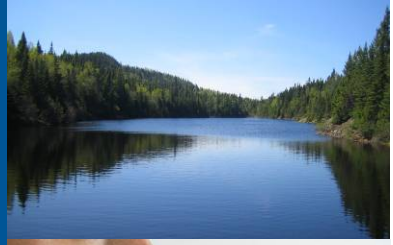




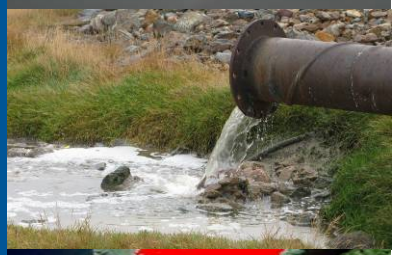


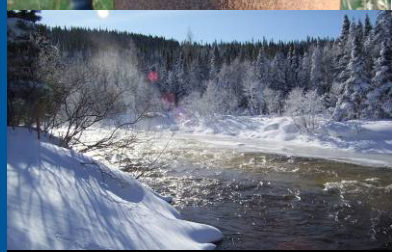

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2016-05-31 to 2016-07-06

Government of Newfoundland & Labrador
Department of Environment and Climate Change
Water Resources Management Division
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General

- During the 2016 field season the Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment and Climate Change Canada, maintained 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 May 31st, 2016 to July 6th, 2016, which was the first deployment period for the 2016 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	2016-6-1	2016-7-6	2016-5-31	2016-7-6	2016-6-1	2016-7-6
Temperature	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
pH	Excellent	Fair	Fair	Good	Excellent	Excellent
Specific Conductivity	Excellent	Good	Excellent	Excellent	Excellent	Excellent
Dissolved Oxygen	Good	Excellent	Excellent	Excellent	Excellent	Excellent
Turbidity	Excellent	Good	Excellent	Excellent	Good	Excellent

- The performance of all 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 Elross Creek on June 1st, 2016, at Goodream Creek on May 31st, 2016, and at Joan Brook on June 1st, 2016. Continuous real-time monitoring continued at both sites without any significant operational issues until July 6th, 2016 when the instruments were removed for calibration and maintenance.

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 (□S/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 1.10 m to 1.23 m at Elross Creek, from 1.78 m to 2.01 m at Goodream Creek, and from 1.48 m to 1.66 m at Joan Brook (Figures 1, 2 and 3). Please note that Stage height data for Joan Brook was not available for the first 10 days of the deployment period. 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.
- For all three stations the stage height was typical for the late spring/early summer season, when hydrological conditions are affected by decreasing snowmelt runoff and significant rainfall events which cause spikes that are relatively short lived. The spikes in stage height generally correspond very well with significant rainfall events (Climate data located in Appendix B). For example, a noticeable spike in stage height at all three stations around July 3 (see inside red ovals) corresponds with 37 mm of rain from July 1st to July 3rd .

Figure 1: Stage Height (m) at Elross Creek –June 1, 2016 to July 6, 2016

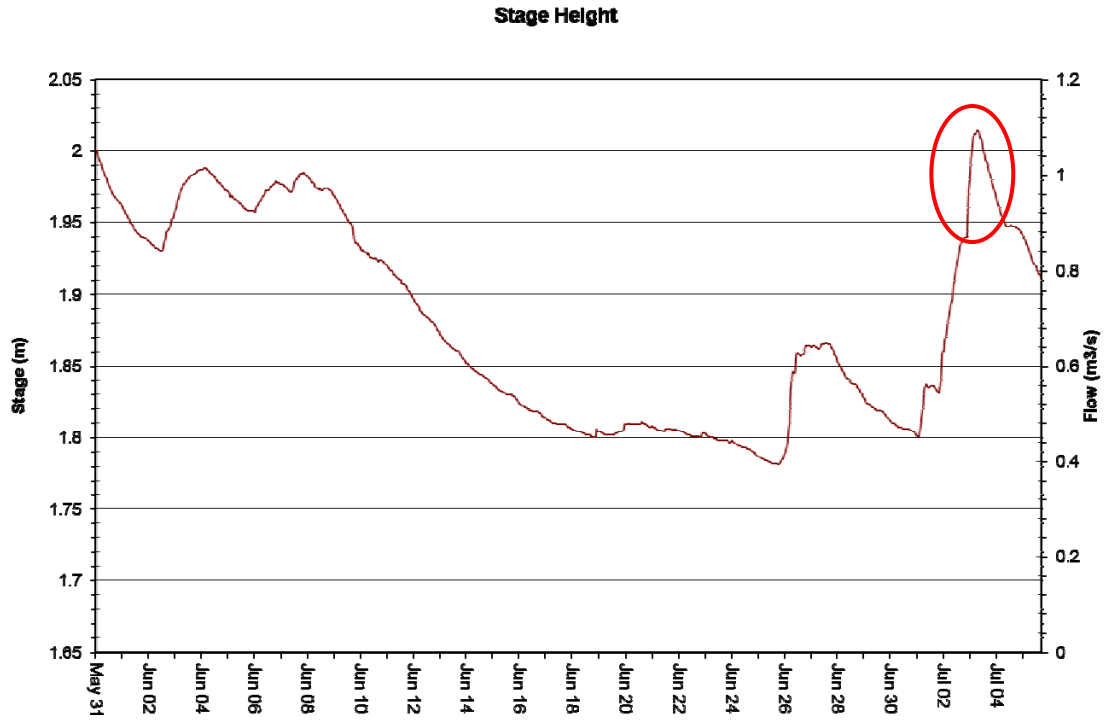

Figure 2: Stage Height (m) at Goodream Creek – May 31, 2016 to July 6, 2016

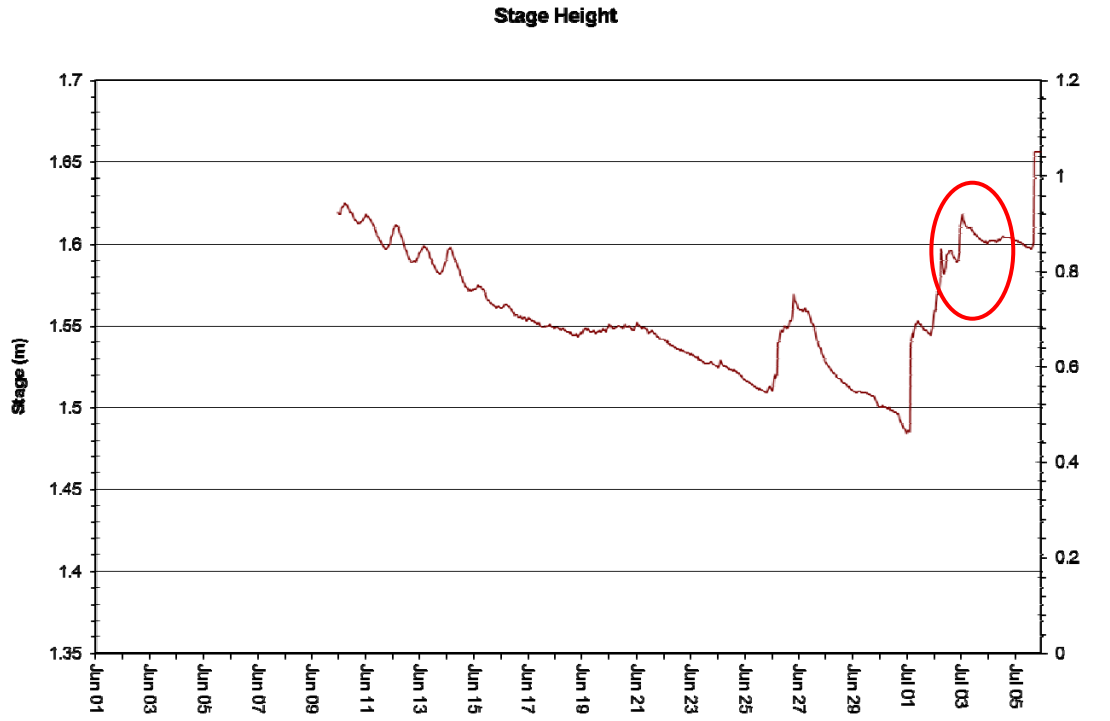

Figure 3: Stage Height (m) at Joan Brook – June 1, 2016 to July 6, 2016

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 1.30˚C to 14.70˚C at Elross Creek, from 1.90˚C to 16.80˚C at Goodream Creek, and from 3.60 to 15.70 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 all three stations there is a noticeable dip in temperature(see inside red ovals) around July 21st and 22nd which is related to a period of cooler air temperatures (climate data is located in Appendix B).
- For all three stations there is a gentle increasing temperature trend over the deployment period which is consistent with the transition from spring to summer.

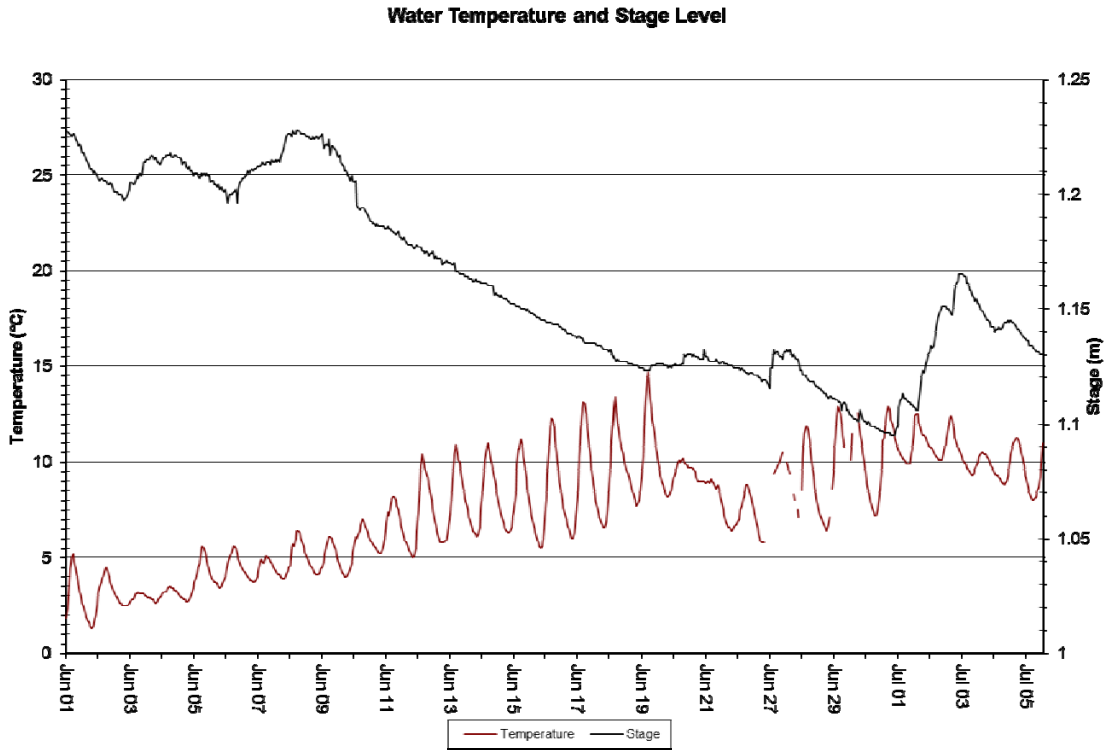

Figure 4: Temperature (°C) - Elross Creek – June 1, 2016 to July 6, 2016

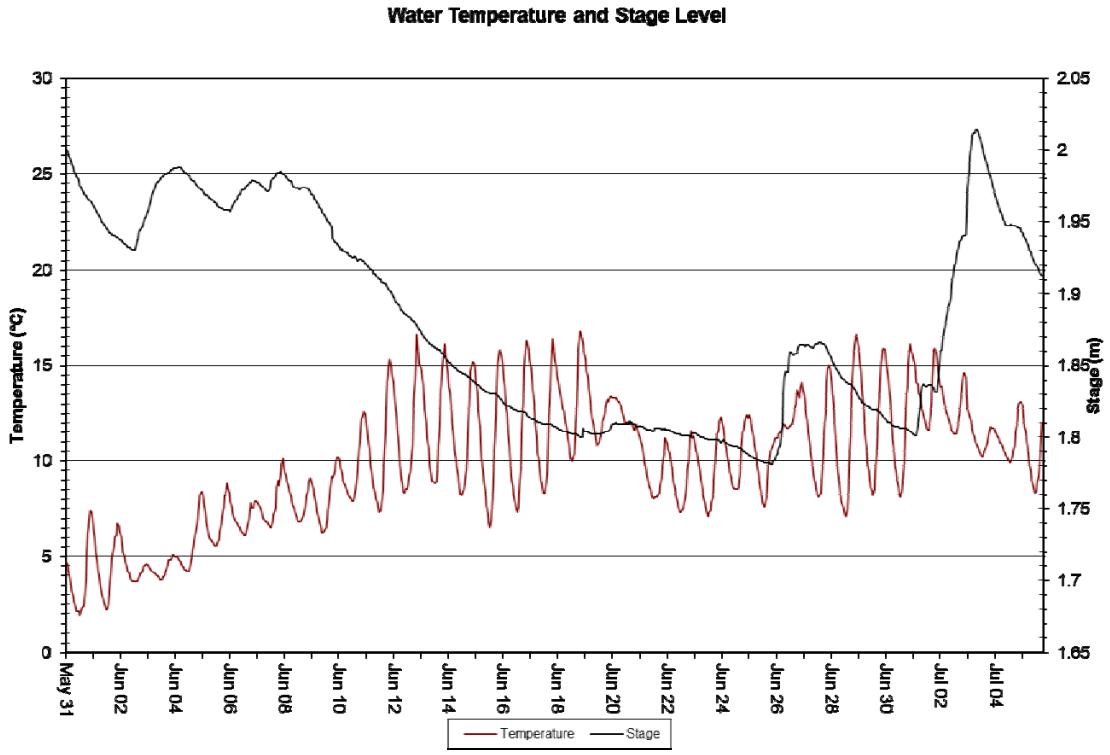

Figure 5: Temperature (°C) - Goodream Creek - May 31, 2016 to July 6, 2016

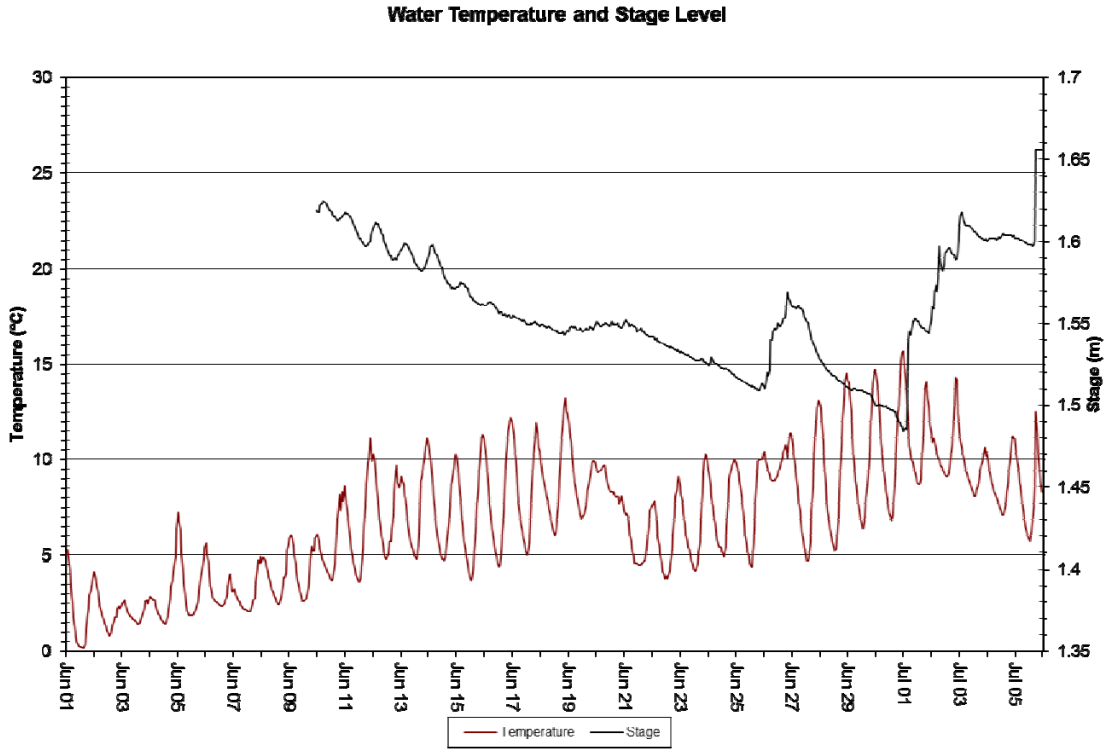

Figure 6: Temperature (°C) – Joan Brook – June 1, 2016 to July 6, 2016

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 6.09 units to 7.01 units at Elross Creek, from 5.13 units to 5.90 units at Goodream Creek, and from 5.66 units to 6.81 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 fairly weak at Goodream Creek; however it is clearly visible at Elross Creek and Joan Brook.
- For Goodream Creek it appears that pH was affected by a period of heavy rainfall and increased flow on two occasions (see inside red ovals, Figure 8). On both occasions the increase in flow seems to be related to noticeable dips in pH.
- With a median value of 6.75 units, pH at Elross Creek is just 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 5.71 units, which is below this guideline. At Joan Brook the median pH value is 6.38 units which is slightly below the guideline. It should be noted that acidic waters are quite common in Canada, particularly in boreal and northern ecoregions, and pH is often naturally below this 6.5 unit guideline.

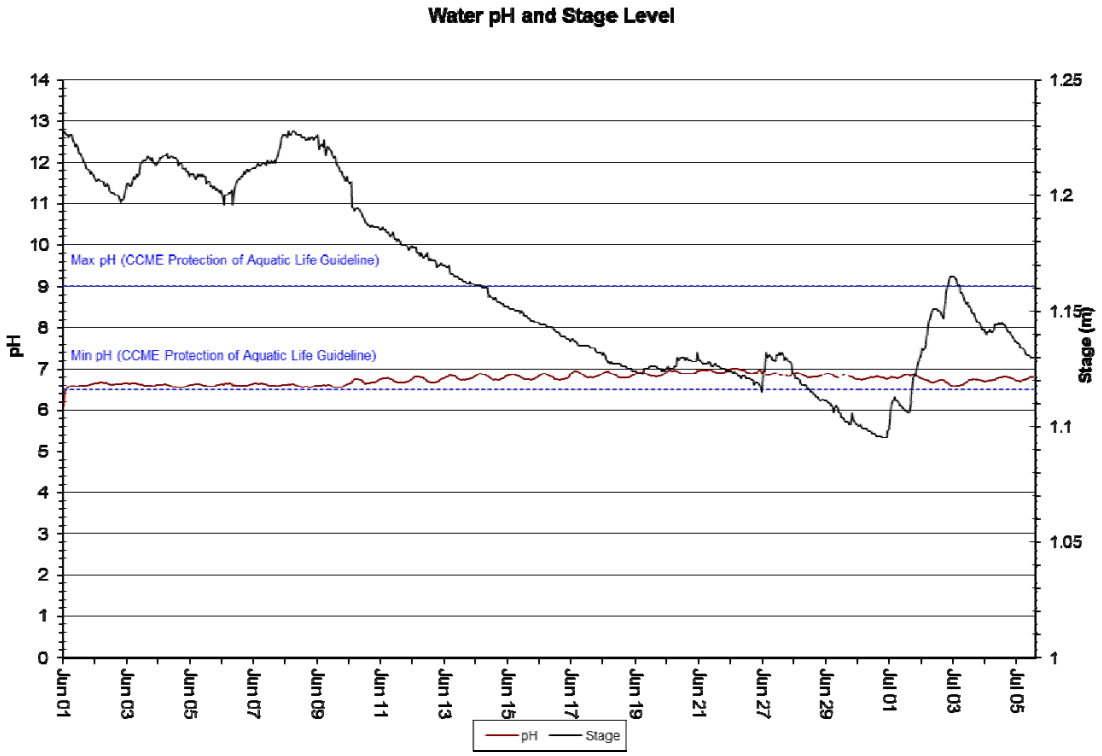

Figure 7: pH at Elross Creek – June 1, 2016 to July 6, 2016

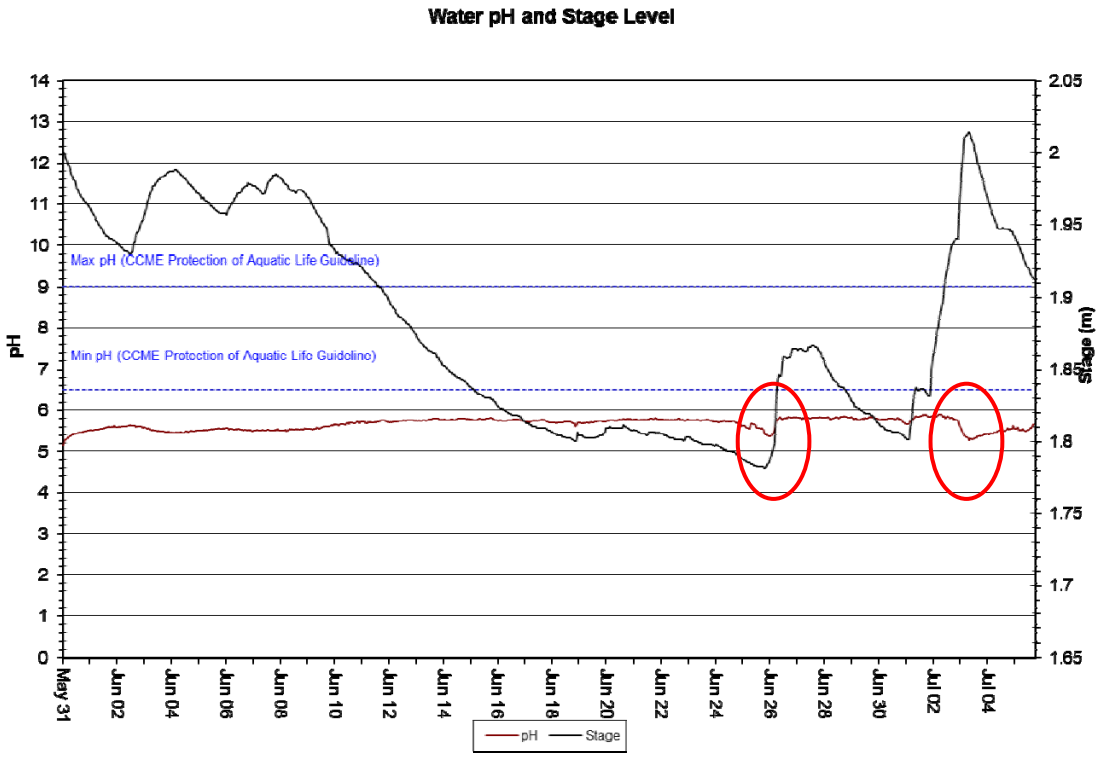

Figure 8: pH at Goodream Creek – May 31, 2016 to July 6, 2016

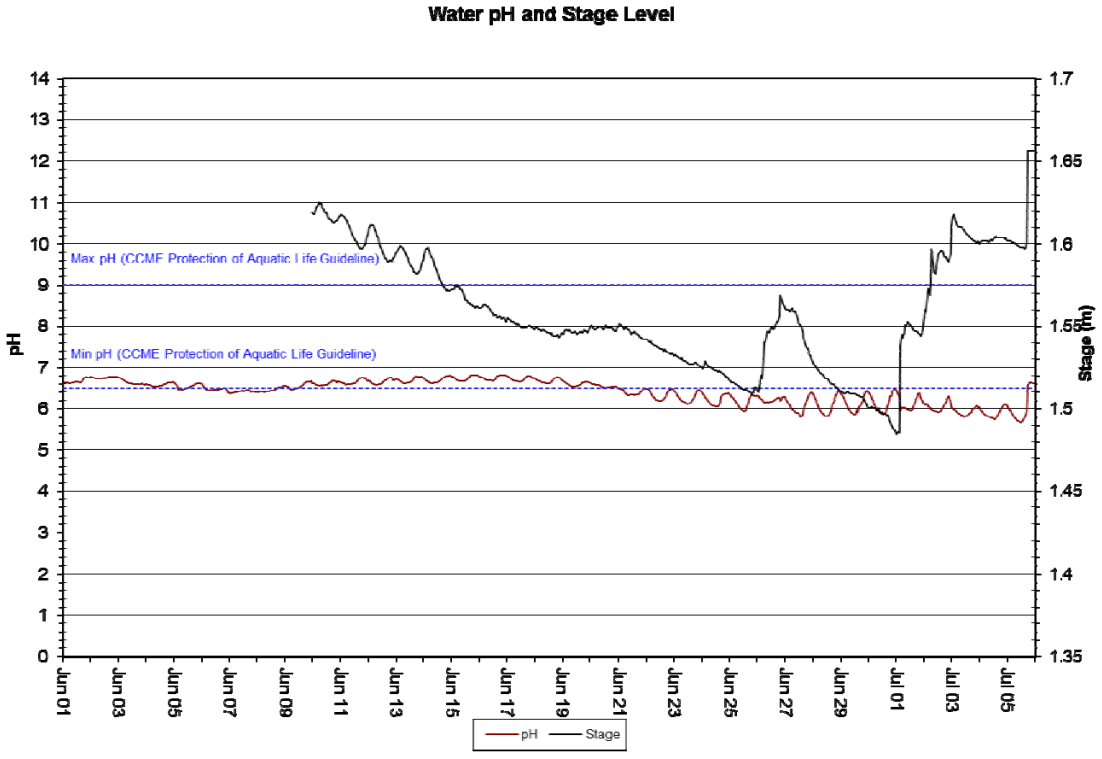

Figure 9: pH at Joan Brook – June 1, 2016 to July 6, 2016

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 10.3 µs/cm to 15.8 µs/cm at Elross Creek, from 2.5 µs/cm to 6.4 µs/cm at Goodream Creek, and from 4.8 µs/cm to 8.3 µs/cm at Joan Brook (Figures 10, 11 & 12).
- At all three stations specific conductivity shows diurnal trends which are related to the diurnal temperature trend.
- At all three stations it is possible to see and increasing specific conductivity trend with decreasing stage height. This trend is clearest from approximately June 6th to June 19th and is most likely related to the increasing temperature trend for the same timeframe and also possibly increased influence from groundwater as flow decreases.
- At Goodream Creek there is a period from approximately June 24th to June 26th when specific conductivity appears to be both slightly elevated and highly variable (see inside red oval, Figure 11. This period corresponds with very low flow conditions when groundwater input is more significant to total flow.

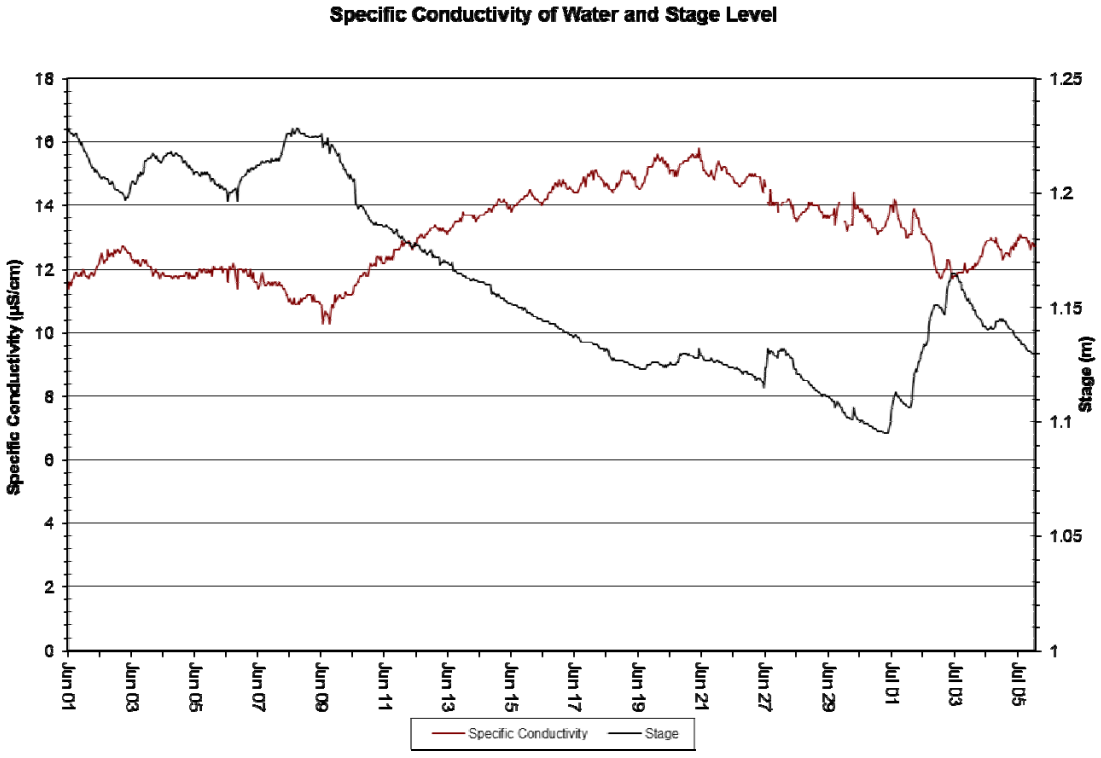

Figure 10: Specific conductivity (us/cm) - Elross Creek – June 1, 2016 to July 6, 2016

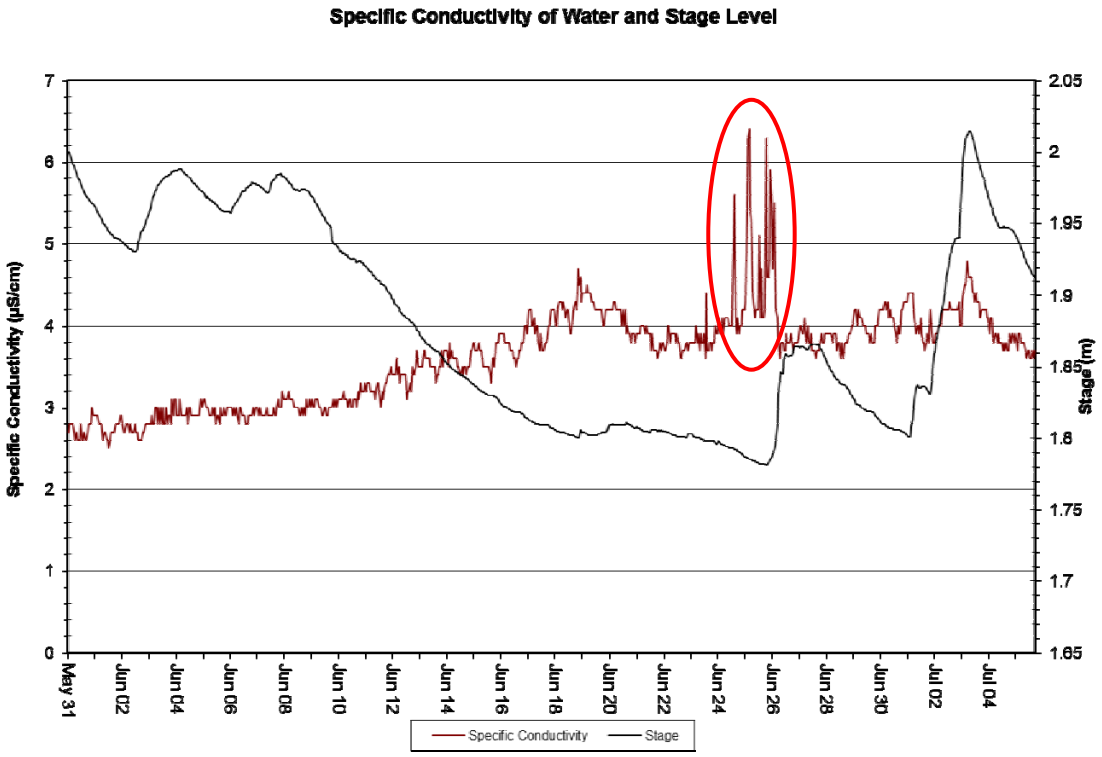

Figure 11: Specific conductivity (us/cm) - Goodream Creek – May 31, 2016 to July 6, 2016

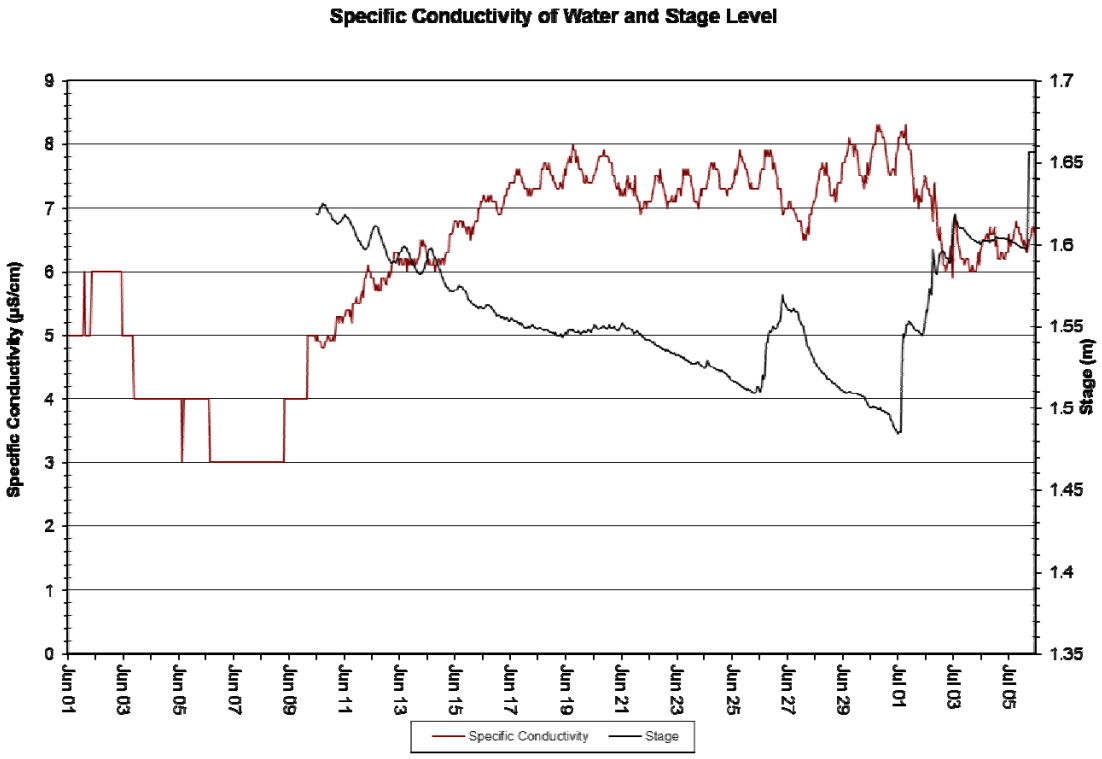

Figure 12: Specific conductivity (us/cm) – Joan Brook – June 1, 2016 to July 6, 2016

Dissolved Oxygen

- During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 9.23 mg/l (89.4% saturation) to 12.92 mg/l (99.5% saturation) at Elross Creek, from 7.07 mg/l (68.1% saturation) to 12.66 mg/l (98.4% saturation) at Goodream Creek, and from 9.18 mg/l (90.8% saturation) to 11.77 mg/l (102.9% saturation) at Joan Brook (Figures 13, 14 & 15).
- DO was relatively stable over the deployment period for all three stations, however there is a period at Goodream Creek from approximately June 25th to 27th (see inside red oval, Figure 14) where DO(mg/l & %saturation) take a noticeable dip. This dip corresponds with a period of low flow when less oxygen would have been introduced into the water.
- At all three stations there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- Towards late June and into July, the DO values at Elross Creek and Joan Brook were at (or slightly below in some cases) 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). DO values at Goodream Creek dipped below this guideline due to low flow conditions. DO values at all three stations were above minimum guidelines set for other life stages (6.5 mg/l).

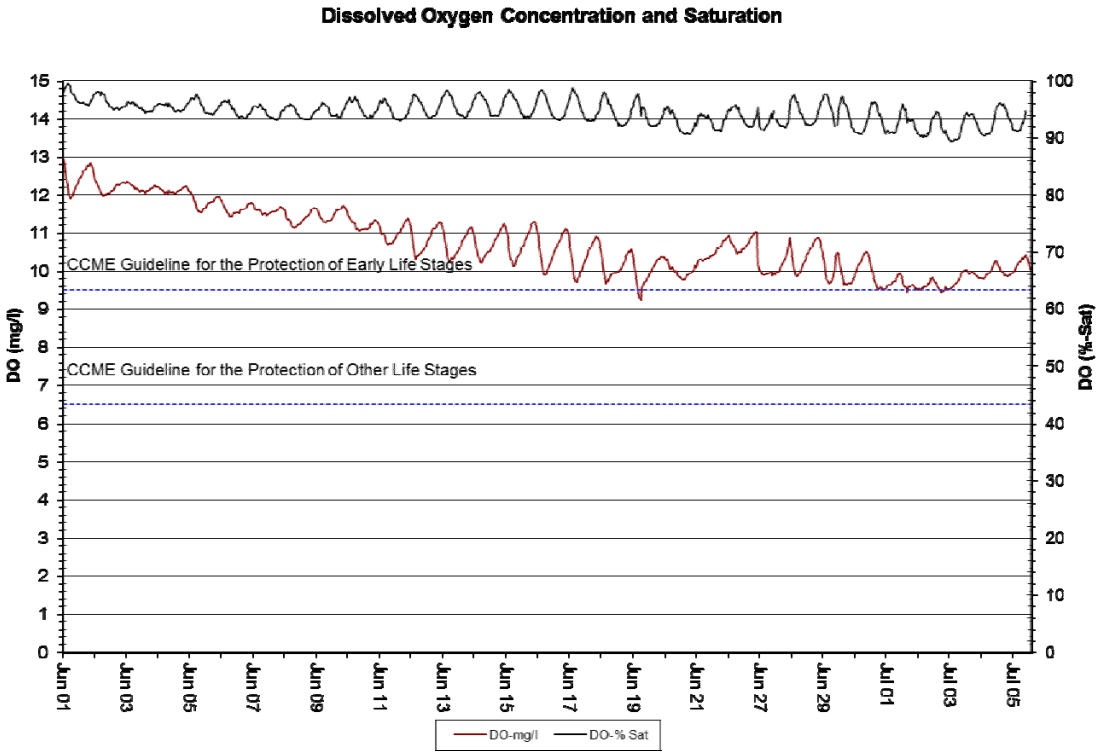

Figure 13: DO (mg/l & % saturation) at Elross Creek – June 1, 2016 to July 6, 2016

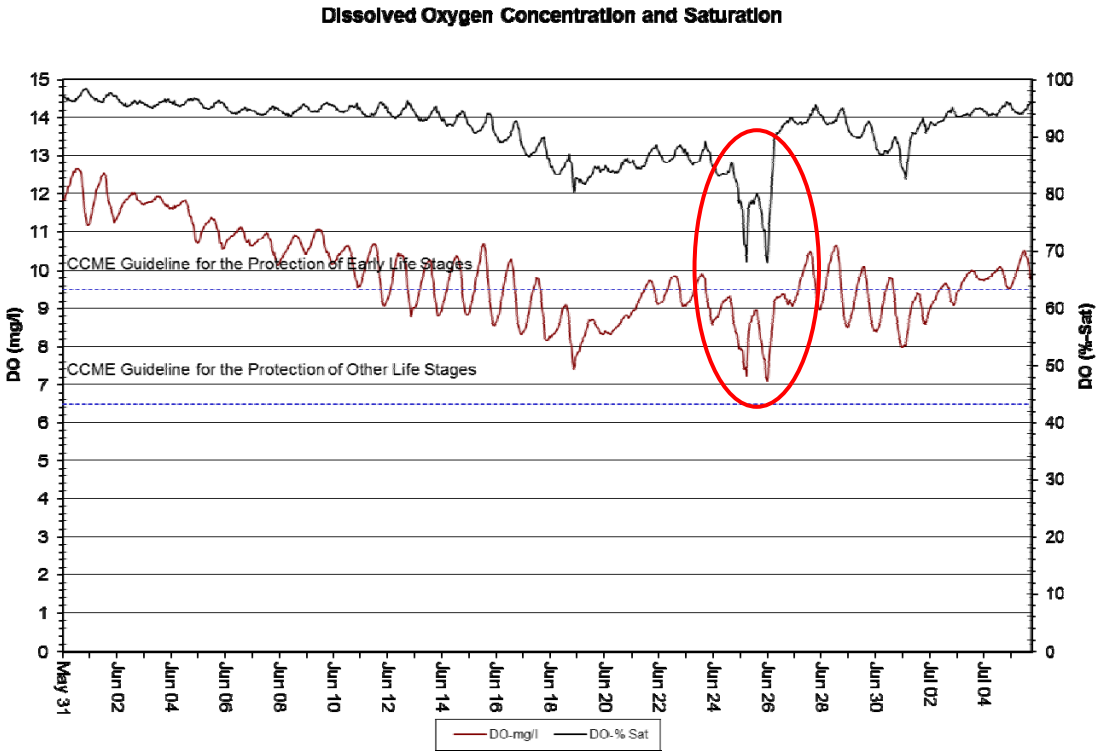

Figure 14: DO (mg/l & % saturation) at Goodream Creek – May 31, 2016 to July 6, 2016

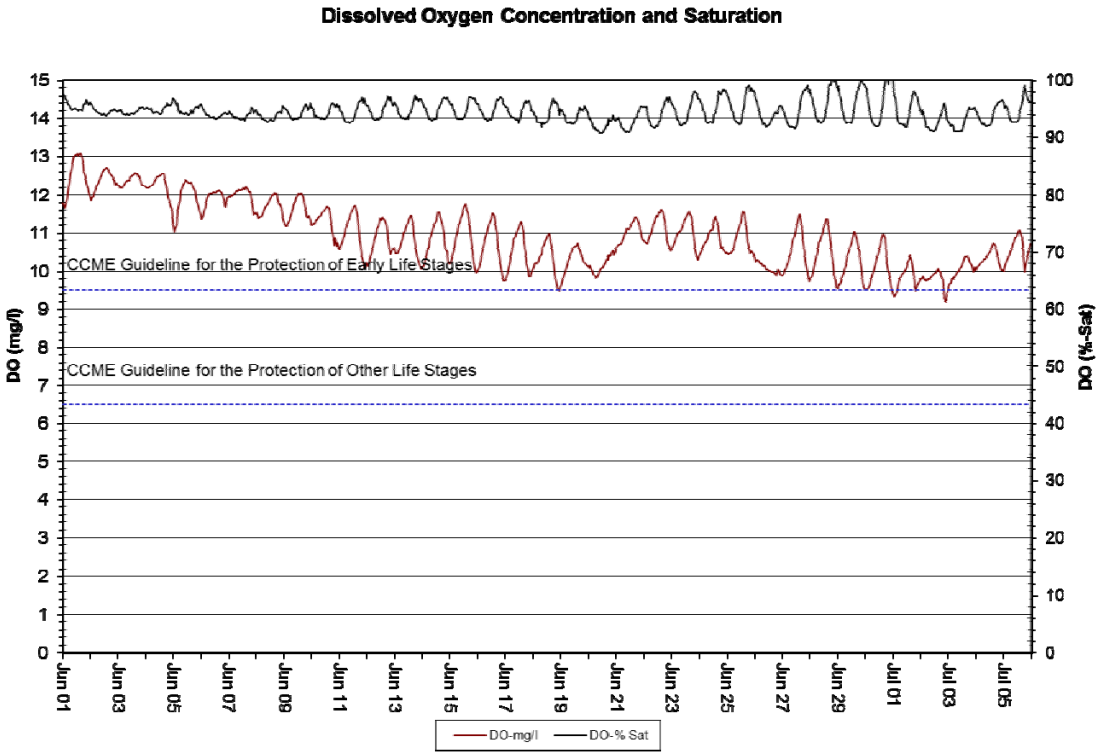

Figure 15: DO (mg/l & % saturation) at Joan Brook – June 1, 2016 to July 6, 2016

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 periods covered by this report, turbidity values ranged from 0.0 NTU to 201.7 NTU at Elross Creek, from 0.7 NTU to 11.7 NTU at Goodream Creek, and from 0.0 to 222.4 and Joan Brook (Figures 16, 17 & 18).
- At Elross Creek water quality is impacted by ground disturbance, erosion and sedimentation in relation to historical mining activity in the area. As a result, background turbidity levels are higher than normal background levels for the general area (see Figure 16).
- At Goodream Creek there appear to be a number of spikes in turbidity which correspond with increases in flow (see inside red ovals, Figure 17). Typically at Goodream Creek turbidity levels are low at around 1 to 2 NTU, however during significant rainfall events which cause higher flow, turbidity tends to increase significantly above background levels. The same phenomenon can be observed at Joan Brook for a brief period around July 3rd (see inside red oval, Figure 18).

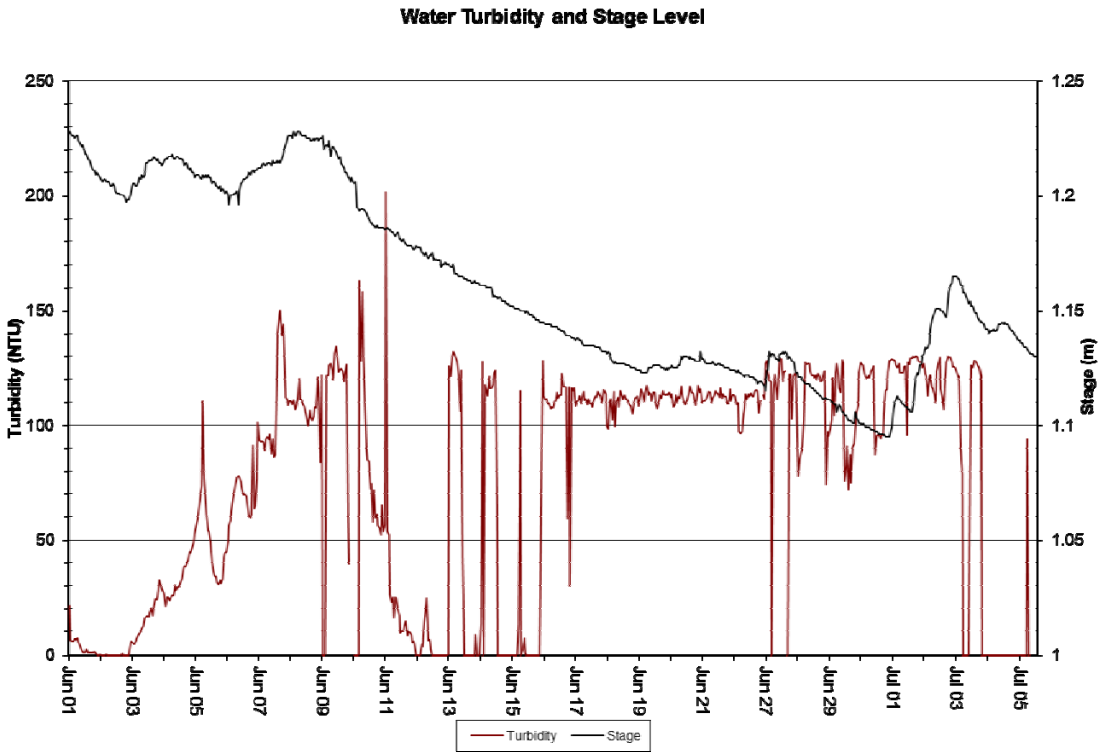

Figure 16: Turbidity (NTU) at Elross Creek – June 1, 2016 to July 6, 2016

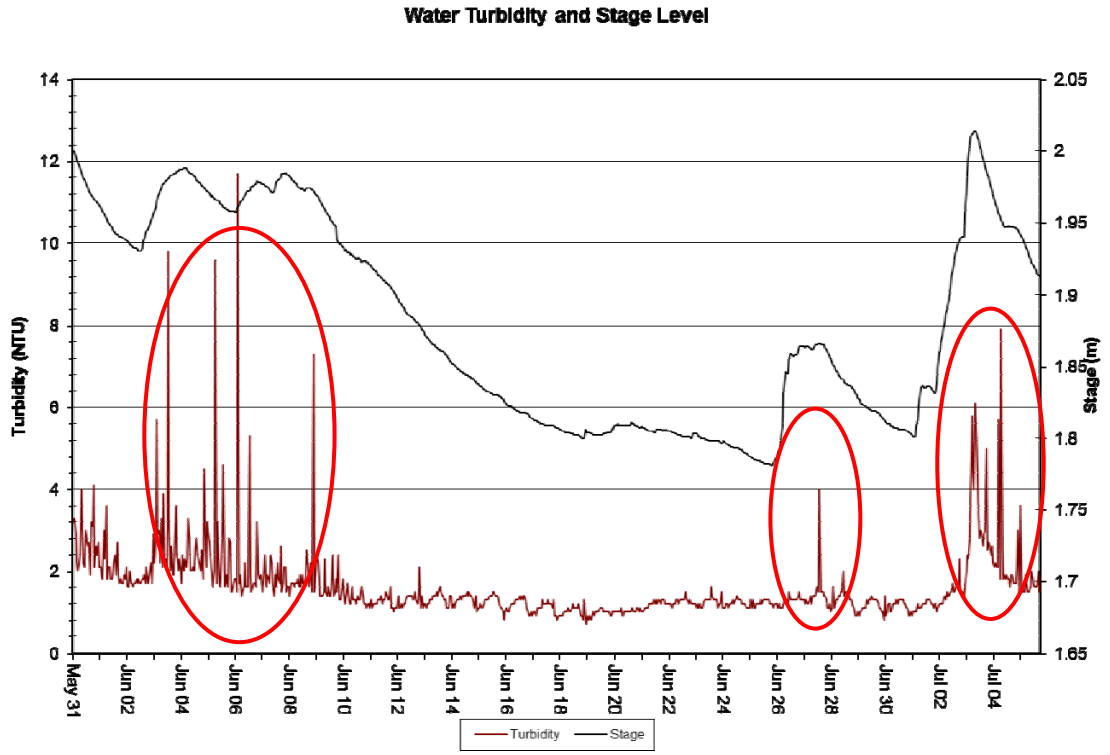

Figure 17: Turbidity (NTU) at Goodream Creek – May 31, 2016 to July 6, 2016

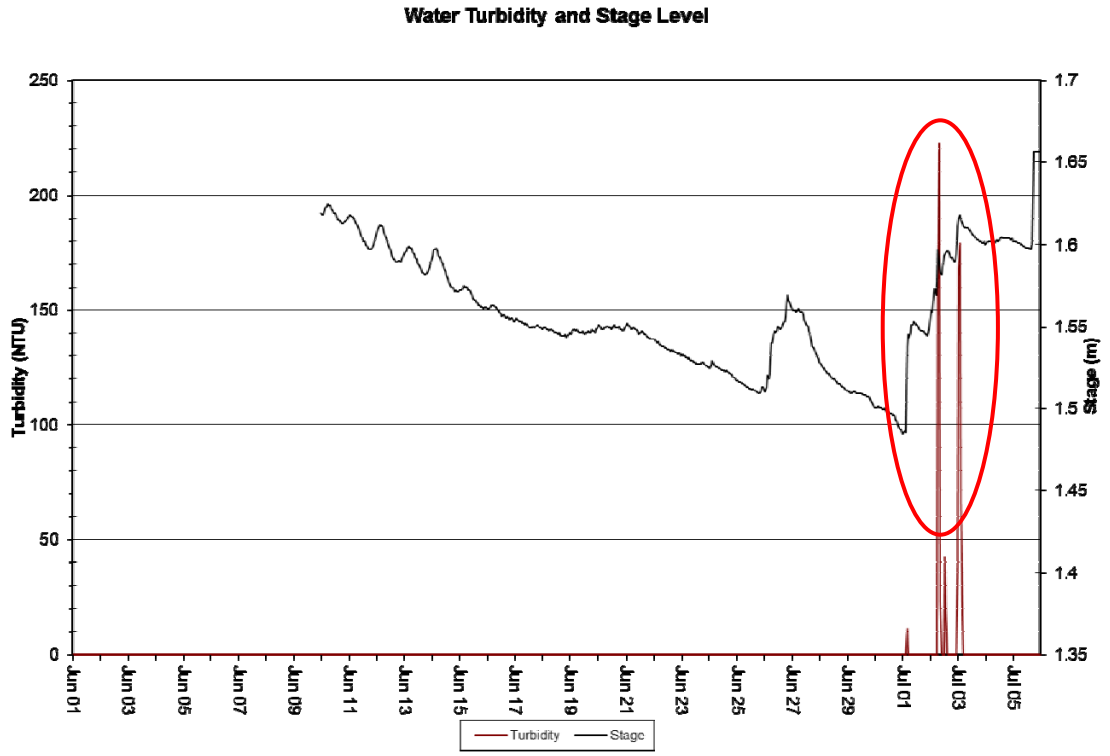

Figure 18: Turbidity (NTU) at Joan Brook – June 1, 2016 to July 6, 2016

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek, Goodream Creek, and Joan Brook stations from May 31st 2016 to July 6th , 2016.
- Field instruments for all three stations performed well over the deployment period with no significant maintenance issues.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For Elross Creek, Goodream Creek and Joan Brook, the stage height is typical for the late spring early summer when hydrological conditions are affected by decreasing snowmelt runoff and significant rainfall events which cause spikes that are relatively short lived.
    - For all three stations there is a gentle increasing temperature trend over the deployment period which is consistent with the season.
    - During the deployment period covered by this report, pH values ranged from 6.09 units to 7.01 units at Elross Creek, from 5.13 units to 5.90 units at Goodream Creek, and from 5.66 units to 6.81 units at Joan Brook .
    - During the deployment period covered by this report, specific conductivity ranged from 10.3 µs/cm to 15.8 µs/cm at Elross Creek, from 2.5 µs/cm to 6.4 µs/cm at Goodream Creek, and from 4.8 µs/cm to 8.3 µs/cm at Joan Brook.
    - During the deployment period covered by this report, dissolved oxygen (DO) values ranged from 9.23 mg/l (89.4% saturation) to 12.92 mg/l (99.5% saturation) at Elross Creek, from 7.07 mg/l (68.1% saturation) to 12.66 mg/l (98.4% saturation) at Goodream Creek, and from 9.18 mg/l (90.8% saturation) to 11.77 mg/l (102.9% saturation) at Joan Brook.
    - During the deployment period covered by this report, turbidity values ranged from 0.0 NTU to 201.7 NTU at Elross Creek, from 0.7 NTU to 11.7 NTU at Goodream Creek, and from 0.0 to 222.4 and 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 (May 31, 2016 to July 6, 2016)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
5/31/2016	3.3	-4.1	-0.4	18.4	0	1.2
6/1/2016	5.6	-4.8	0.4	17.6	0	0
6/2/2016	9.6	-5.3	2.2	15.8	0	0
6/3/2016	5.3	1.9	3.6	14.4	0	7.2
6/4/2016	6.1	3	4.6	13.4	0	0.9
6/5/2016	12.4	2.8	7.6	10.4	0	0.4
6/6/2016	9.3	4.3	6.8	11.2	0	2.8
6/7/2016	8.2	5.4	6.8	11.2	0	1.5
6/8/2016	11.3	5.1	8.2	9.8	0	5.7
6/9/2016	11	3.6	7.3	10.7	0	2.5
6/10/2016	14.4	5.5	10	8	0	0.2
6/11/2016	15.7	5.6	10.7	7.3	0	1.7
6/12/2016	18.8	4.2	11.5	6.5	0	0
6/13/2016	19.3	5.6	12.5	5.5	0	0
6/14/2016	17.3	5.2	11.3	6.7	0	0
6/15/2016	16.6	3.8	10.2	7.8	0	0
6/16/2016	18.8	1.6	10.2	7.8	0	0
6/17/2016	20.4	2.2	11.3	6.7	0	0.3
6/18/2016	25.7	3.9	14.8	3.2	0	0
6/19/2016	24.2	10	17.1	0.9	0	1.9
6/20/2016	17.8	9.4	13.6	4.4	0	4
6/21/2016	15.1	5.6	10.4	7.6	0	0.9
6/22/2016	9.6	3.9	6.8	11.2	0	1.4
6/23/2016	12.2	3.1	7.7	10.3	0	0
6/24/2016	13.4	4.4	8.9	9.1	0	0
6/25/2016	18.5	6.2	12.4	5.6	0	0
6/26/2016	19.2	4.8	12	6	0	12.4
6/27/2016	20.6	5	12.8	5.2	0	12.3
6/28/2016	13.4	2.7	8.1	9.9	0	0.6
6/29/2016	17	1.7	9.4	8.6	0	0.2
6/30/2016	17.2	4.1	10.7	7.3	0	0
7/1/2016	20.5	4.6	12.6	5.4	0	8.7
7/2/2016	18.9	10.2	14.6	3.4	0	20.7
7/3/2016	16.2	8.4	12.3	5.7	0	7.6
7/4/2016	11.4	7.8	9.6	8.4	0	0.8
7/5/2016	11.5	4.2	7.9	10.1	0	2.1
7/6/2016	16.1	3.7	9.9	8.1	0	0.3