Real-Time Water Quality Report

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

Deployment Period
July 18 2018 to August 14 2018

Newfoundland Labrador

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

Prepared by:

Tara Clinton
Environmental Scientist
Water Resources Management Division
Department of Municipal Affairs & Environment
4th Floor, Confederation Building, West Block
PO Box 8700, 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 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	July 18	Deployment	Excellent	Excellent	Excellent	Good	Good
	August 14	Removal	Excellent	Excellent	Excellent	Good	Excellent
Unnamed Pond	July 18	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	August 14	Removal	Fair	Good	Excellent	Excellent	Excellent

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, pH, specific conductivity, dissolved oxygen and turbidity data ranked within 'Good' and 'Excellent' against the QA values.

During removal of the instruments the rankings for water temperature, pH, specific conductivity, dissolved oxygen and Turbidity again ranked 'Excellent' or 'Good' against the QA data.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond, the data for water temperature, pH, specific conductivity, dissolved oxygen and turbidity all ranked as 'Excellent'.

At the end of the deployment, the water quality parameters ranked as the following: pH, specific conductivity, dissolved oxgyen and turbidity ranked as 'Good' and 'Excellent'. Temperature ranked as 'Fair' 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.

Due to transmission issues with Outflow to Unnamed Pond south of Long Pond station during this deployment, there is no hourly stage data to compare against the hourly water quality parameters. However, daily averaged stage levels were provided with each graph for a general overview of the deployment.

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from 13.61°C to 19.46°C during the deployment period (Figure 4). The water temperatures during this deployment are higher than the previous as Summer has arrived. The average water temperature for this deployment is 15.8°C.

During stage increases, water temperature dips slightly. This can indicate influence from rainfall or surrounding runoff. When stage decreases, the water temperature increases as the sun's energy heats the lower volume of water to a greater temperature.

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.

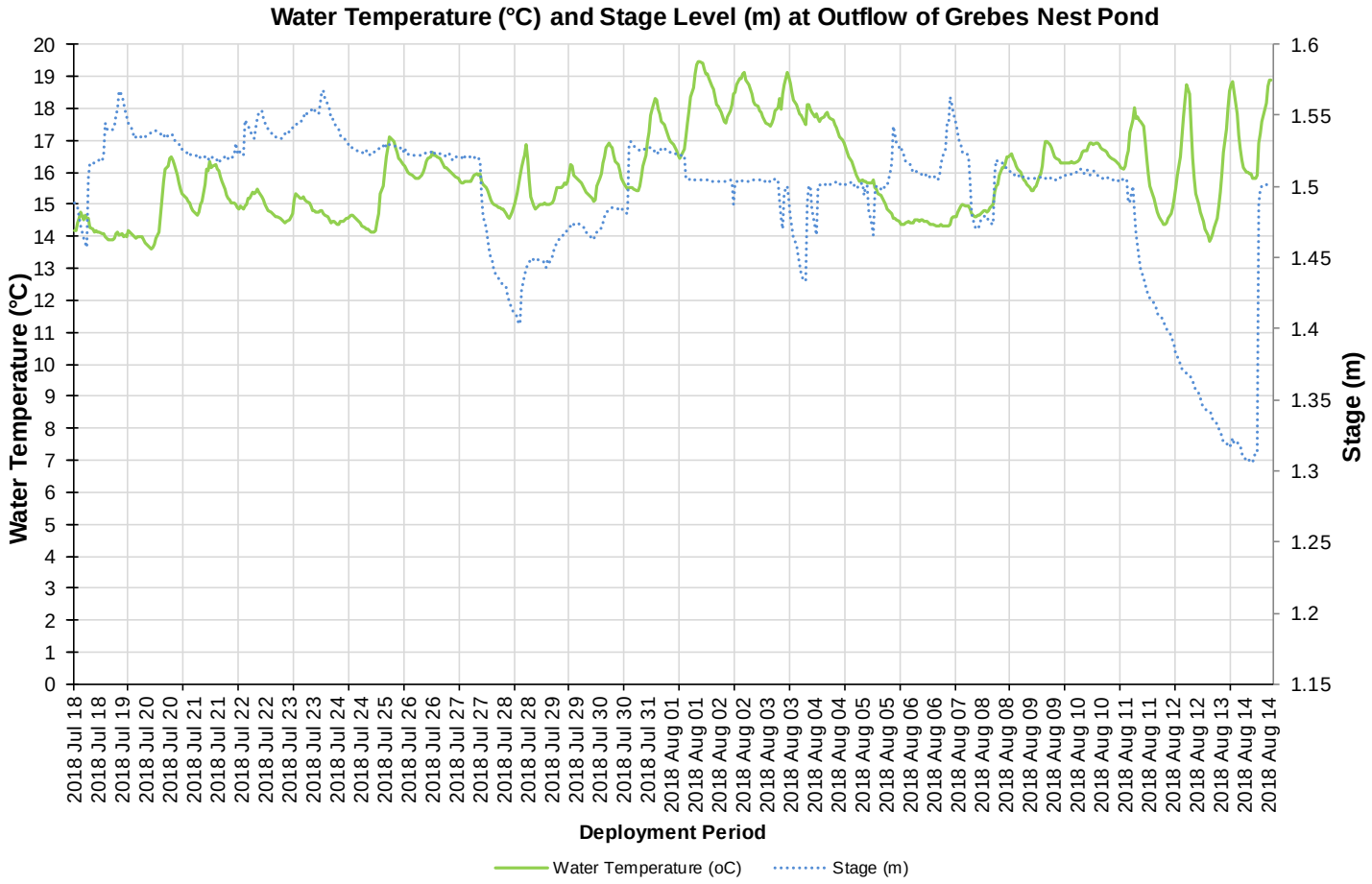

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 6.81 pH units and 7.3 pH units (Figure 5). The pH data remained within the Guidelines for Protection of Aquatic Life the Canadian Council of Ministers of the Environment (CCME).

The pH data showed very slight variation in levels during decreases in the stage. Natural processes such as rainfall, runoff from snowmelt and evaporation 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.

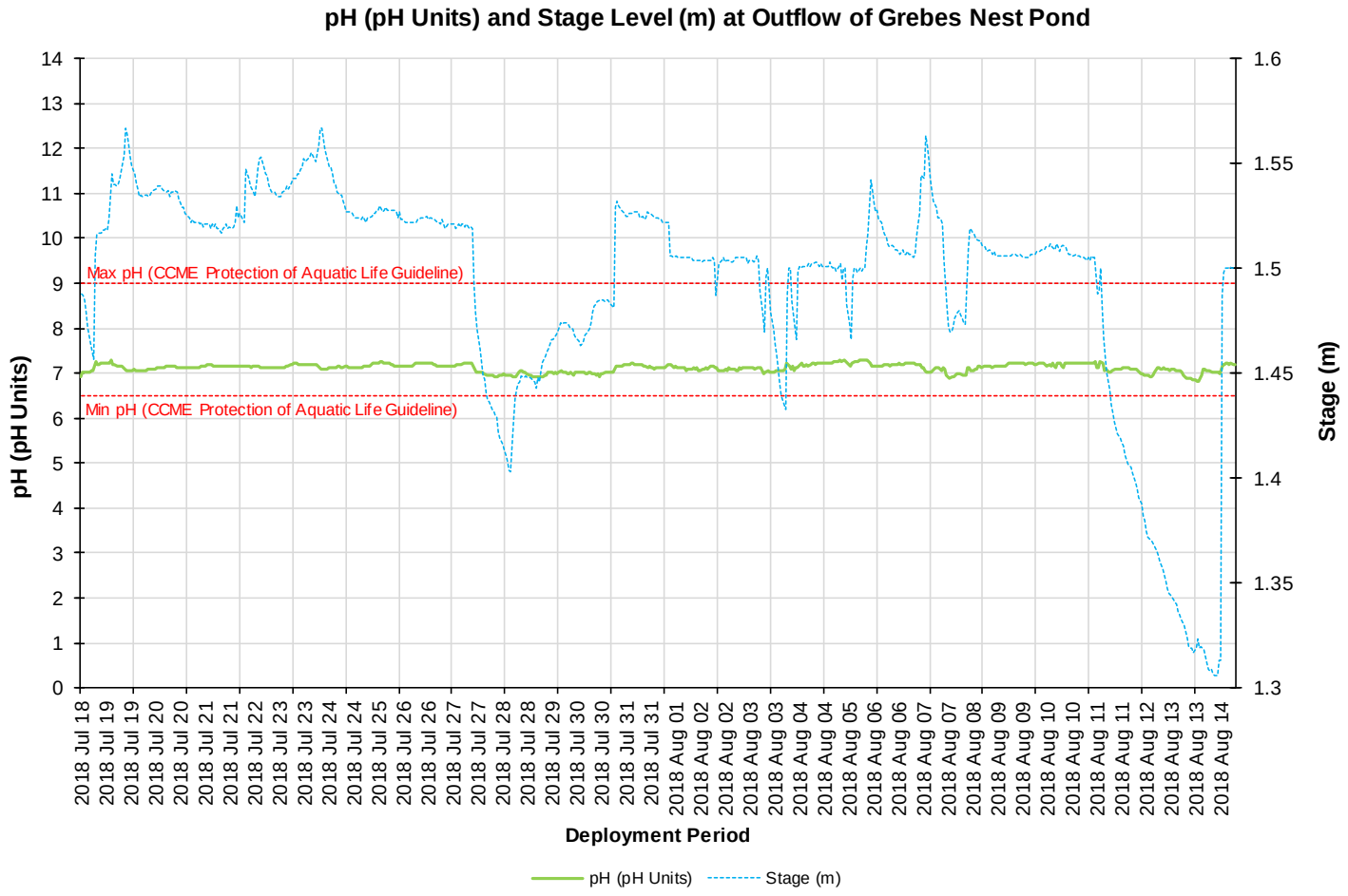

Figure 5: pH (pH units) and stage level (m) values

Specific Conductivity

The conductivity levels were within 130.37 µS/cm and 318.07 µS/cm during this deployment period (Figure 6).

During this deployment, the majority of the specific conductivity data responded to stage increases by initially decreasing. The extra water present in the brook dilutes the particle matter and reduces the conductivity values. However, shortly after a large dip in stage on August 11 2018 the conductivity levels mirrored the stage data and decreased for a short period of time.

Please note the stage data 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.

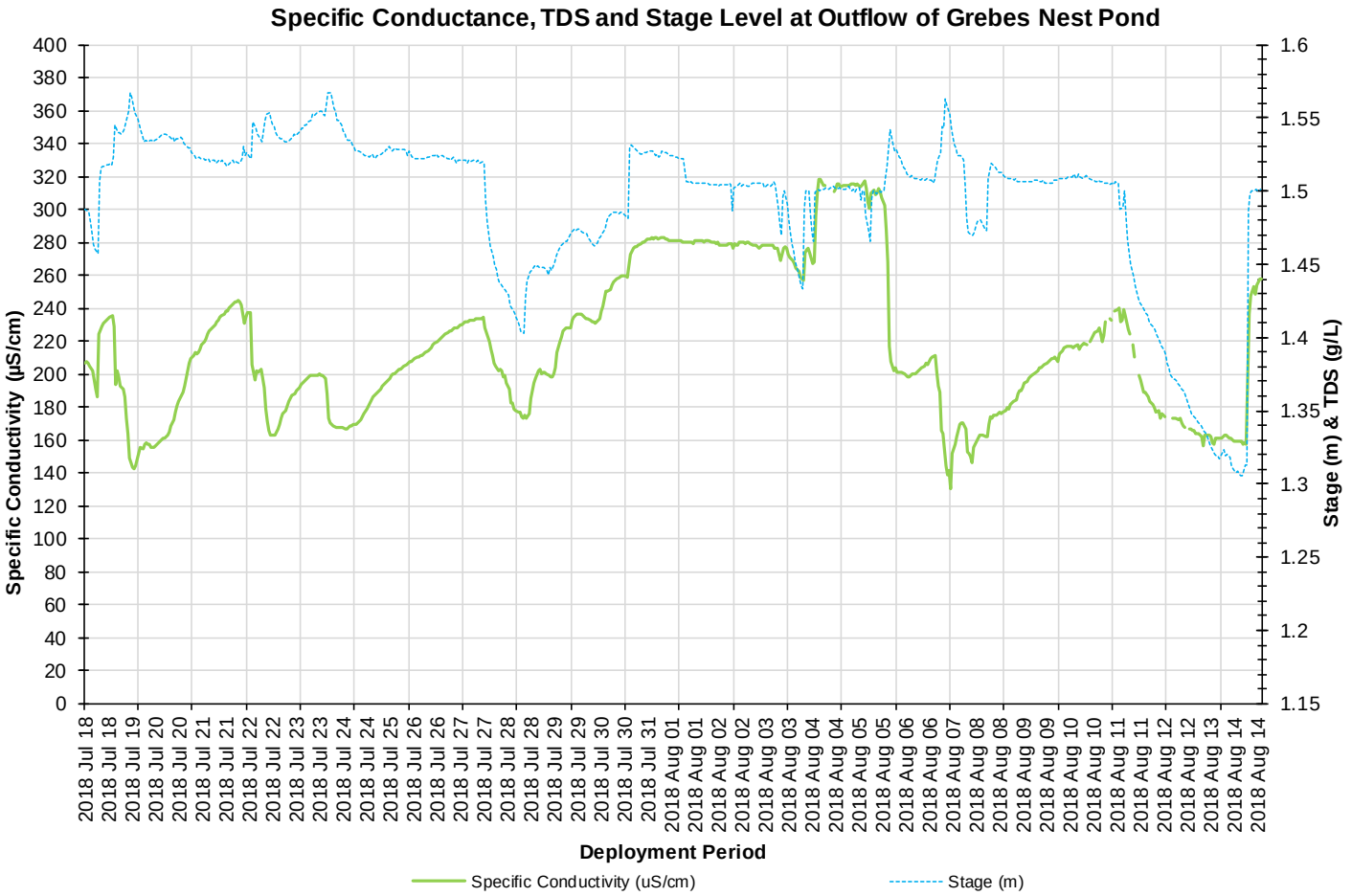

Figure 6: Specific conductivity (µS/cm) and stage (m) values

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 4.92 mg/L to a maximum of 8.93 mg/L. The percent saturation levels for dissolved oxygen ranged within 52.5% Saturation to 88.6% Saturation (Figure 7).

There were several sharp dips in dissolved oxygen during this deployment. The decrease on July 27th corresponded with a large stage decrease 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, creating stagnant water.

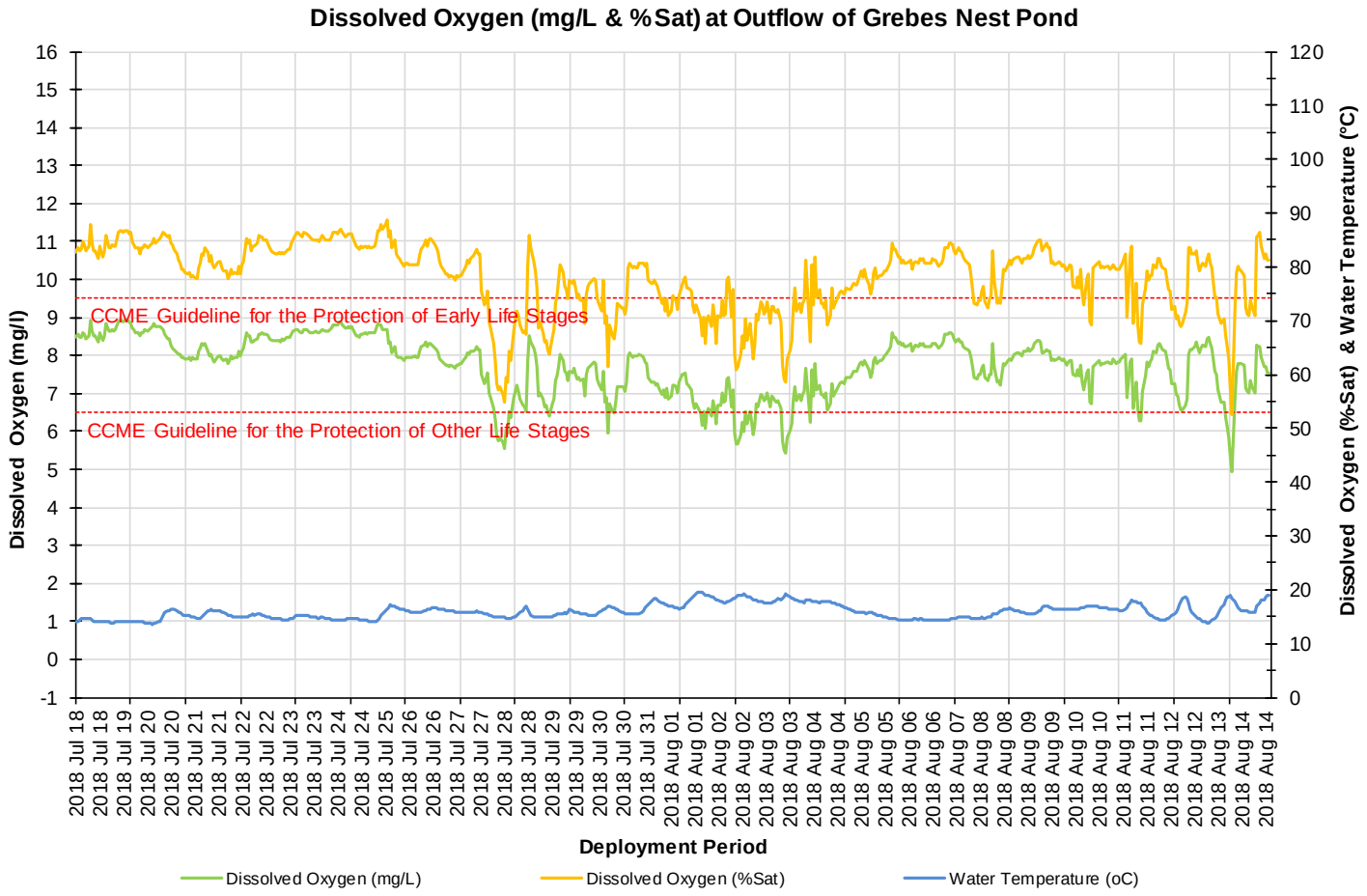

Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 27.8 NTU and 1018.3 NTU (Figure 8). The deployment data has a median of 122.3 NTU which is higher than the previous deployment median of 86.6 NTU.

Outflow to Grebes Nest Brook is fed upstream by a sedimentation pond and is heavily impacted. This station has a lot of variability in its turbidity values. Generally, the turbidity levels increase for a short period of time and then return to baseline range. This brook can also have significantly reduced flow at certain times of the year and coupled with evaporation during the warmer months, the instrument can be in stagnant water 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.

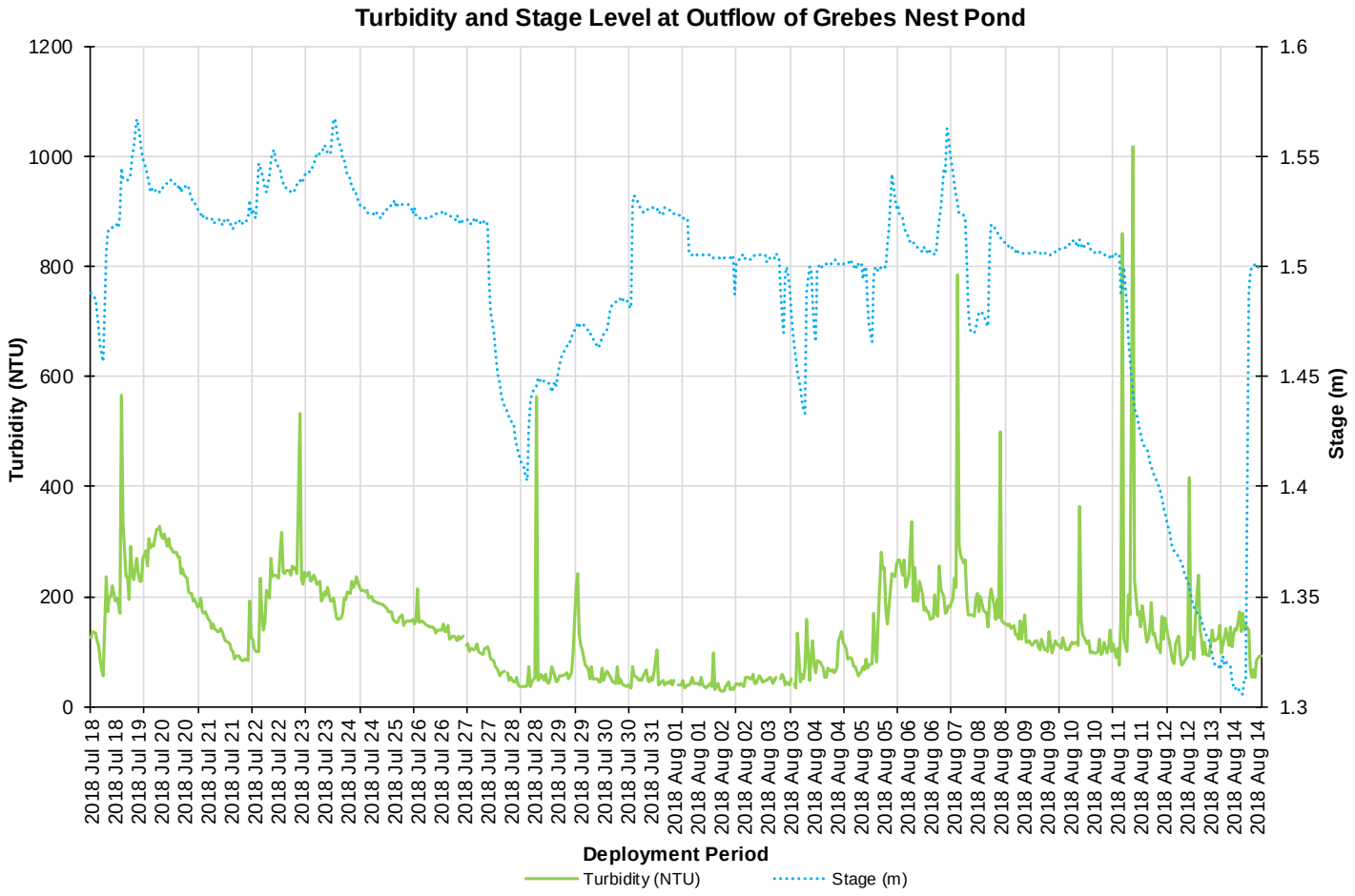

Figure 8: Turbidity (NTU) values.

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 is 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 (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 51.2 mm on August 7th 2018.

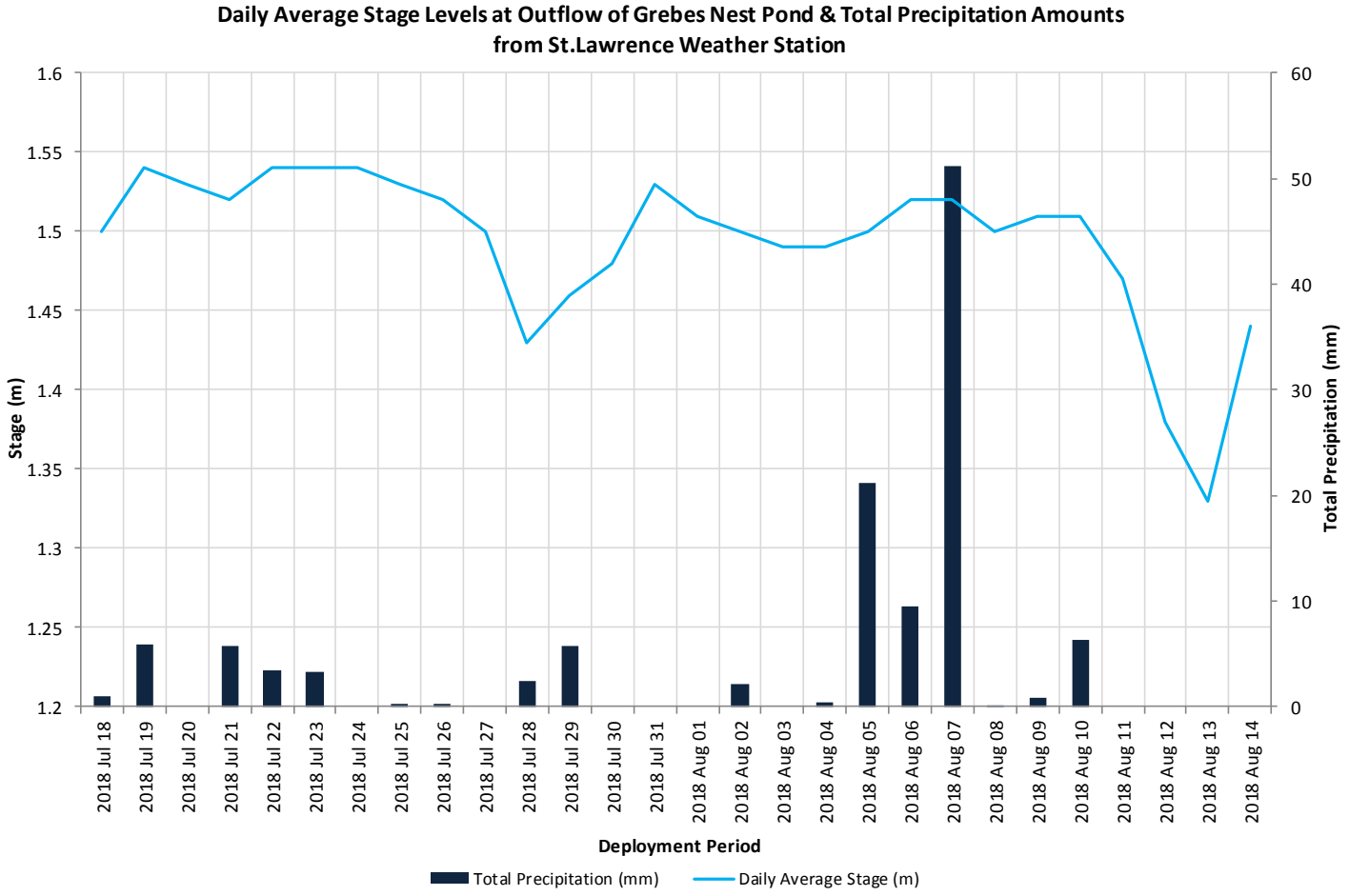

Figure 9: Daily average stage values and daily total precipitation.

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 on 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 variations in the above mentioned water quality parameters.

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 14.53°C to 25.64°C during this deployment period (Figure 10). The water temperatures have increased since the last deployment period, as the air temperatures increase into the Summer.

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

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.

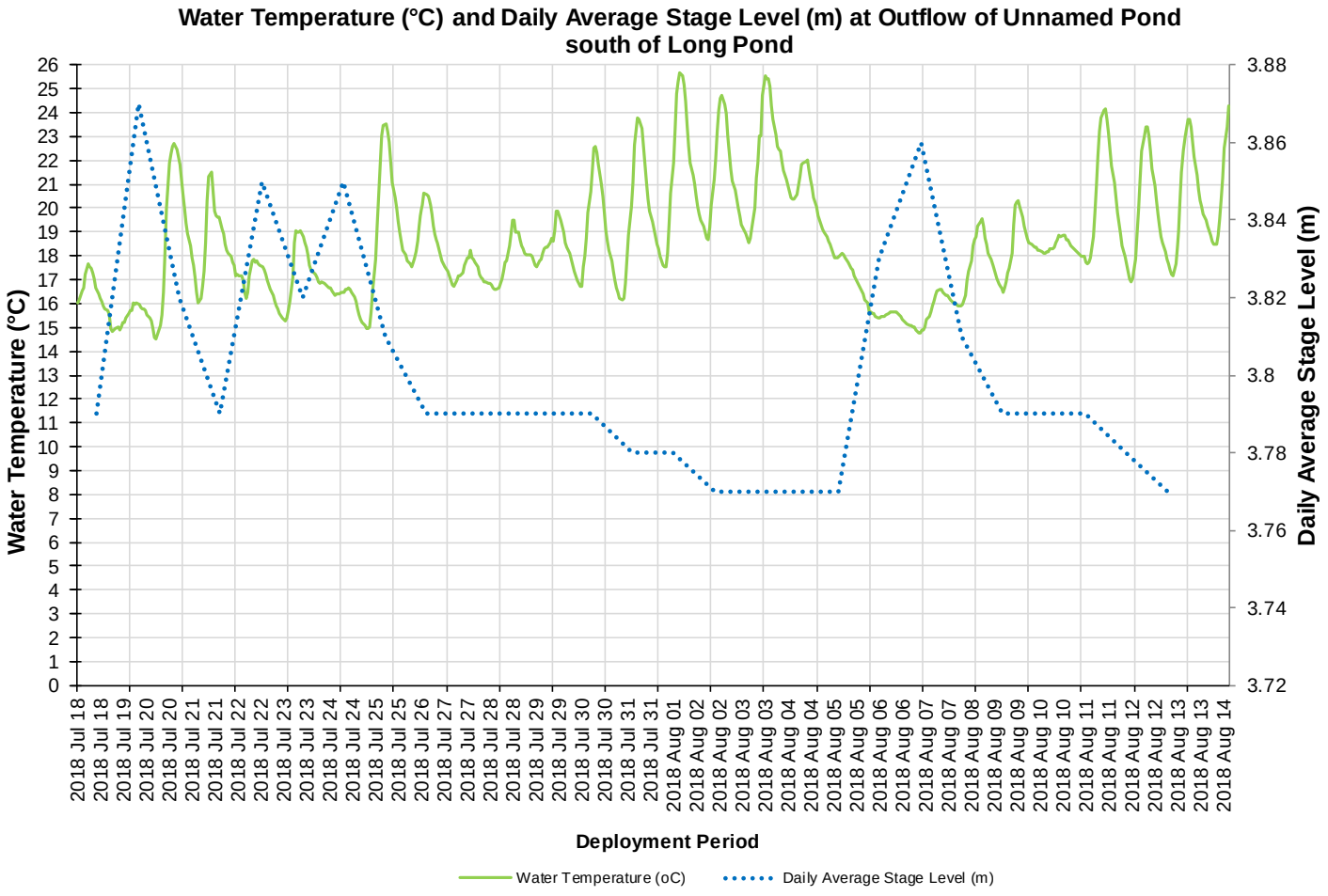

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.23 pH units and 7.97 pH units (Figure 11). The pH values were consistent and remained within the Guidelines for Protection of Aquatic Life the Canadian Council of Ministers of the Environment (CCME).

Natural processes such as rainfall and snowmelt will alter the pH of a brook for a period of time. This is evident during and after stage increases, the pH data decreases for a short period of time. There are decreases in pH recorded July 19th and August 5th to August 7th, 2018, corresponding to increases in stage.

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.

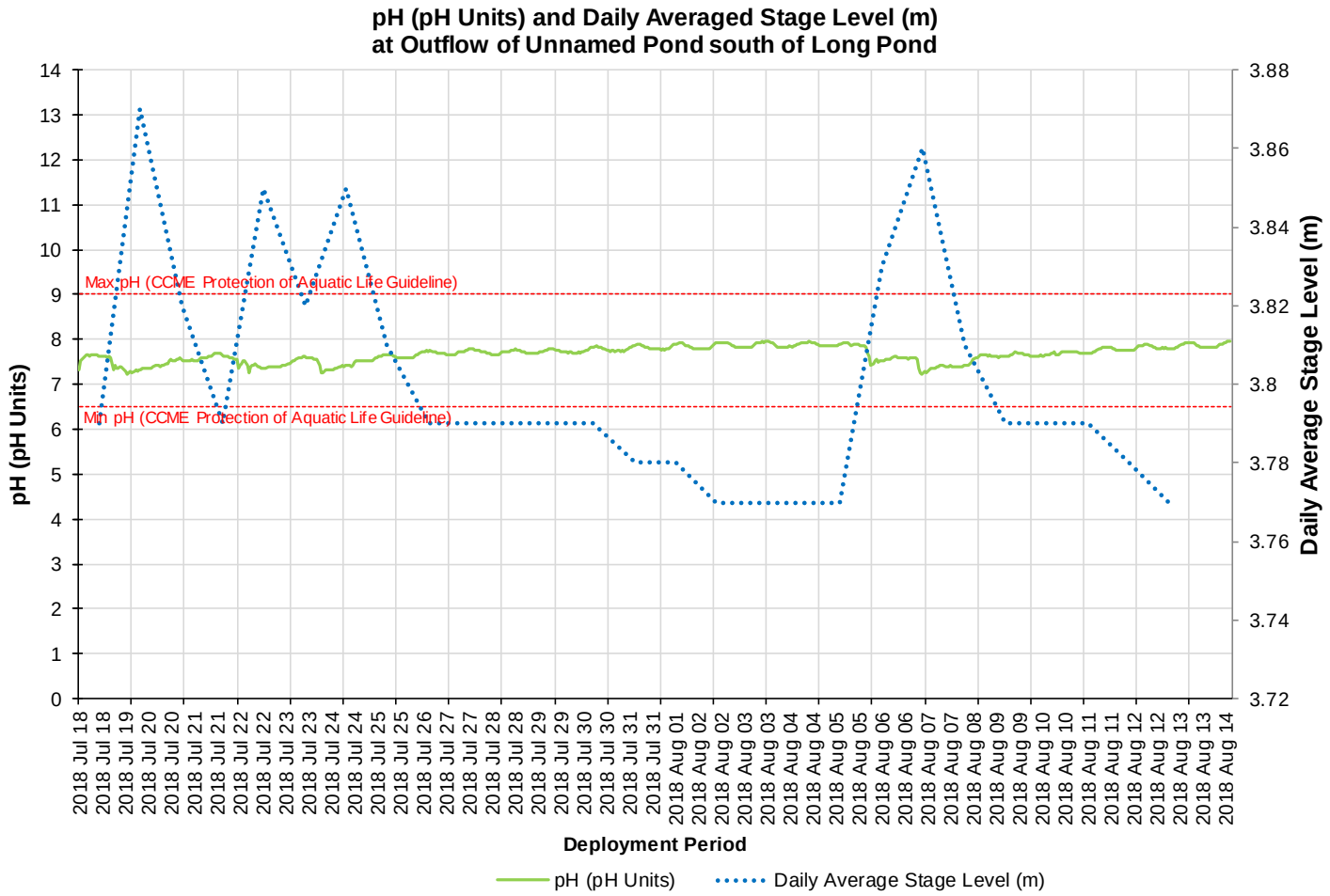

Figure 11: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 105.7 µS/cm and 244.4 µS/cm during deployment (Figure 12). This deployment period had a median of 179.5 µS/cm, which was similar to that of the median of the previous deployment of 178.3 µS/cm.

The conductivity at this station generally increased throughout the deployment (Figure 12). The stage increases at the beginning of the deployment influenced the conductivity levels by diluting the particle matter and reducing the conductivity. As the stage decreased on July 20th, 2018, the conductivity levels increased steadily until August 6th when the stage increased and the conductivity levels dipped again for a short period of time before climbing as the deployment ended.

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.

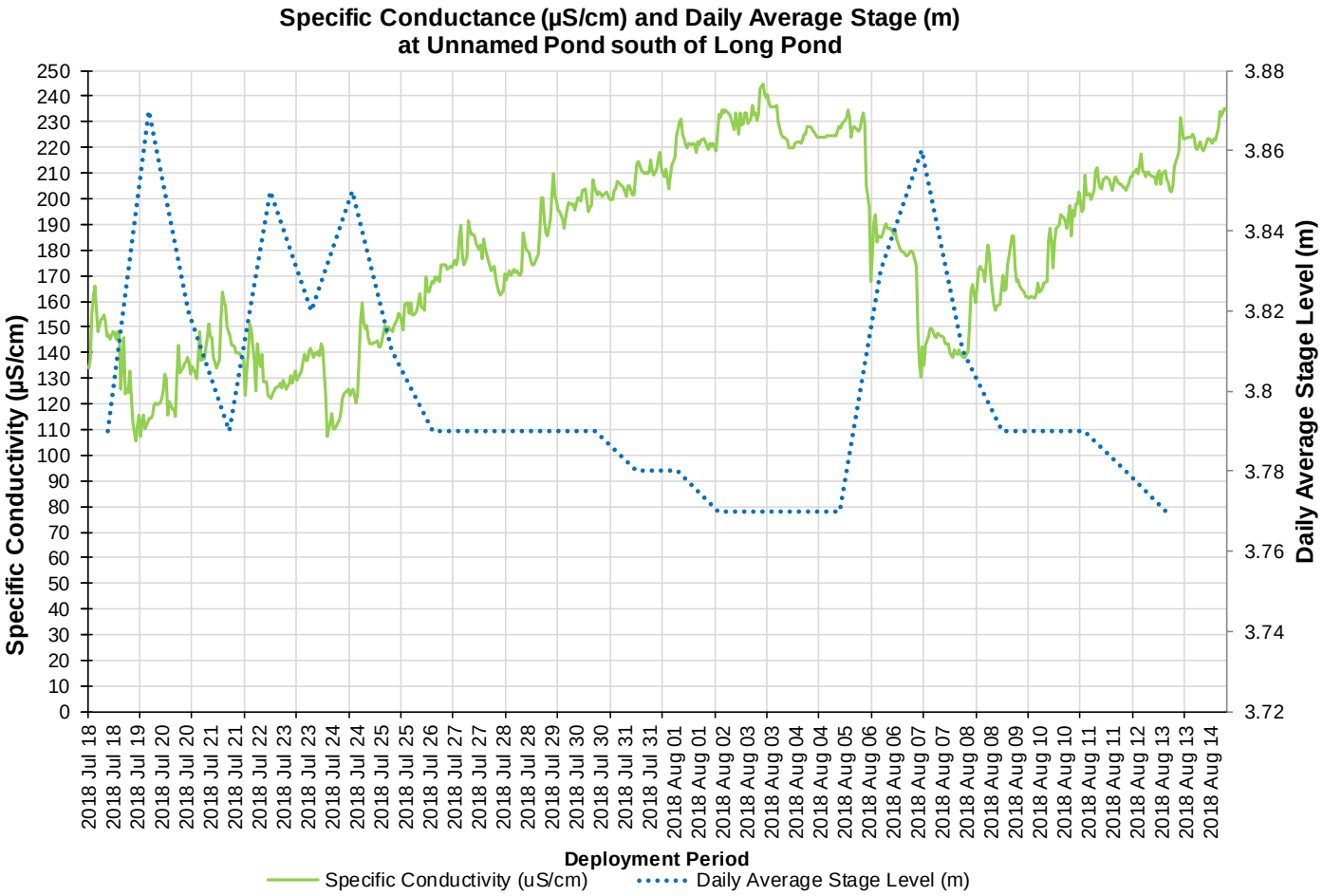

Figure 12: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

Dissolved Oxygen

The water quality instrument directly measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument calculates percent saturation (% Sat) taking into account the water temperature. During this deployment the dissolved oxygen levels where within 8.18mg/L and 9.89mg/L for concentration and 97.9% Sat and 102.3% Sat for percent saturation.

There is a natural diurnal pattern with dissolved oxygen data that represents the oxygen levels throughout the night and day. The significant variations outside of the diurnal pattern are likely a result of fluctuations in water temperature or influences from rainfall/runoff. This can be seen on Figure 13 on July 20th and July 25th as the water temperature peaks on these dates the dissolved oxygen concentration decreases slightly.

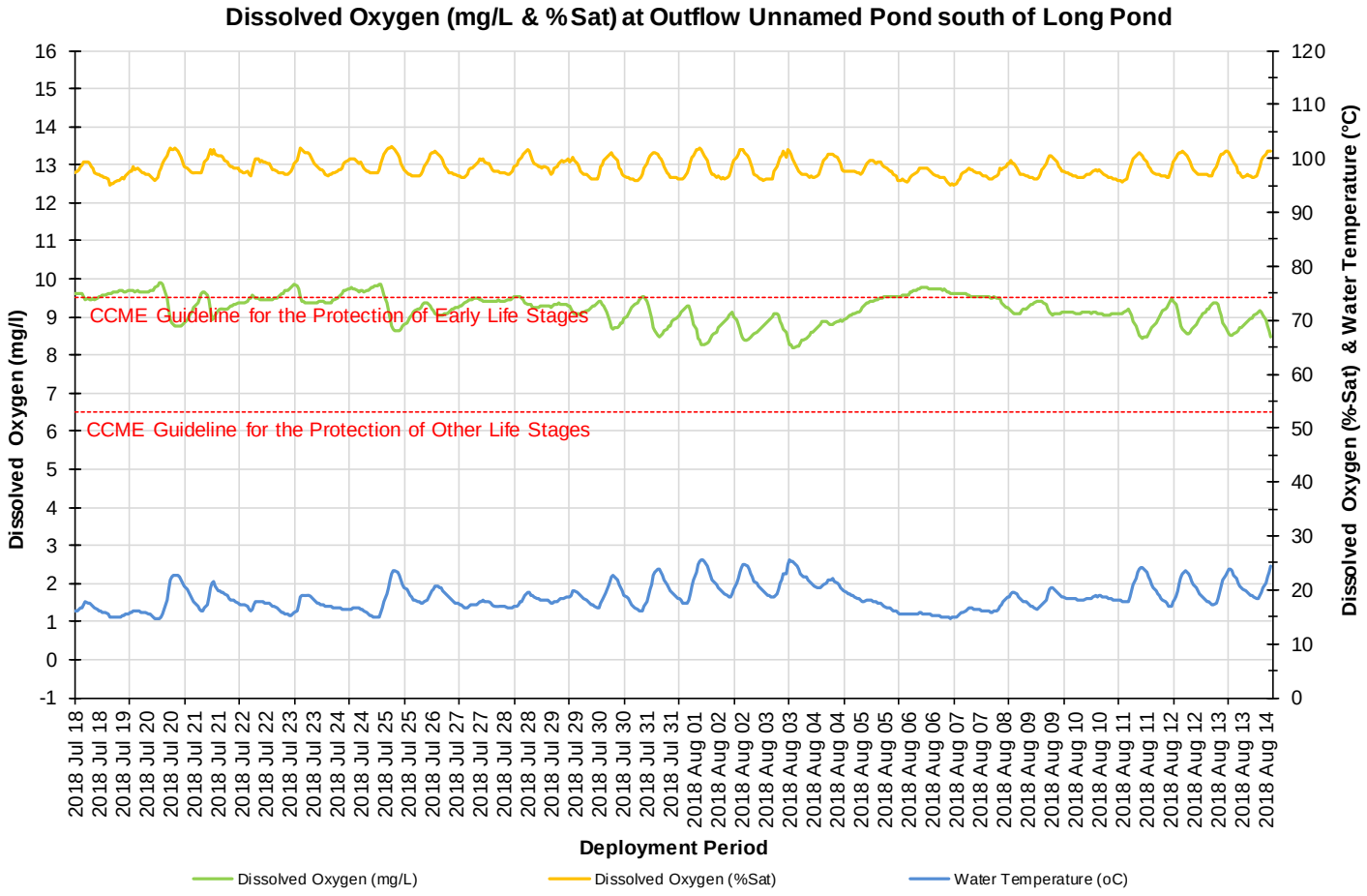

Figure 13: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 0.01 NTU and 7.35 NTU (Figure 14). The deployment data has a median of 1.35 NTU. The median is lower than the previous deployment median of 2.2 NTU.

The turbidity levels during this deployment mirror the stage. 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) that likely contributed to the stage level increases and thus turbidity events occurred.

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.

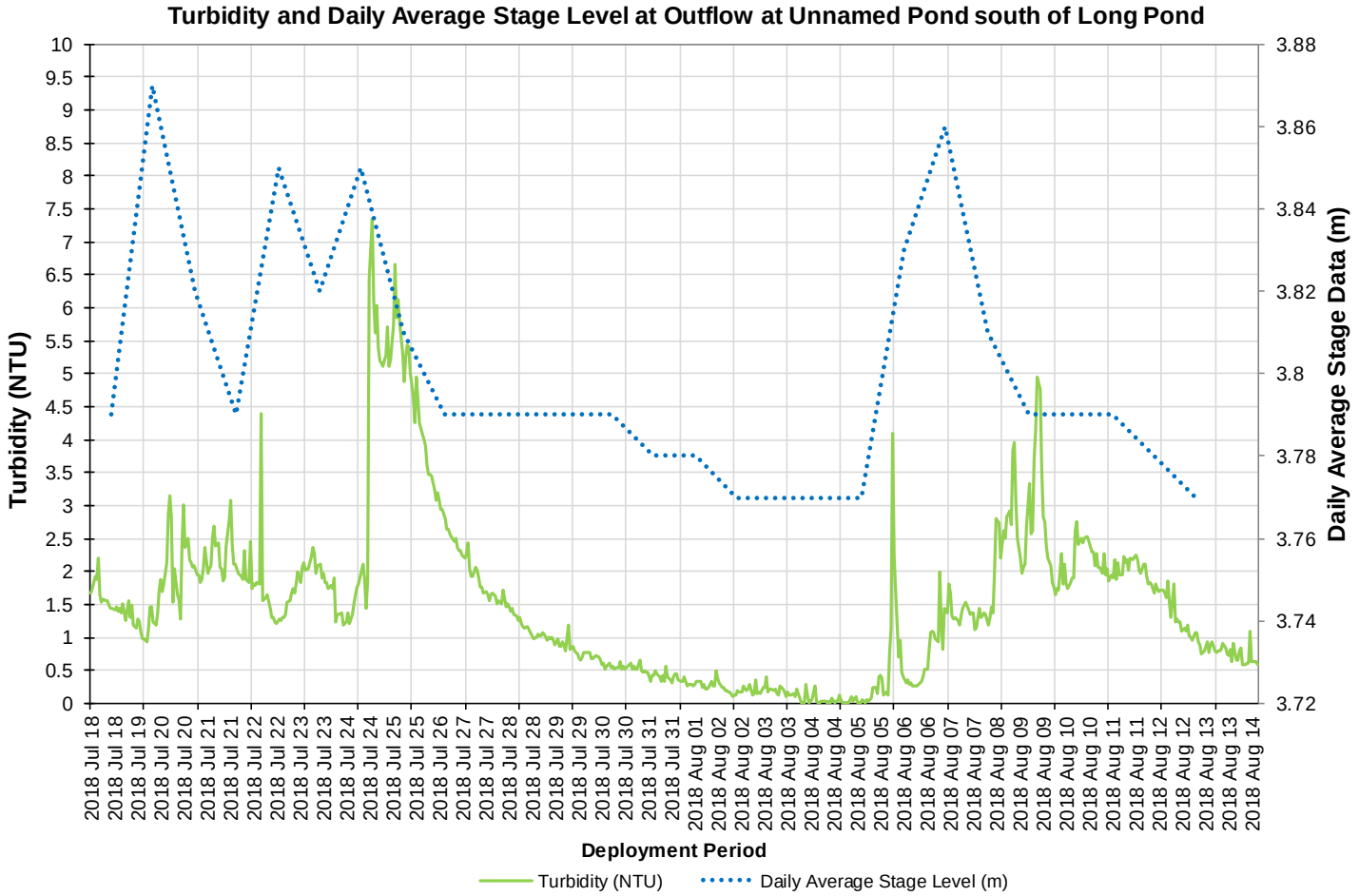

Figure 14: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

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 increases 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.

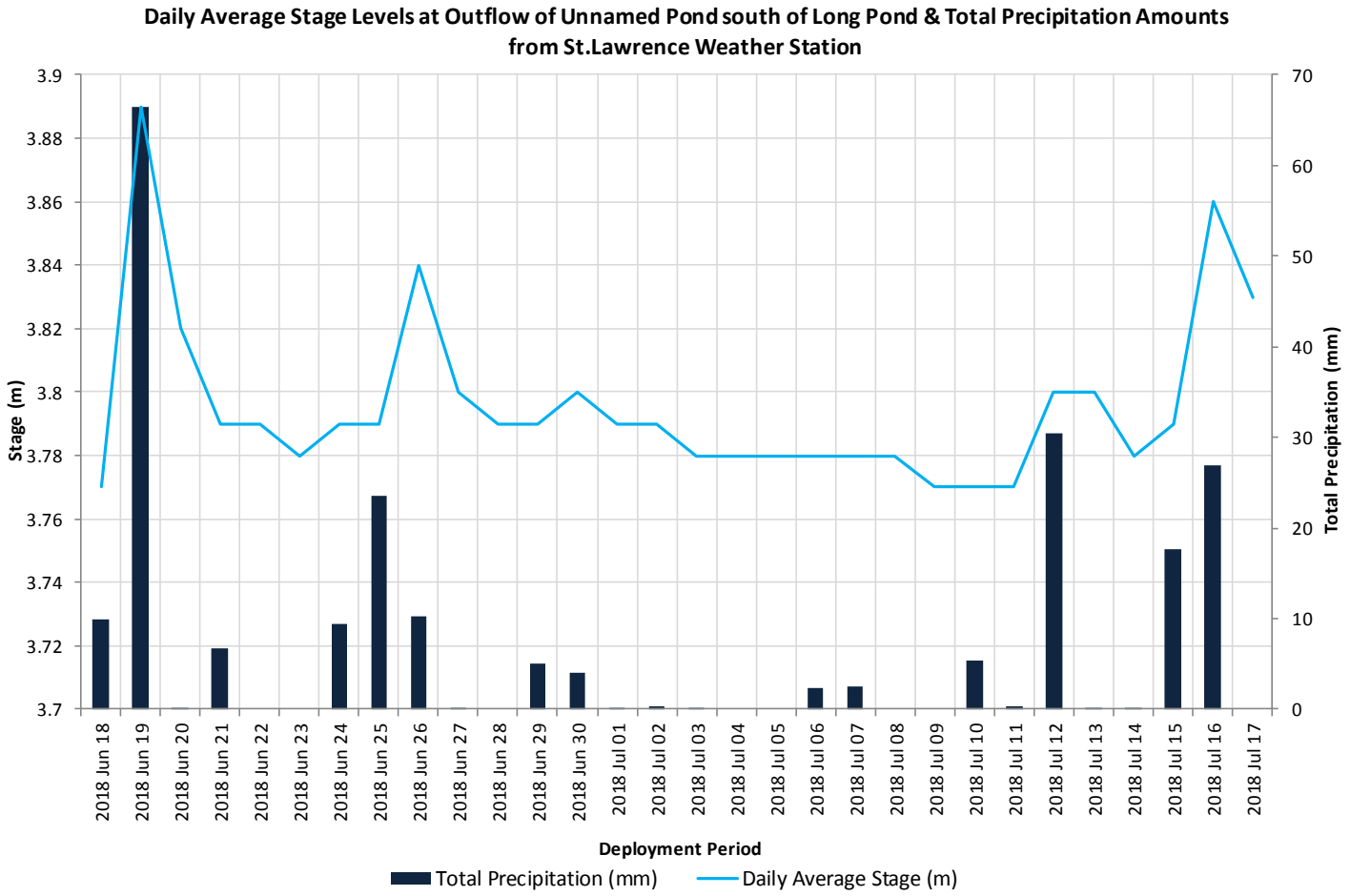

Figure 15: Daily average stage values and daily total precipitation.

Conclusion

As with many shallow brooks and streams, precipitation and runoff events play a significant role in influencing water quality. The Outflow of Unnamed Pond South of Long Pond runs through some undeveloped area that includes natural wetlands and marshlands and skirts along the ongoing construction. 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. 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 108 NTU over the deployment. There was no excessively high turbidity data recorded. This deployment had a turbidity median of 1.34 NTU, which is slightly lower than the previous deployment. At this phase in CFI's development, the majority of construction and earthmoving work on site has been completed. This was likely reflected in the lower turbidity levels recorded at this brook.

Precipitation influences to water quality conditions. Most of these changes are natural quick adjustments in levels before returning 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 its background data range after a water quality event.