Real-Time Water Quality Report

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

Deployment Period
May 15, 2018 to June 18, 2018

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 alongside 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	May 15	Deployment	Excellent	Excellent	Good	Excellent	Poor
	June 18	Removal	Good	Good	Good	Excellent	Poor
Unnamed Pond	May 15	Deployment	Good	Excellent	Good	Excellent	Good
	June 18	Removal	Fair	Excellent	Good	NA	Good

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 that were recorded. Turbidity data ranked ‘Poor’ for comparison data

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. After a performance evaluation of the QA sonde it was determined that the turbidity sensor on the QA sonde needed to be replaced.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond the data ranked as the following; water temperature, pH, specific conductivity, dissolved oxygen and turbidity ranked as ‘Excellent’ to ‘Good’ during deployment. 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 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. DO was unable to be ranked at removal as the DO probe on the field instrument had failed during the deployment.

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 Grebes Nest 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.

Due to a dissolved oxygen probe failure on the instrument deployed at Outflow of Unnamed Pond south of Long Pond, there is no dissolved oxygen data for this report.

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from 5.20°C to 15.58°C during the deployment period (Figure 4). The water temperature graph displays the diurnal variations of temperature throughout deployment. There is a large increase in water temperature on June 7th, 8th and June 9th and 10th this may be a result of the variation in stage level during this time. The water levels flowing into this brook will change with the demand on the sedimentation pond that feeds this brook.

Please note that the daily averaged 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.

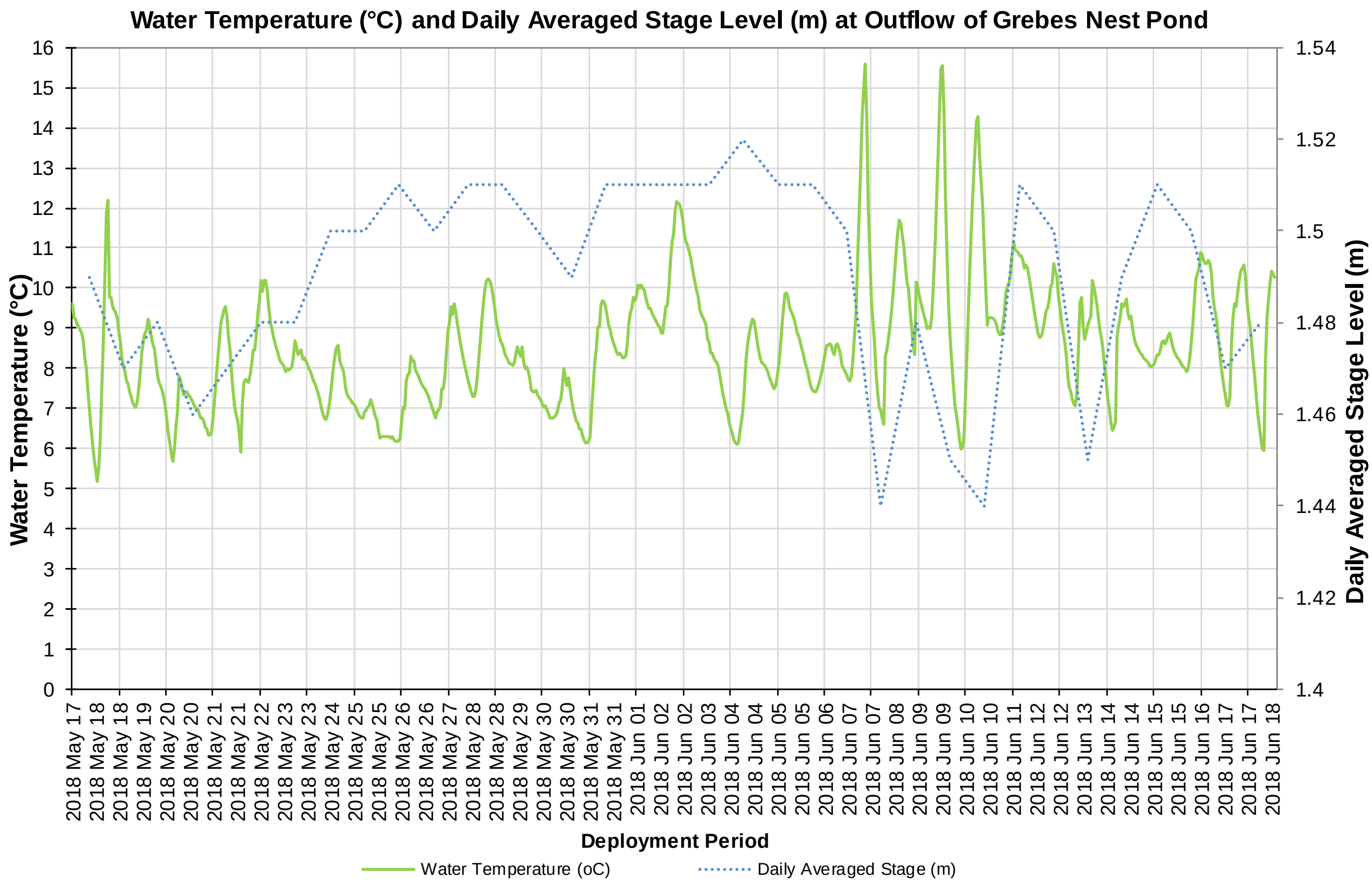

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 6.88 pH units and 7.53 pH units (Figure 5) and are generally consistent. The pH data remained above the minimum Guideline for Protection of Aquatic Life. The Canadian Council of Ministers of the Environment (CCME) guidelines for freshwater aquatic life are a basis by which to compare the pH data within a dataset. 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.

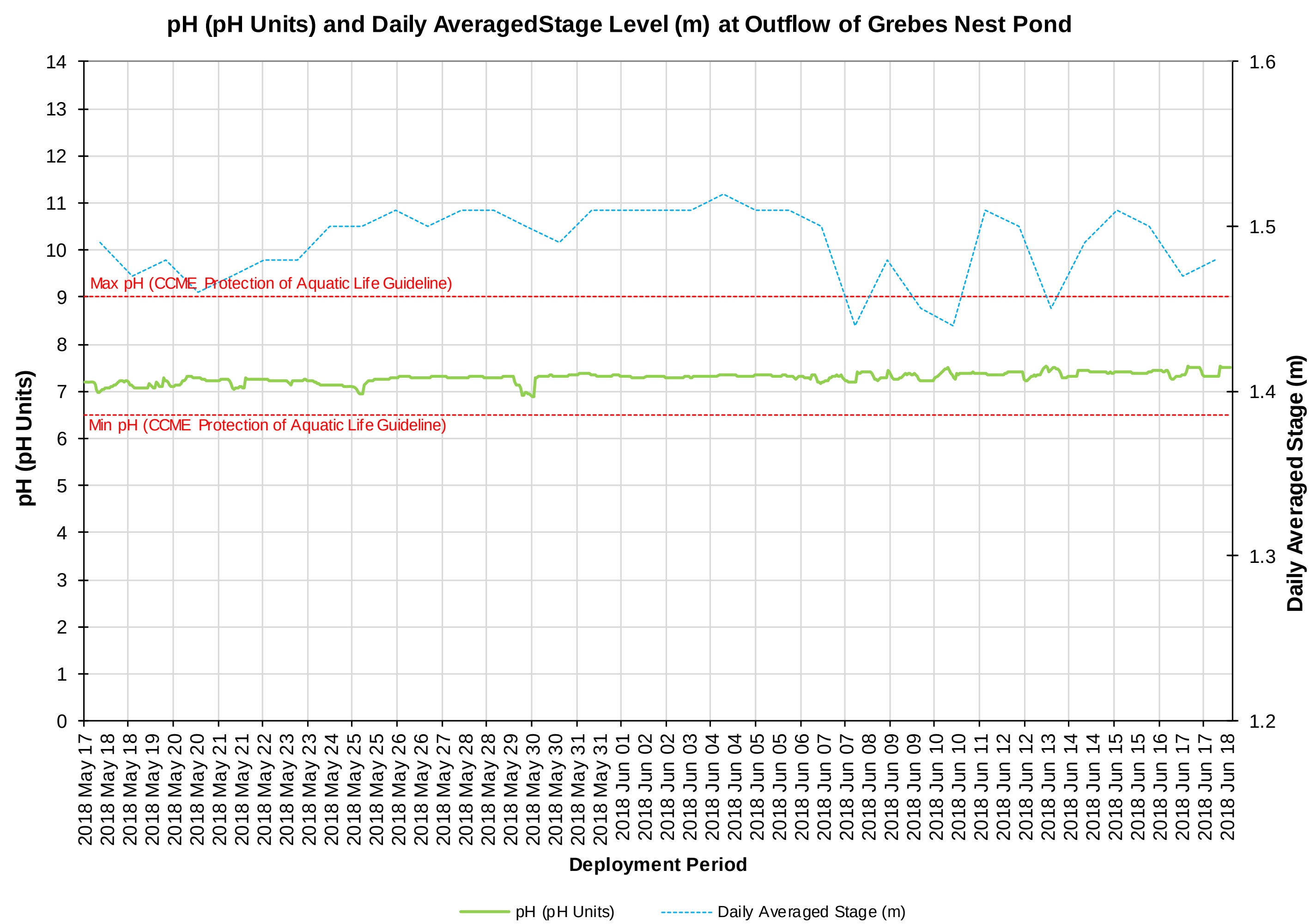

Figure 5: pH (pH units) and stage level (m) values

Specific Conductivity

The conductivity levels were within 112.9.0 µS/cm and 341.5 µS/cm during this deployment period (Figure 6).

During this deployment, the specific conductivity levels responded to high stage levels by decreasing initially at the onset of precipitation; however, shortly after the dip the conductivity levels increased.

Rainfall initially dilutes the brook before the organic and inorganic matter is flushed into the water channel from the surrounding environment. This influx of material increases the conductivity (Figure 9, Precipitation graph). This trend is evident in Figure 6 for several occurrences but most noticeably on June 10th and 11th, 2018.

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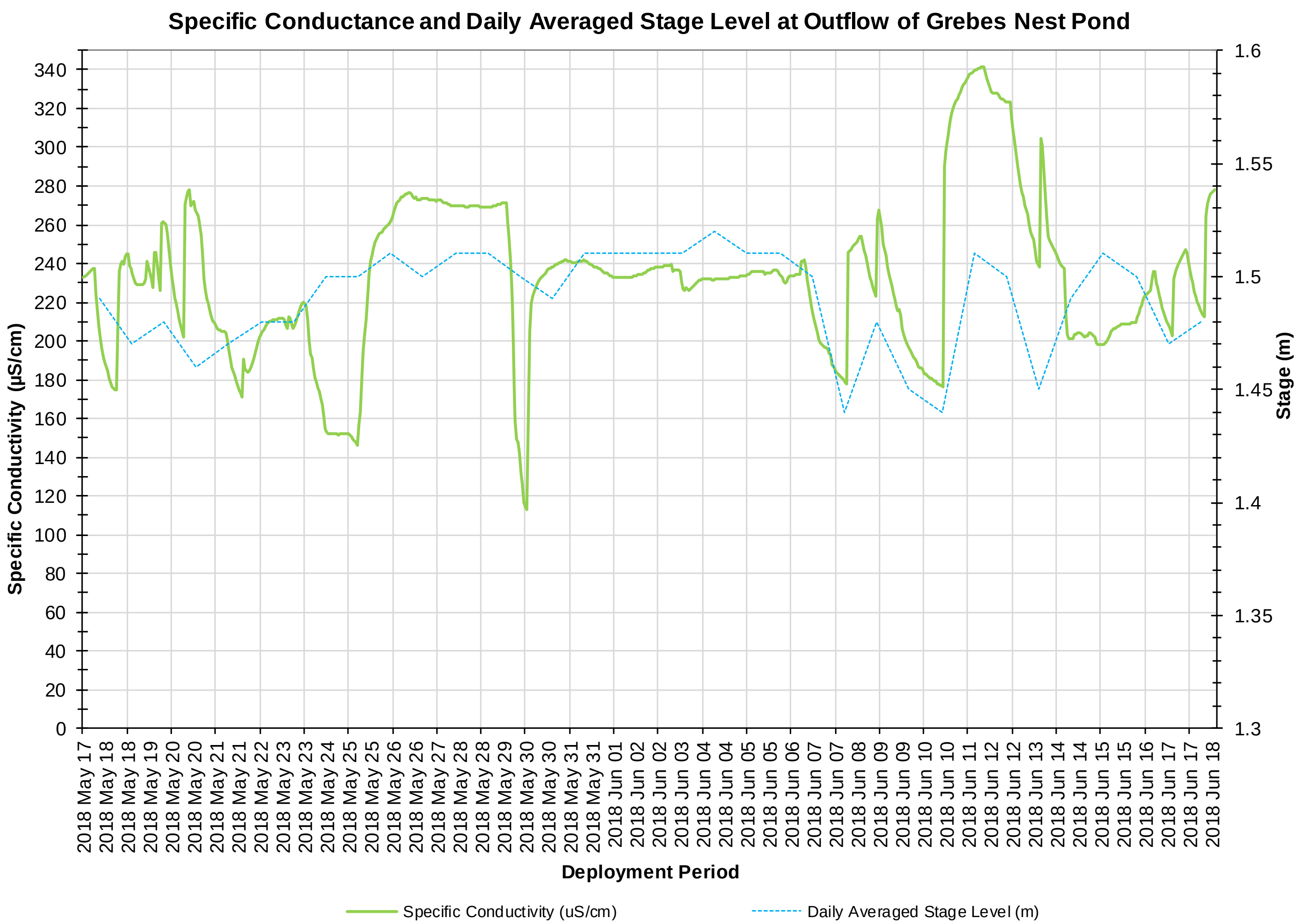

Figure 6: Specific conductivity (µS/cm) and stage (m) values

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 9.56 mg/L to a maximum of 11.90 mg/L. The percent saturation levels for dissolved oxygen ranged within 85.0% Saturation to 114.8% Saturation (Figure 7).

Dissolved oxygen was generally consistent during the deployment. As noted on the water temperature graph, there was a large increase in percent saturation on June 7th, 9th and 10th, 2018.

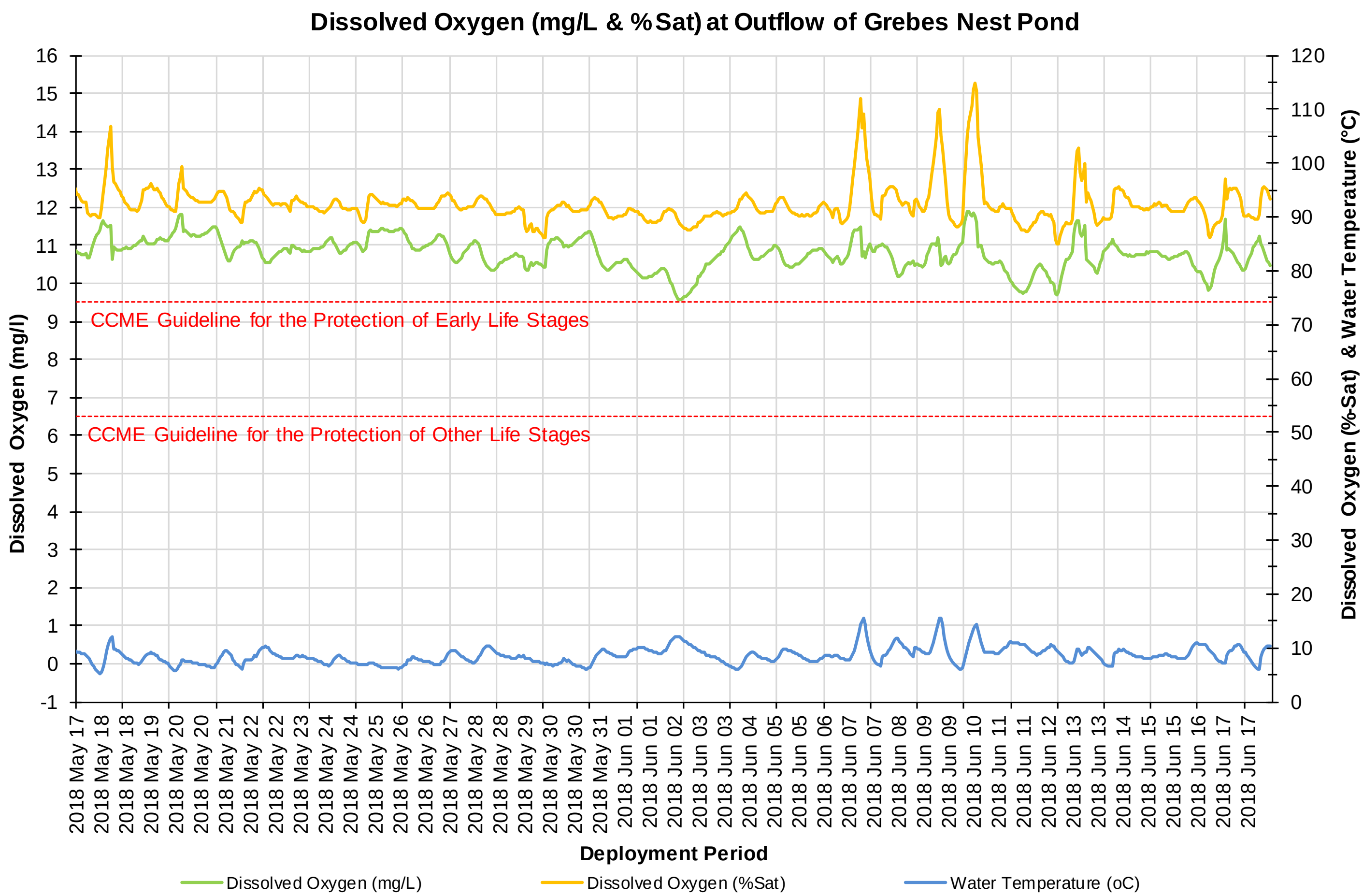

Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 8.8 NTU and 252.0 NTU (Figure 8). The deployment data has a median of 49 NTU which is higher than the previous deployment median of 11.7 NTU.

During rainfall or runoff, higher turbidity readings are expected. 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.

The higher turbidity values in May did correlate with precipitation events (Figure 9). However, Grebes Nest Brook is fed upstream by a sedimentation pond, and it is likely that an increase in flow (due to the rainfall) from the sedimentation pond caused the turbidity increases.

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.

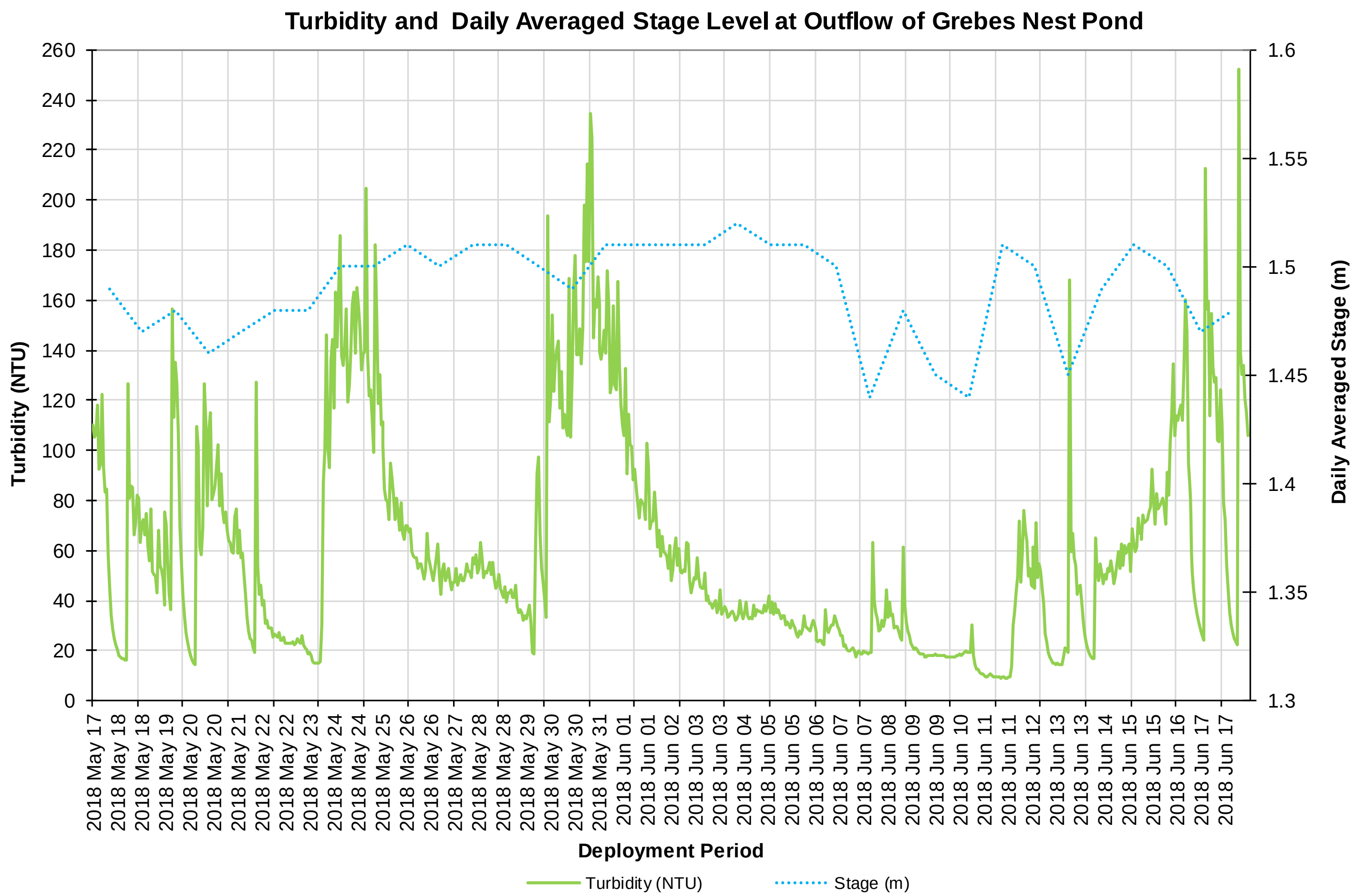

Figure 8: Turbidity (NTU) values.

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 important to display as it 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 water levels to rise significantly.

The larger peaks in stage correspond with substantial rainfall events as noted on 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 31.4 mm on May 23rd, 2018.

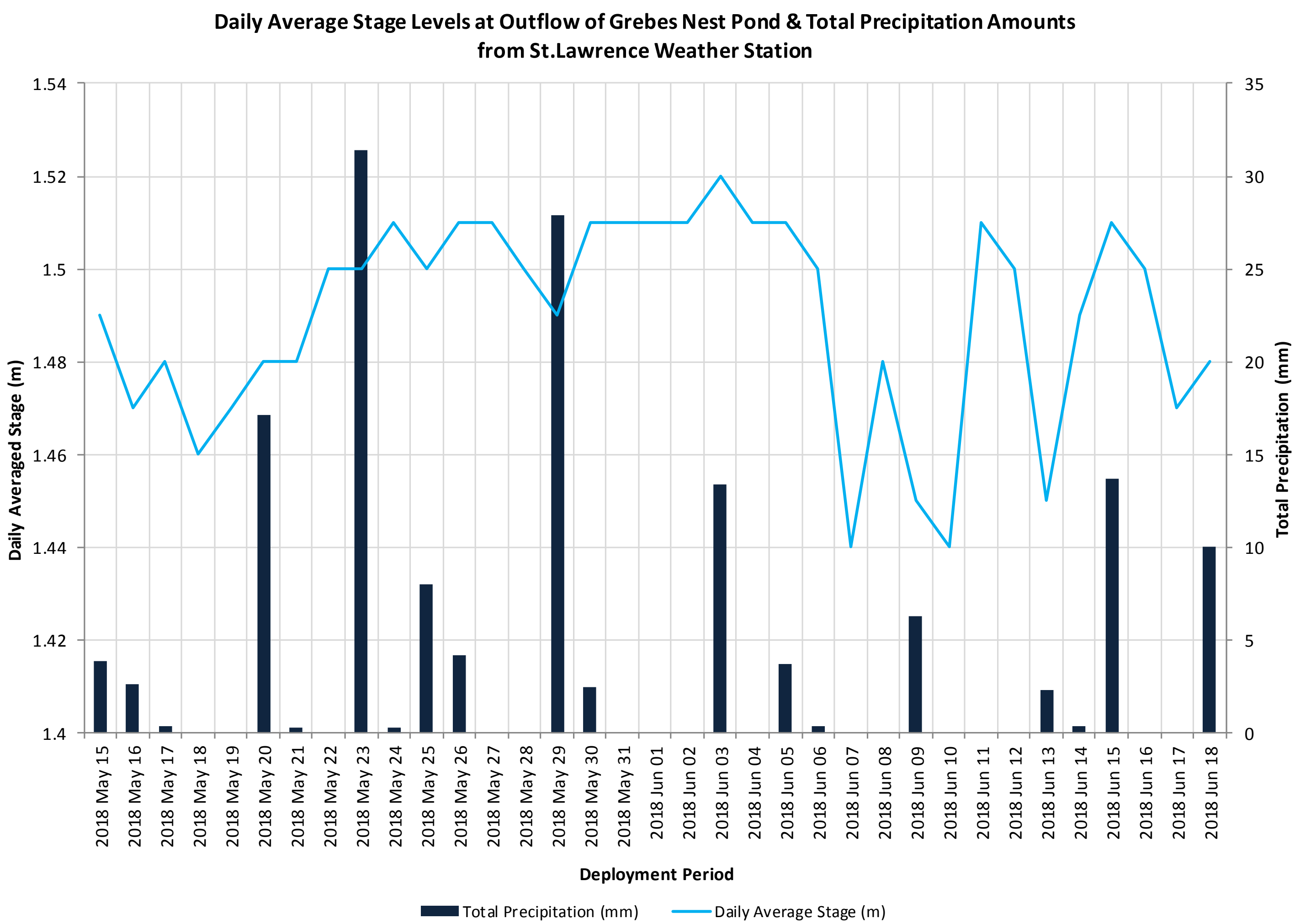

Figure 9: Daily average stage values and daily total precipitation.

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 construction 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. A new 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 combined 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 changes 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 2.96°C to 18.7°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 slightly 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.

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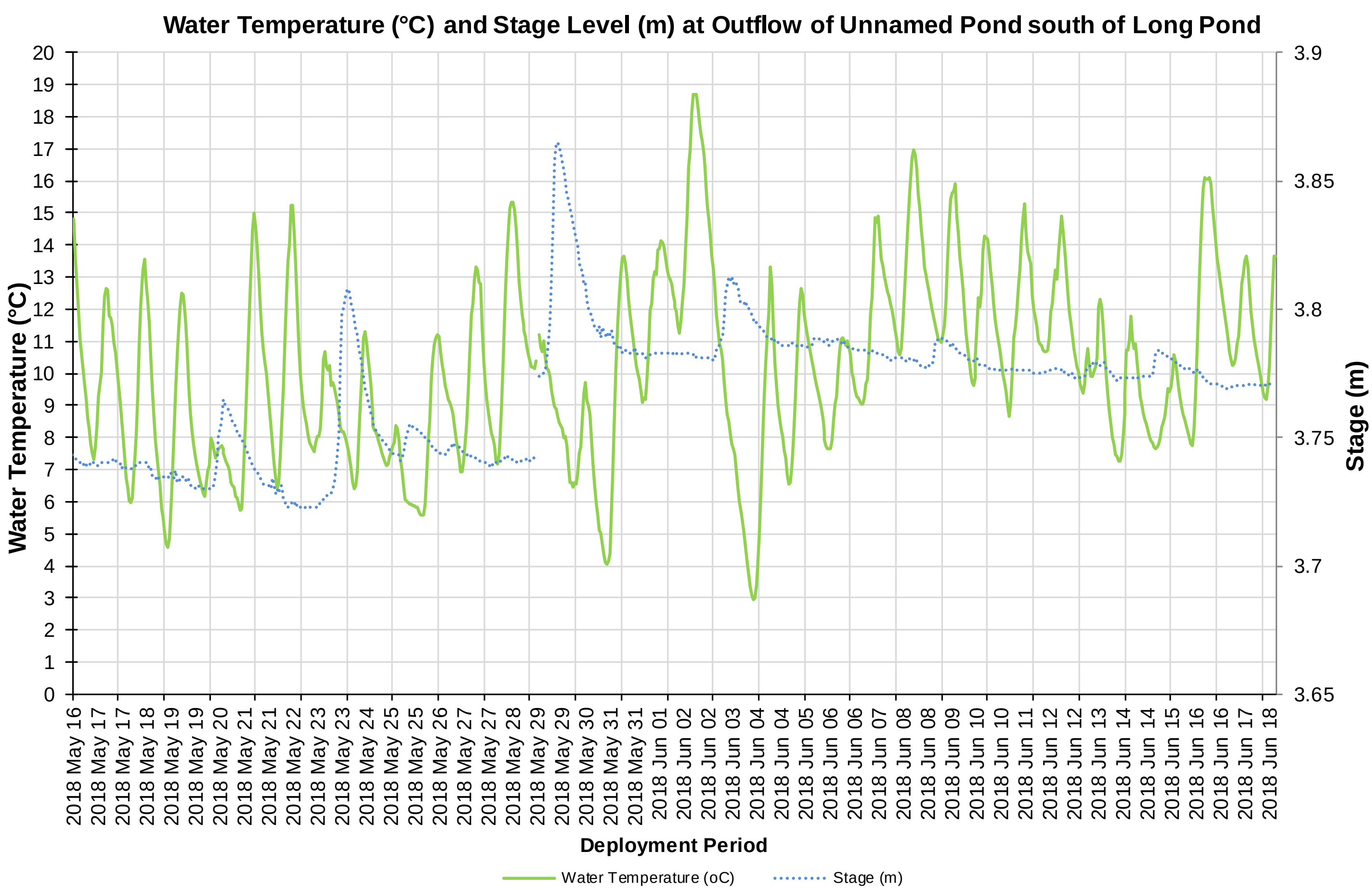

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.16 pH units and 7.87 pH units (Figure 11). This is within the range of the CCME Guidelines for the protection of aquatic life.

Natural processes such as rainfall and snow melt will alter the pH of a brook for a period of time. There is a dip in pH recorded May 23rd and May 29th, 2018. The stage data indicates a slight increase on those same days and was likely a result of rainfall.

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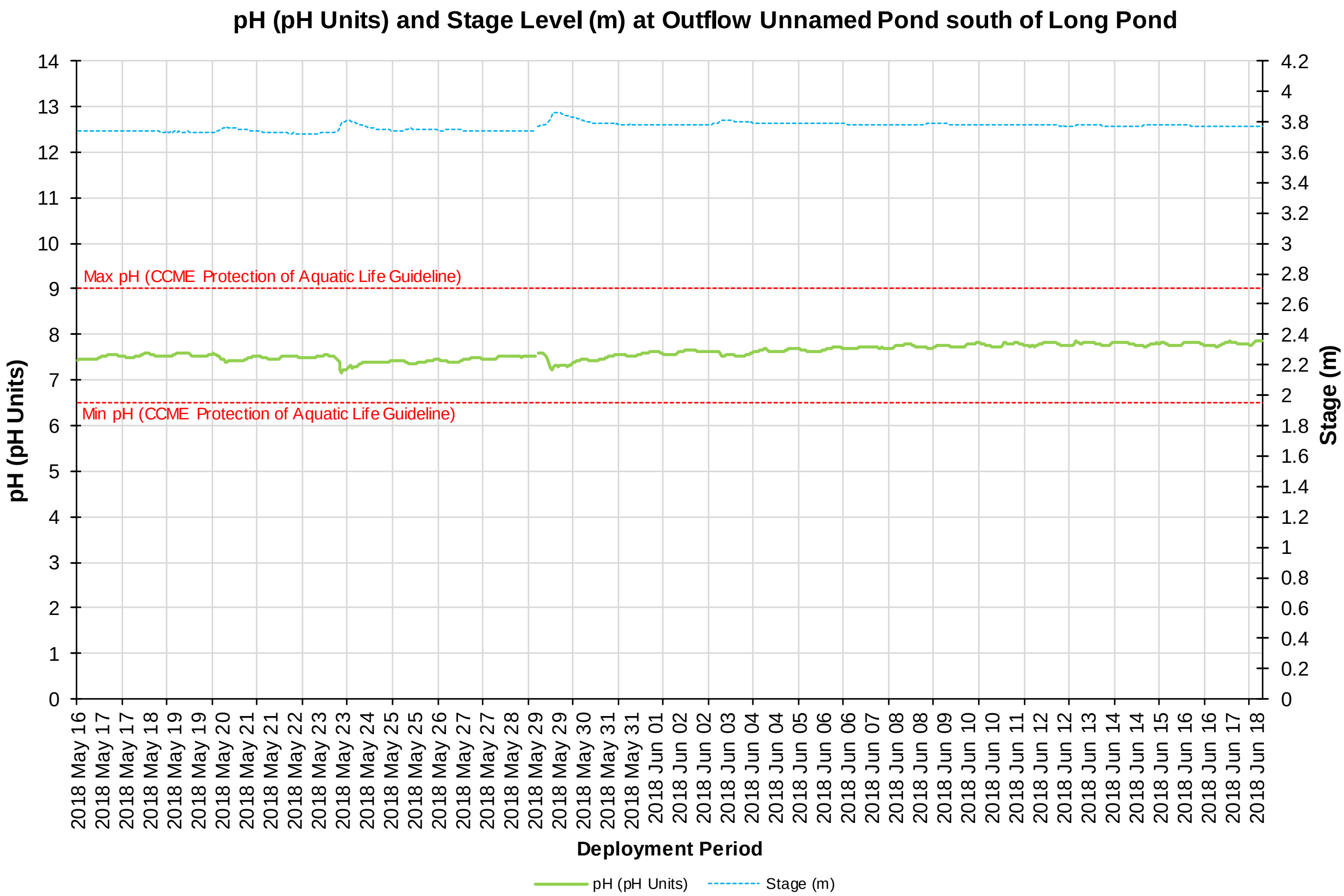

Figure 11: pH (pH units) and stage level (m) values

Specific Conductivity

The conductivity levels ranged between 127.5 µS/cm and 228.4 µS/cm during deployment (Figure 12). This deployment period had a median of 191.6µS/cm, which was close to the median of the previous deployment of 192.5 µS/cm.

The conductivity generally increased as the deployment continued (Figure 12). During the high stage events, conductivity decreased for a short period of time before returning to higher levels.

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.

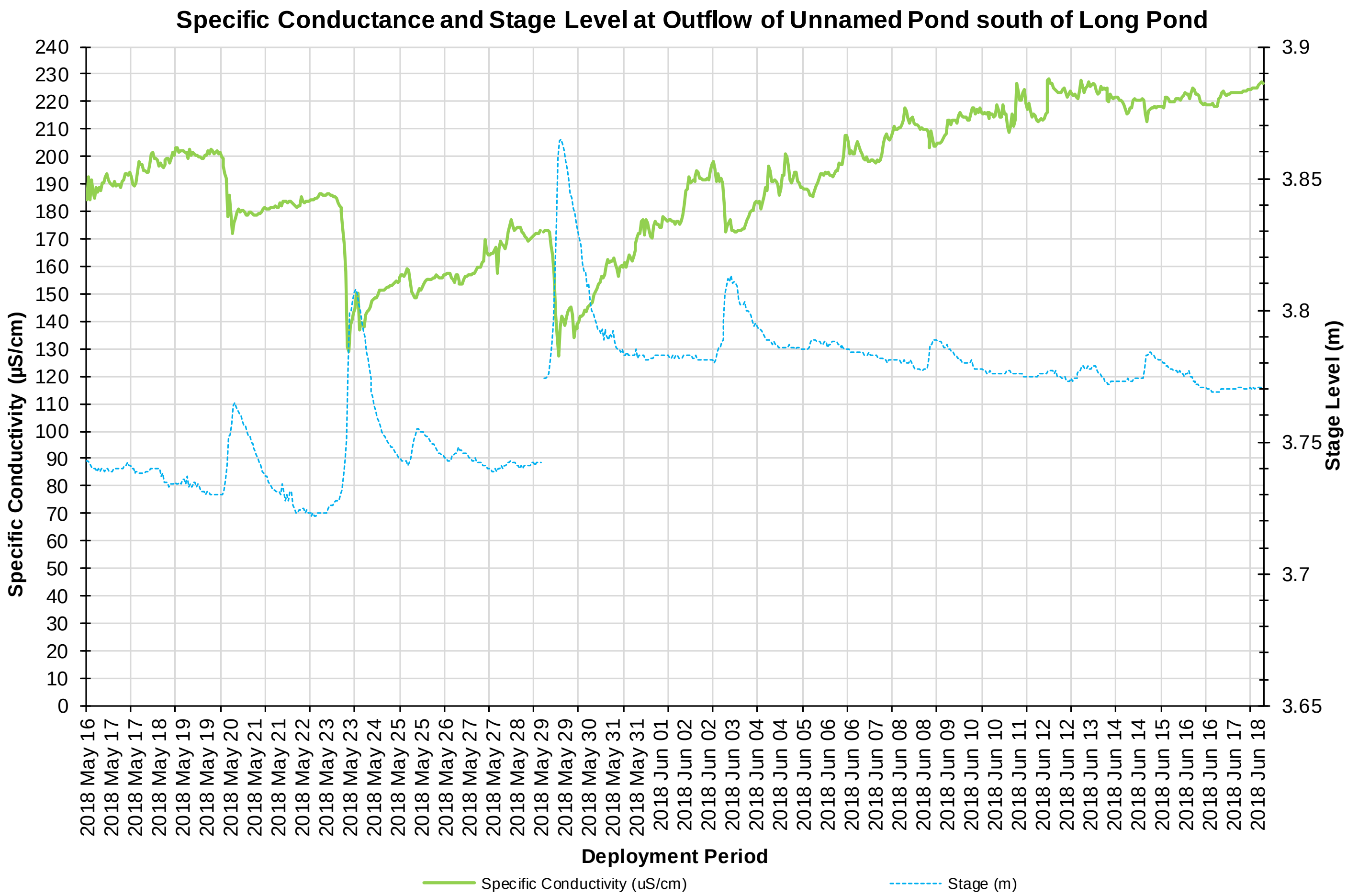

Figure 12: Specific conductivity (µS/cm), and stage (m) values

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.

Due to a dissolved oxygen sensor failure at the start of this deployment, dissolved oxygen data is unavailable for this report.

Turbidity

Turbidity levels during the deployment ranged within 3.7 NTU and 21.7 NTU (Figure 13). The deployment data has a median of 9.8 NTU. This median is lower than the previous deployment median of 15.2 NTU.

There are several rainfall events during the deployment (Figure 14) which likely contributed to the turbidity spikes recorded.

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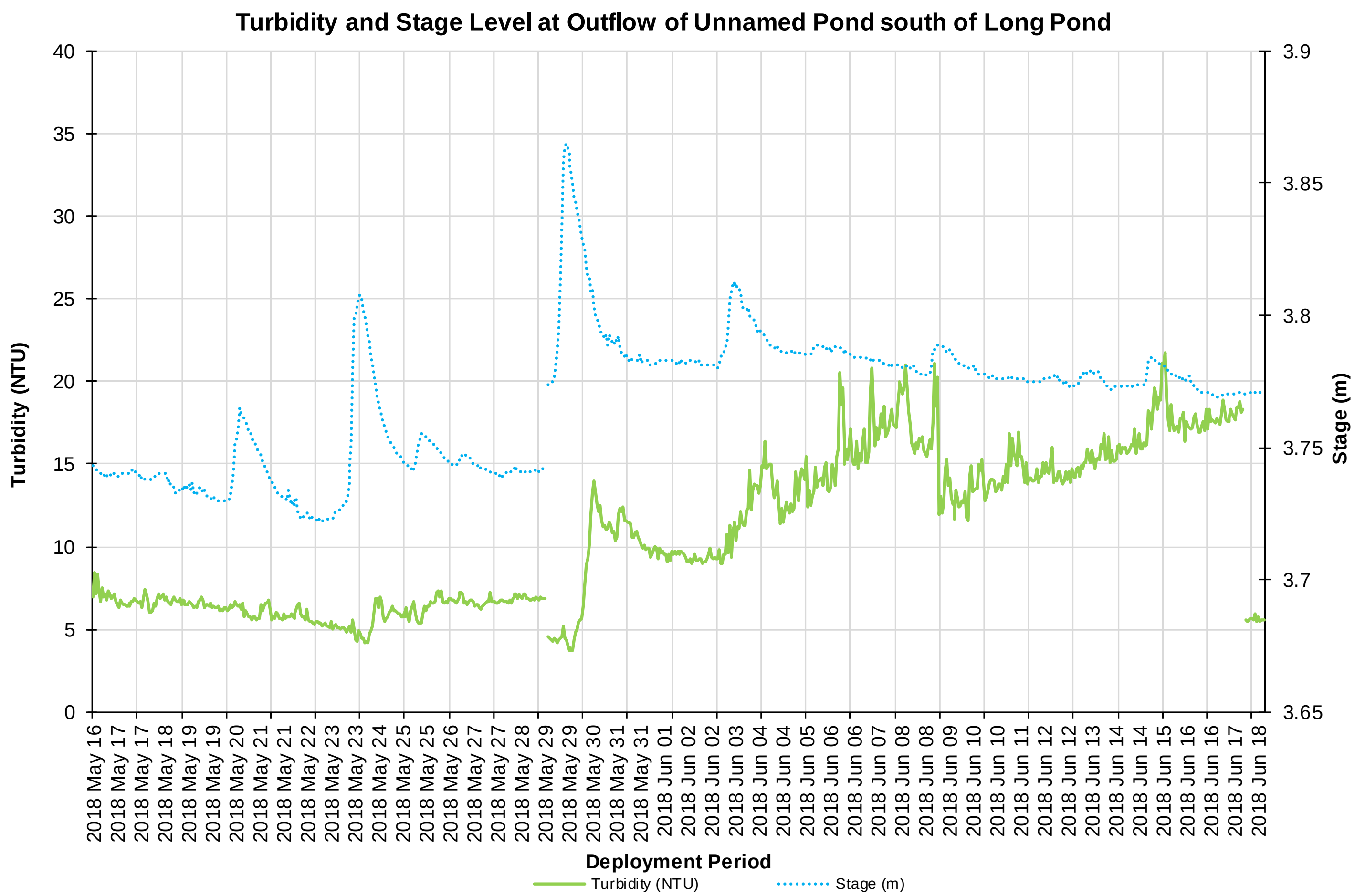

Figure 13: Turbidity (NTU) and stage level (m) values.

Stage and 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 important to display as it 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 14) and during any surrounding snow or ice melt. However, direct snowfall will not cause water levels to rise significantly.

During the deployment period, the stage values ranged from 3.72m to 3.87m. The larger peaks in stage correspond with substantial rainfall events as noted on Figure 14. 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 31.4mm on May 23rd, 2018.

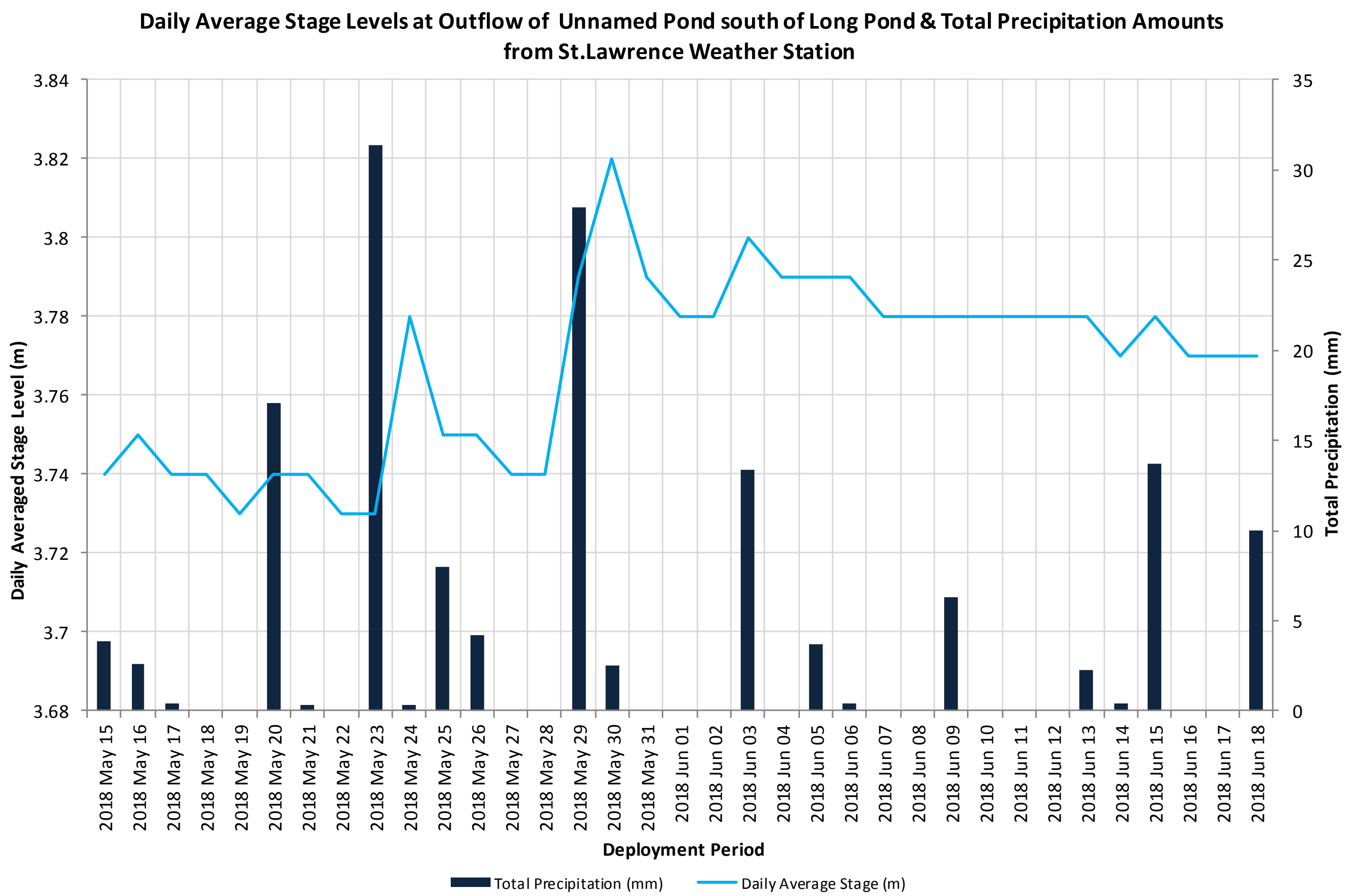

Figure 14: Daily average stage values and daily total precipitation.

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, 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 reasonably consistent for this brook; any significant change in pH data corresponded with a rise in the stage level.

Turbidity levels remained below 30 NTU over the deployment. There were no especially high turbidity spikes recorded, however, turbidity values were expected to drop to a lower level. This month's deployment had a median of 9.8 NTU which was 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.