



Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake/Joan Brook Network

Deployment Period
2018-06-19 to 2018-07-25



Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
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General

- The Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment and Climate Change Canada, maintains three real-time water quality and water quantity stations in close proximity to the Elross Lake Iron Ore Mine in western Labrador, near Schefferville, QC.
- The official name of each station is ELROSS CREEK BELOW PINETTE LAKE INFLOW, GOODREAM CREEK 2KM NORTHWEST OF TIMMINS 6, and JOAN BROOK BELOW OUTLET OF JOAN LAKE, hereafter referred to as the *Elross Creek Station*, the *Goodream Creek Station*, and the *Joan Brook Station*, respectively.
- **Please note that the Goodream Creek Station has been temporarily shut down to allow for moving the station to a new location further downstream near Triangle Lake. It is hoped that this move will be completed early in the 2019 field season and that the station will be fully operational at the new location before the end of the 2019 field season.**
- Station sites were selected to monitor all surface water outflows from the Elross Lake and the DSO4 Project 2B mining sites. The Elross Creek Station is situated downstream of the Timmins 1 pit, and downstream of Pinette Lake. The original Goodream Creek Station served to monitor potential impacts from groundwater flowing from Timmins 6 pit into the surface water of Goodream Creek. The new Goodream Station will monitor impacts from the development of the Howse deposit. The Joan Brook station is downstream of the five pits (Kivivic 1, 2, 3N, 4 and 5) which are included in the DSO4 Project 2B mining operation.
- The Water Resources Management Division will inform Tata Steel Minerals Canada Limited of any significant water quality events by email notification and by monthly deployment reports.
- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Joan Brook stations from June 19th, 2018 to July 25th, 2018, which was the first deployment period for the 2018 field season. It should be noted that due to a very late spring the start of this field season was delayed by several weeks.

Quality Assurance / Quality Control

- Water quality instrument performance is tested at the beginning and end of its deployment period. The process is outlined in Appendix A.
- Instruments are assigned a performance rating (i.e., poor, marginal, fair, good or excellent) for each water quality parameter measured.
- Table 1 shows the performance ratings of five water quality parameters (i.e., temperature, pH, specific conductivity, dissolved oxygen and turbidity) measured by instruments deployed at the water monitoring stations.

- With the exception of water quantity data (stage height), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Table 1: Water quality instrument performance at the beginning and end of deployment

| | Elross Creek | | Joan Brook | |
|-----------------------|--------------|-----------|------------|-----------|
| Stage of deployment | Beginning | End | Beginning | End |
| Date | 2018-6-19 | 2018-7-24 | 2018-6-20 | 2018-7-25 |
| Temperature | Excellent | Excellent | Excellent | Excellent |
| pH | Good | Excellent | Excellent | Good |
| Specific Conductivity | Excellent | Excellent | Excellent | Excellent |
| Dissolved Oxygen | Fair | Good | N.A.* | Excellent |
| Turbidity | Excellent | Fair | Excellent | Excellent |

**Due to a technical issue with the QA/QC sonde oxygen readings were not available at the time of deployment.*

- The performance of all sensors at both stations was within acceptable limits during this deployment period (Table 1).

Deployment Notes

- Water quality monitoring for this deployment period started at on June 19th, 2018 at Elross Creek and June 20th, 2018 at Joan Brook. Continuous real-time monitoring continued at Elross Creek until July 24th, 2018, and at Joan Brook until July 25th. Both stations ran for the full deployment period with only minor operational issues.

Data Interpretation

- Data records were interpreted for each station during the deployment period for the following six parameters:
 - (i.) Stage (m)
 - (ii.) Temperature (°C)
 - (iii.) pH
 - (iv.) Specific conductivity (µS/cm)
 - (v.) Dissolved oxygen (mg/l)
 - (vi.) Turbidity (NTU)

Stage

- The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- During the deployment period covered by this report, stage height values ranged from 1.11 m to 1.23 m at Elross Creek,, and from 1.49 m to 1.59 m at Joan Brook (Figures 1 & 2). Stage height is directly related to the volume of flow in a stream, as defined by a rating curve which is unique for every site.
- Please note that stage height data for Joan Brook was missing for about five days from June 21st to 26th, for a day or so around July 1st and again around July 7th, due to technical issues with the data transmission system.

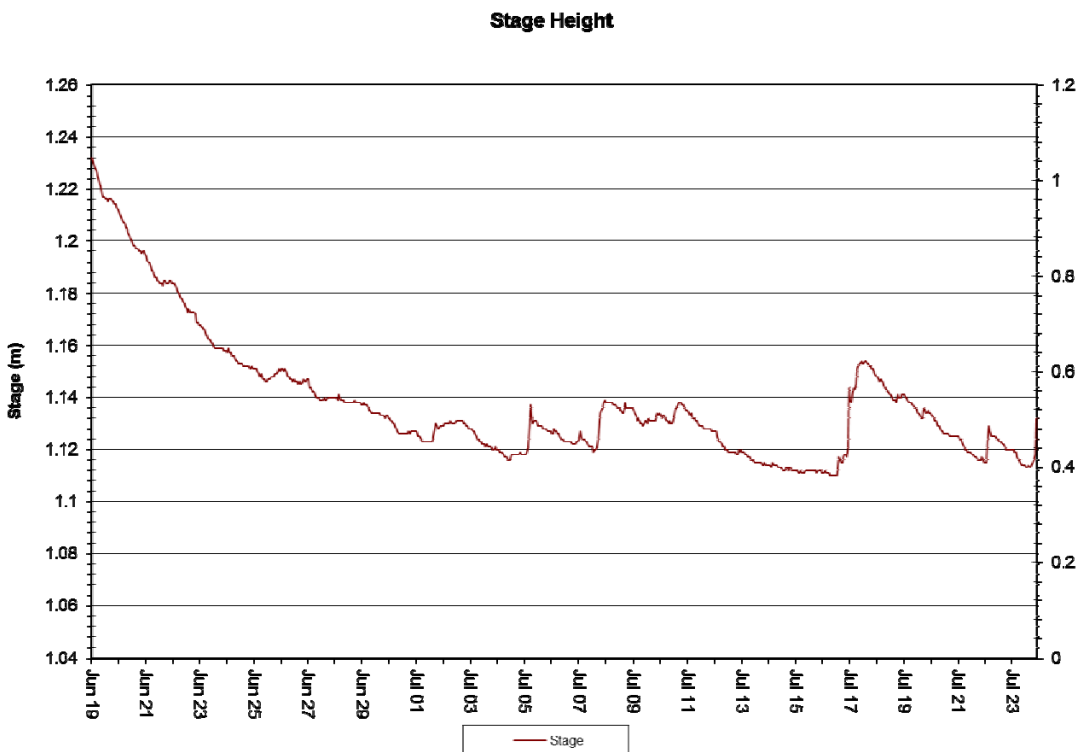


Figure 1: Stage Height (m) at Elross Creek – June 19, 2018 to July 24, 2018

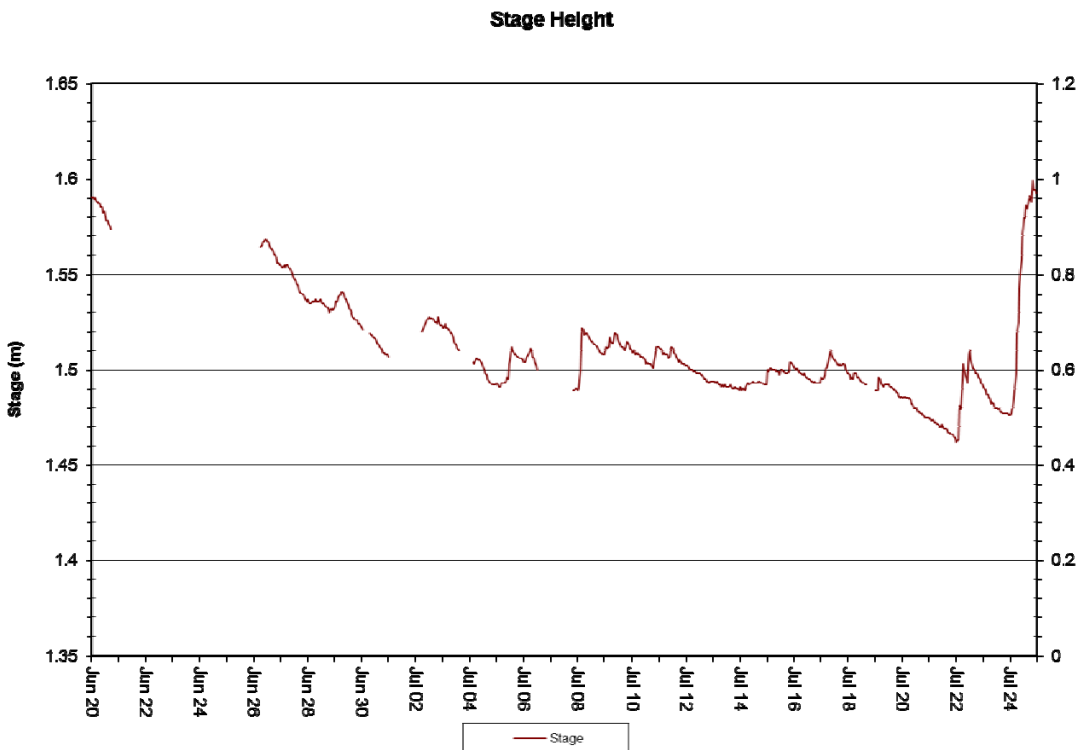


Figure 2: Stage Height (m) at Joan Brook – June 20, 2018 to July 25, 2018

Temperature

- The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- During the deployment period covered by this report, water temperature ranged from - 2.70°C to 15.50°C at Elross Creek, and from 0.83 °C to 16.10 °C at Joan Brook (Figures 3 & 4).
- Both stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- At both Elross Creek and Joan Brook there is an increasing temperature trend which is consistent with the transition from late spring to summer.

Water Temperature and Stage Level

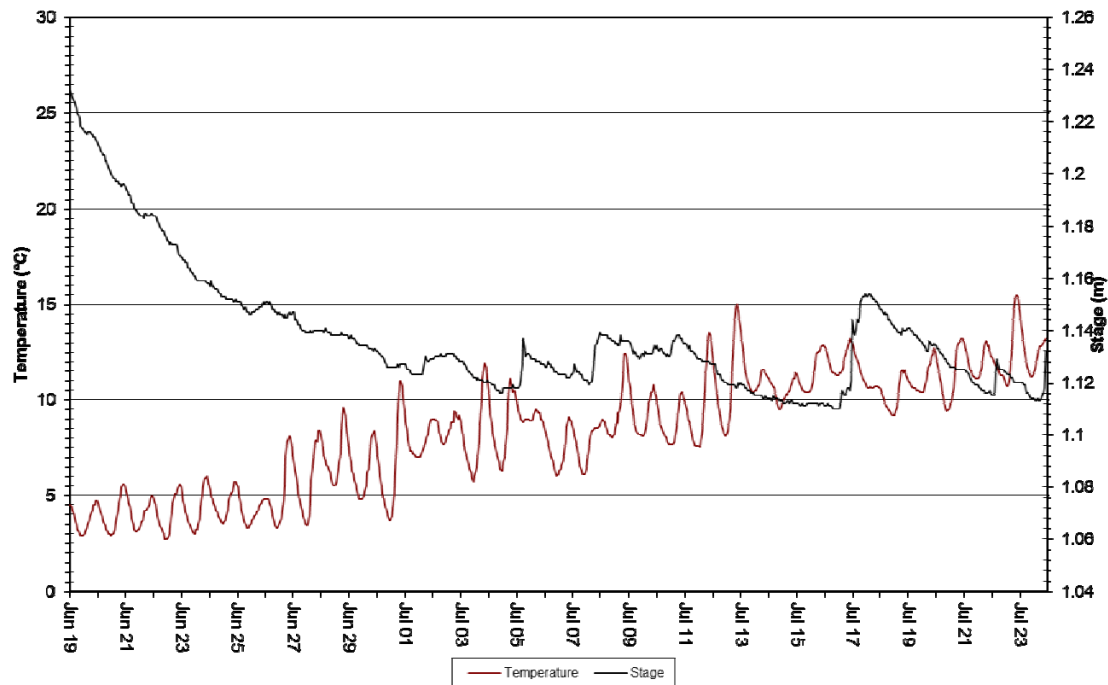


Figure 3: Temperature (°C) - Elross Creek – June 19, 2018 to July 24, 2018

Water Temperature and Stage Level

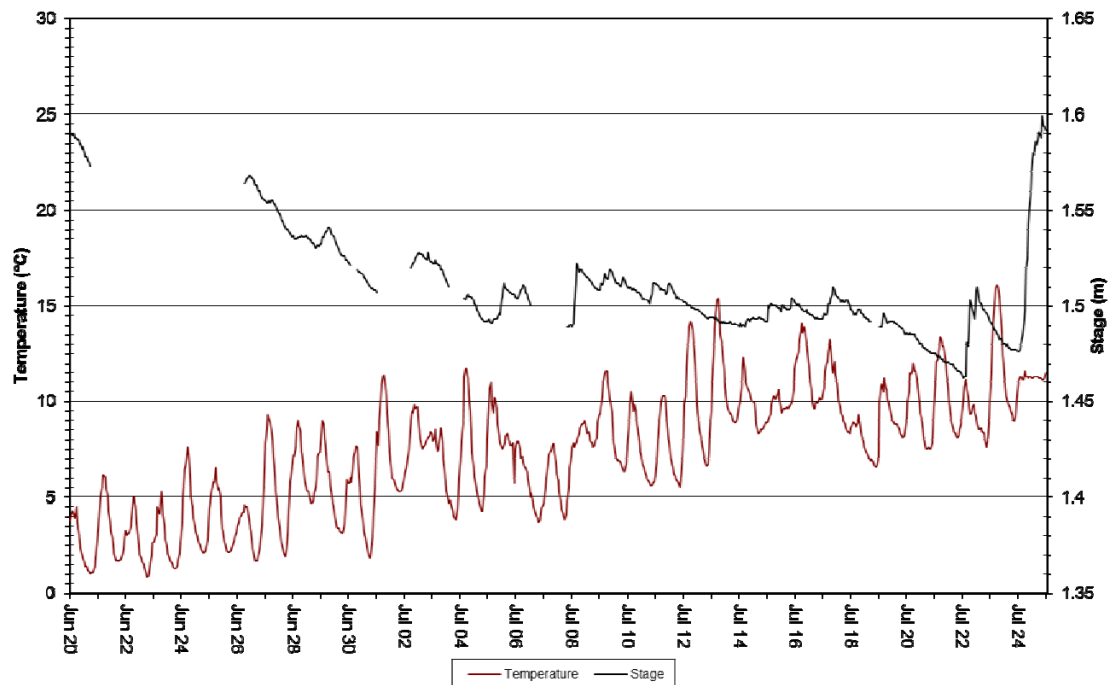


Figure 4: Temperature (°C) – Joan Brook – June 20, 2018 to July 25, 2018

pH

- The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- During the deployment period covered by this report, pH values ranged from 5.63 units to 6.39 units at Elross Creek, and from 6.30 units to 6.78 units at Joan Brook (Figures 5 & 6).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is visible at both stations.
- pH appears to be relatively stable at both stations during this deployment period.
- With a median value of 6.15 units, pH values at Elross Creek are just below the minimum guideline set for the protection of aquatic life (i.e., 6.5 units), as defined by the Canadian Council of Ministers of the Environment (CCME) (2007). At Joan Brook the median pH value is 6.67 units with almost all values just above the minimum guideline range. It should be noted that acidic waters are quite common in Canada, particularly in boreal and northern ecoregions, and pH is often naturally below the 6.5 unit guideline.

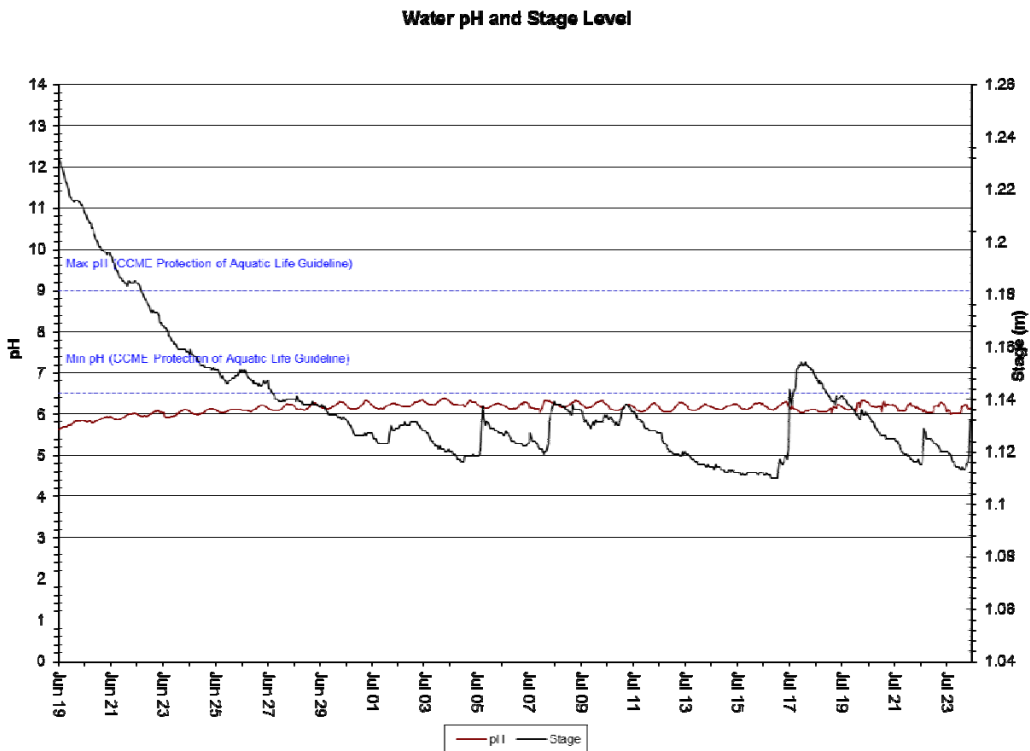


Figure 5: pH at Elross Creek – June 19, 2018 to July 24, 2018

Water pH and Stage Level

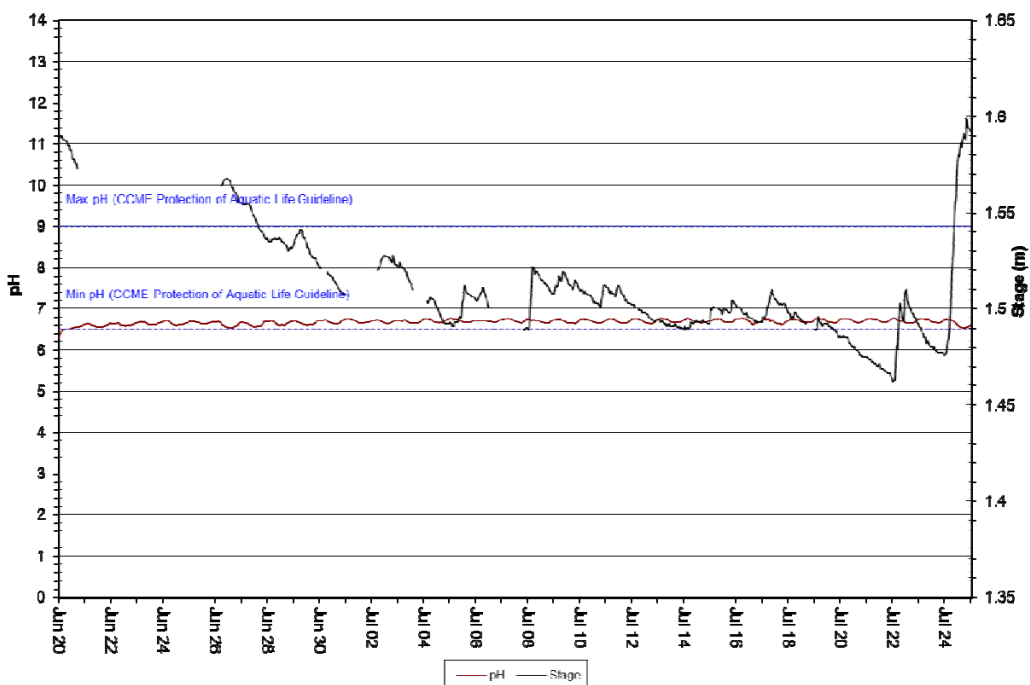


Figure 6: pH at Joan Brook – June 20, 2018 to July 25, 2018

Specific Conductivity

- The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- During the deployment period covered by this report, specific conductivity ranged from 4.7 $\mu\text{S}/\text{cm}$ to 15.6 $\mu\text{S}/\text{cm}$ at Elross Creek, and from 5.3 $\mu\text{S}/\text{cm}$ to 10.2 $\mu\text{S}/\text{cm}$ at Joan Brook (Figures 7 & 8).
- Specific conductivity normally shows clear diurnal trends which are related to the diurnal temperature trend.

Specific Conductivity of Water and Stage Level

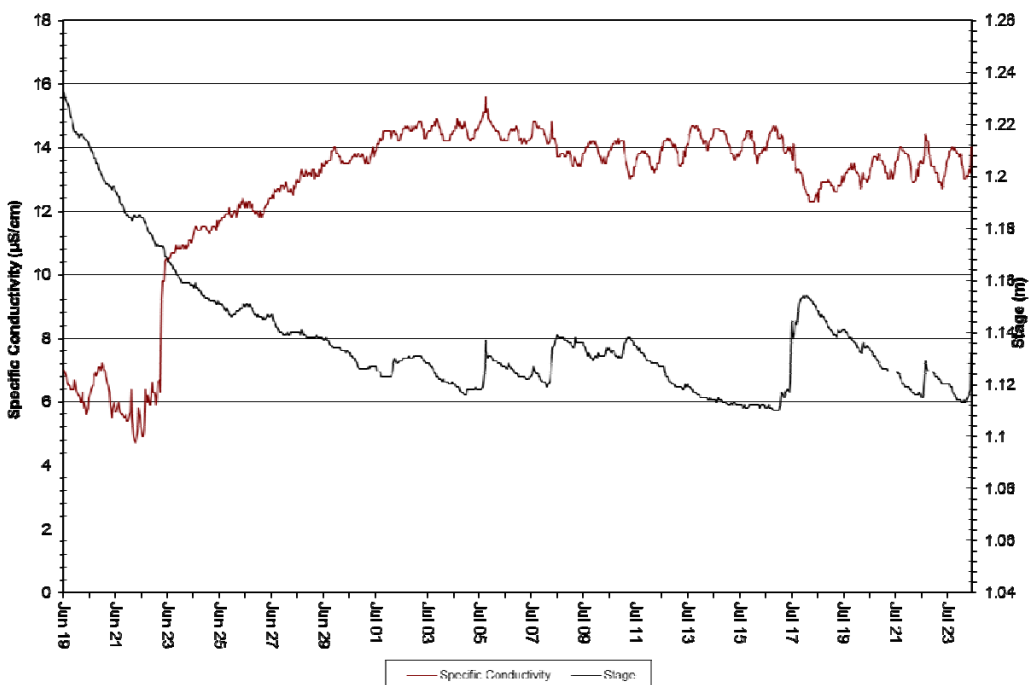


Figure 7: Specific Conductivity at Elross Creek – June 19, 2018 to July 24, 2018

Specific Conductivity of Water and Stage Level

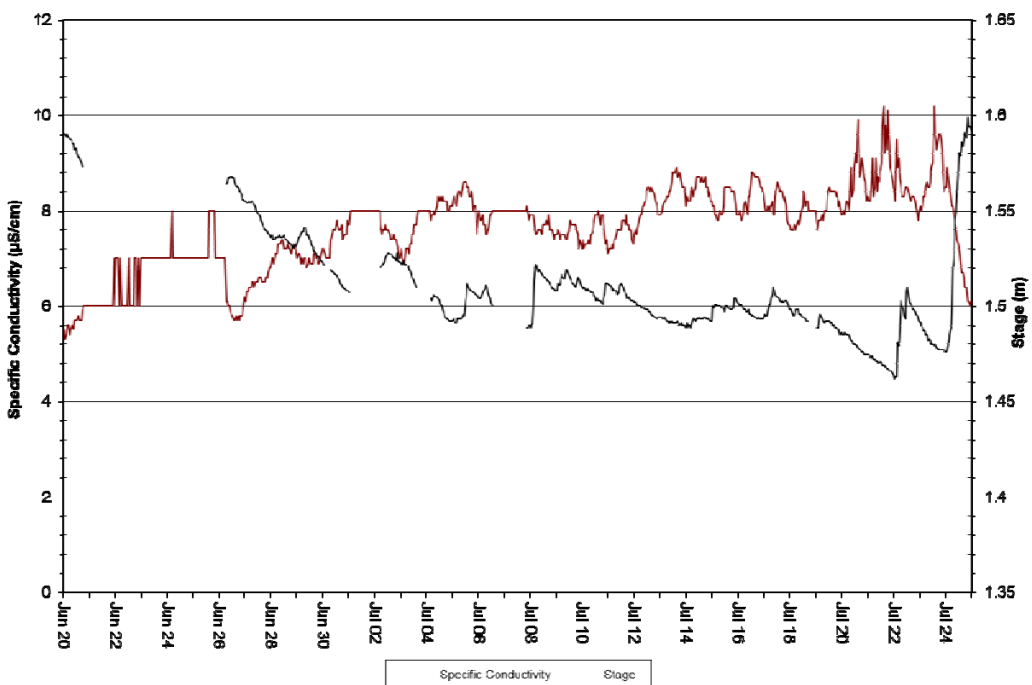


Figure 8: Specific Conductivity at Joan Brook – June 20, 2018 to July 25, 2018

Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.20 mg/l (82.2% saturation) to 10.97 mg/l (92.4% saturation) at Elross Creek, and from 9.08 mg/l (91.8% saturation) to 12.74 mg/l (100.7% saturation) at Joan Brook (Figures 9 & 10).
- DO was relatively stable over the deployment period for both stations.
- At both stations there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- The DO values at Elross Creek and Joan Brook are above the minimum guidelines set for other life stages (6.5 mg/l) and near or above the minimum guideline set for cold-water biota during early life stages (9.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).

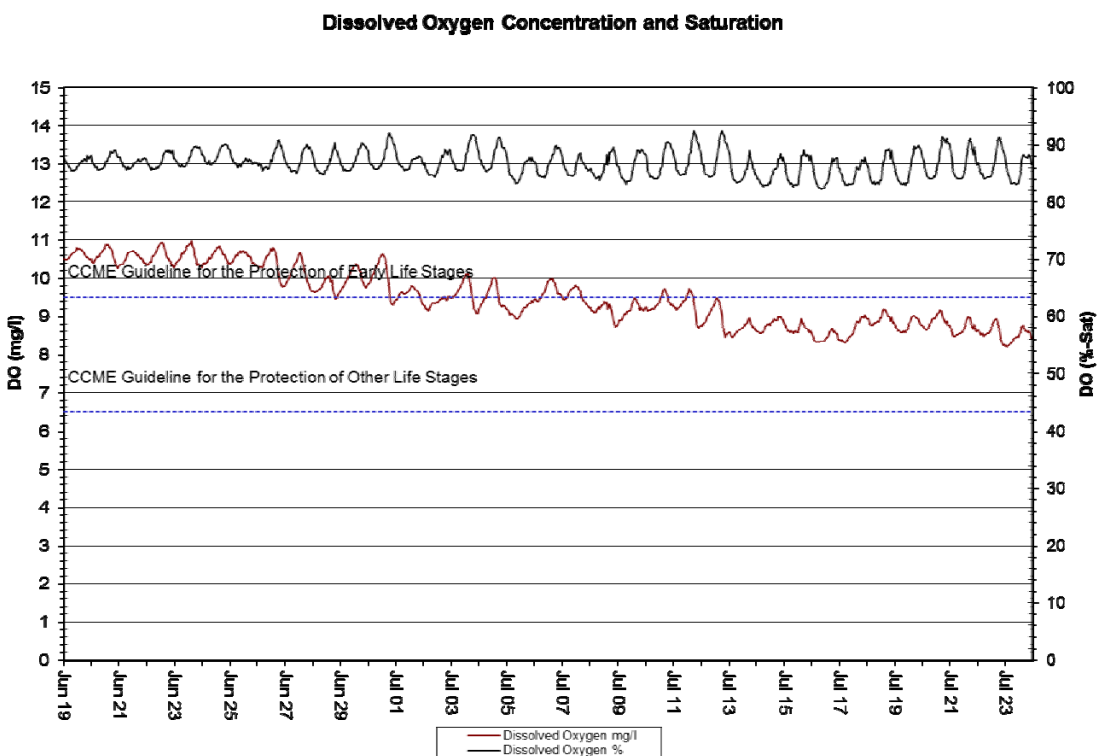


Figure 9: DO (mg/l & % Sat.) at Elross Creek – June 19, 2018 to July 24, 2018

Dissolved Oxygen Concentration and Saturation

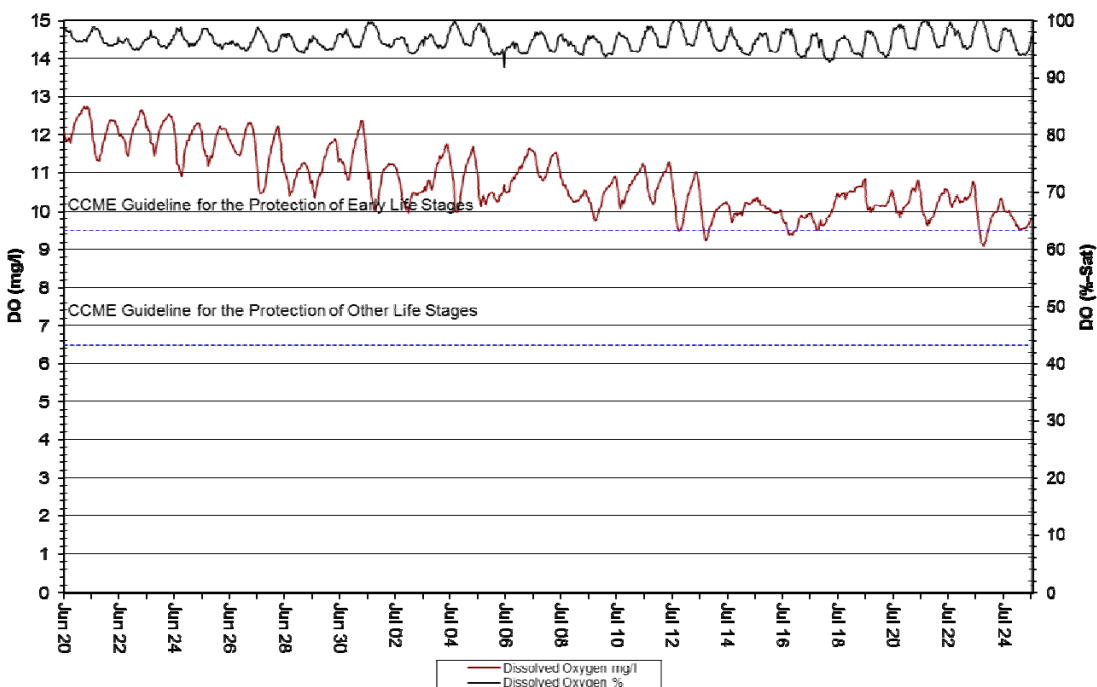


Figure 10: DO (mg/l & % Sat.) at Joan Brook – June 20, 2018 to July 25, 2018

Turbidity

- The stage data is raw data that is transmitted via satellite and published on our web page. It has not been corrected for backwater effect. The Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- During the deployment period covered by this report, turbidity values ranged from 3.0 NTU to 2768.0 NTU at Elross Creek, and from 0.4 NTU to 799.0 NTU at Joan Brook (Figures 11 & 12).
- At Elross Creek there is a significant spike in turbidity on July 17th (see inside red oval) which is most likely related to significant precipitation for the same time period.
- At Joan Brook there are two significant spikes in turbidity on June 26th and July 24th (see inside red ovals) which are most likely related to significant increases in flow from snowmelt and or precipitation events.

Water Turbidity and Stage Level

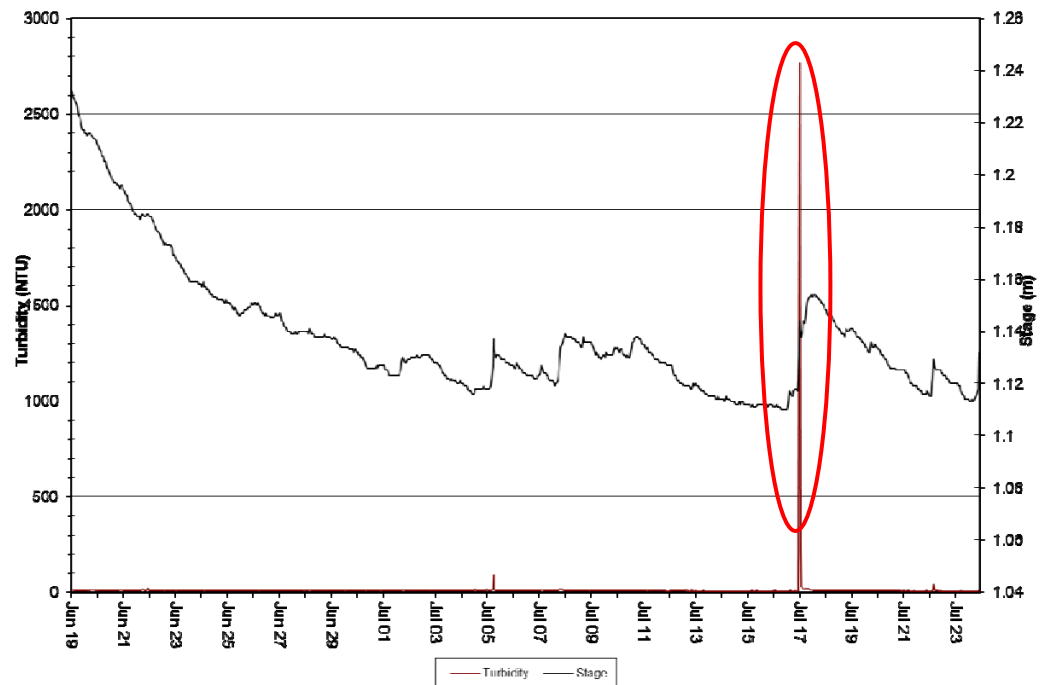


Figure 11: Turbidity (NTU) at Elross Creek – June 19, 2018 to July 24, 2018

Water Turbidity and Stage Level

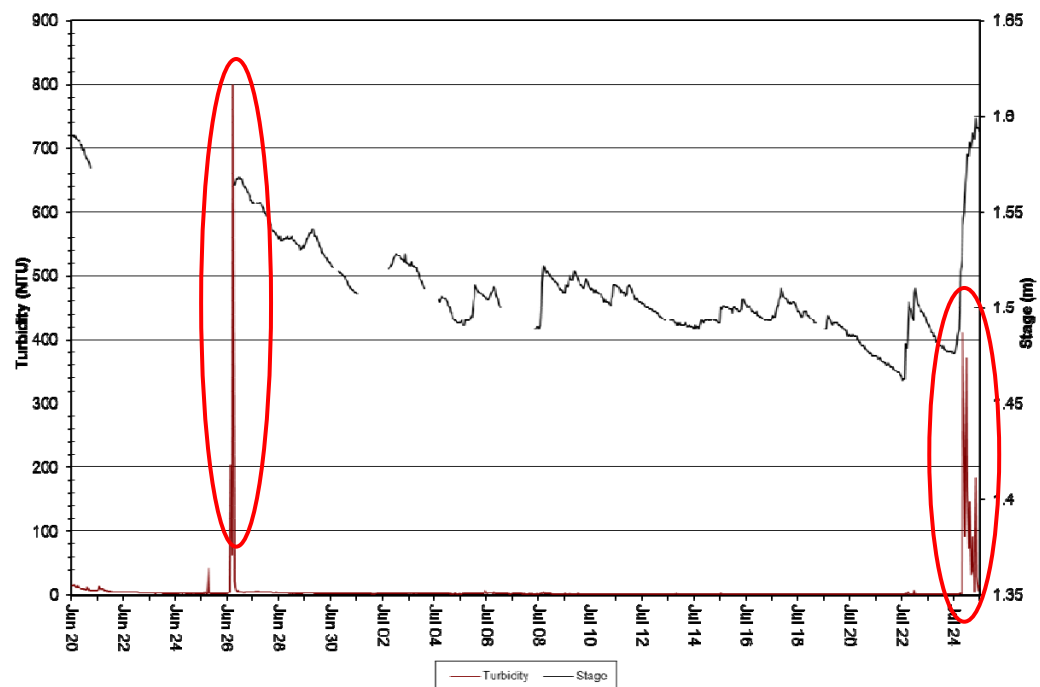


Figure 12: Turbidity (NTU) at Joan Brook – June 20, 2018 to July 25, 2018

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Joan Brook stations from June 19th, 2018 to July 25th, 2018.
- Field instruments for both stations performed well over the deployment period with only minor operational issues.
- Variations in water quality/quantity values recorded at each station are summarized below:
 - For both stations the stage height was typical for the late spring to early summer season when hydrological conditions are affected by snowmelt and significant rainfall events which cause spikes that are relatively short lived.
 - For both stations there was an increasing temperature trend which is typical of the late spring to early summer season in this northerly location.
 - During the deployment period covered by this report, pH values ranged from 5.63 units to 6.39 units at Elross Creek, and from 6.30 units to 6.78 units at Joan Brook .
 - During the deployment period covered by this report, specific conductivity ranged from 4.7 $\mu\text{S}/\text{cm}$ to 15.6 $\mu\text{S}/\text{cm}$ at Elross Creek, and from 5.3 $\mu\text{S}/\text{cm}$ to 10.2 $\mu\text{S}/\text{cm}$ at Joan Brook.
 - During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 8.20 mg/l (82.2% saturation) to 10.97 mg/l (92.4% saturation) at Elross Creek, and from 9.08 mg/l (91.8% saturation) to 12.74 mg/l (100.7% saturation) at Joan Brook.
 - During the deployment period covered by this report, turbidity values ranged from 3.0 NTU to 2768.0 NTU at Elross Creek, and from 0.4 NTU to 799.0 NTU at Joan Brook.

References

Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated December, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. (Website: <http://ceqg-rcqe.ccme.ca/download/en/222/>)

APPENDIX A

Quality Assurance / Quality Control Procedures

As part of the Quality Assurance / Quality Control (QA/QC) protocol, the performance of a station's water quality instrument (i.e., Field Sonde) is rated at the beginning and end of its deployment period. The procedure is based on the approach used by the United States Geological Survey (Wagner *et al.* 2006)¹.

At the beginning of the deployment period, a fully cleaned and calibrated QA/QC water quality instrument (i.e., QA/QC Sonde) is placed *in-situ* with the fully cleaned and calibrated Field Sonde. After Sonde readings have stabilized, which may take up to five minutes in some cases, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde. If the readings from both Sondes are in close agreement, the QA/QC Sonde can be removed from the water. If the readings are not in close agreement, there will be attempts to reconcile the problem on site (e.g., removing air bubbles from sensors, etc.). If no fix is made, the Field Sonde may be removed for recalibration.

At the end of the deployment period, a fully cleaned and calibrated QA/QC Sonde is once again deployed *in-situ* with the Field Sonde, which has already been deployment for 30-40 days. After Sonde readings have stabilized, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde.

Performance ratings are based on differences listed in the table below.

| Parameter | Rating | | | | |
|--|----------------|--------------------|--------------------|------------------|------------|
| | Excellent | Good | Fair | Marginal | Poor |
| Temperature (°C) | $\leq \pm 0.2$ | $> \pm 0.2$ to 0.5 | $> \pm 0.5$ to 0.8 | $> \pm 0.8$ to 1 | $> \pm 1$ |
| pH (unit) | $\leq \pm 0.2$ | $> \pm 0.2$ to 0.5 | $> \pm 0.5$ to 0.8 | $> \pm 0.8$ to 1 | $> \pm 1$ |
| Sp. Conductance ($\mu\text{S}/\text{cm}$) | $\leq \pm 3$ | $> \pm 3$ to 10 | $> \pm 10$ to 15 | $> \pm 15$ to 20 | $> \pm 20$ |
| Sp. Conductance $> 35 \mu\text{S}/\text{cm}$ (%) | $\leq \pm 3$ | $> \pm 3$ to 10 | $> \pm 10$ to 15 | $> \pm 15$ to 20 | $> \pm 20$ |
| Dissolved Oxygen (mg/l) (% Sat) | $\leq \pm 0.3$ | $> \pm 0.3$ to 0.5 | $> \pm 0.5$ to 0.8 | $> \pm 0.8$ to 1 | $> \pm 1$ |
| Turbidity < 40 NTU (NTU) | $\leq \pm 2$ | $> \pm 2$ to 5 | $> \pm 5$ to 8 | $> \pm 8$ to 10 | $> \pm 10$ |
| Turbidity > 40 NTU (%) | $\leq \pm 5$ | $> \pm 5$ to 10 | $> \pm 10$ to 15 | $> \pm 15$ to 20 | $> \pm 20$ |

¹ Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at <http://pubs.water.usgs.gov/tm1d3>

APENDIX B

Environment Canada Weather Data – Schefferville (June 19, 2018 to July 25, 2018)

| Date/Time | Max Temp (°C) | Min Temp (°C) | Mean Temp (°C) | Heat Deg Days (°C) | Cool Deg Days (°C) | Total Precip (mm) |
|-----------|---------------|---------------|----------------|--------------------|--------------------|-------------------|
| 6/19/2018 | 8.9 | 0.4 | 4.7 | 13.3 | 0 | 1.4 |
| 6/20/2018 | 6.9 | -0.1 | 3.4 | 14.6 | 0 | 3.7 |
| 6/21/2018 | 10 | 0.4 | 5.2 | 12.8 | 0 | 0.6 |
| 6/22/2018 | 11.4 | 1.4 | 6.4 | 11.6 | 0 | 2.3 |
| 6/23/2018 | 8.9 | 0.2 | 4.6 | 13.4 | 0 | 0 |
| 6/24/2018 | 8 | 1 | 4.5 | 13.5 | 0 | 1 |
| 6/25/2018 | 10.5 | 2.5 | 6.5 | 11.5 | 0 | 0 |
| 6/26/2018 | 11.6 | 2.7 | 7.2 | 10.8 | 0 | 2.8 |
| 6/27/2018 | 12.7 | 0.5 | 6.6 | 11.4 | 0 | 0.5 |
| 6/28/2018 | 16.8 | -0.7 | 8.1 | 9.9 | 0 | 1.5 |
| 6/29/2018 | 18.5 | 1.7 | 10.1 | 7.9 | 0 | 0.2 |
| 6/30/2018 | 12.1 | -0.6 | 5.8 | 12.2 | 0 | 0.8 |
| 7/1/2018 | 18.5 | -2.2 | 8.2 | 9.8 | 0 | 0 |
| 7/2/2018 | 19.9 | 8.7 | 14.3 | 3.7 | 0 | 2.8 |
| 7/3/2018 | 16.8 | 7.8 | 12.3 | 5.7 | 0 | 0 |
| 7/4/2018 | 17.5 | 4.1 | 10.8 | 7.2 | 0 | 0 |
| 7/5/2018 | 17.7 | 2.1 | 9.9 | 8.1 | 0 | 10.6 |
| 7/6/2018 | 15.1 | 9 | 12.1 | 5.9 | 0 | |
| 7/7/2018 | 12.6 | 3.7 | 8.2 | 9.8 | 0 | 4.6 |
| 7/8/2018 | 17.7 | 4.8 | 11.3 | 6.7 | 0 | 8.7 |
| 7/9/2018 | 22.6 | 7 | 14.8 | 3.2 | 0 | 3.8 |
| 7/10/2018 | 12.4 | 6.2 | 9.3 | 8.7 | 0 | 5.4 |
| 7/11/2018 | 13.2 | 5.1 | 9.2 | 8.8 | 0 | 6.3 |
| 7/12/2018 | 20.7 | 4.6 | 12.7 | 5.3 | 0 | 0 |
| 7/13/2018 | 25.6 | 6.3 | 16 | 2 | 0 | 0 |
| 7/14/2018 | 18.9 | 13.7 | 16.3 | 1.7 | 0 | 0.4 |
| 7/15/2018 | 19.2 | 13.1 | 16.2 | 1.8 | 0 | 0.6 |
| 7/16/2018 | 22.8 | 16.5 | 19.7 | 0 | 1.7 | 1.9 |
| 7/17/2018 | 22 | 11 | 16.5 | 1.5 | 0 | 14.6 |
| 7/18/2018 | 11.6 | 7.6 | 9.6 | 8.4 | 0 | 5.4 |
| 7/19/2018 | 18.3 | 7.3 | 12.8 | 5.2 | 0 | 4.4 |
| 7/20/2018 | 17.1 | 6.7 | 11.9 | 6.1 | 0 | 2.3 |
| 7/21/2018 | 21.1 | 5.3 | 13.2 | 4.8 | 0 | 0 |
| 7/22/2018 | 20.4 | 10.3 | 15.4 | 2.6 | 0 | 6.6 |
| 7/23/2018 | 22.9 | 10.1 | 16.5 | 1.5 | 0 | 0 |
| 7/24/2018 | 20.8 | 12.9 | 16.9 | 1.1 | 0 | 29 |
| 7/25/2018 | 16.6 | 11.5 | 14.1 | 3.9 | 0 | 17.1 |