Real-Time Water Quality Report

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

Deployment Period
May 15, 2018 to January 8, 2019

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 at the Canada Fluorspar mine site near St. Lawrence, Newfoundland and Labrador.

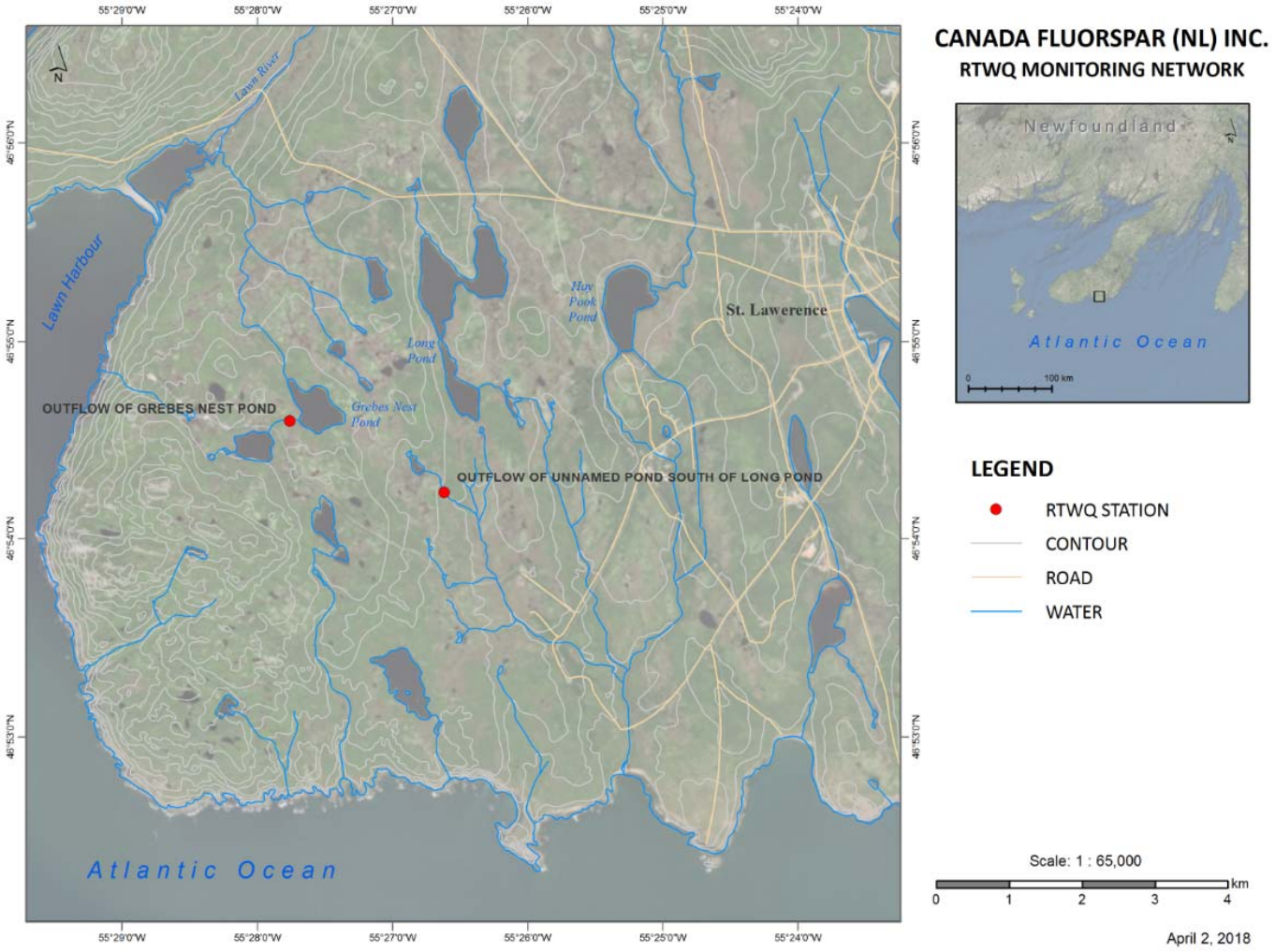

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

Outflow of Grebes Nest Pond

The Outflow of Grebes Nest Pond station is established northwest of the pit dewatering effluent outfall 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 situated in (Figure 3). The pool depth is approximately 0.5 to 1.0 metres. The GPS coordinates for this site are **N46° 54' 35.9" W055° 27' 45.6"**.

The station hut was placed on the North bank approximately 5 metres from the stream (Figure 2). 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, and to allow the appropriate mitigation measures to be implemented in a timely manner, reducing any adverse effect on the downstream systems.

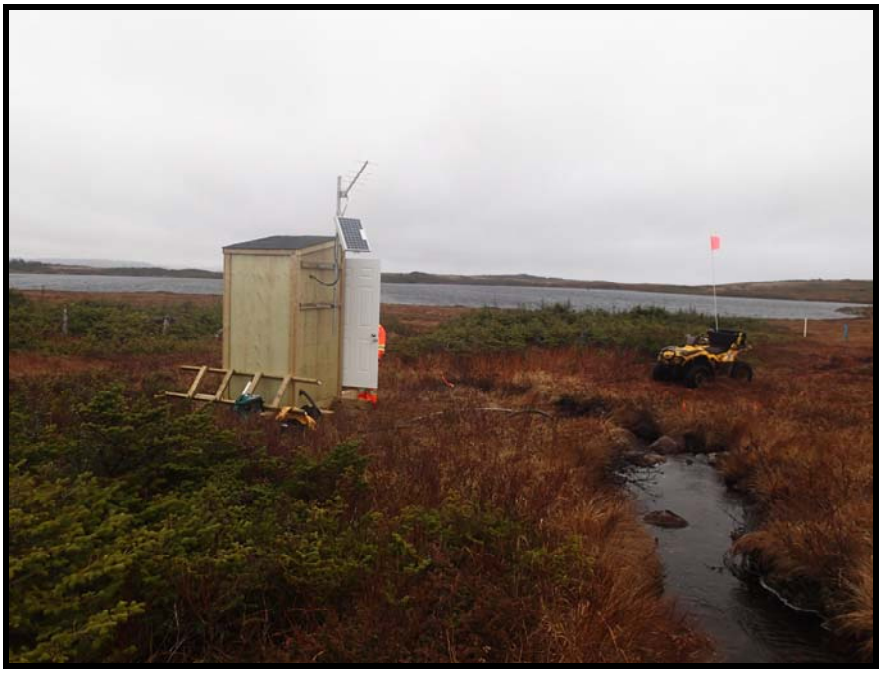

Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest Pond.

Figure 3: Instrument deployed at Outflow of Grebes Nest Pond Real-Time Station

Outflow of Unnamed Pond south of Long Pond

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, allowing the appropriate mitigation measures to be implemented in a timely manner, 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 5). The stream originates from a small unnamed pond and meanders through marshland adjacent to 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 west bank approximately 8 meters from the stream (Figure 4).

Figure 4: Real-Time Water Quality and Quantity Station at Outflow of Unnamed Pond south of Long Pond

Figure 5: Instrument deployed at Unnamed Pond south of Long Pond Real-Time Station.

Station Setup

Water quality parameters are measured at each station using a HOSKIN EXO 2 multiprobe instrument (Figure 6).

Figure 6: HOSKIN EXO 2 used for monitoring water quality parameters.

Six water parameters are measured at each station, including five water quality parameters (water temperature, dissolved oxygen, pH, turbidity and specific conductivity), and one water quantity parameter (stage). An additional water quality parameter, total dissolved solids (TDS) is calculated from specific conductivity and water temperature.

Water quality data is recorded on an hourly basis (every 60 minutes) at both stations, while water quantity data is recorded at Outflow of Grebes Nest hourly and Outflow of Unnamed Pond every 15 minutes.

The data for both stations is viewable and downloadable online through WRMD's Real Time Water Quality Monitoring webpage located here: https://www.mae.gov.nl.ca/waterres/rti/stations.html

Data Interpretation

Performance issues and data records were interpreted for each station during the deployment period for the following parameters:

- Water Temperature (^{o}C)
- pH (pH units)
- Specific Conductivity (µS/cm)
- Total Dissolved Solids (g/L)
- Dissolved Oxygen (mg/L)
- Dissolved Oxygen (%Sat)
- Turbidity (NTU)
- Stage (m)

A description of each parameter is provided in Appendix A.

The following report discusses the water quality parameters over the deployment period from May 15, 2018 to January 8, 2019. These interpretations aim to point out seasonal and overall trends and any major issues influencing the parameters. Any gaps in data are the result of transmission loss or periods where the instrument was removed from the water.

WSC staff play 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 transmission equipment are working properly. WSC is responsible for handling stage and streamflow issues. The raw water quantity data is transmitted via satellite and published online with the water quality data on the Real-Time Station's website. Water quantity data published online or used in the monthly station report has not been corrected or groomed. WSC is responsible for QA/QC of water quantity data. Corrected stage and streamflow data can be obtained upon request to WSC.

WRMD staff with the Department of 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 maintenance and calibration of the water quality instrument, as well as grooming, analyzing and reporting on the water quality data recorded at the station.

Quality Assurance and Quality Control

To ensure accurate data collection, water quality instruments are subjected to quality assurance procedures in order to mitigate any errors caused by biofouling and/or sensor drift. Quality assurance procedures include: (i) a thorough cleaning of the instrument, (ii) replacement of any small sensor parts that are damaged or unsuitable for reuse, and (iii) the calibration of the sensors using standard solutions. Quality assurance procedures are carried out every 40-50 days, before the start of a new deployment period. Deployment periods for 2018 are summarized in Table 1.

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, the water quality data is assigned a performance ranking (i.e. poor, marginal, fair, good, excellent) (Table 2). Appendix B details the rankings for each of the instrument sensors deployed at Canada Fluorspar Inc over the course of the year.

For more detailed analyses of a particular time period, date or deployment period, please refer to the individual deployment reports: https://www.mae.gov.nl.ca/waterres/rti/rtwq/csdr/index.html

Table 1: Water quality instrument deployment start and end dates for 2018 at Canada Fluorspar (NL) Inc

		Deployment	Removal
Canada Fluorspar Real Time Stations	Outflow of Grebes Nest Pond	May 15, 2018	June 18, 2018
	Outflow of Unnamed Pond south of Long Pond	May 15, 2018	June 18, 2019
	Outflow of Grebes Nest Pond	June 19, 2018	July 17, 2018
	Outflow of Unnamed Pond south of Long Pond	June 18, 2018	July 17, 2018
	Outflow of Grebes Nest Pond	July 18, 2018	August 14, 2018
	Outflow of Unnamed Pond south of Long Pond	July 18, 2018	August 14, 2018
	Outflow of Grebes Nest Pond	August 15, 2018	September 26, 2018
	Outflow of Unnamed Pond south of Long Pond	August 14, 2018	September 26, 2018
	Outflow of Grebes Nest Pond	September 27, 2018	November 21, 2018
	Outflow of Unnamed Pond south of Long Pond	September 27, 2018	November 21, 2018
	Outflow of Grebes Nest Pond	November 21, 2018	January 8, 2019
	Outflow of Unnamed Pond south of Long Pond	November 21, 2018	January 8, 2019

Table 2: 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

Concerns or Issues during the Deployment Period

During the deployment year, the water supply for Outflow of Grebes Nest Pond station was intermittent. The water was originating from a sedimentation pond upstream of the Real-Time station, however, due to upgrades and supply issues, there were significant changes to how the water was being fed into the brook. The timeline of the changes affecting Outflow of Grebes Nest Pond Station are captured in Appendix C.

During the May to June deployment, the dissolved oxygen probe failed on the instrument deployed at Outflow of Unnamed Pond south of Long Pond, resulting in the removal of the data from the dataset for that timeframe.

During the November 2018 to January 2019 deployment period there was a failure of the pH sensor on the water quality instrument deployed at Outflow of Grebes Nest Pond. This pH data was removed from the dataset and this report.

Throughout this report, daily averaged stage data was used for comparison against water quality parameters and corresponding precipitation data from ECCC's weather station in St. Lawrence.

Please note that the stage data in this document is raw data. It has not been corrected for backwater effect. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to Water Survey of Canada.

Please note that the total precipitation and air temperature data from Environment and Climate Change Canada does not warrant the quality, accuracy, or completeness of any information, data or product from these web pages. It is provided "AS IS" without warranty or condition of any nature.

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

Water Temperature

The minimum and maximum water temperatures were both recorded at Outflow of Grebes Nest Pond at -0.17°C and 25.64°C, respectively (Table 3). This station also had water temperatures fluctuate to a greater degree than Outflow to Grebes Nest Pond.

Both sites displayed evident increases in water temperature as the seasons changed from spring into summer, and decreases in water temperature as summer cooled into fall and winter. Outflow of Unnamed Pond south of Long Pond's median of 10.42°C was higher than that of Outflow to Grebes Nest Pond which was 9.34°C (Table 3).

Outflow of Unnamed Pond south of Long Pond water temperatures during the summer months were slightly higher than that of Outflow of Grebes Nest Pond (Figure 7). Throughout the year, both stations displayed similar fluctuations such as the decreases in water temperatures on June 26th to June 27th and August 5th to August 8th (Figure 8), which were a response to decreases in air temperature (Figure 8).

Figure 8 displays the mean daily air temperatures that were recorded at the St. Lawrence weather station during the 2018 deployment period. Air temperature directly influences water temperature of surface water, which in turn, can effect other water quality parameters such as dissolved oxygen.

The water temperature data recorded during 2018 is what would be expected from shallow brooks in Newfoundland and Labrador.

Table 3. Summary of the 2018 Water Temperature data at Fluorspar Real-Time Stations

	Water Temperature (oC)	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.03	-0.17
Max	22.58	25.64
Median	9.34	10.42

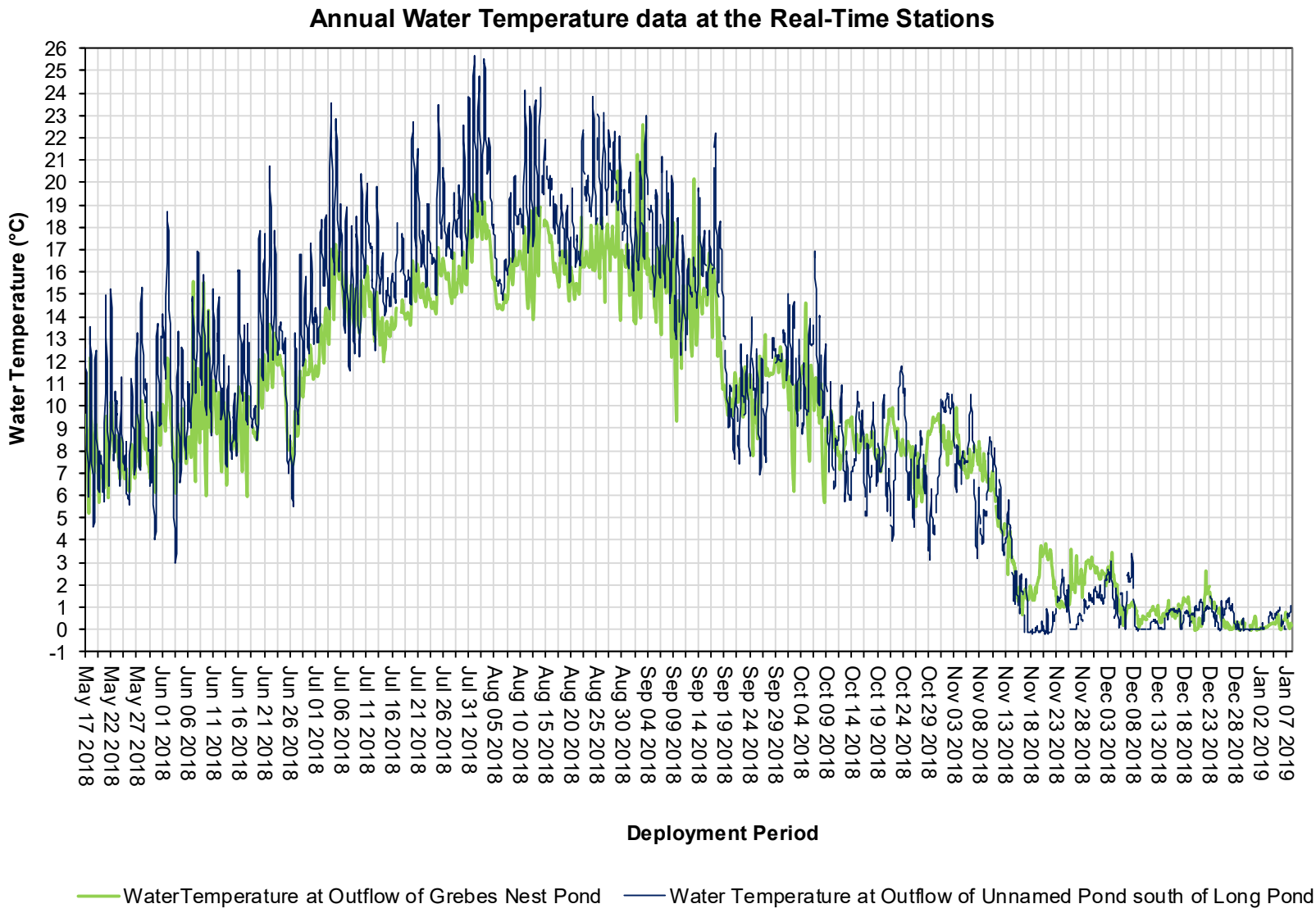

Figure 7: Water temperature (°C) values at the Canada Fluorspar Real-Time Water Quality Stations

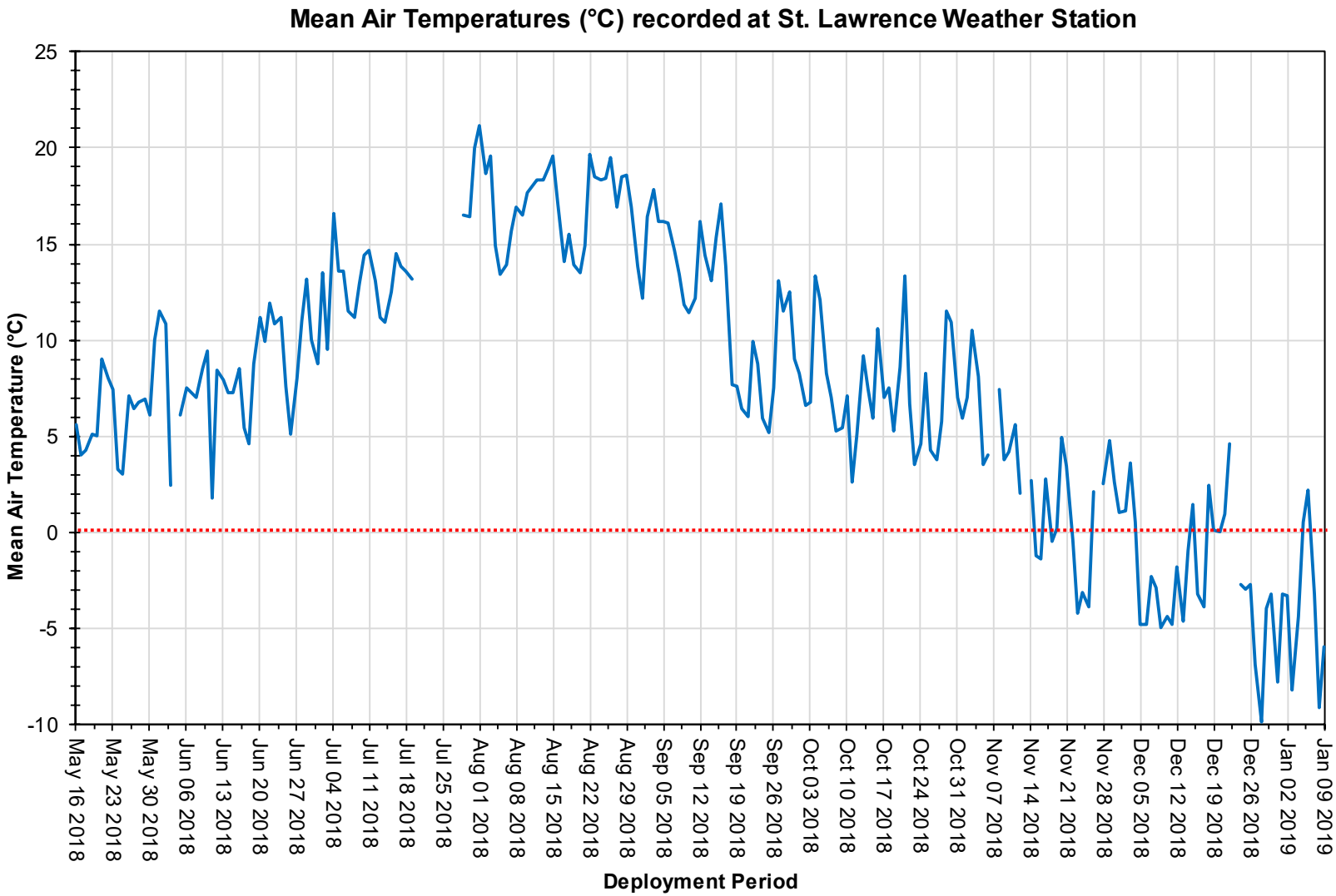

Figure 8: Mean Air Temperatures (°C) recorded at the St. Lawrence Weather Station

pH

Canada Fluorspar real-time stations recorded pH data ranging between 6.71 pH units at Outflow of Grebes Nest Pond and 8.37 pH units recorded at Outflow of Unnamed Pond south of Long Pond (Table 4).

For most of the deployment, the pH data from Outflow of Grebes Nest Pond remained within the Canadian Council of Ministers of the Environment (CCME) pH guidelines for the protection of aquatic life of 6.5 and 9 pH units. However, after an instrument switch out on November 21st the pH values dropped to below 6.5pH and remained there until the end of deployment (Figure 9). It was determined that the pH data from November 21st to January 8th was not representative of the brook and was removed from the report. The Outflow of Grebes Nest pond median of 7.3 pH units was higher than the median recorded for the 2017 deployment of 5.82 pH units (Appendix D).

Outflow of Unnamed Pond south of Long Pond is located downstream from a storage area for the mine's tailings. Due to the station's location, there may be external factors affecting the pH. However, pH levels remained relatively consistent at this station throughout the year. The short decreases in pH level at this station were likely a result of precipitation or snow melt, dependent on the time of year. The pH data returned to background levels after each event (Figure 9). The annual median at Unnamed Pond, of 7.81 pH units, was higher than the median recorded during 2017 of 6.1 pH units at Outflow of Unnamed Pond south of Long Pond (Appendix D).

Both water bodies decrease during the same timeframes indicating that external climatic influences were likely the cause for the dips in pH levels

Table 4. Summary of 2018 pH data at Fluorspar Real-Time Stations

	pH(pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.71	7.07
Max	7.81	8.37
Median	7.3	7.81

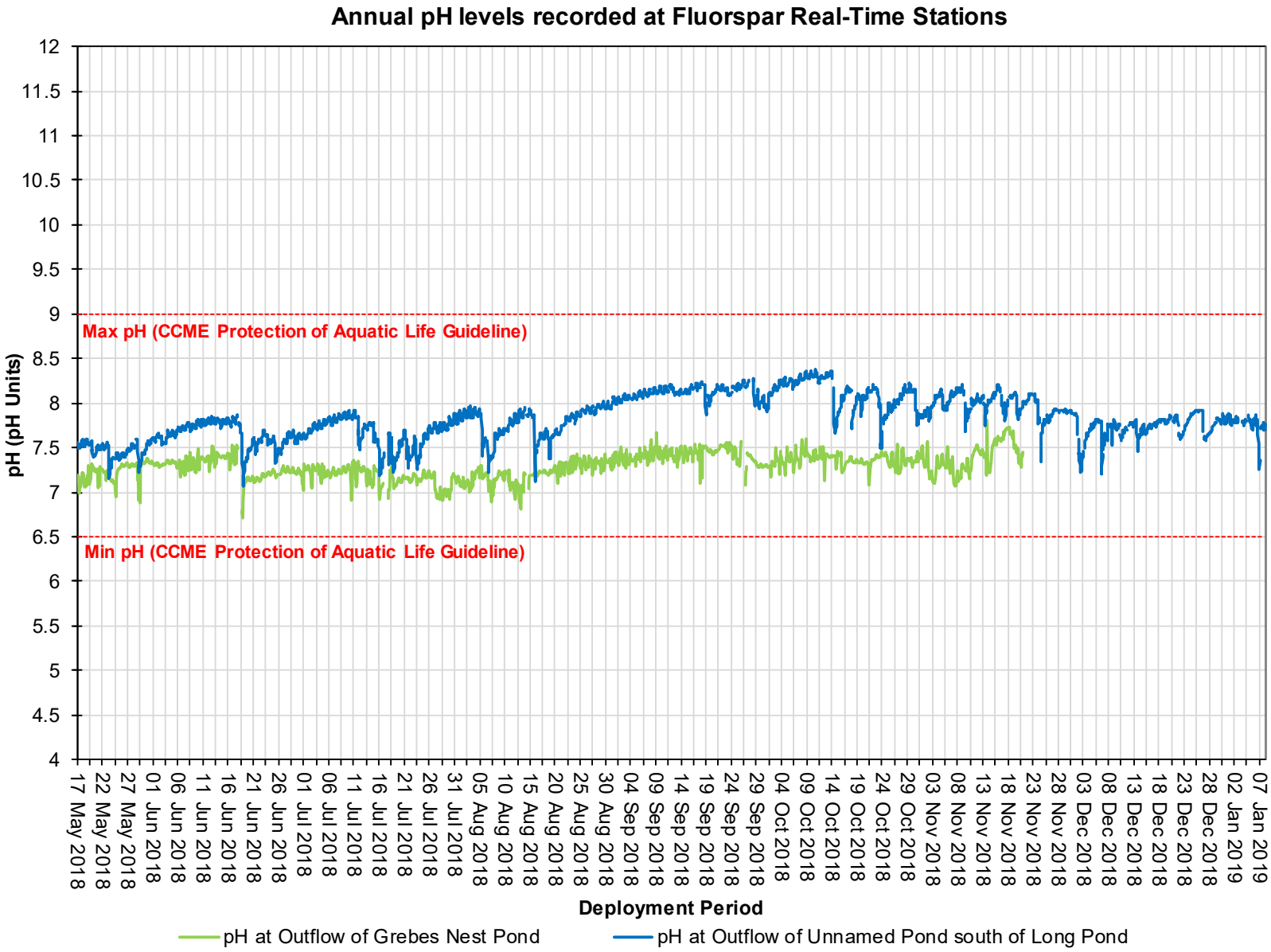

Figure 9: pH (pH units) at the Canada Fluorspar (NL) Inc Real-Time Stations

Specific Conductivity

The conductivity levels over the deployment year recorded minimum and maximum levels at Outflow of Grebes Nest Pond of 87.79 µS/cm and 649.3 µS/cm, respectively (Table 5).

There is a direct relationship between conductivity and stage. During rainfall events, the water column will become diluted by the added water, lowering the conductivity levels. Then if sediment or materials from the surrounding environment are flushed into the brook, conductivity levels will increase for a short period of time until they are flushed from the system.

Specific conductivity data recorded at Outflow of Grebes Nest Pond was generally higher in 2018 than 2017. The median for 2018 was 244.44 µS/cm compared to the 2017 median of 59.1 µS/cm. This was likely a result of the water supply issues that were occurring on site throughout 2018 deployment year (Appendix C). There were occasions when the brook was not being supplemented and this likely resulted in a greater concentration of particle matter. Conductivity increases steadily over the summer period, peaking at its highest on September 21st before returning to background levels. Rainfall events can flush particles and reduce the conductivity in a brook for a short period of time, however, with the sediment laden runoff from the sedimentation pond upstream, the conductivity at Outflow to Grebes Nest Pond remained above 87 µS/cm throughout 2018 (Figure 10).

Unnamed Pond site displayed high conductivity increases at the onset of precipitation, before decreasing quickly and then increasing again (Figure 10). However on September 14th there was a spike in conductivity that was not a result of precipitation. This event was also evident on the turbidity data graphed on Figure 12 indicating a change in the water quality during that time frame. During the summer months, the conductivity at Outflow of Unnamed Pond south of Long Pond steadily increased. Conductivity levels started to decrease in October, but showed high variability through late November and December.

Specific Conductivity levels at Outflow of Unnamed Pond south of Long Pond generally increased in 2018 when compared to 2017 data. The 2017 median was 87.1 µS/cm and the 2018 median was recorded at 234.8µS/cm (Appendix D). The conductivity data collected at Outflow of Unnamed Pond south of Long Pond indicates there may be another factor influencing conductivity levels at this station. It is likely that the higher conductivity recorded may be a result of anthropogenic activities on site upstream from this station (Figure 10).

Table 5. Summary of 2018 specific conductivity data at Fluorspar Real-Time Stations

	Specific Conductivity (uS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	87.79	105.7
Max	649.3	535.34
Median	244.44	234.8

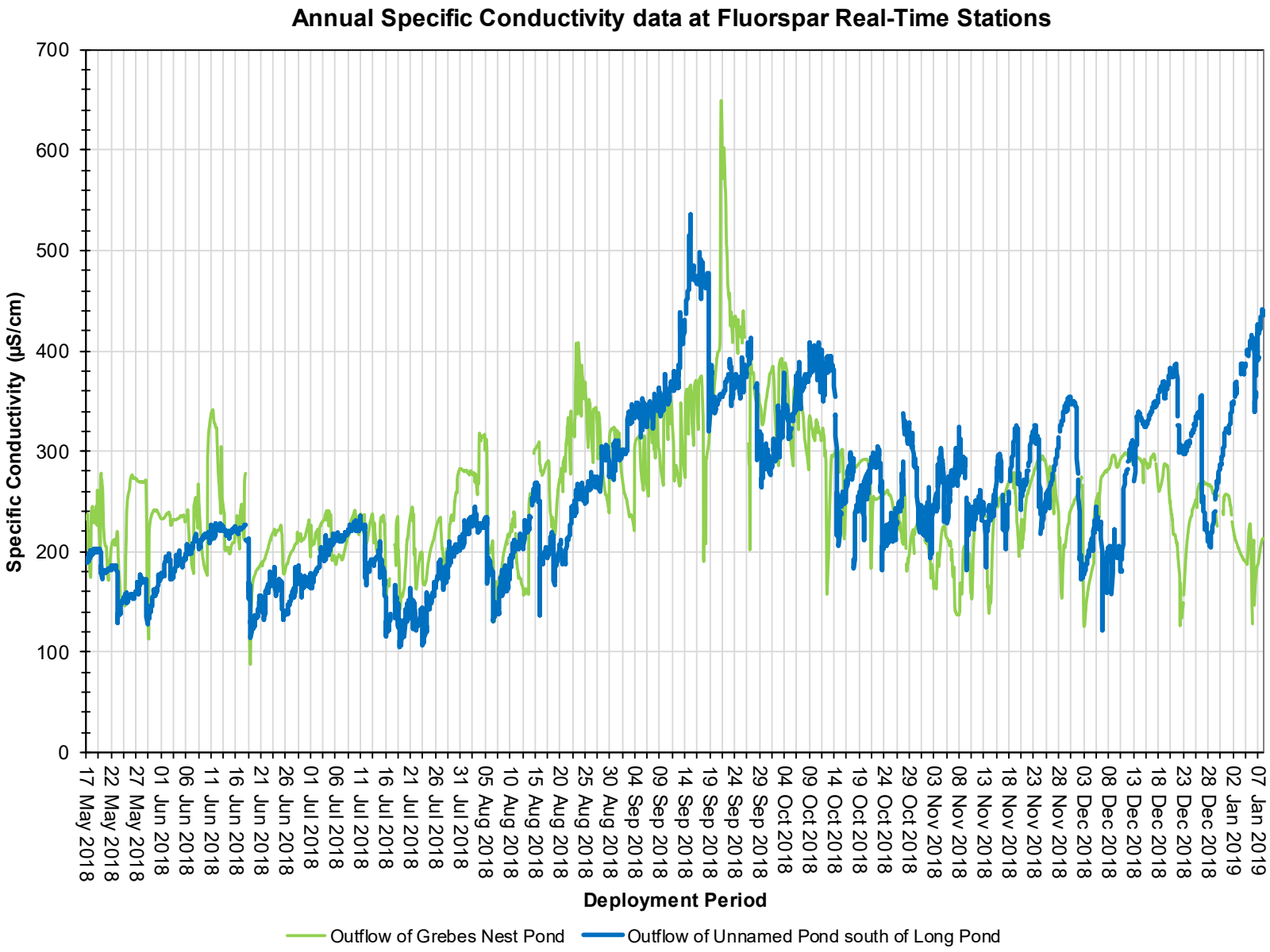

Figure 10: Specific conductivity (µS/cm) at the Canada Fluorspar (NL) Inc Real-Time Stations

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. Both parameters are important and helpful in analyzing the conditions in an ambient water body.

Over the deployment period, the dissolved oxygen concentration ranged from a minimum of 4.92 mg/L recorded at Outflow of Grebes Nest Pond to a maximum of 15.18 mg/L, also recorded at Outflow of Grebes Nest Pond (Table 6). The percent saturation levels for dissolved oxygen ranged from 52.5% Saturation to 114.8% Saturation, with both values recorded at Outflow of Grebes Nest Pond.

Outflow of Grebes Nest Pond showed significant variation in the dissolved oxygen data. The instrument frequently recorded sharp increases and decreases in concentration levels instead of the cyclic wave of a natural diurnal pattern (Figure 11). As expected, there was less dissolved oxygen in the brook during the warmer periods of the year. The intermittent water supply to the brook may have contributed to the low dissolved oxygen levels. The 2018 median of 10.03mg/L dissolved oxygen for Outflow of Grebes Nest Pond was lower than the 2017 median of 12.35 mg/L (Appendix D).

Dissolved Oxygen concentration at the Outflow of Unnamed Pond south of Long Pond station remained above the CCME Guideline for the Protection of Other Life Stages of Aquatic Life (6.5 mg/L) throughout the year and above the guideline for the Protection of Early Life Stages (9.5 mg/L) for the majority of the year (Figure 11). Concentration levels decreased as the deployment moved into the warmer months, before increasing into the cooler months. This would be expected as high water temperatures decrease the amount of dissolved oxygen the water can hold, and vice versa. Outflow of Unnamed Pond south of Long Pond recorded a median dissolved oxygen value for 2018 of 11.00 mg/L, while the median for 2017 was 11.74 mg/L (Appendix D).

On January 2nd 2019 and January 6th 2019 at Outflow of Unnamed Pond South of Long Pond, there were decreases in dissolved oxygen as well as a decrease in water temperature. Weather data for that timeframe indicated precipitation events on both days, therefore it was likely that snow melt and ice buildup in the brook caused the water temperature and the dissolved oxygen to decrease rapidly.

Table 6. Summary of 2018 Dissolved oxygen data at Outflow of Grebes Nest Pond

	Grebes: Dissolved Oxygen	
	mg/L	%Sat
Min	4.92	52.5
Max	15.18	114.8
Median	10.03	89.3

Table 7. Summary of 2018 Dissolved oxygen data at Outflow of Unnamed Pond south of Long Pond

	Unnamed Pond: Dissolved Oxygen	
	mg/L	%Sat
Min	7.11	63.7
Max	14.76	105.8
Median	11.00	98.7

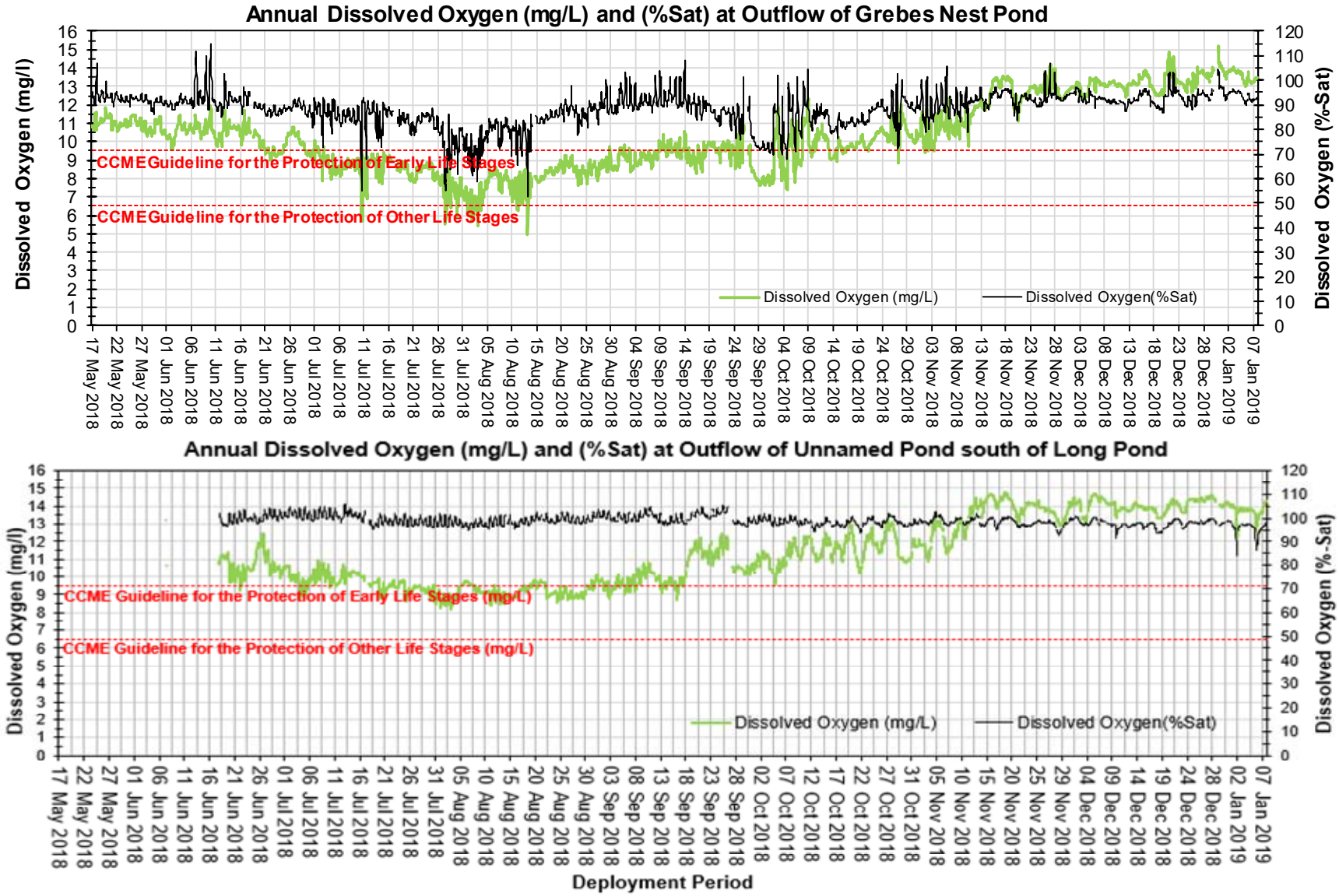

Figure 11: Dissolved Oxygen (mg/L & Percent Saturation) values

Turbidity

Turbidity levels during the deployment ranged from a minimum of 0.0 NTU recorded at Outflow of Unnamed Pond south of Long Pond to a maximum of 1341.9 NTU recorded at Outflow of Grebes Nest Pond (Table 8). The highest median was recorded at Outflow of Grebes Nest Pond, 60.3 NTU, indicating that the brook had consistently higher turbidity across the deployment year than Outflow of Unnamed Pond south of Long Pond with a median of 13.2 NTU (Table 8). Outflow to Grebes Nest Pond originates at a sedimentation pond which is fed directly from the open pit mine. A higher median for this site is to be expected.

During the spring thaw, there is a higher amount of material present in the brooks as the surrounding environment thaws and flushes into the nearby waterways. During rainfall or runoff, higher turbidity readings are expected as sediments in the brook are suspended by the increased flow. Generally, turbidity increases for a short period of time before returning to baseline range after the sediments settle or are flushed out of the system. If turbidity increases but does not decrease shortly after and results in higher values for a period of time, the turbidity would be of concern.

Figure 12 displays turbidity during 2018 for both stations, but with different axis scales due to their degree of difference. During the summer, turbidity levels generally decrease as there is less precipitation occurring. This trend was most evident at Outflow to Unnamed Pond south of Long Pond station. Outflow of Grebes Nest Pond site continued to have ongoing turbidity spikes throughout the summer. During the 2018 deployment year, Outflow of Grebes Nest Pond experienced intermediate flow issues and periodically the instrument was sitting in stagnant water. It is likely the higher turbidity values are representative of this situation (Appendix C).

The medians for both stations have increased when compared to the previous year. The data indicates that the baseline for turbidity levels in the brooks in 2018 is slightly higher and there were more turbidity events recorded in 2018.

Table 8. Summary for 2018 Turbidity data at Fluorspar Real-Time stations

	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	4.23	0.0
Max	1341.9	76.8
Median	60.3	13.2

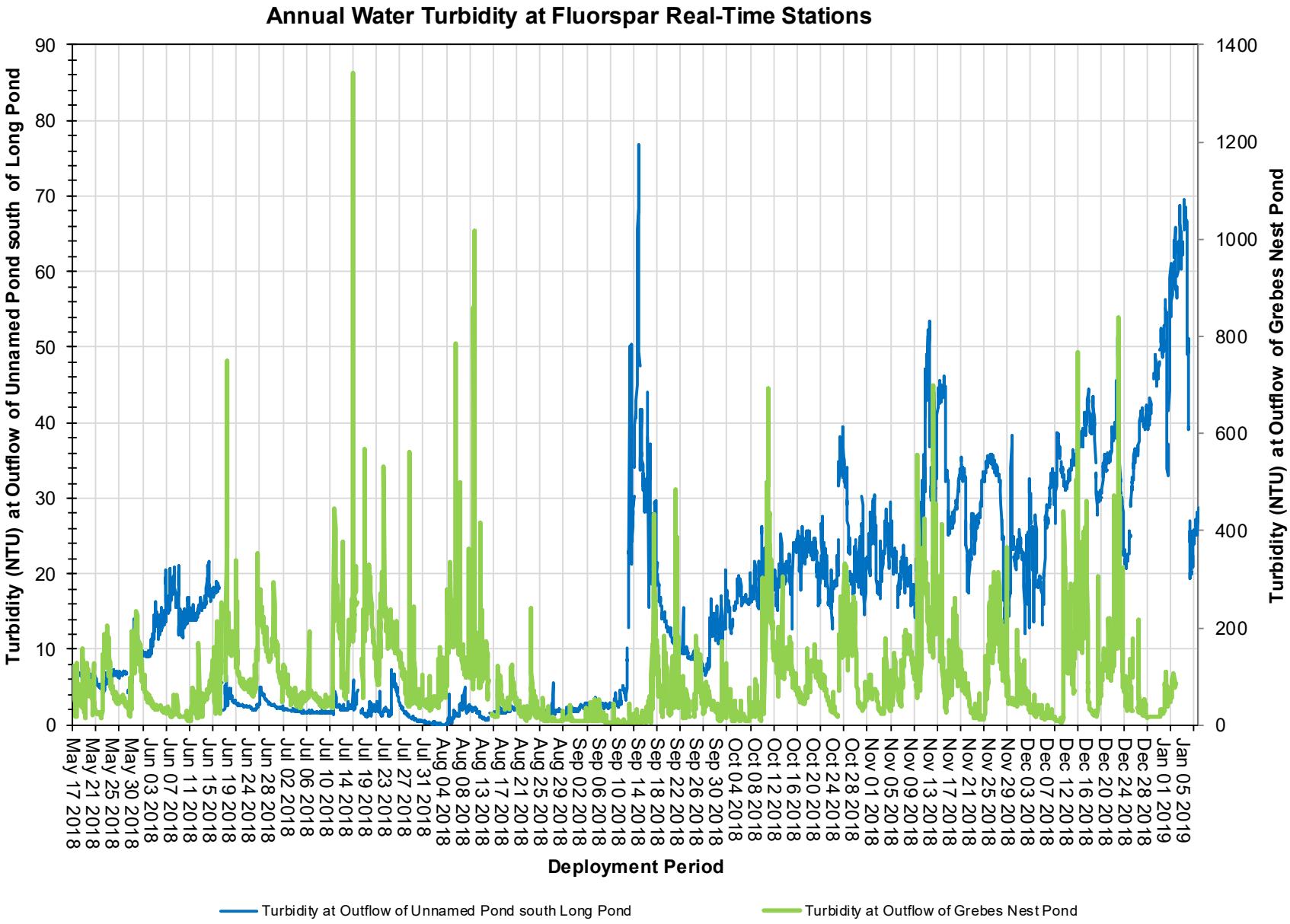

Figure 12: Turbidity (NTU) values at the Canada Fluorspar (NL) Inc Real-Time Stations

Total Precipitation & Daily Averaged Stage Data

Please note the daily averaged 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.

Stage is important as it provides an estimation of water level at the station and can explain some of the fluctuations that are occurring in relation to other parameters (i.e. Specific Conductivity, DO, turbidity). Stage will increase naturally during rainfall events (Figure 13) and during any surrounding snow or ice melt as runoff collects in the brooks. However, direct snowfall will not cause stage to rise significantly.

Outflow of Grebes Nest Pond daily averaged stage values ranged from 1.33m to 2.00m (Table 9). Despite the changes in the water supply to Outflow of Grebes Nest Pond, the stage level did not change significantly over the deployment year. Outflow of Unnamed Pond south of Long Pond recorded stage levels ranging from 3.73m to a maximum of 4.14m. Although the stations are not on the same river, both sites had similar peaks in stage during the rainfall events.

Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. During a 239 day deployment, 139 days recorded precipitation. Total Daily Precipitation for the deployment period ranged from 0.0 mm to a maximum of 66.4 mm, which occurred on June 19th, 2018.

Table 9. Summary of for 2018 Daily Averaged Stage data at Fluorspar Real-Time stations

	Daily Averaged Stage (m)	
	Outflow of Grebes	Outflow of Unnamed
Min	1.33	3.73
Max	1.67	4.14
Median	1.5	3.78
Range	0.34	0.41

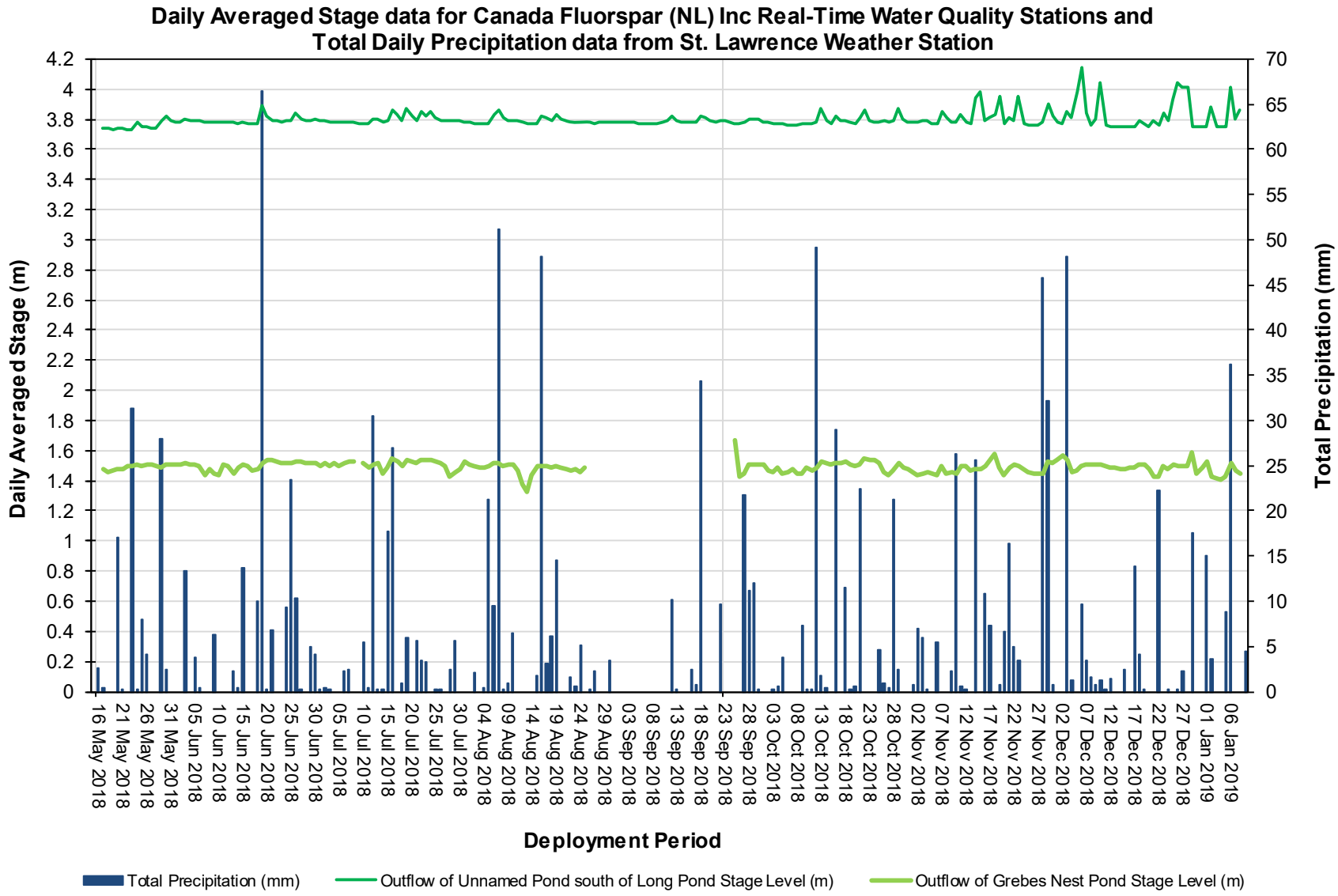

Figure 13: Daily Averaged stage values and total precipitation.

Conclusion

Water temperatures during the deployment were representative of climatic changes throughout a year in St. Lawrence, NL. Seasonal changes in water temperature are evident in the data recorded with the highest temperatures occurring in summer and the overall decrease in temperature as the water cools with the air temperature changes into winter. Water temperature also directly influences the concentration of dissolved oxygen in the brook. Both stations displayed a decrease in dissolved oxygen during the warmer months of the year and increases during the cooler periods. Outflow to Grebes Nest Pond had the lowest dissolved oxygen recorded during the warmer months of the year, however, the levels during 2018 deployment are within expected limits for both real-time stations.

For the 2018 deployment, both stations pH data remained within the CCME Water Quality Guidelines for the Protection of Aquatic Life Guidelines (6.5 to 9 pH units). Drops in pH values were evident at both stations, indicating that precipitation was likely an influence during those timeframes.

Specific Conductivity at Outflow to Unnamed Pond south of Long Pond and Outflow of Grebes Nest Pond increased during the summer months before returning to background levels. This would be expected as lower rainfall events and evaporation can concentrate the presence of suspended solids and particles in the water. Outflow to Grebes Nest Pond had the highest spike in conductivity for the year, this was likely a result of the reduced flow this brook was experiencing. Outflow to Unnamed Pond had an unexplained spike in conductivity on September 14th 2018 that was also evident on the turbidity graph. This may be a result of on site activities.

Outflow to Grebes Nest Pond had ongoing turbidity spikes throughout 2018. Between late August and early September, the turbidity levels dropped. Turbidity spikes then returned for the remainder of the year. Outflow of Grebes Nest Pond had intermediate flow issues, resulting in the instrument periodically sitting in stagnant water. It is likely the higher turbidity values are representative of this situation. The median for turbidity at both stations indicate turbidity has increased since 2017 for both brooks. Rainfall and runoff can directly affect sediment in waterways, however, the sediment should settle out after a period of time.

During 2018, the water supply for Outflow of Grebes Nest Pond station did not consistently come from the same source. Currently, the brook is supplied via a sedimentation pond that was established to settle out the sediment-laden pit water from the open pit mine. While there were no supply issues with Outflow of Unnamed Pond south of Long Pond, this station also went through changes as the activity on the mine site continued with development. The Outflow of Unnamed Pond south of Long Pond station is downstream from the Tailings Management Facility and ongoing anthropogenic activities on the mine site. There can be influences from these activities on the water quality parameters.

As with many brooks and streams, precipitation and runoff influence the water quality within a water body. Catchment areas for Outflow of Unnamed Pond south of Long Pond and Outflow of Grebes Nest Pond are impacted by anthropogenic changes from the mining activity. Precipitation can increase 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 after a water quality event.

APPENDIX A

WATER QUALITY PARAMETER DEFINITIONS

Dissolved Oxygen

The amount of Dissolved Oxygen (DO) (mg/l) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (Allan 2010).

pH

pH is the measure of hydrogen ion activity and affects: (i) the availability of nutrients to aquatic life; (ii) the concentration of biochemical substances dissolved in water; (iii) the efficiency of hemoglobin in the blood of vertebrates; and (iv) the toxicity of pollutants. Changes in pH can be attributed to industrial effluent, saline inflows, precipitation or aquatic organisms involved in the photosynthetic cycling of CO_2 (Allan 2010).

Specific conductivity

Specific conductivity (µS/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25˚C. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

Stage

Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature

Essential to the measurement of most water quality parameters, temperature (^oC) controls most processes and dynamics of limnology. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth (Allan 2010; Hach 2006).

Total Dissolved Solids

Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

Turbidity

Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Allan 2010; Hach 2006; Swanson and Baldwin 1965).

APPENDIX B

INSTRUMENT PERFORMANCE RANKINGS

Instrument Performance Rankings

Station	Date	Action	2018 Deployment Season Comparison Ranking				
			Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Outflow of Grebes Nest Pond	May 15 2018	Deployment	Excellent	Excellent	Good	Excellent	Poor
	June 18 2018	Removal	Good	Good	Good	Excellent	Poor
Outflow of Unnamed Pond south of Long Pond	May 15 2018	Deployment	Good	Excellent	Good	Excellent	Good
	June 18 2018	Removal	Fair	Excellent	Good	NA	Good
Outflow of Grebes Nest Pond	June 19 2018	Deployment	Good	Excellent	Excellent	Excellent	Fair
	July 17 2018	Removal	Good	Good	Excellent	Good	Poor
Outflow of Unnamed Pond south of Long Pond	June 18 2018	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	July 17 2018	Removal	Poor	Excellent	Excellent	Excellent	Excellent
Outflow of Grebes Nest Pond	July 18 2018	Deployment	Excellent	Excellent	Excellent	Good	Good
	August 14 2018	Removal	Excellent	Excellent	Excellent	Good	Excellent
Outflow of Unnamed Pond south of Long Pond	July 18 2018	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	August 14 2018	Removal	Fair	Good	Excellent	Excellent	Excellent
Outflow of Grebes Nest Pond	August 15 2018	Deployment	Good	Excellent	Good	Excellent	Excellent
	Sept 26 2018	Removal	Good	Good	Fair	Excellent	Excellent
Outflow of Unnamed Pond south of Long Pond	August 15 2018	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	Sept 26 2018	Removal	Excellent	Good	Good	Good	Excellent
Outflow of Grebes Nest Pond	Sept 27 2018	Deployment	Good	Good	Good	Good	Marginal
	Nov 21 2018	Removal	Good	Excellent	Good	Marginal	Poor
Outflow of Unnamed Pond south of Long Pond	Sept 27 2018	Deployment	Good	Excellent	Good	Excellent	Excellent
	Nov 21 2018	Removal	Excellent	Excellent	Good	Good	Excellent
Outflow of Grebes Nest Pond	Nov 21 2018	Deployment	Excellent	Good	Good	Good	Poor
	January 8 2019	Removal	Good	Excellent	Marginal	Fair	Good
Outflow of Unnamed Pond south of Long Pond	Nov 21 2018	Deployment	Excellent	Excellent	Excellent	Poor	Excellent
	January 8 2019	Removal	Good	Good	Excellent	Fair	Good

*Please note that one station may be installed before the other. Therefore there may be a difference in the initial start date for deployments.

APPENDIX C

TIMELINE OF WATER SUPPLY CHANGES TO THE

OUTFLOW OF GREBES NEST POND REAL-TIME STATION

TIMELINE OF WATER SUPPLY CHANGES TO THE OUTFLOW OF GREBES NEST POND REAL-TIME STATION

No.	Date	Water Supply
1	April 1st, 2018 to May 4th, 2018	Sedimentation pond was dewatered in order to expand the pond and line it with geotextile. The water from the pit was pumped to the tailings pond. Water levels were likely low at this time.
2	May 13th 2018	Water supply was returned to the sedimentation pond, pumped from the pit into the sediment pond. Levels were not high enough to maintain a healthy flow into Outflow to Grebes Nest Pond therefore a geotextile bag was installed and water was pumped into the geotextile bag, which fed the brook.
3	May 13th, 2018 – October 18th 2018	The water supply included water being pumped from the geotextile bag, along with overflow from the sedimentation pond when conditions allowed. Fluctuations in the water level were apparent when the pump for the sedimentation pond and/or the geotextile bag were switched off.
4	October 18th 2018 – December 2018	Two smaller geotextile bags where installed to try and gravity feed the brook and eliminate the pump during this timeframe.
5	December 6th, 2018	Due to issues with sediment-laden water overflowing from the sedimentation pond into the brook without proper filtering, the two smaller geotextile bags were stopped and the CFI team returned to using the large geotextile bag at that the beginning of the brook. Water supply for Grebes Nest Pond station returned to water being pumped from the pit into the sedimentation pond and then onto the geotextile bag before flowing into the brook.
6	January 16th, 2019	After ongoing issues with water back flowing into the pit and high turbidity in the brook from seepage at the sedimentation pond, CFI stopped pumping into the sedimentation pond and the process now involves water lines running from the pit into the large geotextile bag then fed into the brook for water supply.

*All dates are approximate. There are no exact dates for when the flow of the water supply changed.

APPENDIX D

COMPARISON STATISTICS FROM 2017 DEPLOYMENT AT CANADA FLUORSPAR INC

Comparison Statistics from 2017 (Nov. 26 2016 to Jan. 8 2018)		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.15	-0.154
Max	21.2	26.57
Median	3.772	7.2

	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	5.11	4.57
Max	7.41	7.73
Median	5.82	6.1

	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	29.1	43.7
Max	227.09	229.71
Median	59.1	87.1

	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.06	8.2
Max	14.34	15.16
Median	12.35	11.74

	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	67.2	88
Max	115.1	105.6
Median	95	98.4

	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.35	0.16
Max	1314.4	133.9
Median	1.49	8.8