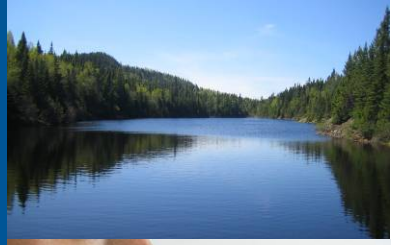




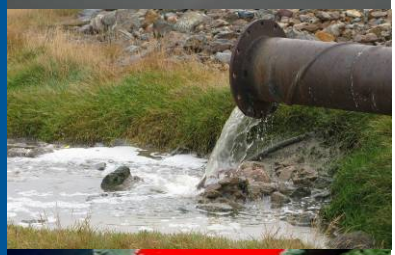


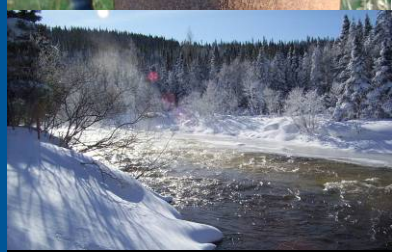

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2015-09-01 to 2015-10-06

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

- During the 2015 field season the Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment Canada, maintained 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 September 1st , 2015 to October 6th, 2015, which was the fourth deployment period for the 2015 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	
Stage of deployment	Beginning	End		Beginning	End
Date	2015-9-1	2015-10-6		2015-9-2	2015-10-6
Temperature	Excellent	Excellent		Excellent	Excellent
pH	Excellent	Good		Excellent	Marginal
Specific Conductivity	Excellent	Excellent		Excellent	Excellent
Dissolved Oxygen	Excellent	Excellent		Excellent	Good
Turbidity	Excellent	Excellent		Excellent	Excellent

- The performance of all sensors at both Elross and Goodream Creeks were within acceptable limits during this deployment period (Table 1).

Deployment Notes

- Water quality monitoring for this deployment period season started at Elross Creek on September 1st, 2015 and at Goodream Creek on September 2nd, 2015. Continuous real-time monitoring continued at both sites without any significant operational issues until October 6th, 2015 when the instruments at both stations were removed for the end of the 2015 field season.

Data Interpretation

- Data records were interpreted for each station during the deployment period for the following six parameters:

  (i.) Stage (m)
  (ii.) Temperature (ºC)
  (iii.) pH
  (iv.) Specific conductivity (□S/cm)
  (v.) Dissolved oxygen (mg/l)
  (vi.) Turbidity (NTU)

Stage

- During the deployment periods covered by this report, stage height values ranged from 1.06 m to 1.26 m at Elross Creek and from 1.79 m to 2.08 m at Goodream Creek (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 the stage height is typical for the late summer/early fall season, when hydrological conditions are affected by rainfall events which cause spikes that are relatively short lived. This deployment period saw significant precipitation, with approximately 75 mm falling over five days from September 16th to the 20th (Climate data located in Appendix B) and the impact of this wet period is plain to see on the stage height graphs for both stations.

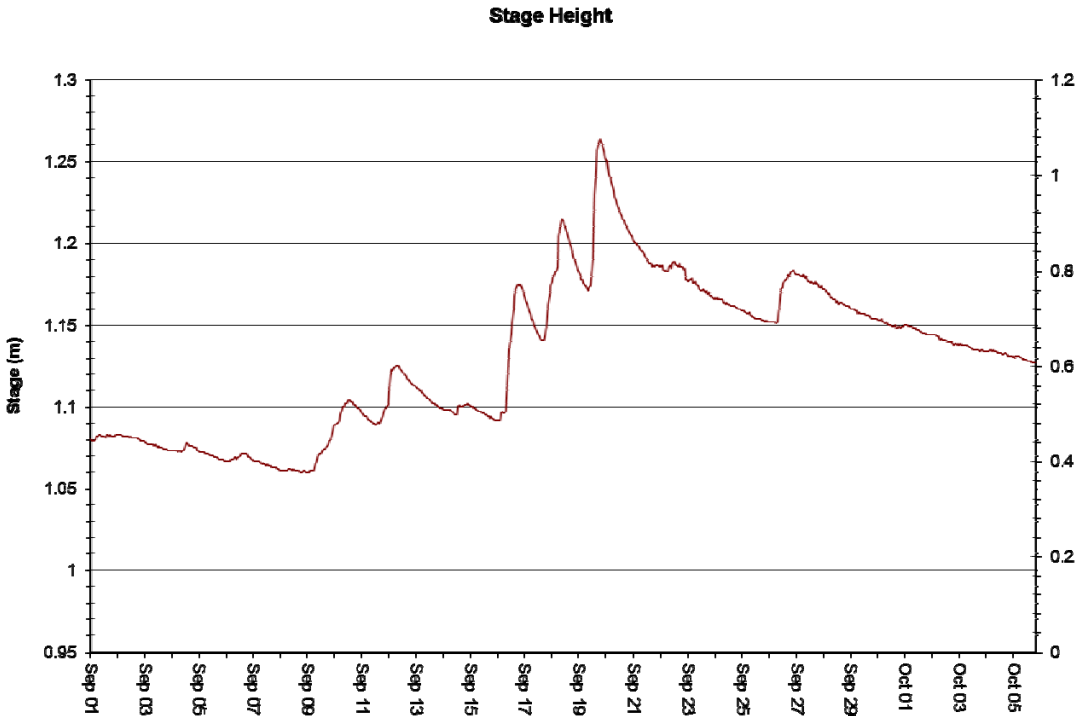

Figure 1: Stage Height (m) at Elross Creek –Sept 1, 2015 to October 6, 2015

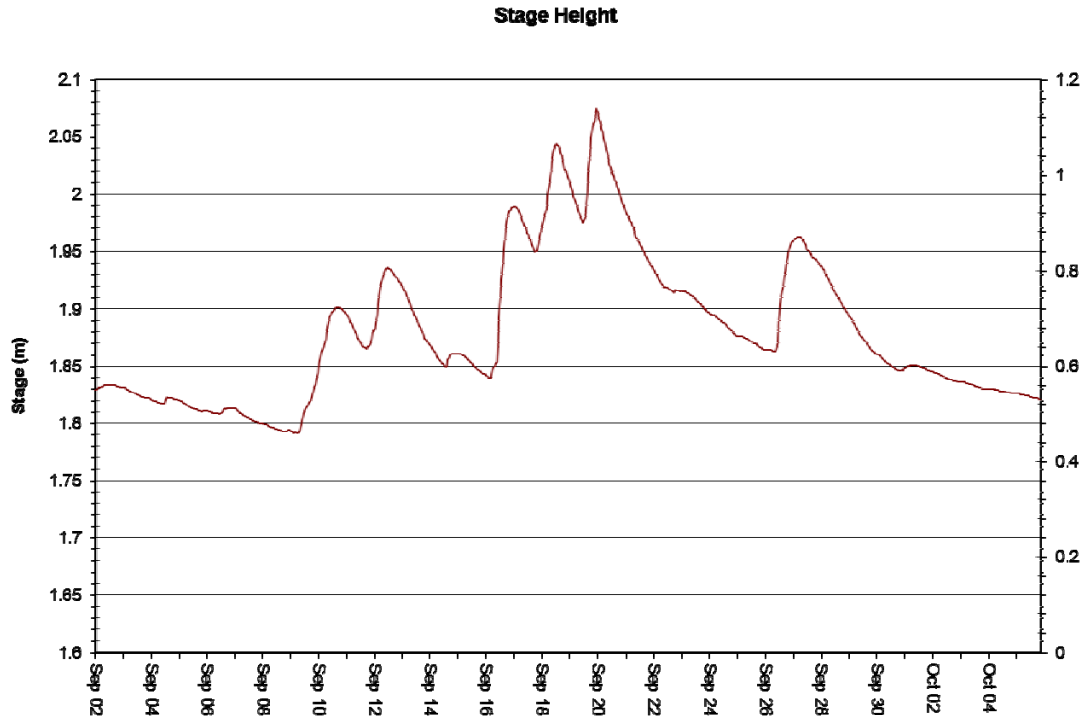

Figure 2: Stage Height (m) at Goodream Creek – Sept 2, 2015 to October 6, 2015

Temperature

- During the deployment periods covered by this report, water temperature ranged from 3.50˚C to 10.80˚C at Elross Creek and from 1.30˚C to 12.80˚C at Goodream Creek (Figures 3 & 4).
- Both Goodream and Elross stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- For both Elross and Goodream Creeks there is a gentle decreasing temperature trend over the deployment period which is consistent with the season.
- There is a period from approximately September 24th to 27th (see inside red ovals) where water temperature at both sites are noticeably cooler as a result of several days of cooler air temperatures.

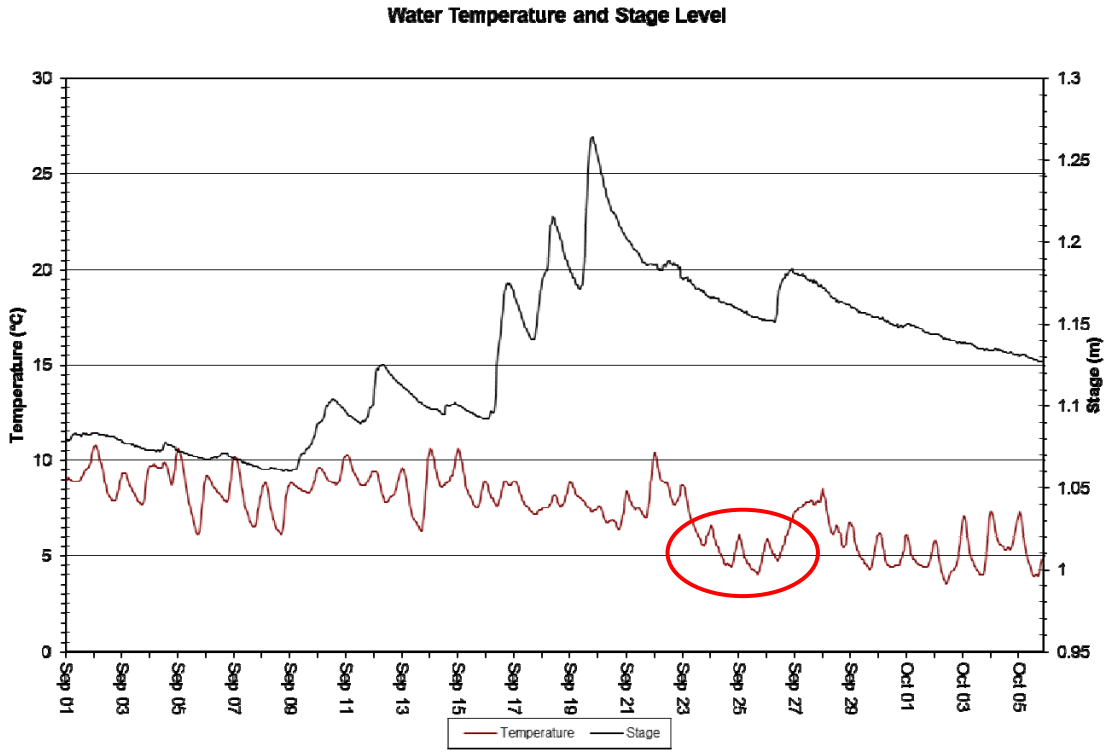

Figure 3: Temperature (°C) - Elross Creek – Sept 1, 2015 to October 6, 2015

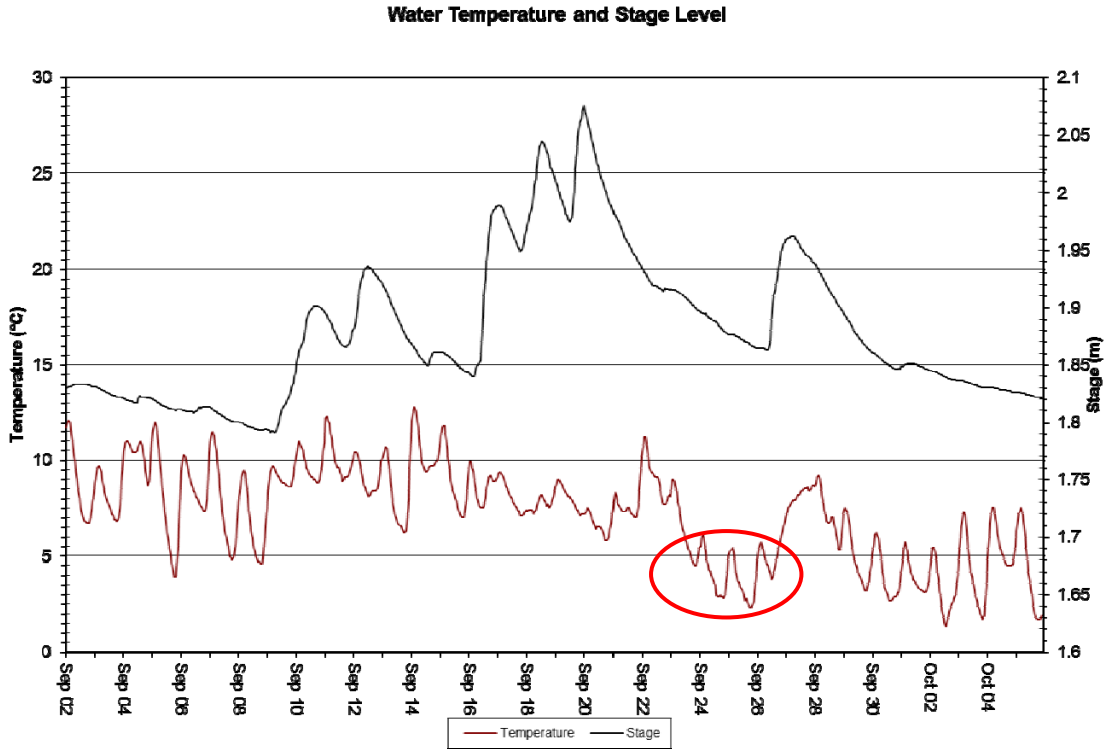

Figure 4: Temperature (°C) - Goodream Creek - Sept 2, 2015 to October 6, 2015

pH

- During the deployment periods covered by this report, pH values ranged from 6.22 units to 6.83 units at Elross Creek, and from 5.39 units to 6.53 units at Goodream Creek (Figures 5 & 6).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is fairly weak during this deployment period and difficult to see at Goodream Creek; however it is visible at Elross Creek.
- For both Elross and Goodream Creeks it appears that pH was affected by a period of heavy rainfall and increased flow during the middle of the deployment period from about September 16th to the 21st (see inside green ovals). During this period of higher flow pH is more variable and tends to fluctuate outside its normal range. These impacts are more noticeable at Goodream Creek.
- With a median value of 6.49, pH at Elross Creek is very close to 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 pH is slightly below this 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.

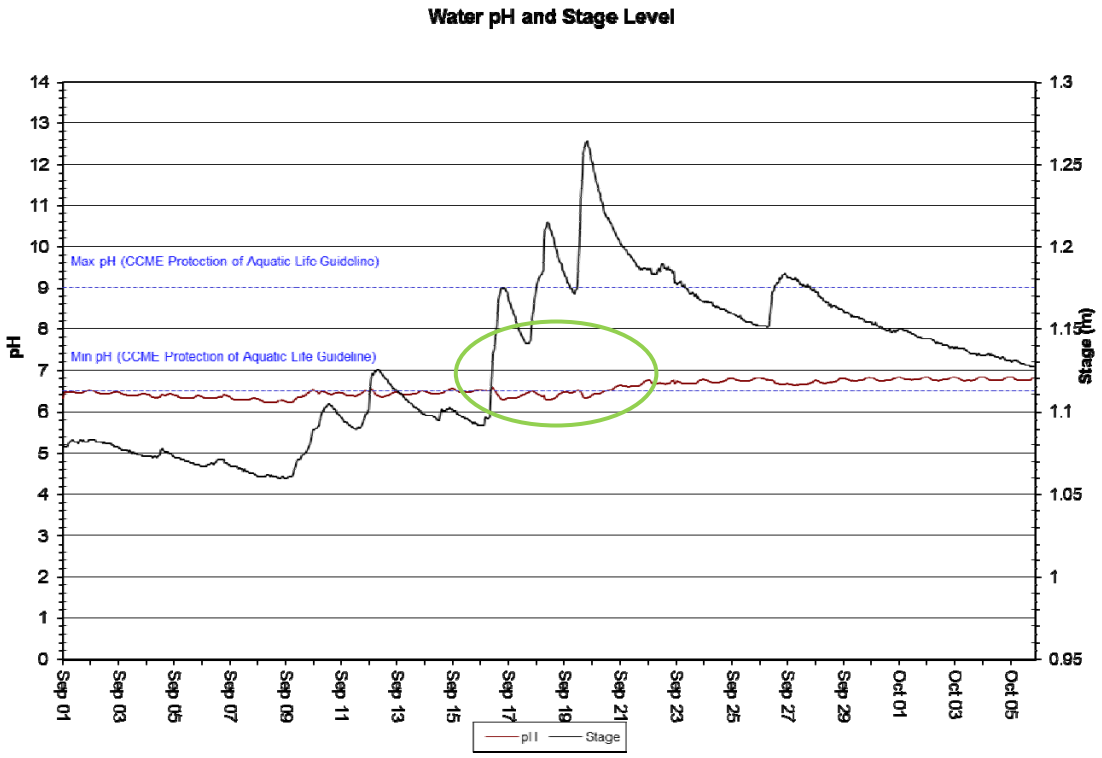

Figure 5: pH at Elross Creek – Sept 1, 2015 to October 6, 2015

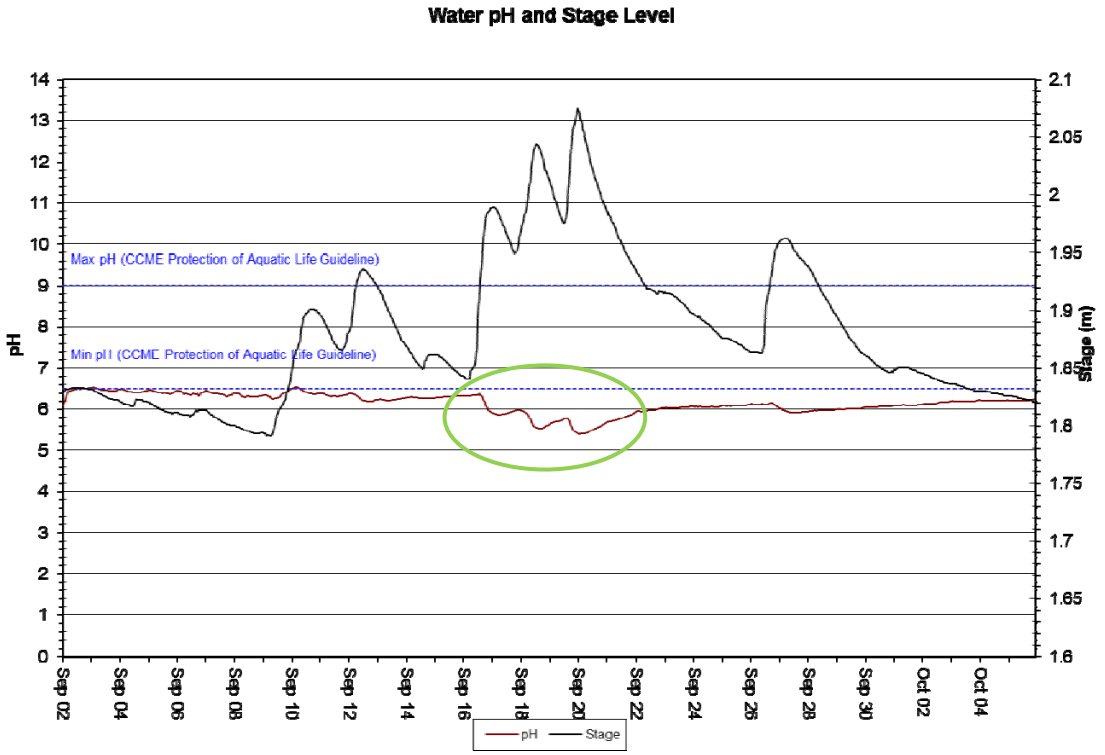

Figure 6: pH at Goodream Creek – Sept 2, 2015 to October 6, 2015

Specific Conductivity

- During the deployment periods covered by this report, specific conductivity ranged from 7.4 µs/cm to 17.6 µs/cm at Elross Creek, and from 3.8 µs/cm to 8.7 µs/cm at Goodream Creek (Figures 7 & 8).
- At both Elross and Goodream creeks, specific conductivity shows diurnal trends which are related to the diurnal temperature trend.
- Specific conductivity is an indicator parameter of general water quality which is affected by a variety of other parameters. Specific conductivity is temperature dependant and under normal circumstances when there is a decreasing temperature trend, such as there is during this deployment period, there is usually an associated decreasing specific conductivity trend. However, during this deployment period the impacts of temperature are not as apparent, which is most likely explained by the fact that significant precipitation for this deployment period (*There was a total of approximately 128 mm for this deployment while the average for the three previous deployment periods was about 90 mm.*) had an impact on general water quality which was more significant to specific conductivity than temperature alone.

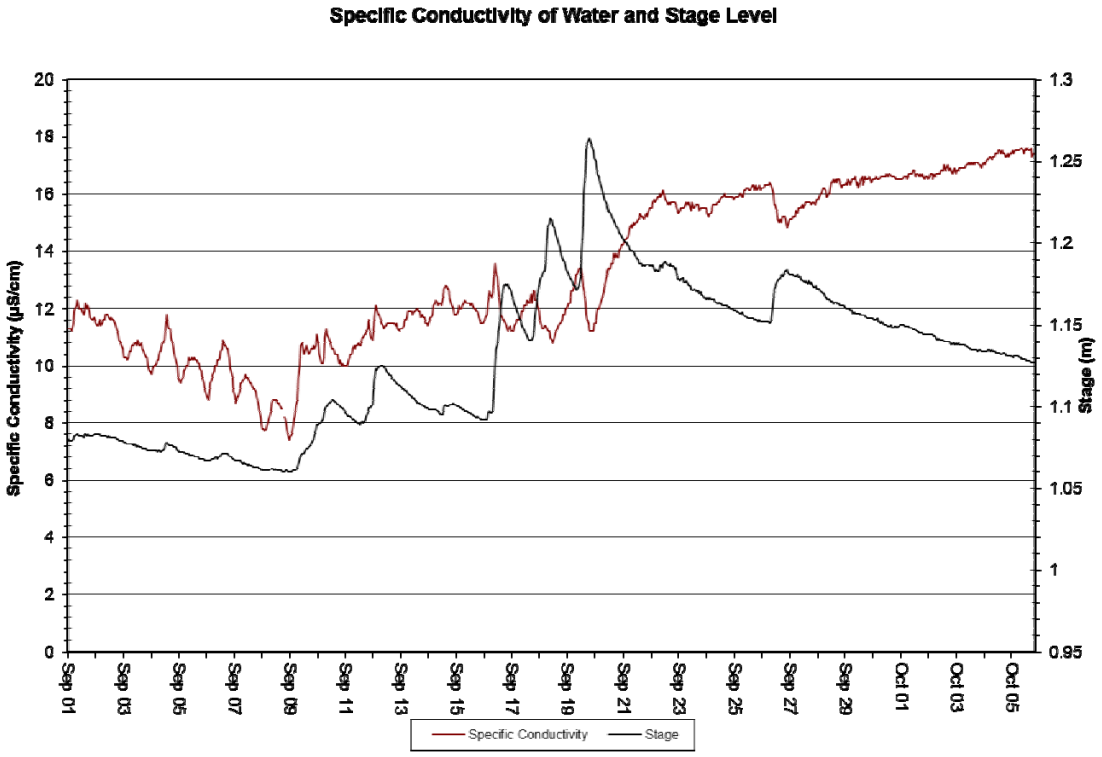

Figure 7: Specific conductivity (us/cm) - Elross Creek – Sept. 1, 2015 to Oct. 6, 2015

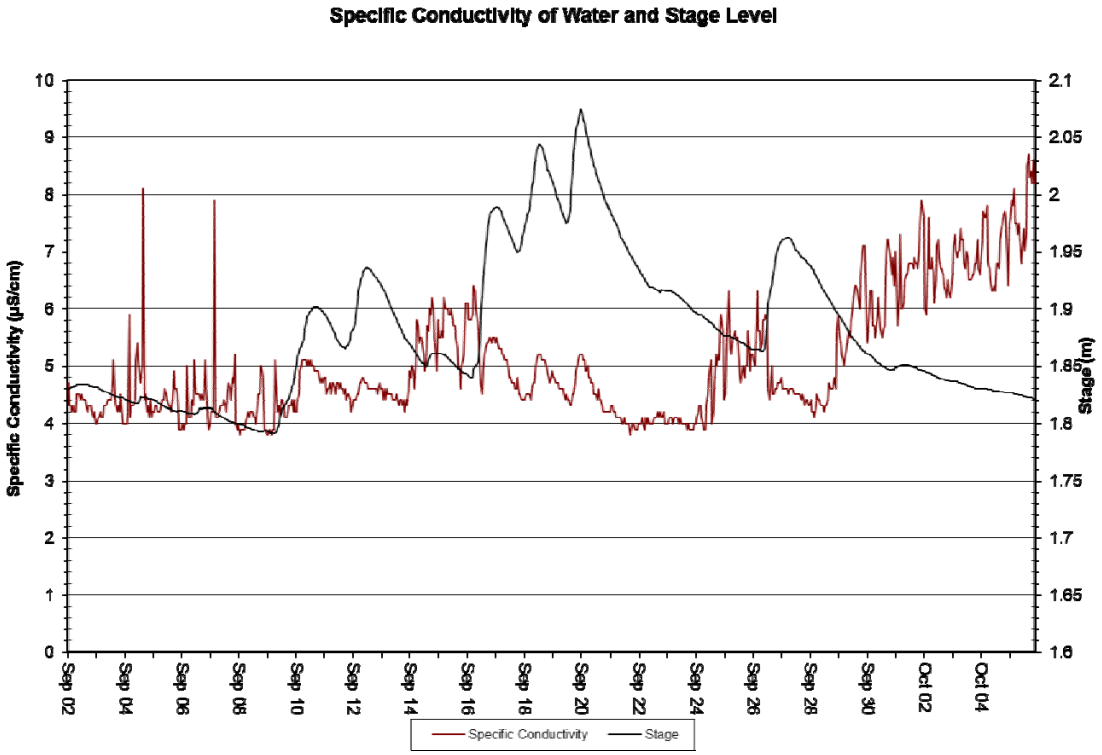

Figure 8: Specific conductivity (us/cm) - Goodream Creek – Sept 2, 2015 to Oct. 6, 2015

Dissolved Oxygen

- During the deployment periods covered by this report, dissolved oxygen (DO) values ranged from 8.84 mg/l (81.3% saturation) to 11.47 mg/l (95.0% saturation) at Elross Creek (Figure 9). At Goodream Creek DO values ranged from 8.96 mg/l (83.3% saturation) to 11.80 mg/l (102.1% saturation) (Figure 10).
- DO was relatively stable over the deployment period for both stations, however there is a period from approximately September 24th to 27th (see inside red ovals) where DO(mg/l) is slightly elevated due to cooler water temperatures associated with a period of cooler air temperatures.
- At both sites there are obvious diurnal trends in DO which are related to diurnal temperature trends.
- The DO values at both stations were at, or slightly above, the minimum guideline set for cold-water biota 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).

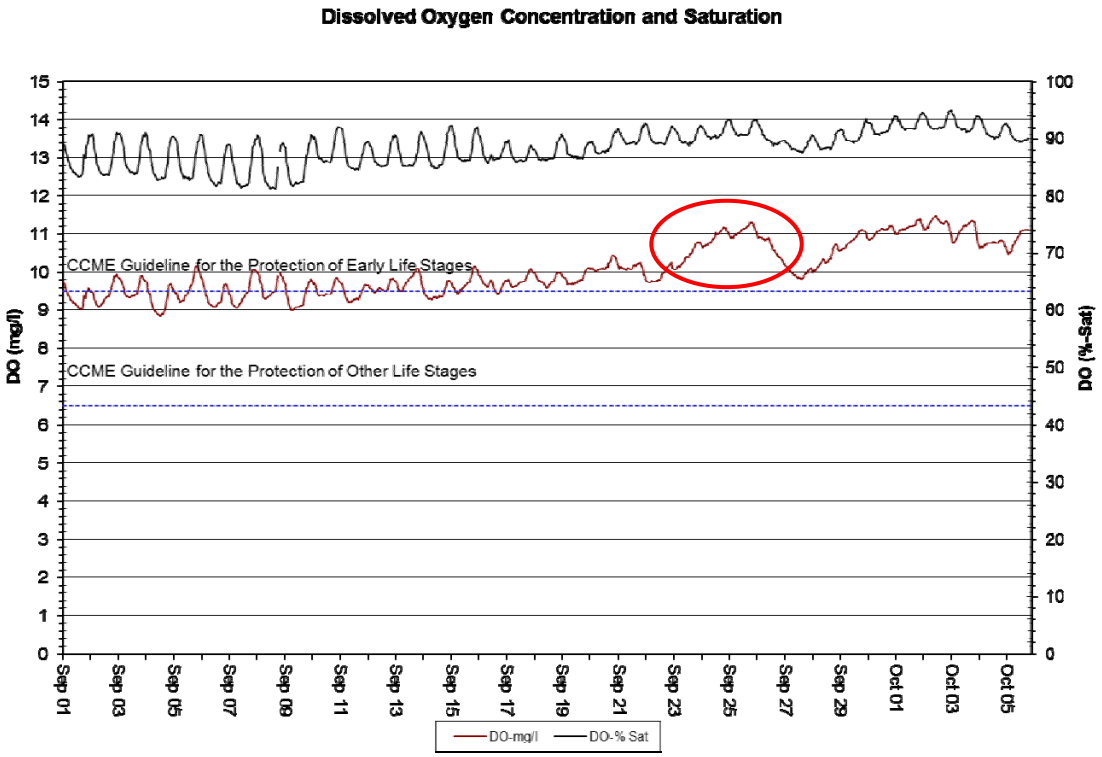

Figure 9: DO (mg/l & % saturation) at Elross Creek – Sept 1, 2015 to October 6, 2015

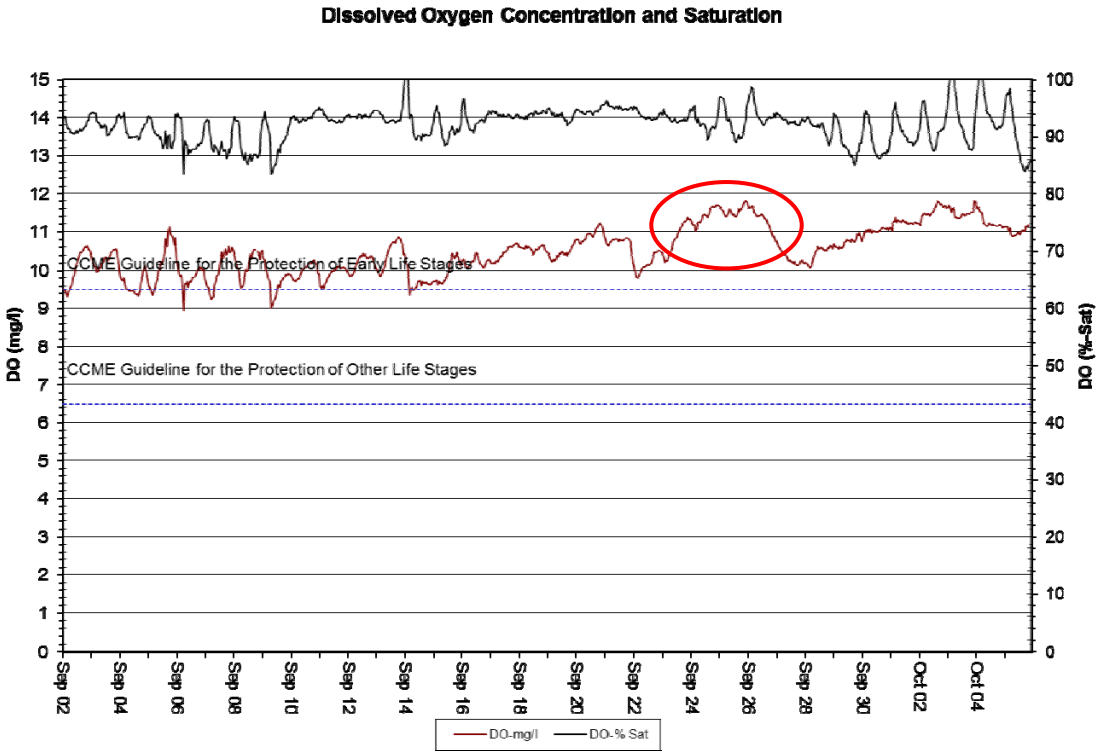

Figure 10: DO (mg/l & % saturation) at Goodream Creek – Sept. 2, 2015 to Oct. 6, 2015

Turbidity

- During the deployment periods covered by this report, turbidity values ranged from 0.4 NTU to 208.0 NTU at Elross Creek (Figure 11) and from 1.2 NTU to 51.0 NTU at Goodream Creek (Figure 12). In order to give a better indication of background turbidity levels at Elross Creek, Figure 13 shows only the turbidity data which was less than 100 NTU. This required removing 3 datum from the September dataset.
- During this deployment period there was significant precipitation from September 16th to the 20th, with approximately 75 mm falling over five days, and with this increased runoff turbidity at Goodream Creek was elevated well above normal background levels for a couple days (see inside red oval).
- 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 13) and therefore the impacts of significant runoff events are more pronounced. During this deployment period peak turbidity levels at Elross Creek are correlated with peak flows.
- For both stations the peak flows in the middle of the deployment period led to increased turbidity levels which appear to have elevated background turbidity for the remainder of the deployment period. This effect is most noticeable at Elross Creek (see the green oval in Figure 13). Once significant sediment loads are introduced in a small watercourse, it can take weeks before it is flushed through the system, and background turbidity levels return to normal.

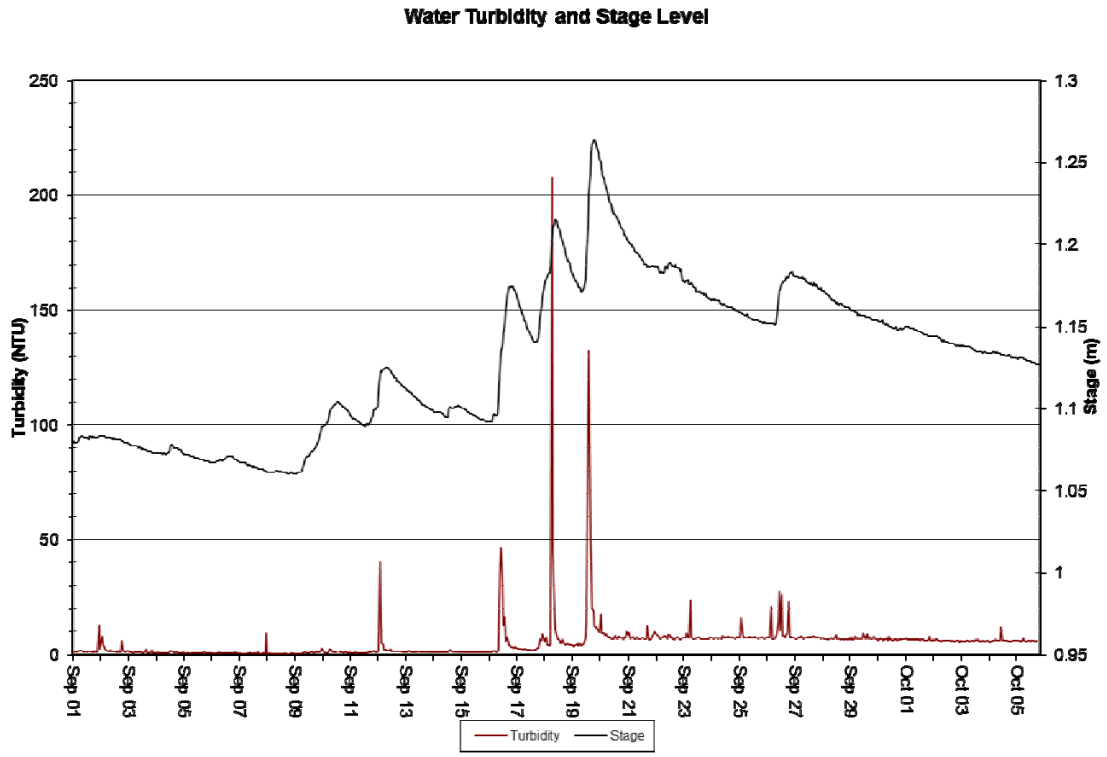

Figure 11: Turbidity (NTU) at Elross Creek – Sept 1, 2015 to October 6, 2015

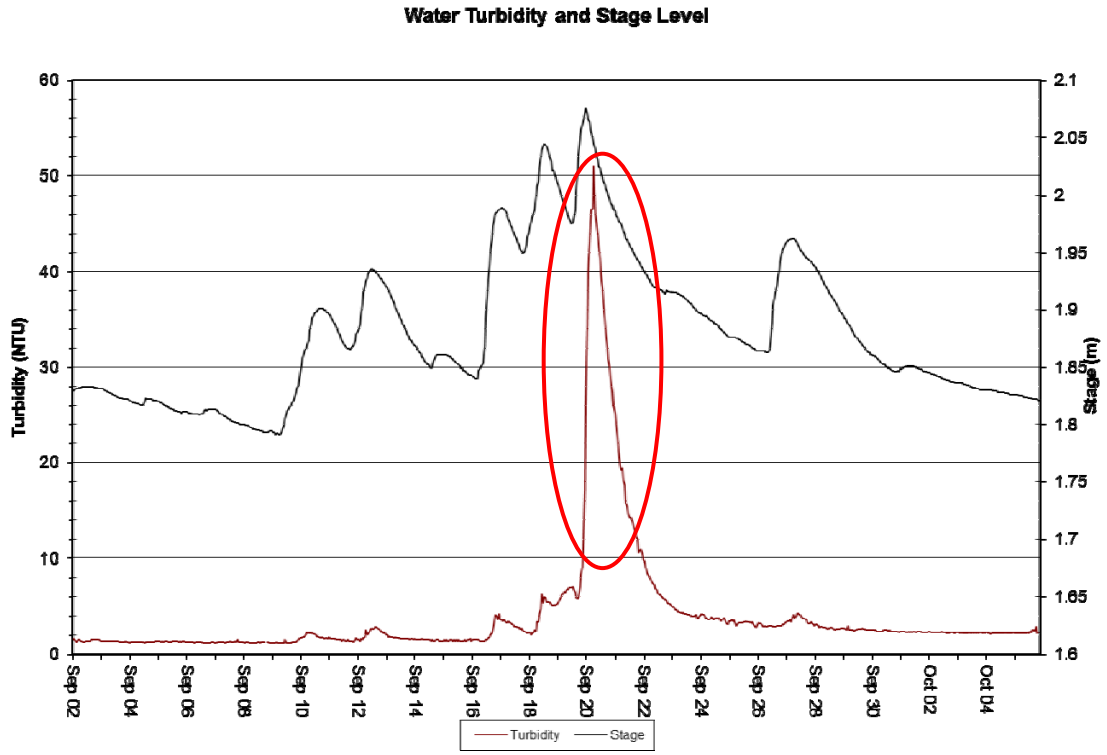

Figure 12: Turbidity (NTU) at Goodream Creek – Sept 2, 2015 to October 6, 2015

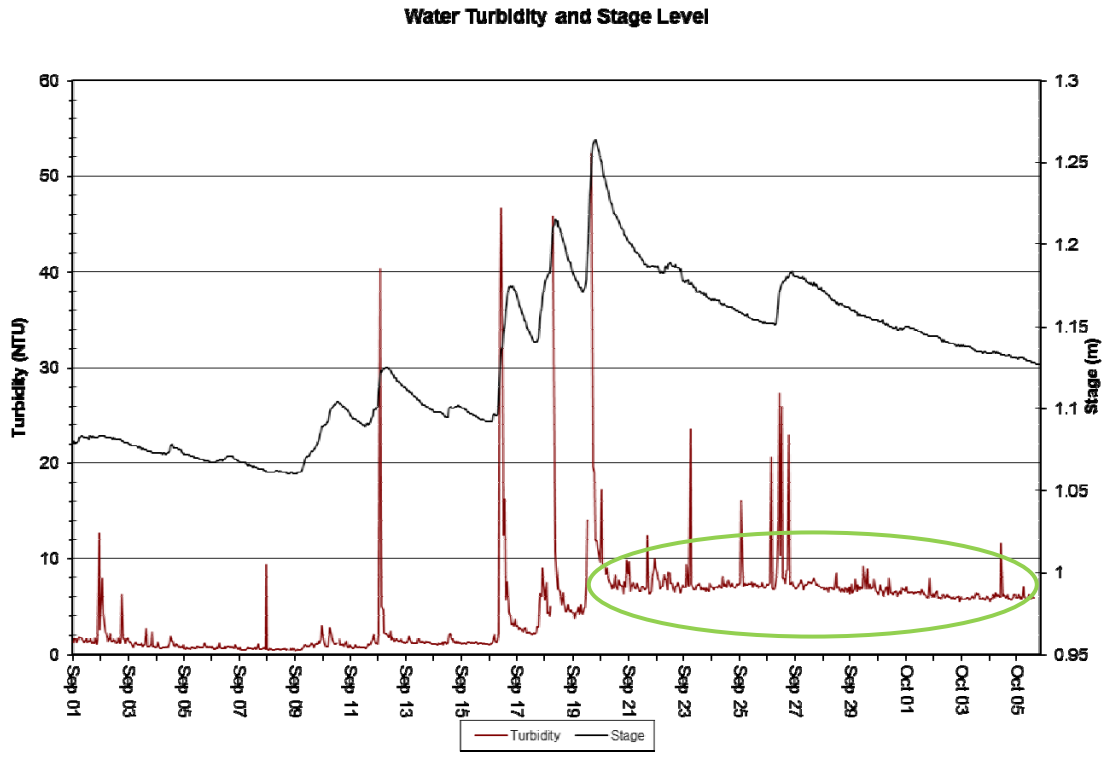

Figure 13: Turbidity (NTU<100)) at Elross Creek – Sept 1, 2015 to October 6, 2015

Conclusions

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from Sept 1st, 2015 to October 6th , 2015.
- Field instruments for both 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 both Elross Creek and Goodream Creek the stage height is typical for the late summer/early fall season, when hydrological conditions are affected by rainfall events which cause spikes that are relatively short lived. This deployment period saw significant precipitation, with approximately 75 mm falling over five days from September 16th to the 20th and the impact of this wet period is plain to see on the stage height graphs for both stations.
    - For both Elross and Goodream Creeks there is a gentle decreasing temperature trend over the deployment period which is consistent with the season.
    - During the deployment periods covered by this report, pH values ranged from 6.22 units to 6.83 units at Elross Creek, and from 5.39 units to 6.53 units at Goodream Creek.

- During the deployment periods covered by this report, specific conductivity ranged from 7.4 µs/cm to 17.6 µs/cm at Elross Creek, and from 3.8 µs/cm to 8.7 µs/cm at Goodream Creek.
- During the deployment periods covered by this report, dissolved oxygen (DO) values ranged from 8.84 mg/l (81.3% saturation) to 11.47 mg/l (95.0% saturation) at Elross Creek. At Goodream Creek DO values ranged from 8.96 mg/l (83.3% saturation) to 11.80 mg/l (102.1% saturation).
- During the deployment periods covered by this report, turbidity values ranged from 0.4 NTU to 208.0 NTU at Elross Creek and from 1.2.0 NTU to 51.0 NTU at Goodream Creek.

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 (°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 (Sept 1, 2015 to October 6, 2015)

Date/Time	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Precip (mm)
9/1/2015	9.4	1.1	5.3	12.7	0	1.6
9/2/2015	13.8	1.8	7.8	10.2	0	0.3
9/3/2015	7.4	1.8	4.6	13.4	0	1.7
9/4/2015	15.5	3	9.3	8.7	0	0
9/5/2015	14.5	0.3	7.4	10.6	0	0.2
9/6/2015	12	-1.8	5.1	12.9	0	0.3
9/7/2015	13.2	0.2	6.7	11.3	0	1.9
9/8/2015	10.5	-1	4.8	13.2	0	0
9/9/2015	14.6	1.7	8.2	9.8	0	7.6
9/10/2015	11.2	8.4	9.8	8.2	0	9.6
9/11/2015	13.6	7.9	10.8	7.2	0	0
9/12/2015	11.8	6.5	9.2	8.8	0	4.9
9/13/2015	13.2	3.9	8.6	9.4	0	0
9/14/2015	19.4	2.9	11.2	6.8	0	0
9/15/2015	13.2	4.1	8.7	9.3	0	3.3
9/16/2015	8.2	3.3	5.8	12.2	0	17.7
9/17/2015	15.2	2.6	8.9	9.1	0	5.5
9/18/2015	15.4	2.7	9.1	8.9	0	27.8
9/19/2015	10.5	6	8.3	9.7	0	4.7
9/20/2015	6.5	2.8	4.7	13.3	0	18.8
9/21/2015	12.7	1	6.9	11.1	0	0.4
9/22/2015	19	10.4	14.7	3.3	0	0
9/23/2015	10.4	1.6	6	12	0	0.3
9/24/2015	4.5	-0.8	1.9	16.1	0	0
9/25/2015	3.6	-1.5	1.1	16.9	0	0.3
9/26/2015	5.7	-1.7	2	16	0	18.1
9/27/2015	16.5	5.6	11.1	6.9	0	1.5
9/28/2015	14.7	5.4	10.1	7.9	0	1.6
9/29/2015	8.6	1.1	4.9	13.1	0	0
9/30/2015	5.6	-0.7	2.5	15.5	0	0
10/1/2015	5	0	2.5	15.5	0	0.2
10/2/2015	5.1	-3.2	1	17	0	0
10/3/2015	12.3	-0.4	6	12	0	0
10/4/2015	13.4	0.4	6.9	11.1	0	0
10/5/2015	12.2	-1.6	5.3	12.7	0	0
10/6/2015	9.5	-1.8	3.9	14.1	0	0