Real-Time Water Quality Report

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

Deployment Period
June 18, 2018 to July 17, 2018

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	June 19	Deployment	Good	Excellent	Excellent	Excellent	Fair
	July 17	Removal	Good	Good	Excellent	Good	Poor
Unnamed Pond	June 18	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	July 17	Removal	Poor	Excellent	Excellent	Excellent	Excellent

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, pH, specific conductivity and dissolved oxygen data ranked within 'Good' and 'Excellent' against the QA values. Turbidity data ranked 'Fair' for comparison data. The weather on the deployment day was extremely wet and windy. On this day the brook's flow was variable and it was extremely muddy with sediment. It is likely these factors contributed to the 'Fair' ranking for Turbidity.

During removal of the instrument, the ranking for water temperature, pH, specific conductivity and dissolved oxygen ranked 'Excellent' and 'Good' against the QA data. Turbidity data ranked 'Poor' for comparison data. When the instrument was removed from the brook it was coated in a fine silt or sediment. The interference of the silt on the sensor likely influenced the ranking of 'Poor' between the QA and the field sonde.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond the data ranked as 'Excellent' for all parameters. All rankings were acceptable for deployment of the instrument.

At the end of the deployment the water quality parameters ranked as the following: pH, specific conductivity, dissolved oxygen and turbidity ranked as 'Good' and 'Excellent'. Temperature ranked as 'Poor' which may have been a direct result of the QA instrument not stabilized for temperature before the reading was taken.

Concerns or Issues during the Deployment Period

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.

During the deployment period from June 18th to July 17th, there were transmission issues with Outflow to Unnamed Pond south of Long Pond station. An internal log file on the water quality instrument was used for the water quality data. Hourly stage data was unavailable to compare against the hourly water quality data. However, daily averaged stage levels are provided with each graph for a general overview of the deployment.

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from 7.35°C to 17.23°C during the deployment period (Figure 4). Water temperature displays a diurnal pattern throughout deployment. There is a large increase in water temperature on June 3rd to the 6th. This may be a result of the variation in stage level during this time. The water level at this brook is influenced by the water level of the sedimentation pond which is feeding this brook upstream. Water level at this brook can change quickly.

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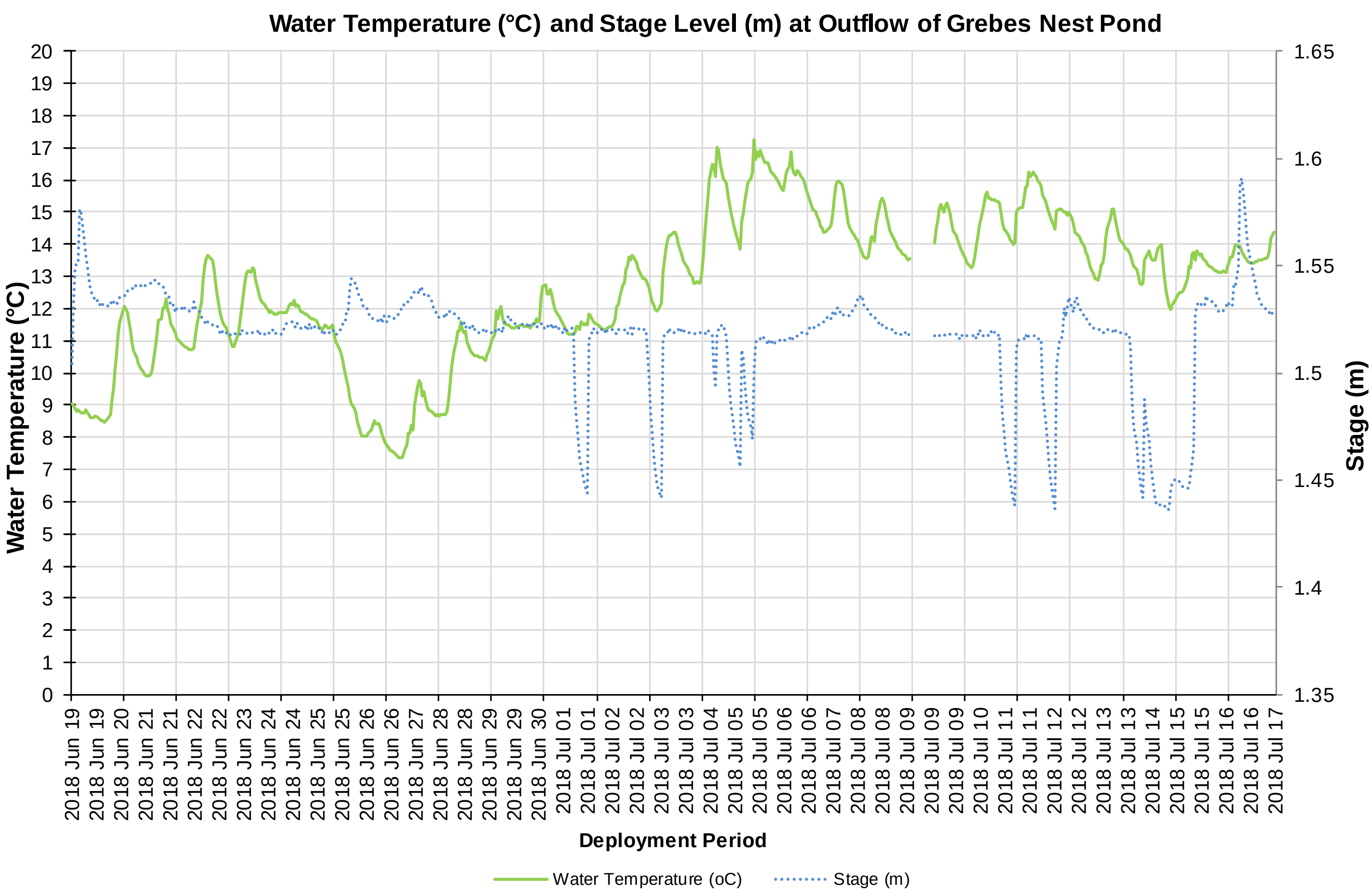

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 6.71 pH units and 7.36 pH units (Figure 5) and are generally consistent. pH remained within Guideline for the Protection of Aquatic Life. 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 guideline.

The pH data showed some variation in levels with changes in the stage level. Natural processes such as rainfall and snow melt will alter the pH of a brook for a period of time.

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.

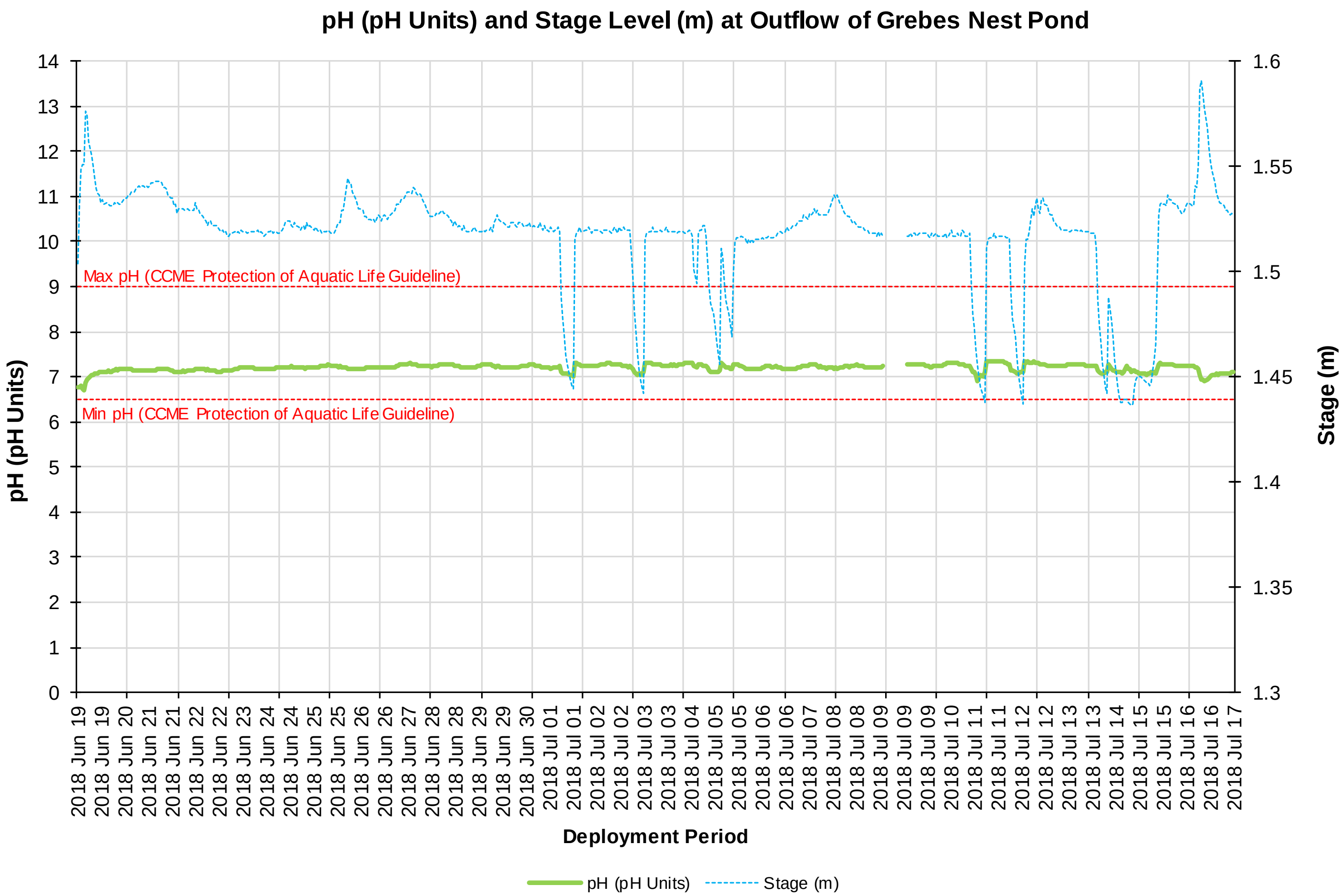

Figure 5: pH (pH units) and stage level (m) values

Specific Conductivity

The conductivity levels were within 87.73 µS/cm and 241.3 µS/cm during this deployment period (Figure 6).

During this deployment, the specific conductivity levels responded to stage increases by decreasing initially at the onset of precipitation then increasing shortly after.

Conductivity data levels reacted with sharp dips before increasing. This may be a result of reduced flow in the brook.

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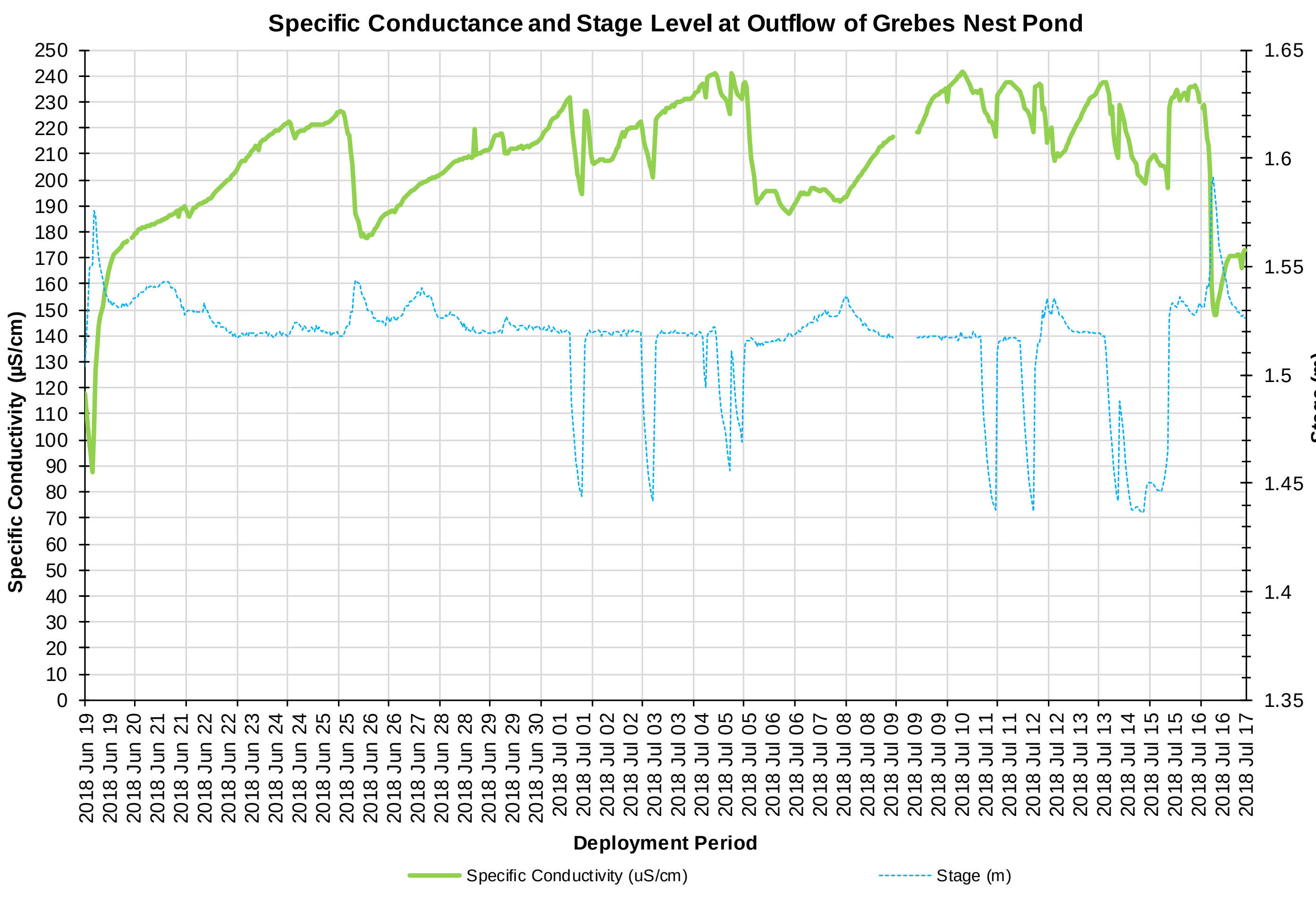

Figure 6: Specific conductivity (µS/cm) and stage (m) values

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 5.67 mg/L to a maximum of 10.78 mg/L. The percent saturation levels for dissolved oxygen ranged within 55% Saturation to 92.9% Saturation (Figure 7).

There were several large dips in dissolved oxygen during this deployment. The decreases on July 1st - 4th and again on July 10th-11th, and 12th correspond with the large stage decreases noted on Figure 9. This could be a result of reduced water supply to the brook from the sedimentation pond. Without adequate flow through the brook, the dissolved oxygen present in the water column can be used up quickly, especially when coupled with warmer temperatures. This instrument can be in stagnant water for a period of time.

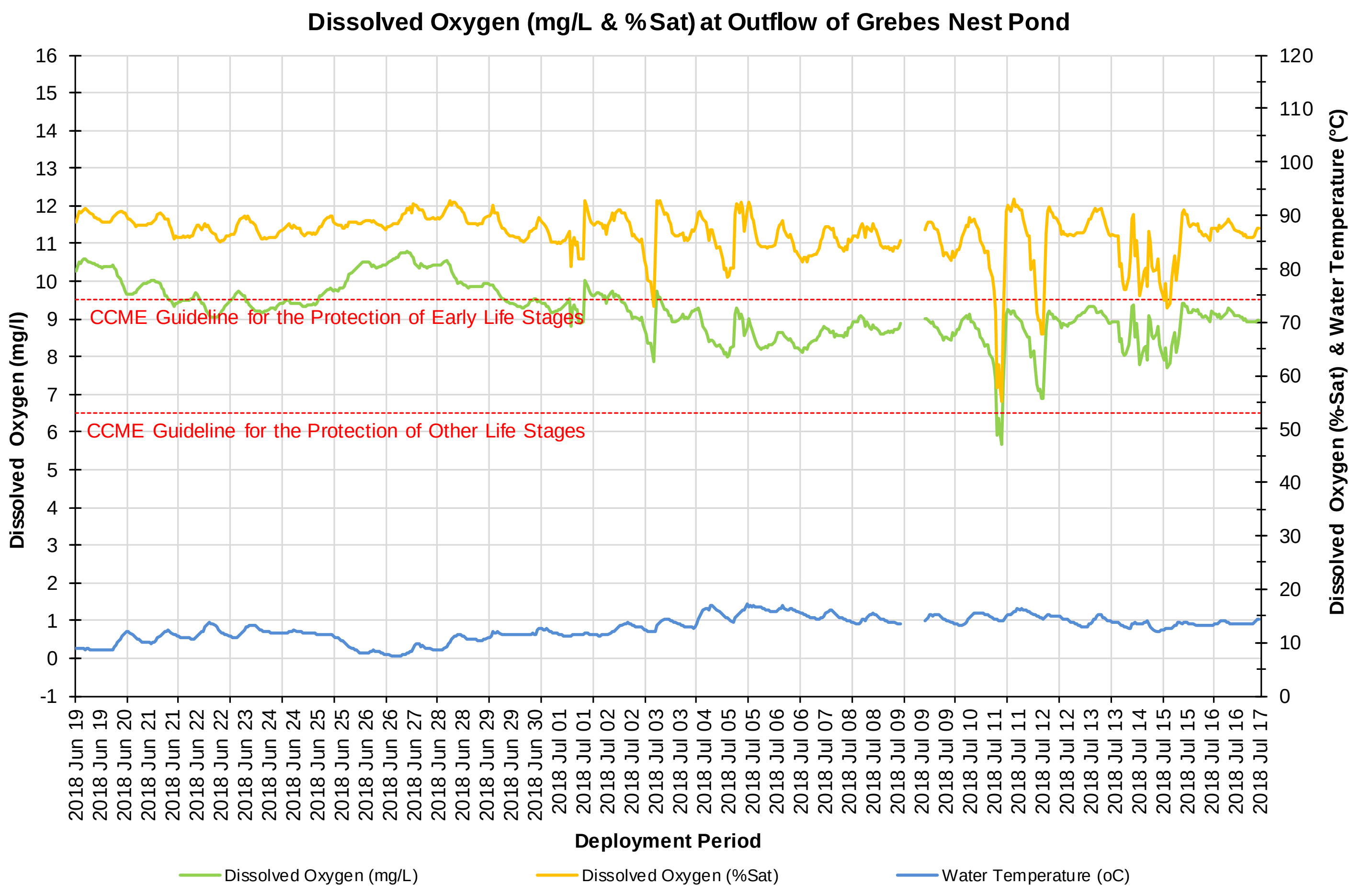

Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 34.6 NTU and 1341.9 NTU (Figure 8). The deployment data has a median of 86.6 NTU which is higher than the previous deployment median of 49 NTU.

Outflow to Grebes Nest Brook is fed upstream by a sedimentation pond and is heavily impacted. It is likely that the spikes in turbidity were a result of rainfall/runoff coupled with an increase in the flow from the sedimentation pond. Generally, the turbidity levels increase for a short period of time and then return to baseline range. Turbidity events with high variability and occurring over a prolonged period of time may warrant concern. This brook can also have significantly reduced flow at certain times of the year and coupled with evaporation during warmer months the instrument can be in stagnant water for a period of time.

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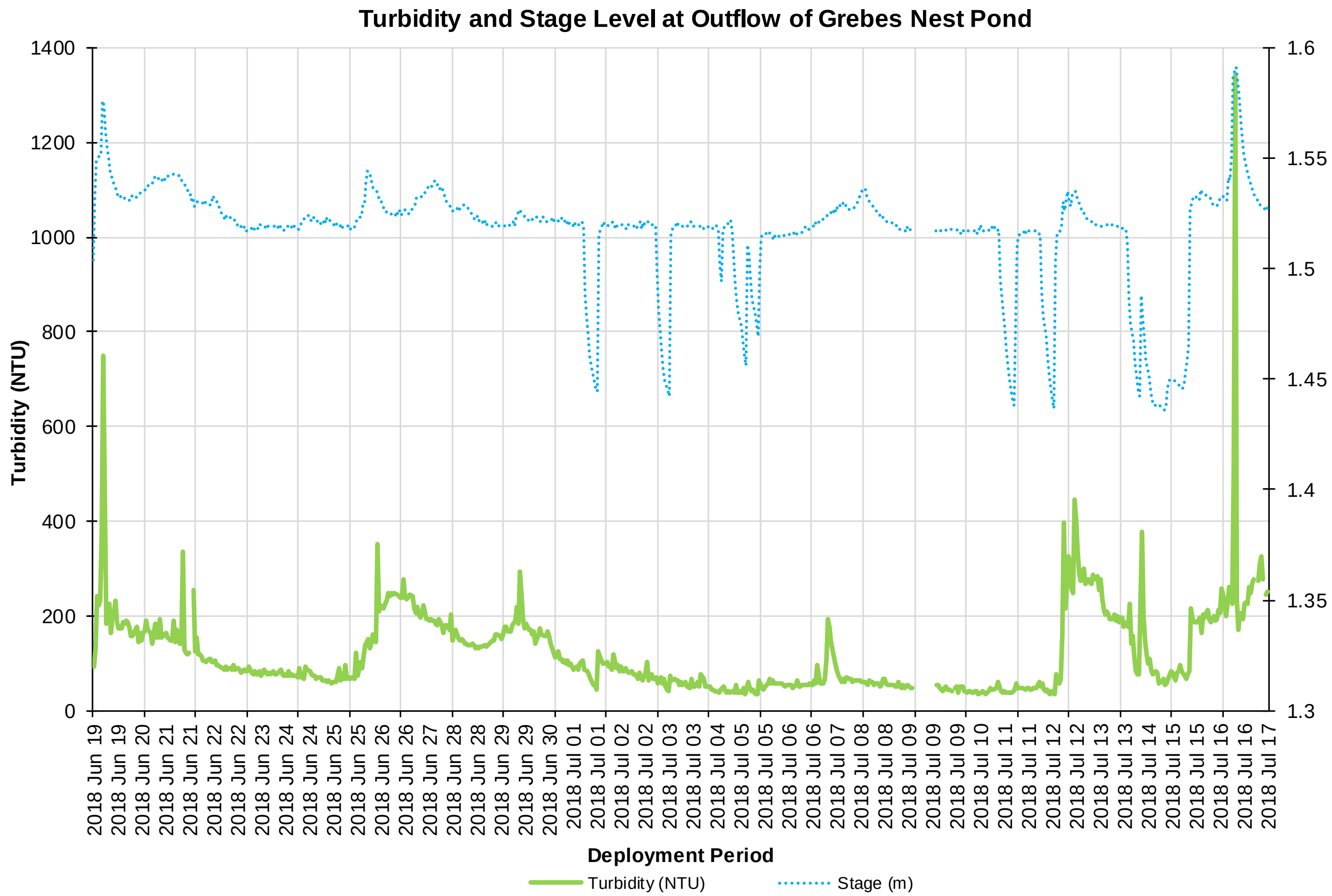

Figure 8: Turbidity (NTU) values.

Stage and Precipitation

Please note the stage data graphed below is daily averaged 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 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 9) 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.

Although this brook is fed via a sedimentation pond, rainfall is very important as it assists in maintaining water level. When there is little to no rainfall recorded the stage level drops significantly. The larger peaks in stage correspond with rainfall events (Figure 9). Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 66.4 mm.

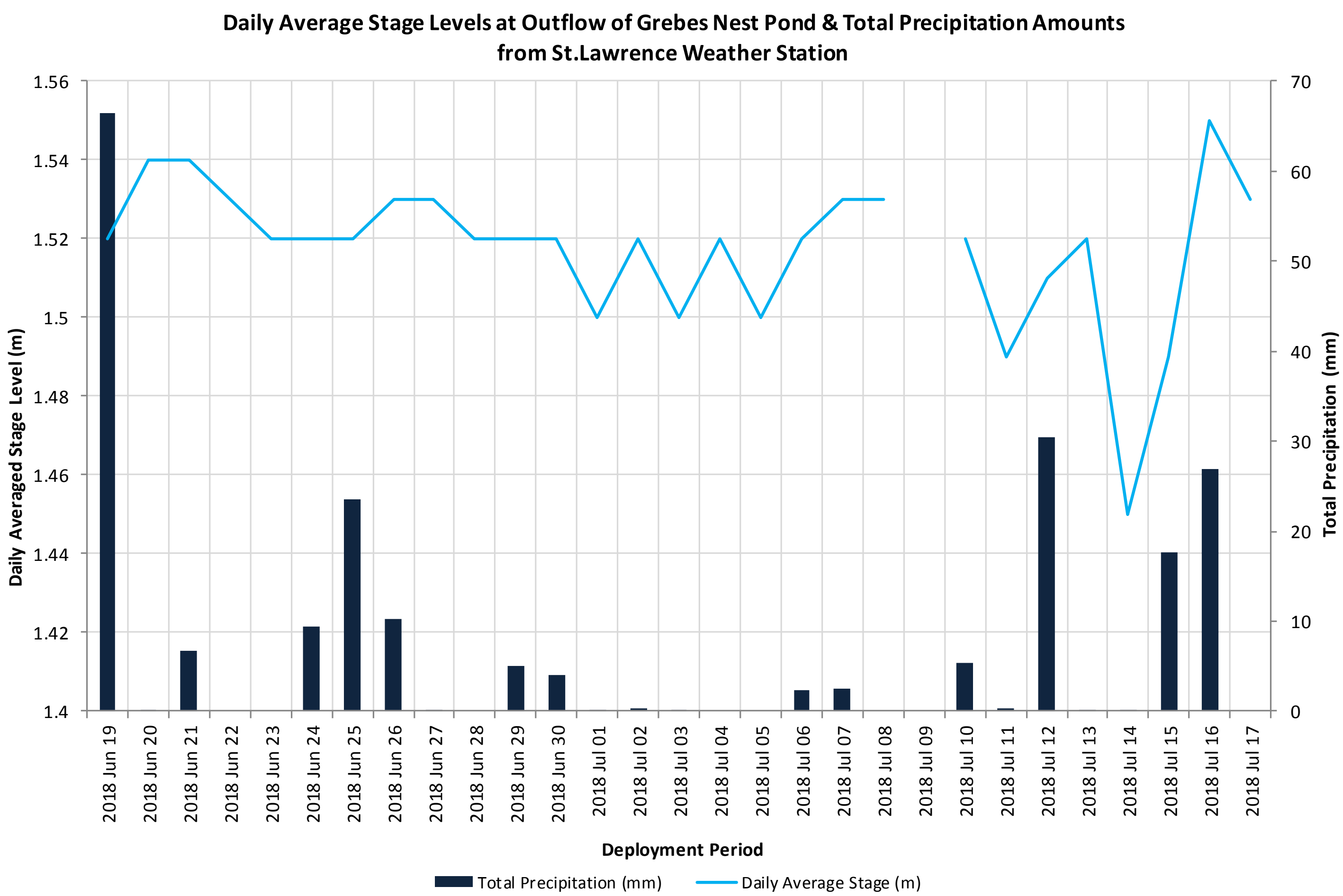

Figure 9: Daily average stage values and daily total precipitation.

Conclusion

Outflow of Grebes Nest Pond currently flows through a developing mine site. At this phase of the project, the natural environment is constantly being disturbed by ongoing mining activities. 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.

Currently the water is originating from 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 a sedimentation pond that naturally overflows down a trough and into a culvert that flows into Outflow of Grebes Nest Pond.

These factors can impact the water quality parameters during climatic events such as precipitation and snow melt from high air temperatures. When reviewing the parameter graphs as a whole it is evident that the larger precipitation events did cause varying effects with the water quality parameters pH, conductivity, dissolved oxygen and turbidity. It can be assumed that the increased flow from the sedimentation pond was responsible for the increases in the above mentioned water quality parameters.

Overall the water quality parameters recorded at Outflow of Grebes Nest Pond displayed water quality 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 5.49°C to 23.51°C during this deployment period (Figure 10). The graph displays the diurnal pattern that is evident with water temperature and also several large increases as the water temperatures start to adjust for the warmer seasonal changes into Summer.

The water temperatures decrease with each stage increase. The stage level increases are likely a result of rainfall (Figure 15) as the rainfall can decrease the temperature of the water for a short period of time.

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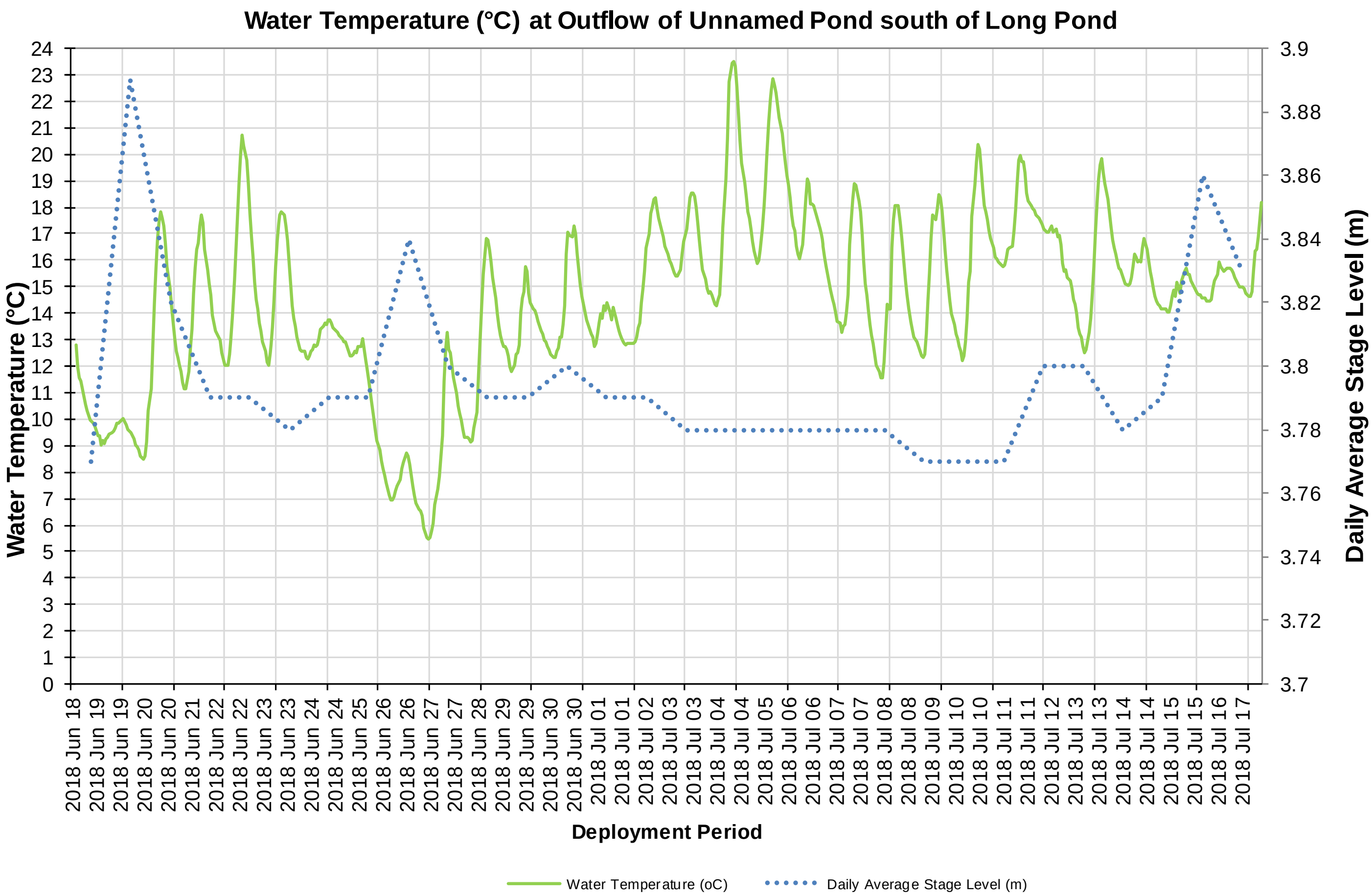

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.07 pH units and 7.92 pH units (Figure 11) values remain within the Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life and are generally consistent.

Natural processes such as rainfall and snow melt will alter the pH of a brook for a period of time. This is evident during and after high stage events. The pH data will increase or decrease for a short period of time. There is a dip in pH recorded June 19th, June 26th, July 13th and again on July 15th-16th.

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.

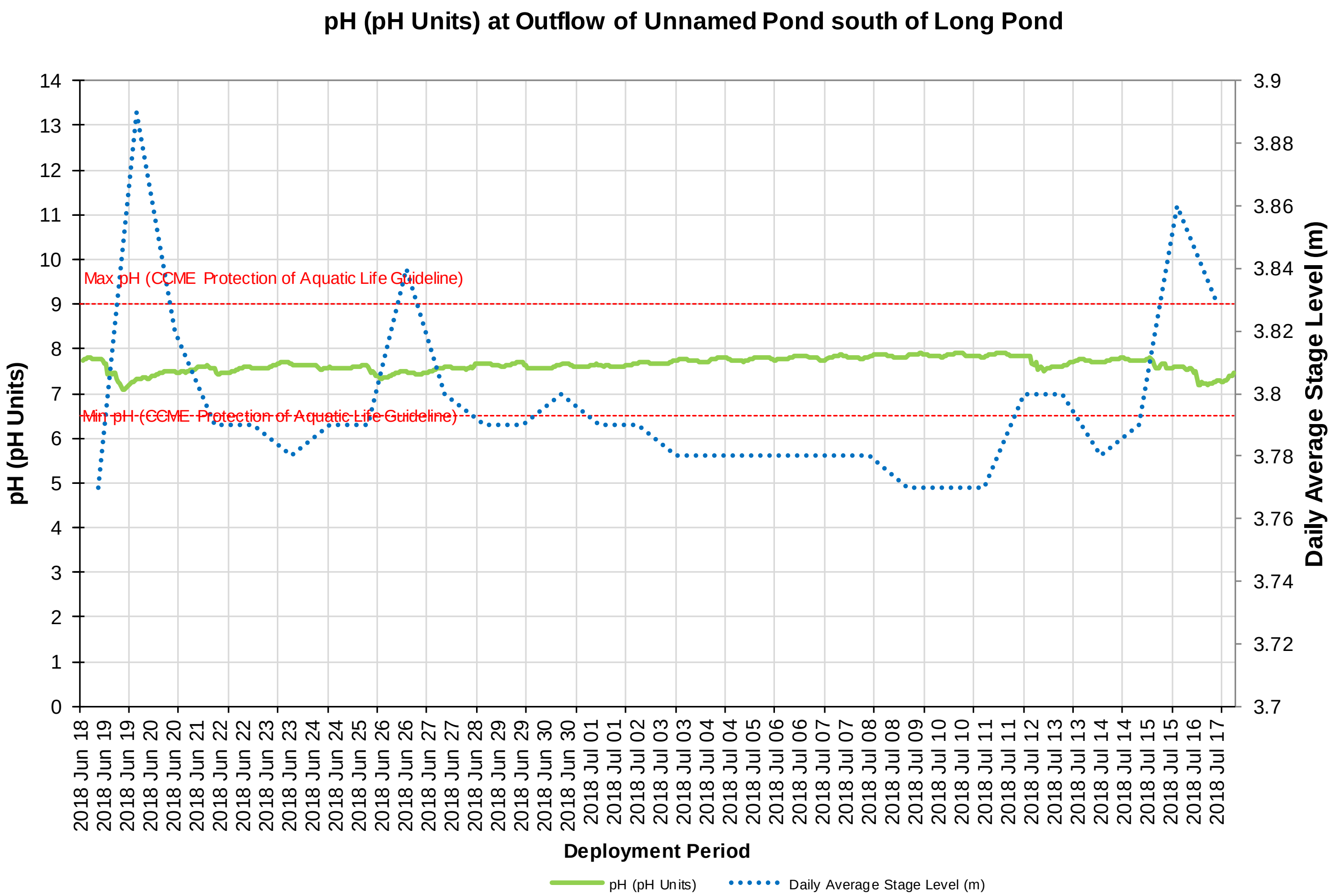

Figure 11: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 113.4 µS/cm and 236.2 µS/cm during deployment (Figure 12). This deployment period had a median of 178.3µS/cm, which was slightly lower than the median of the previous deployment of 191.6 µS/cm.

This station generally decreased in conductivity as the deployment continued (Figure 12). During the high stage events, conductivity decreased for a short period of time before returning to higher levels. From June 27th to July 11, 2018 the conductivity steadily increased, possibility due to reduced rainfall and ongoing evaporation, as these factors can concentrate the suspended solids in the brook increasing the conductivity levels.

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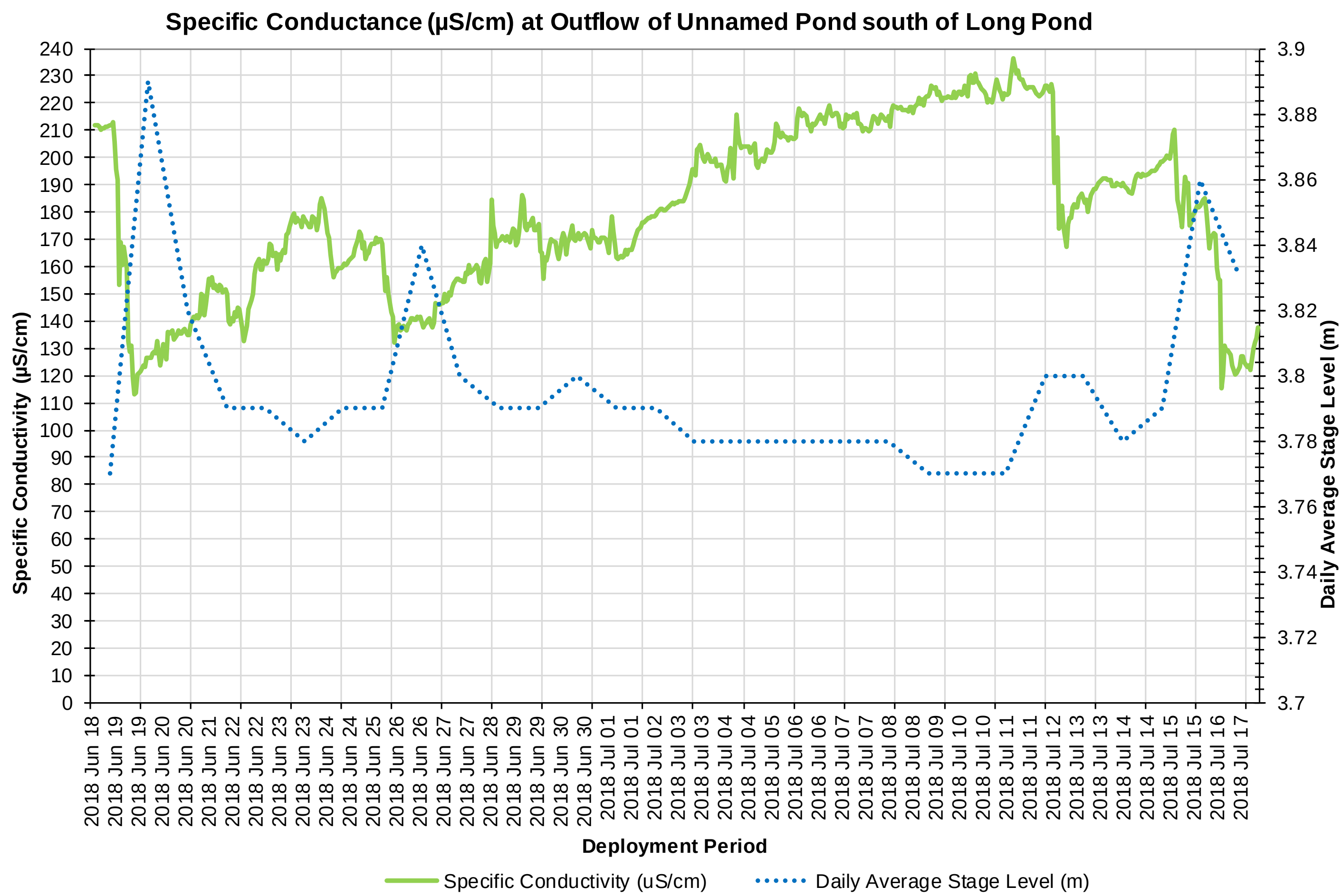

Figure 12: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

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 8.78mg/L and 12.48mg/L for concentration and 96.7% Sat and 105.8% Sat for percent saturation.

There is a natural diurnal pattern with dissolved oxygen data that represents the oxygen levels during the night and during the day. The larger variations in the dissolved oxygen data are likely a result of influence from water temperature during those times. Water temperature directly impacts the saturation of dissolved oxygen present in the waterbody.

This can be seen on Figure 13 on June 26th and June 27th, 2018 as the water temperature decreases, the dissolved oxygen concentration increases for the same timeframe.

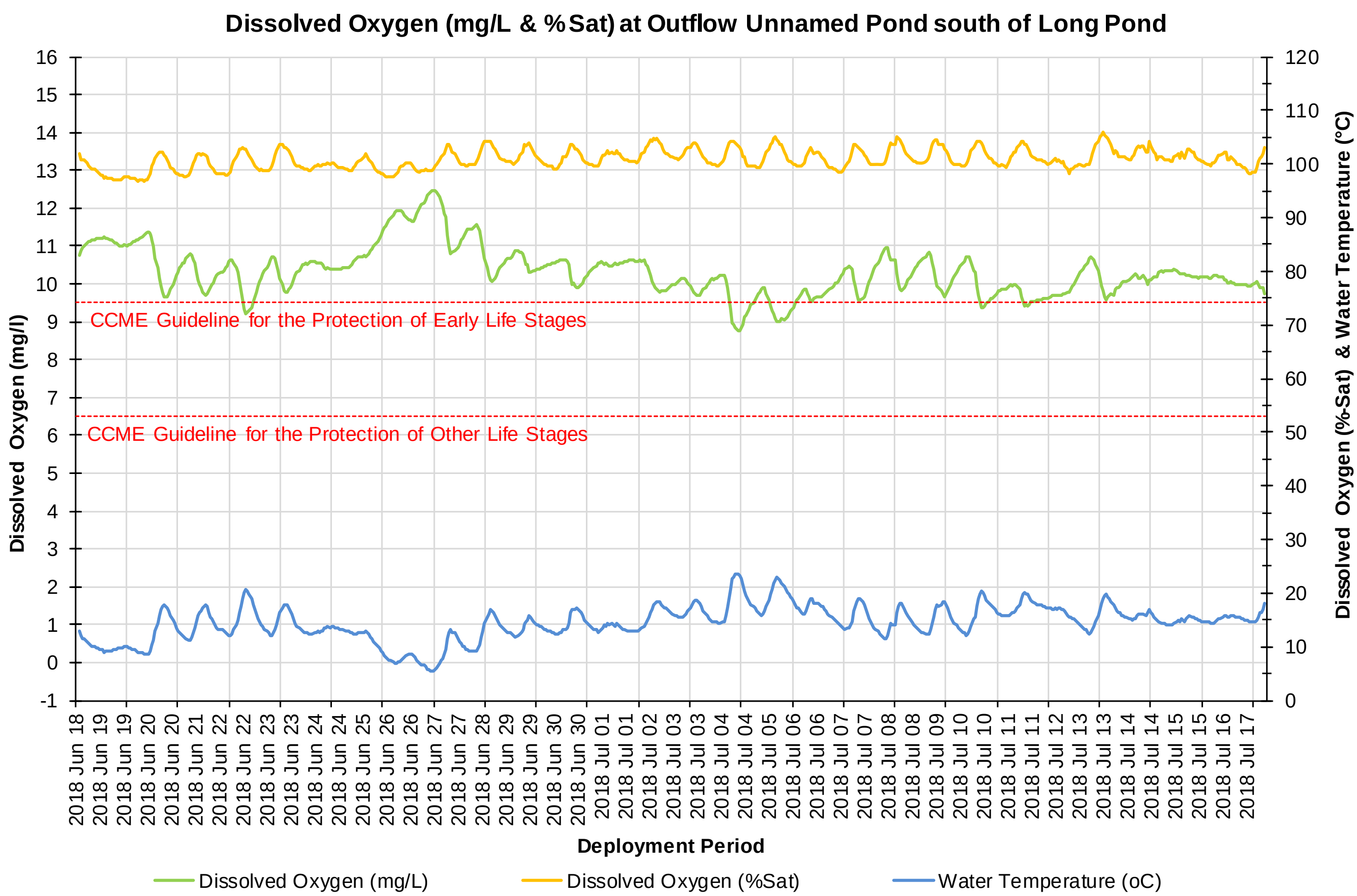

Figure 13: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 1.1 NTU and 6.6 NTU (Figure 14). The deployment data has a median of 2.2 NTU. The median is lower than the previous deployment median of 9.8 NTU.

The turbidity levels during this deployment mirror the stage variations. It is evident that as the stage level increases, it influences the particle matter and suspended solids in the brook, increasing the turbidity levels. There are several rainfall events during the deployment (Figure 15) which likely contributed to the stage level. There are distinct increases in turbidity although the values are very small and the turbidity data settles back to background levels shortly after the increase.

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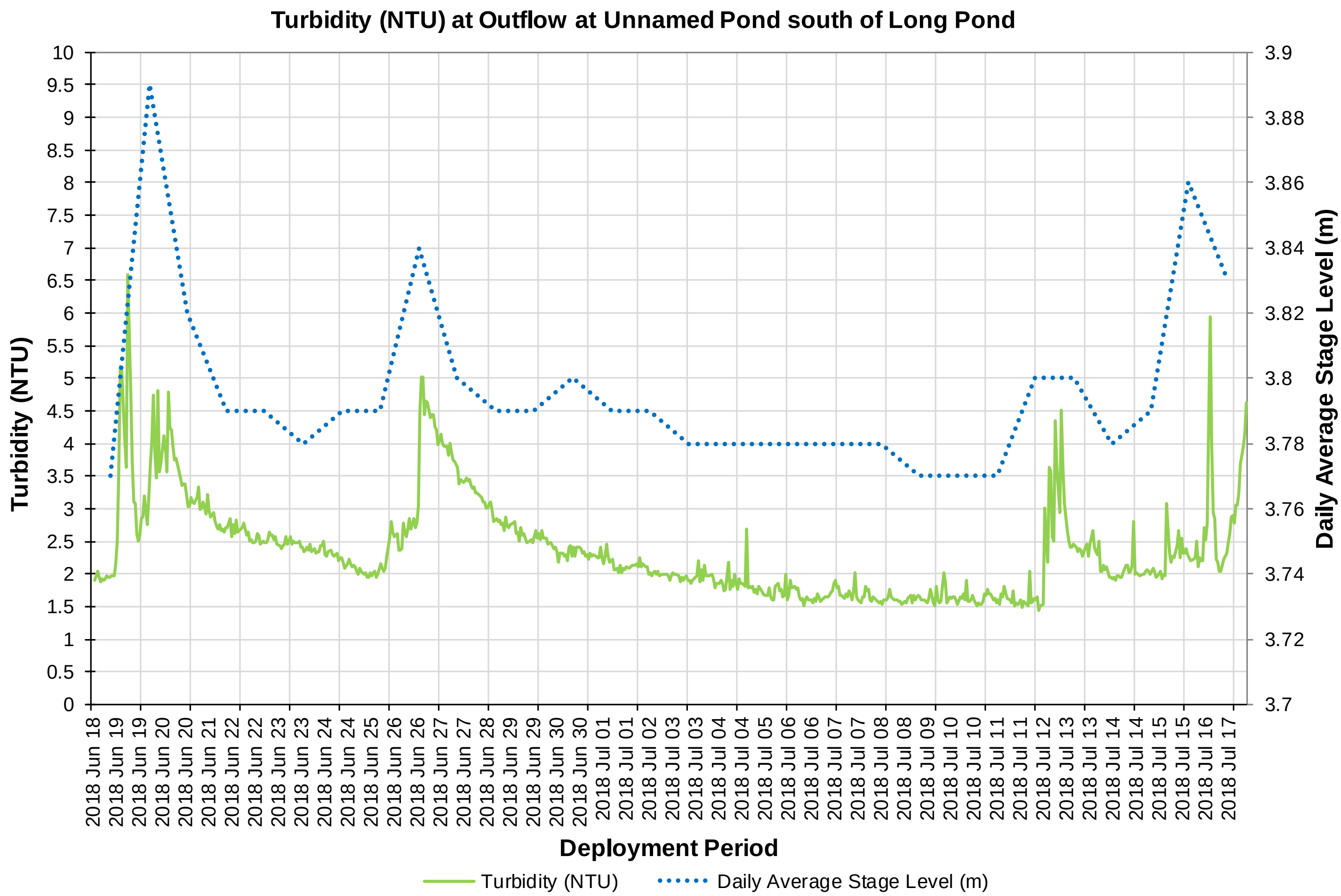

Figure 14: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

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 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 15) and during any surrounding snow or ice melt. However, direct snowfall will not cause stage to rise significantly.

The larger peaks in stage correspond with substantial rainfall events as noted on Figure 15. Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 66.4mm on June 19th, 2018.

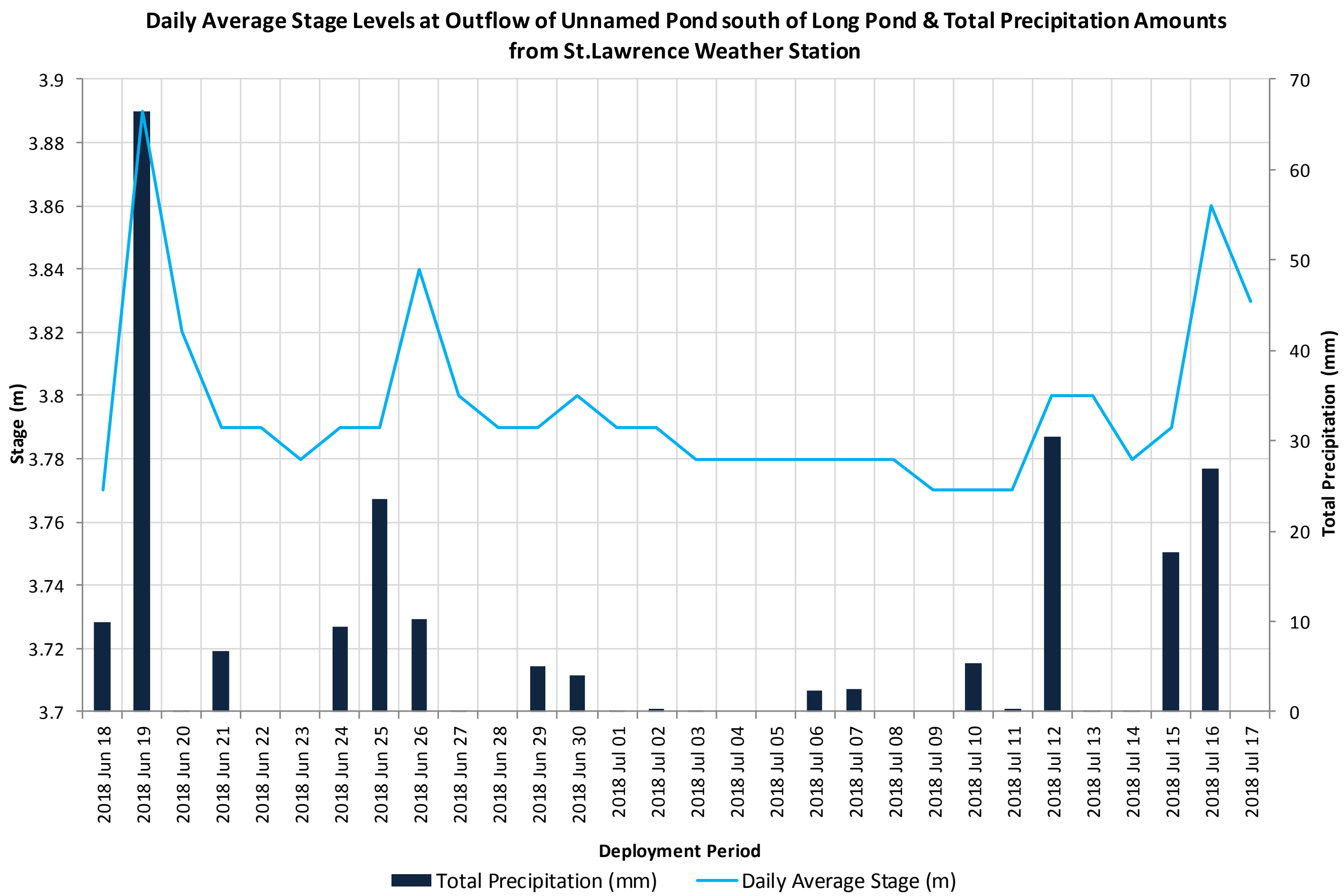

Figure 15: Daily average stage values and daily total precipitation.

Conclusion

As with many shallow brooks and streams, precipitation and runoff play a significant role in influencing the water quality within the water body. The Outflow of Unnamed Pond South of Long Pond runs through some undeveloped area that includes natural wetlands and marshlands, however, the brook skirts along the ongoing construction activity. There will be influences from these activities on the water quality parameters. This station is the furthest away from the anthropogenic activities that are occurring on the mine site.

Water temperatures during this deployment were representative of the climate for this time of year. Water temperatures are directly influenced by air temperatures. Seasonal changes in water temperature are evident in the data displayed. The pH values were consistent for this brook; any significant change in pH data corresponded with a rise in the stage level.

Turbidity levels remained below 10 NTU over the deployment. There were no high turbidity events recorded. This deployment had a median of 2.2 NTU which is significantly lower than the previous deployment.

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 watershed for this brook is impacted by anthropogenic changes as the mining activity continues. The health of a brook can be determined by how quickly it returns to a consistent parameter level after a water quality event.