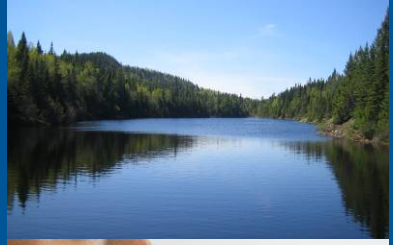







Real-Time Water Quality Report

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

Deployment Period
November 21, 2018 to January 8, 2019

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
Water Resources Management Division

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General

The Water Resources Management Division (WRMD), in partnership with Water Survey of Canada (WSC) -Environment and Climate Change Canada (ECCC), maintain real-time water quality and water quantity monitoring stations on Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond, brooks that are within the site of Canada Fluorspar (NL) Inc, St. Lawrence, Newfoundland & Labrador.

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

Outflow of Grebes Nest Pond

The Outflow of Grebes Nest Pond station is established downstream of the pit dewatering effluent outfall and upstream of John Fitzpatrick Pond. The stream is approximately 1.0 to 2.0 meters wide and sustains a sufficient pool for the instrumentation to be placed in (Figure 2). The pool depth is approximately 0.5 to 1.0 metres. The GPS coordinates for this site are as follows**: N46° 54' 35.9" W055° 27' 45.6"**.

The station hut was placed on the north bank looking downstream approximately 5 metres from the stream. This station will provide real-time water quality and quantity data to ensure emerging issues associated with the open pit (from both the construction and operational phases)are detected, to allow the appropriate mitigation measures to be implemented in a timely manner, thus reducing any adverse effect on the downstream systems.

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 3). The stream initiates 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 3).

Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest Pond.

Figure 3: Real-Time Water Quality and Quantity Station at Outflow of Unnamed Pond south of Long Pond.

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 adjacent to 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)) are responsible for maintenance of the real-time water quality monitoring equipment, as well as recording and managing the water quality data. Tara Clinton, is MAE's main contact for the real-time water quality monitoring operation at Canada Fluorspar (NL) Inc, 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 have an essential role in the data logging/communication aspect of the network and the maintenance of the water quantity monitoring equipment. WSC 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 dependent 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

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Grebes Nest Pond	November 21	Deployment	Excellent	Good	Good	Good	Poor
	January 8	Removal	Good	Excellent	Marginal	Fair	Good
Unnamed Pond	November 21	Deployment	Excellent	Excellent	Excellent	Poor	Excellent
	January 8	Removal	Good	Good	Excellent	Good	Fair

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, pH, specific conductivity and dissolved oxygen data ranked 'Excellent' to 'Good' against the QA sonde data. The turbidity data ranked 'Poor' against the QA values. This site is heavily impacted by sediment from the sedimentation pond which may have influenced the readings for both sondes.

During removal of the instrument, the ranking for water temperature, pH, and turbidity data were 'Excellent' or 'Good' against the QA data. Dissolved oxygen ranked as 'Fair' and conductivity data ranked as 'Marginal'. It was noted at removal of the instrument that the brook had frozen over, and there was frazzle ice suspended around the instrument. It is likely that these factors influenced the rankings for the sonde at removal.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond, the data ranked 'Excellent' for water temperature, pH, specific conductivity and turbidity. Dissolved oxygen data was ranked as 'Poor'. It was later determined that that the QA sonde dissolved oxygen probe was not working accurately.

At the end of the deployment, water temperature, pH, specific conductivity and dissolved oxygen ranked 'Good' or 'Excellent'. Turbidity data ranked as 'Fair' at removal, likely a result of sediment or silt build up on the sensor after the 48 day deployment.

Concerns or Issues during the Deployment Period

During the deployment at Outflow to Unnamed Pond south of Long Pond, hourly stage data was not available for comparison against the hourly water quality parameters. Daily averaged stage levels were provided with each graph for a general overview of the deployment.

Outflow to Grebes Nest Pond station is fed via a sedimentation pond. The lack of consistent flow results in significant stage level fluctuations across a deployment.

During the removal site visit, it was determined that the ice conditions could potentially damage the water quality instruments. The instruments were removed until conditions improve. These brooks freeze over almost completely, and Outflow to Grebes Nest Pond station freezes from the bottom up.

Please note that the stage data in this document 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.

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from -0.03°C to 3.85°C during the deployment period (Figure 4). The average water temperature for the deployment is 1.1°C, lower than the previous deployment as the air temperature and subsequently the water temperature have decreased into winter.

Outflow to Grebes Nest Pond station is fed via a sedimentation pond. It does not have consistent flow, thus the stage data can fluctuate significantly across a deployment. Stage fluctuations can influence water temperature as indicated in Figure 4 on December 20th; when the stage decreased, the water temperatures dipped for the same period.

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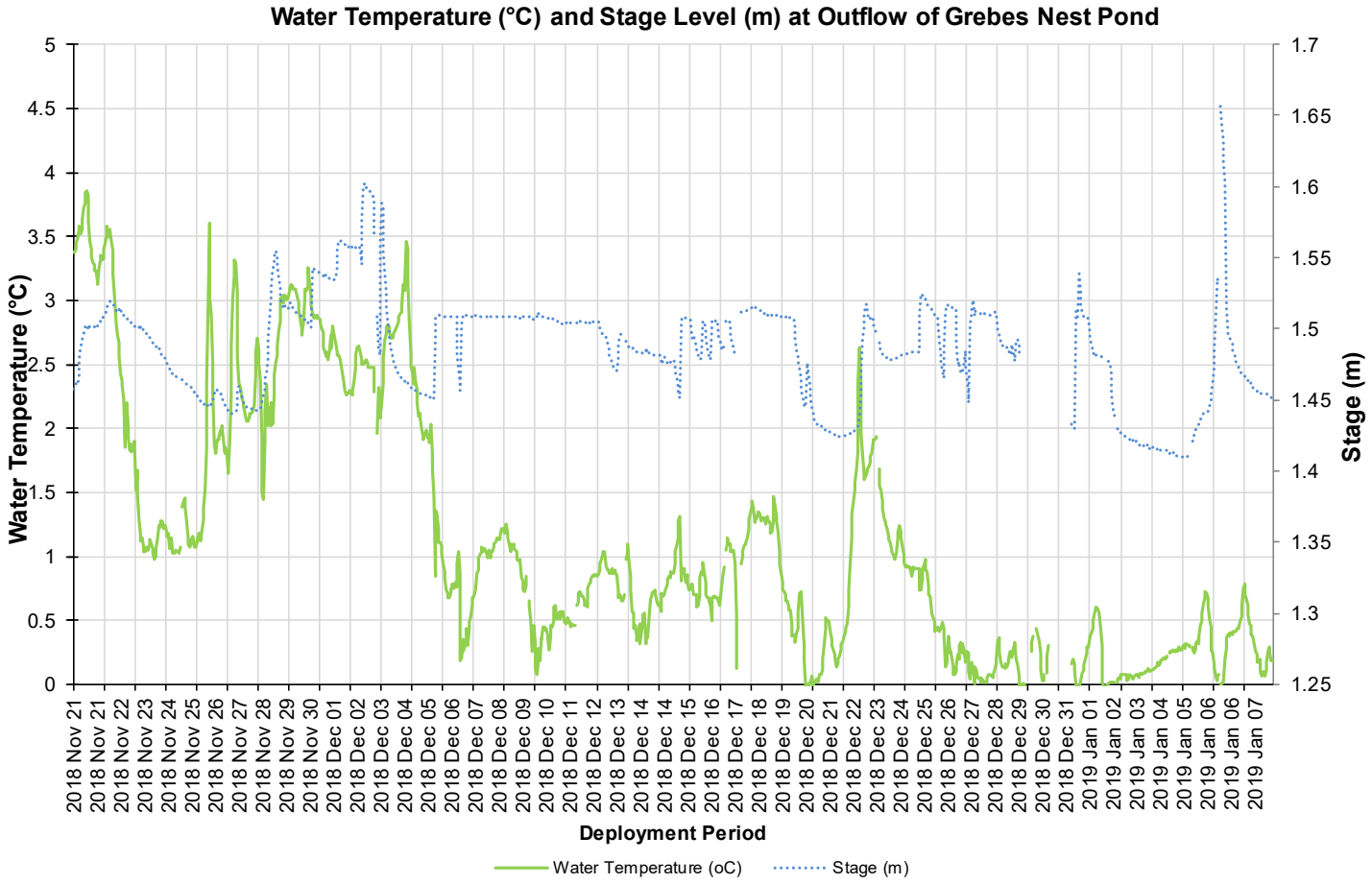

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 5.42 pH units and 6.35 pH units.

The pH data remained below the minimum Canadian Council of Ministers of the Environment (CCME) guideline for the protection of aquatic life for the duration of the deployment. This pH range was lower than those recorded in the previous deployments and may be a result of the cooler temperatures and ice present in the brook. Every brook is different with its own natural background range. It is not uncommon for Newfoundland and Labrador waters to be below or within the CCME pH guidelines.

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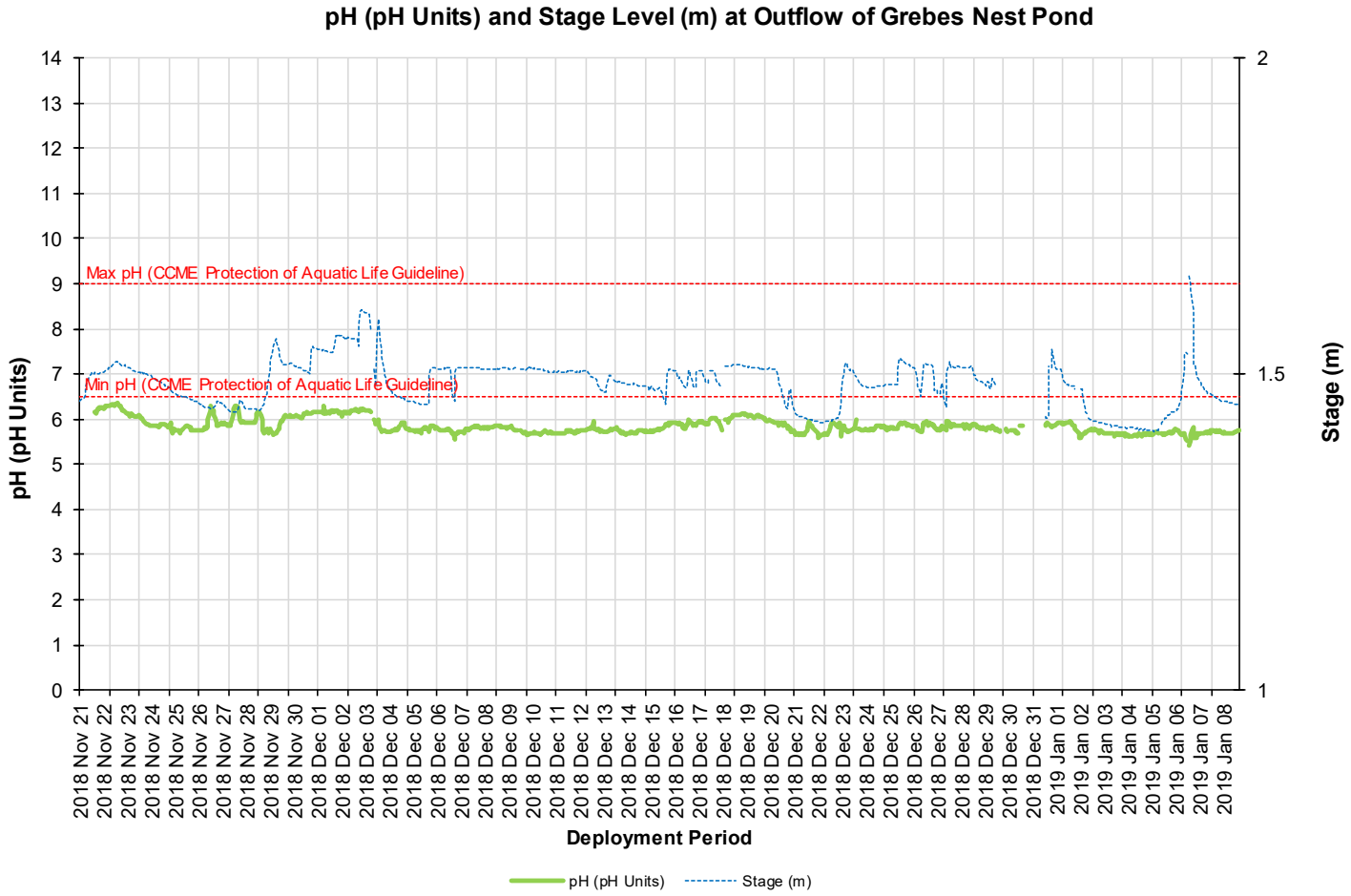

Figure 5: pH (pH units) values

Specific Conductivity

The conductivity levels were within 125.59 µS/cm and 298.36 µS/cm during this deployment period (Figure 6). The specific conductivity probe measured the diluted salts and inorganic materials present in the brook. The conductivity in a brook can be diluted by rainfall or increased by rainfall if there is runoff occurring.

Across the deployment period, the conductivity in the brook fluctuated with the changes to stage level. During stage increases, the conductivity levels responded by decreasing as the water was diluted.

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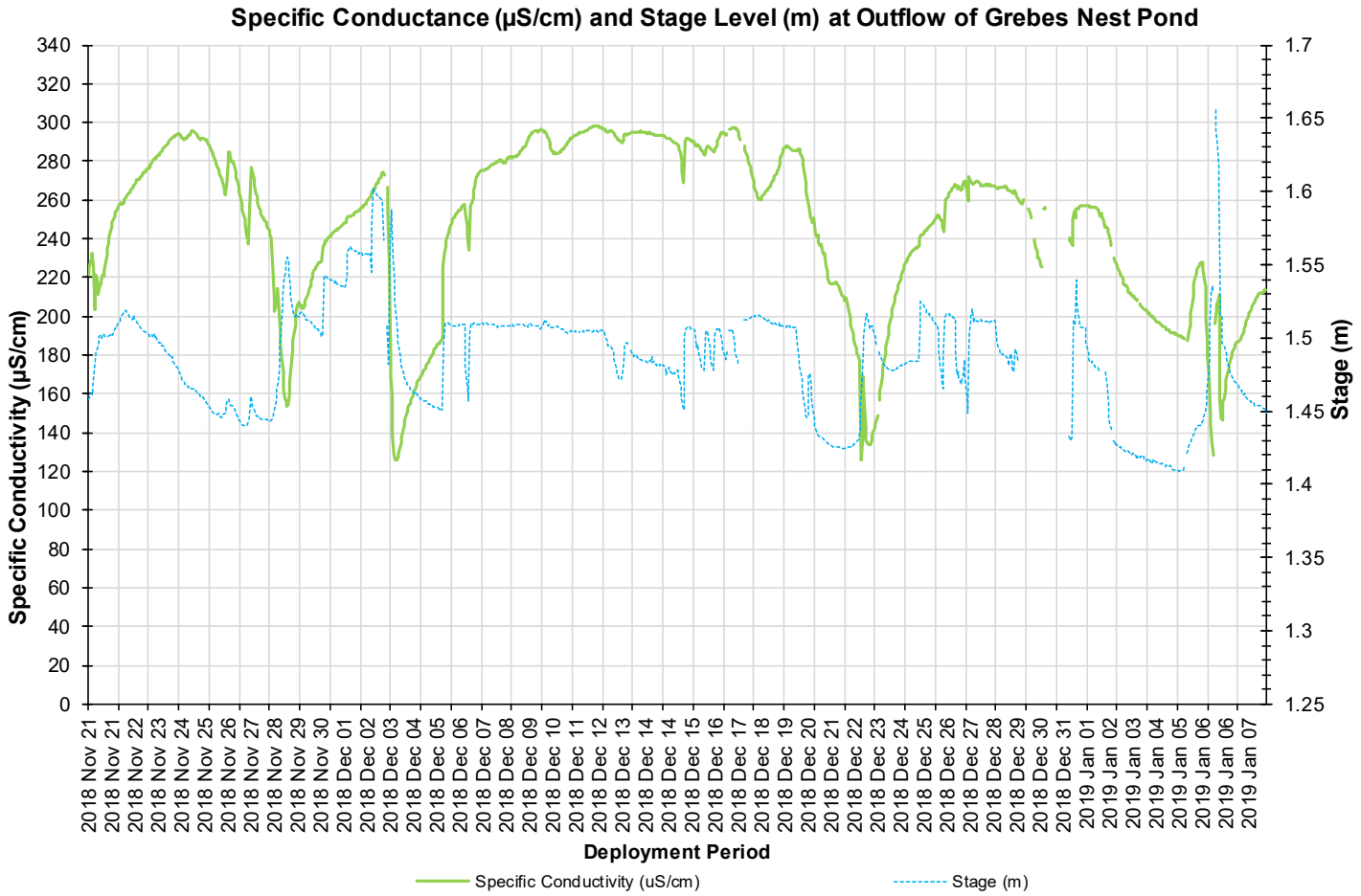

Figure 6: Specific conductivity (µS/cm) values

Dissolved Oxygen

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

During the deployment, the dissolved oxygen concentration levels ranged within a minimum of 11.51 mg/L to a maximum of 15.18 mg/L. The percent saturation levels for dissolved oxygen ranged within 86.8% Saturation to 106.8% Saturation (Figure 7). Dissolved oxygen concentration maximums were higher than the previous deployment, a result of the cooler air and water temperatures during Winter.

Large variations in dissolved oxygen concentration and saturation on November 25th to 27th and December 21st to December 22nd, may be a result of temperature changes due to low stage level and /or streamflow through the brook at that time.

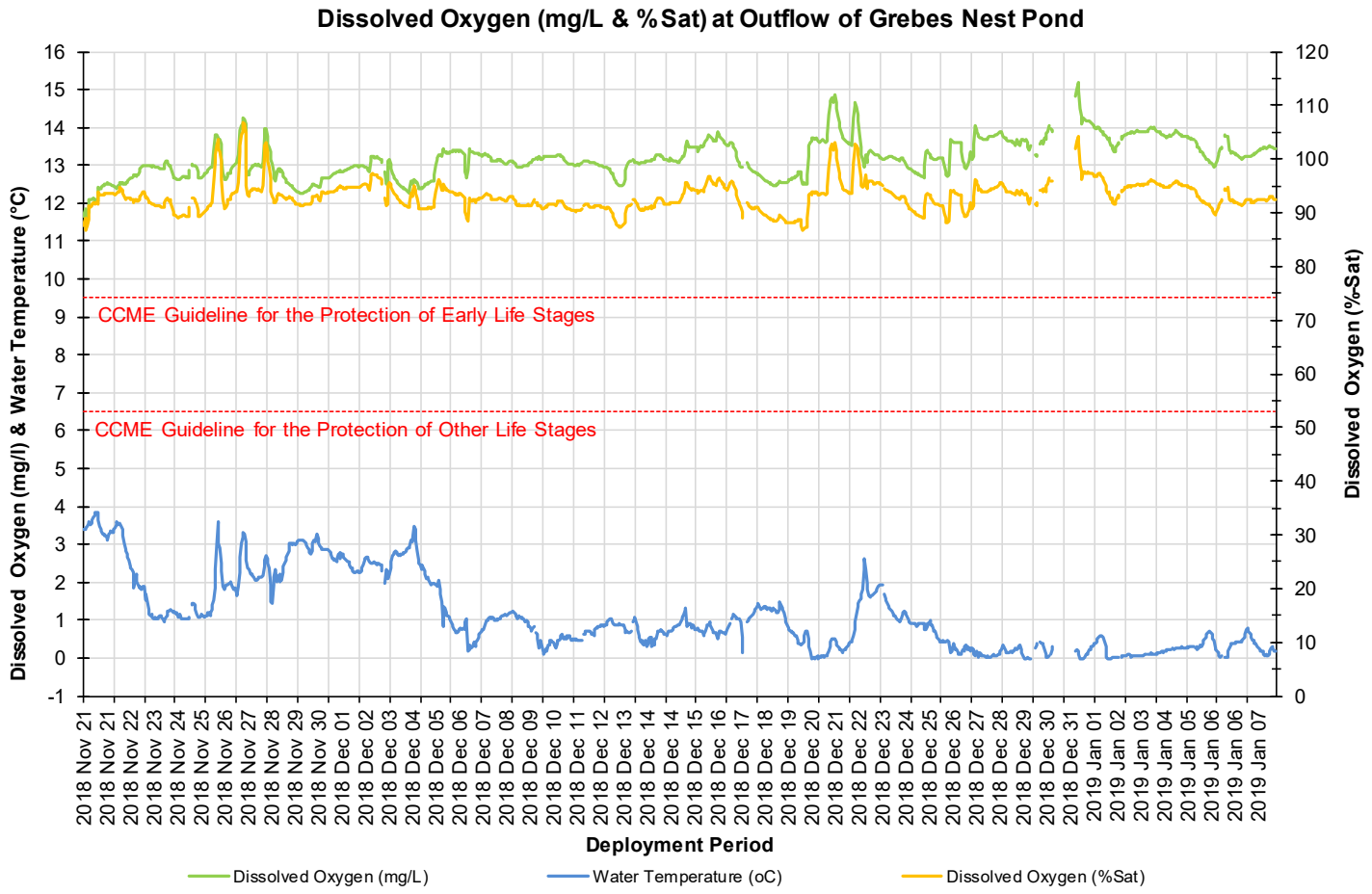

Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 5.8 NTU and 839.7 NTU (Figure 8). The deployment data had a median of 62.4 NTU which was lower than the previous deployment median of 73.3 NTU.

Outflow to Grebes Nest Brook is fed upstream by a sedimentation pond and is heavily impacted by the material that is in the sedimentation pond. The real-time station has significant fluctuations in turbidity and the turbidity levels will increase in either high or low stage events.

Please note the stage data on the graph 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.

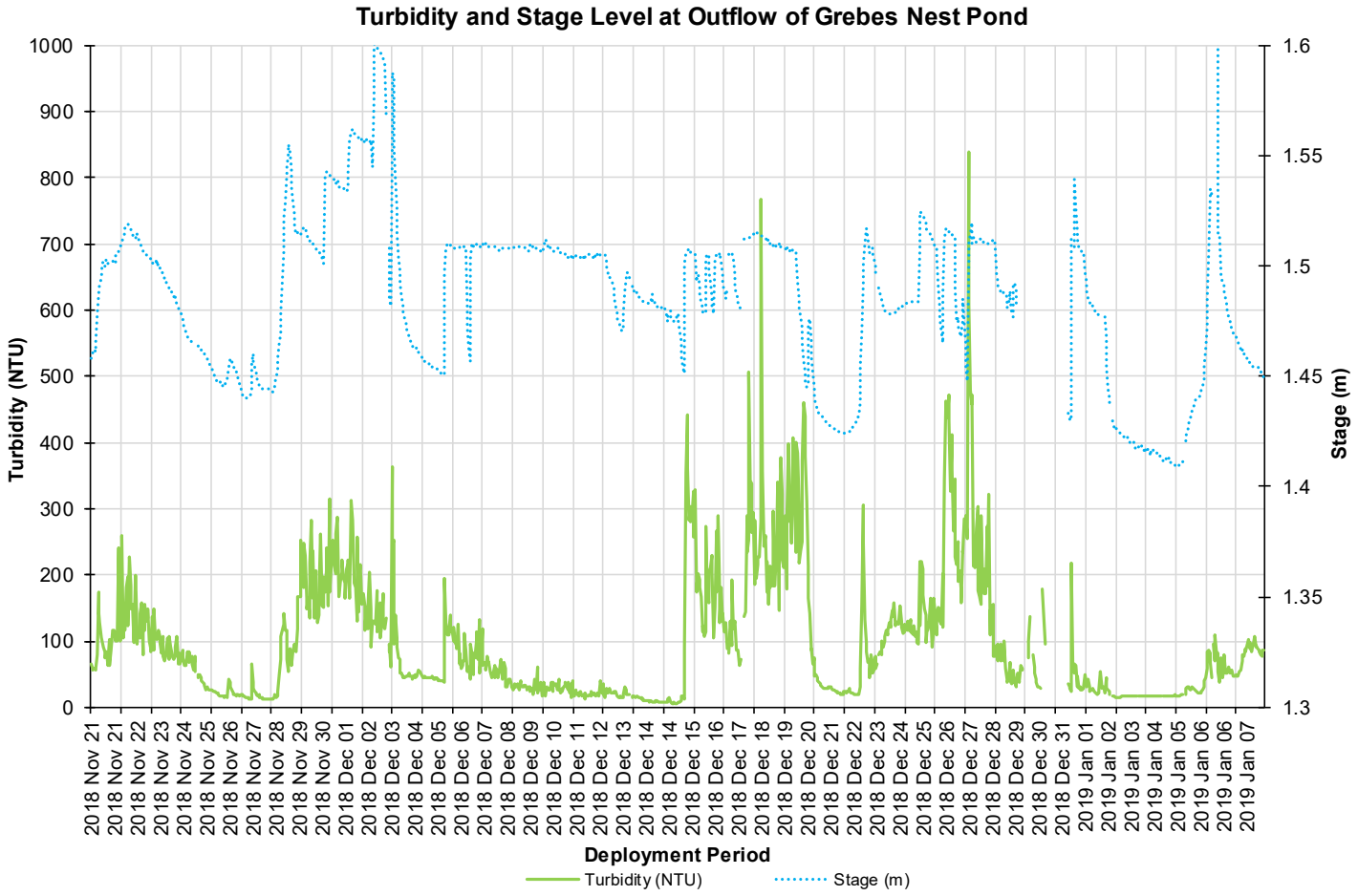

Figure 8: Turbidity (NTU) values.

Total Precipitation & Stage Level

Stage is the level of the water surface above a given datum at the station. Stage provides an estimation of the water level at the station and can explain some of the water quality fluctuaitons that occur. Stage will increase during rainfall events (Figure 9) and during snow or ice melt, as the runoff will collect in the brook, influencing the water level.

Although this brook is fed via a sedimentation pond, rainfall is very influential as it assists in supplementing the water supply. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and maximum of 48.1 mm on December 3rd, 2018.

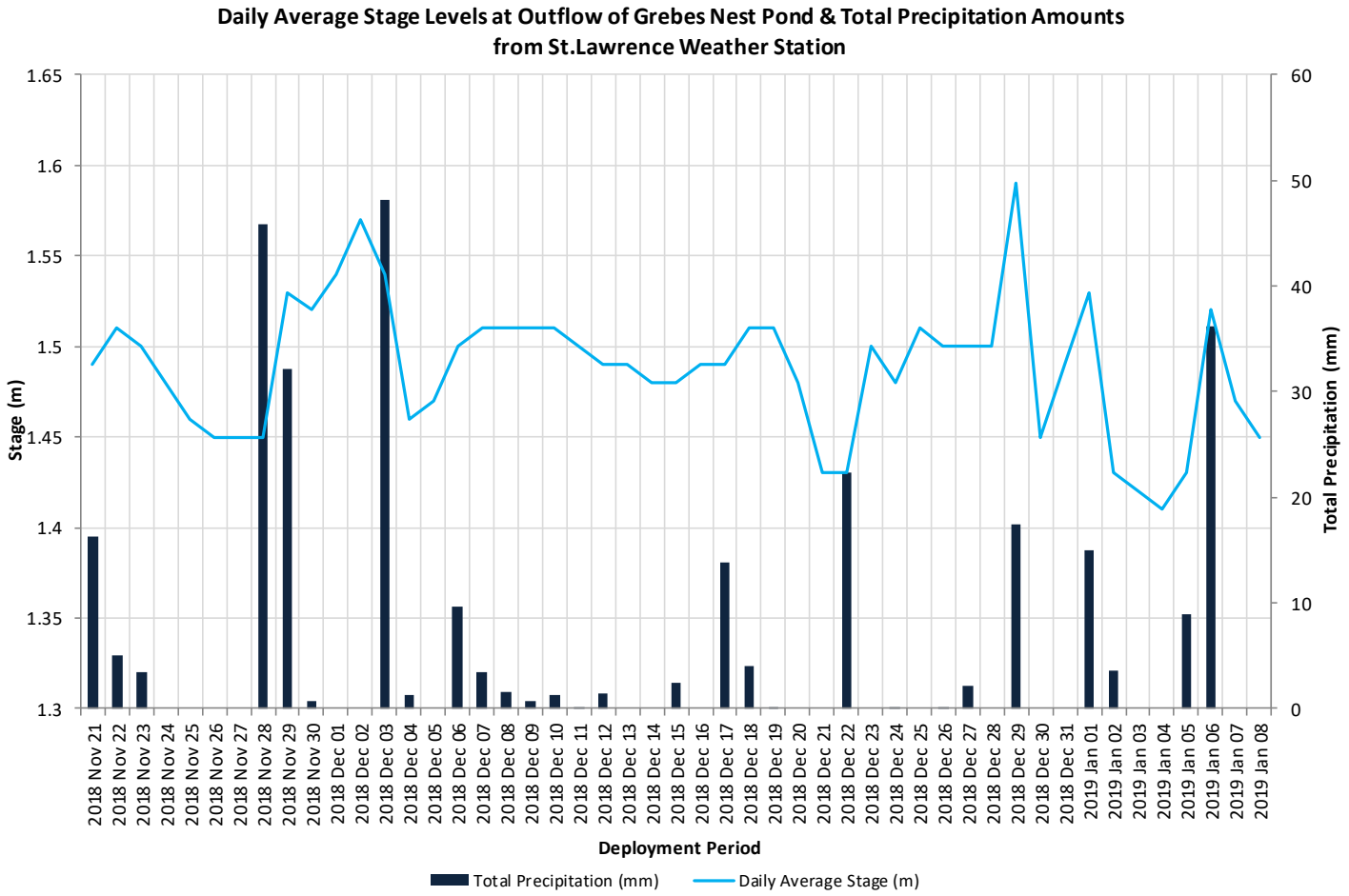

Figure 9: Daily average stage values and daily total precipitation.

Conclusion

Outflow of Grebes Nest Pond currently flows through a evolving mine site. Grebes Nest Pond has been dewatered for mining purposes and no longer exists. The water supply for Outflow of Grebes Nest Pond station has changed. The water supply is a sedimentation pond that is upstream of the Real-Time station. The sedimentation pond was developed to assist in settling out the sediment-laden water that is pumped from the open mine pit. Canada Fluorspar has created the sedimentation pond to naturally overflow down into a trough and through a culvert that flows into Outflow of Grebes Nest Pond.

When reviewing the parameter graphs it was evident that the larger precipitation events affected the water quality. Water temperature fluctuated with stage changes, but continued to decrease into the deployment, approaching freezing into winter. pH levels at Grebes Nest station were consistent during the deployment, but remained lower than had been recorded throughout the year.

Conductivity at the brook ranged from 125µS/cm to 298µS/cm. The lowest conductivity values were during the stage increases, a result of the brook being diluted then flushed of suspended material for a short period of time.

Outflow to Grebes Nest Pond station is fed via a sedimentation pond and does not always have consistent flow. The dissolved oxygen concentration can thus change quickly over a few hours or days. During this deployment, dissolved oxygen steadily increased as water temperatures cooled into winter.

This brook has significant fluctuations in turbidity and the turbidity levels will increase in either high or low stage events due to the influence of the upstream sedimentation pond. This deployment had high turbidity events although the majority of turbidity was reduced after stage increases flushing the system.

Overall, the water quality parameters recorded at Outflow of Grebes Nest Pond displayed events expected of a brook in an environment influenced by anthropogenic activities.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranges from -0.03ºC to 3.43ºC during this deployment period (Figure 10). The water temperatures decrease steadily across the deployment, dropping to zero and below winter arrives.

During the large increases in stage at the station, the water temperatures dropped. The majority of the stage increases were likely a result of snowmelt as the water temperatures dropped to 0.0 ºC or below.

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.

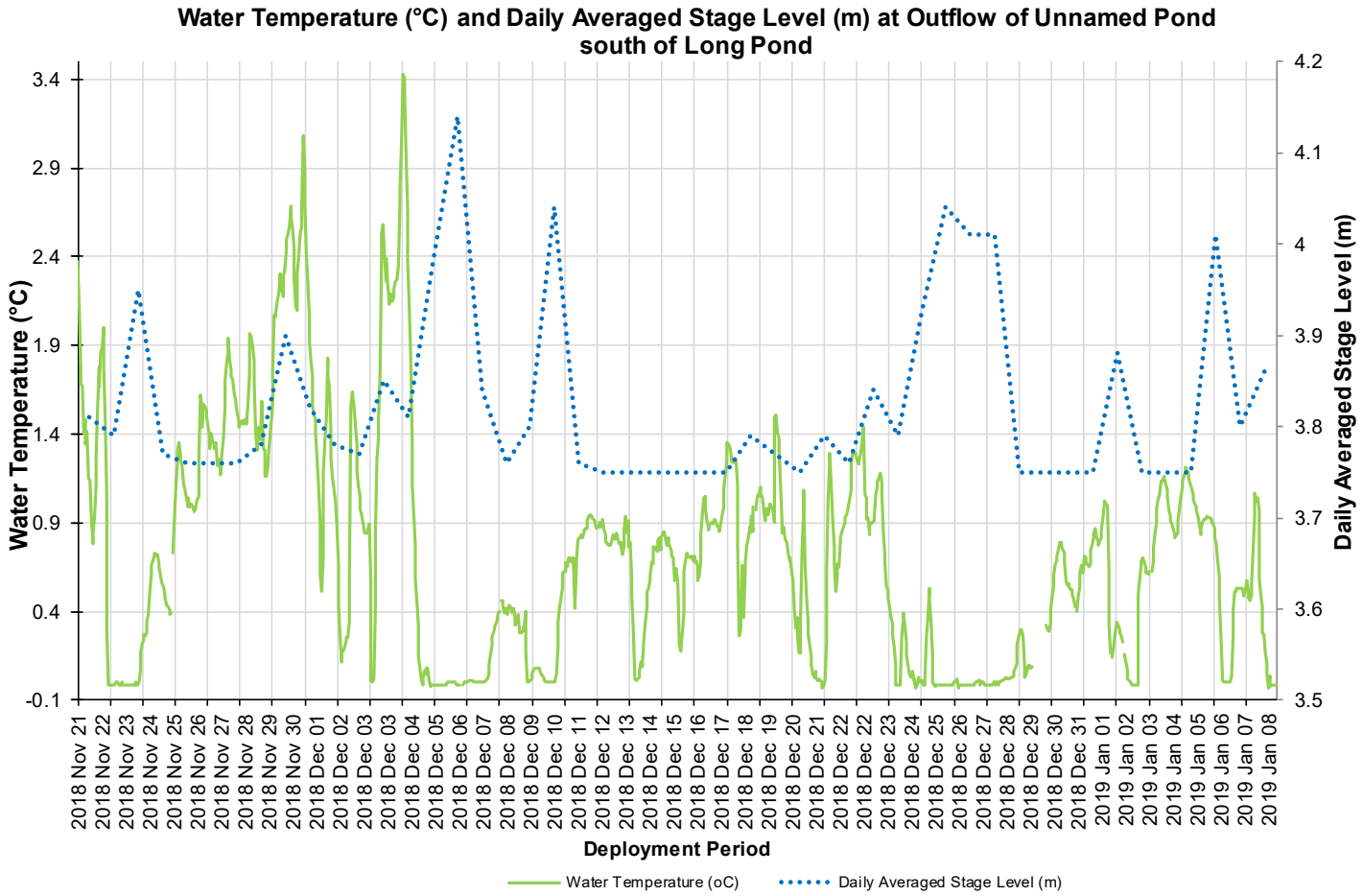

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.2 pH units and 7.94 pH units (Figure 11), consistently remaining within the Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life. Every brook is different with its own natural background range.

The pH data was consistent with slight decreases during the stage increases before returning to background levels shortly after. Natural processes such as rainfall and snowmelt will alter the pH of a brook for a period of time.

Please note the daily averaged stage data on the graph 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.

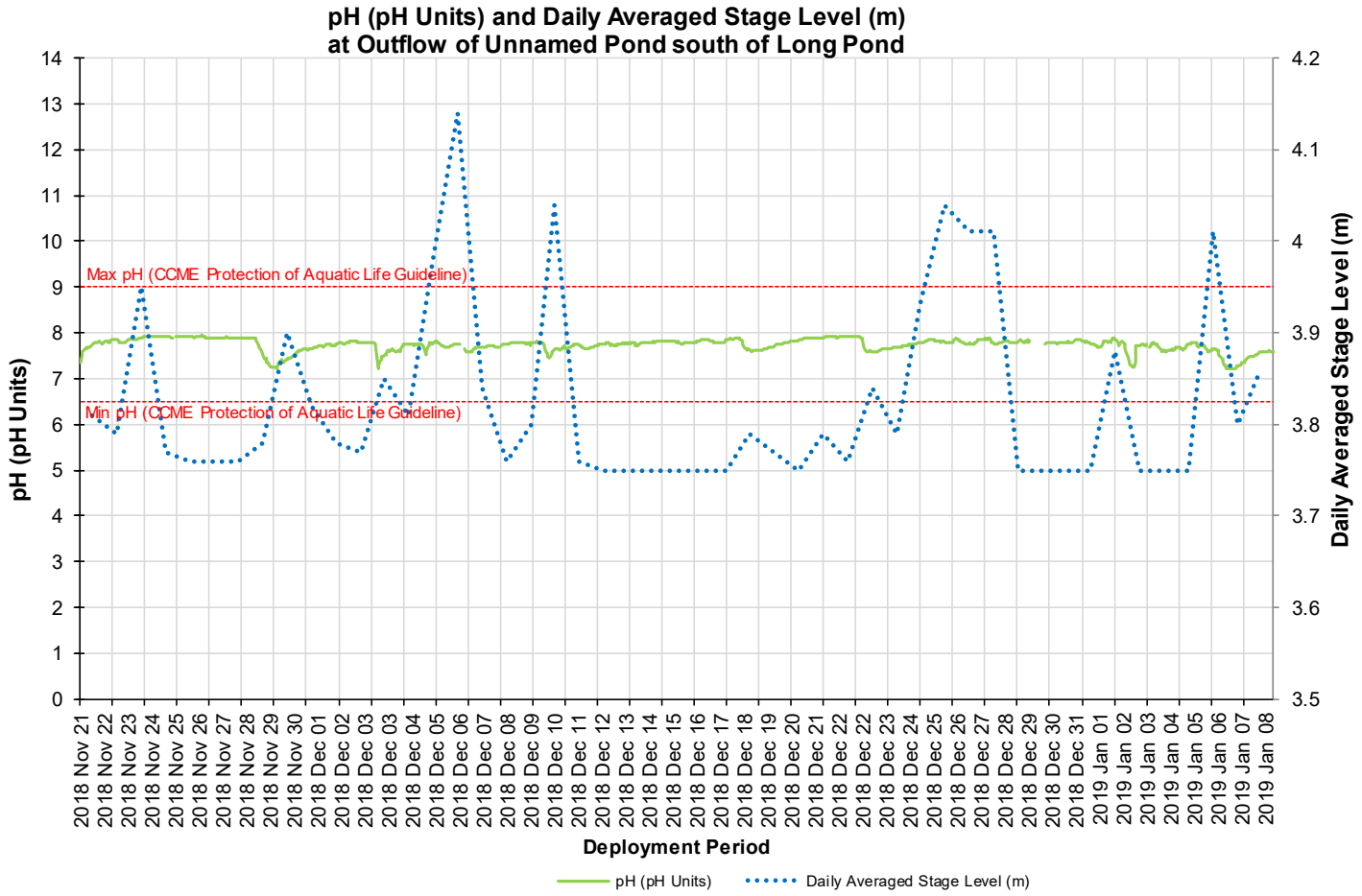

Figure 11: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 122.2 µS/cm and 451.8 µS/cm during deployment (Figure 12). The deployment period had a median of 317.0 µS/cm, which was higher than the median of the previous deployment of 287.7 µS/cm.

The conductivity in the brook was influenced by the fluctuation in stage (Figure 12). The stage increases dilute the particle matter and suspended solids present in a water body. When stage level decreases, the conductivity levels will increase as the suspended solids become concentrated in the water column. These relationships can be seen in Figure 13.

Please note the daily averaged stage data on the graph 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.

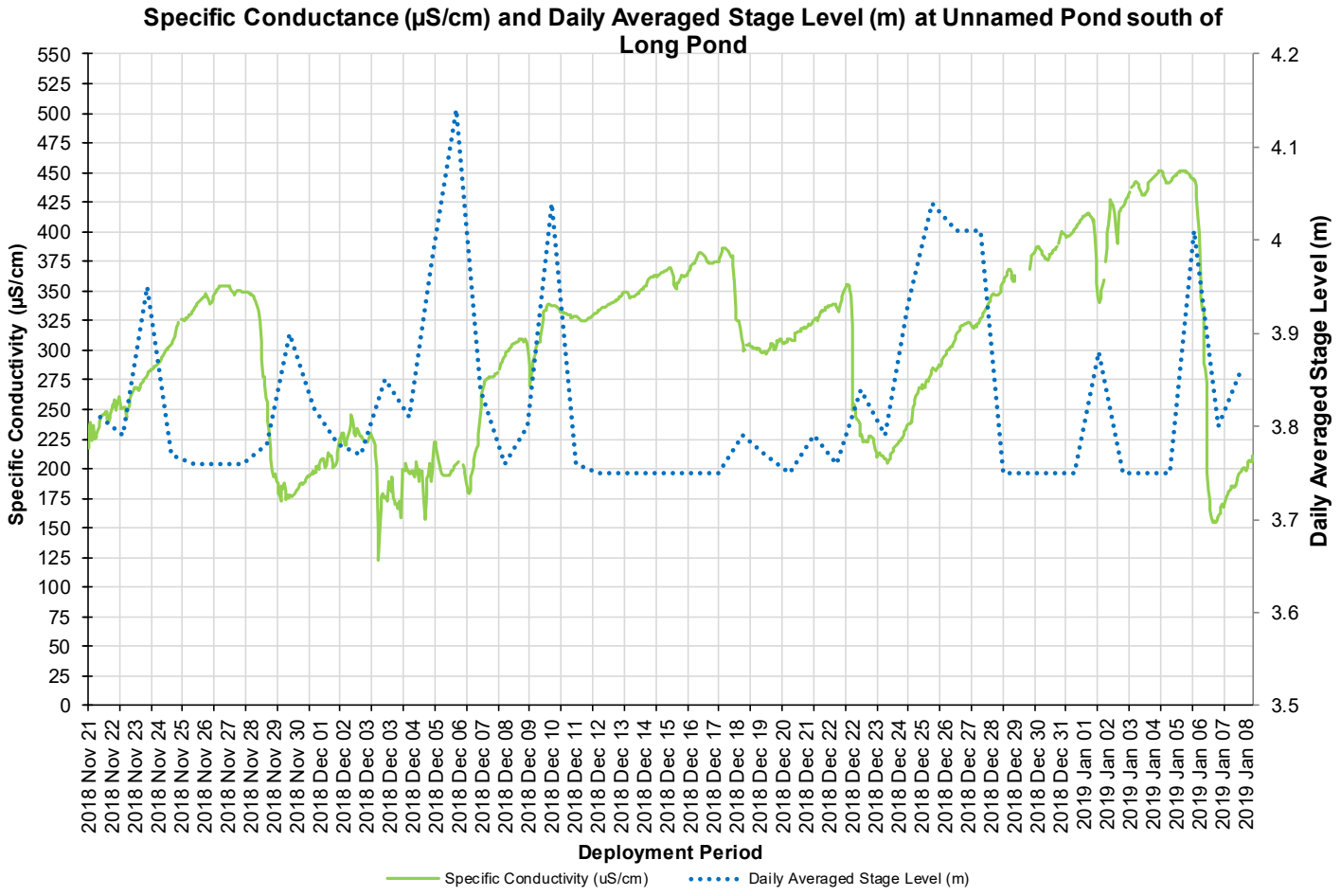

Figure 12: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

Dissolved Oxygen

The water quality instrument directly measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account the water temperature. During this deployment, the dissolved oxygen levels where within 12.3 mg/L and 14.66 mg/L for concentration and 84.2 % Sat and 101 % Sat for percent saturation.

There is a natural diurnal pattern with dissolved oxygen. Oxygen concentration levels will fluctuate throughout night and day. The significant dips/peaks outside of the diurnal pattern, are a result of fluxes in water temperature or influences from rainfall/runoff.

On January 2nd and January 6th, there were large decreases in dissolved oxygen accompanied by a decrease in water temperature. Total precipitation for that timeframe indicated events on both days, therefore it was likely that snow melt and ice buildup in the brook caused the water temperature and the dissolved oxygen to decrease rapidly.

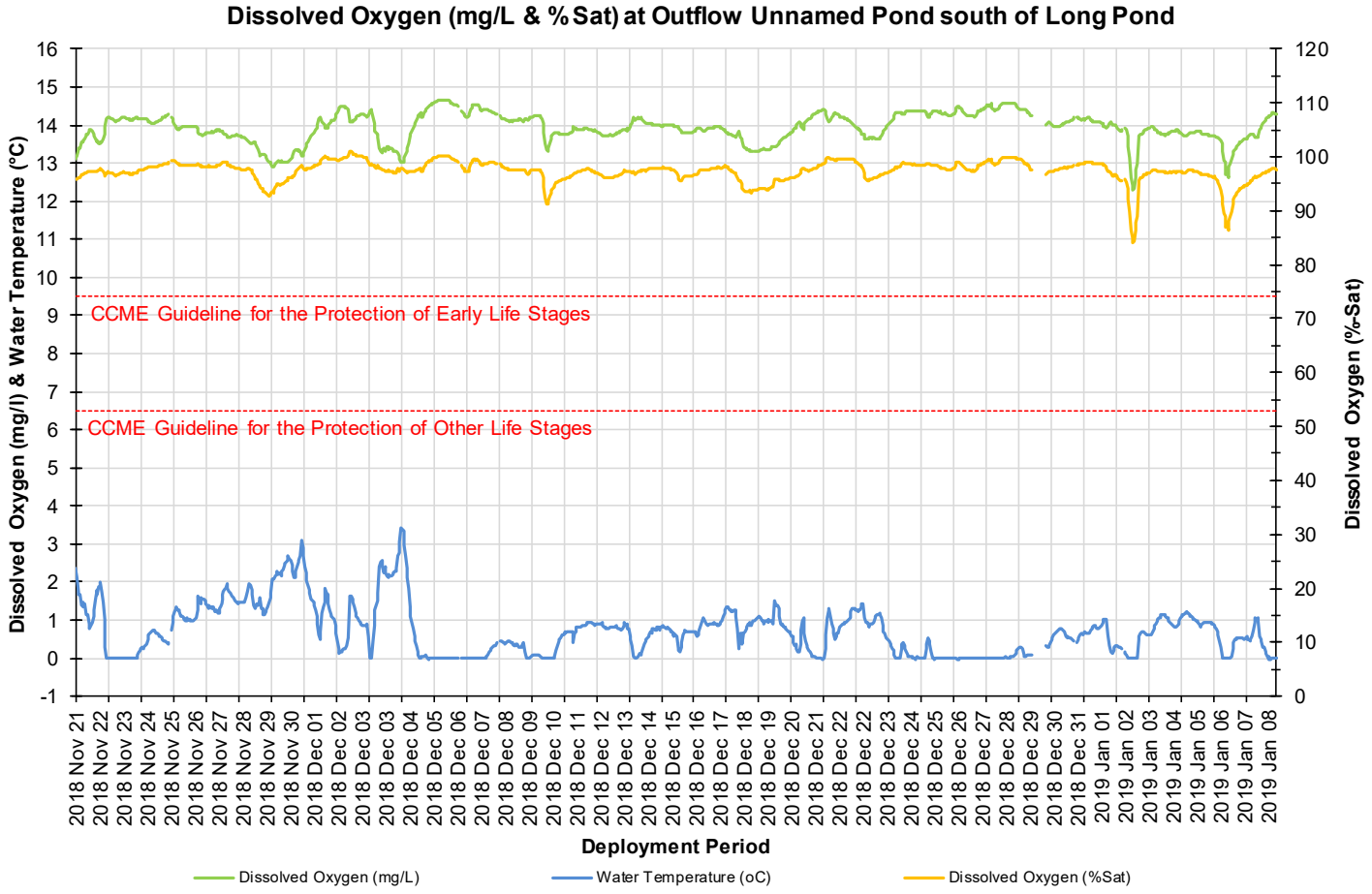

Figure 13: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 11.5 NTU and 69.5 NTU (Figure 14). The deployment data had a median of 33.5 NTU. The median was higher than the previous deployment median of 21.0 NTU.

The turbidity remained above 10 NTU, indicating a higher amount of sediment or suspended material present throughout the deployment. Recorded stage events seemed to flush the brook and reduce the turbidity for a period of time before increasing again shortly after.

Please note the daily averaged stage data on the graph 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.

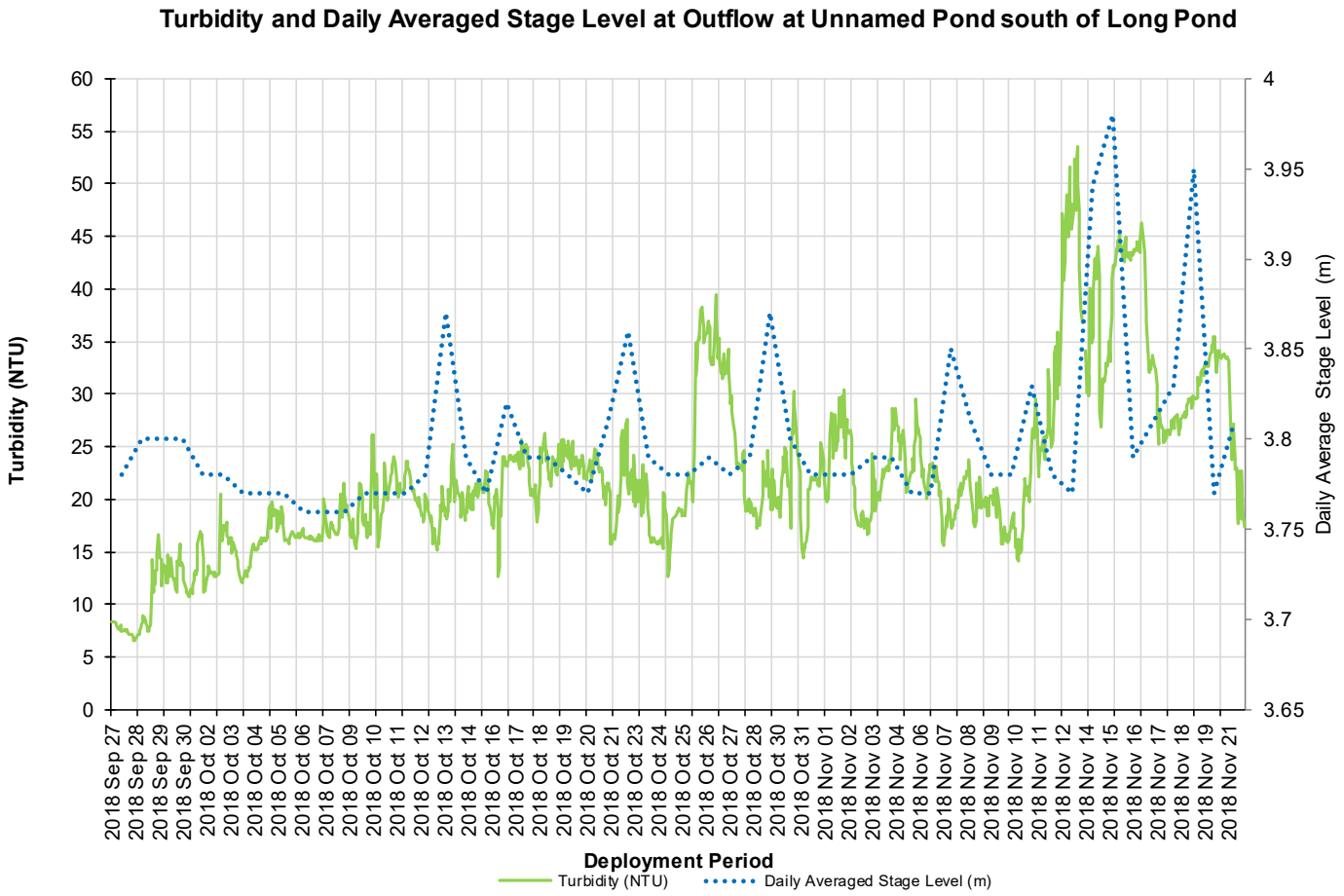

Figure 14: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

Please note the stage data on the graph 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 an estimation of water level at the station and can explain fluctuations occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage will increase during rainfall events (Figure 15) and during any surrounding snow or ice melt. However, direct snowfall will not cause stage to rise significantly.

Large peaks in stage correspond with the total precipitation events as noted on Figure 15. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and maximum of 48.1 mm on December 3rd, 2018.

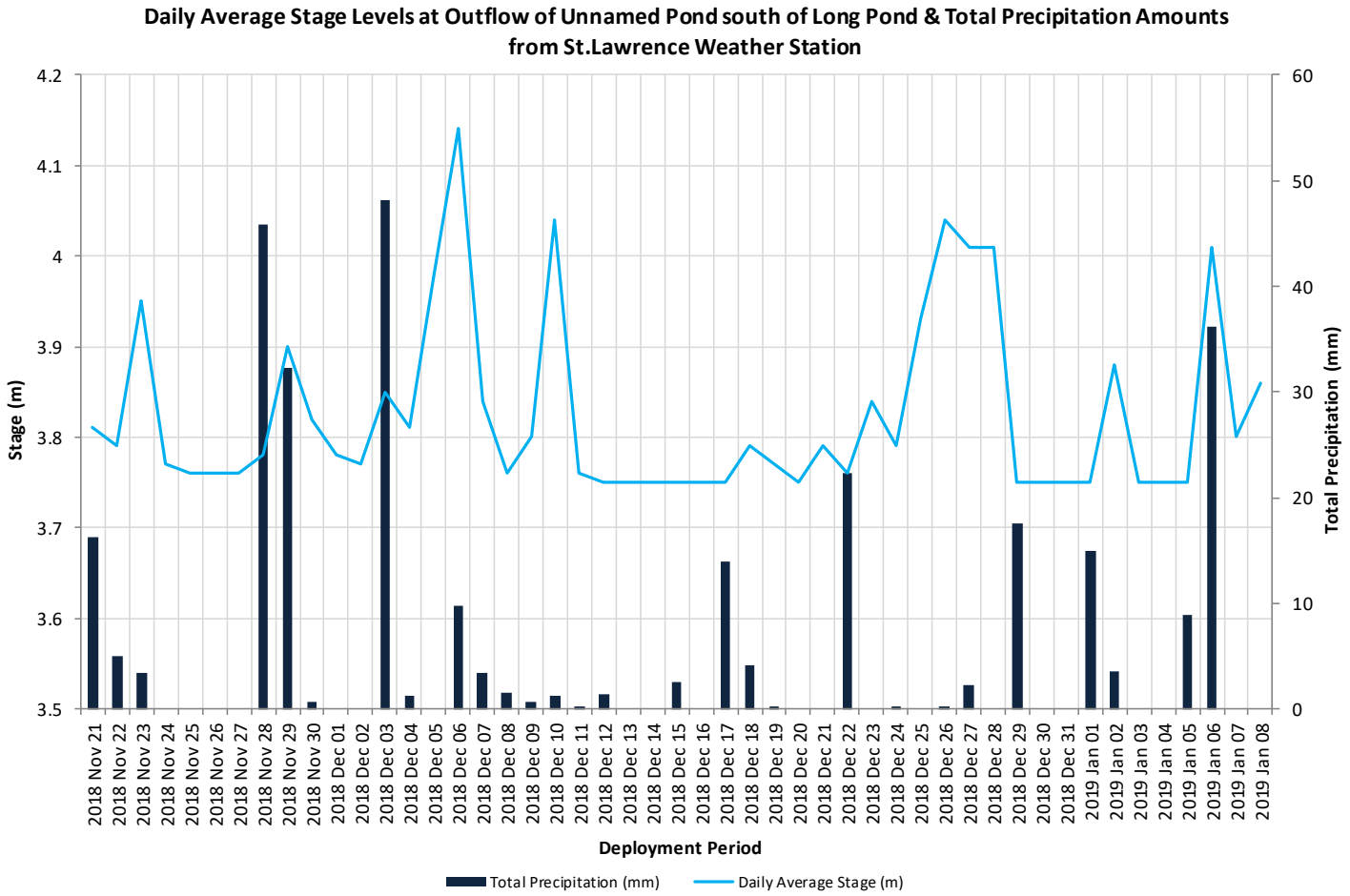

Figure 15: Daily averaged stage values and total precipitation.

Conclusion

The Outflow of Unnamed Pond south of Long Pond is established downstream of the Tailings Management Facility (TMF), to assist in capturing any emerging water quality issues with the management of the tailings facility. The Outflow of Unnamed Pond South of Long Pond also flows through undeveloped area that includes natural wetlands and marshlands. This station is the furthest away from the anthropogenic activities that are occurring on the Canada Fluorspar mine site.

As with many shallow brooks and streams, precipitation and runoff events play a significant role in influencing water quality. Decreasing water temperatures during the deployment were representative of the climate for the time of year. The pH values were consistent for this brook with any significant changes in pH data corresponding to a rise in the stage.

Conductivity levels responded to stage fluctuations by decreasing during high stage events and increasing during periods of low stage. Dissolved oxygen levels were influenced by the cooler water temperatures, resulting in in higher oxygen levels than previous deployments.

Turbidity levels were higher during this deployment than previously recorded throughout 2018. This deployment had a turbidity median of 33.5 NTU while the previous deployment's median was 21.0 NTU. This deployment recorded precipitation on 28 days of the 48 day deployment, which likely influenced the turbidity.

Precipitation brings changes to water quality conditions. Most of these changes are natural, quick adjustments in levels before the data returns to background levels. Precipitation can influence the transfer of runoff from surrounding construction areas by flushing excess material into waterways. The health of a brook can be determined by how quickly it returns to its background data range after a water quality event.