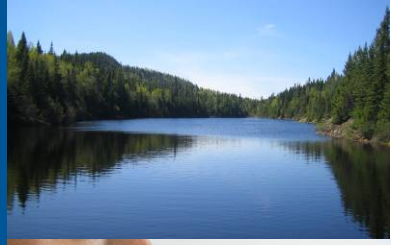




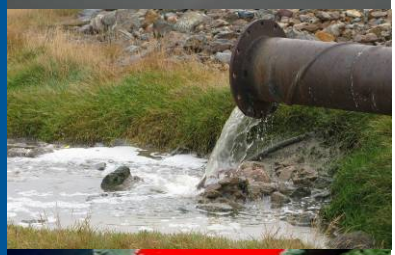


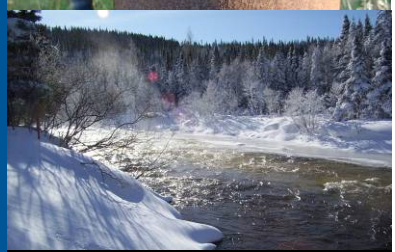

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2013-08-07 to 2013-09-11

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

- The Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment Canada, maintain two 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 and GOODREAM CREEK 2KM NORTHWEST OF TIMMINS 6, hereafter referred to as the *Elross Creek Station* and the *Goodream Creek Station*, respectively.
- Station sites were selected to monitor all surface water outflows from the Elross Lake mining site. 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 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 Goodream Creek stations from August 7, 2013 to September 11, 2013.

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.

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

	Elross Creek			Goodream Creek	
Stage of deployment	Beginning	End		Beginning	End
Date	2013-08-07	2013-09-11		2013-08-07	2013-09-11
Temperature	Excellent	Excellent		Excellent	Fair
pH	Excellent	Excellent		Excellent	Good
Specific Conductivity	Excellent	Excellent		Excellent	Excellent
Dissolved Oxygen	Excellent	Good		Excellent	Excellent
Turbidity	Excellent	Good		Excellent	Excellent

Deployment Notes

- Water quality monitoring for this deployment period started at Elross Creek on August 7, 2013 at 11:15 am and at Goodream Creek on the same date at 1:30 pm. Continuous real-time monitoring continued at both sites without any significant operational issues until September 11, 2013 when the instruments were removed for routine 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 (^{o}C)
(iii.) pH
(iv.) Specific conductivity (□S/cm)
(v.) Dissolved oxygen (mg/l)
(vi.) Turbidity (NTU)

Stage

- Stage height values ranged from 1.17 m to 1.42 m at Elross Creek and from 1.84 m to 2.25 m at Goodream Creek from August 8, 2013 to September 11, 2013 (Figures 1 and 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.
- For both Elross Creek and Goodream Creek stage height and flow are relatively stable over the duration of the deployment.
- For both Elross Creek and Goodream Creek there are significant spikes in stage height around August 11 and August 22 (see inside red ovals) which coincide with significant rainfall events at that time (Climate data located in Appendix B).

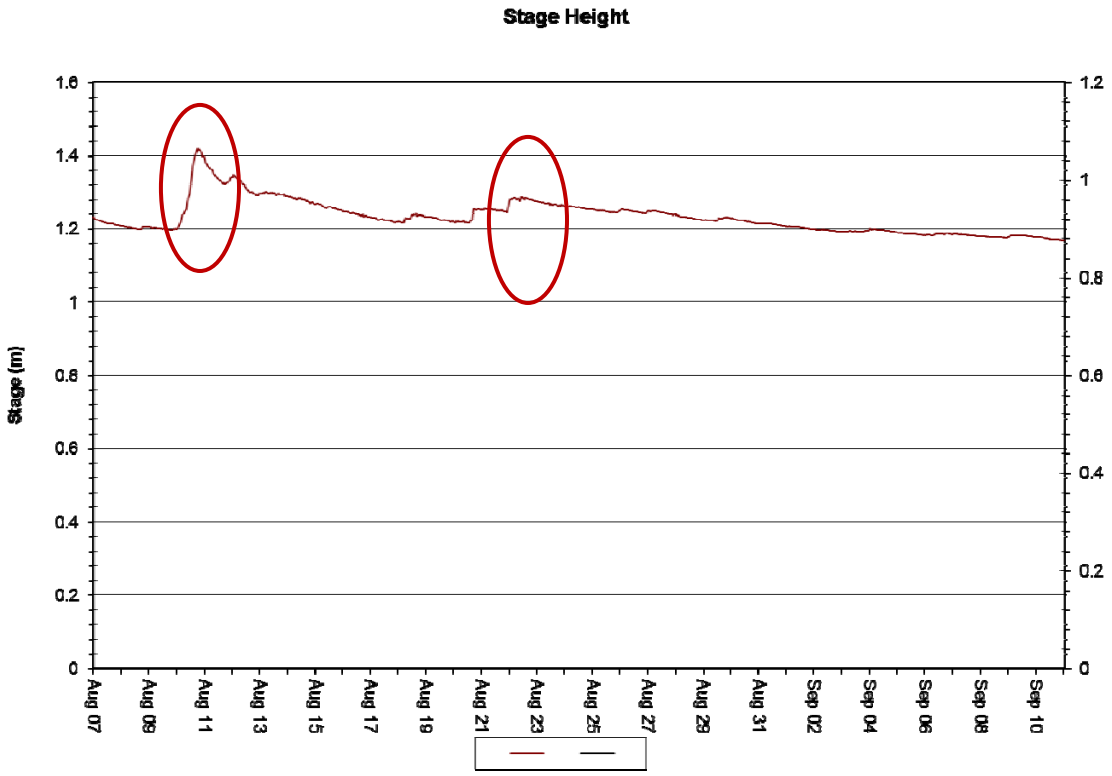

Figure 1: Stage Height (m) at Elross Creek –August 7, 2013 to September 11, 2013

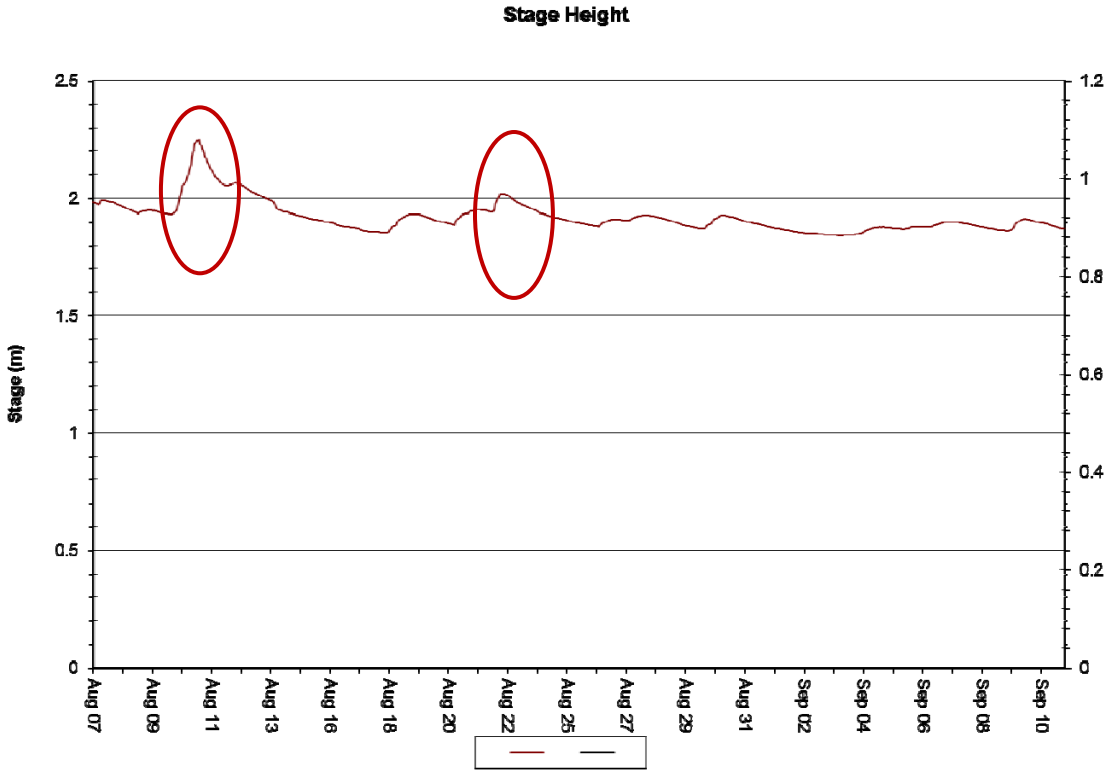

Figure 2: Stage Height (m) at Goodream Creek – August 7, 2013 to September 11, 2013

Temperature

- Water temperature ranged from 4.80˚C to 15.80˚C at Elross Creek and from 1.20˚C to 16.60˚C at Goodream Creek from August 7, 2013 to September 11, 2013 (Figures 3 & 4).
- Both Elross Creek and Goodream Creek show a general cooling trend throughout the deployment period which corresponds with the cooling temperatures associated with the end of summer and onset of autumn.
- Water temperatures at both stations display large diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- During periods of increased stage and flow the diurnal temperature trends are reduced making them less noticeable.

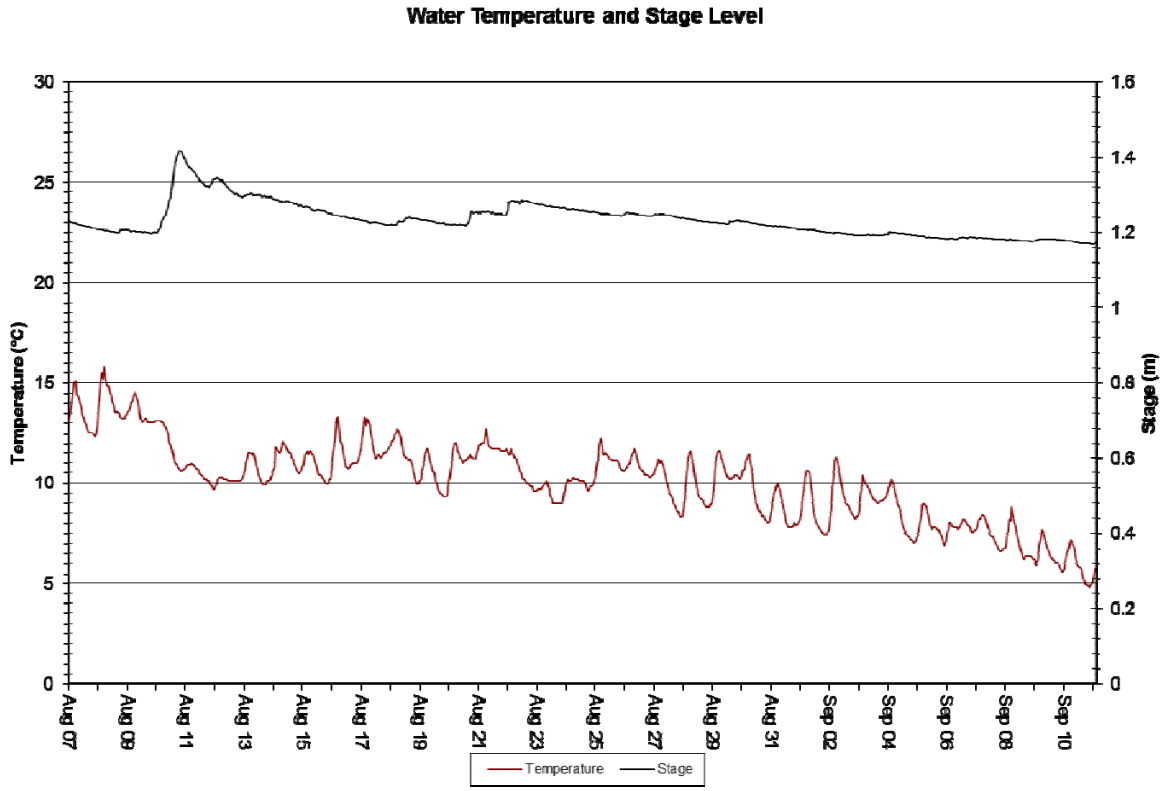

Figure 3: Temperature (°C) - Elross Creek – August 7, 2013 to September 11, 2013

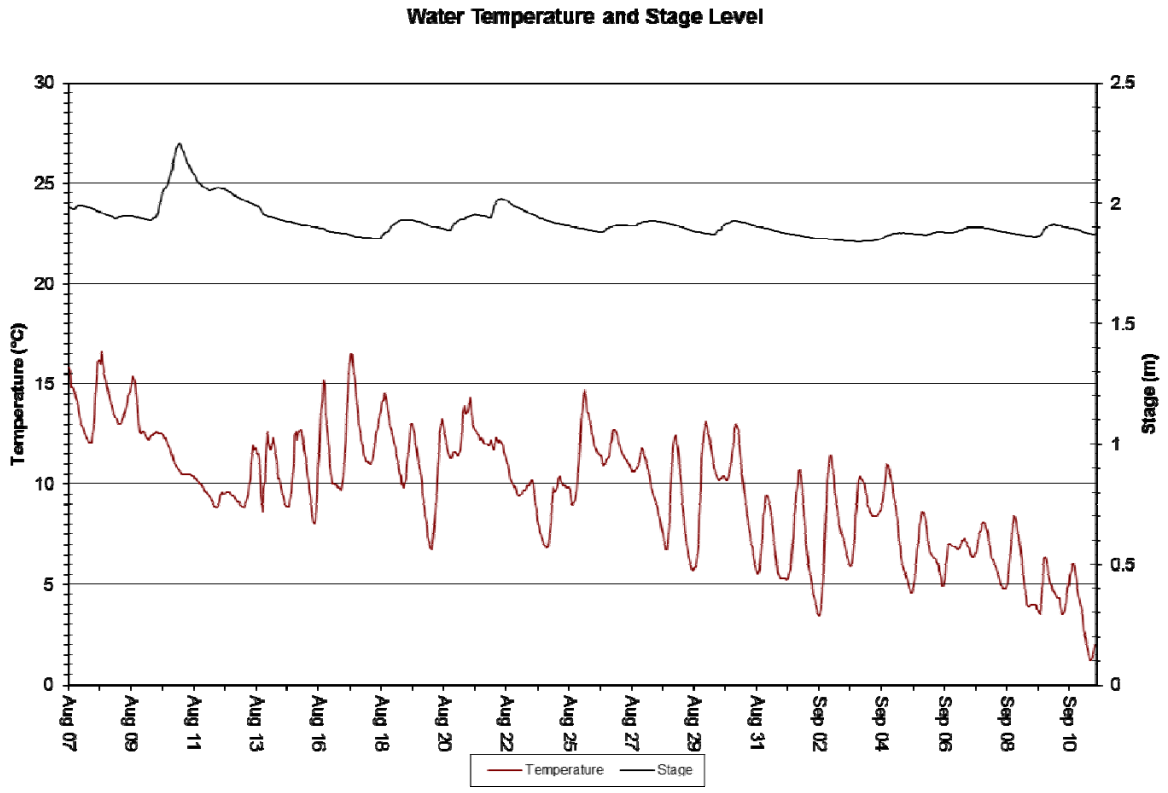

Figure 4: Temperature (°C) - Goodream Creek - August 7, 2013 to September 11, 2013

pH

- pH values ranged from 6.34 units to 7.01 units at Elross Creek and from 5.07 units to 6.50 units at Goodream Creek from August 7, 2013 to September 11, 2013 (Figures 5 & 6).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend.
- At both Elross and Goodream Creeks it appears that pH is affected by significant changes in stream flow (see inside red ovals), with slight dips around August 11 and 22 due to a significant increase in flow for the corresponding period.
- With a mean value of 6.86, pH values recorded at Elross Creek were at, or slightly above, the minimum pH guideline set for the protection of aquatic life (i.e., 6.5 units), as defined by the Canadian Council of Ministers of the Environment (2007). With a mean value of 6.11, pH values recorded at Goodream Creek were slightly below this minimum 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.

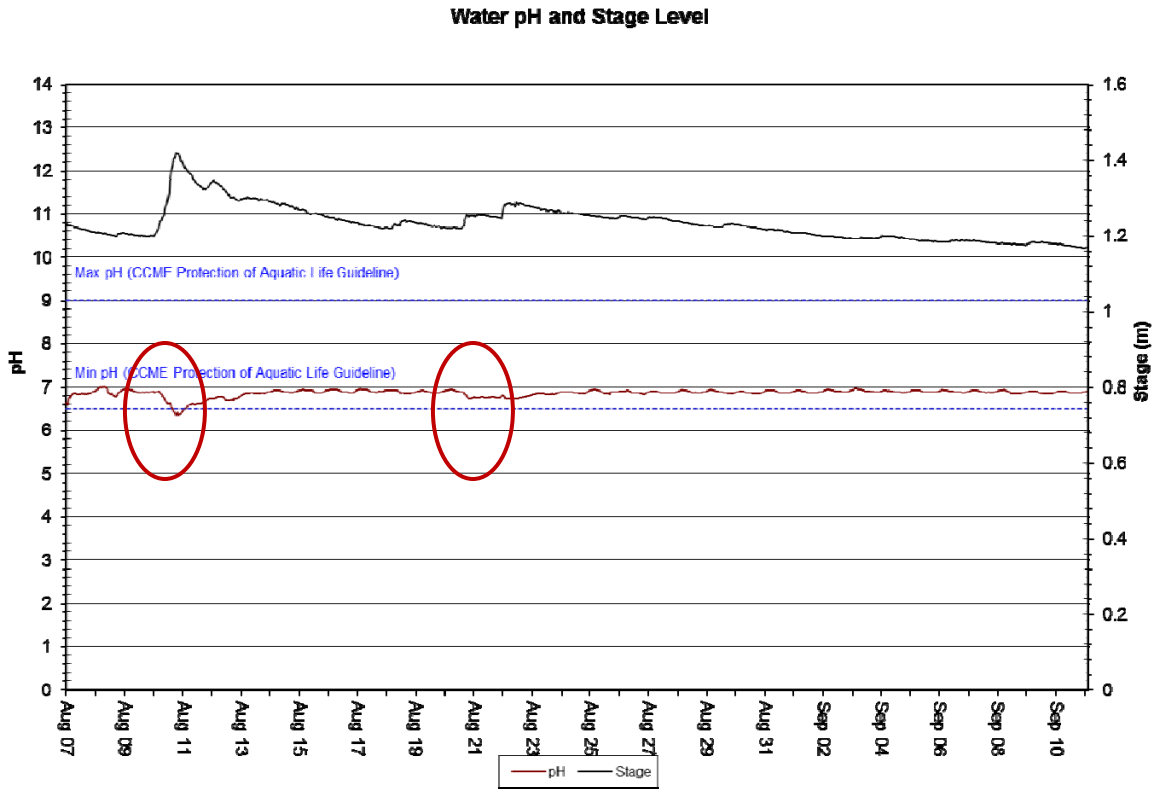

Figure 5: pH at Elross Creek – August 7, 2013 to September 11, 2013

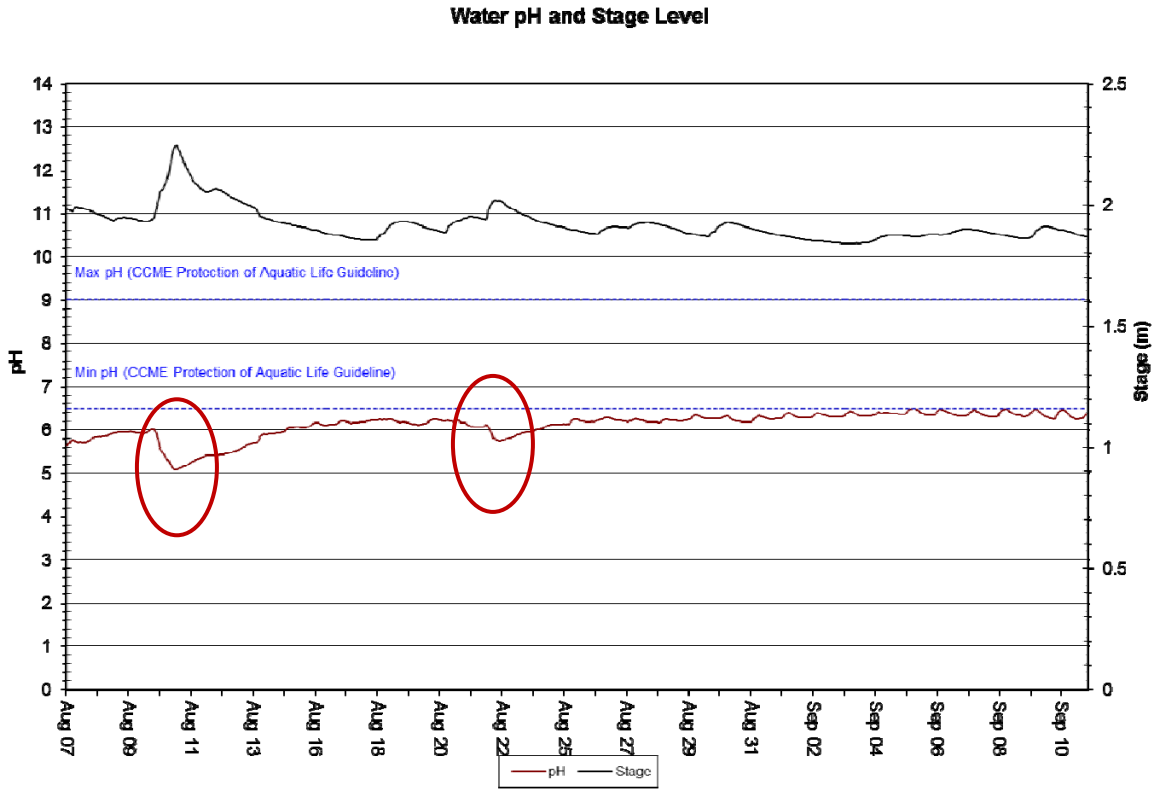

Figure 6: pH at Goodream Creek – August 7, 2013 to September 11, 2013

Specific Conductivity

- Specific Conductivity ranged from 11.8 µs/cm to 23.8 µs/cm at Elross Creek and from 3.3 µs/cm to 6.1 µs/cm at Goodream Creek from August 7, 2013 to September 11, 2013 (Figures 7 & 8).
- Sudden changes in flow appear to have a noticeable impact on specific conductivity (see inside red ovals). It appears that a sudden increase in flow around August 11 is having opposite effects on specific conductivity at the two stations with a noticeable dip at Elross Creek and a distinct spike at Goodream Creek.

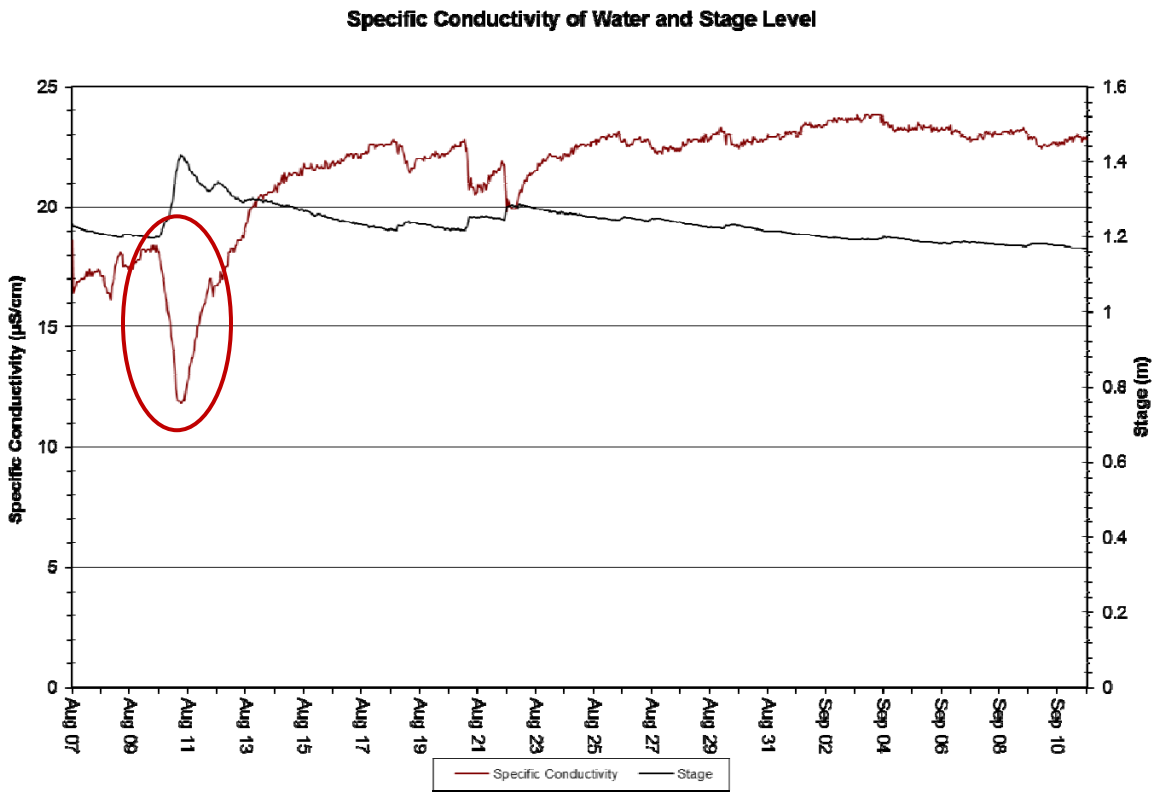

Figure 7: Specific conductivity (us/cm) - Elross Creek – Aug. 7, 2013 to September 11, 2013

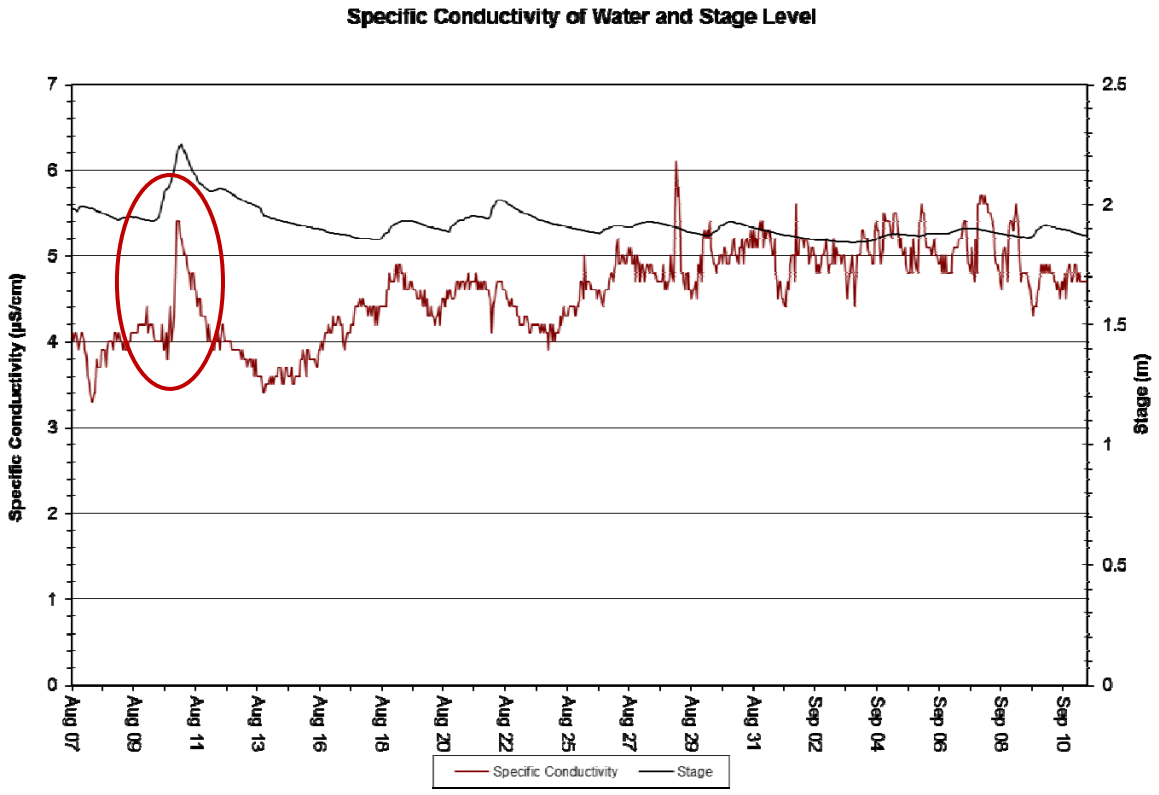

Figure 8: Specific conductivity (us/cm) - Goodream Creek – Aug. 7, 2013 to Sept. 11, 2013

Dissolved Oxygen

- Dissolved Oxygen (DO) values ranged from 8.88 mg/l (86.6% saturation) to 11.40 mg/l (95.2% saturation) at Elross Creek and from 8.62 mg/l (86.4% saturation) to 12.40 mg/l (100.2 % saturation) at Goodream Creek from August 7, 2013 to September 11, 2013 (Figures 9 & 10).
- There appears to be a slight increasing trend in dissolved oxygen over the deployment period, which is most noticeable in the mg/l data. This increasing oxygen trend is related to the decreasing temperature trend.
- There is a distinct diurnal trend for DO (mg/l & % saturation) which is clearly visible at both sites. This diurnal trend is related to the diurnal temperature trends.
- The DO values at both stations were very close to or above the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and above minimum guidelines set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).

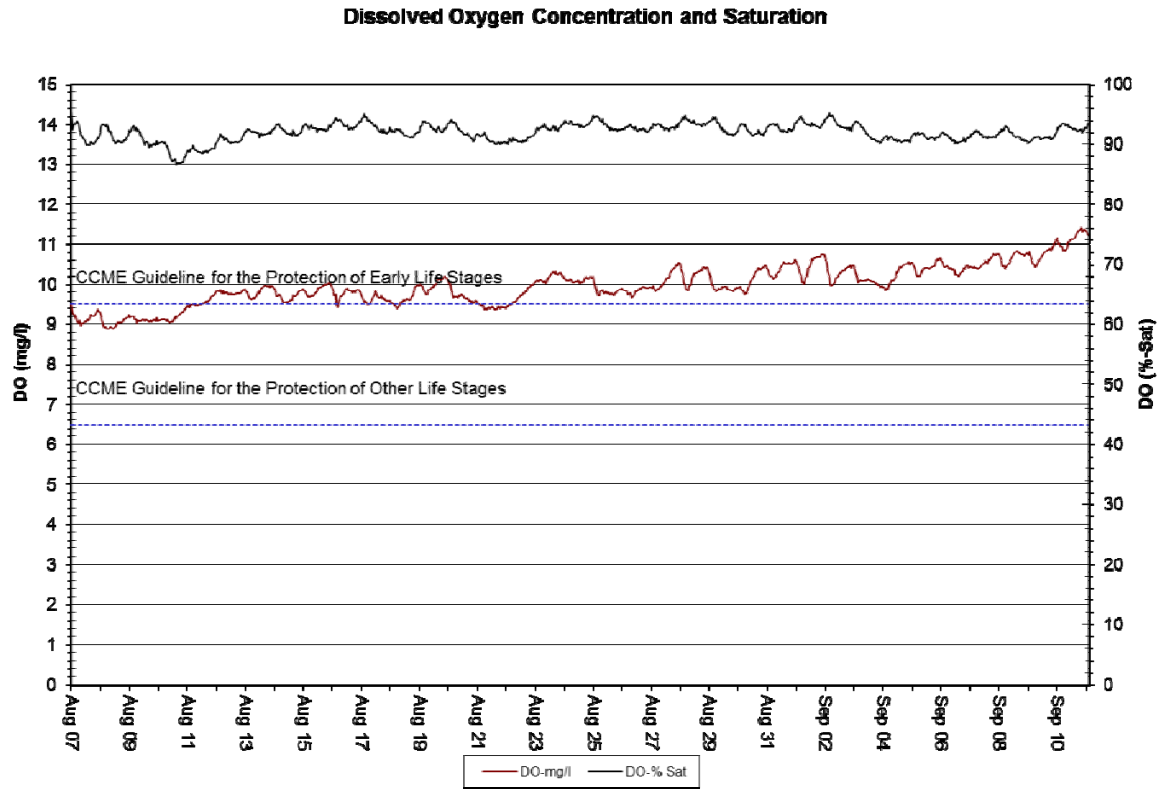

Figure 9: DO (mg/l & % saturation) at Elross Creek – August 7, 2013 to Sept. 11, 2013

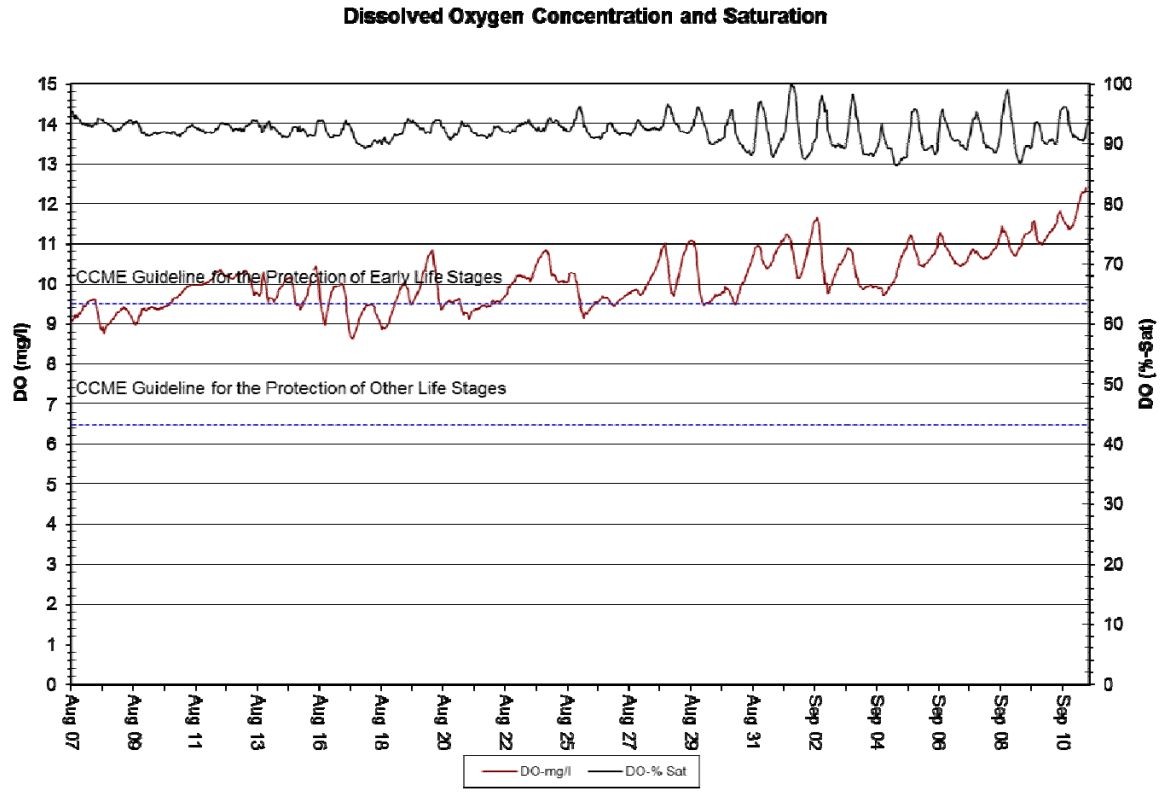

Figure 10: DO (mg/l & % saturation) at Goodream Creek – Aug. 7, 2013 to Sept. 11, 2013

Turbidity

- Turbidity values ranged from 11.5 NTU to 1398.0 NTU at Elross Creek and from 0.0 NTU to 131.2 NTU at Goodream Creek from August 7, 2013 to September 11, 2013 (Figures 11 & 12).
- Several spikes in turbidity at Elross Creek (see inside red ovals) correspond with significant rainfall events and subsequent increases in flow. Likewise, the large spike in turbidity recorded at Goodream Creek around August 11 (see inside red oval) coincided with a significant rainfall event and subsequent rapid increase in flow.
- With a median of 44.4 NTU, turbidity at Elross Creek appears to be consistently higher during this deployment period than in the two preceding deployment periods where the averages were 9.0 NTU and 4.4 NTU respectively. This may be attributed to more precipitation during this deployment period, with a total of 199.2 mm compared with totals of 44.1mm and 171.1 mm for the two preceding deployment periods. However it may also be indicative of the level of ground disturbance associated with ongoing developments at the mine site.

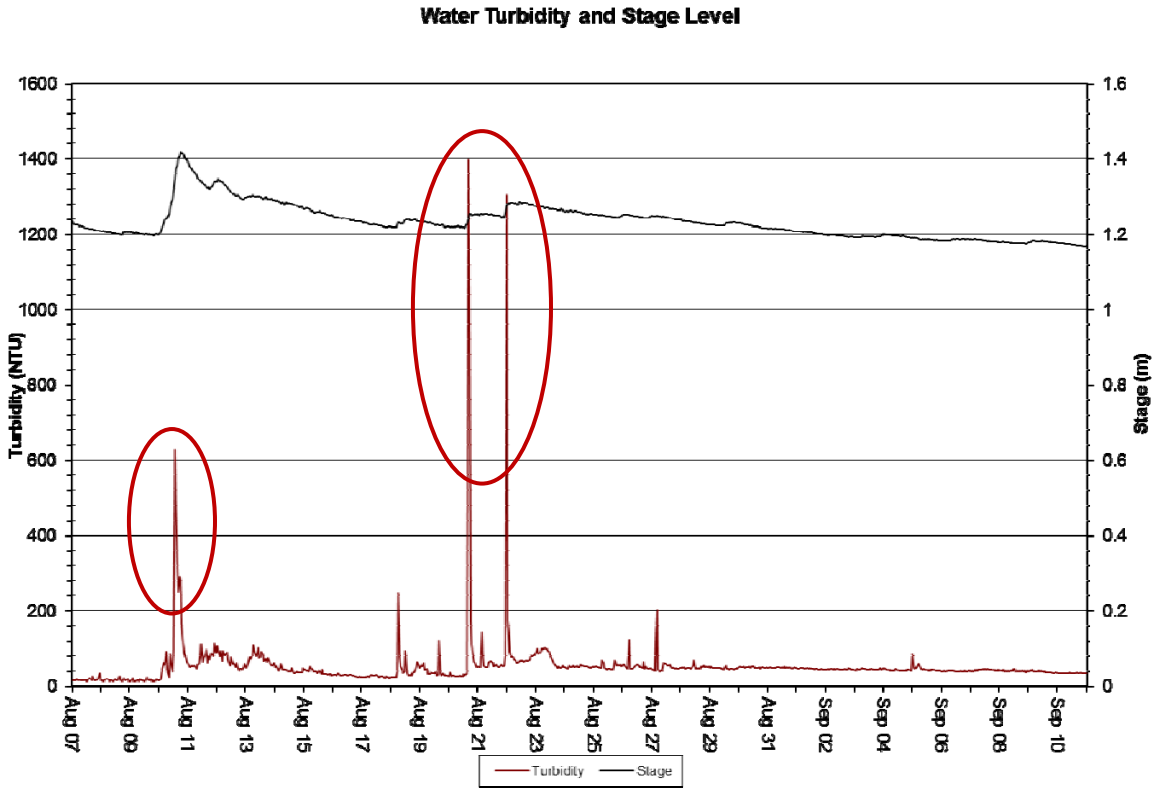

Figure 11: Turbidity (NTU) at Elross Creek – August 7, 2013 to September 11, 2013

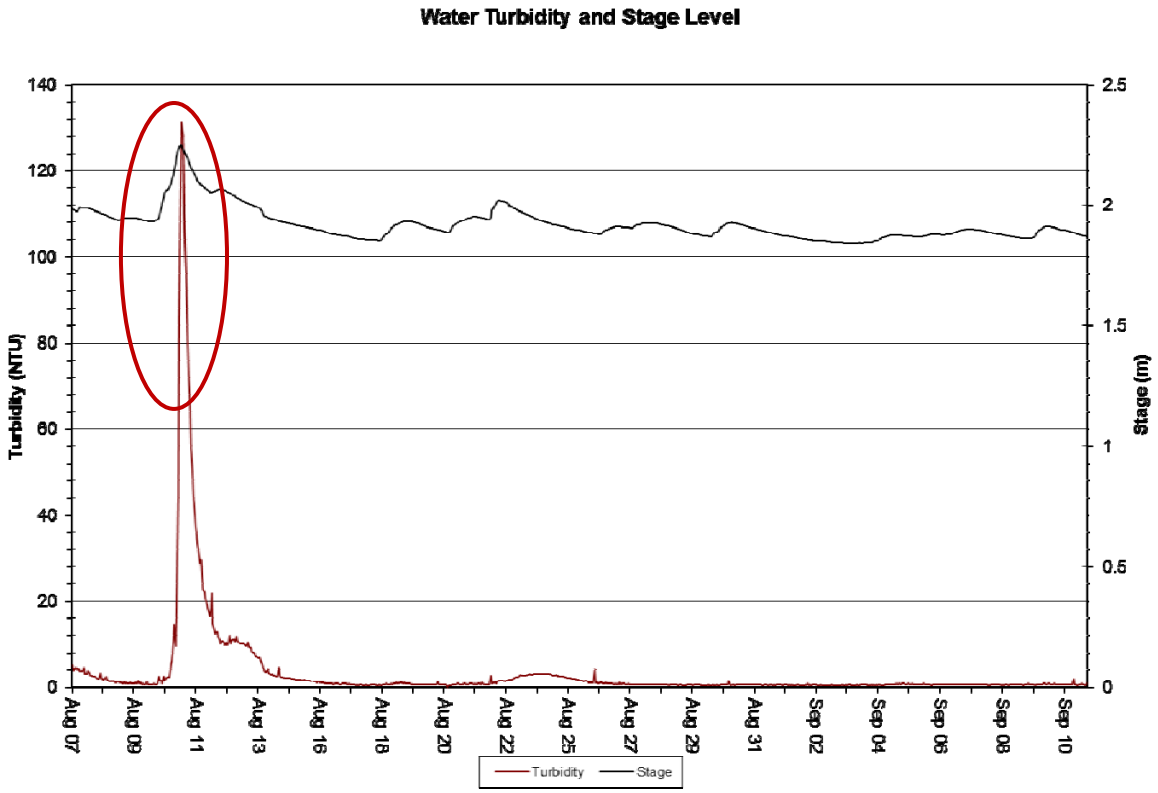

Figure 12: Turbidity (NTU) at Goodream Creek – August 7, 2013 to September 11, 2013

Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from August 7, 2013 to September 11, 2013.
- The performances of all sensors were rated excellent at the beginning of the deployment and fair to excellent at the end.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For both Elross Creek and Goodream Creek there were significant spikes in stage height around August 11 and 22 which coincide with significant rainfall events.
    - Both Elross Creek and Goodream Creek show a general cooling trend throughout the deployment period which corresponds with the cooling air temperatures associated with the transition from summer to fall.
    - Diurnal fluctuations in water temperature corresponded with fluctuations in air temperature. This diurnal temperature trend is reflected in similar diurnal trends for pH and dissolved oxygen.

  - At both Elross and Goodream Creeks it appears that pH is affected by significant changes in stream flow, with slight dips around August 11 and 22 due to significant increases in flow for the corresponding periods.
  - Sudden changes in flow appear to have a noticeable impact on specific conductivity. It appears that a sudden increase in flow around August 11 is having opposite effects on specific conductivity at the two stations with a noticeable dip at Elross Creek and a distinct spike at Goodream Creek.
  - There appears to be a slight increasing trend in dissolved oxygen over the deployment period, which is most noticeable in the mg/l data. This increasing oxygen trend is related to the decreasing temperature trend.
  - Turbidity events at both Elross Creek and Goodream Creek appear to coincide with significant rainfall events. Median Turbidity at Elross Creek appears to be higher during this deployment period compared to the two previous ones.

- Field instruments for both stations performed quite well over the deployment period with no significant maintenance issues.

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 (August 7, 2013 to September 11, 2013)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Rain Flag	Total Snow Flag	Total Precip (mm)
8/7/2013	19.8	11.6	15.7	2.3	0	M	M	0
8/8/2013	24	11	17.5	0.5	0	M	M	3.8
8/9/2013	17.3	11.7	14.5	3.5	0	M	M	5.3
8/10/2013	14	9.7	11.9	6.1	0	M	M	53.9
8/11/2013	10.2	7.2	8.7	9.3	0	M	M	13.3
8/12/2013	9	4.7	6.9	11.1	0	M	M	16.4
8/13/2013	15.1	6.1	10.6	7.4	0	M	M	0
8/14/2013	16.6	4.4	10.5	7.5	0	M	M	0
8/15/2013	16.5	6.4	11.5	6.5	0	M	M	0
8/16/2013	19.6	6.5	13.1	4.9	0	M	M	0
8/17/2013	20.9	10.6	15.8	2.2	0	M	M	0
8/18/2013	20.1	8.8	14.5	3.5	0	M	M	5.1
8/19/2013	10.9	1.7	6.3	11.7	0	M	M	1.3
8/20/2013	15.2	1.2	8.2	9.8	0	M	M	8.8
8/21/2013	21.2	14.2	17.7	0.3	0	M	M	21.2
8/22/2013	14.6	6.9	10.8	7.2	0	M	M	35.9
8/23/2013	11.6	2.2	6.9	11.1	0	M	M	0.8
8/24/2013	13.4	3.1	8.3	9.7	0	M	M	0.3
8/25/2013	20	5.3	12.7	5.3	0	M	M	0
8/26/2013	16.1	11	13.6	4.4	0	M	M	5.5
8/27/2013		10.2				M		
8/28/2013						M	M	
8/29/2013	18.3	2.8	10.6	7.4	0	M	M	5.3
8/30/2013	13.2	0.8	7	11	0	M	M	2
8/31/2013	7.8	0	3.9	14.1	0	M	M	0.5
9/1/2013	9.5	-0.6	4.5	13.5	0	M	M	0
9/2/2013	14.2	-0.4	6.9	11.1	0	M	M	0
9/3/2013	12.2	4	8.1	9.9	0	M	M	3.6
9/4/2013	14.4	1.7	8.1	9.9	0	M	M	4.8
9/5/2013	6.9	0.7	3.8	14.2	0	M	M	2.5
9/6/2013	10.7	0.4	5.6	12.4	0	M	M	3.3
9/7/2013	7.5	1	4.3	13.7	0	M	M	0.3
9/8/2013	6	-1.7	2.2	15.8	0	M	M	0
9/9/2013	8	0.2	4.1	13.9	0	M	M	5.3
9/10/2013	3.8	-2.1	0.9	17.1	0	M	M	0
9/11/2013	11.8	-3.5	4.2	13.8	0	M	M	0