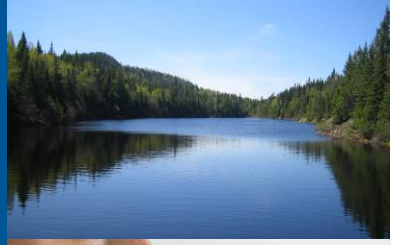




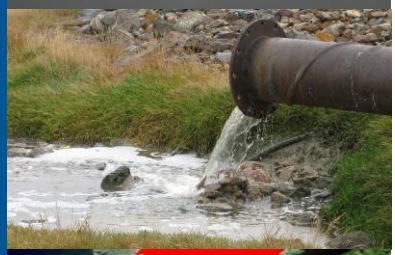


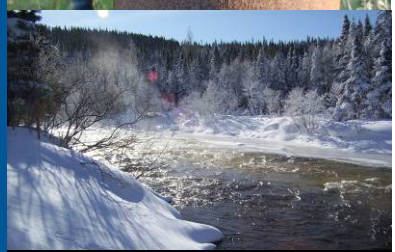

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2014-06-11 to 2014-07-16

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division
St. John's, NL, A1B 4J6 Canada

Prepared by:

Ian Bell
Environmental Scientist

Department of Environment & Conservation
Water Resources Management Division
PO Box 2006, Corner Brook, NL, A2H 6J8

t. 709.637.2431
f. 709.637.2541
e. ianbell@gov.nl.ca

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 June 11, 2014 to July 16, 2014, which was the first deployment of the 2014 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.

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	2014-06-11	2014-07-16		2014-06-12	2014-07-16
Temperature	Excellent	Excellent		Excellent	Good
pH	Excellent	Excellent		Good	Excellent
Specific Conductivity	Excellent	Excellent		Excellent	Excellent
Dissolved Oxygen	Excellent	Excellent		Excellent	Excellent
Turbidity	Excellent	Excellent		Excellent	Excellent

The performances of all sensors were rated good to excellent at the beginning of the deployment period and good to excellent at removal (Table 1).

Deployment Notes

- Water quality monitoring for this deployment period season started at Elross Creek on June 11, 2014 at 3:30 pm and at Goodream Creek on June 12, 2014 at 12:00 pm. Continuous real-time monitoring continued at both sites without any significant operational issues until July 16, 2014 when the instruments were removed for maintenance and calibration.

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 1.04 m to 1.13 m at Elross Creek and from 1.75 m to 1.88 m at Goodream Creek from June 11, 2014 to July 16, 2014 (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 there are a number of significant spikes in stage height with several examples shown inside red ovals for each station. In all these cases these spikes coincide with significant rainfall events (Climate data located in Appendix B).
- For Goodream Creek there is a period of extreme low stage height (see inside green oval) from around June 27 to June 30. At this time flow was critically low in Goodream Creek and many of the water quality parameters were affected as a result.

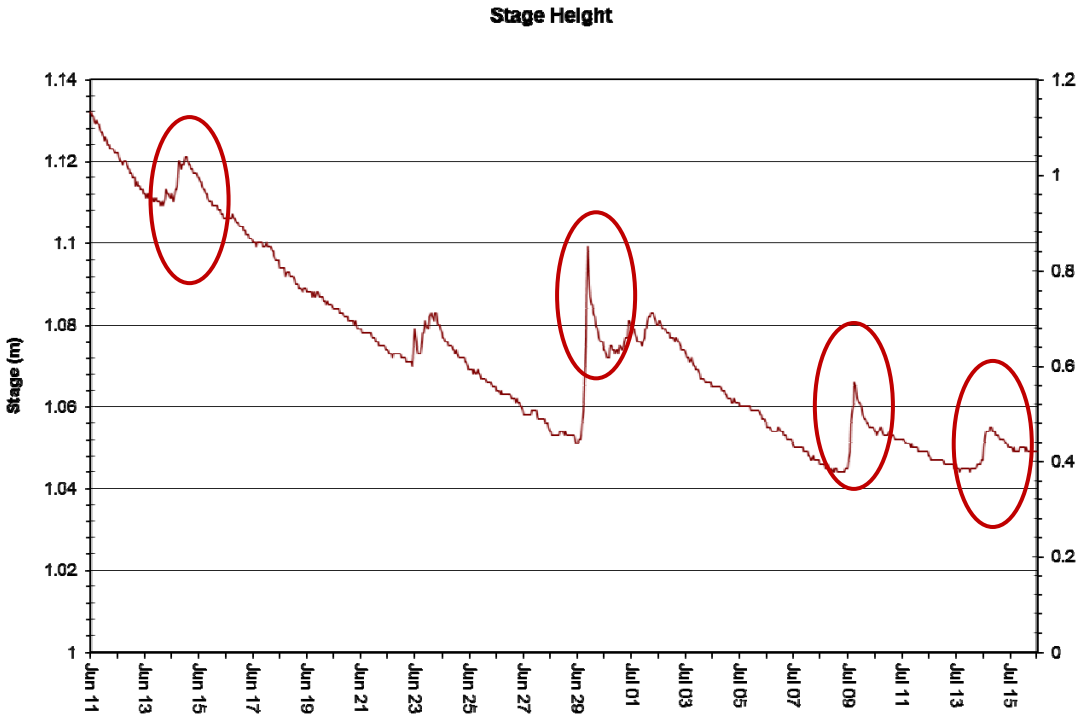

Figure 1: Stage Height (m) at Elross Creek –June 11, 2014 to July 16, 2014

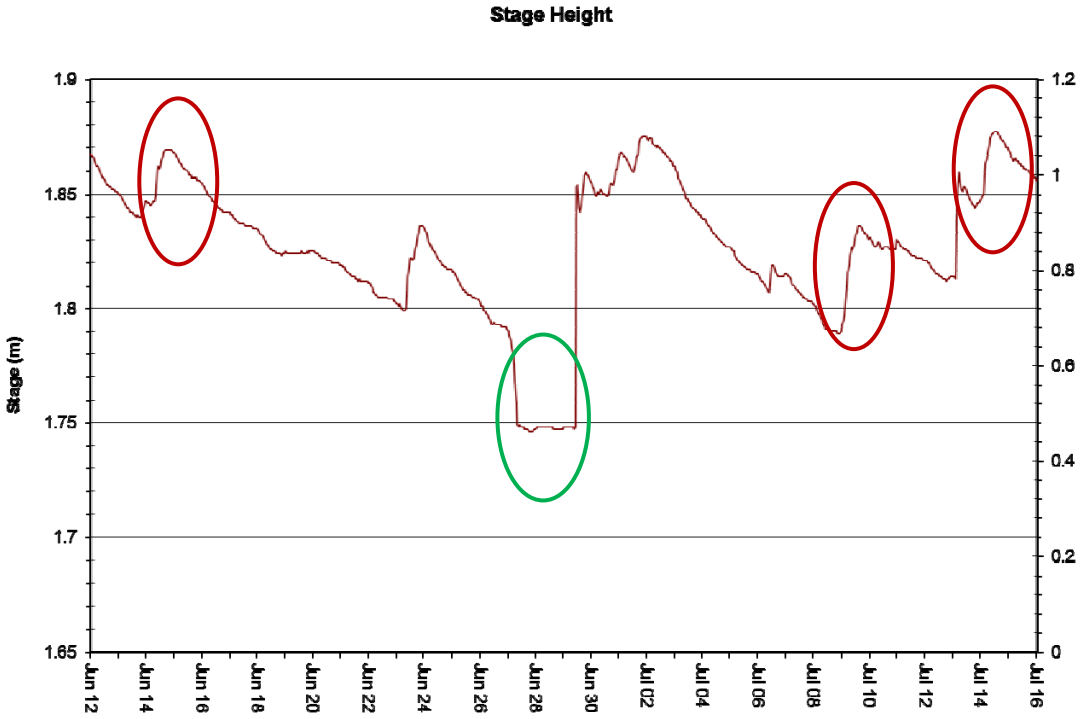

Figure 2: Stage Height (m) at Goodream Creek – June 12, 2014 to July 16, 2014

Temperature

- Water temperature ranged from 6.35˚C to 15.72˚C at Elross Creek and from 7.70˚C to 21.50˚C at Goodream Creek from June 11, 2014 to July 16, 2014 (Figures 3 & 4).
- For both Elross Creek and Goodream Creek temperature there are no appreciable increasing or decreasing trends during the deployment period.
- 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.
- At Goodream Creek there is a significant spike in temperature (see inside red oval) during the low flow period around June 29, 2014, indicating the sensor was likely exposed to air.

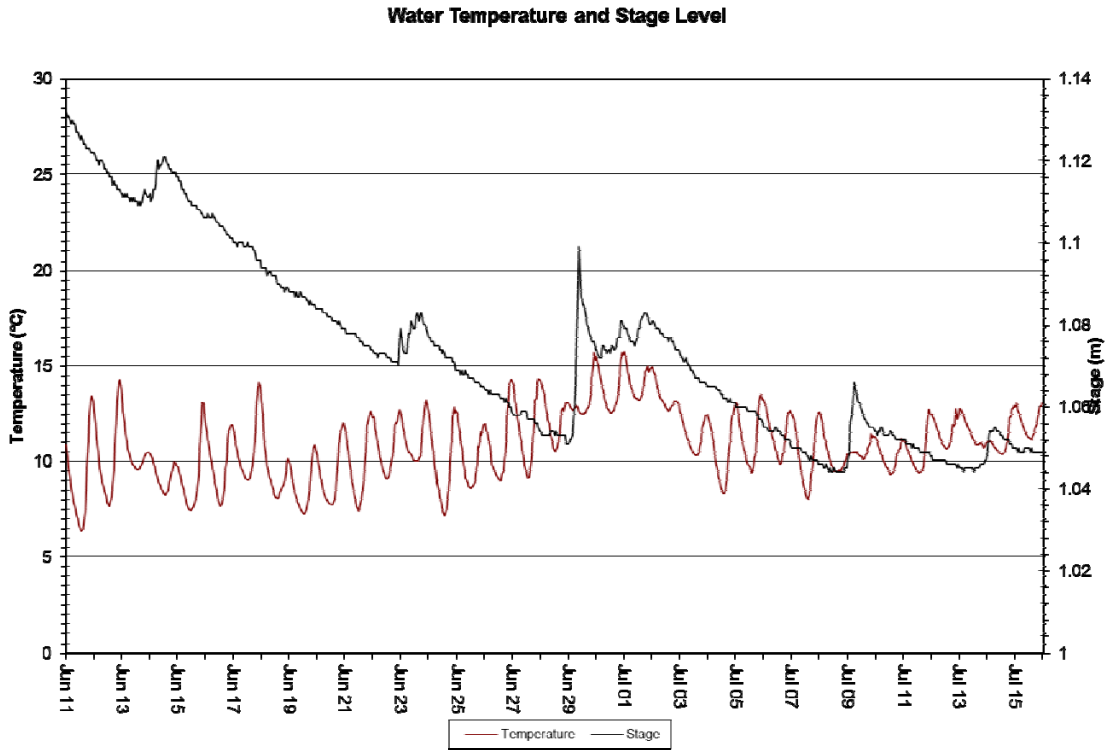

Figure 3: Temperature (°C) - Elross Creek – June 11, 2014 to July 16, 2014

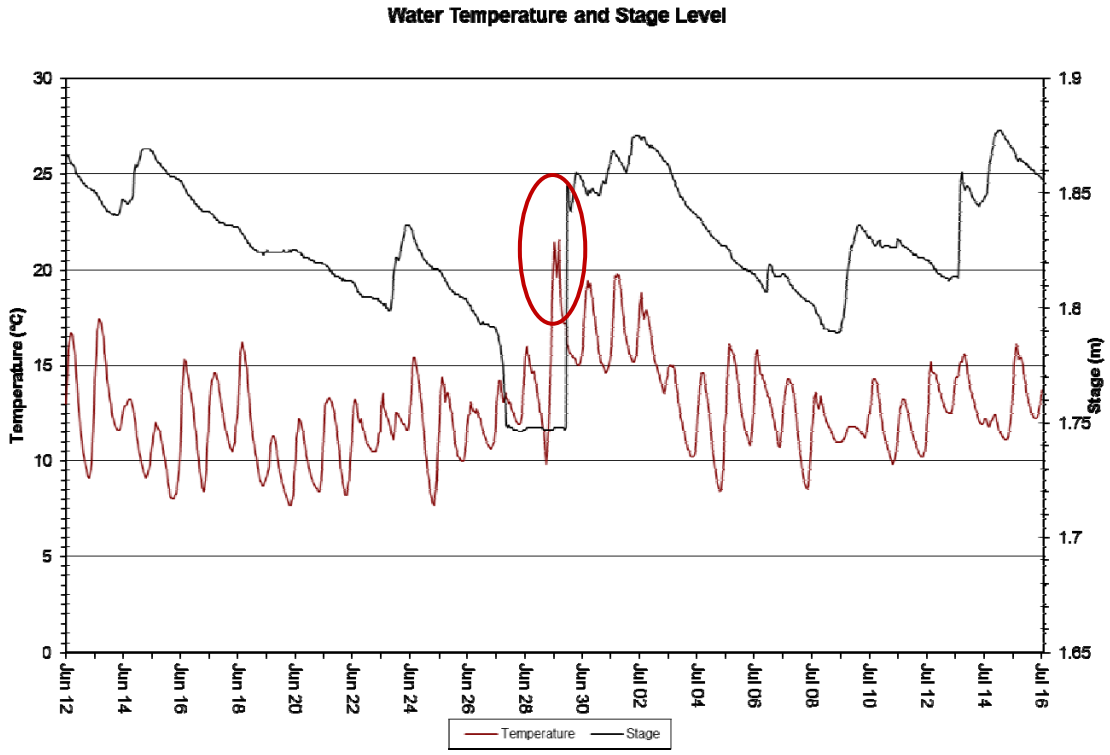

Figure 4: Temperature (°C) - Goodream Creek - June 12, 2014 to July 16, 2014

pH

- pH values ranged from 6.03 units to 6.60 units at Elross Creek from June 11, 2014 to July 16, 2014 (Figure 5). At Goodream Creek pH values were significantly affected by low flow conditions during two distinct periods and values were recorded well outside the normal range for pH at this station (Figure 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 but is still discernible for the two stations.
- At Goodream Creek it appears that pH was significantly affected by low flow conditions (see inside red ovals). Between June 28 and June 30 during extreme low flow it appears that the pH probe gave false high and low values, most likely indicating that it was exposed to air. In addition between July 6 and July 9 during a period of relatively low flow it appears that pH was significantly affected dropping much lower than usual.
- With a mean value of 6.29, pH values recorded at Elross Creek were mostly slightly below 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). 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. Because the low flow conditions affected normal pH readings at Goodream Creek it is difficult to determine a mean value for the deployment period, however pH at Goodream Creek is routinely lower than the recommended minimum guideline.

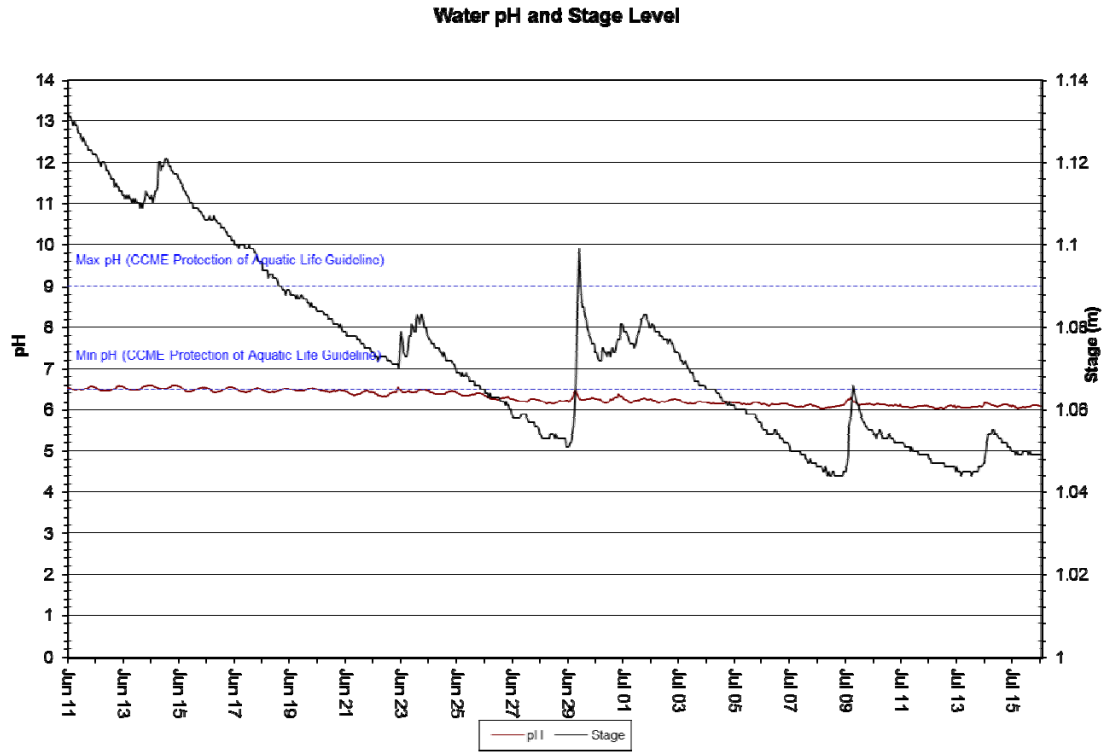

Figure 5: pH at Elross Creek – June 11, 2014 to July 16, 2014

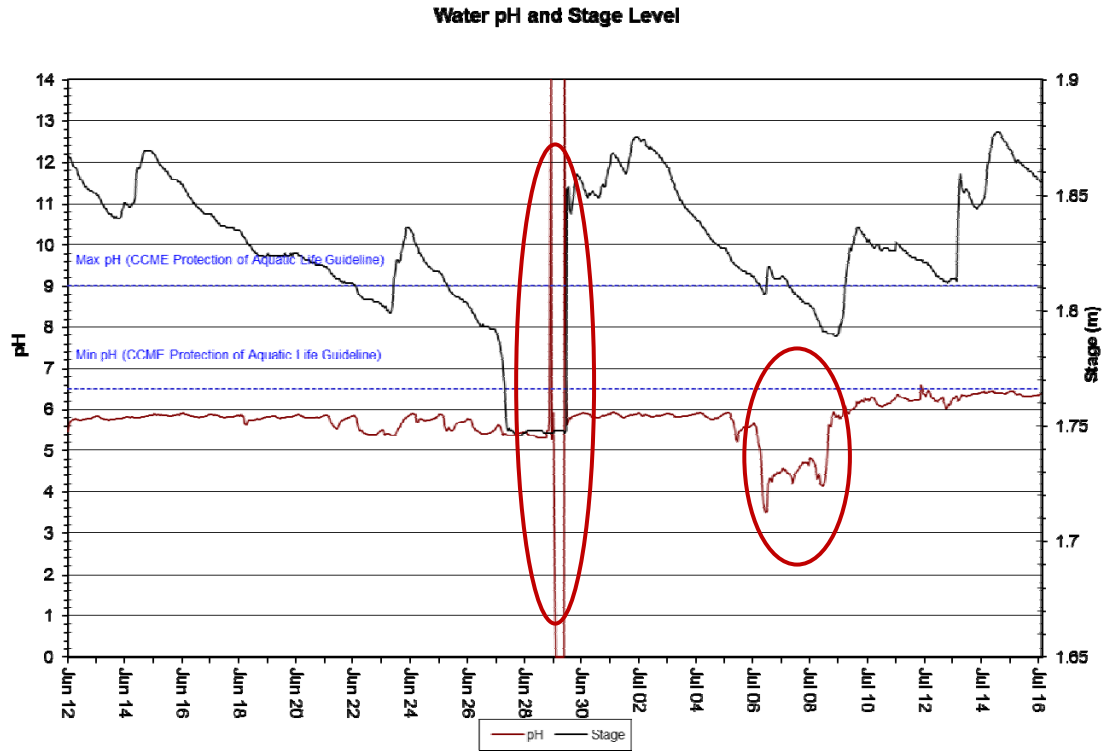

Figure 6: pH at Goodream Creek – June 12, 2014 to July 16, 2014

Specific Conductivity

- Specific Conductivity ranged from 6.0 µs/cm to 15.0 µs/cm at Elross Creek from June 11, 2014 to July 16, 2014 (Figures 7). At Goodream Creek the sensor malfunctioned during a low flow period and therefore it is impossible to determine the exact range of specific conductivity during the deployment , however it ranged from approximately 3.5 µs/cm to 10.5 µs/cm from June 12, 2014, to July 16, 2014 (Figure 8).
- At Elross Creek sudden changes in flow appear to have a noticeable impact on specific conductivity (see inside red ovals) with distinct spikes in specific conductivity corresponding with spikes in flow. At Goodream Creek the specific conductivity data is more variable making it more difficult to notice the impact of changes in flow.
- At Goodream Creek the specific conductivity sensor appears to have been exposed to air during an extreme low flow period around June 29, 2014 (see inside red oval).

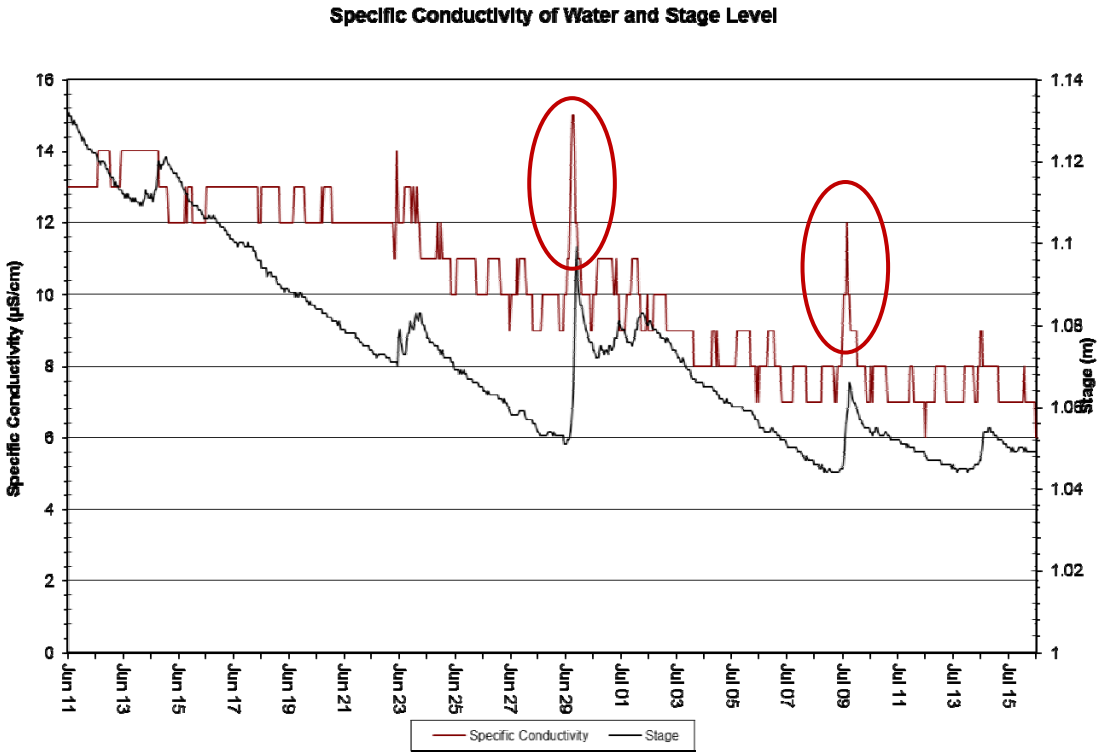

Figure 7: Specific conductivity (us/cm) - Elross Creek – June 11, 2014 to July 16, 2014

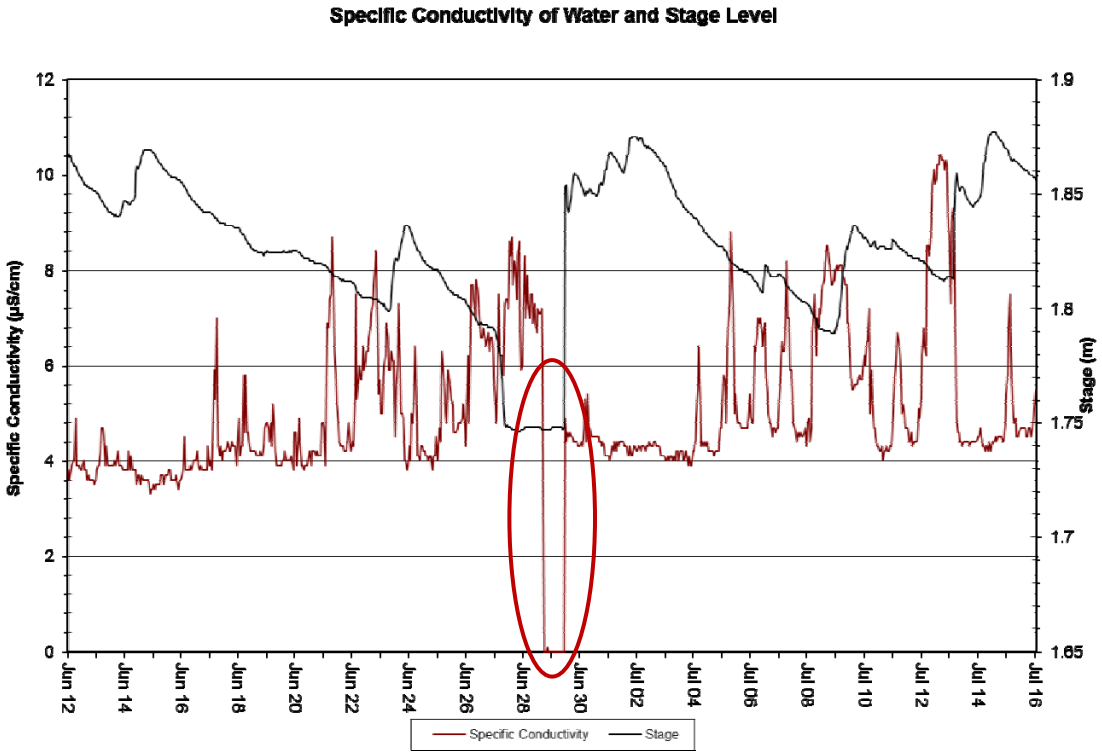

Figure 8: Specific conductivity (us/cm) - Goodream Creek – June 12, 2014 to July 16, 2014

Dissolved Oxygen

- Dissolved oxygen (DO) values ranged from 8.23 mg/l (81.1% saturation) to 10.69 mg/l (96.1% saturation) at Elross Creek from June 11, 2014 to July 16, 2014 (Figures 9). At Goodream Creek dissolved oxygen values were significantly impacted by low flow conditions, including no readings when the probe was exposed to air around June 29, 2014, (see inside red oval) which makes it difficult to offer any meaningful comments on DO for this deployment period (Figure 10).
- Dissolved oxygen remains relatively stable over the deployment period for Elross Creek, however for Goodream Creek there are numerous points in the deployment were low flow conditions throw off the DO values and it is therefore impossible to comment on any trends.
- There is a diurnal trend for DO (mg/l & % saturation) which is clearly visible at Elross Creek and partially visible at Goodream Creek for the times when there is good data. These diurnal DO trends are related to the diurnal temperature trends.
- The DO values at Elross Creek were at or slightly below 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). At Goodream Creek DO values are thrown off significantly and repeatedly by low flow conditions and it is difficult to make any meaningful comparison to these guidelines.

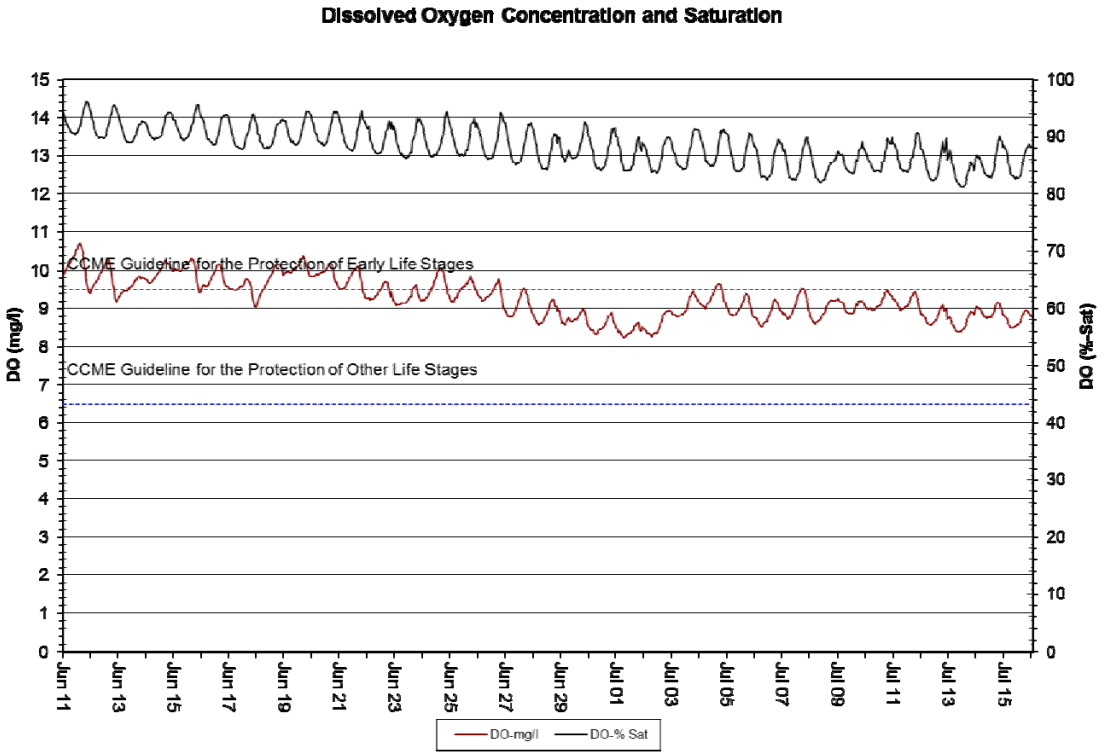

Figure 9: DO (mg/l & % saturation) at Elross Creek – June 11, 2014 to July 16, 2014

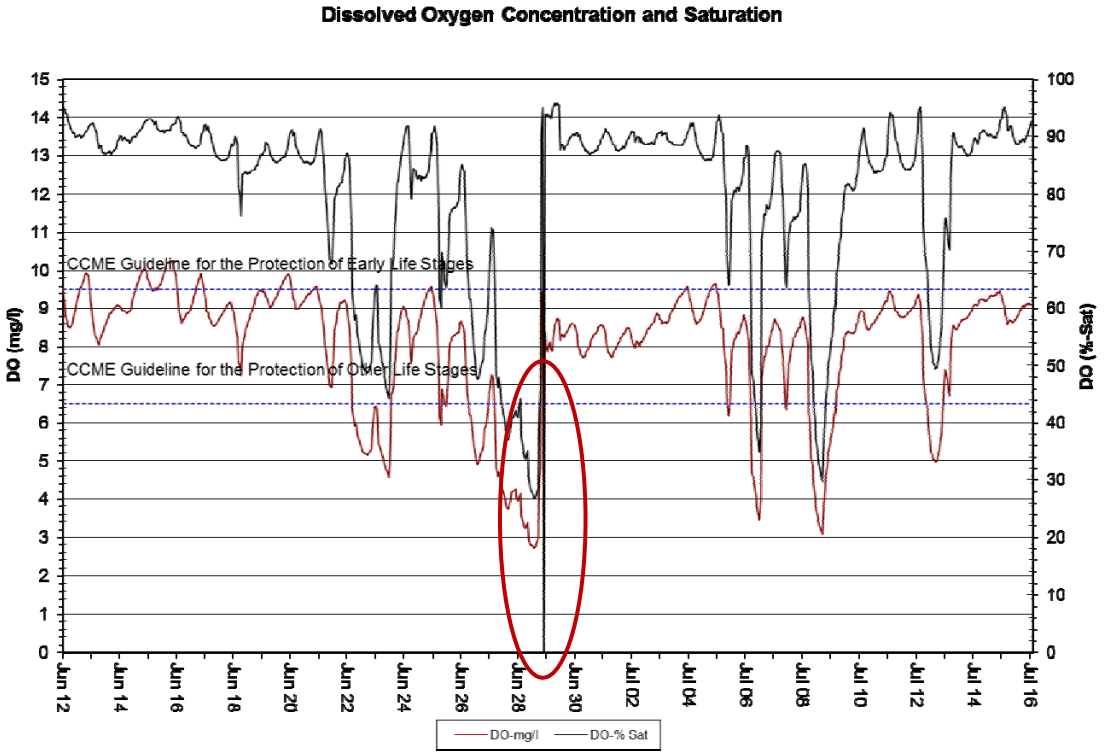

Figure 10: DO (mg/l & % saturation) at Goodream Creek – June 12, 2014 to July 16, 2014

Turbidity

- Turbidity values ranged from 1.1 NTU to 230.9 NTU at Elross Creek and from 0.0 NTU to 5.6 NTU at Goodream Creek from June 12, 2014 to July 16, 2014 (Figures 11 & 12).
- A significant spike in turbidity at Elross Creek (see inside red ovals) corresponds with significant rainfall events and a subsequent increase in flow which took place around June 29, 2014.
- It appears that the low flow conditions at Goodream Creek did not have any significant impact on turbidity during this deployment period.

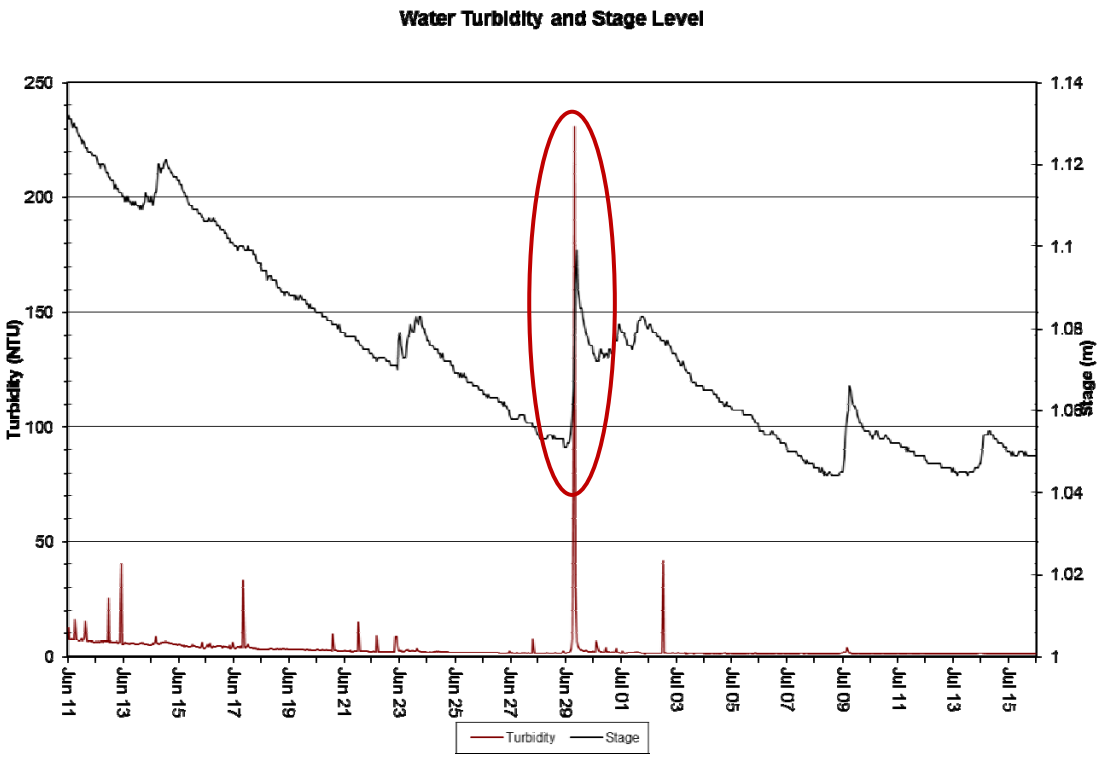

Figure 11: Turbidity (NTU) at Elross Creek – June 11, 2014 to July 16, 2014

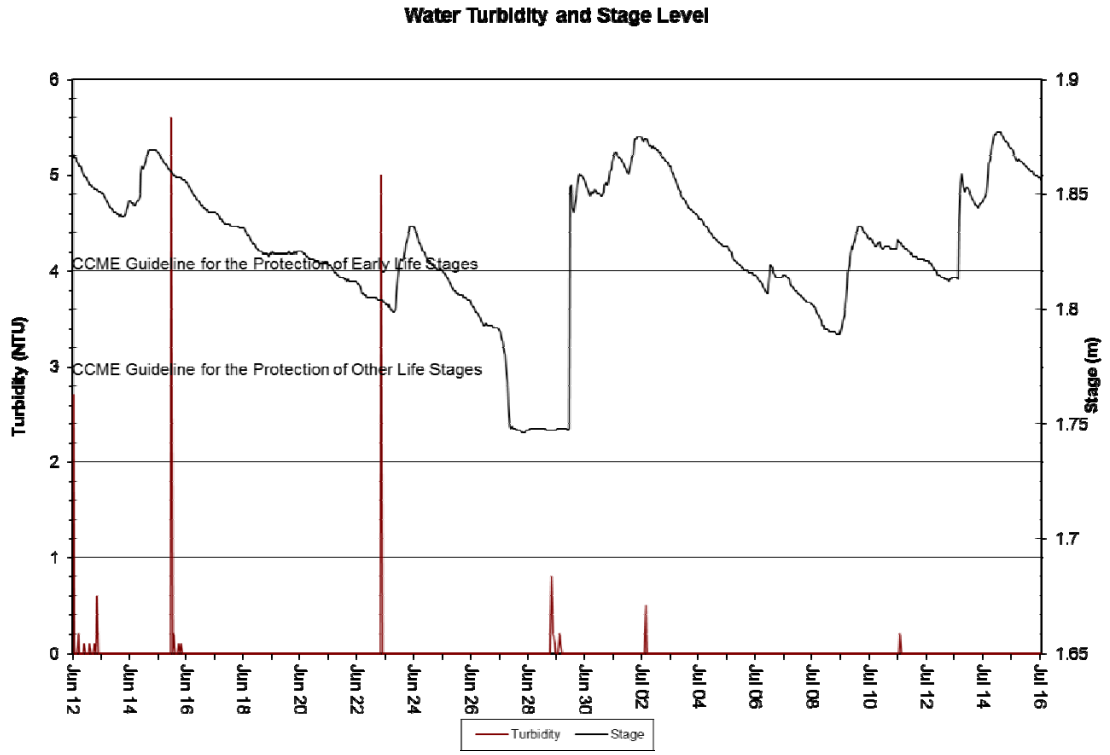

Figure 12: Turbidity (NTU) at Goodream Creek – June 12, 2014 to July 16, 2014

Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from June 11, 2014 to July 16, 2014.

- The performances of all sensors were rated good to excellent at the beginning of the deployment period and good to excellent at removal.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For both Elross Creek and Goodream Creek there are a number of significant spikes in stage which coincide with significant rainfall events.
    - For Goodream Creek there is a period of extreme low stage height from around June 27 to June 30. At this time flow was critically low in Goodream Creek and many of the water quality parameters were affected as a result.
    - For both Elross Creek and Goodream Creek temperature there are no appreciable increasing or decreasing trends during the deployment period.
    - 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.

- At Goodream Creek there is a significant spike in temperature during the low flow period around June 29, 2014, indicating the sensor was likely exposed to air.
- 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 but is still discernible for the two stations.
- At Goodream Creeks it appears that pH was significantly affected by low flow conditions. Between June 28 and June 30 during extreme low flow it appears that the pH probe gave false high and low values, most likely indicating that it was exposed to air. In addition, between July 6 and July 9 during a period of relatively low flow, it appears that pH was significantly affected dropping much lower than usual.
- With a mean value of 6.29, pH values recorded at Elross Creek were mostly slightly below 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). 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. Because the low flow conditions affected normal pH readings at Goodream Creek it is difficult to determine a mean value for the deployment period, however pH at Goodream Creek is routinely lower than the recommended minimum guideline.
- At Elross Creek sudden changes in flow appeared to have a noticeable impact on specific conductivity with distinct spikes in specific conductivity corresponding with spikes in flow. At Goodream Creek the specific conductivity data is more variable making it more difficult to notice the impact of changes in flow.
- At Goodream Creek the specific conductivity sensor appears to have been exposed to air during an extreme low flow period around June 29, 2014.
- Dissolved oxygen remains relatively stable over the deployment period for Elross Creek, however for Goodream Creek there are numerous points in the deployment where low flow conditions throw off the DO values and it is therefore impossible to comment on any trends.
- There is a diurnal trend for DO (mg/l & % saturation) which is clearly visible at Elross Creek and partially visible at Goodream Creek during times when there is good data. These diurnal DO trends are related to the diurnal temperature trends.

- The DO values at Elross Creek were at or slightly below 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). At Goodream Creek DO values are thrown off significantly by low flow conditions, and it is difficult to make any meaningful comparison to these guidelines.
- A significant spike in turbidity at Elross Creek corresponds with significant rainfall events and a subsequent increase in flow which took place around June 29, 2014.
- It appears that the low flow conditions at Goodream Creek did not have any significant impact on turbidity during this deployment period.
- 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 (June 11, 2014 to July 16, 2014)

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)
6/11/2014	17.4	0.9	9.2	8.8	0	M	M	0
6/12/2014	21.8	1	11.4	6.6	0	M	M	0
6/13/2014	23.3	7.1	15.2	2.8	0	M	M	0
6/14/2014	14.9	6.5	10.7	7.3	0	M	M	10.7
6/15/2014	12.9	5.1	9	9	0	M	M	1.3
6/16/2014	19.4	6.2	12.8	5.2	0	M	M	0
6/17/2014	19.9	5.2	12.6	5.4	0	M	M	0.5
6/18/2014	18	4.4	11.2	6.8	0	M	M	0
6/19/2014	8.5	2.4	5.5	12.5	0	M	M	0.5
6/20/2014	9.8	3.6	6.7	11.3	0	M	M	0
6/21/2014								
6/22/2014	22.5	5.3	13.9	4.1	0	M	M	0
6/23/2014								
6/24/2014	13.4	4.3	8.9	9.1	0	M	M	4.3
6/25/2014	17.7	4.3	11	7	0	M	M	0
6/26/2014	20.5	10.6	15.6	2.4	0	M	M	0
6/27/2014	25.1	11.5	18.3	0	0.3	M	M	0
6/28/2014	25.9	10.5	18.2	0	0.2	M	M	0
6/29/2014	26.2	15.2	20.7	0	2.7	M	M	16.3
6/30/2014	25.7	15.9	20.8	0	2.8	M	M	6.9
7/1/2014	25.2	15	20.1	0	2.1	M	M	4.1
7/2/2014	22.9	15.4	19.2	0	1.2	M	M	4.6
7/3/2014	15.6	6.7	11.2	6.8	0	M	M	1.1
7/4/2014	12.5	5.6	9.1	8.9	0	M	M	0.8
7/5/2014	18.1	5.5	11.8	6.2	0	M	M	0
7/6/2014	18.4	7.9	13.2	4.8	0	M	M	0.8
7/7/2014	15	3.4	9.2	8.8	0	M	M	0.5
7/8/2014	18.1	3.1	10.6	7.4	0	M	M	0
7/9/2014	13.8	7.4	10.6	7.4	0	M	M	12.1
7/10/2014	14.7	8.6	11.7	6.3	0	M	M	4.1
7/11/2014	13.2	8.1	10.7	7.3	0	M	M	1.3
7/12/2014	19.4	8	13.7	4.3	0	M	M	1
7/13/2014	18.8	11.6	15.2	2.8	0	M	M	0.3
7/14/2014	11.5	9.3	10.4	7.6	0	M	M	13.6
7/15/2014	17.2	10.1	13.7	4.3	0	M	M	3.3
7/16/2014	20.2	11.4	15.8	2.2	0	M	M	5.1