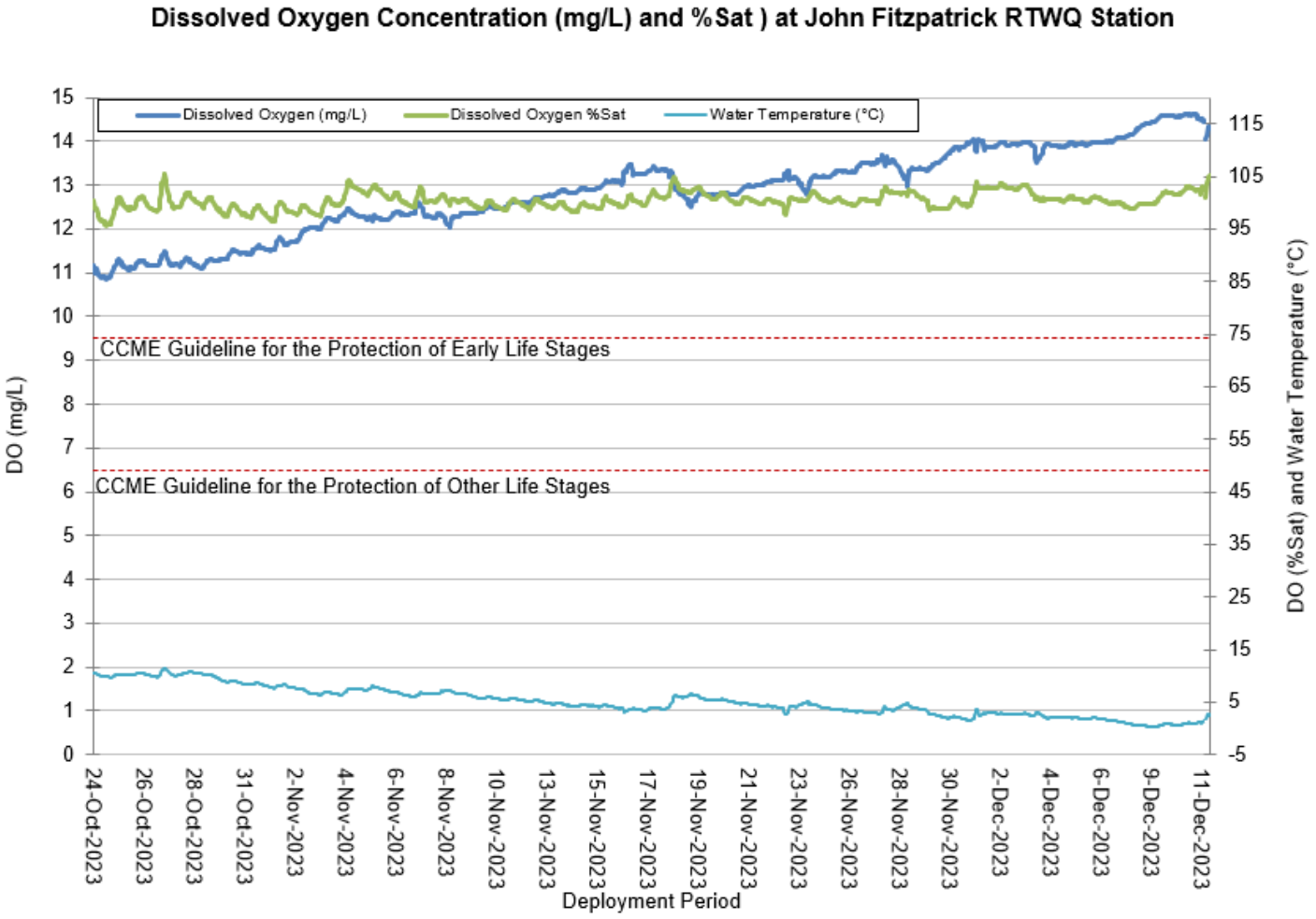

Figure 6: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C) at John Fitzpatrick Pond RTWQ Station

Turbidity

Turbidity levels during the deployment ranged within 1.6 NTU and 9.4 NTU, with an average of 2.32 NTU (Figure 7). During a site visit to this station, it was noted that the pond is extremely clear with a rocky bottom made up of large rocks (Figure 1). Turbidity remained low and stable throughout the deployment period other than a few short-term spikes that were likely due to precipitation events. Precipitation can increase run-off and disturb sediment on the waterbed that can temporarily increase turbidity.

Turbidity sensors use light scattering or absorption principles to quantify the degree of cloudiness in the water. Turbidity is caused by suspended particles, such as silt, clay, organic matter, and plankton, that scatter and absorb light.

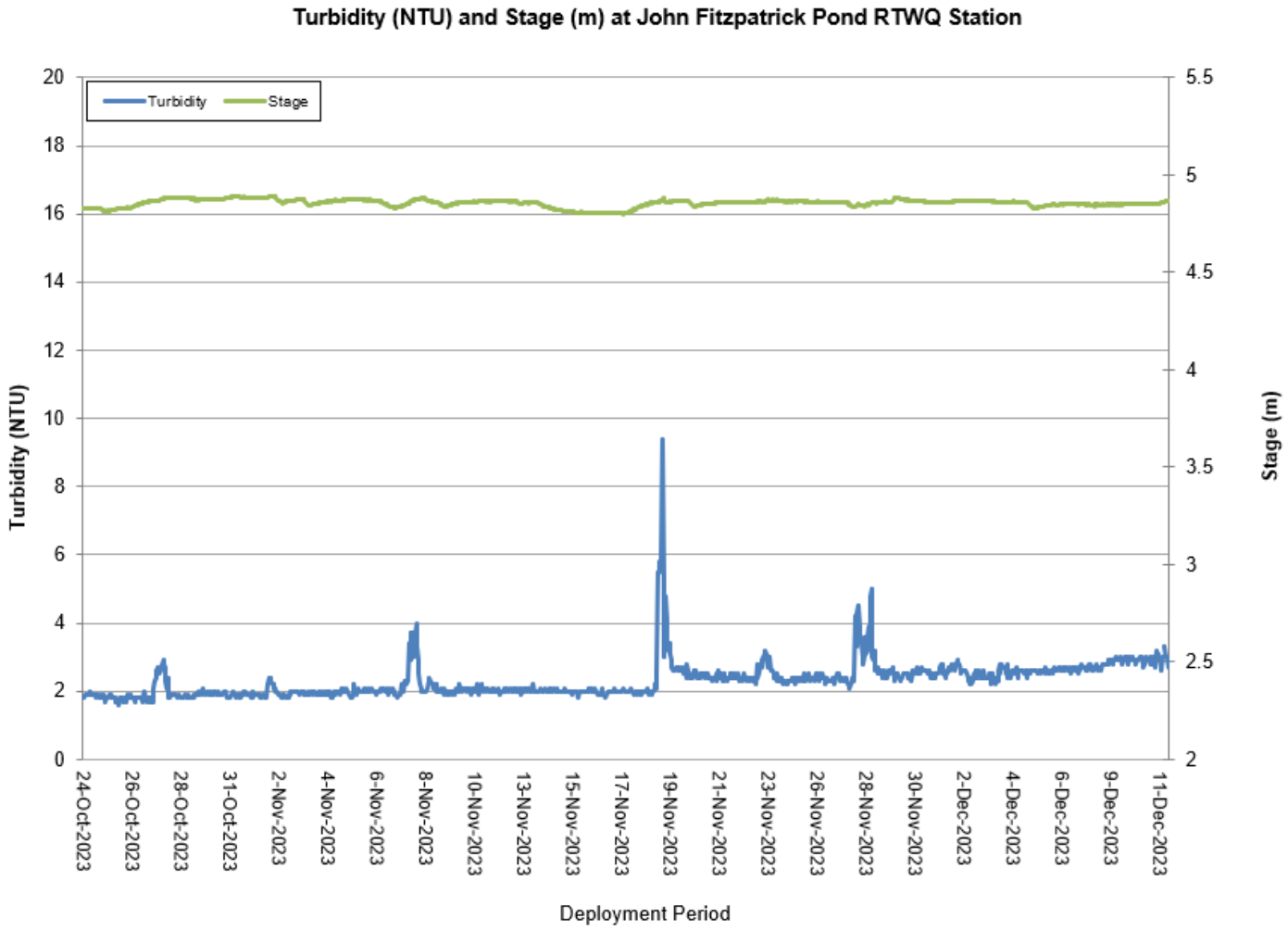

Figure 7: Turbidity (NTU) values at John Fitzpatrick Pond RTWQ Station

Daily Averaged Stage Level and Total Precipitation

Stage is an estimation of water level at the station and can account for variations in water quality parameters (e.g., Specific Conductivity, Dissolved Oxygen, turbidity). The stage ranged between 4.80m and 4.89m throughout the deployment. Significant peaks in stage align with total precipitation events, as indicated in Figure 8. Total Precipitation data were obtained from Environment Canada's St. Lawrence weather station.

Water Resources Management Division hydrometric data is quality controlled on a less frequent basis than water quality data due to differences in protocols. The hydrometric data shown in this report is provisional and has not undergone quality control checks.

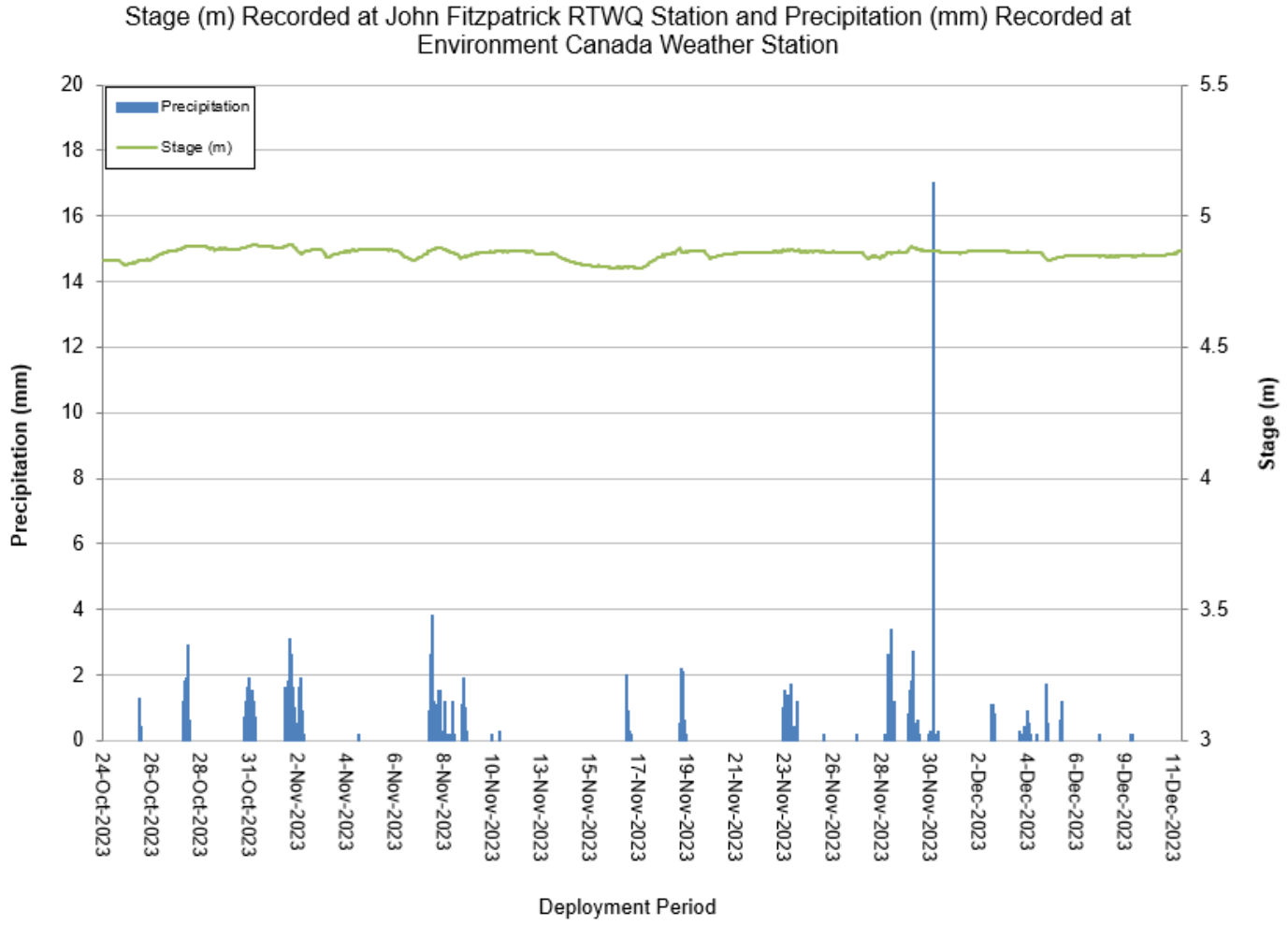

Figure 8: Stage values at John Fitzpatrick Pond RTWQ Station and total precipitation.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranged from 0.26ºC to 12.00ºC during the deployment period, with an average of 4.18°C (Figure 9). Decreases in water temperature frequently correspond with higher stage, likely due to wintery precipitation. Temperature decreased throughout the deployment period, which is typical as the season transitions to Winter.

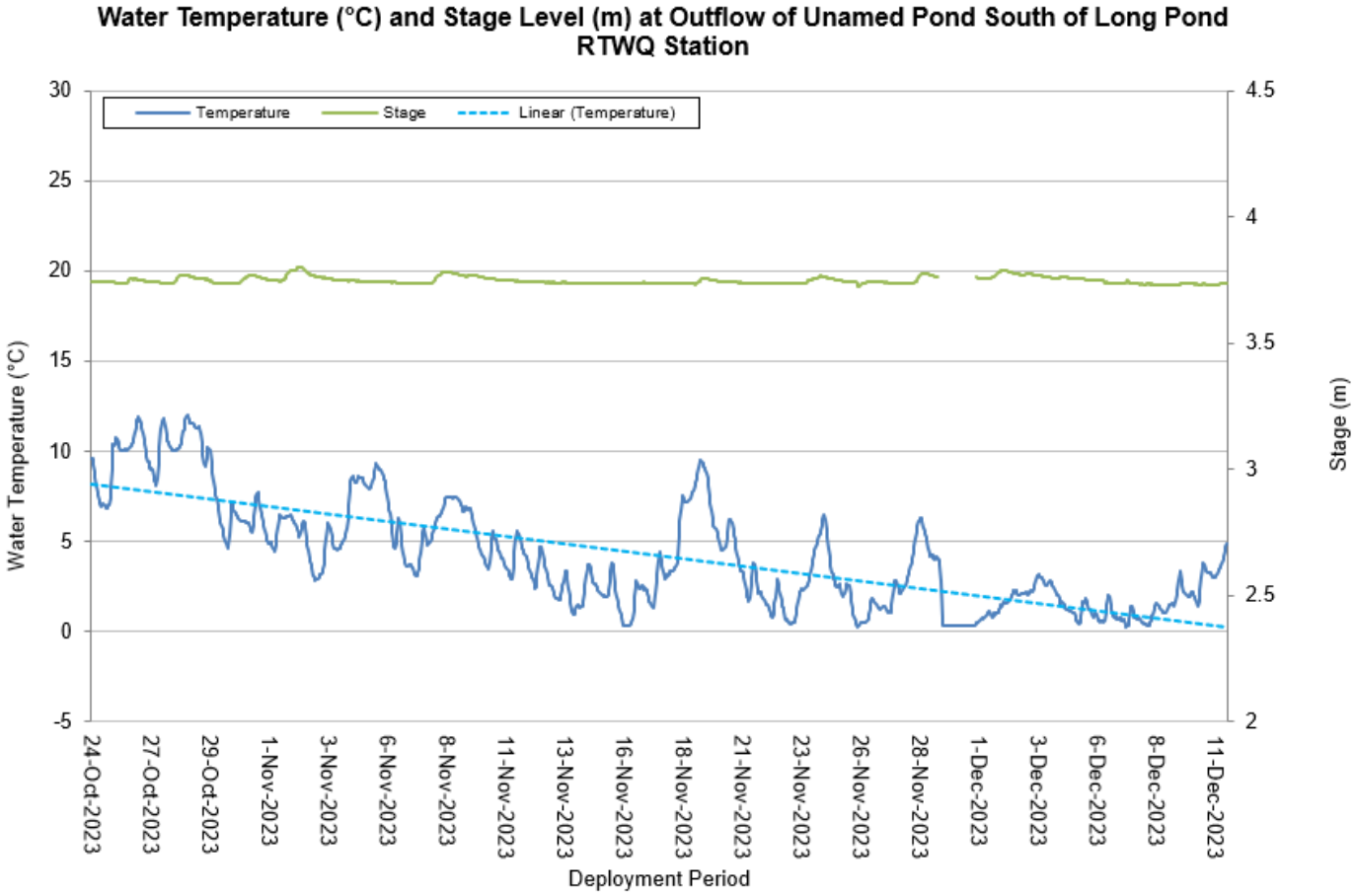

Figure 9: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged within 7.35 pH units and 8.10 pH units with an average of 7.92 pH units (Figure 10), remaining within the Canadian Council of Ministers of the Environment (CCME) Guidelines for aquatic life of 6.5-9.0 pH units.

Small decreases in pH during stage peaks are evident on Figure 10. pH does not return to background levels after each event, and overall, the pH data was consistent across deployment.

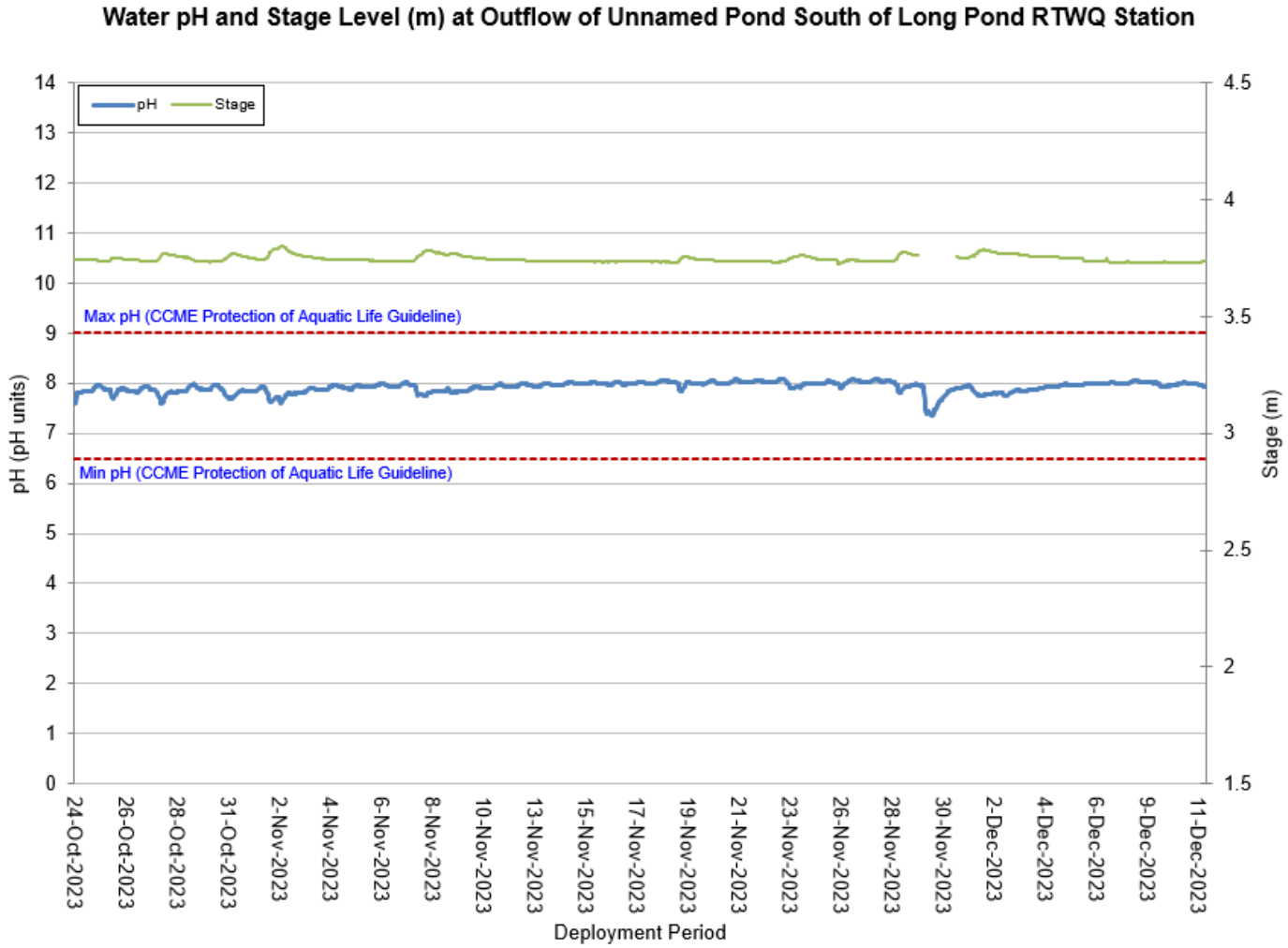

Figure 10: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

Conductivity levels ranged between 156.77 µS/cm and 282.62 µS/cm, with an average of 225.22 µS/cm during the deployment period.

Variations in water level, as depicted in the graph below, notably influence conductivity data. This is evident as conductivity rises and falls throughout the deployment period (Figure 11). When the water stage rises, often in response to precipitation events, conductivity tends to decrease as the water body is diluted. However, it generally returns to normal levels within a few days to weeks.

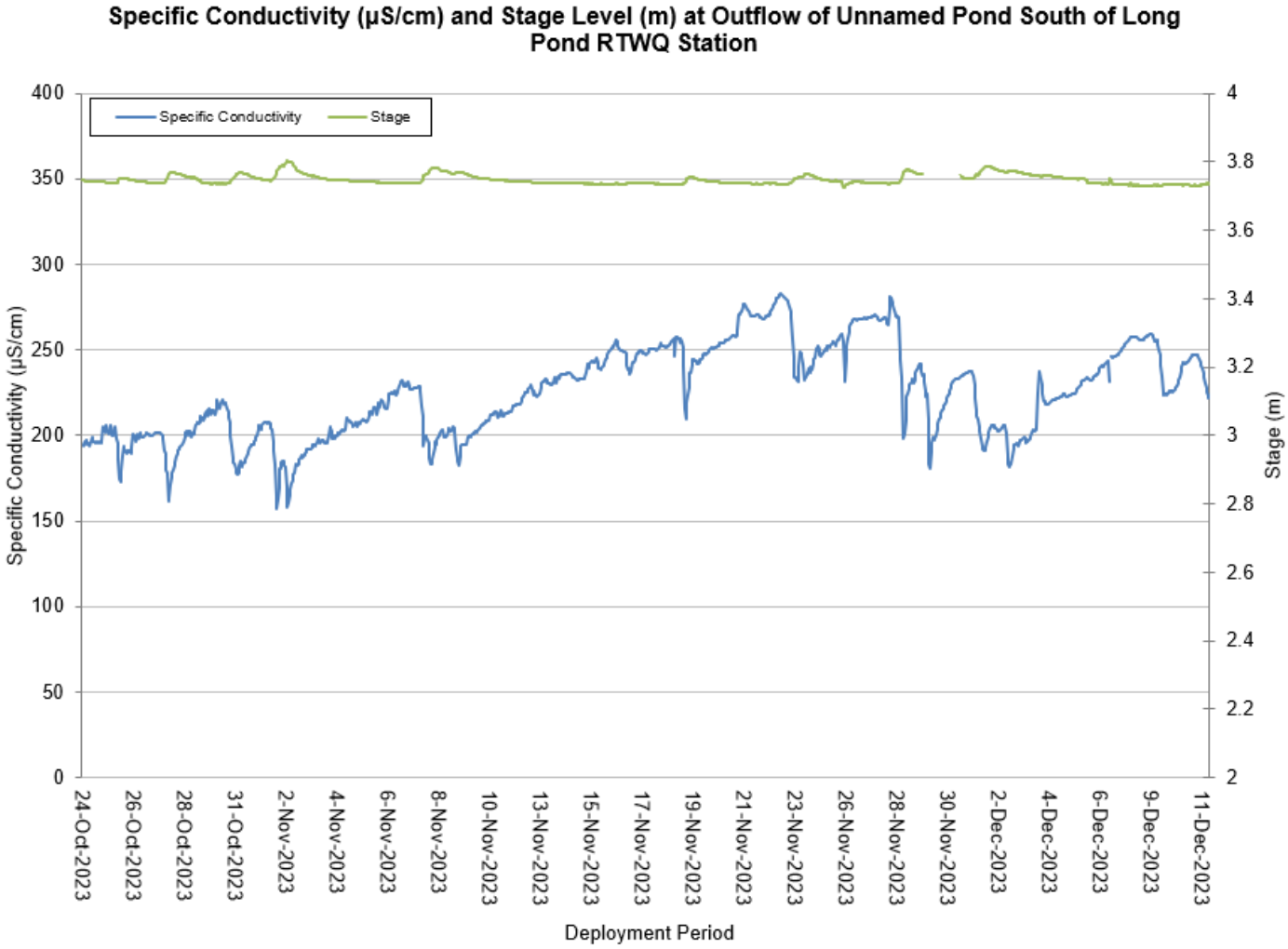

Figure 11: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

Dissolved Oxygen

During this deployment, dissolved oxygen concentrations ranged from 10.56 mg/L to 14.45 mg/L, with corresponding percent saturation values between 94.00% and 103.00%. Dissolved oxygen concentration levels remained above the CCME Guidelines for the Protection of Aquatic Life, as expected given the cooler water temperatures. Dissolved oxygen concentrations demonstrate an inverse relationship with water temperature, as depicted in the figure below. When water temperature decreases, dissolved oxygen typically increases.

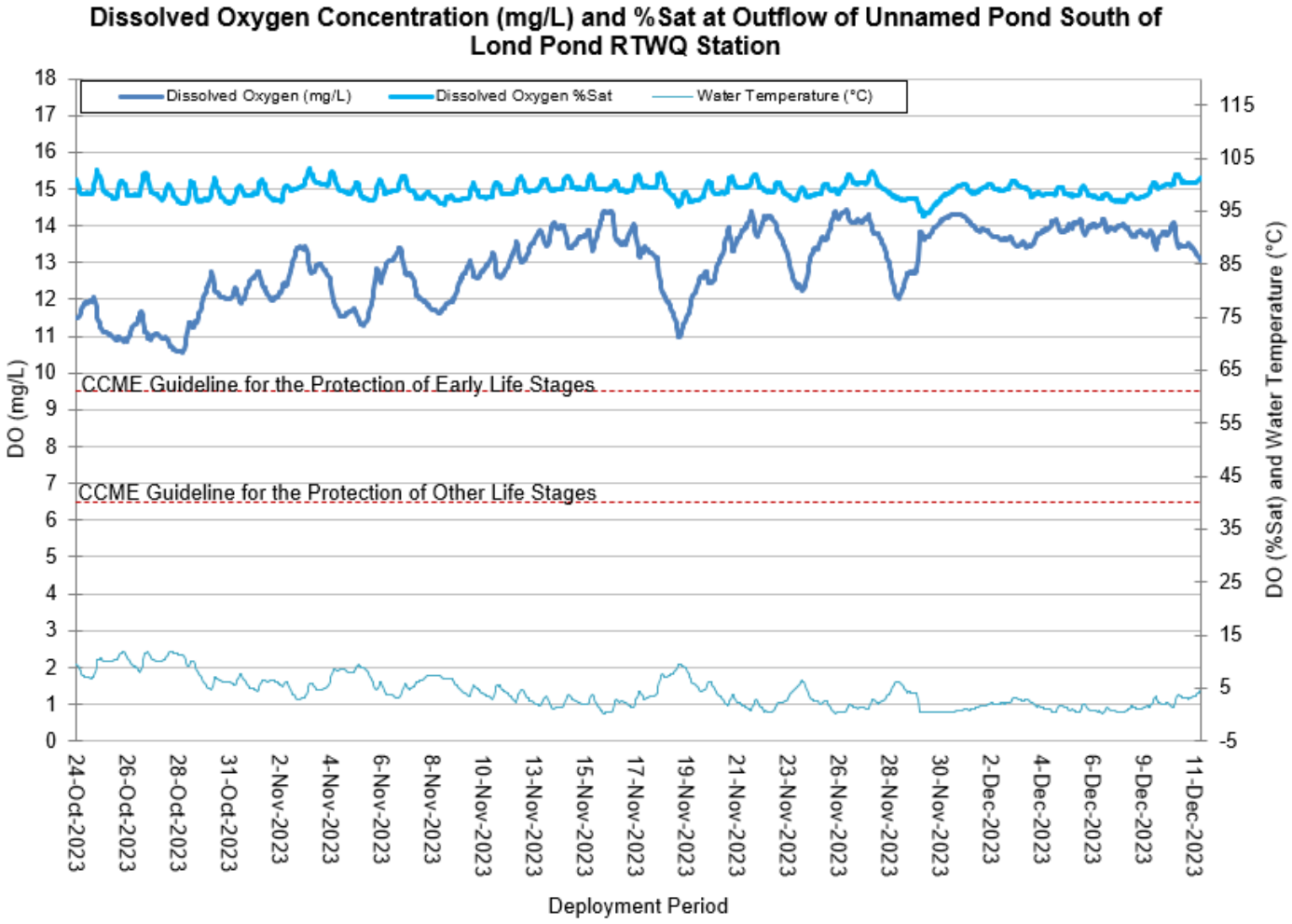

Figure 12: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 1.60 NTU and 8.90 NTU, with an average of 3.33 NTU (Figure 13).

The turbidity levels remained consistently low throughout the deployment period. The rise in turbidity observed on November 19th can be attributed to a precipitation event and the possible presence of particulate matter lodged within the sensor protection cage. This led to a slight elevation in turbidity, which gradually decreased over time. Minor fluctuations in the data can be linked to rises in water level caused by precipitation events (Appendix I).

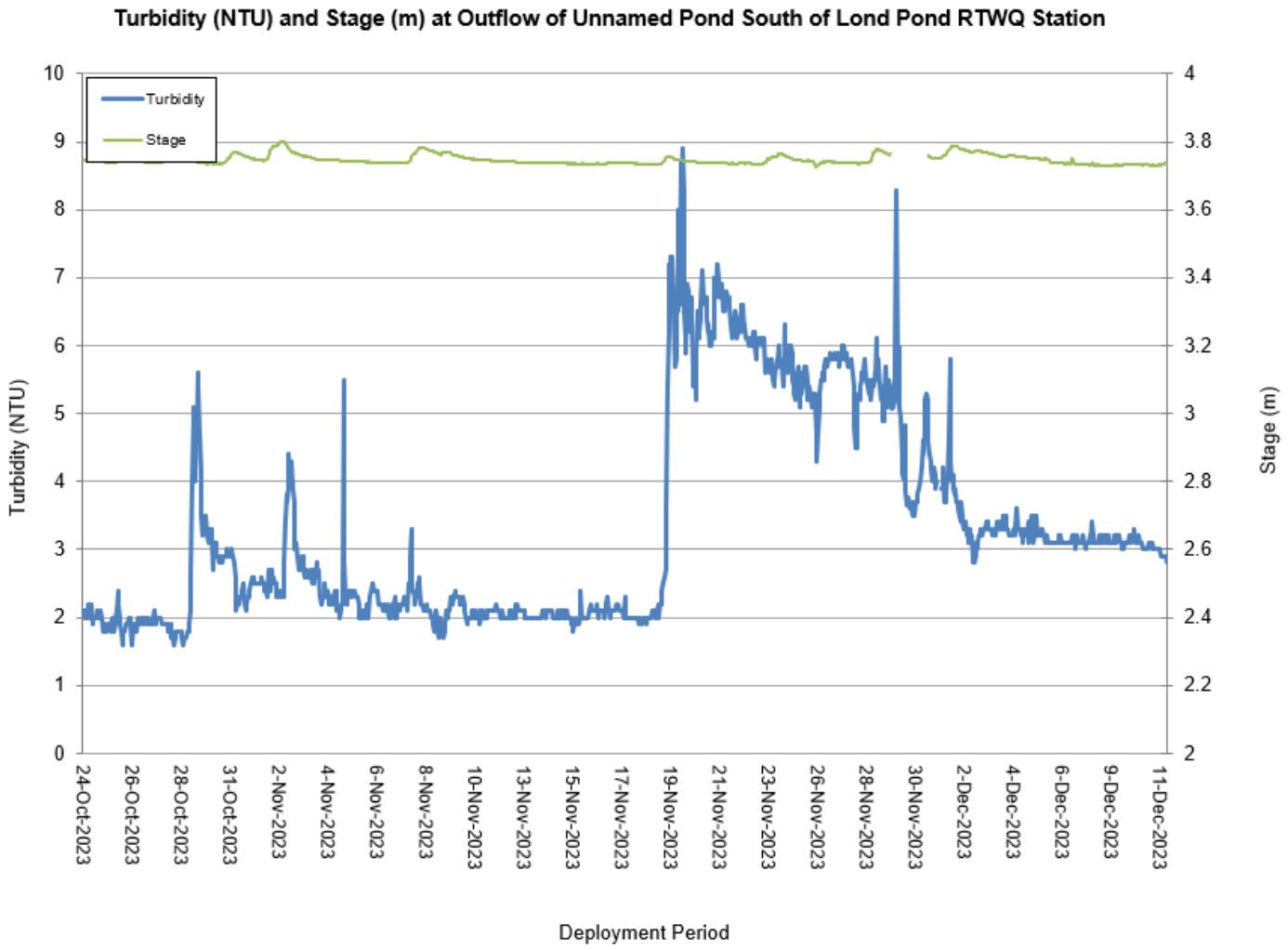

Figure 13: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

Stage is an estimation of water level at the station and can explain fluctuations occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage ranged between 3.72m to 3.80m during the deployment. Large peaks in stage correspond with the total precipitation events as noted on Figure 14. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station (Appendix I).

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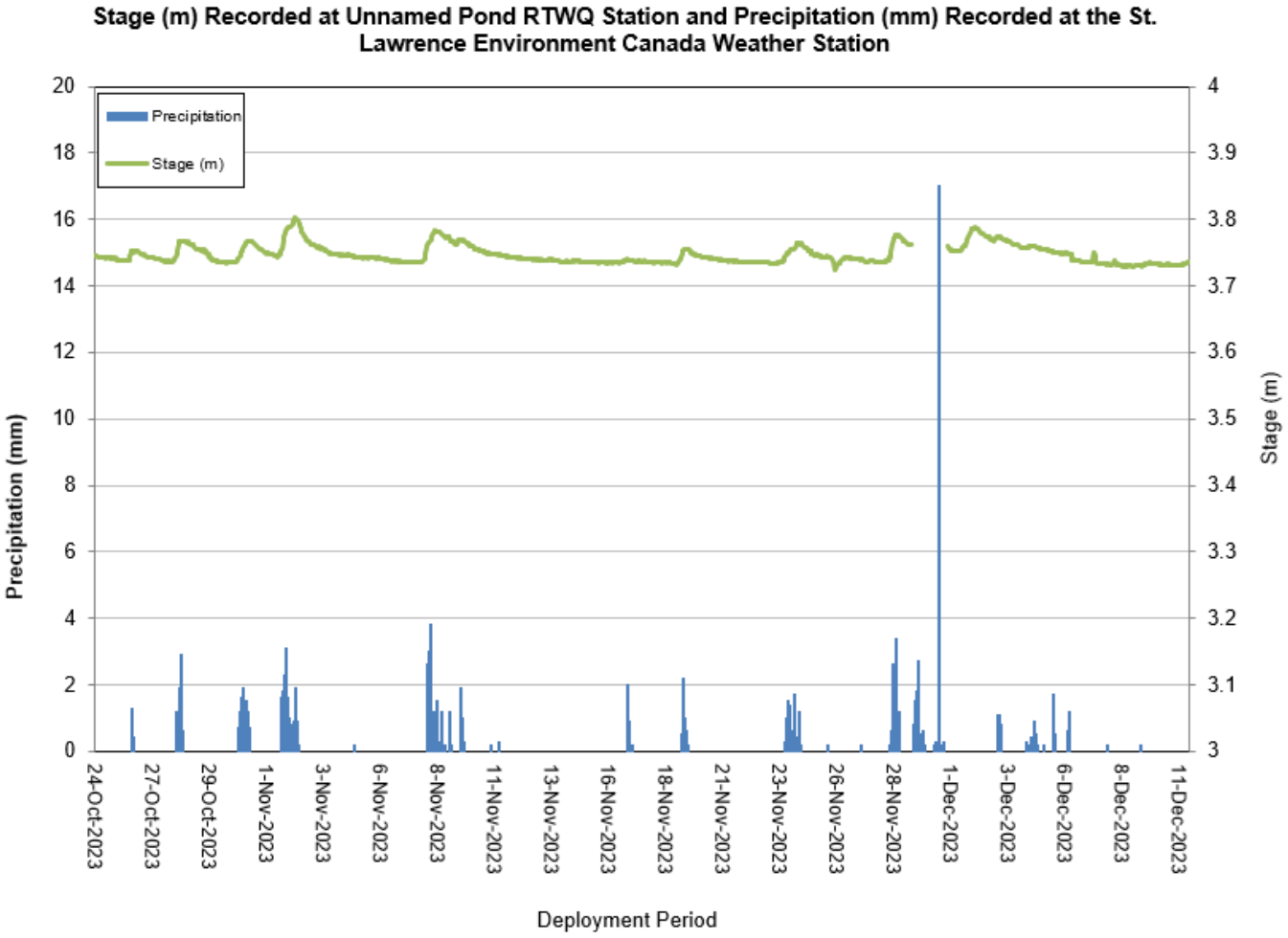

Figure 14: Daily averaged stage values and total precipitation.

APPENDIX I

Total Precipitation recorded at Environment Canada, St. Lawrence Weather Station

Parameter statistics for each RTWQ Station

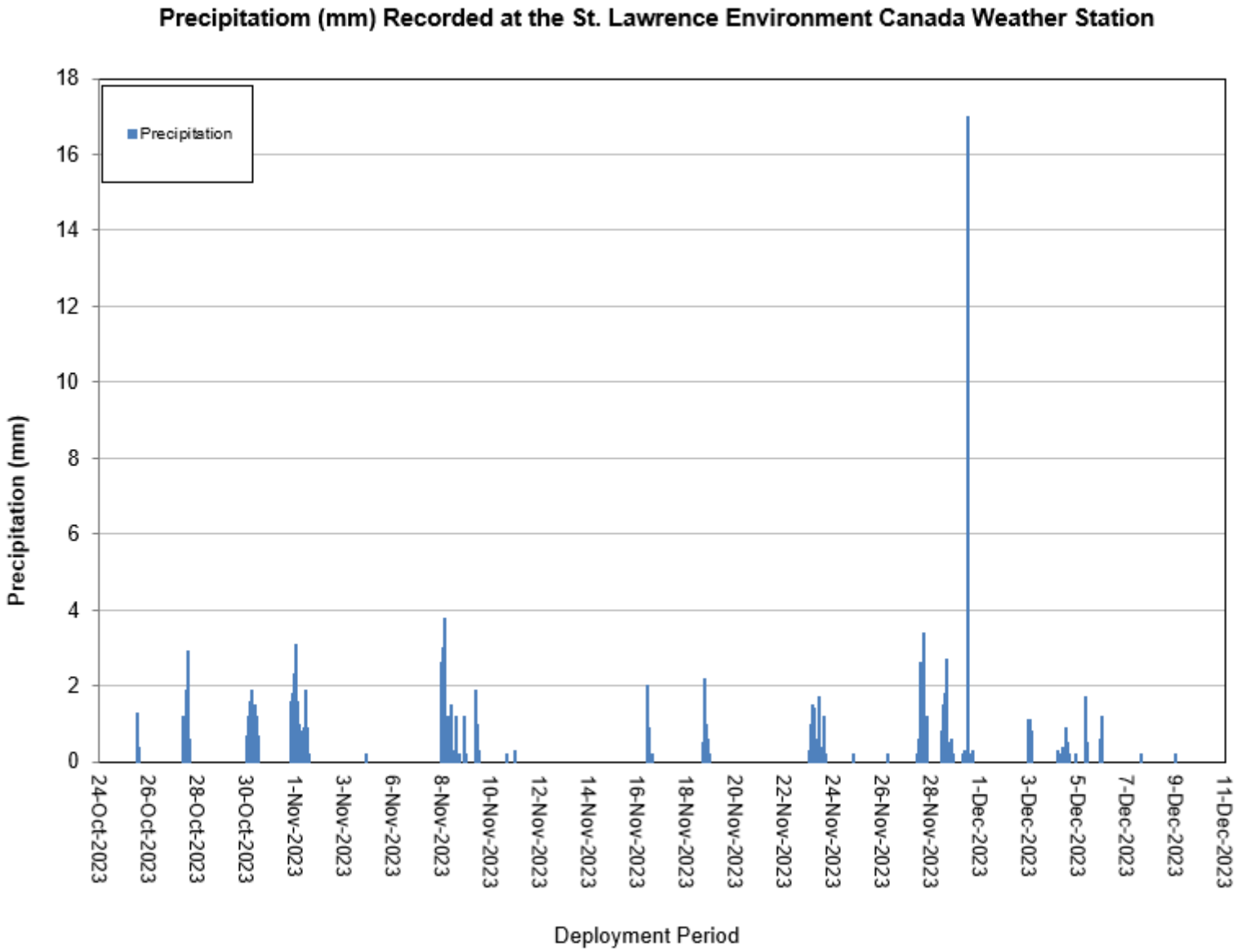

Figure 15: Precipitation recorded at Environment Canada Weather Station during the deployment period.

Deployment Period Parameter Statistics for CFI RTWQ Stations

John Fitzpatrick Pond RTWQ Station

Parameter	Max.	Min.	Median	Mean
Temperature(°C)	11.46	0.34	4.61	5.10
pH	7.99	7.71	7.94	7.93
Specific Conductivity (µS/cm)	272.52	217.56	248.64	246.03
TDS (g/mL)	0.18	0.14	0.16	0.16
Dissolved Oxygen (%Sat)	105.40	95.70	100.40	100.42
Dissolved Oxygen (mg/L)	14.62	10.86	12.89	12.84
Turbidity (NTU)	9.40	1.60	2.20	2.32
Stage (m)	4.89	4.80	4.86	4.86

Table 3: John Fitzpatrick Pond RTWQ station deployment period parameter statistics

Outflow of Unnamed Pond South of Long Pond RTWQ Station

Parameter	Max.	Min.	Median	Mean
Temperature(°C)	12.00	0.26	3.45	4.18
pH	8.10	7.35	7.94	7.92
Specific Conductivity (µS/cm)	282.62	156.77	225.36	225.22
TDS (g/mL)	0.18	0.10	0.15	0.15
Dissolved Oxygen (%Sat)	103.00	94.00	98.90	98.90
Dissolved Oxygen (mg/L)	14.45	10.56	13.24	12.96
Turbidity (NTU)	8.90	1.60	2.90	3.33
Stage (m)	3.80	3.72	3.74	3.75
Flow	0.61	0.00	0.01	0.01

Table 4: Outflow of Unnamed Pond South of Long Pond RTWQ station deployment period parameter statistics