



Real-Time Water Quality Report

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

Deployment Period
July 11, 2019 to August 20, 2019



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. These brooks are within the mining site of Canada Fluorspar (NL) Inc, St. Lawrence, Newfoundland & Labrador (Figure 1).



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" W55° 27' 45.6"**.

The station hut was placed on the north bank looking downstream approximately 5 metres from the stream. This station provides 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, allowing appropriate mitigation measures to be implemented in a timely manner and thus reducing any adverse effect on the downstream systems.



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

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 provides near real-time water quality and quantity data to ensure emerging issues associated with the TMF are detected, allowing appropriate mitigation measures to be implemented in a timely manner and 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 (Figure 3). The stream originates 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. At the deployment location, 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" W55° 26' 37.5"**. The station hut was placed on the right bank looking downstream approximately 8 meters from the stream (Figure 3).



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. Leona Hyde, 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 transmission 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 Station's 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: 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 11	Deployment	Good	Fair	Good	Good	Poor
	Aug 20	Removal	Marginal	Excellent	Good	Excellent	Marginal
Unnamed Pond	July 11	Deployment	Marginal	Excellent	Good	Excellent	Poor
	Aug 20	Removal	Good	Excellent	Good	Excellent	Excellent

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, specific conductivity and dissolved oxygen data ranked 'Good' while pH and Turbidity ranked 'Fair' and 'Poor' respectfully against the QA sonde data. 'Poor' rankings may indicate that the placement of the QAQC sonde during deployment may not have been as comparable to the Field sonde as assumed.

During removal of the instrument, the rankings for pH, dissolved oxygen and turbidity data were 'Excellent' or 'Good'. Water temperature and turbidity ranked 'Marginal' against the QA data. The marginal rating for temperature was that the sonde was not left submersed long enough to regulate temperature; the turbidity rating was caused by the field sonde experiencing sedimentation hence the higher number.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond, the pH, specific conductivity, dissolved oxygen, Turbidity data ranked 'Excellent' while water temperature and ranked 'Fair' respectfully against the QA sonde data.

At the end of the deployment, the data ranked 'Excellent' or 'Good' for all parameters.

Concerns or Issues during the Deployment Period

Outflow to Grebes Nest Pond Water Quality sonde was removed on July 12th and was reinstalled on the 15th due to low water levels. The station experienced spotty transmissions from August 4-15th due to hardware issues.

Outflow to Grebes Nest Pond station is fed via Grebes Nest Pit. The lack of consistent flow resulted in significant stage level fluctuations across the deployment.

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 9.86°C to 22.58°C during the deployment period (Figure 4). The average water temperature for the deployment is 13.38°C.

Outflow of Grebes Nest Pond station is fed via Grebes Nest Pit. It does not have consistent flow, thus the stage data can fluctuate significantly across a deployment. Stage fluctuations can influence water temperature as indicated in Figure 4.

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.

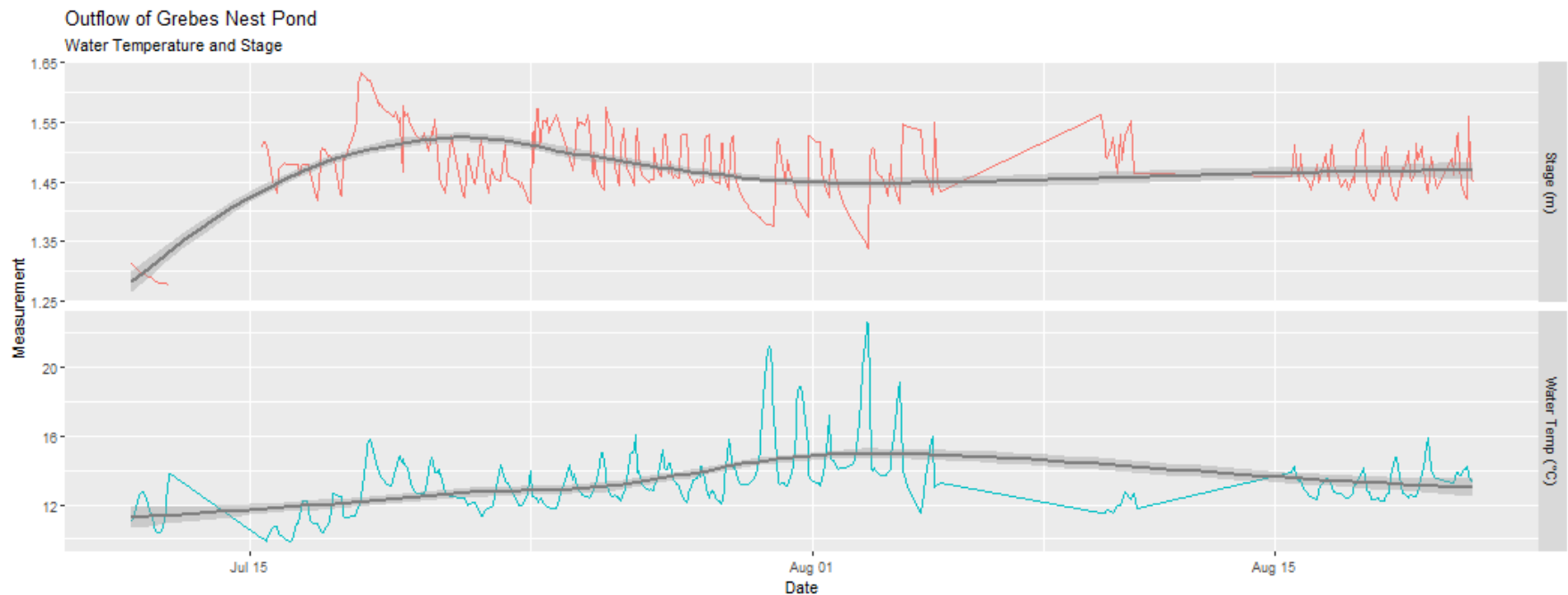


Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 6.65 pH units and 7.82 pH units with a median of 7.23 pH units.

The pH data remained within the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life for the duration of the deployment. This pH range less variable than those recorded in the previous deployments. Variations in measurement are a result of the dewatering effluent on the brook. Every brook is different with its own natural background range. It is not uncommon for Newfoundland and Labrador waters to be below or within the CCME pH guidelines.

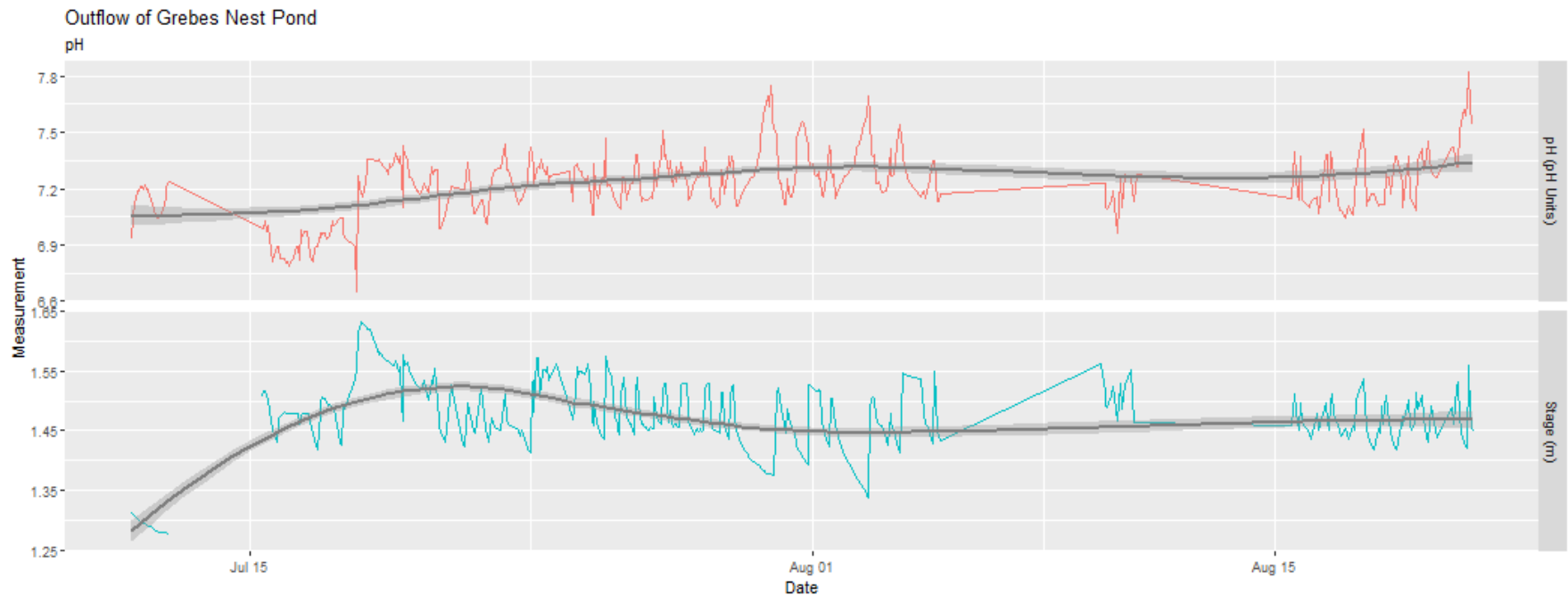


Figure 5: pH (pH units) values

Specific Conductivity

The conductivity levels were within 199.8 $\mu\text{S}/\text{cm}$ and 537.9 $\mu\text{S}/\text{cm}$ during this deployment period (Figure 6). The specific conductivity probe measured the diluted salts and inorganic materials present in the brook. The conductivity in a brook can be diluted and decreased by rainfall or increased by rainfall if there is surface runoff into the brook.

Across the deployment period, the conductivity in the brook fluctuated with the changes to stage level. During stage increases, the conductivity levels responded by decreasing as the water was diluted. This trend was evident in July 18th.

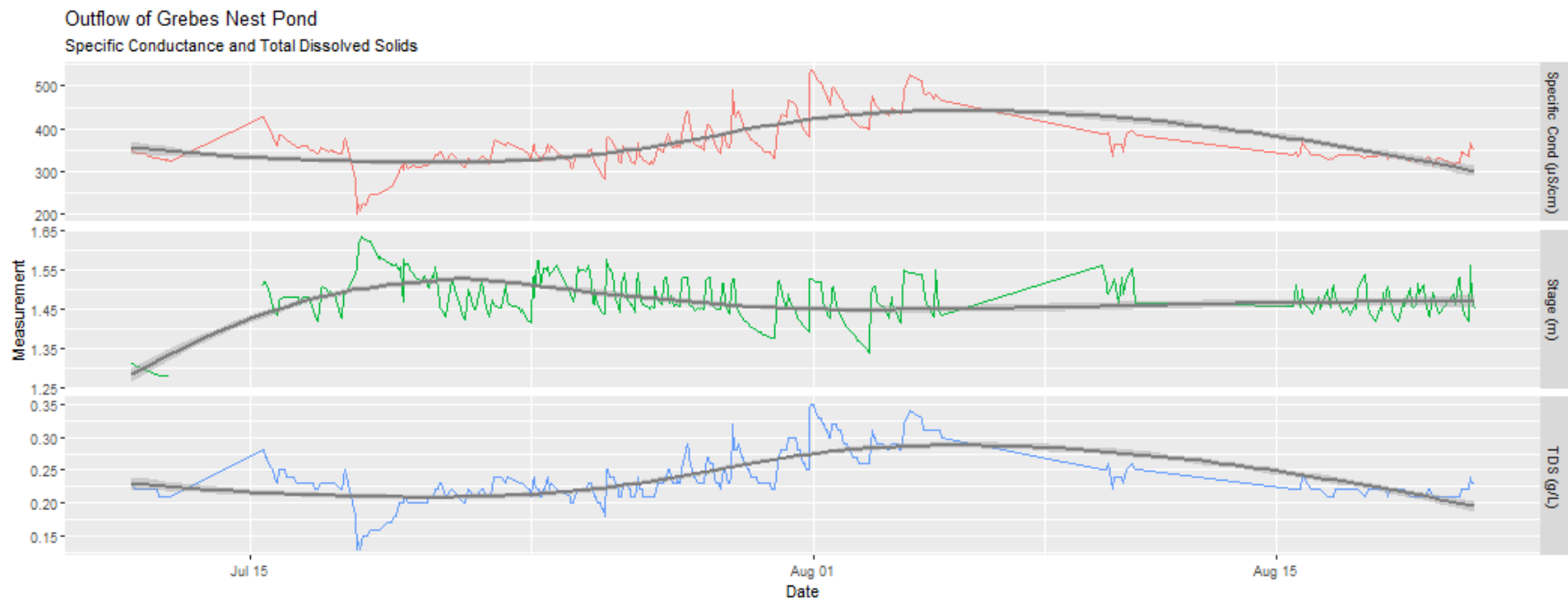


Figure 6: Specific conductivity ($\mu\text{S}/\text{cm}$) values

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 7.36 mg/L to a maximum of 11.07 mg/L. The percent saturation levels for dissolved oxygen ranged within 70.9% Saturation to 116.3% Saturation (Figure 7).

Values remained above CCME's minimum Guideline for the Protection of Other Life Stages, while the majority of data remained below the minimum Guideline for the Protection of Early Life Stages.

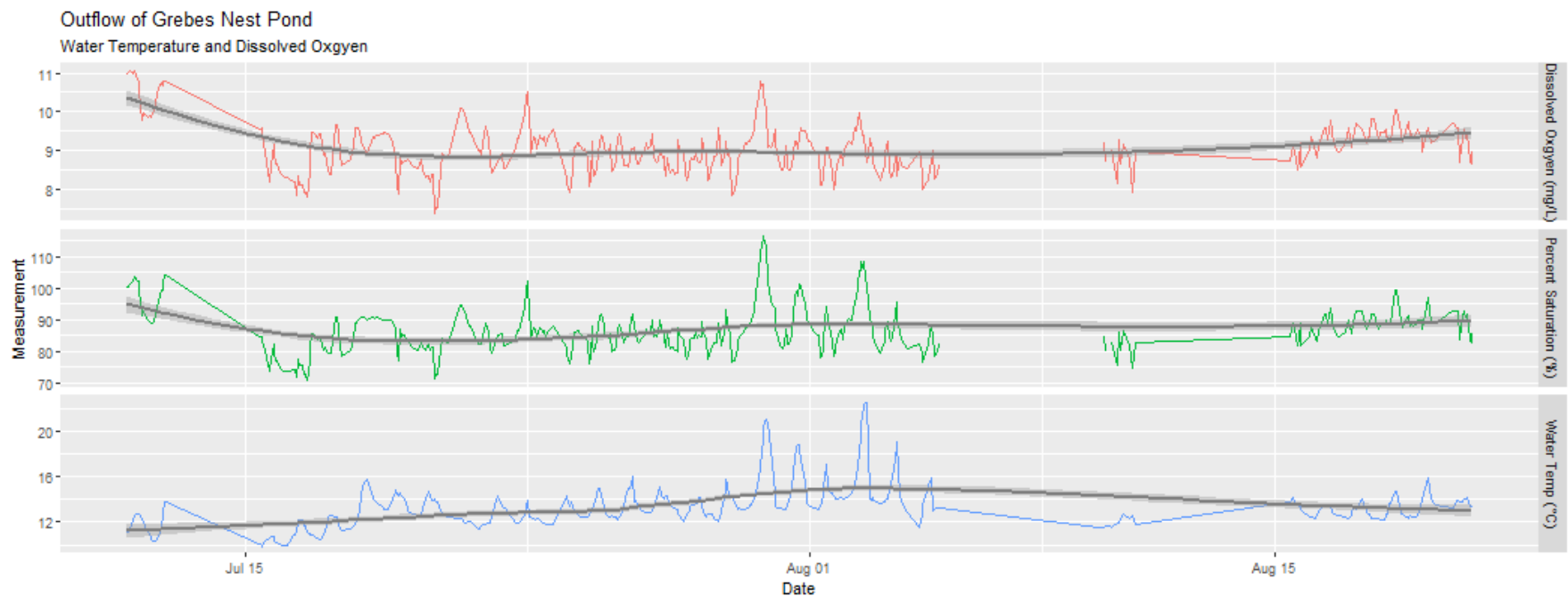


Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 0 NTU and 2901.4 NTU (Figure 8). The deployment data had a median of 150.2 NTU. On July 11th, water was not available to pump into the stream from the pit, resulting in stagnant water and sediment accumulating on the instrument. Higher turbidity was observed when the pump was reactivated and sediment was suspended due to increased flow.

Outflow to Grebes Nest Brook is fed upstream by an open pit and is heavily impacted by the material at the pit. The real-time station has significant fluctuations in turbidity as the sediment is resuspended into the water column.

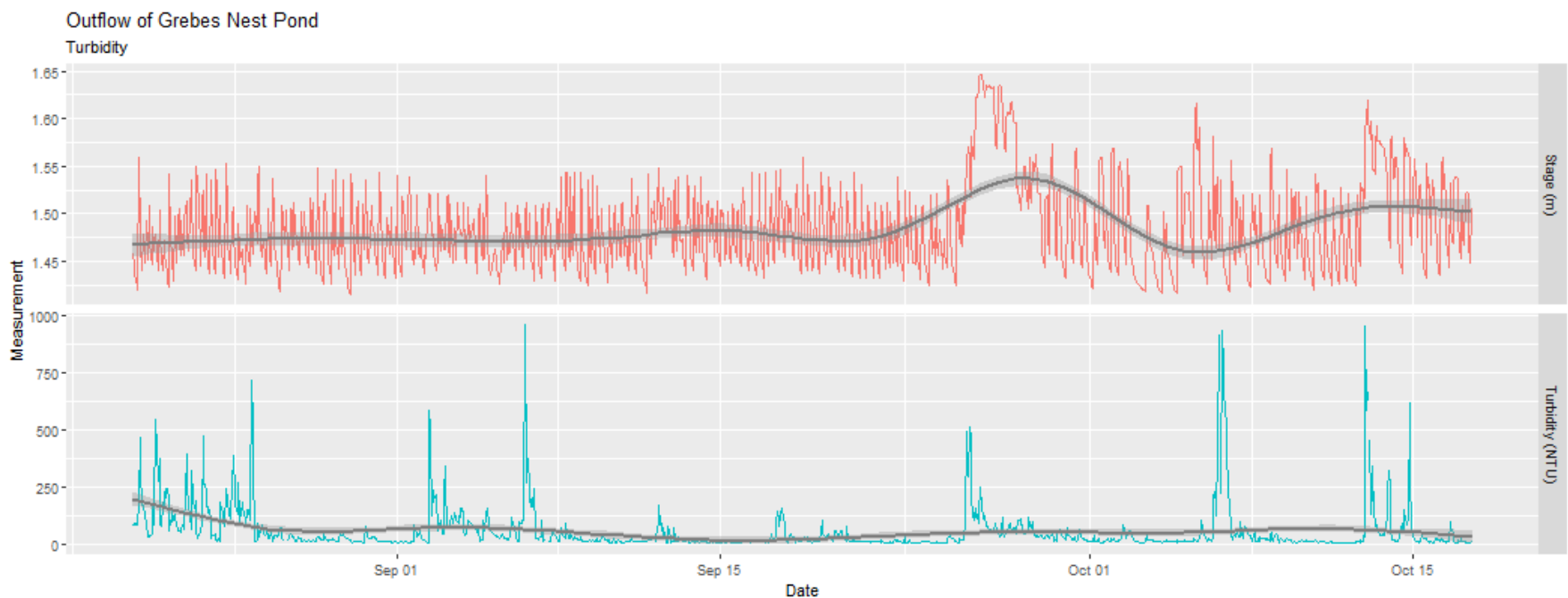


Figure 8: Turbidity (NTU) values.

Total Precipitation & Stage Level

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

Although this brook is fed intermittently via Grebes Nest Pit, rainfall is very influential as it assists in supplementing the water supply. Large peaks in stage correspond with the total precipitation events listed in Figure 15. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and maximum of 293.7 mm on July 18th.

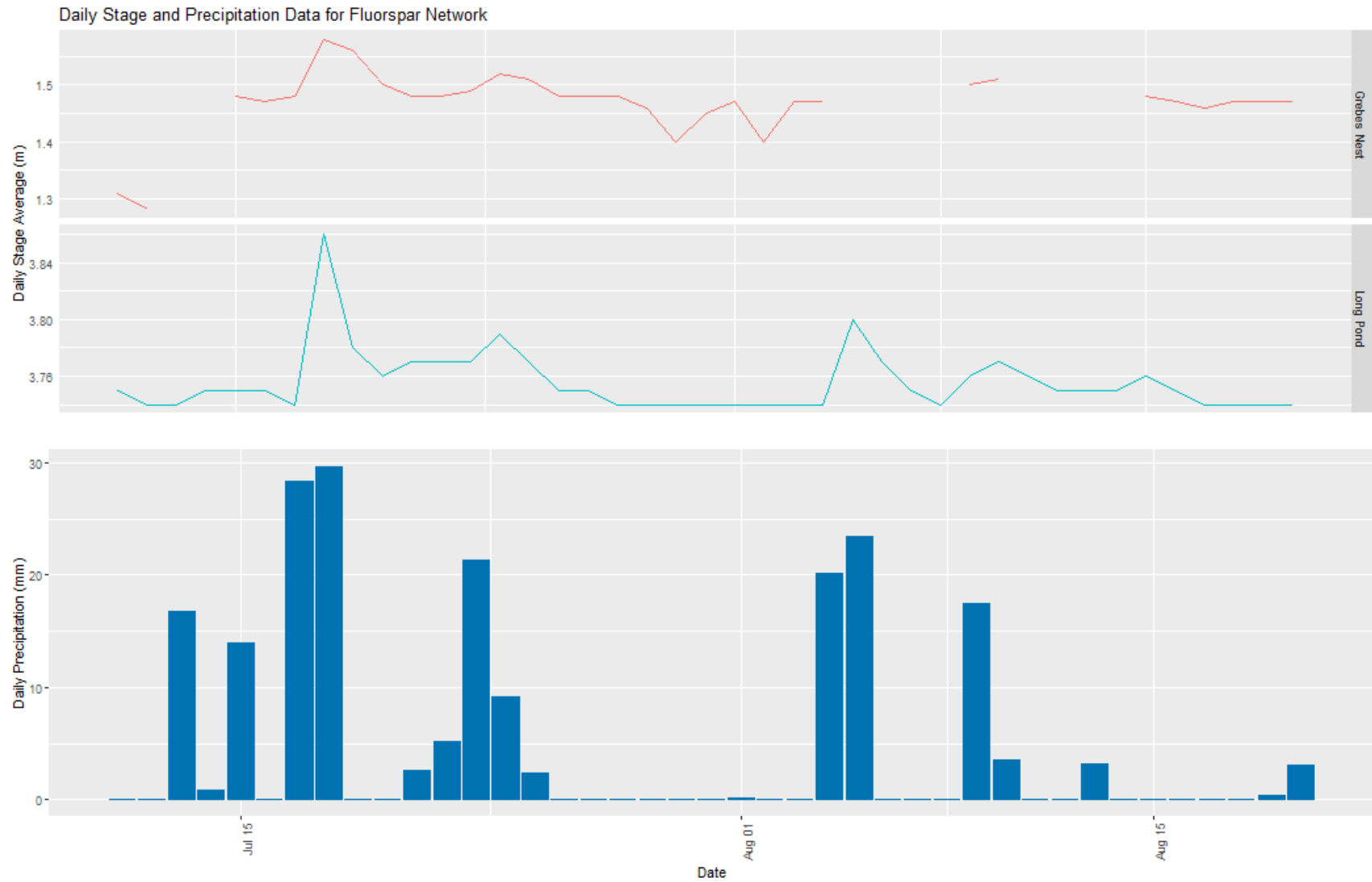


Figure 9: Daily average stage values and daily total precipitation.

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 Grebes Nest Pit that is upstream of the Real-Time station. In 2019 water was pumped into the river intermittently, depending on water levels in the pit.

When reviewing the parameter graphs it was evident that the larger precipitation events affected the water quality. It can be assumed that the increased flow from the Grebes Nest Pit was responsible for the variations in the turbidity levels. Water temperature fluctuated with stage changes, but continued to increase into the deployment. pH levels at Grebes Nest station were consistent during the deployment.

Conductivity at the brook ranged from 199.8 μ S/cm to 537.9 μ S/cm. The lowest conductivity values were during the stage increases, a result of the brook being diluted then flushed of suspended material for a short period of time.

Outflow to Grebes Nest Pond station is fed via Grebes Nest Pit and does not always have consistent flow. The dissolved oxygen concentration can thus change quickly over a few hours or days as water in the pool becomes stagnant. During this deployment, dissolved oxygen decreased as water temperatures warmed.

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

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

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranges from 12.46°C to 26.88°C with an average of 18.51 °C during this deployment period (Figure 10). The water temperature increases steadily across the deployment, consistent with warming air temperature.

During the large increases in stage at the station, the water temperatures dropped.

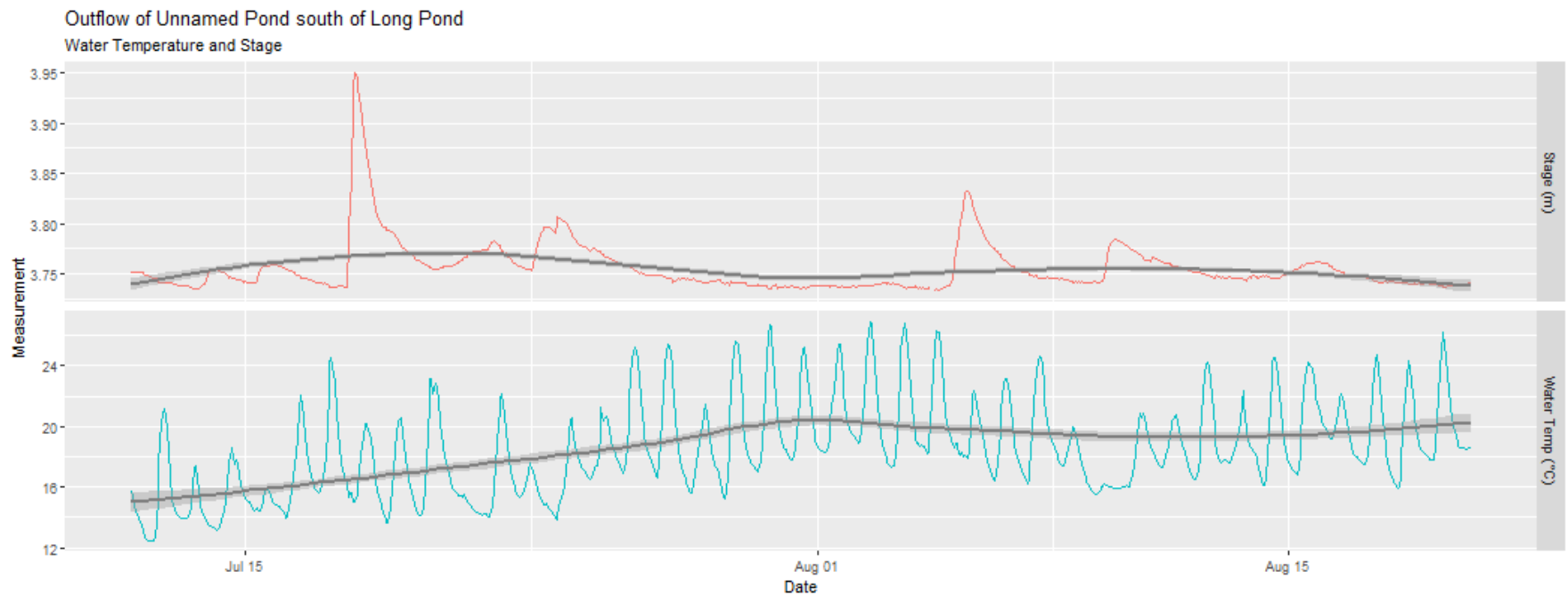


Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.35 pH units and 8.27 pH units (Figure 11), consistently remaining within the Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life. Every brook is different with its own natural background range.

The pH data was consistent over the deployment with decreases as stage levels increased before returning to background levels. Natural processes such as rainfall will alter the pH of a brook for a period of time. This relationship is very notable on July 18th, August 5th and 9th.

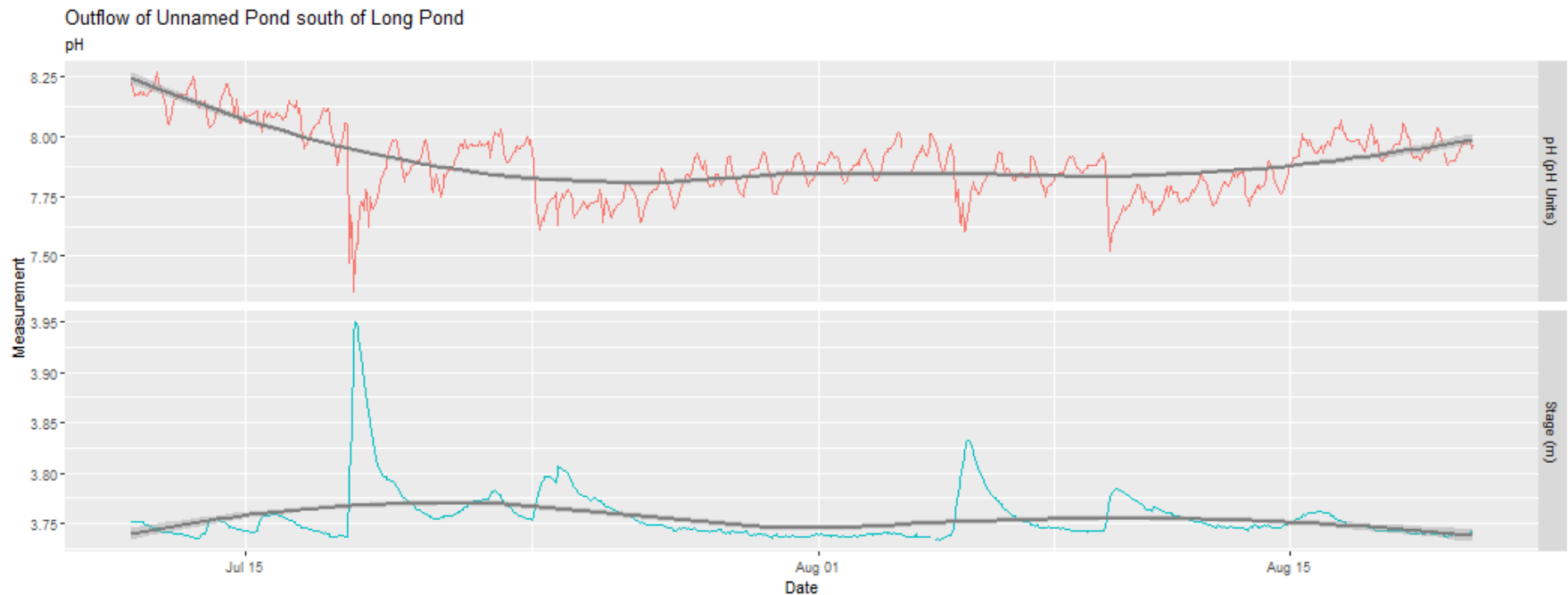


Figure 11: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 185.7 $\mu\text{S}/\text{cm}$ and 506.6 $\mu\text{S}/\text{cm}$ during deployment with a median value of 348.9 $\mu\text{S}/\text{cm}$.

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

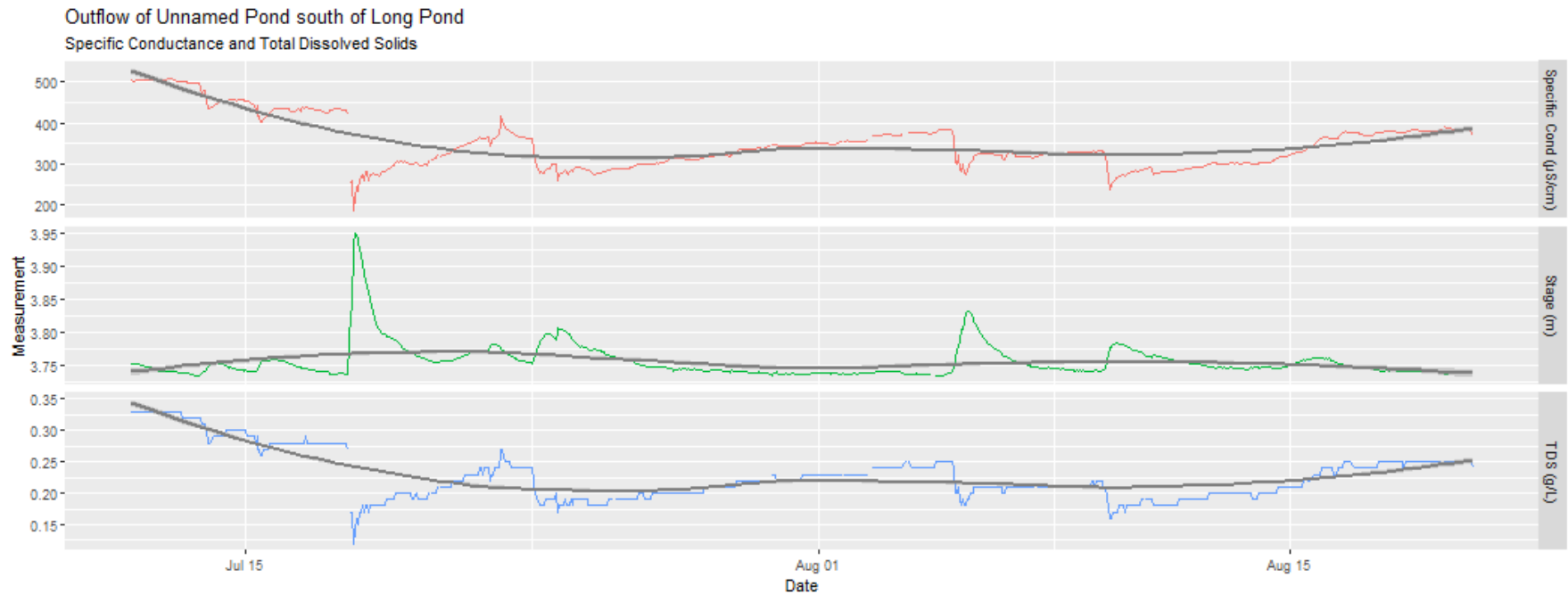


Figure 12: Specific conductivity ($\mu\text{S}/\text{cm}$) at Outflow of Unnamed Pond south of Long Pond

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 were within 8.02 mg/L and 10.47 mg/L for concentration and 93.8 % Sat and 102.6 % Sat for percent saturation. Values remained above the minimum CCME Guideline for the Protection of Other Life Stages, but the majority of values were below the Guideline for Early Life Stages.

There is a natural diurnal pattern with dissolved oxygen. Oxygen concentration levels will fluctuate throughout night and day. The significant dips/peaks outside of the diurnal pattern, are a result of fluxes in water temperature or influences from rainfall/runoff. This can be seen on Figure 13: as the water temperature peaks, dissolved oxygen concentration decreases.

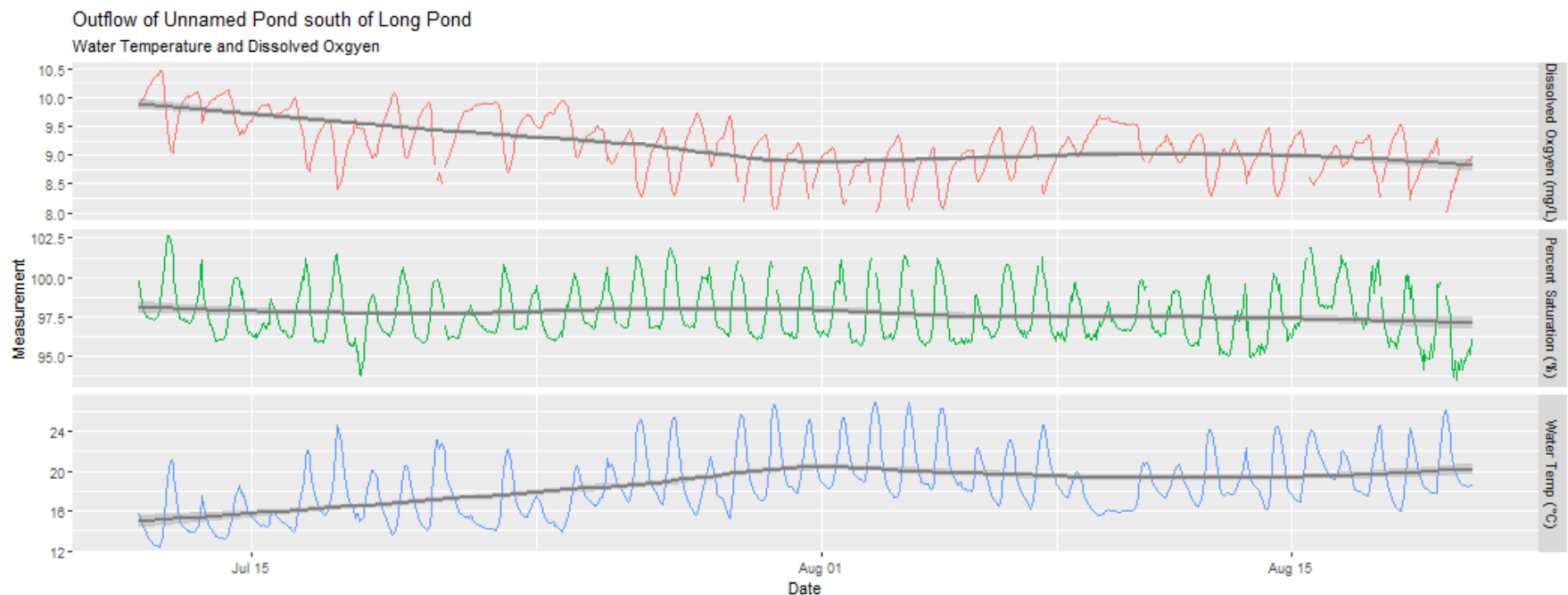


Figure 13: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 11.1 NTU and 148.7 NTU (Figure 14) with a median value of 39.6 NTU.

The turbidity remained above 10 NTU, indicating sediment or suspended material present throughout the deployment. There is leakage from the polishing pond which may be the cause of the high turbidity levels. There are mitigation steps in place to resolve the issue with the polishing pond. A report was submitted by Canada Fluorspar to WMRD on July 19, 2019.

Recorded stage events seemed to increase turbidity before flushing the brook and reducing the turbidity for a period of time before increasing again shortly after.

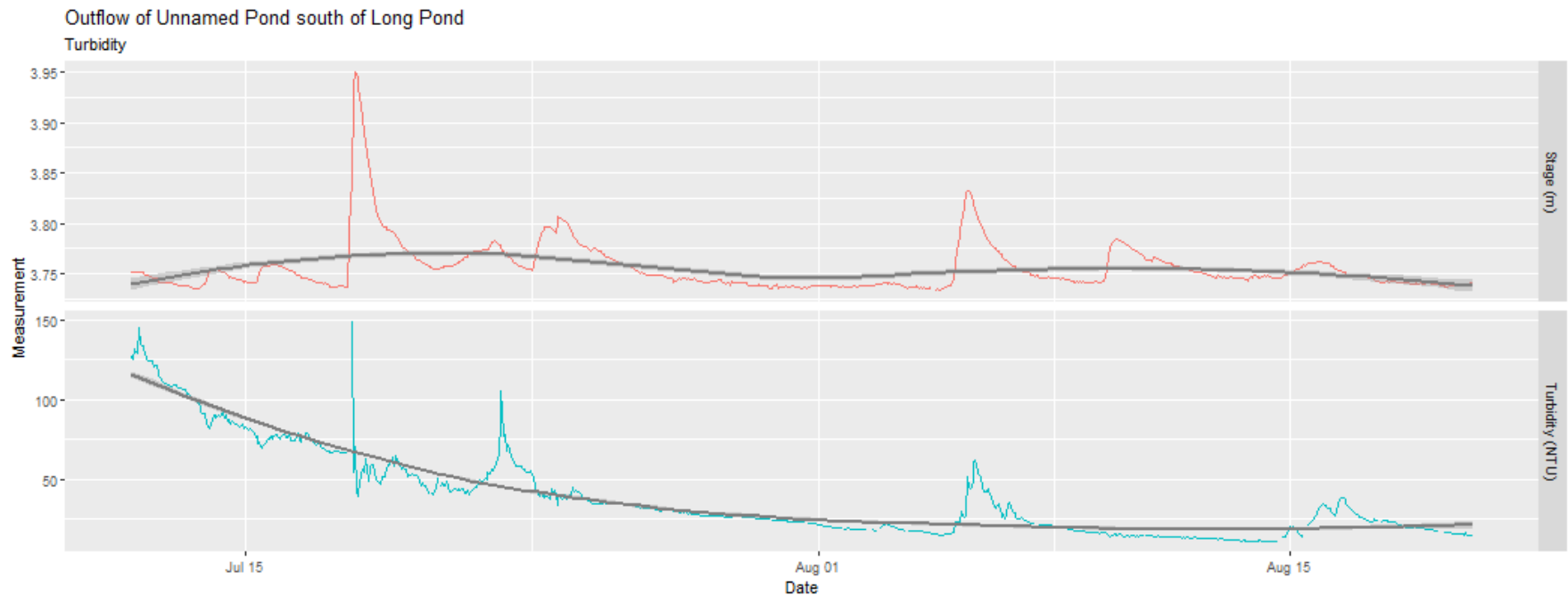


Figure 14: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

Stage is an estimation of water level at the station and can explain fluctuations occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage will increase during rainfall events (Figure 15).

Large peaks in stage correspond with the total precipitation events as noted on Figure 15. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and maximum of 29.7 mm on July 18th.

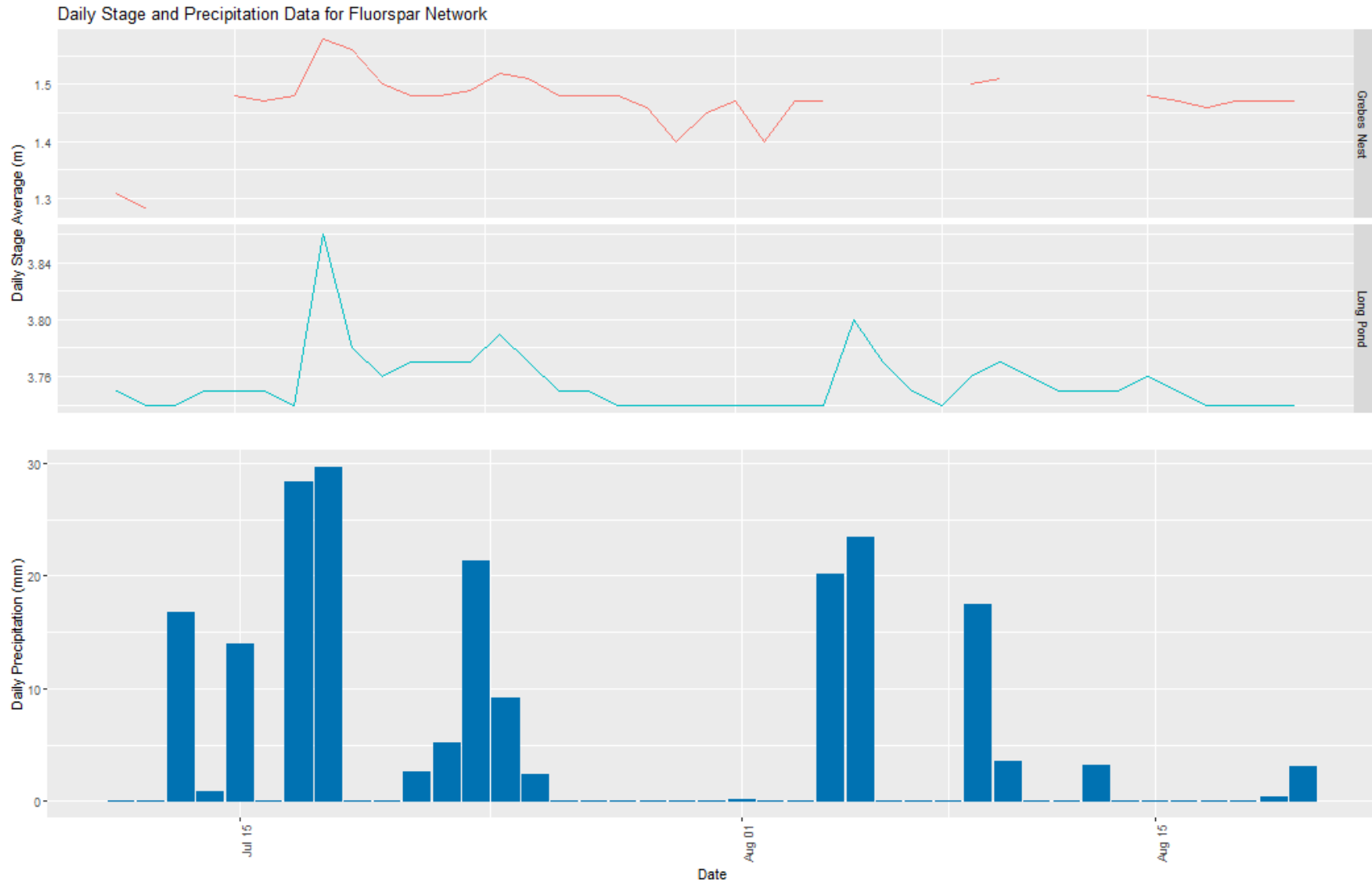


Figure 15: Daily averaged stage values at total precipitation.

Conclusion

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

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

Conductivity levels responded to stage fluctuations by decreasing during high stage events and increasing during periods of low stage. Dissolved oxygen levels were influenced by the warmer water temperatures, resulting in decreased oxygen levels.

This deployment had a turbidity median of 39.6 NTU which is decreased from the last deployment. There is leakage from the polishing pond which may be the cause of the turbidity levels. Corrective steps for the leakage were put in place there was an overall decrease in turbidity. A report was submitted by Canada Fluorspar to WRMD on July 19, 2019.

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