Real-Time Water Quality Report

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

Deployment Period
August 5, 2020 to December 21, 2020

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

Prepared by:

Tara Clinton
Environmental Scientist
Water Resources Management Division
Department of Environment, Climate Change & Municipalities
4th Floor, Confederation Building, West Block
St. John's NL A1B 4J6
Ph. No.: (709) 729 - 5925
Fax No.: (709) 729 - 0320
taraclinton@gov.nl.ca

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 originates at 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 (Environment, Climate Change & Municipalities (ECCM)) 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	August	Deployment	Good	Good	Excellent	Excellent	Poor
	December	Removal	Good	Good	Excellent	Excellent	Poor
Unnamed Pond	August	Deployment	Poor	Excellent	Excellent	Good	Excellent
	December	Removal	Excellent	Poor	Good	Fair	Marginal

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. Turbidity data ranked 'Poor' at both deployment and removal. The water suppling this site originates from the bottom of the open pit mine and is impacted significantly by sediment. It is likely that the turbidity sensors on the field and QA sonde were not positioned in the brook correctly to capture closer data sets.

During deployment of the instrument at Outflow of Unnamed Pond south of Long Pond, the ranking for pH, conductivity, dissolved oxygen and turbidity were 'Excellent' or 'Good' against the QA data. The water temperature data ranked 'Poor' against the QA data. This may be a result of the instruments not acclimating to the brook before the data was recorded. At removal, the field data ranked 'Poor' for pH and 'Fair' for Dissolved Oxygen. Due to the length of the deployment and conditions at the site it is likely that there was influence from biofouling of the sensors.

Concerns or Issues during the Deployment Period

The water supply for Outflow to Grebes Nest Pond originates at the bottom of an open pit mine. The pit water is pumped from the open pit mine into geo bags that strain out the majority of the sediment, from there the water is gravity fed into Outflow to Grebes Nest Pond. The water supply is intermittent as the pit water is pumped when water levels reach a certain height in the open pit. The lack of consistent flow can result in significant stage level fluctuations across a deployment. The stage fluctuations can influence water quality parameters.

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 1.93°C to 20.4°C during the deployment period (Figure 3). The average water temperature for the deployment is 10.04°C. Due to the length of the deployment, the data captured the change in water temperature from summer into winter.

Outflow to Grebes Nest Pond station does not have consistent flow, thus the stage data can fluctuate significantly across a deployment. The large variations in stage were the result of precipitation events that occurred on the same day (Appendix I). Water temperature displayed a natural diurnal pattern. Higher water temperature represents the daylight hours and the lower temperatures occur during the nighttime hours.

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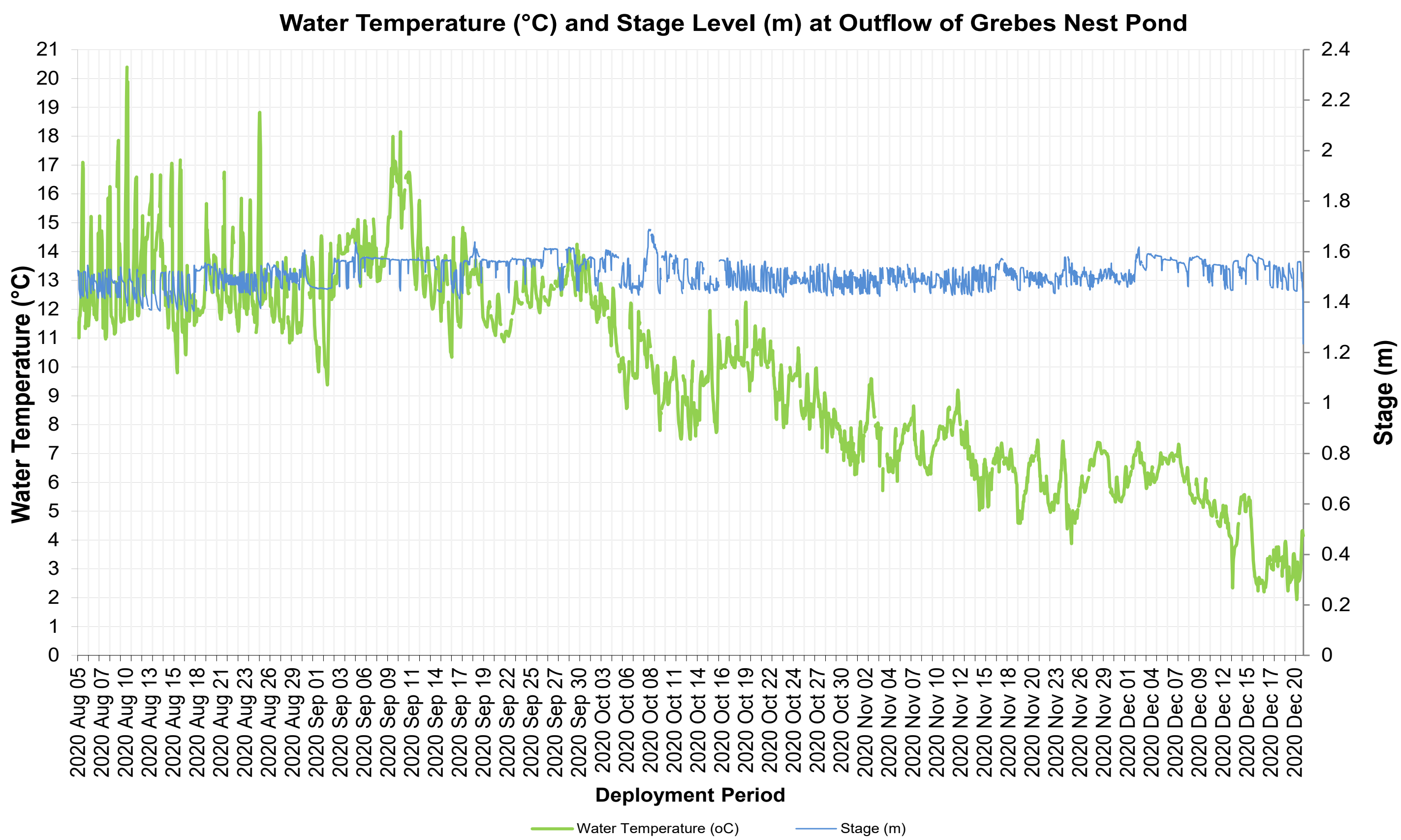

Figure 3: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 7.06 pH units and 8.11 pH units. The pH data remained consistent and within the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life for the duration of the deployment.

Small changes in pH were likely the result of rainfall, or could be a result of the flow differences from the inconsistency of pumping water into the brook.

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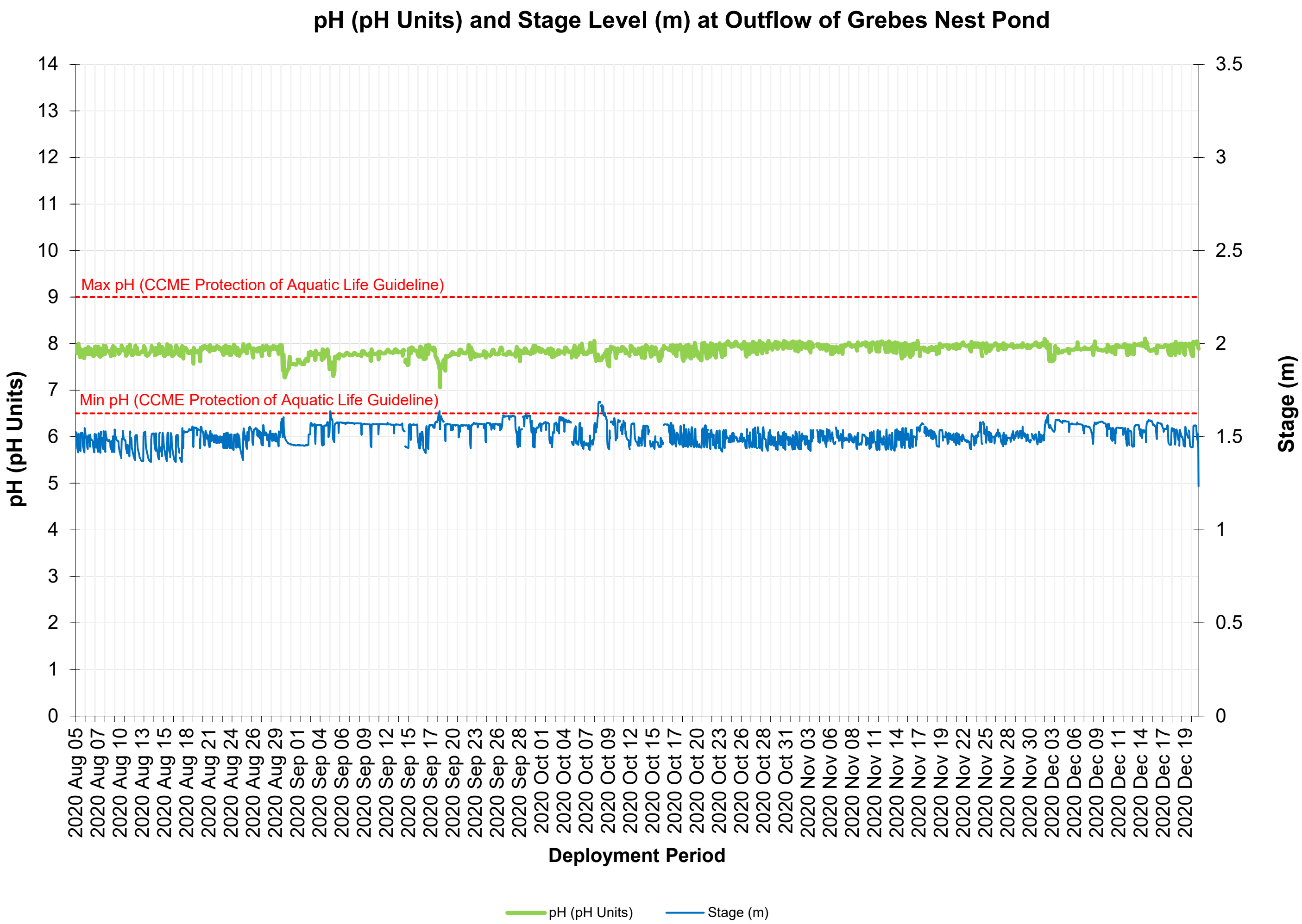

Figure 4: pH (pH units) values

Specific Conductivity

The conductivity levels were within 86.16 µS/cm and 456 µS/cm during this deployment period (Figure 5). 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 corresponding to changes in stage level. During stage increases, the conductivity levels responded by decreasing as the diluted salts and inorganic matter present in the brook were flushed through. Due to the nature of the inconsistent water source for this brook, large variations in conductivity are expected.

During low or no stage increases, diluted salts and inorganic material will accumulate in the brook, increasing the conductivity data. Until there is a sufficient increase in stage flow to flush the system, conductivity will remain high and continue to accumulate.

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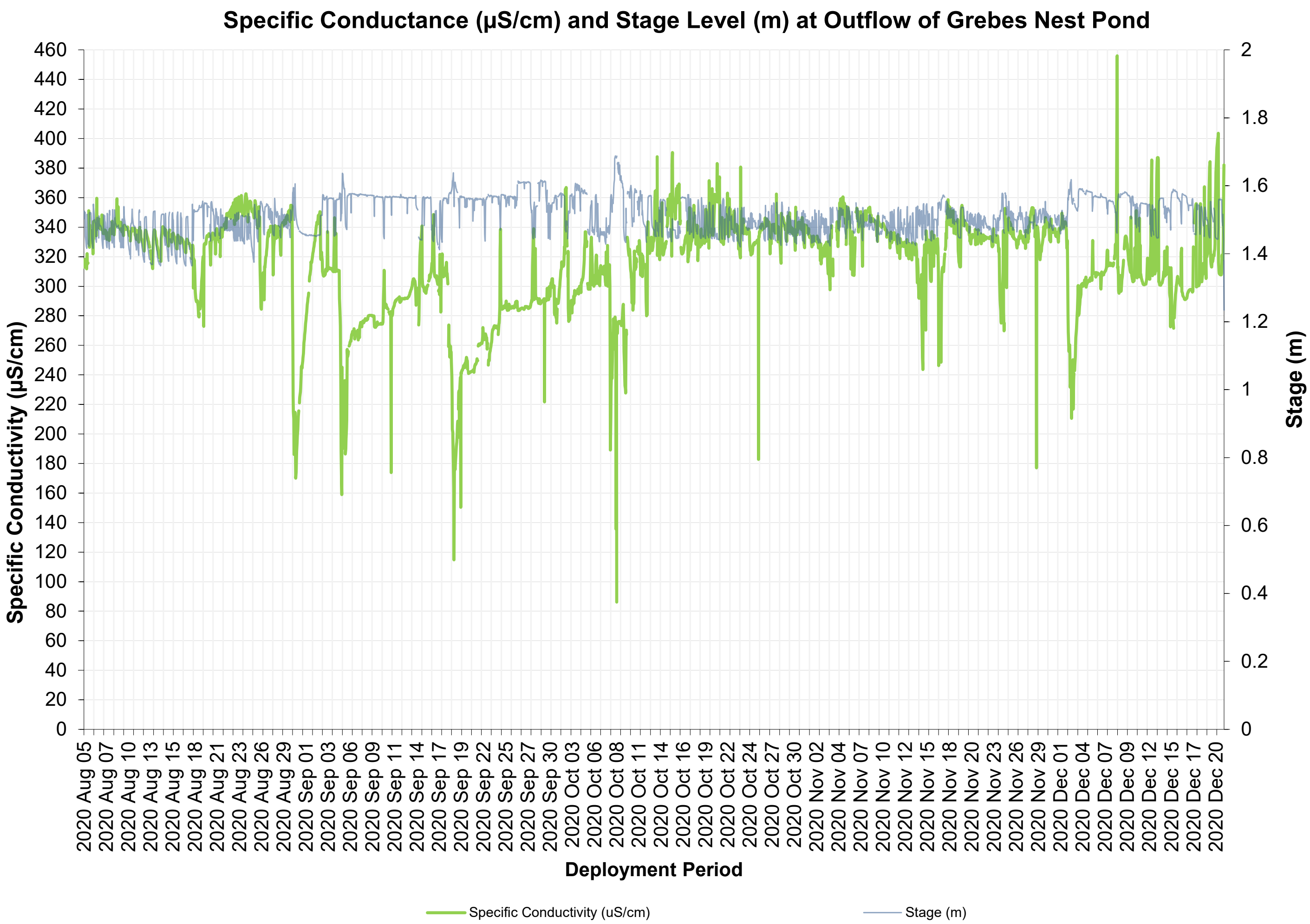

Figure 5: Specific conductivity (µS/cm) values

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 9.18 mg/L to a maximum of 13.89 mg/L. The percent saturation levels for dissolved oxygen ranged within 88.8% Saturation to 107.1% Saturation (Figure 6). A steady increase of dissolved oxygen concentration was recorded from September to December, representative of the climatic changes that occurred during the long deployment.

Dissolved oxygen remained above the CCME guidelines for the protection of aquatic life for the majority of the deployment, dipping below the early life stages guideline only occasionally.

Due to the intermittent stream flow at this brook, dissolved oxygen concentration does not always display the expected diurnal pattern that accompanies natural ambient waterways. Water temperature is included with dissolved oxygen as it directly influences the water column's ability to store dissolved oxygen.

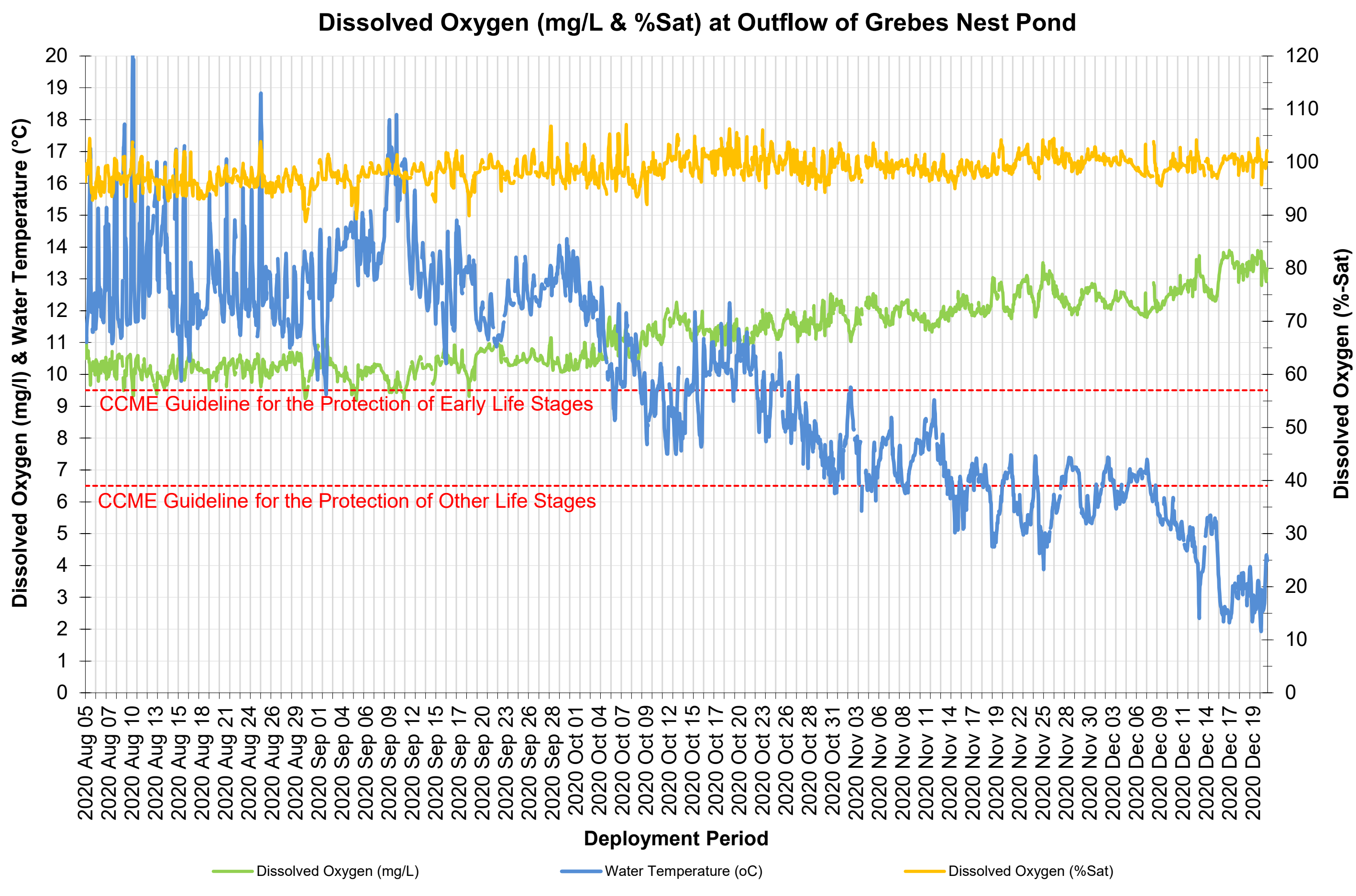

Figure 6: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 2.8 NTU and 3599.9 NTU (Figure 7). The deployment data had a median of 35 NTU.

Outflow to Grebes Nest Brook is fed via a sump pump from a pit mine. The pit water is fed through a geo bag before it gravity flows into the Outflow of Grebes Nest Brook. Based on the nature of the location, it is expected for the turbidity to fluctuate throughout the deployment. If the brook is not replenished periodically with rainfall or subsequent pumped water, the water can become stagnant.

Due to periods of low flow at this site, there is more variation in the turbidity data (Figure 7). During warmer seasons, evaporation plays a part in reducing the water level, concentrating the sediments in the remaining water.

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.

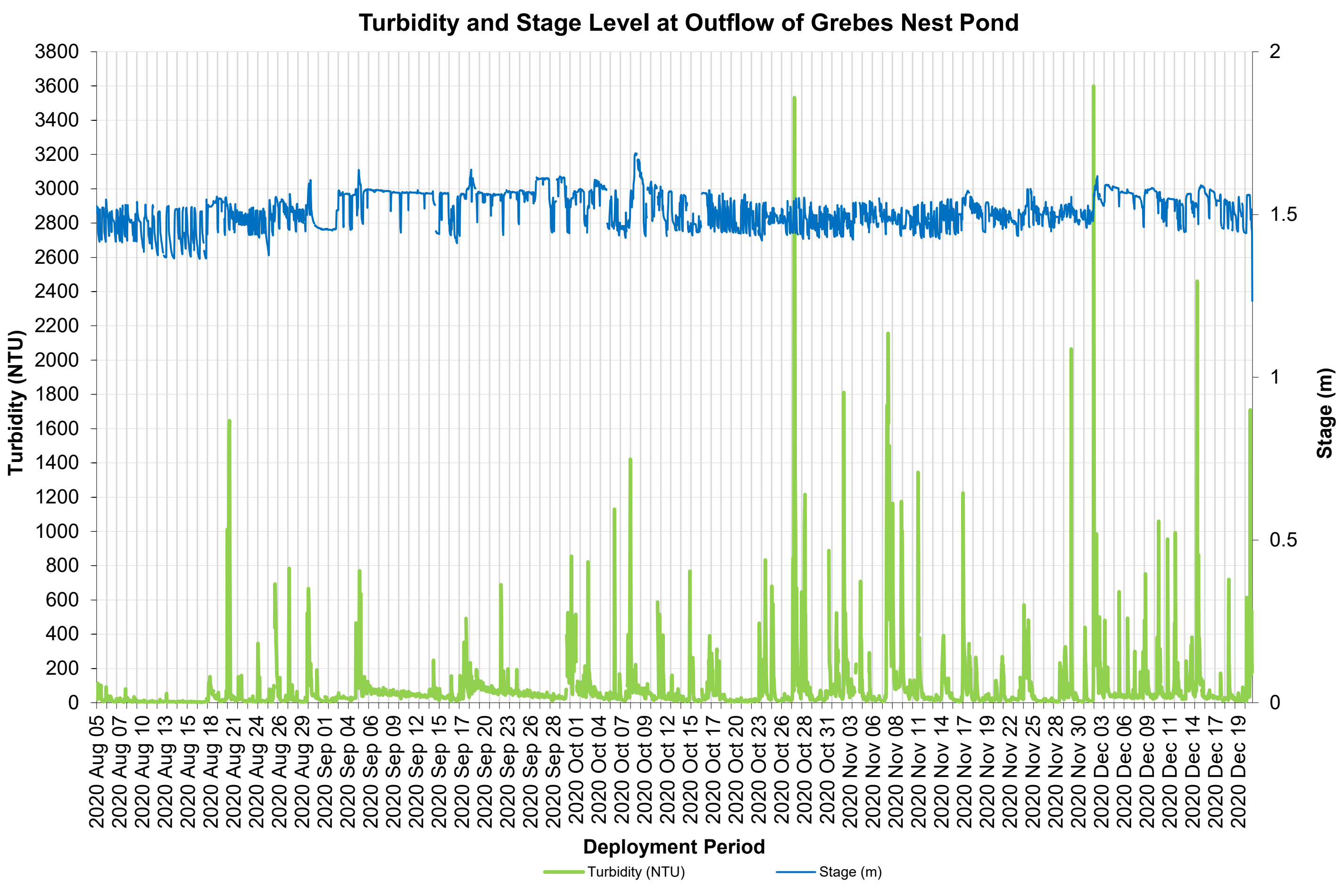

Figure 7: Turbidity (NTU) values.

Conclusion

Outflow of Grebes Nest Pond currently flows through an 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 pit water pumped via a sump pump into a geo bag, that is then gravity fed into Outflow of Grebes Nest Pond. The geo-bag is used to strain out the sediment-laden water that is pumped from the open pit mine.

Water temperature fluctuated with stage changes, but remained within a range that is expected throughout the deployment. pH levels at Grebes Nest station were consistent during the deployment, outside of the decreases in pH during the higher stage events. Outflow to Grebes Nest Pond station does not have consistent flow to replenish the brook. Stage level will alter the specific conductivity within Grebes Nest. At the beginning of deployment, conductivity was recorded decreasing during a high stage event, however, toward the end of the deployment, as the stage decreased, conductivity increased.

The dissolved oxygen concentration can change quickly over a few hours or days and can be influenced by periods of low flow. Outflow to Grebes Nest Pond station does not always have consistent flow. Despite the periods of low or no flow, the dissolved oxygen concentration at this site was predictable. Due to the length of the deployment the dissolved oxygen recorded represents expected changes across summer, fall and winter.

This brook has significant fluctuations in turbidity. At this site, turbidity levels will increase in high or low stage events due to the remaining sediment present in the water filtered from the geobag.

Due to the length of the deployment, the data recorded captures changes in water quality parameters across summer, fall and winter. Overall, the water quality parameters recorded at Outflow of Grebes Nest Pond displayed changes in water quality that would be expected of a brook in an environment influenced heavily by anthropogenic activities.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranged from -0.02C to 25.41°C during the deployment period (Figure 8). Due to the length of this deployment period there is a large range in the data. The data captures water temperatures from Summer into Winter. Naturally, the water temperature decreased across the deployment, adjusting as the air temperatures decreased with the cooler climatic change (Figure 8).

Water temperature displayed the natural diurnal pattern representing the influence of air temperature on the brook, with the high temperatures during the daylight hours and the low temperatures representing the nighttime hours (Figure 8). Outside of the diurnal movement of the water temperature, the data does indicate small decreases in water temperature during stage increases.

Stage changes can be a result of precipitation or rainfall. Generally, if the stage increases occur during low air temperature events it was likely a result of rainfall. Please note that the stage data in this document is raw data. The data 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.

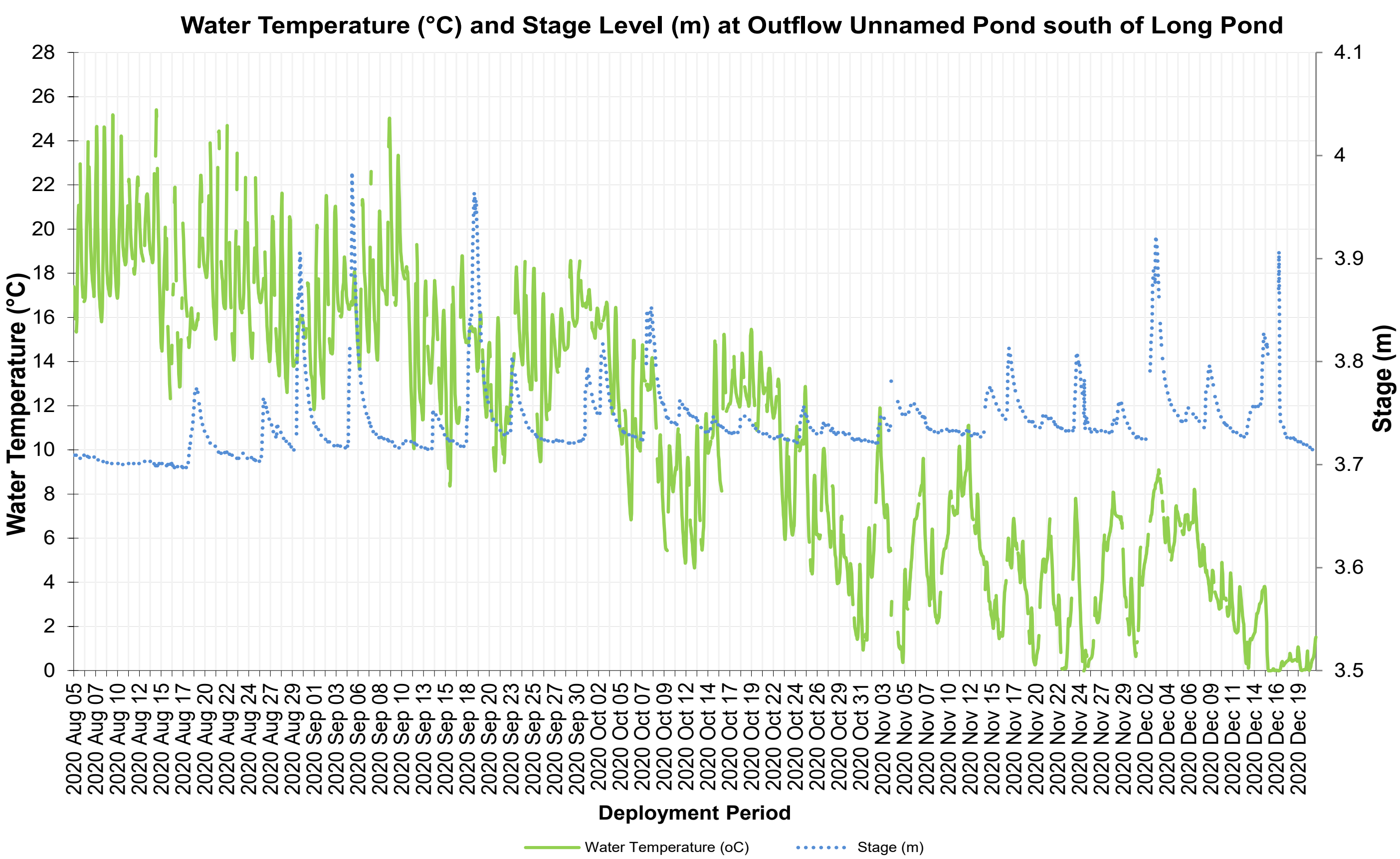

Figure 8: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged within 6.66 pH units and 7.64 pH units (Figure 10), remaining within the Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life. The guidelines provide the overall range for the protection of aquatic life across all waterways in Canada. Every brook is different with its own specific natural background range.

Small decreases in pH during stage peaks are evident on Figure 10. The pH values return to background levels shortly after each event and overall the pH data was consistent across deployment. The stage increases recorded for this deployment were a result of rainfall events (Appendix I). An increase in pH level was recorded at the end of deployment at the same time as a stage level decrease. This may indicate a more basic substance entered the brook at this time. Natural processes such as rainfall, snowmelt and surrounding runoff will alter the pH of a brook for a period. However, it is the persistent long-term changes in pH that create the most damage to the natural aquatic environment.

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.

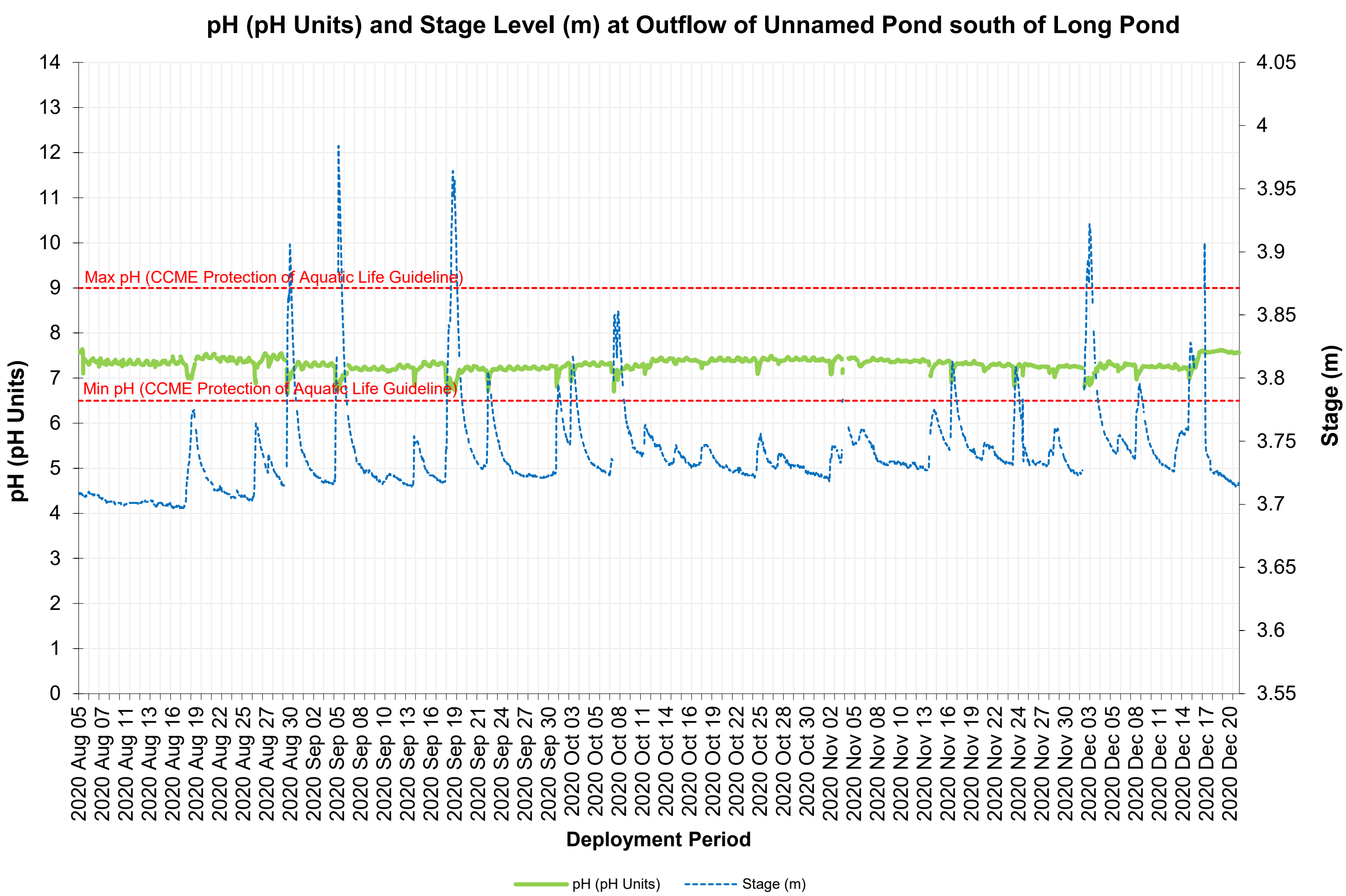

Figure 10: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 66.04 µS/cm and 221.76 µS/cm during deployment (Figure 11). The deployment period had a median of 140.58 µS/cm.

Changes in stage will influence the conductivity data (Figure 11). The extra volume of water during a stage increase will dilute the particle matter present in a water column. When stage level drops, the conductivity levels will increase. Suspended solids are concentrated in the water column as the volume of water reduces.

During this deployment, the decreases in conductivity are likely a result of rainfall flushing the brook for a short period and diluting the water (Appendix I). The highest readings are recorded at the end of the deployment as stage increases and then decreases, which is followed by the conductivity levels peaking. This occurs at the same time as an abnormal rise in pH at this location. This is further evidence that some substance entered the stream around this time.

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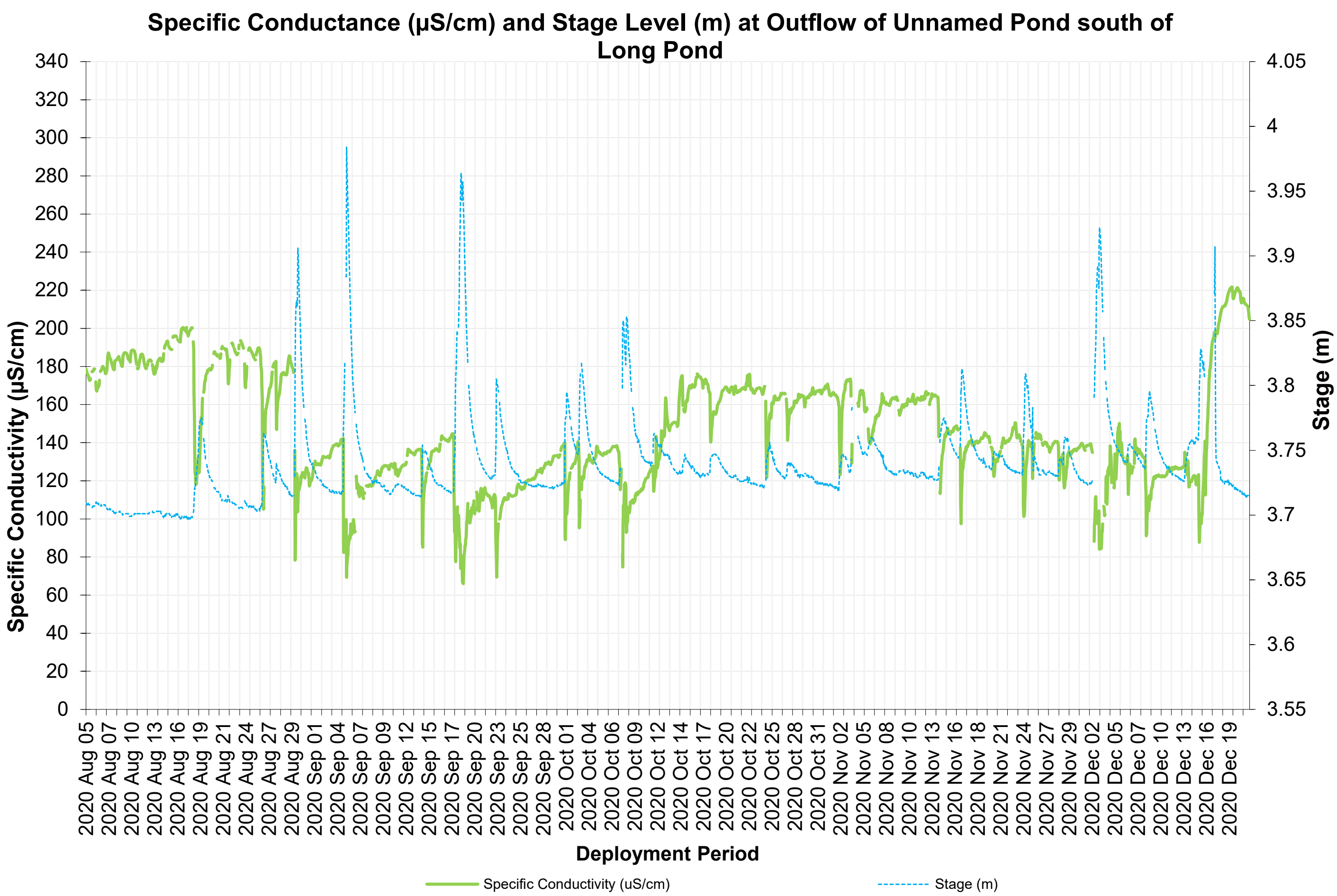

Figure 11: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

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 8.04 mg/L and 14.94 mg/L for concentration and 91.3 % Sat and 118.5 % Sat for percent saturation.

There is a natural diurnal pattern present in aquatic environments with dissolved oxygen. Oxygen concentration levels will fluctuate throughout night and day. Cooler night temperatures influence higher dissolved oxygen concentrations and warmer day light temperature influence lower concentrations.

All other prominent dips/peaks - outside of the diurnal pattern - are a result of fluxes in water temperature or influences from rainfall/runoff (Figure 12). Dissolved oxygen values hovered around the CCME Aquatic Life Guideline for Early Life stages for the first half of the deployment and remained above the guideline for other life stages throughout the deployment.

From November 10th to November 27th, 2020 the dissolved oxygen data was not representative of the brook and was removed from this analysis.

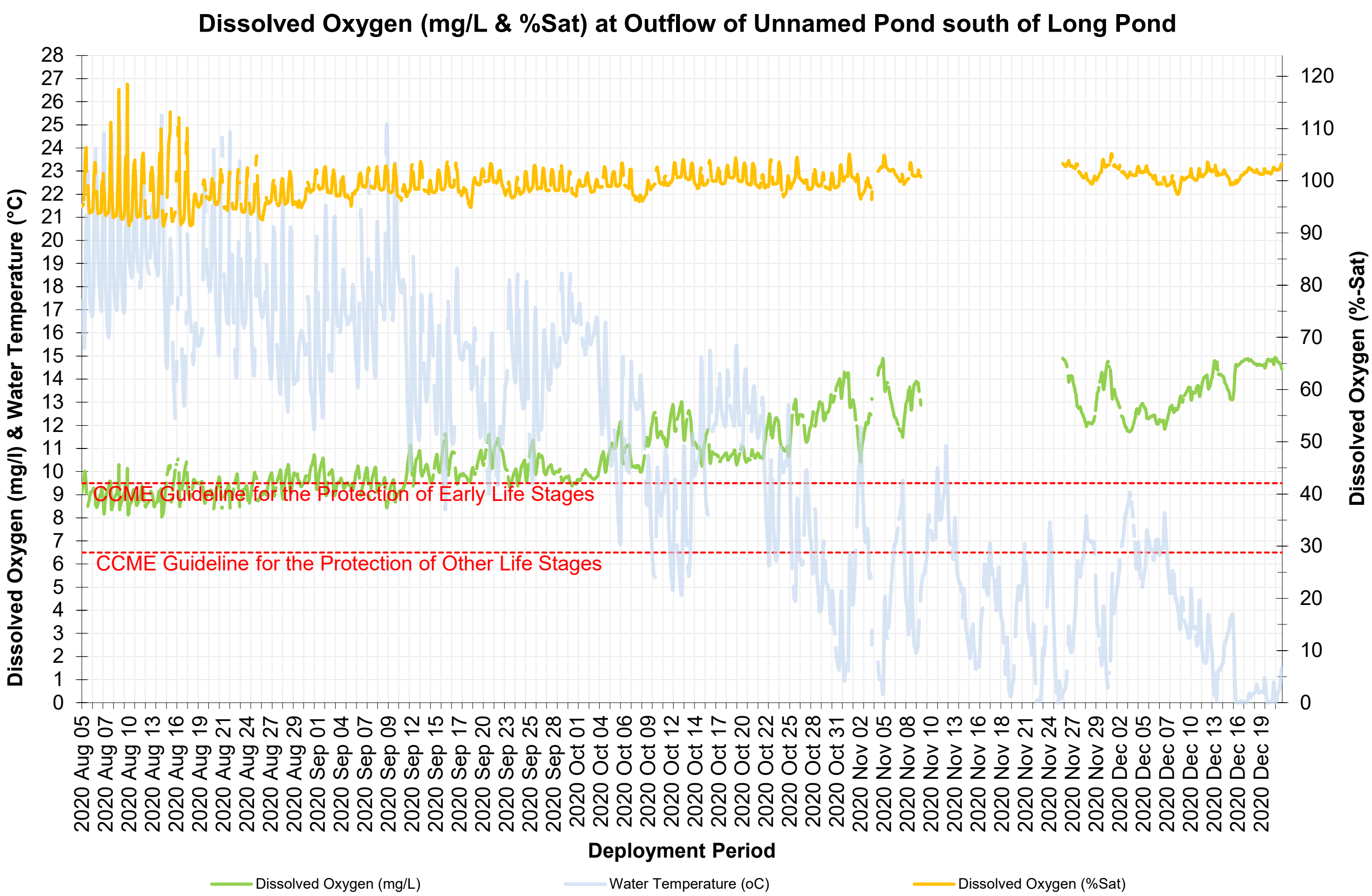

Figure 12: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 5.6 NTU and 280.6 NTU (Figure 13). The deployment data had a median of 21.5 NTU.

The larger three turbidity events recorded on November 2nd, November 24th and December 16th indicate that the sensors may have been blocked with debris for a short period of time until rainfall events flushed the brook, returning the turbidity to background levels (Appendix I). This would account for the issues with the DO sensor during this timeframe.

Notably, turbidity did not always fluctuate with stage during this deployment, and remained low for the first portion of the deployment.

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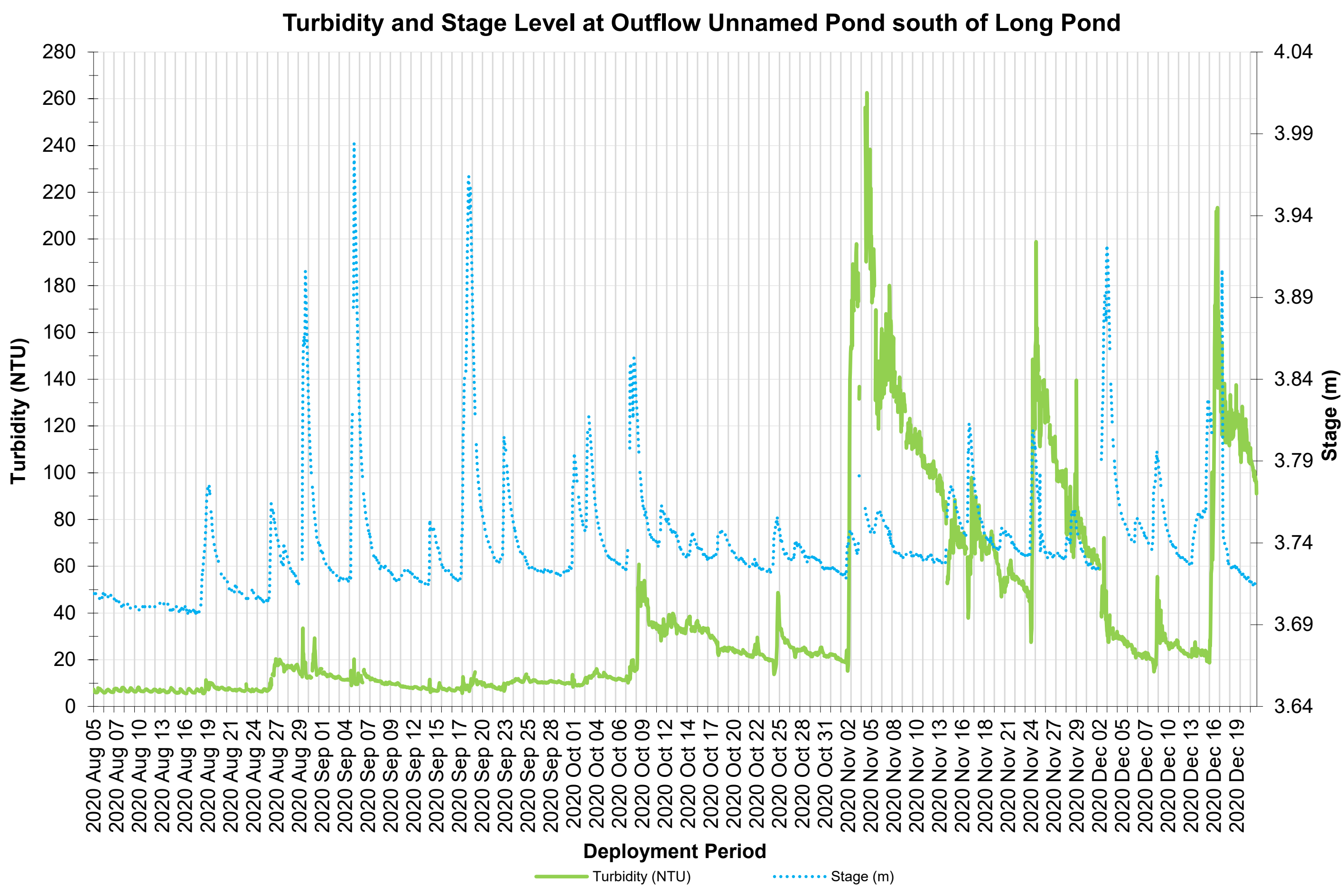


Figure 13: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

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 an undeveloped area that includes natural wetland and marshland. This station is further away from the activity of the mine site than Outflow to Grebes Nest Pond.

As with many shallow brooks and streams, precipitation and runoff events play a significant role in influencing water quality. Water temperatures during the deployment were representative of the climate across August to December. Changes in pH data corresponded with changes in stage. The pH values were consistent for this brook.

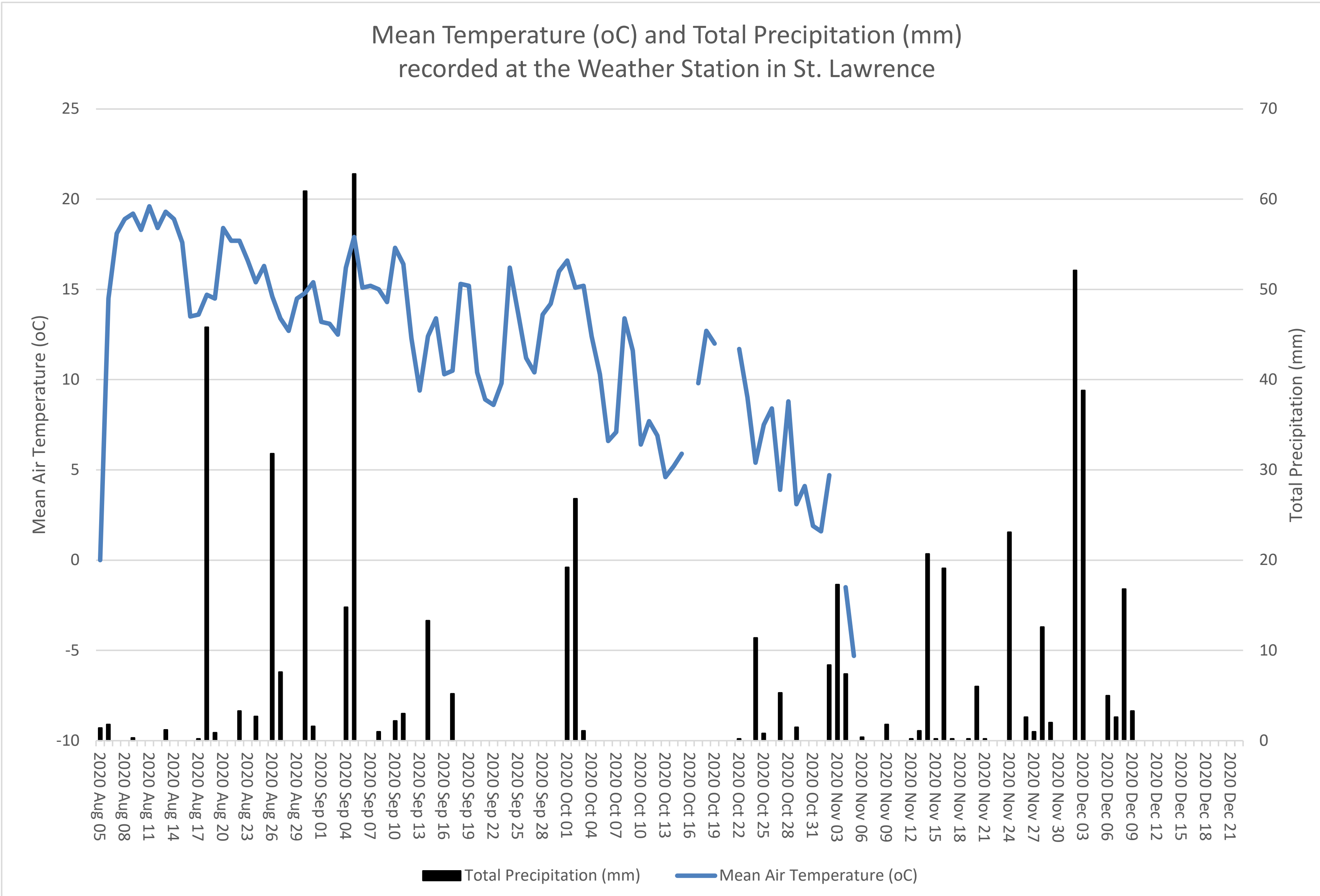
At this site the conductivity levels respond to increases in stage by decreasing, flushing the particle matter out of the brook, and increasing when stage level decreases concentrate the particle matter. At this site, dissolved oxygen levels represented what would be expected during the changes from Summer into Winter. Oxygen levels increased slightly across deployment as the air temperature decreased with the climatic change.

The deployment had moderate turbidity, with a greater range in turbidity data due to sediment buildup in the stream. The highest turbidity spikes recorded were directly after several precipitation events which also caused enough disturbance in the brook to impact the turbidity sensor for a number of days before the data returned to background levels.

There was evidence of a change in the water parameters at the end of deployment. Changes to the water parameters included an increase in pH, an increase in conductivity levels and a spike in turbidity.

The majority of the differences and fluctuations in water quality at this site were natural and a direct result of stage changes. However it should be noted that disturbance from anthropogenic activities can influence larger decreases and increases. The health of a waterway can be determined by how quickly the parameters return to background data after a water quality event.

APPENDIX I


Mean Temperature (oC) and Total Precipitation (mm)
recorded at the Weather Station in St. Lawrence
Mean Air Temperature (oC)
Total Precipitation (mm)
25
20
15
10
5
0
-5
-10
70
60
50
40
30
20
10
0
2020 Aug 05
2020 Aug 08
2020 Aug 11
2020 Aug 14
2020 Aug 17
2020 Aug 20
2020 Aug 23
2020 Aug 26
2020 Aug 29
2020 Sep 01
2020 Sep 04
2020 Sep 07
2020 Sep 10
2020 Sep 13
2020 Sep 16
2020 Sep 19
2020 Sep 22
2020 Sep 25
2020 Sep 28
2020 Oct 01
2020 Oct 04
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2020 Nov 03
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2020 Nov 12
2020 Nov 15
2020 Nov 18
2020 Nov 21
2020 Nov 24
2020 Nov 27
2020 Nov 30
2020 Dec 03
2020 Dec 06
2020 Dec 09
2020 Dec 12
2020 Dec 15
2020 Dec 18
2020 Dec 21
Total Precipitation (mm)
Mean Air Temperature (oC)