Real-Time Water Quality Report

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

Annual Deployment Period
April 14, 2021 to January 3, 2022

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment & Climate Change
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.

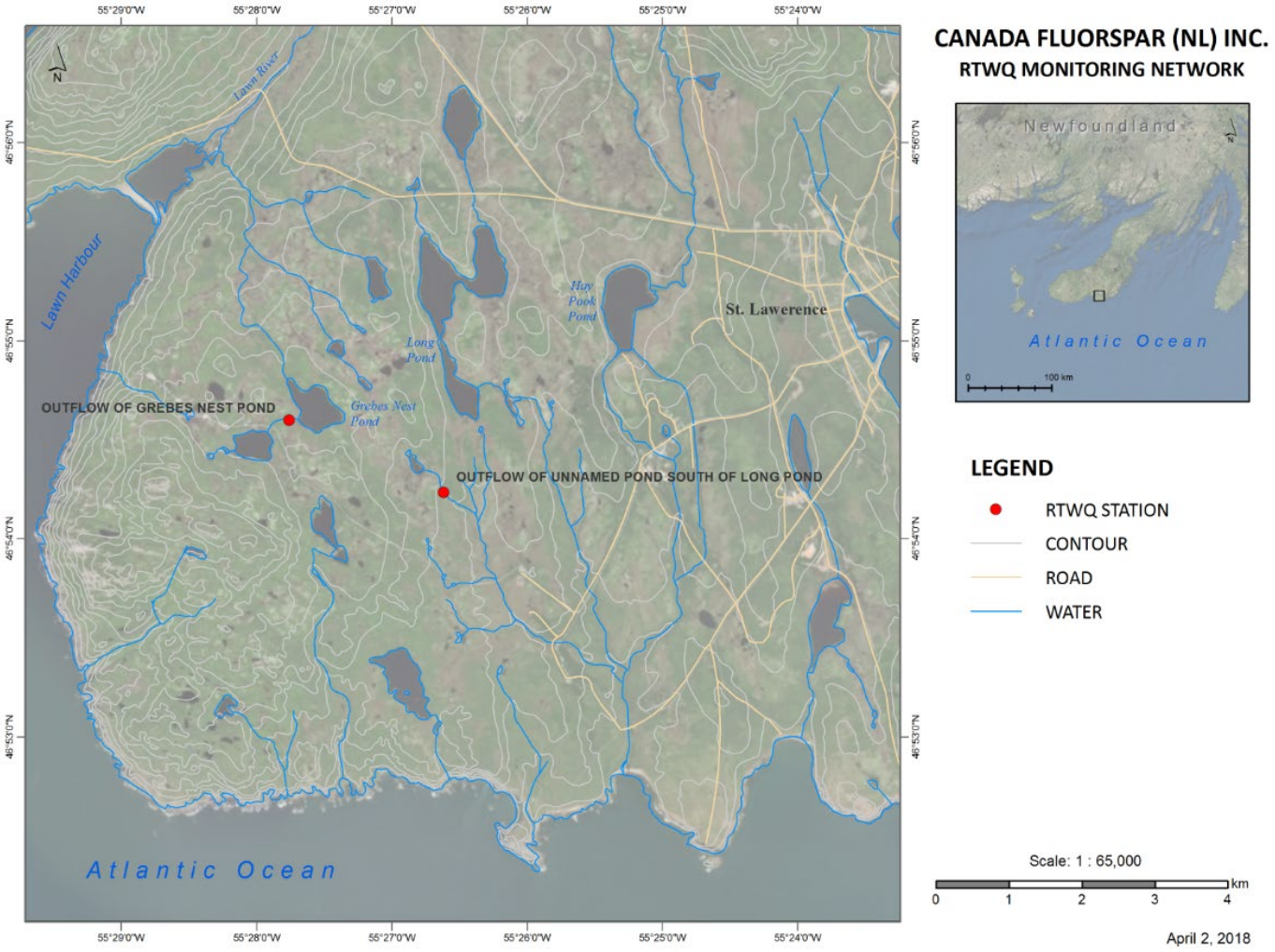


Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

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 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, and to allow the appropriate mitigation measures to be implemented in a timely manner, reducing any adverse effect on the downstream systems.

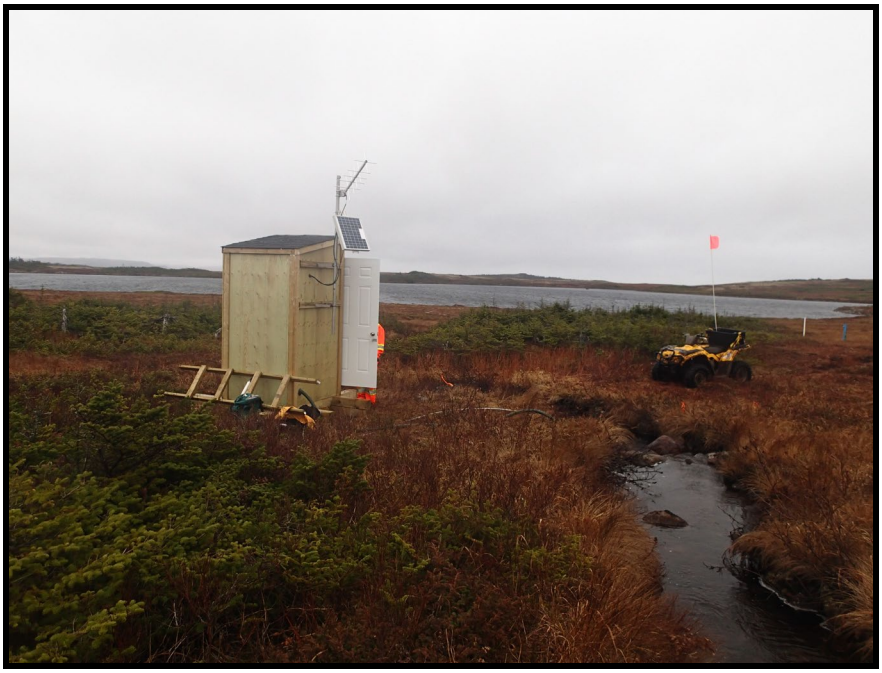


Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest Pond.

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 provides 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 an EXO 2 multiprobe instrument (Figure 6).

Figure 6: 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). Additionally the water quality instrument has the capability to use specific conductivity and water temperature to calculate the total dissolved solids (TDS) present in the brook.

Water quality data is captured on an hourly basis (every 60 minutes) at both stations. The water quantity data is recorded at Outflow of Grebes Nest hourly and Outflow of Unnamed Pond every 15 minutes, this data can be accessed from Water Survey of Canada.

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

Data Interpretation

Performance and data records were interpreted for both stations for the following parameters:

• Water Temperature (°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 outlined in Appendix I

The following report discusses the water quality parameters recorded from April 2021 to January, 2022. These interpretations aim to point out seasonal trends and any major issues influencing the water quality parameters.

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 Environment & Climate Change (ECC) 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 ECC's main contact for the water quality monitoring equipment 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. Deployment periods for 2021 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 II 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.gov.nl.ca/ecc/waterres/rti/rtwq/csdr/#Fluor

Table 1: Water quality instrument deployment start and end dates for 2021 at Canada Fluorspar (NL) Inc

	Stations	Deployment	Removal
Canada Fluorspar Real Time Stations	Outflow of Grebes Nest Pond	April 14, 2021	May 18, 2021
	Outflow of Unnamed Pond south of Long Pond	April 14, 2021	May 18, 2021
	Outflow of Grebes Nest Pond	May 18, 2021	June 15, 2021
	Outflow of Unnamed Pond south of Long Pond	May 18, 2021	June 15, 2021
	Outflow of Grebes Nest Pond	June 15, 2021	July 27, 2021
	Outflow of Unnamed Pond south of Long Pond	June 15, 2021	July 27, 2021
	Outflow of Grebes Nest Pond	July 27, 2021	August 23, 2021
	Outflow of Unnamed Pond south of Long Pond	July 27, 2021	August 23, 2021
	Outflow of Grebes Nest Pond	August 23, 2021	September 28, 2021
	Outflow of Unnamed Pond south of Long Pond	August 23, 2021	September 28, 2021
	Outflow of Grebes Nest Pond	September 28, 2021	Jan 3, 2022
	Outflow of Unnamed Pond south of Long Pond	September 28, 2021	Jan 3, 2022

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

The water supply for Outflow to Grebes Nest Pond station originates at the bottom of an open pit mine. There is also a small influence from runoff and precipitation. The pit water is pumped from the open pit into geo bags that strain out the majority of the sediment and then the water is gravity fed into Outflow to Grebes Nest Pond. The water supply is intermittent as the pit water is only pumped when water levels reach a certain height in the open pit. Lack of consistent flow can result in significant stage level fluctuation across a deployment and have an effect on water quality.

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 groomed or corrected. 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.

Due to the COVID-19 pandemic, WRMD environmental staff were unable to travel to site and remove the instruments for the winter, therefore there were no QA readings taken at removal on January 3, 2022 to compare to the field readings.

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

Water Temperature

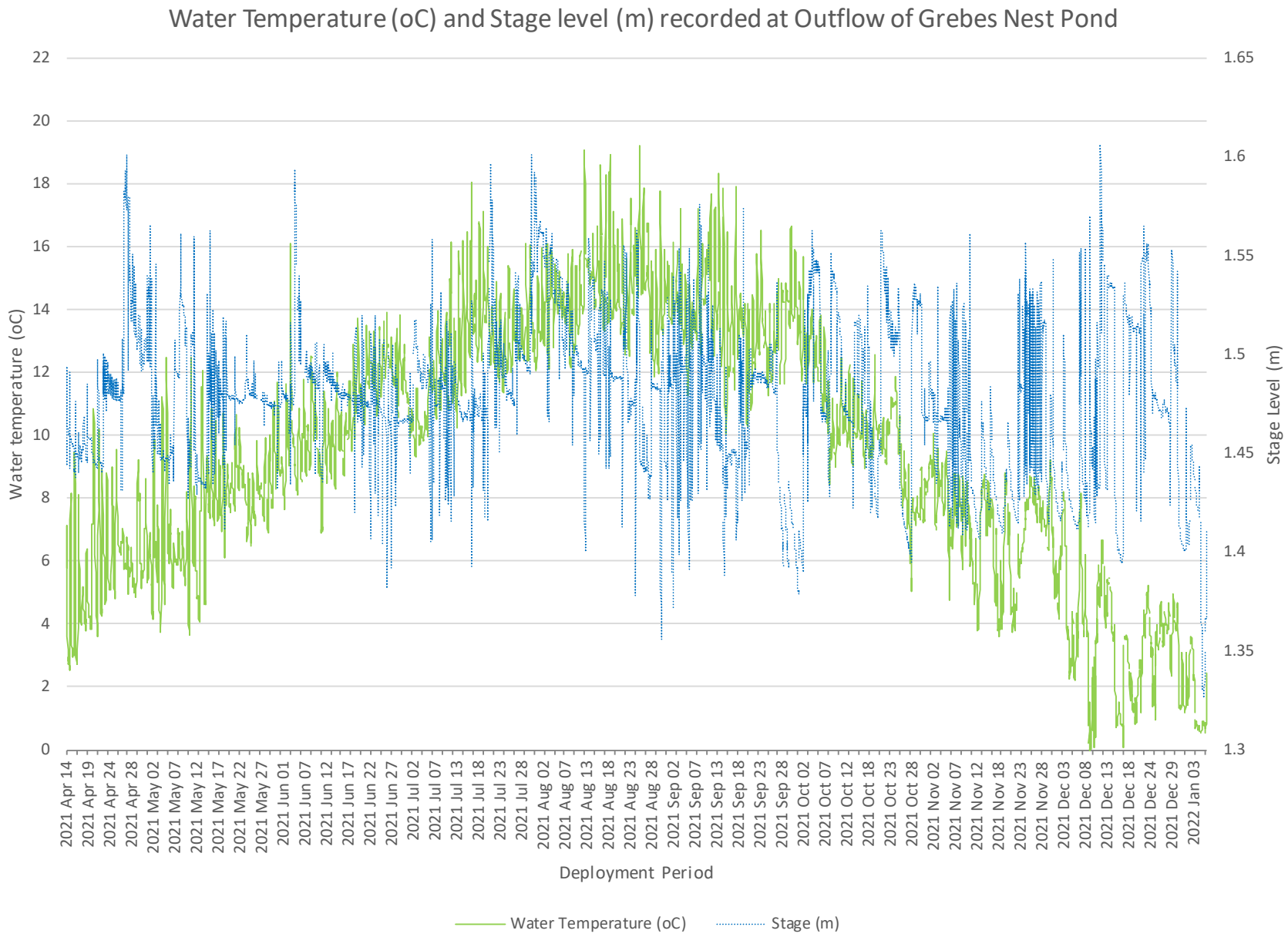
The Outflow of Grebes Nest Pond water temperature ranged from 0.0°C and 19.2°C while Outflow of Unnamed Pond south of Long Pond station the temperature ranged from -0.01 °C to 27.28 °C (Table 3).

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 10.87°C was higher than that of Outflow to Grebes Nest Pond which was 9.78°C (Table 3).

Water temperatures at both stations display large diurnal variations (Figure 7). This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures (Figure 8). Trends in water temperature corresponded well with trends in air temperatures, displaying increases from June through August and decreases as fall then winter sets in (Figure 8).

Table 3. Summary of the 2021 Water Temperature data at Fluorspar Real-Time Stations

	Water Temperature (oC)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.0	-0.01
Max	19.2	27.28
Median	9.78	10.87


Water Temperature (oC) and Stage level (m) recorded at Outflow of Grebes Nest Pond
Water temperature (oC)
Stage Level (m)
Deployment Period
Water Temperature (oC)
Stage (m)

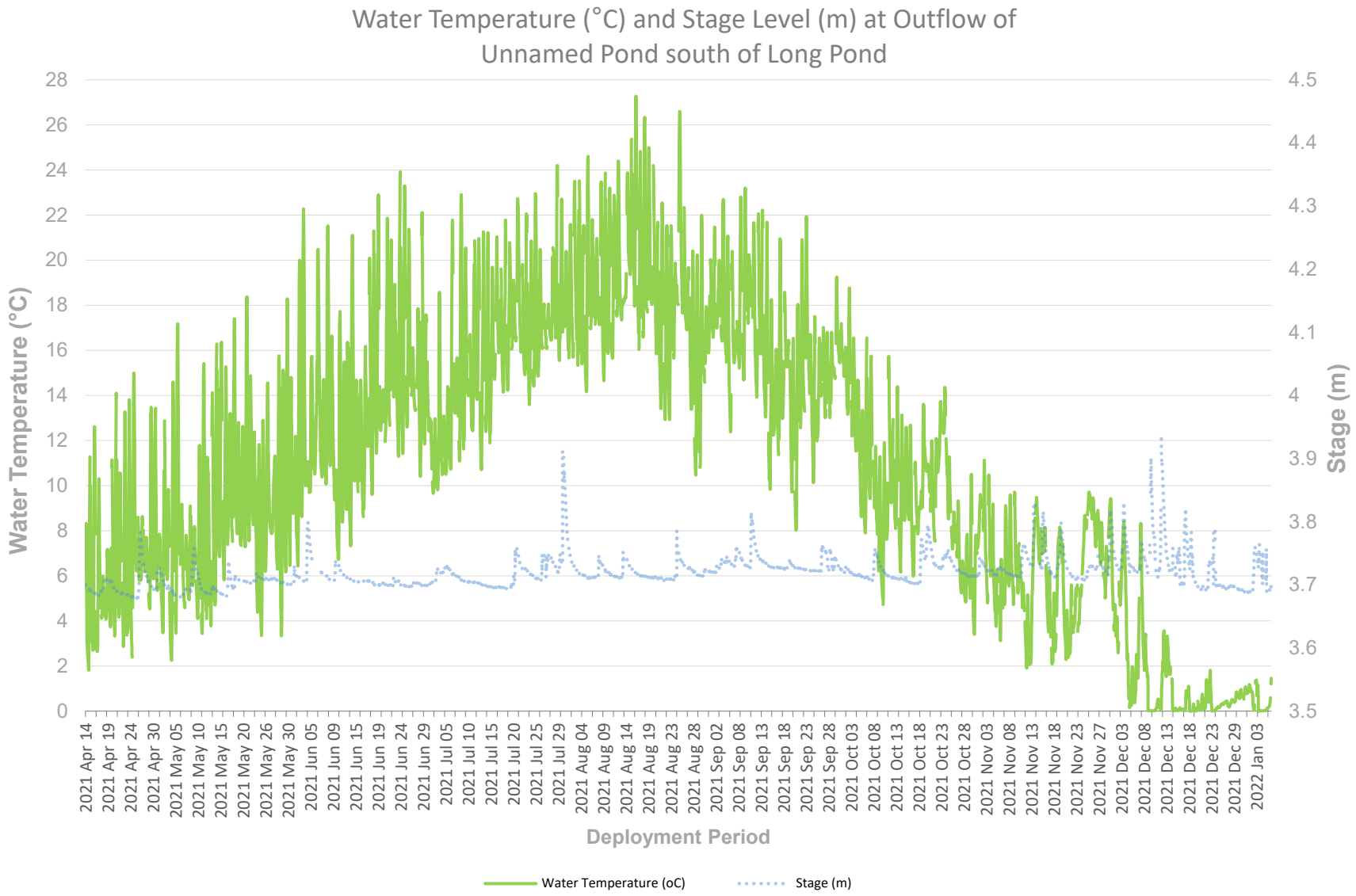


Figure 7. Water temperature recorded at the Real-Time Stations on CFI

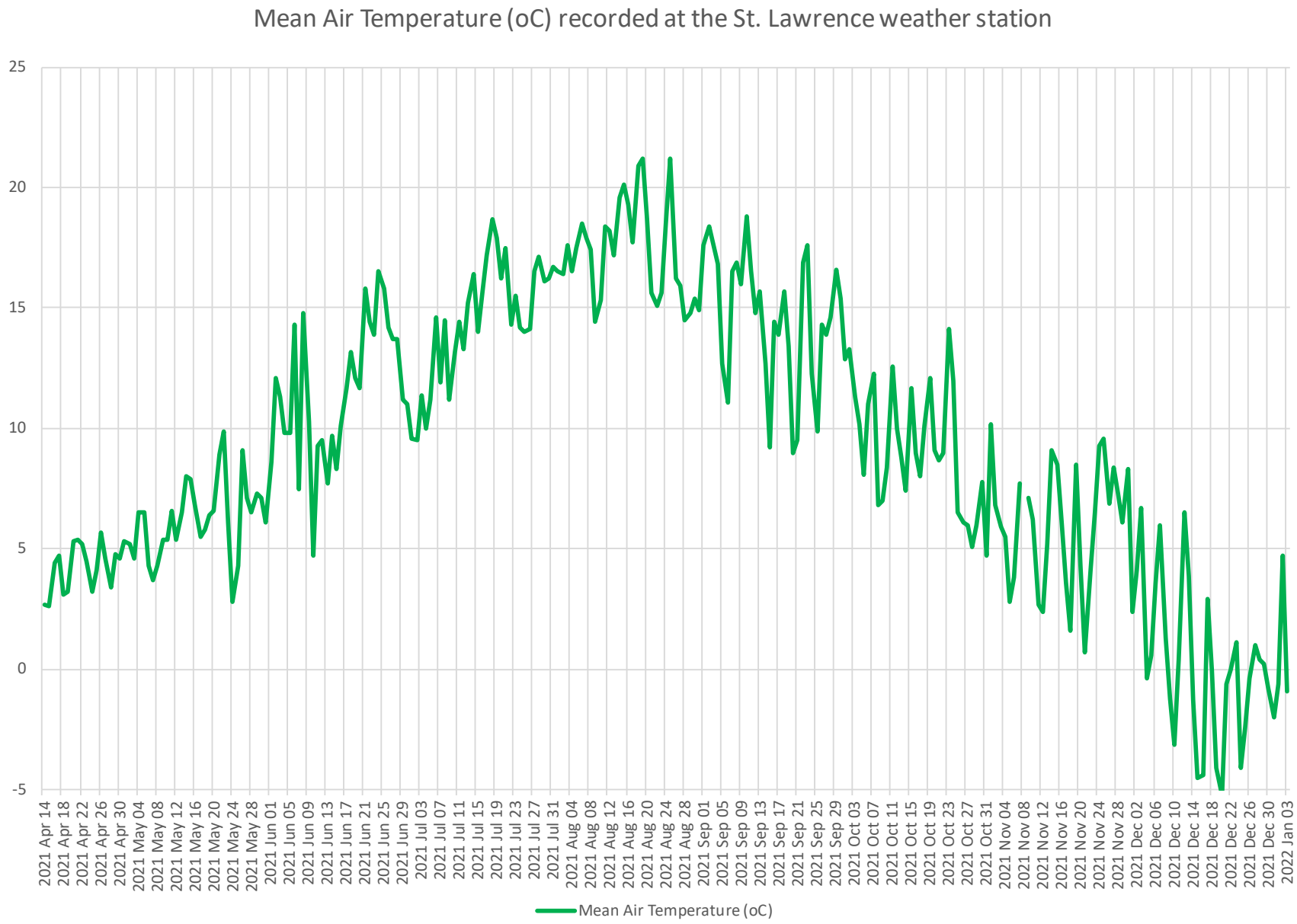


Figure 8: Mean Air temperature (°C) recorded at St. Lawrence Weather Station

pH

The Outflow of Grebes Nest Pond pH ranged from 6.88 to 8.35 (pH units) while Outflow of Unnamed Pond south of Long Pond station the pH ranged from 6.37 to 8.02 (Table 4).

Outflow of Grebes Nest Pond pH data displayed several days (highlighted in red circles) with decreased staged and decreased pH. The data indicated that, for a short period of time pH in the brook was slightly more acidic than background levels. Due to the nature of water that supplies Grebes Nest station it is likely that a substance was present in the water and ultimately impacted the pH. In all of the events indicated, pH did return to previous levels after a couple of days. Furthermore, across the deployment the pH data remained within the CCME guidelines for the protection of aquatic life: 6.5 -9.5 pH units.

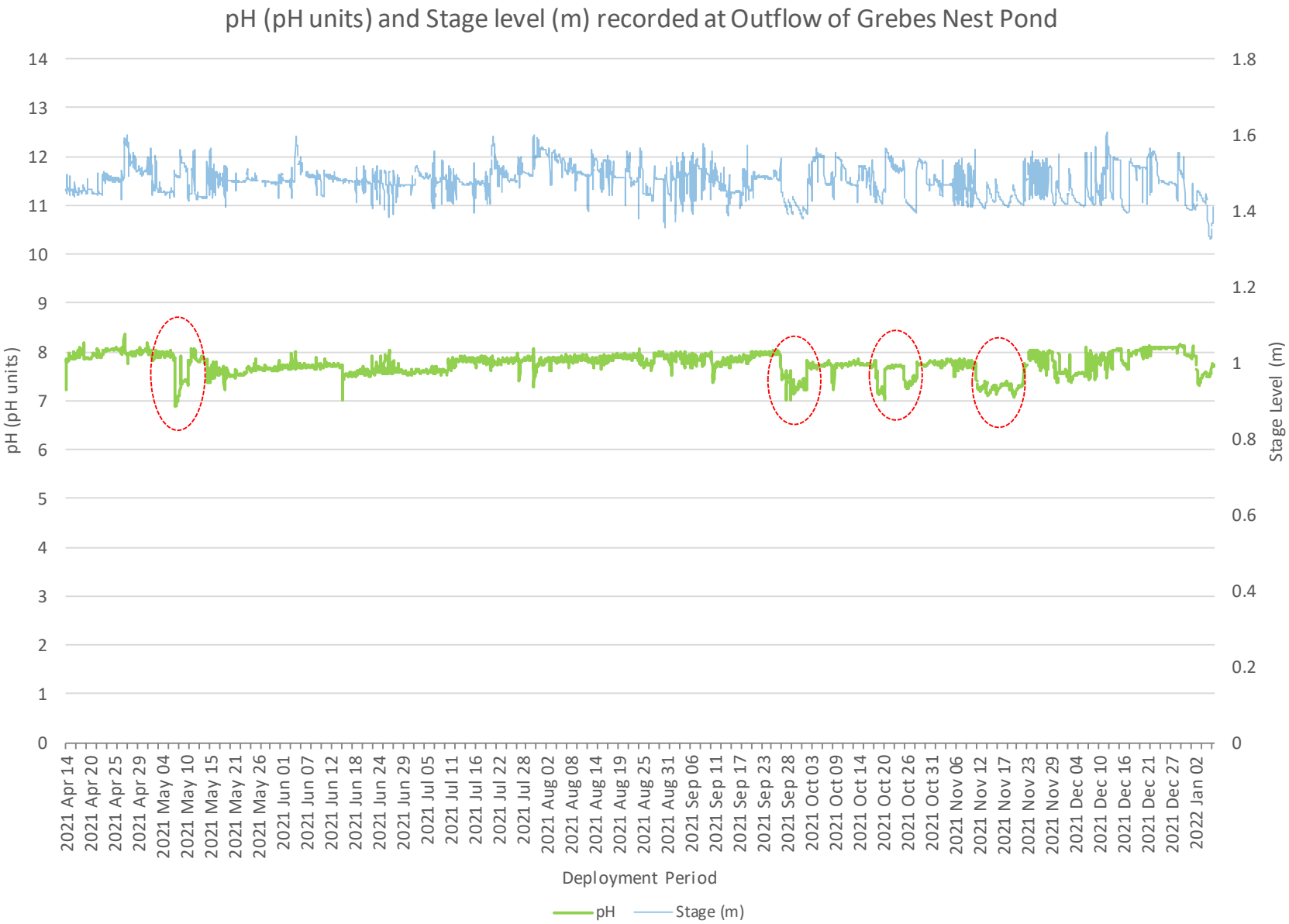
When comparing Grebes Nest pH median of 7.76 pH units from 2021, to 7.9 pH units in 2020, despite a slight decrease in the pH value in 2021 there is not a significant difference between the values.

Outflow of Unnamed Pond south of Long Pond is located downstream from a storage area for the mine tailings. On May 17th 2021 a pump failed at the sedimentation pond and sediment-laden water escaped into the watershed of Outflow of Unnamed Pond station. During this event the pH, conductivity and turbidity values increased for a period of a couple of days. The increase is evident on the graph around May 17th (highlighted in red). There was another recorded spike in pH on July 30, 2021, which corresponded with a significant total precipitation event of 44 mm, the highest record for this deployment (highlighted in purple). After both events the pH stabilized and returned to background levels.

pH levels remained relatively consistent at Outflow of Unnamed Pond throughout the year with the exceptions noted above. pH remained within the CCME pH guidelines for the majority of the deployment (Figure 9). The annual median at Unnamed Pond of 7.46 pH units was slightly higher than the median recorded during 2020 of 7.38 pH units (Appendix III).

Table 4. Summary of 2021 pH data at Fluorspar Real-Time Stations

	pH(pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.88	6.37
Max	8.35	8.02
Median	7.76	7.46


pH (pH units) and Stage level (m) recorded at Outflow of Grebes Nest Pond
pH (pH units)
Stage Level (m)
Deployment Period
pH
Stage (m)

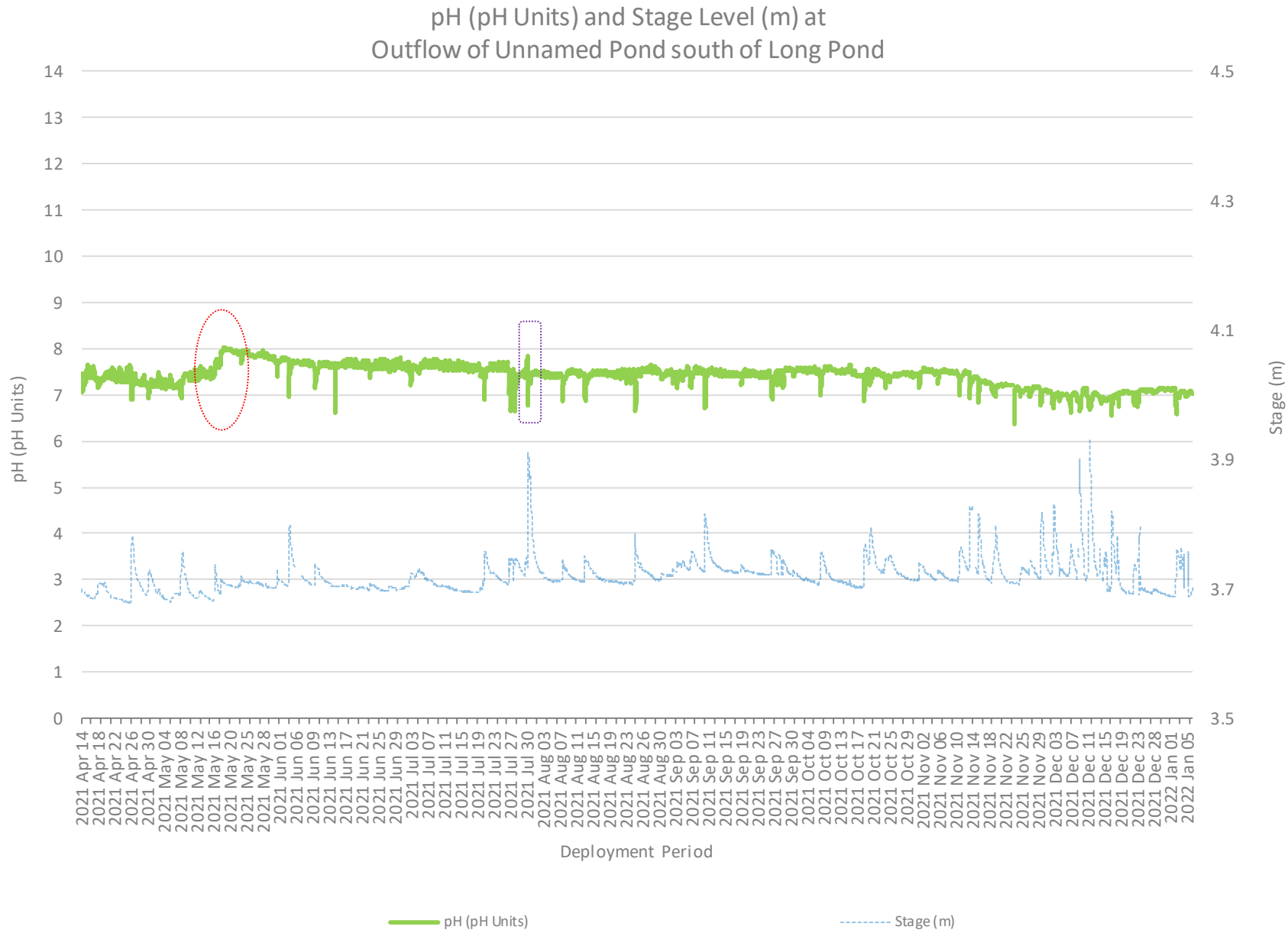


Figure 9: pH (pH units) at the Canada Fluorspar (NL) Inc Real-Time Stations

Specific Conductivity

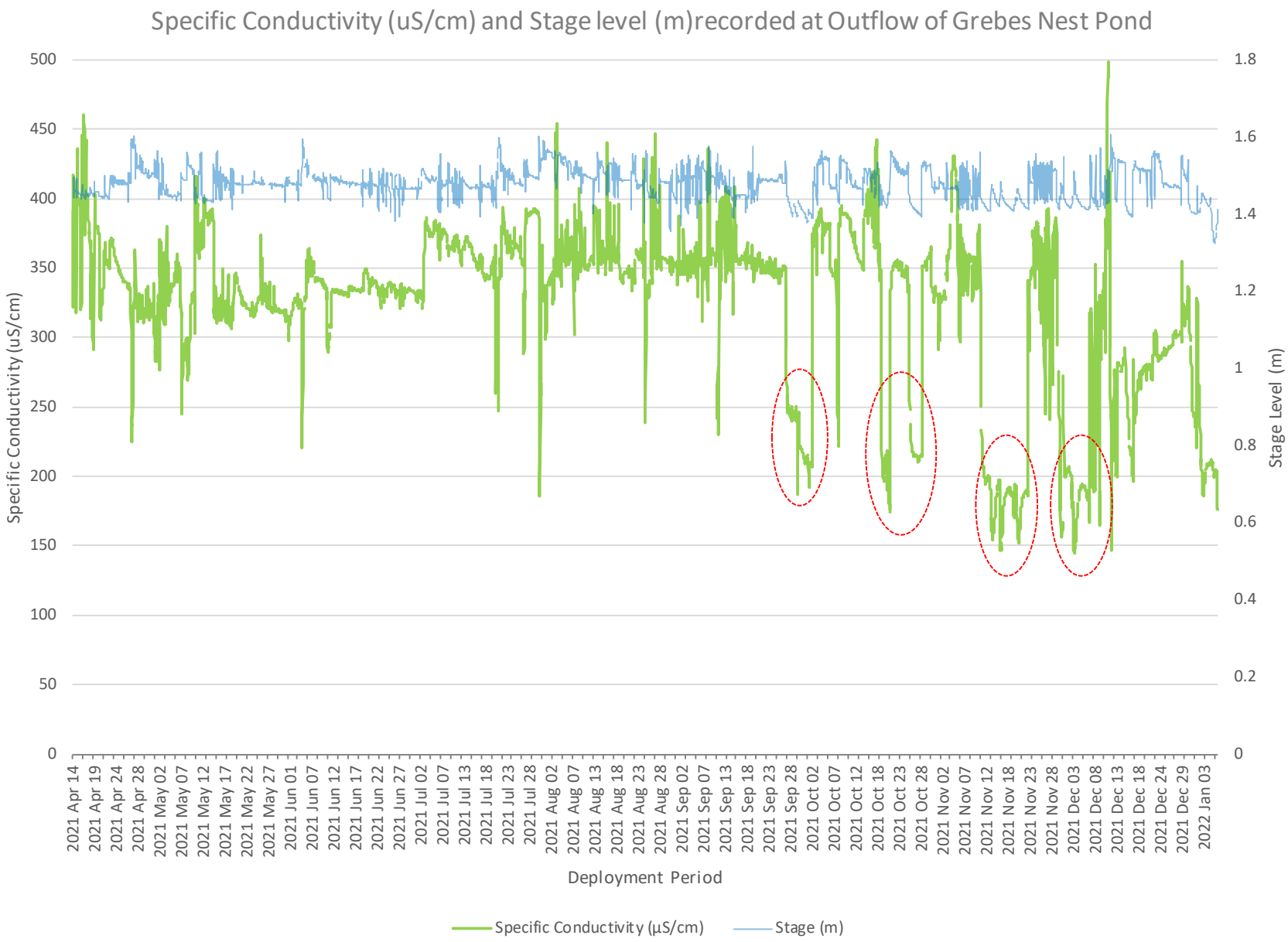
There is a direct relationship between conductivity and stage. Generally during rainfall events, the additional water dilutes the minerals and material present in the water column, lowering the conductivity levels. However, if sediment or materials from the surrounding environment are flushed into the brook, conductivity levels can increase. During the 2021 deployment year, conductivity levels ranged from 144.9 µS/cm to 497.95 µS/cm at Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond ranged from 76.08 µS/cm to 510.94 µS/cm.

Specific conductivity median recorded at Outflow of Grebes Nest Pond median of 341.1 µS/cm, slightly higher than the 2020 median for conductivity of 318.74 µS/cm (Appendix III). Conductivity at Outflow of Grebes Nest Pond was erratic. On several different occasions there were significant dips in the data (highlighted by the red circles) which corresponded with low stage level as well. Directly after these events, conductivity levels spiked as the stage increased. These actions can indicate that during the higher stage events the water supply into the brook had a substantial level of particulate matter that caused the higher conductivity data. Due to the type of water supplied into this brook it would be expected that there is a large amount of suspended material present in the water (Figure 10).

During the first deployment period, at Unnamed Pond south of Long Pond, a pump failed upstream at the sedimentation pond. Sediment-laden water escaped into the watershed of Outflow of Unnamed Pond station, highlighted on the graph by the spike in data circled in red (Figure 10). Conductivity levels remained high for approximately 15 days before settling to a lower range. There was another recorded spike in conductivity on July 30, 2021 (circled in purple) which corresponded with a total precipitation event of 44 mm, the highest record for this deployment. The majority of the decreases in conductivity were a result of precipitation events and for a period of time, when the stage levels increased the conductivity decreased (Figure 10). Conductivity levels started to decrease in September, but showed persistent variability between November and December (Figure 10).

Table 5. Summary of 2021 specific conductivity data at Fluorspar Real-Time Stations

	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	144.9	76.08
Max	497.95	510.94
Median	341.1	169.41


Specific Conductivity (uS/cm) and Stage level (m)recorded at Outflow of Grebes Nest Pond
Specific Conductivity (uS/cm)
Stage Level (m)
Deployment Period
Specific Conductivity (µS/cm)
Stage (m)

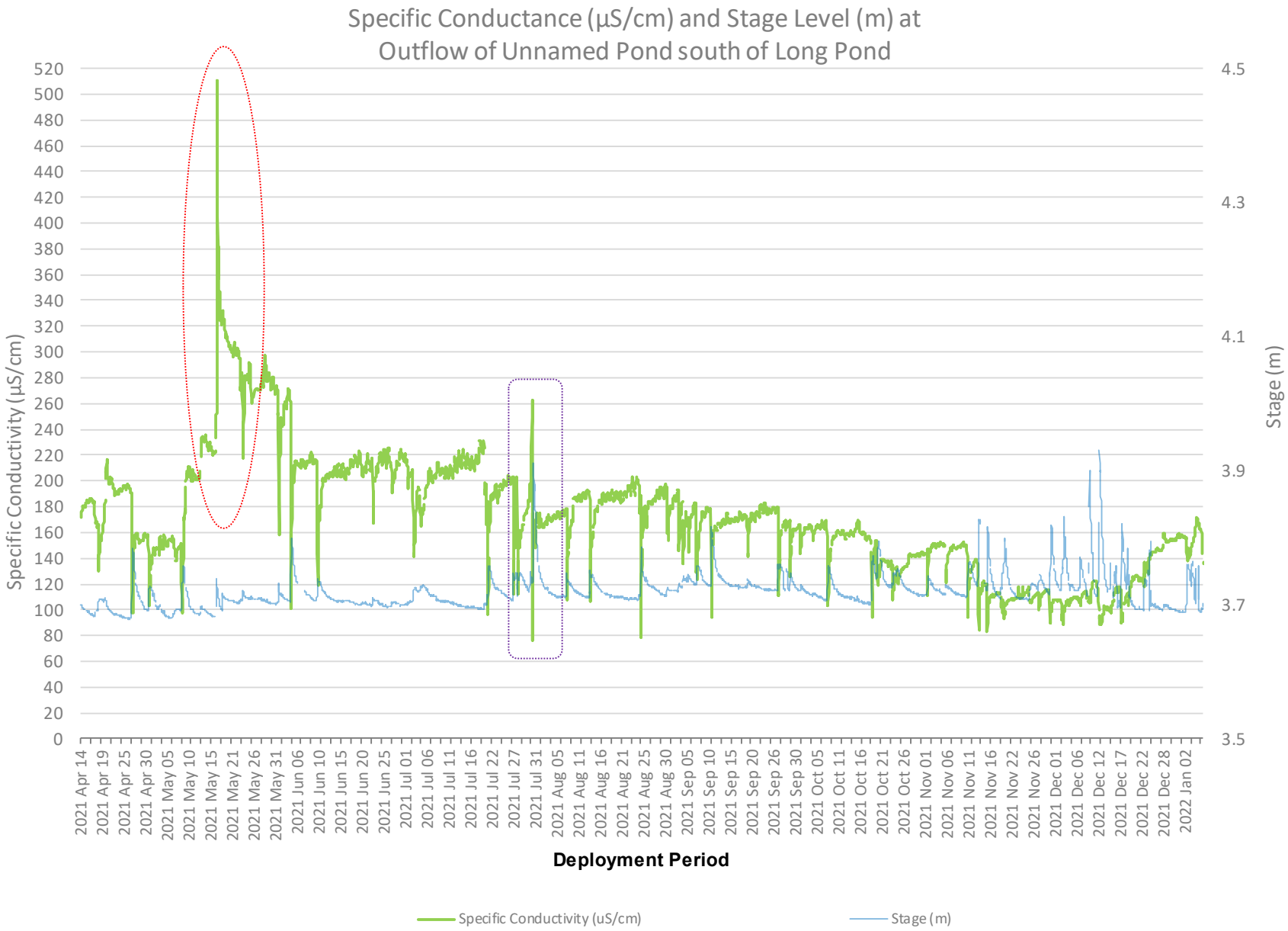


Figure 10: Specific conductivity (µS/cm) at the Canada Fluorspar (NL) Inc Real-Time Stations

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 8.91mg/L to 14.16mg/L at Outflow of Grebes Nest Pond. The percent saturation levels for dissolved oxygen ranged 85.8% Saturation to 108.6% Saturation. The median for 2021 season was 10.85mg/L which was similar to the median from 2020 of 10.96mg/L (Figure 11).

Outflow of Unnamed Pond south of Long Pond dissolved oxygen concentration ranged from 7.98 mg/L to 14.25 mg/L and Saturation ranged from 88.1 % to 118.4 %. The recorded median for 2021 was 10.93 mg/L, close to the median recorded for Unnamed Pond station in 2020 of 10.38 mg/L (Appendix III).

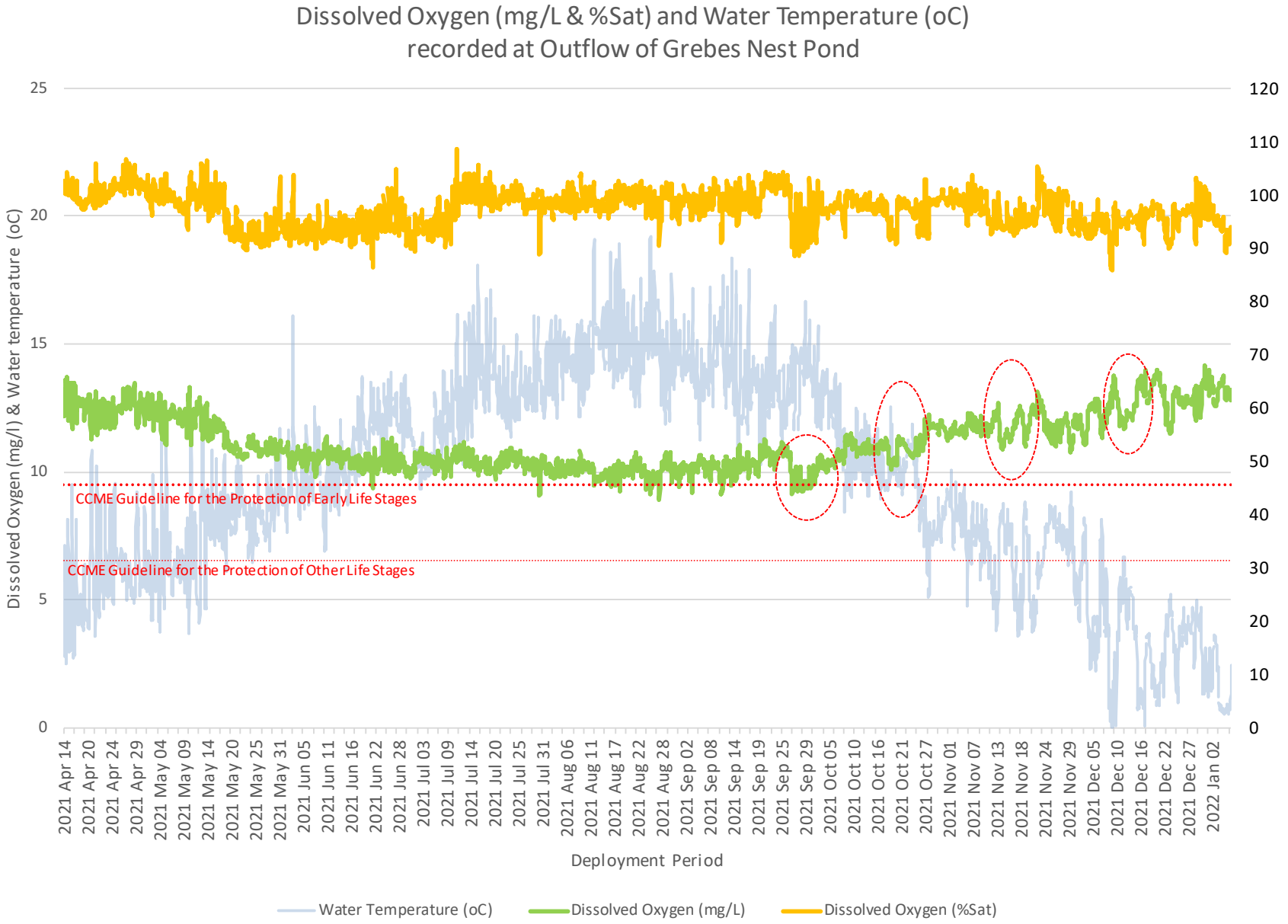
Dissolved oxygen levels displayed natural diurnal variations at both sites. These variations are related to daily fluctuations in temperature and photosynthetic cycling of CO^2 by aquatic organisms. Trends in DO corresponded with the inverse of water temperature as colder water has a greater potential to dissolve oxygen compared to warmer water. As a result, DO is generally higher in the spring, fall and winter when water temperatures are coolest. Unnamed Pond south of Long Pond displayed a brief shift in the DO data on November 23rd, 2021 when calibrated instrument was installed. The ranking of the DO probe on removal was 'Fair' indicating that there was likely interference on the sensor from debris or a buildup of sediment around the sensors at the time the instrument was removed for cleaning.

On the same days that pH and conductivity displayed decreases, the concentration of DO recorded at Outflow of Grebes Nest Pond displayed low readings (highlighted by the red circles). These changes also corresponded with low stage level. Furthermore, such as noted on pH and conductivity graphs, the DO returned to background levels after several days. Due to the type of water supplied into this brook it would be expected that there is a large amount of suspended material present in the water, which can greatly affect the presence of dissolved oxygen in the water column (Figure 10).

Dissolved Oxygen for both stations remained above the CCME Guideline for the Protection of Other Life Stages of Aquatic Life (6.5 mg/L) throughout the year and close to or above the guideline for the Protection of Early Life Stages (9.5 mg/L) for the majority of the year (Figure 11).

Table 6. Summary of 2021 Dissolved oxygen data at Fluorspar Real-Time Stations

	Grebes Dissolved Oxygen		Unnamed Pond Dissolved Oxygen	
	mg/L	%Sat	mg/L	%Sat
Min	8.91	85.8	7.98	88.1
Max	14.16	108.6	14.25	118.4
Median	10.85	97.6	10.93	98.4


Dissolved Oxygen (mg/L & %Sat) and Water Temperature (oC)
recorded at Outflow of Grebes Nest Pond
Dissolved Oxygen (mg/l) & Water temperature (oC)
Deployment Period
CCME Guideline for the Protection of Early Life Stages
CCME Guideline for the Protection of Other Life Stages
Water Temperature (oC)
Dissolved Oxygen (mg/L)
Dissolved Oxygen (%Sat)

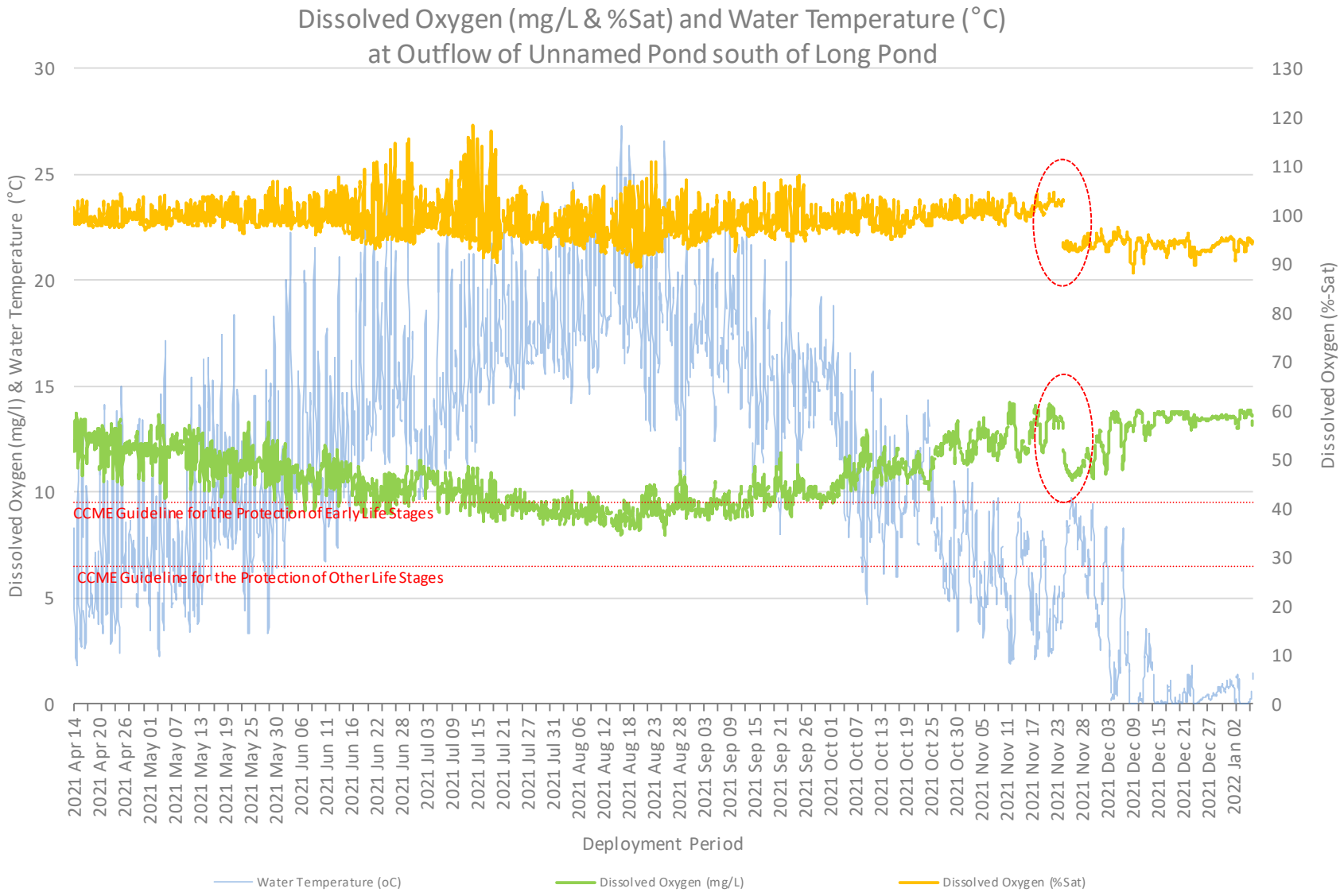


Figure 11: Dissolved Oxygen (mg/L & Percent Saturation) values

Turbidity

Turbidity levels during the deployment ranged from 0.8 NTU to 6616 NTU at Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond ranged 3.1 NTU to 792.5 NTU (Table 7). The medians for both stations were similar, with Outflow of Unnamed Pond south of Long Pond median at 20.0 NTU, and Outflow of Grebes Nest Pond with a median of 12.4 NTU (Table 7).

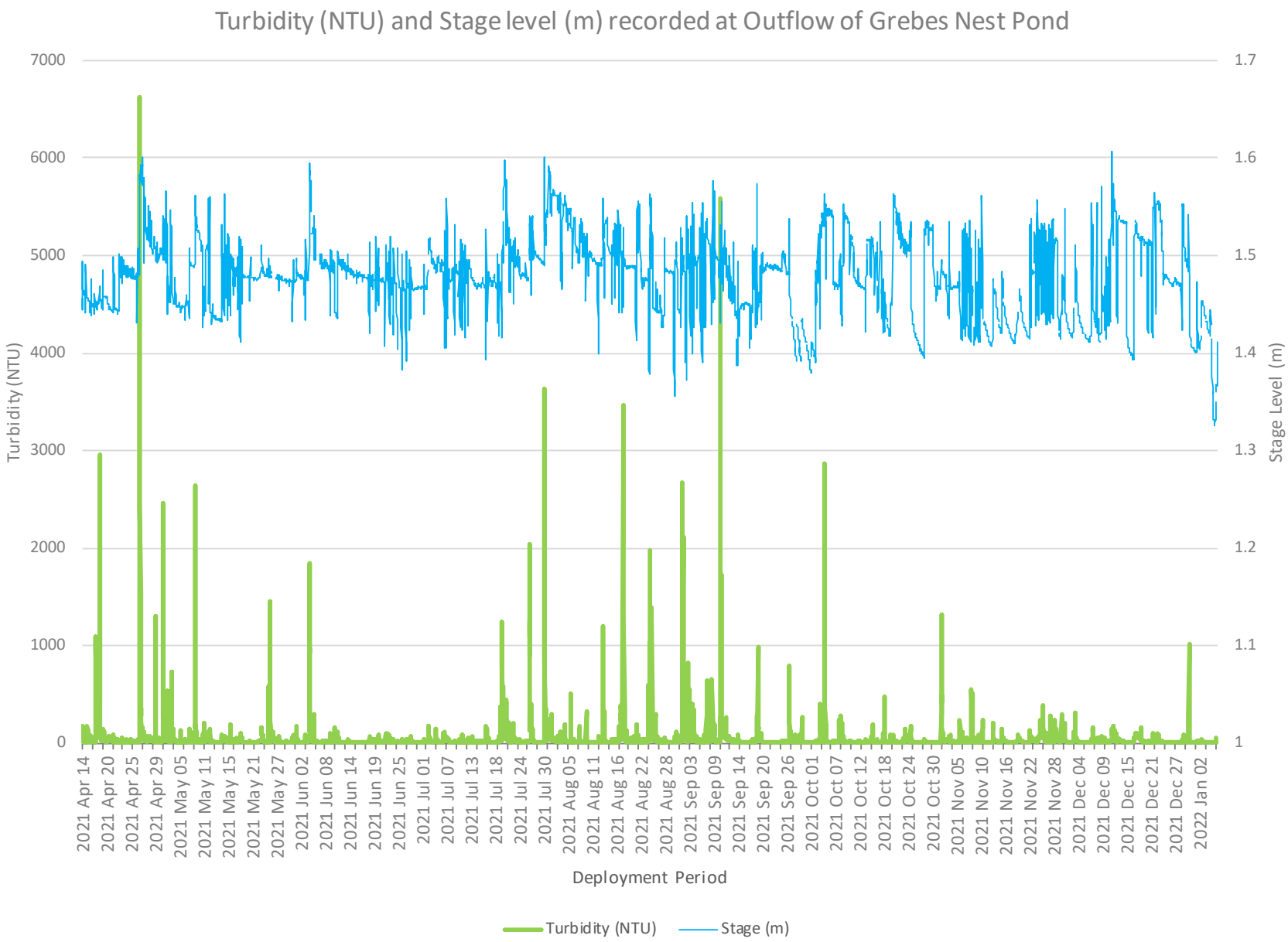
At Outflow of Grebes Nest Pond the spikes in turbidity were likely a result of the combined influence from sporadic pumping from the open pit mine and fluctuating stage levels from total precipitation events. At times, these factors can lead to the instrument recording data of theoretically, stagnant water (Figure 12). Should the sediment levels in the pit water increase, the water will be either redirected into a geo bag before being released into Grebes Nest brook or pumped directly into one of the sedimentation ponds.

On or around May 17th one of the pumps located at the perimeter of the large sedimentation pond stopped working. This allowed a volume of sediment laden water to flush into Outflow of Unnamed Pond south of Long Pond station. During this event the turbidity values increased for a couple of days. This is evident on Figure 12 by the largest turbidity spike recorded 792.5 NTU on May 17, 2021. Once the issue was identified the break in the pump was repaired within days. It took turbidity about 30 days to decrease to background levels.

The remaining increases in turbidity at Unnamed Pond station were a direct or indirect result of precipitation. For example, the turbidity increase on July 31, 2021 corresponded with the highest recorded total precipitation event for the season, of 44 mm (Figure 13). This was also the case on December 10th, 2021 when the turbidity spiked to 232.2 NTU, likely a result of the precipitation event 27.9 mm that occurred on and around December 9th, 2021. Outside of the large turbidity increases, the reminder of the deployment season saw turbidity levels around or below 50 NTU (Figure 12).

Table 7. Summary for 2021 Turbidity data at Fluorspar Real-Time stations

	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.8	3.1
Max	6616	792.5
Median	12.4	20.0


Turbidity (NTU) and Stage level (m) recorded at Outflow of Grebes Nest Pond
Turbidity (NTU)
Stage Level (m)
Deployment Period
Turbidity (NTU)
Stage (m)

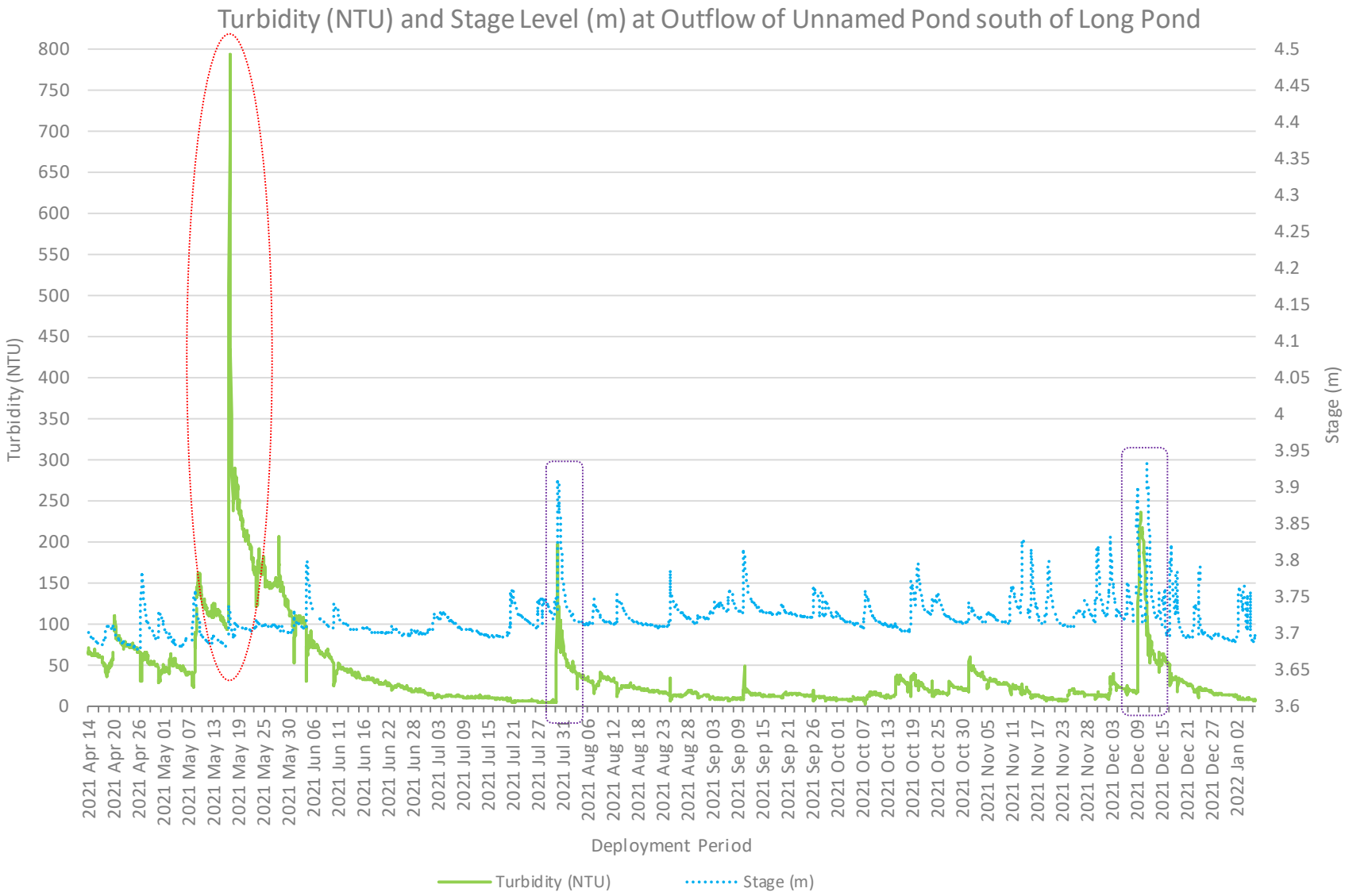


Figure 12: Turbidity (NTU) values at the Canada Fluorspar (NL) Inc Real-Time Stations

Total Precipitation & Daily Averaged Stage Data

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 1.606m (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 3.68m to a maximum of 3.96m. 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. Total Daily Precipitation for the deployment period ranged from 0.0 mm to a maximum of 44 mm, which occurred on July 30th 2021.

Table 9. Summary of 2021 Daily Averaged Stage data at Fluorspar Real-Time stations

	Daily Averaged Stage (m)	
	Outflow of Grebes	Outflow of Unnamed
Min	1.326	3.678
Max	1.606	3.967
Median	1.478	3.715
Mean	1.47	3.72

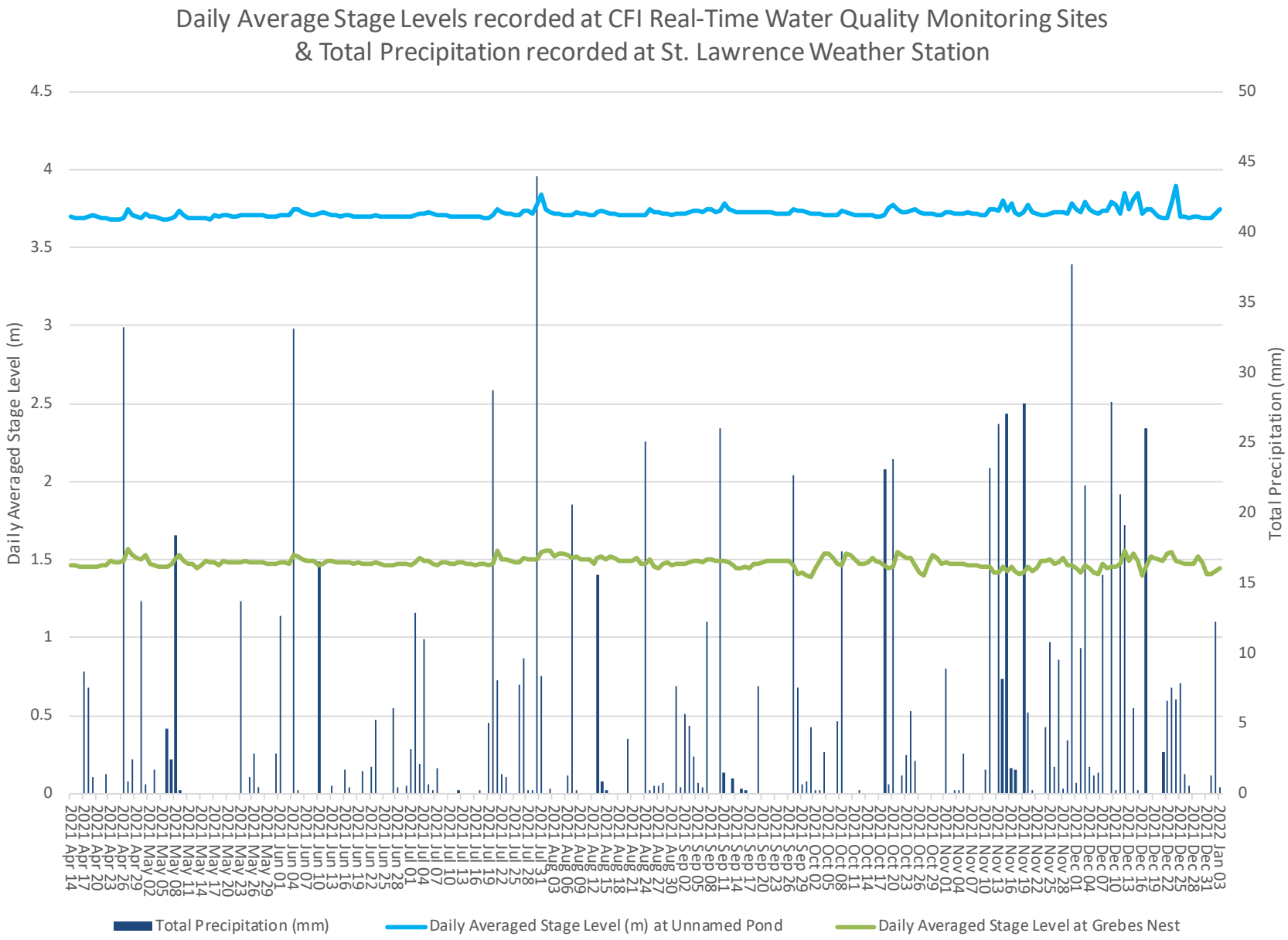


Figure 13: Daily Averaged stage values and total precipitation.

Conclusion

The water quality monitoring instruments for the Fluorspar network were deployed on both Outflow of Grebes Nest Pond and Outflow to Unnamed Pond south of Long Pond on April 14th, 2021 and removed for the winter season on January 3, 2022. 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 adjacent 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 level after a water quality event.

Throughout deployment, water temperatures followed the expected seasonal trend of increasing during the summer and decreasing into the fall. Outflow of Grebes Nest Pond pH data displayed several days with decreased staged and decreased pH. This indicated that, for a short period of time, pH in the brook was slightly more acidic than background levels. pH did return to previous levels after a couple of days.

Conductivity at Outflow of Grebes Nest Pond was erratic. On several different occasions, significant dips in the data corresponded with low stage level. Directly after these events, conductivity levels spiked as the stage increased. This may indicate that during the higher stage events the water supply into the brook had a substantial level of suspended sediment that caused the higher values. Due to the type of water supplied into this brook it would be expected that there is a large amount of suspended material present in the water**.** Outflow to Grebes Nest Pond continues to have ongoing turbidity spikes. It is likely the higher turbidity values are the result of low flow with limited flushing potential and a water supply that has a high silt content.

Outflow of Unnamed Pond south of Long Pond is located downstream from a storage area for the mine tailings. Due to equipment failure at the sedimentation pond, sediment-laden water escaped into the watershed of Outflow of Unnamed Pond station. During this event the pH, conductivity and turbidity values increased for a period of a couple of days.

While Outflow of Unnamed Pond south of Long Pond recorded the highest temperatures for this deployment year, the medians for both stations remained close in range with Unnamed site recording a 10.87°C and Grebes site recording 9.78°C. Toward the end of the deployment at Unnamed Pond there were significantly larger turbidity events which took longer to return to background levels. A cluster of precipitation events was recorded in November and December and may have contributed to the higher turbidity values and spike in conductivity as well.

Outside of the mentioned events at each of the stations, the water quality parameters displayed expected data for surface water bodies that can be periodically impacted by anthropogenic events.

Path Forward 2022

- The water quality instruments will undergo proficiency testing and evaluation during the winter of 2021-2022. ECC will inform Canada Fluorspar of any instrument performance issues.

- ECC staff will deploy real time water quality instruments in spring 2022, when ice conditions allow and perform regular site visits throughout the 2022 deployment season for calibration and maintenance of the instruments.

- If necessary, deployment techniques will be evaluated and modified, ensuring secure and suitable conditions for RTWQ monitoring.

- ECC will continue to work on its Automatic Data Retrieval System, to incorporate new capabilities in data management and data display.

- Ongoing liaison between ECC, ECCC and Canada Fluorspar in order to monitor or respond to emerging issues on a proactive basis. Canada Fluorspar will receive deployment reports and an annual report, summarizing the events of the deployment season throughout the year.

APPENDIX I

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 II

INSTRUMENT PERFORMANCE RANKINGS

2021 Instrument Performance Rankings

Station	Date	Action	2021 Deployment Season Comparision Ranking				
			Temperature	pH	Specific Conductivity	Dissolved Oxgyen	Turbidity
Outflow of Grebes Nest Pond	April 14, 2021	Deployment	Excellent	Fair	Excellent	Fair	Fair
	May 18, 2021	Removal	Excellent	Excellent	Good	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	April 14, 2021	Deployment	Fair	Excellent	Good	Excellent	Good
	May 18, 2021	Removal	Good	Excellent	Excellent	Excellent	Good
Outflow of Grebes Nest Pond	May 18, 2021	Deployment	Good	Good	Exceelent	Excellent	Fair
	June 15, 2021	Removal	Excellent	Good	Good	Excellent	Excellent
Outflow to Unnamed Pond south of Long Pond	May 18, 2021	Deployment	Good	Excellent	Excellent	Excellent	Good
	June 15, 2021	Removal	Excellent	Excellent	Excellent	Excellent	Good
Outflow of Grebes Nest Pond	June 15, 2021	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	July 27, 2021	Removal	Excellent	Fair	Fair	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	June 15, 2021	Deployment	Excellent	Good	Excellent	Excellent	Good
	July 27, 2021	Removal	Excellent	Excellent	Good	Good	Excellent
Outflow of Grebes Nest Pond	July 27, 2021	Deployment	Excellent	Good	Marginal	Excellent	Poor
	August 23, 2021	Removal	Excellent	Excellent	Excellent	Excellent	Good
Outflow to Unnamed Pond south of Long Pond	July 27, 2021	Deployment	Excellent	Good	Excellent	Excellent	Good
	August 23, 2021	Removal	Excellent	Excellent	Good	Good	Excellent
Outflow of Grebes Nest Pond	August 23, 2021	Deployment	Good	Excellent	Excellent	Excellent	Good
	September 28, 2021	Removal	Good	Good	Excellent	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	August 23, 2021	Deployment	Poor	Excellent	Excellent	Fair	Good
	September 28, 2021	Removal	Excellent	Excellent	Excellent	Excellent	Good
Outflow of Grebes Nest Pond	September 28, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Marginal
	November 23, 2021	Removal	Excellent	Good	Good	Excellent	Marginal
Outflow to Unnamed Pond south of Long Pond	September 28, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Good
	November 23, 2021	Removal	Good	Marginal	Fair	Fair	Good
Outflow of Grebes Nest Pond	November 23, 2021	Deployment	Excellent	Good	Good	Excellent	Good
	January 3, 2022	Removal	No	QA	readings	at this	time
Outflow to Unnamed Pond south of Long Pond	November 23, 2021	Deployment	Excellent	Excellent	Fair	Fair	Excellent
	January 3, 2022	Removal	No	QA	readings	at this	time

APPENDIX III

COMPARISON STATISTICS ACROSS DEPLOYMENTS AT CANADA FLUORSPAR INC

Canada Fluorspar (NL) Inc, Newfoundland and Labrador

Comparison Statistics from 2017		
	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

Comparison Statistics from 2018		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.03	-0.017
Max	22.586	25.642
Median	9.34	10.43
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.71	7.07
Max	7.81	8.37
Median	7.3	7.81
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	87.79	105.7
Max	649.3	535.34
Median	244.44	234.8
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	4.92	7.11
Max	15.18	14.76
Median	10.025	11
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	52.5	63.7
Max	114.8	105.8
Median	89.3	98.7
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	4.23	0
Max	1341.9	76.8
Median	60.3	13.2

Comparison Statistics from 2019		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	2.41	-0.04
Max	22.58	26.88
Median	9.54	11.62
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.21	7.31
Max	8.13	8.44
Median	7.6	8.01
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	190.2	182.12
Max	586.91	507.59
Median	344.145	357.94
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.36	7.98
Max	13.27	14.59
Median	10.41	10.81
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	70.7	90.8
Max	131	103.6
Median	90.6	98.4
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.4	6.5
Max	3548.1	166
Median	24.3	48.6

Comparison Statistics from 2020		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	1.93	-0.02
Max	20.4	27.1
Median	10.33	12.75
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.06	6.66
Max	8.21	7.87
Median	7.9	7.38
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	86.16	66.04
Max	456	221.76
Median	318.74	154.97
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	9.18	8.04
Max	13.89	14.94
Median	10.96	10.38
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	86.1	88
Max	116.7	124.1
Median	97.9	99.3
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.6	3.9
Max	4117.1	280.6
Median	24.35	21.9

Comparsion Statistics from 2021		
	Water Temperature (oC)	
	Outflow of Grebes	Outflow of Unnamed
Min	0	-0.01
Max	19.2	27.28
Median	9.78	10.87
	pH(pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.88	6.37
Max	8.35	8.02
Median	7.76	7.46
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	144.9	76.08
Max	497.95	510.94
Median	341.1	169.41
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	8.91	7.98
Max	14.16	14.25
Median	10.85	10.93
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	85.8	88.1
Max	108.6	118.4
Median	97.6	98.4
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.8	3.1
Max	6616	792.5
Median	12.4	20