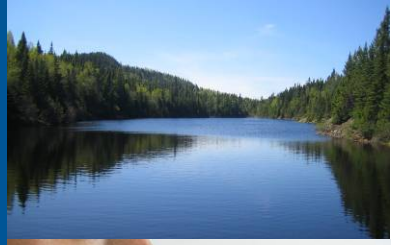




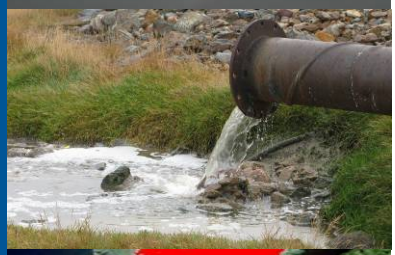


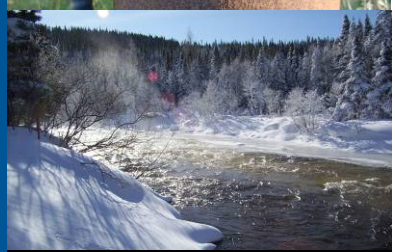

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake/Joan Brook Network

Deployment Period
2017-06-07 to 2017-07-12

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
Water Resources Management Division
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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.
- 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 Goodream Creek Station will serve to monitor potential impacts from groundwater flowing from Timmins 6 pit into the surface water of Goodream Creek. 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, Goodream Creek and Joan Brook stations from June 7th, 2017 to July 12th, 2017, which was the first deployment period for the 2017 field season.

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. 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		Goodream Creek		Joan Brook	
Stage of deployment	Beginning	End	Beginning	End	Beginning	End
Date	2017-6-7	2017-7-11	2017-6-7	2017-7-12	2017-6-7	2017-7-12
Temperature	Excellent	Poor	Excellent	Excellent	Excellent	Excellent
pH	Good	Fair	Good	Good	Excellent	Good
Specific Conductivity	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Dissolved Oxygen	Excellent	Poor	Fair	Good	Excellent	Fair
Turbidity	Good	Good	Excellent	Excellent	Excellent	Excellent

- The performance of the temperature sensor at Elross Creek was poor at the end of the deployment period which may have been caused by a faulty temperature probe (Table 1). The performance of the Dissolved Oxygen sensor was also poor at the time the probe was removed and this is most likely related to the faulty temperature probe.
- The performance of all remaining sensors at all three stations were within acceptable limits during this deployment period (Table 1).

Deployment Notes

- Water quality monitoring for this deployment period started at all three stations on June 7th, 2017. Continuous real-time monitoring continued at Elross Creek until July 11th, 2017, and at Joan Brook and Goodream Creek until July 12th. All three 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 (^{o}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. 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 0.79 m to 1.25 m at Elross Creek, from 1.84 m to 2.03 m at Goodream Creek, which corresponded to a flow of 0.00 m^3/sec to 0.19 m^3/sec , and from 0.79 m to 1.25 m at Joan Brook (Figures 1, 2 and 3). 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.
- At Elross Creek on around June 12th there is a sudden increase in stage height (see inside red oval) which was caused by an adjustment made by Water Survey of Canada staff while conducting routine maintenance at the site.
- Please note that stage height data for Joan Brook was missing for about five days from June 7th to 12th due to technical issues with the data transmission system.

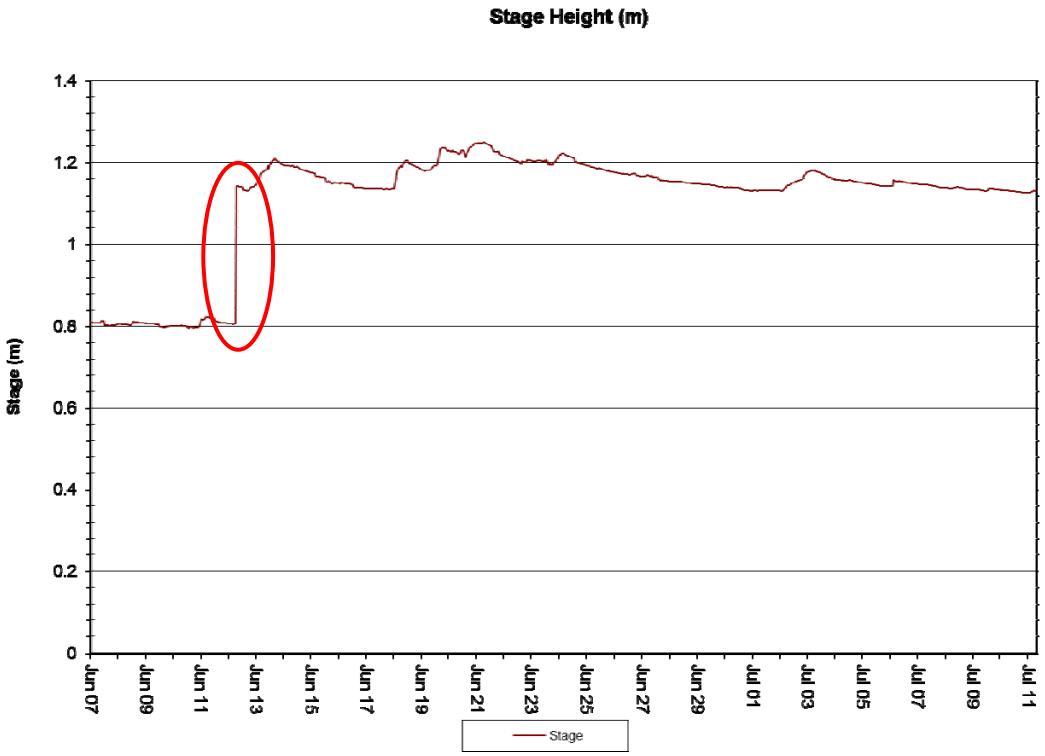

Figure 1: Stage Height (m) at Elross Creek – June 7, 2017 to July 11, 2017

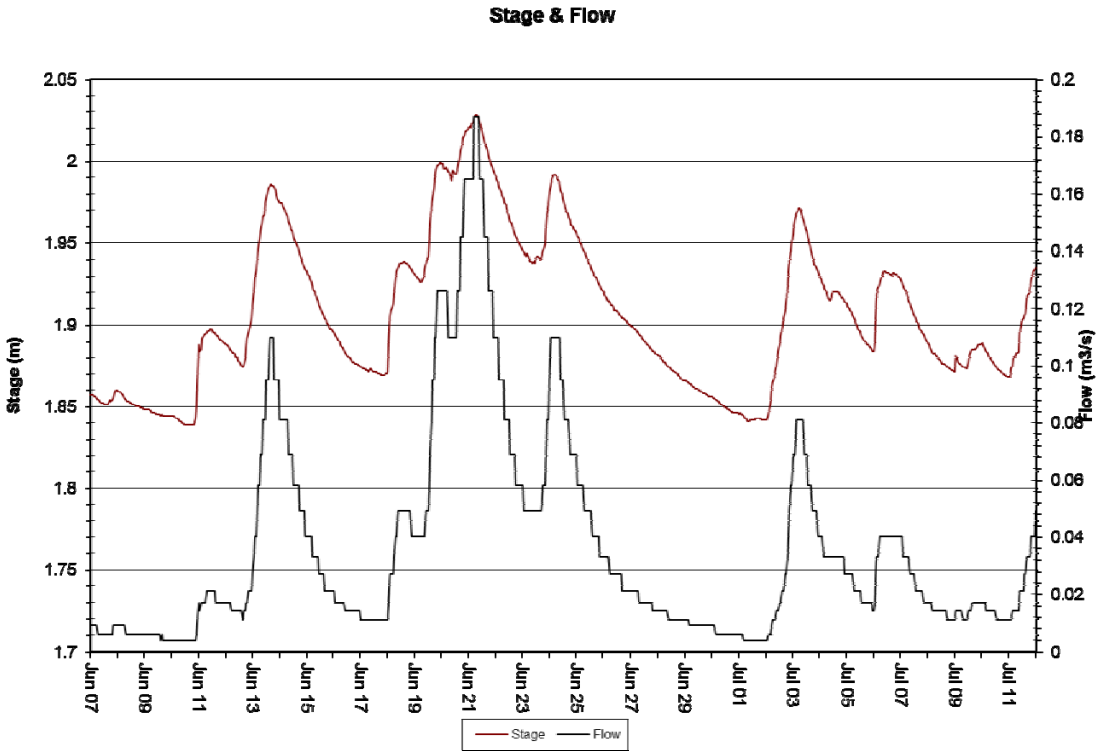

Figure 2: Stage Height (m) and Flow (m3/s) at Goodream Creek – June 7, 2017 to July 12, 2017

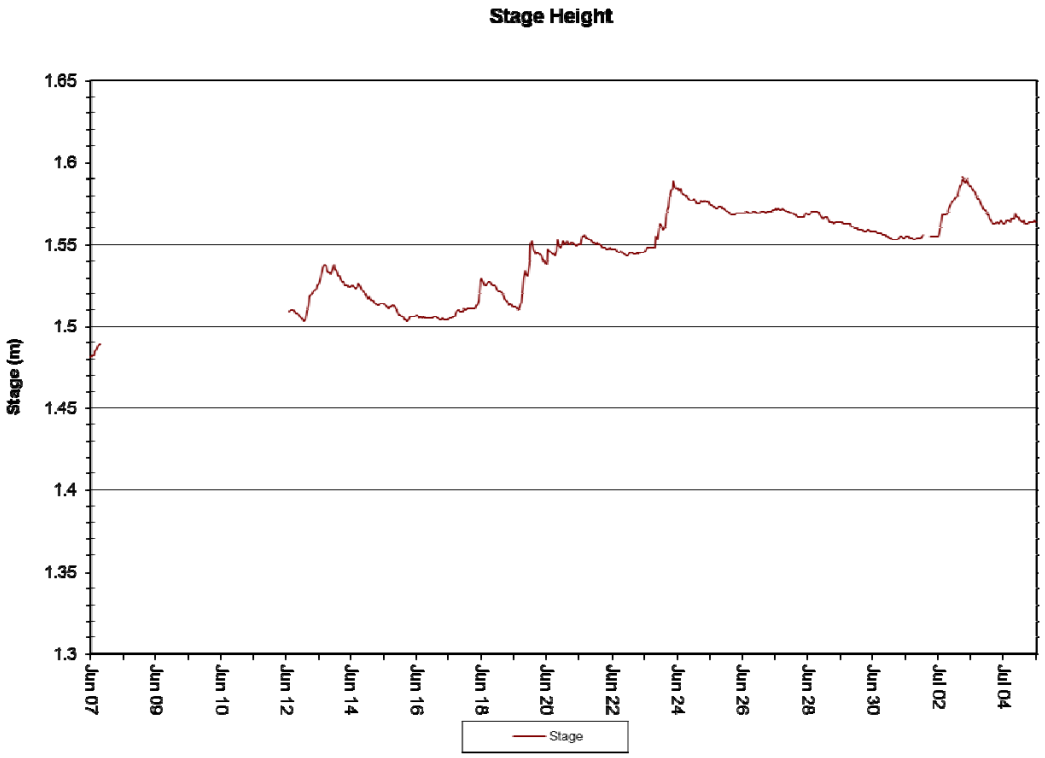

Figure 3: Stage Height (m) at Joan Brook – June 7, 2017 to July 12, 2017

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. 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 -4.50˚C to 11.60˚C at Elross Creek, from 5.50˚C to 16.90˚C at Goodream Creek, and from 2.47 ˚C to 14.16 ˚C at Joan Brook (Figures 4, 5 & 6).
- All three stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- At Elross Creek it appears that the temperature probe may have had technical issues which caused a short data gap on June 10th and an extended data gap from June 22nd to June 23rd.

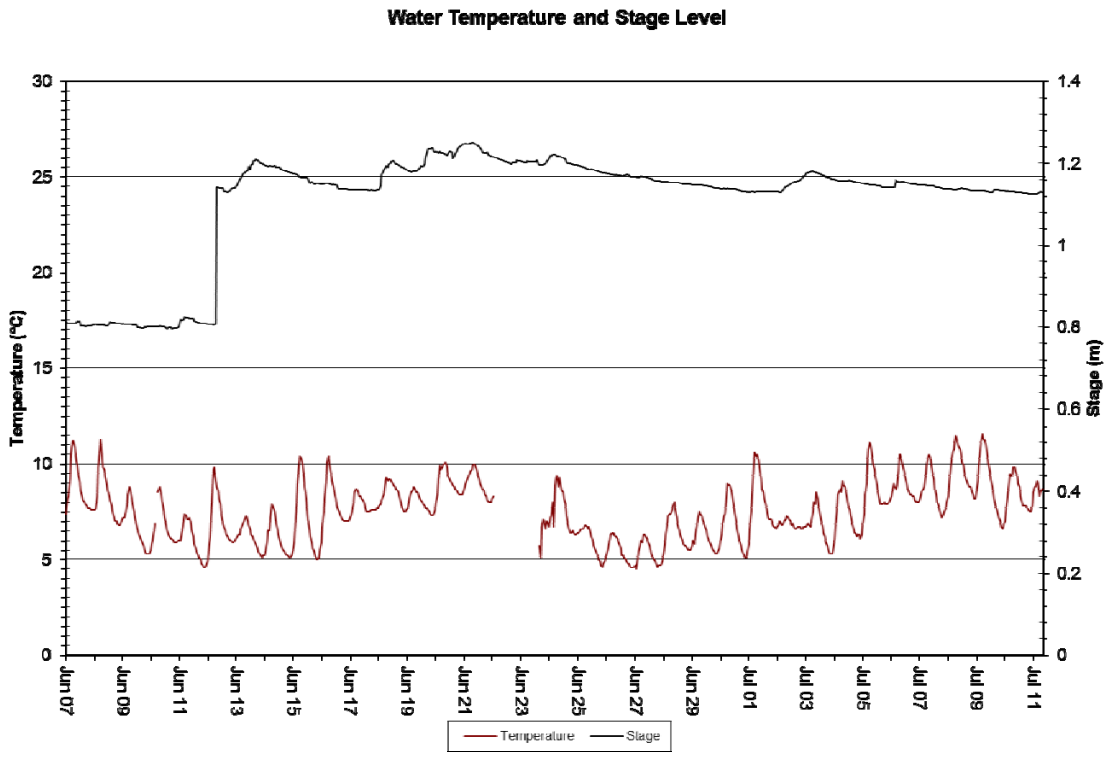

Figure 4: Temperature (°C) - Elross Creek – June 7, 2017 to July 11, 2017

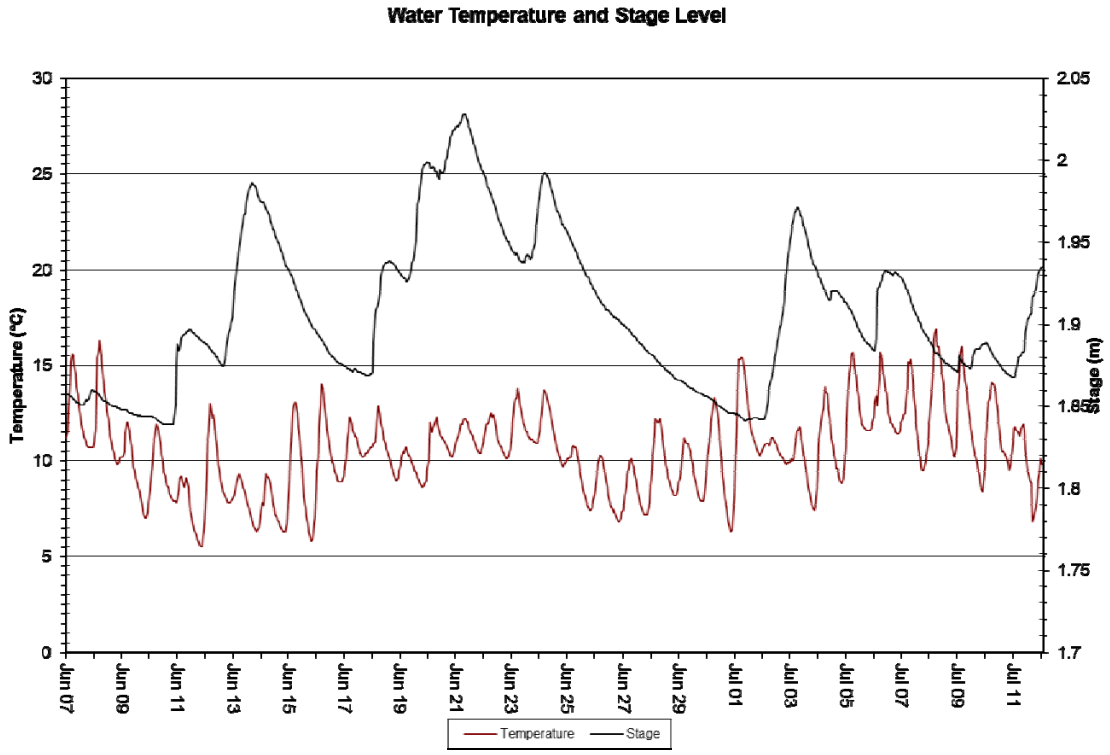

Figure 5: Temperature (°C) - Goodream Creek – June 7, 2017 to July 12, 2017

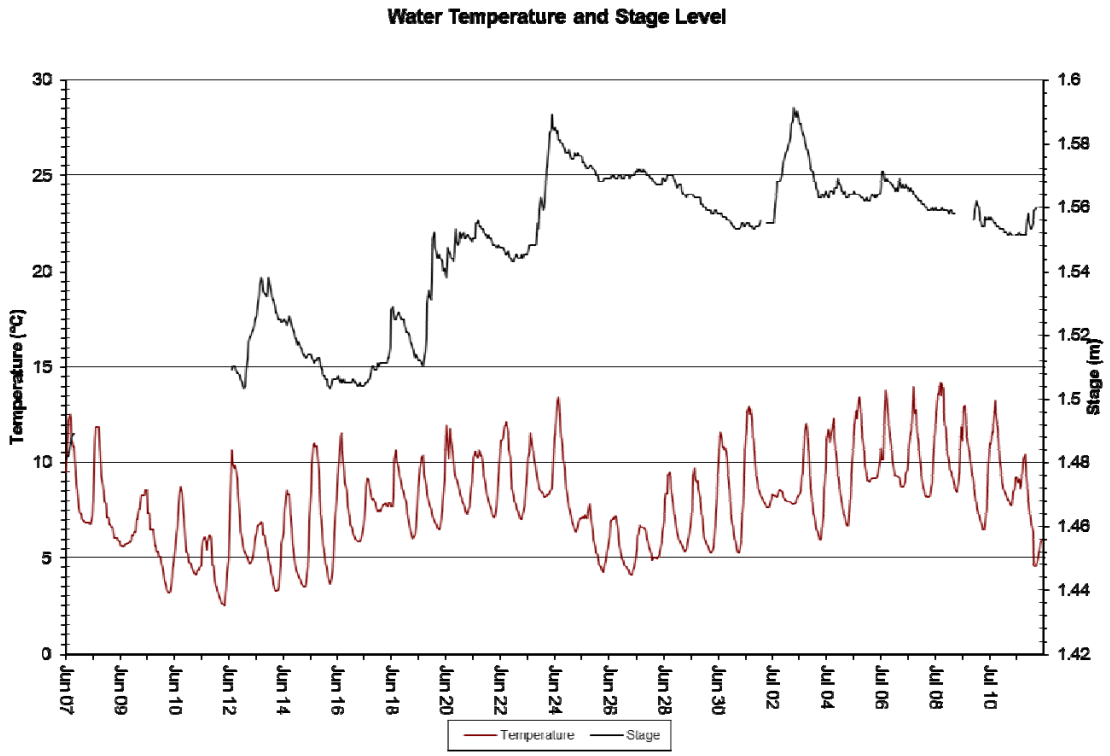

Figure 6: Temperature (°C) – Joan Brook – June 7, 2017 to July 12, 2017

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. 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 6.40 units to 6.90 units at Elross Creek, from 4.83 units to 5.92 units at Goodream Creek, and from 6.41 units to 6.90 units at Joan Brook (Figures 7, 8 & 9).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is visible at all three stations.
- pH appears to be relatively stable at all three stations during this deployment period.
- When the instrument was first installed at Goodream Creek, pH appears to be initially low and then climbs slowly up to the normal range (see inside red oval). This is indicative of an aging pH sensor which is slow to respond and will soon need to be replaced.
- With a median value of 6.73 units, pH values at Elross Creek are almost all above 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 Goodream Creek the median pH value is 5.78 units with all pH values below this minimum guideline range. At Joan Brook the median pH value is 6.77 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.

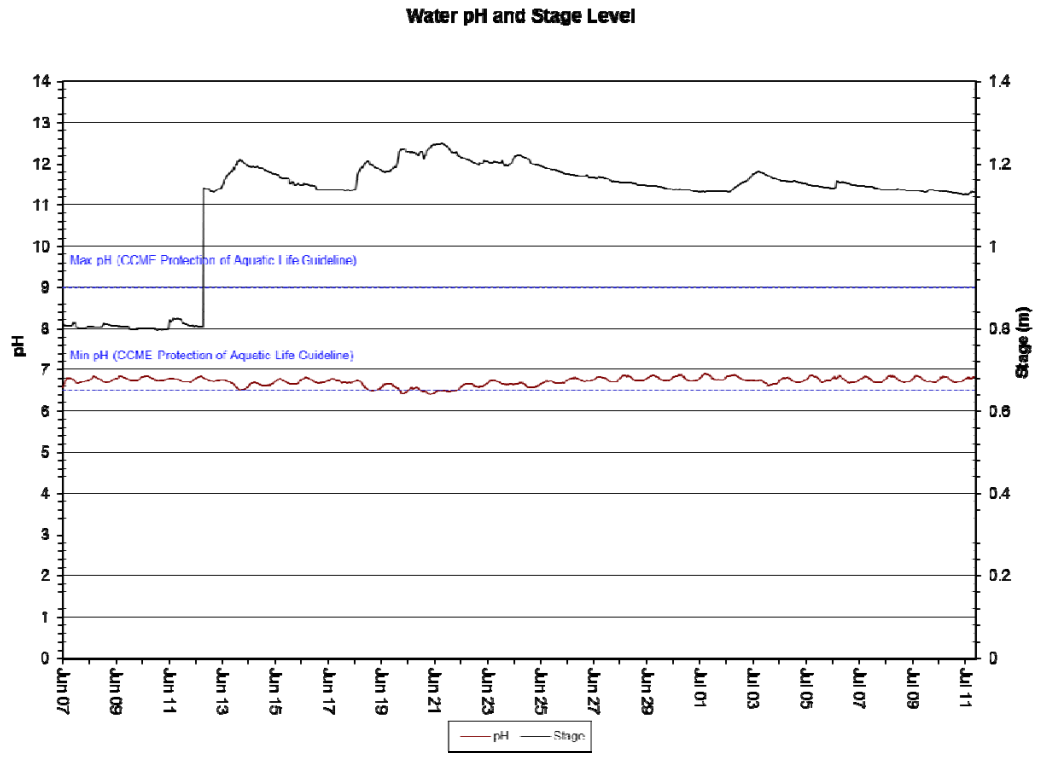

Figure 7: pH at Elross Creek – June 7, 2017 to July 11, 2017

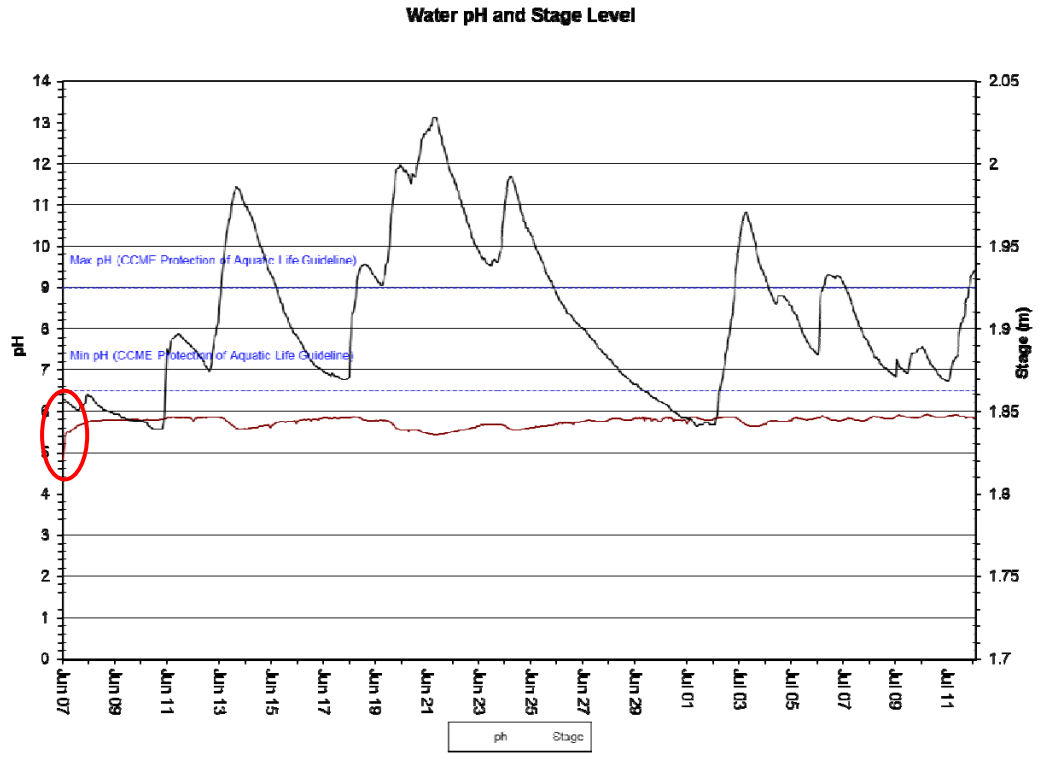

Figure 8: pH at Goodream Creek – June 7, 2017 to July 12, 2017

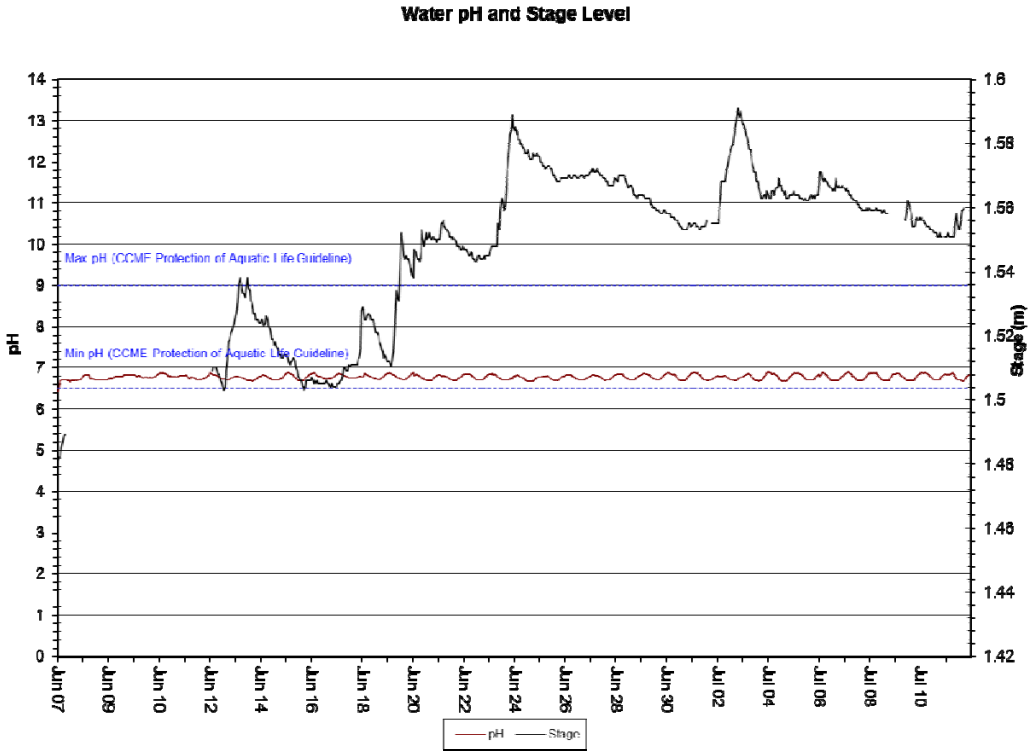

Figure 9: pH at Joan Brook – June 7, 2017 to July 12, 2017

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. 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 10.0 µs/cm to 16.9 µs/cm at Elross Creek, from 1.9 µs/cm to 5.8 µs/cm at Goodream Creek, and from 5.0 µs/cm to 7.3 µs/cm at Joan Brook (Figures 10, 11 & 12).
- Specific conductivity normally shows clear diurnal trends which are related to the diurnal temperature trend.
- The step-like graph for Figure 12 (Specific Conductivity at Joan Brook) is due to a programming issue with not enough decimal places being recorded.
- At Goodream Creek there is a significant dip in specific conductivity around June 21st (see inside red oval) which corresponds with a significant spike in flow for the same time period. At Goodream Creek there is also a significant spike in specific conductivity around July 1st (see inside green oval) which corresponds with extremely low flow conditions for the same time period. During low flow groundwater input becomes more significant and specific conductivity increases as a result.

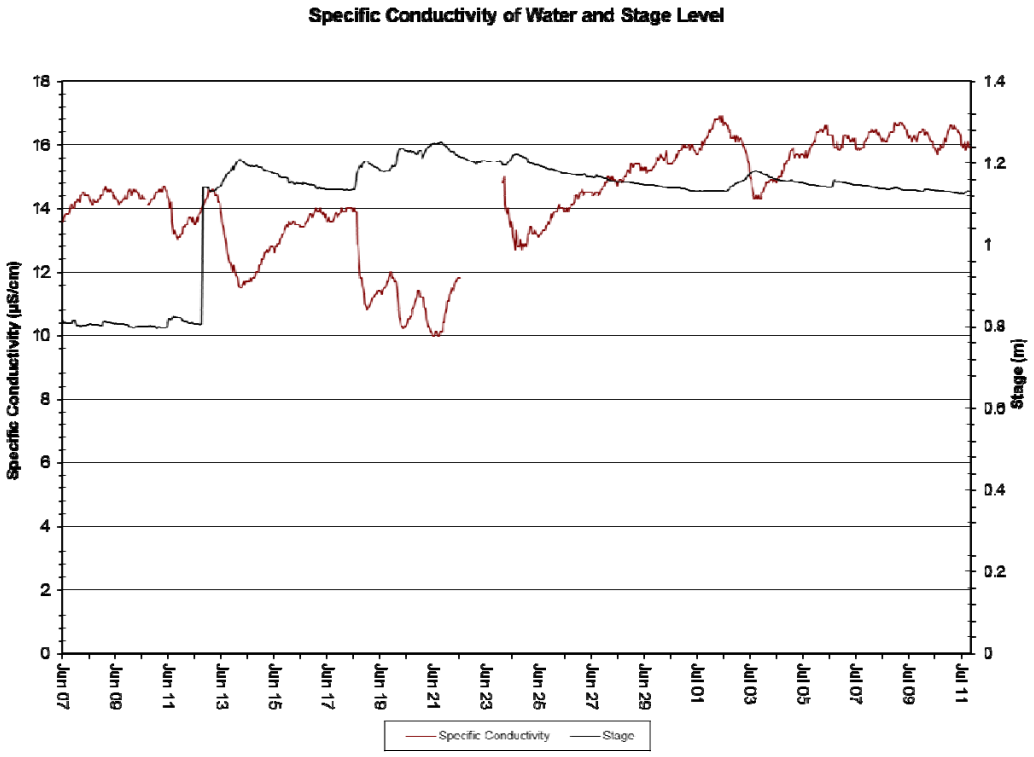

Figure 10: Specific Conductivity at Elross Creek – June 7, 2017 to July 11, 2017

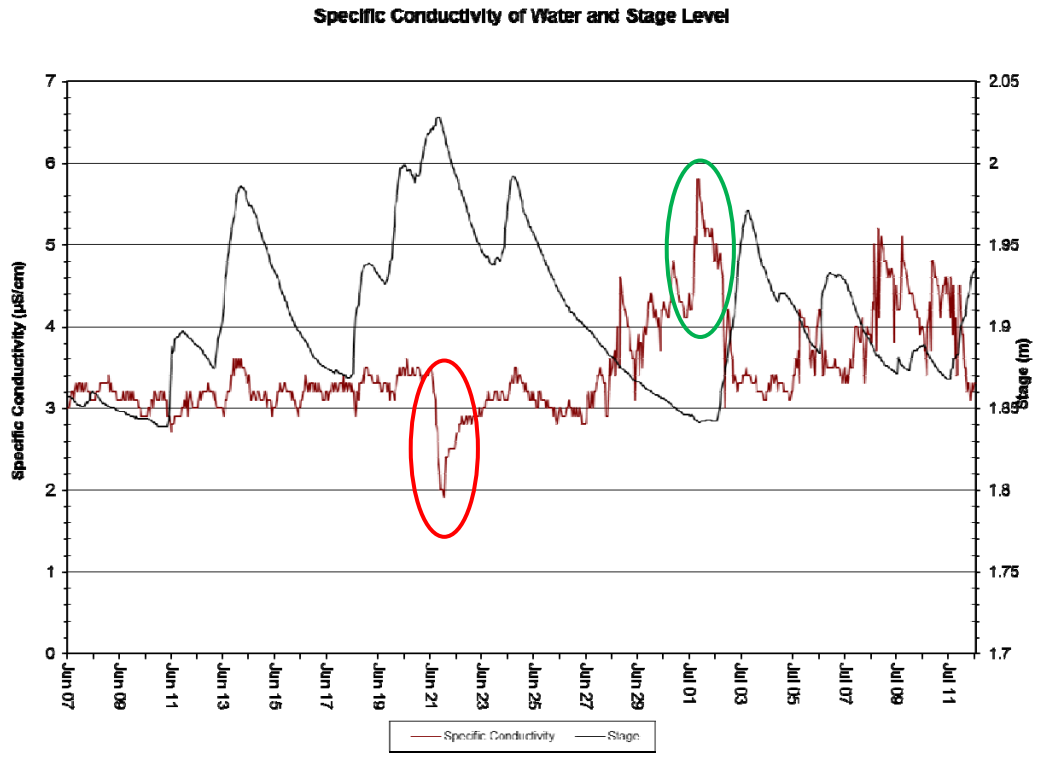

Figure 11: Specific Conductivity at Goodream Creek - September 7, 2016 to Oct. 4, 2016

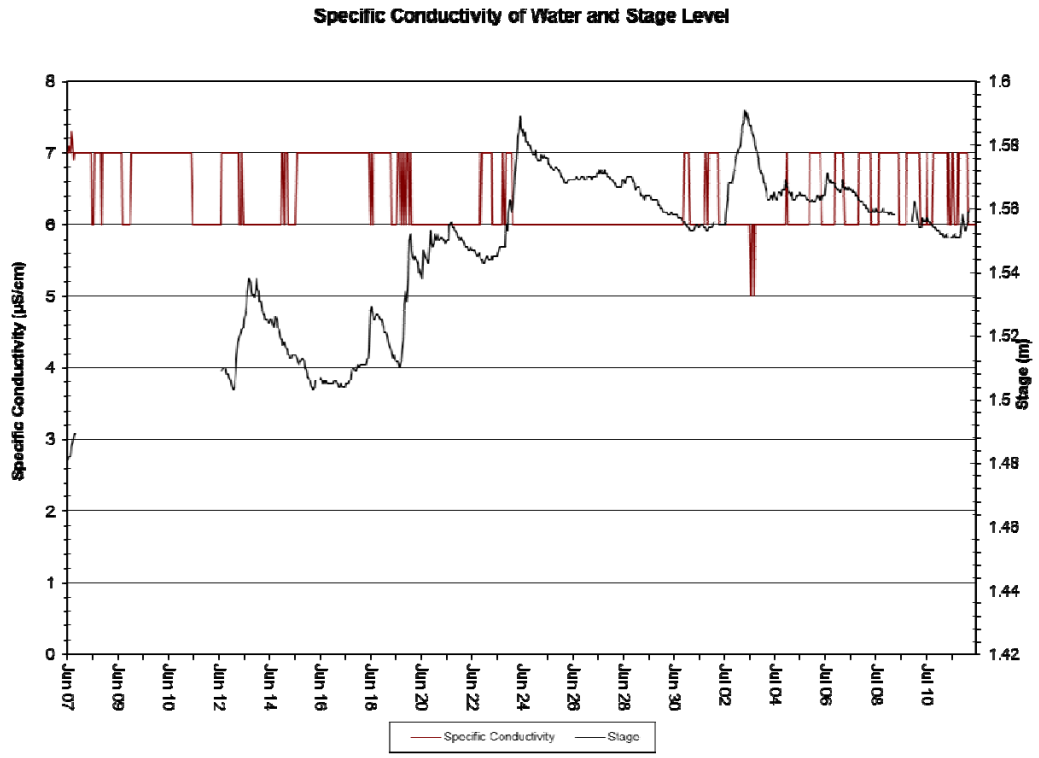

Figure 12: Specific Conductivity at Joan Brook – June 7, 2017 to July 12, 2017

Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 10.32 mg/l (90.8% saturation) to 12.40 mg/l (102.9% saturation) at Elross Creek, from 8.41 mg/l (87.6 % saturation) to 11.08 mg/l (107.9% saturation) at Goodream Creek, and from 9.81 mg/l (88.0% saturation) to 12.59 mg/l (99.4% saturation) at Joan Brook (Figures 13, 14 & 15).
- DO was relatively stable over the deployment period for all three stations.
- At all three 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 both minimum guidelines set for other life stages (6.5 mg/l) and 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). At Goodream Creek DO values were well above the minimum guidelines set for other life stages (6.5 mg/l) and at, or just above (Median value of 9.68 mg/l), the minimum guideline set for cold-water biota during early life stages (9.5 mg/l)

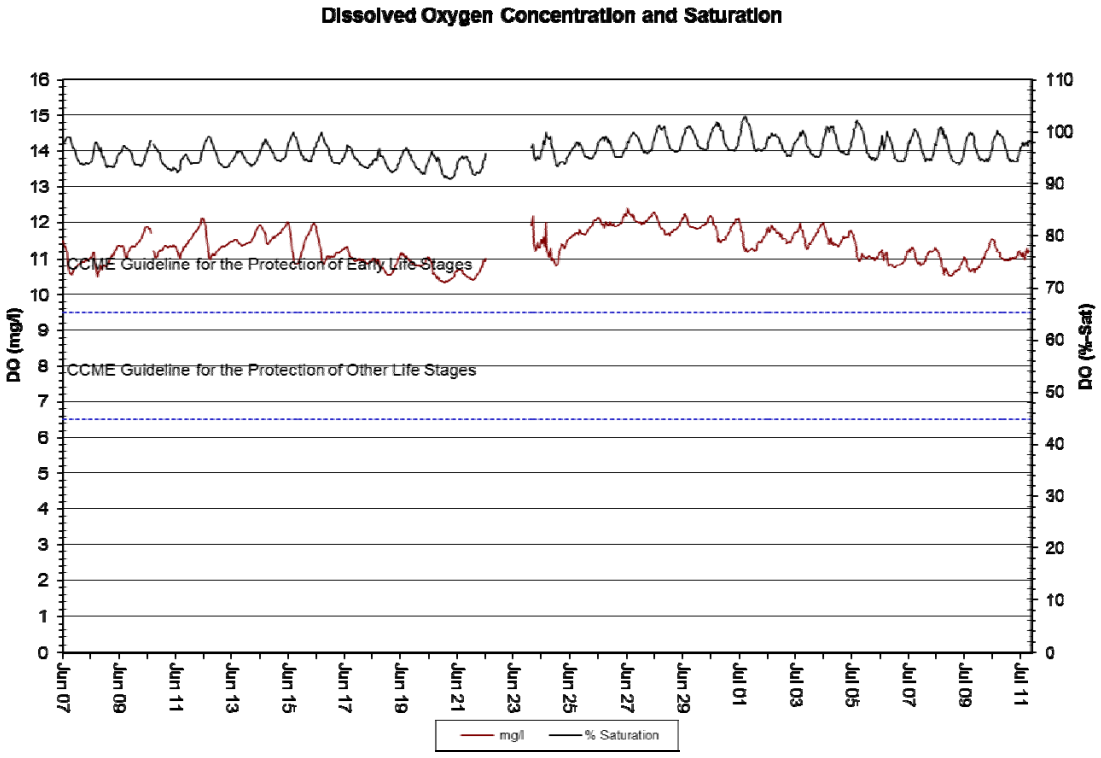

Figure 13: DO (mg/l & % Sat.) at Elross Creek – June 7, 2017 to July 11, 2017

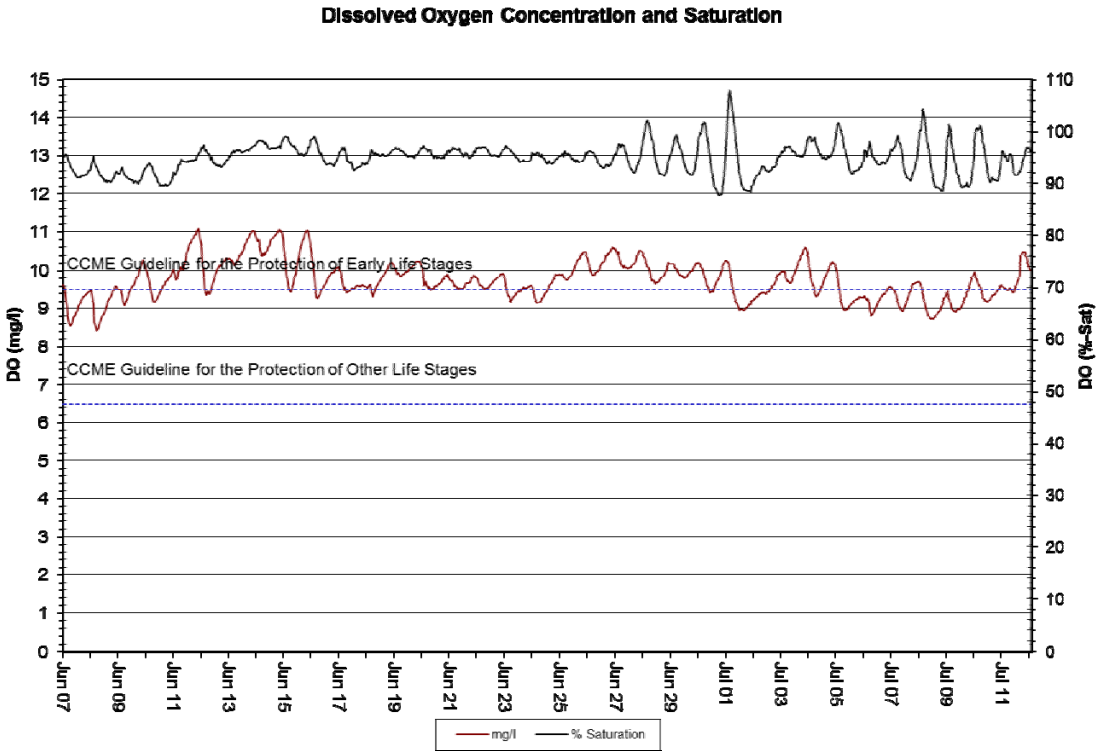

Figure 14: DO (mg/l & % Sat.) at Goodream Creek – June 7, 2017 to July 12, 2017

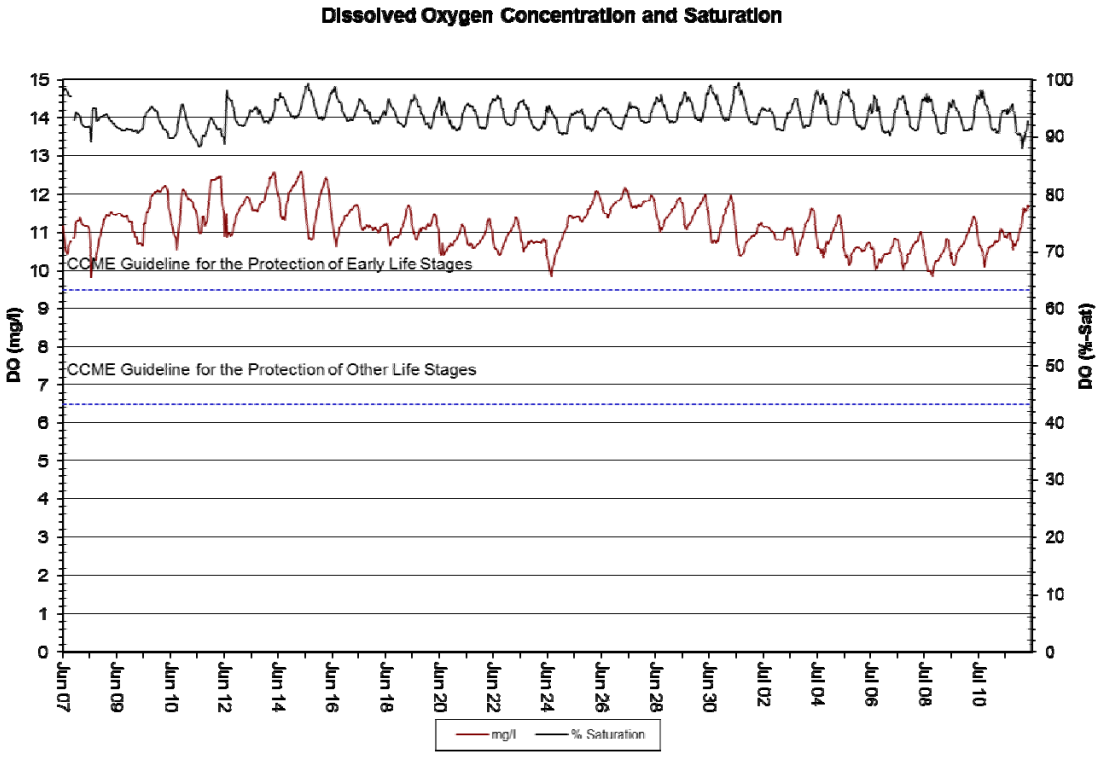

Figure 15: DO (mg/l & % Sat.) at Joan Brook – June 7, 2017 to July 12, 2017

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. 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 0.0 NTU to 217.4 NTU at Elross Creek, from 0.9 NTU to 18.0 NTU at Goodream Creek, and from 0.0 NTU to 73.7 NTU at Joan Brook (Figures 16, 17 & 18).
- At Elross Creek there is a significant spike in turbidity early on June 20th (see inside red oval) which is most likely related to significant precipitation on June 18th and 19th. At Elross creek there is a gap in turbidity data from approximately July 2nd to July 8th which was mostly likely caused by organic debris trapped near the sensor head interfering with normal readings.
- At Goodream Creek there are two periods (see inside red ovals) when elevated turbidity readings appear to correspond with periods of high flow as indicated by stage height.
- At Joan Brook it appears that most of the increases in turbidity are related to corresponding increases in stage.

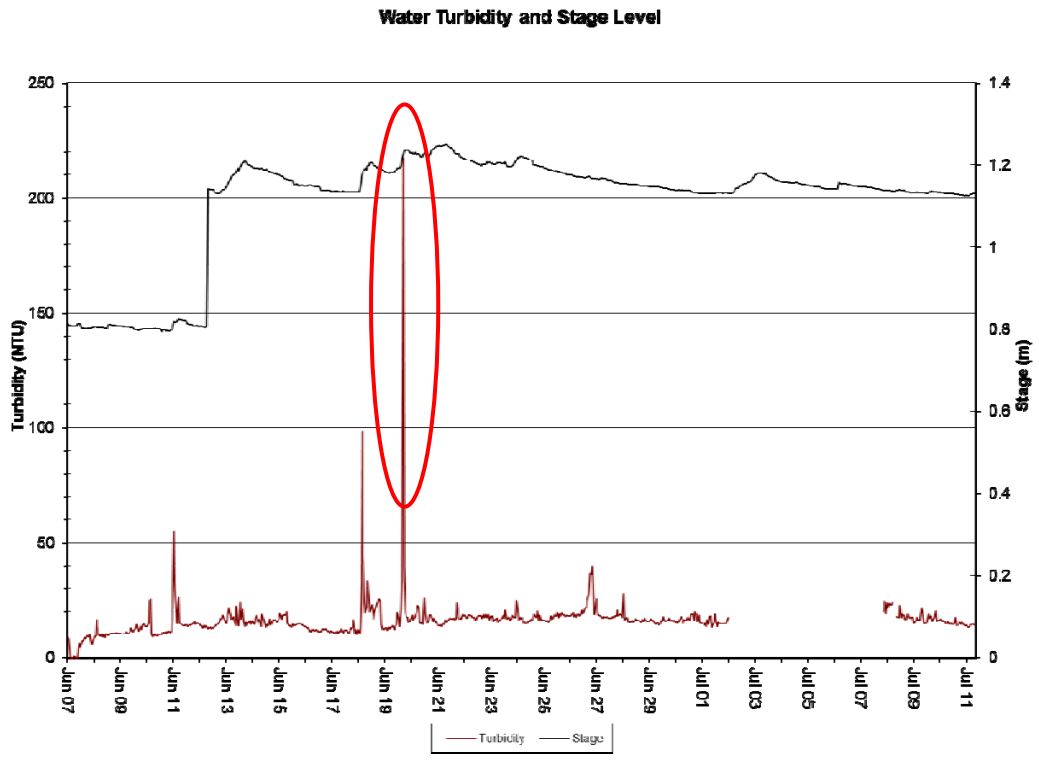

Figure 16: Turbidity (NTU) at Elross Creek – June 7, 2017 to July 11, 2017

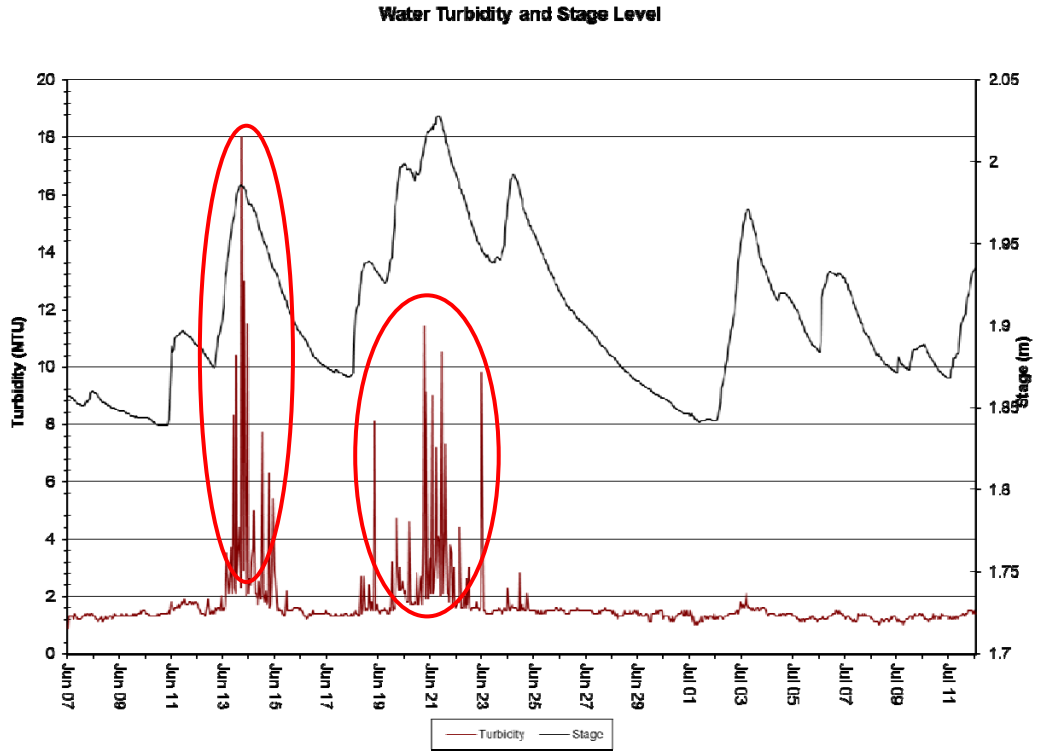

Figure 17: Turbidity (NTU) at Goodream Creek – June 7, 2017 to July 12, 2017

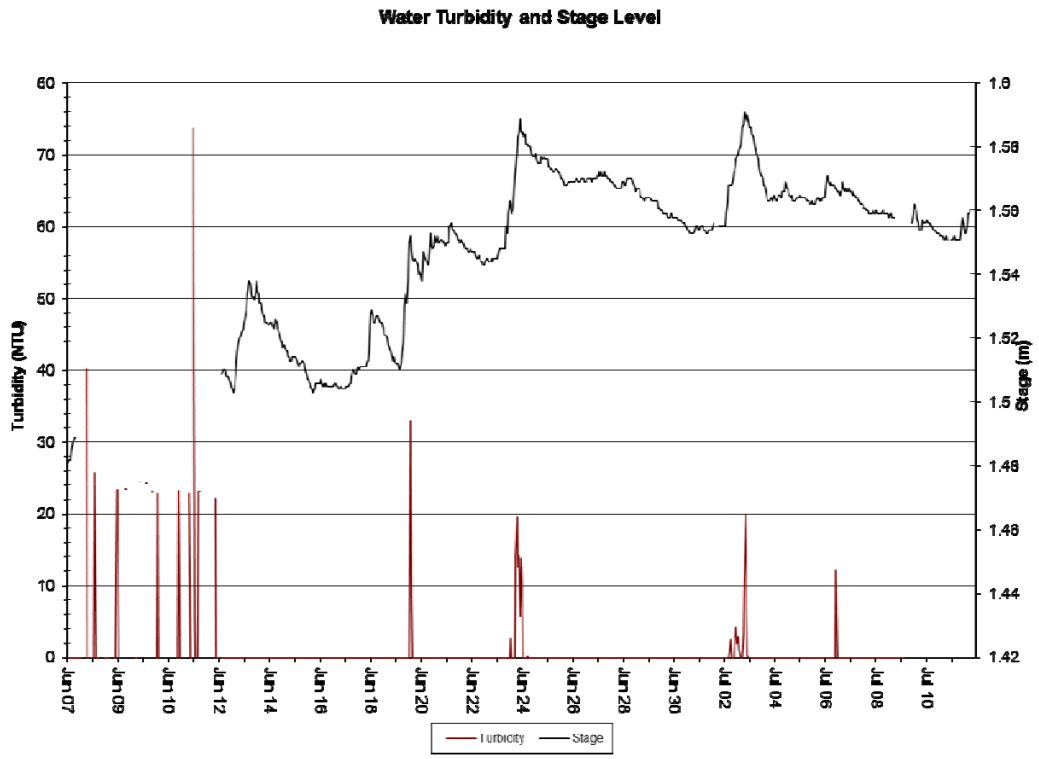

Figure 18: Turbidity (NTU) at Joan Brook – June 7, 2017 to July 12, 2017

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek, Goodream Creek, and Joan Brook stations from June 7th, 2017 to July 12th, 2017.
- Field instruments for all three stations performed well over the deployment period with only minor operational issues; including possible technical issues with the temperature probe at Elross Creek which may have also impacted oxygen and specific conductivity readings. The affected temperature, specific conductivity and dissolved oxygen data at Elross Creek were removed from the dataset.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For all three stations the stage height was typical for the late spring to early summer season when hydrological conditions are affected by significant rainfall events which cause spikes that are relatively short lived.
    - For all three stations temperatures were 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 6.40 units to 6.90 units at Elross Creek, from 4.83 units to 5.92 units at Goodream Creek, and from 6.41 units to 6.90 units at Joan Brook.
    - During the deployment period covered by this report, specific conductivity ranged from 10.0 µs/cm to 16.9 µs/cm at Elross Creek, from 1.9 µs/cm to 5.8 µs/cm at Goodream Creek, and from 5.0 µs/cm to 7.3 µs/cm at Joan Brook
    - During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 10.32 mg/l (90.8% saturation) to 12.40 mg/l (102.9% saturation) at Elross Creek, from 8.41 mg/l (87.6 % saturation) to 11.08 mg/l (107.9% saturation) at Goodream Creek, and from 9.81 mg/l (88.0% saturation) to 12.59 mg/l (99.4% saturation) at Joan Brook.
    - During the deployment period covered by this report, turbidity values ranged from 0.0 NTU to 217.4 NTU at Elross Creek, from 0.9 NTU to 18.0 NTU at Goodream Creek, and from 0.0 NTU to 73.7 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.

	Rating				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (^{o}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

[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 7, 2017 to July 12, 2017)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
6/7/2017	20.1	3.7	11.9	6.1	0	0
6/8/2017	18.7	8.6	13.7	4.3	0	1.4
6/9/2017	9.5	3	6.3	11.7	0	0
6/10/2017	10.9	1.6	6.3	11.7	0	0
6/11/2017	14.3	3.1	8.7	9.3	0	13.9
6/12/2017	12.8	1.4	7.1	10.9	0	0
6/13/2017	8.4	3	5.7	12.3	0	16.8
6/14/2017	8.7	2	5.4	12.6	0	0.3
6/15/2017	12.9	1	7	11	0	0
6/16/2017	16.6	0.2	8.4	9.6	0	0.9
6/17/2017	15.1	8.1	11.6	6.4	0	0
6/18/2017	16.7	8.9	12.8	5.2	0	14.3
6/19/2017	10.7	7	8.9	9.1	0	12.7
6/20/2017	14.8	6.8	10.8	7.2	0	5.3
6/21/2017	14	7.5	10.8	7.2	0	23.3
6/22/2017	9.7	6.9	8.3	9.7	0	2
6/23/2017	14.7	6.5	10.6	7.4	0	8.6
6/24/2017	17.9	5.9	11.9	6.1	0	13.7
6/25/2017	9.8	4	6.9	11.1	0	0.4
6/26/2017	9.3	3.5	6.4	11.6	0	0.8
6/27/2017	10.1	3	6.6	11.4	0	0
6/28/2017	14.9	4.9	9.9	8.1	0	0
6/29/2017	10.7	5.2	8	10	0	0.7
6/30/2017	16	5	10.5	7.5	0	0
7/1/2017	18.9	2.7	10.8	7.2	0	8.9
7/2/2017	11.3	8.9	10.1	7.9	0	9.3
7/3/2017	15.8	4.3	10.1	7.9	0	6.1
7/4/2017	18.1	3	10.6	7.4	0	1
7/5/2017	21.5	10.6	16.1	1.9	0	0
7/6/2017	19.6	13	16.3	1.7	0	7.5
7/7/2017	17.2	6.2	11.7	6.3	0	1.1
7/8/2017	20.7	5.8	13.3	4.7	0	1.5
7/9/2017	18.8	4.6	11.7	6.3	0	5.2
7/10/2017	16.6	3	9.8	8.2	0	0
7/11/2017	14.1	3.1	8.6	9.4	0	6.4
7/12/2017	10.2	0.3	5.3	12.7	0	8