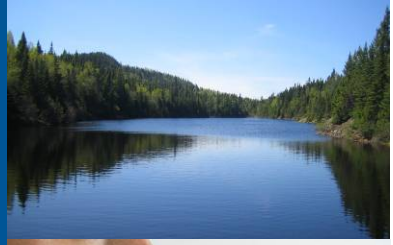




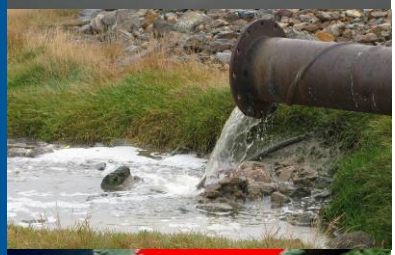


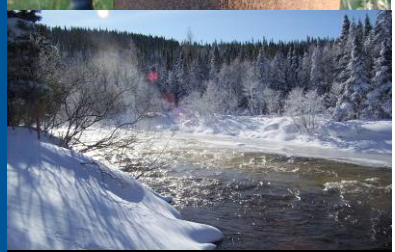

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2013-06-04 to 2013-07-03

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 4, 2013 to July 3, 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	2013-06-04	2013-07-03		2013-06-04	2013-07-03
Temperature	Excellent	Good		Excellent	Good
pH	Good	Excellent		Excellent	Excellent
Specific Conductivity	Excellent	Good		Excellent	Excellent
Dissolved Oxygen	Excellent	Excellent		Excellent	Fair
Turbidity	Good	Excellent		Excellent	Excellent

Deployment Notes

- Water quality monitoring for the 2013 field season started at Goodream Creek on June 4, 2013 at 11:30 am and at Elross Creek on the same date at 1:00 pm. Continuous real-time monitoring continued at both sites without any significant operational issues until July 3, 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 (µS/cm)
(v.) Dissolved oxygen (mg/l)
(vi.) Turbidity (NTU)

Stage

- Stage height values ranged from 1.11 m to 1.22 m at Elross Creek and from 1.75 m to 2.02 m at Goodream Creek from June 4, 2013 to July 3, 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 there is a general decreasing trend in stage height over the duration of the deployment which is consistent with the transition from spring to summer.
- For both Elross Creek and Goodream Creek there is a significant spike in stage height around June 15 (see inside red ovals) which coincides with a significant rainfall event at that time (Climate data located in Appendix B).
- In the last 7 to 10 days of the deployment period at Goodream Creek, the flows were critically low which affected instrument performance. The instrument was removed and could not be redeployed for the following deployment period.

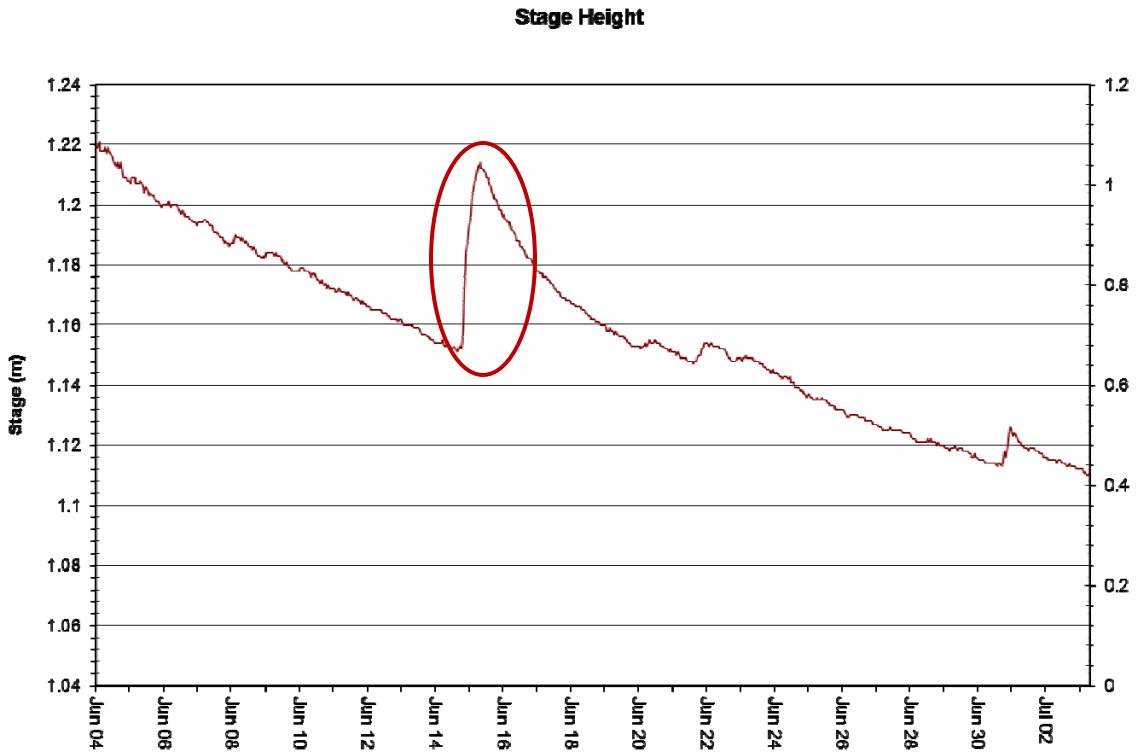

Figure 1: Stage height (m) recorded at Elross Creek – June 4, 2013 to July 3, 2013.

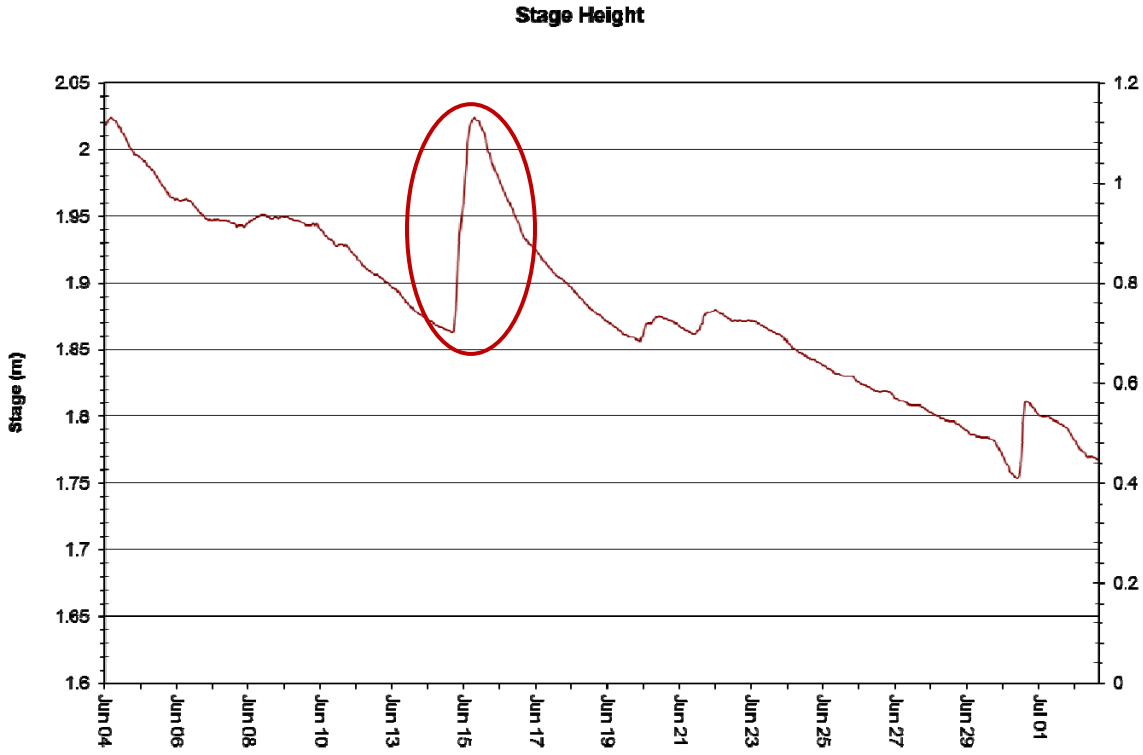

Figure 2: Hourly stage (m) recorded at Goodream Creek – June 4, 2013 to July 3, 2013.

Temperature

- Water temperature ranged from 1.60˚C to 15.70˚C at Elross Creek and from 2.00˚C to 16.50˚C at Goodream Creek from June 4, 2013 to July 3, 2013 (Figures 3 & 4).
- Both Elross Creek and Goodream Creek show a general warming trend throughout the deployment period which corresponds with the warming air temperatures associated with the onset of summer.
- 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.

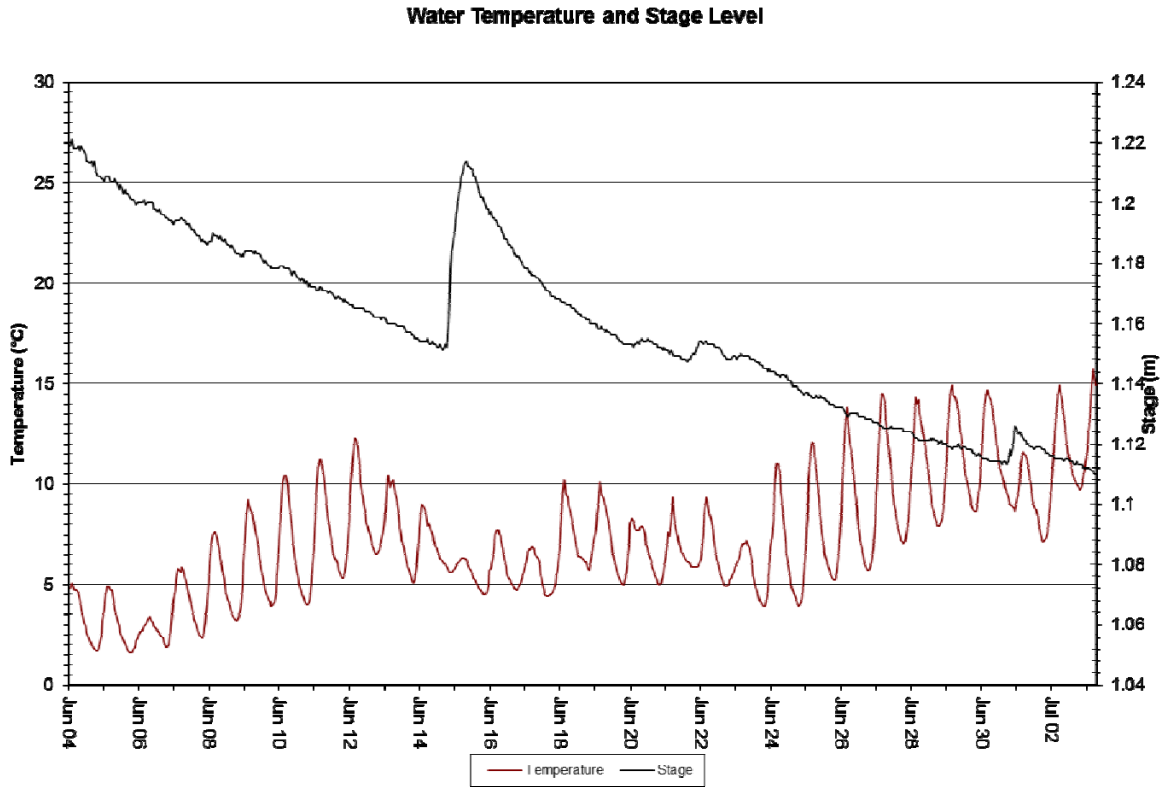

Figure 3: Water temperature (°C) - Elross Creek – June 4, 2012 to July 3, 2012.

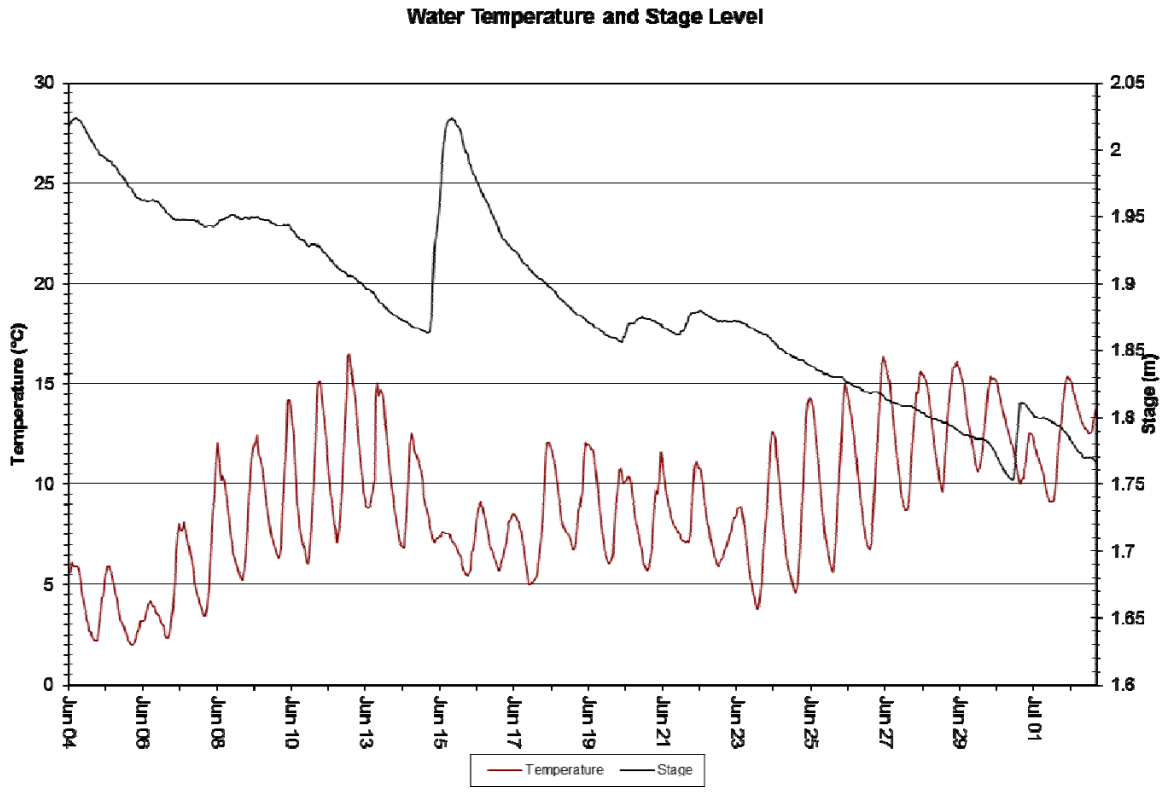

Figure 4: Water temperature (°C) - Goodream Creek - June 4, 2012 to July 3, 2012.

pH

- pH values ranged from 6.17 units to 6.90 units at Elross Creek and from 5.78 units to 6.62 units at Goodream Creek from June 4, 2013 to July 3, 2013 (Figures 5 & 6).
- pH tends to show a diurnal trend which is most visible at Elross Creek. This diurnal pH trend is related to the diurnal temperature trend.
- At Goodream Creek it appears that pH is affected by significant changes in stream flow (see inside red ovals), with a slight dip around June 15 due to a significant increase in flow as well as a small spike around June 30 during an extreme low flow period.
- 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), while 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.

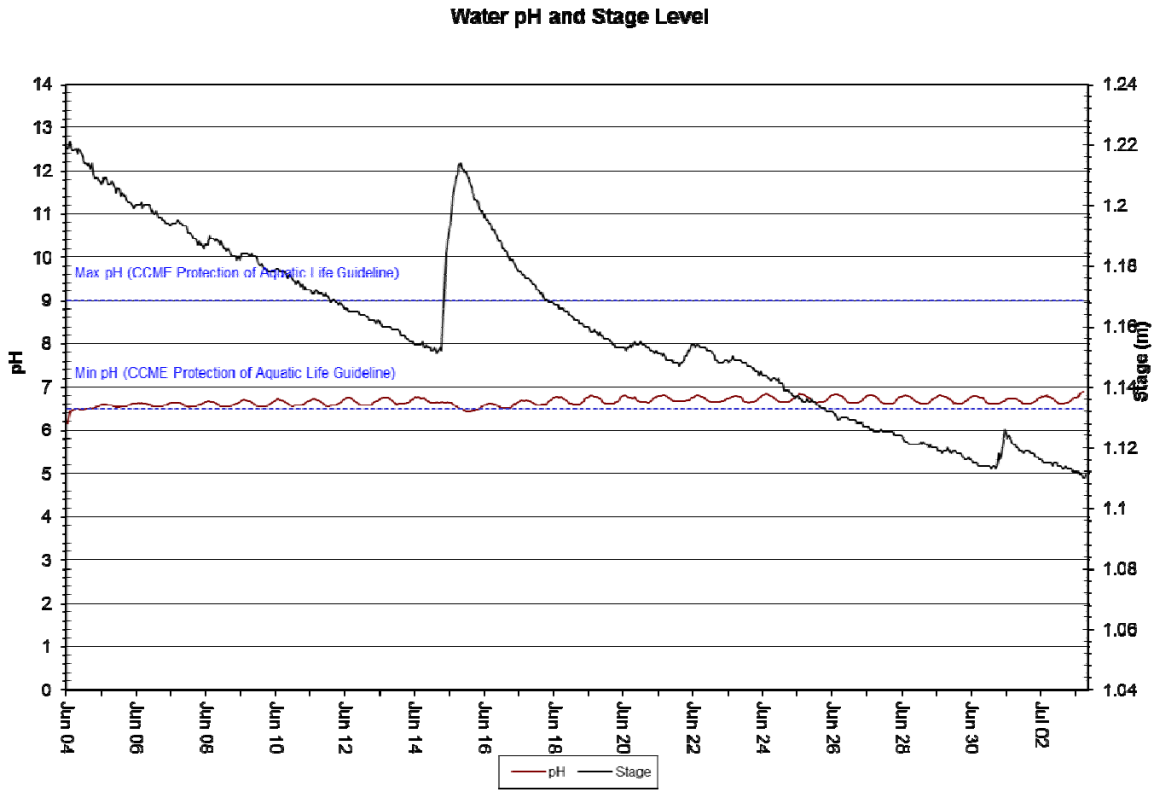

Figure 5: pH at Elross Creek – June 4, 2013 to July3, 2013.

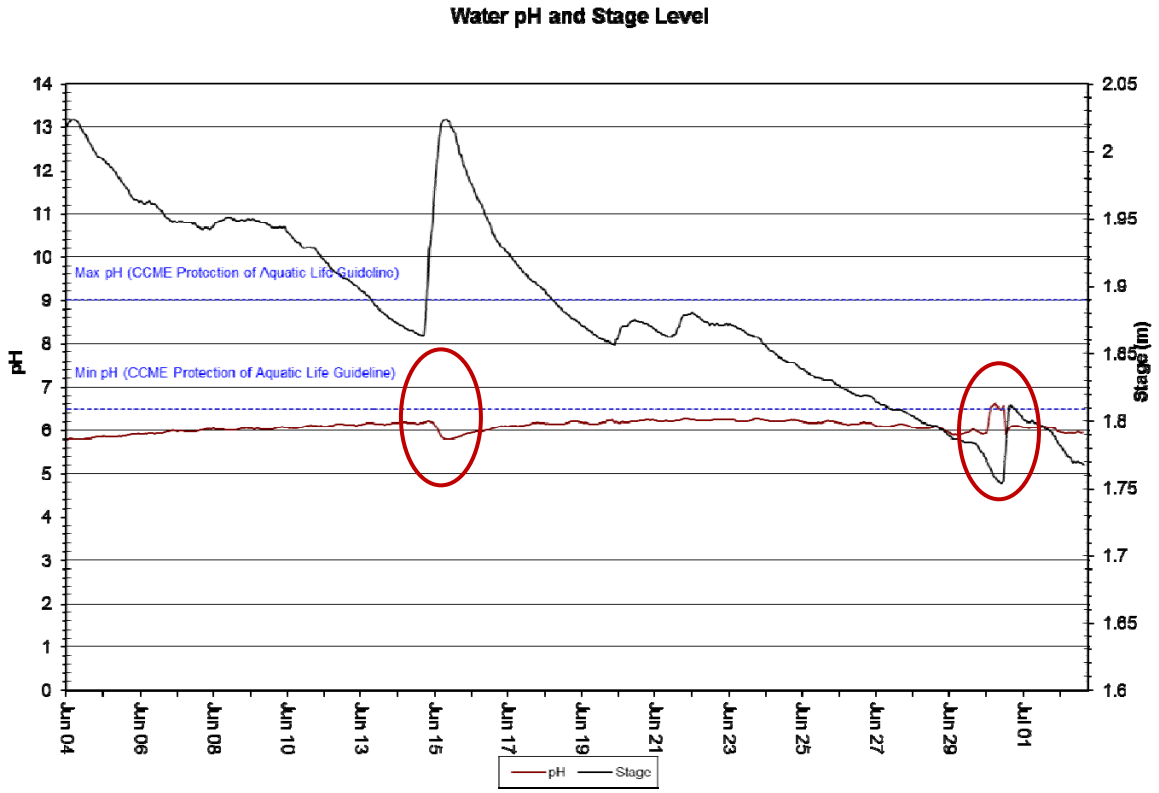

Figure 6: pH at Goodream Creek – June 4, 2013 to July3, 2013.

Specific Conductivity

- Specific Conductivity ranged from 11.6 µs/cm to 20.8 µs/cm at Elross Creek and from 2.3 µs/cm to 6.2 µs/cm at Goodream Creek from June 4, 2013 to July 3, 2013 (Figures 7 & 8).
- There is a diurnal trend in specific conductivity which is most visible at Goodream Creek. This diurnal trend is related to the diurnal temperature trend.
- For both sites there is a general increasing trend in specific conductivity over the deployment period. This increasing trend in specific conductivity is most likely related to a decreasing trend in flow. With lower flows, input from groundwater becomes more significant, and groundwater tends to have more dissolved minerals than surface water.
- Sudden changes in flow appear to have an impact on specific conductivity (see inside red ovals). This relationship can be seen at Elross Creek where a significant increase in flow around June 15 corresponds with a dip in conductivity. Likewise at Goodream Creek around July 1st a sudden increase in flow corresponds with a significant dip in conductivity.

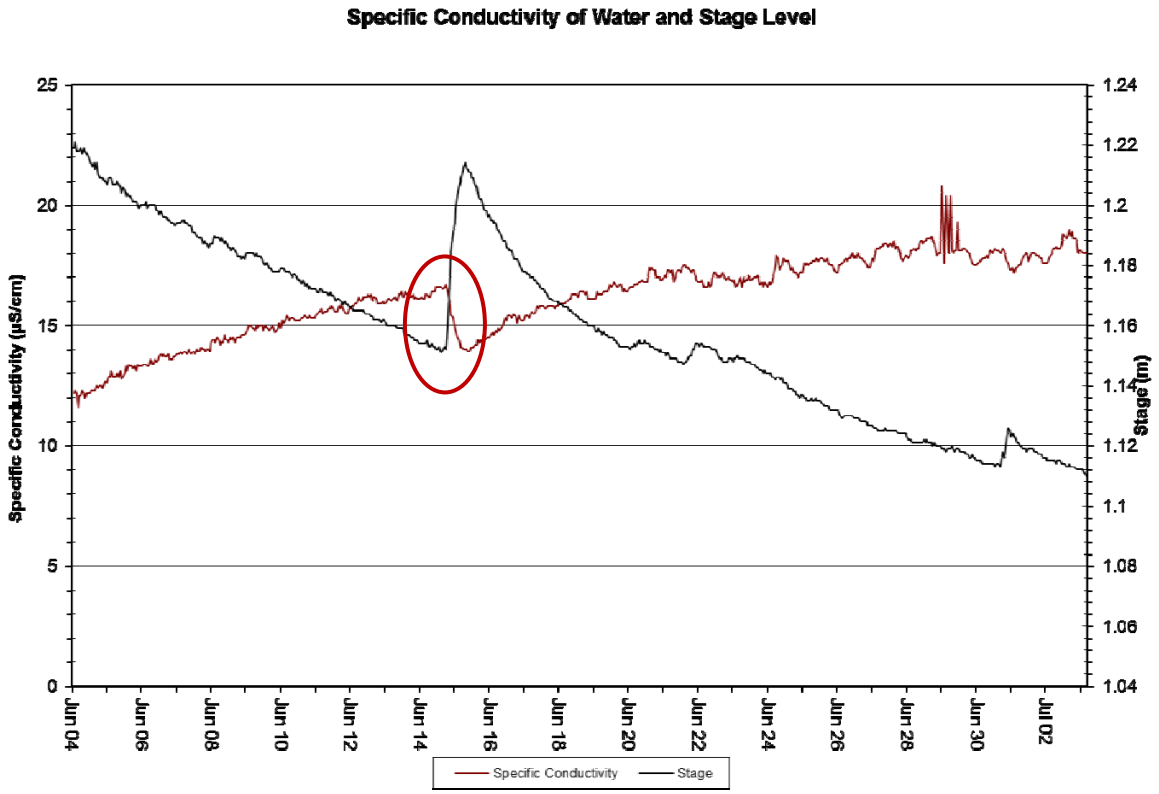

Figure 7: Specific conductivity (µs/cm) - Elross Creek –June 4, 2013 to July 3, 2013.

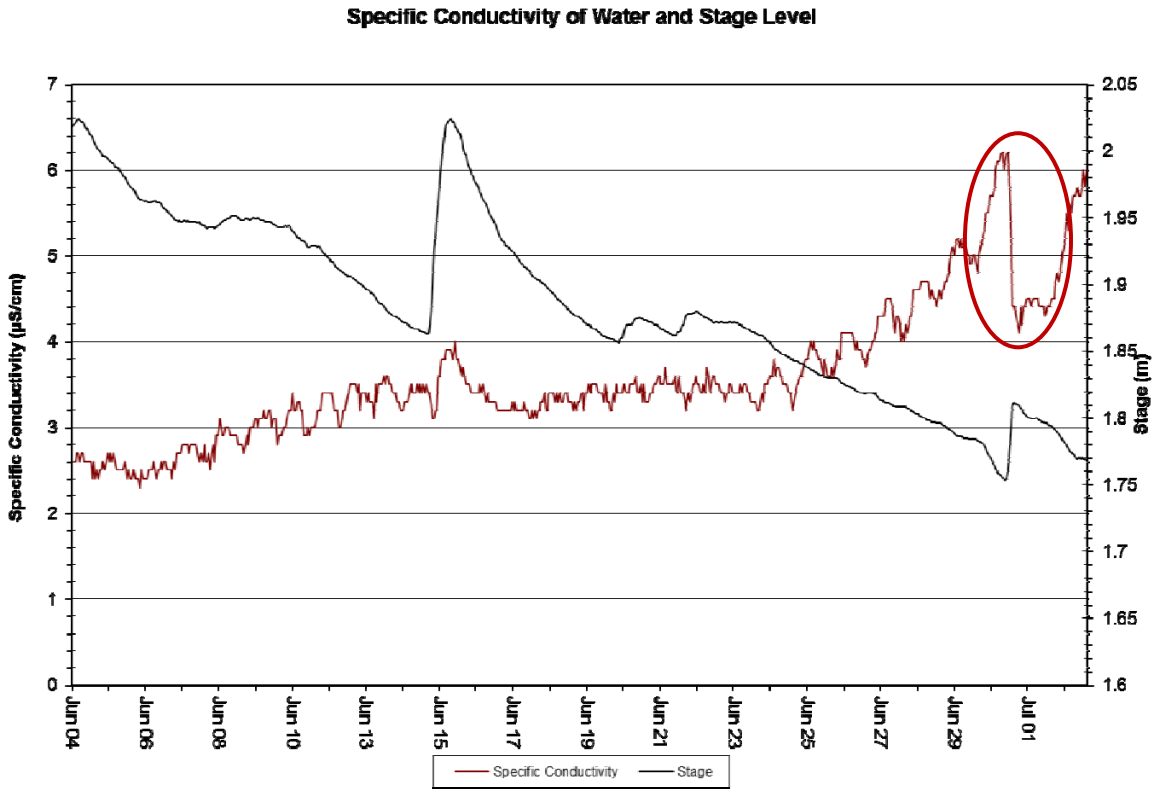

Figure 8: Specific conductivity (µs/cm) - Goodream Creek –June 4, 2013 to July 3, 2013.

Dissolved Oxygen

- Dissolved Oxygen (DO) values ranged from 8.82 mg/l (91.3% saturation) to 13.29 mg/l (99.3% saturation) at Elross Creek and from 5.14 mg/l (47.0% saturation) to 13.30 mg/l (100.0 % saturation) at Goodream Creek from June 4, 2013 to July 3, 2013 (Figures 9 & 10).
- It should be noted that for the last 7 to 10 days at Goodream Creek flows were critically low and oxygen levels and/or performance of the oxygen sensor may have been adversely affected (see inside red oval). Flows were so low that the instrument could not be redeployed for the following deployment period.
- 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.
- With the exception of the last 7 to 10 days at Goodream Creek when flows were critically low, the DO values at both stations were above cold water minimum guidelines 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).

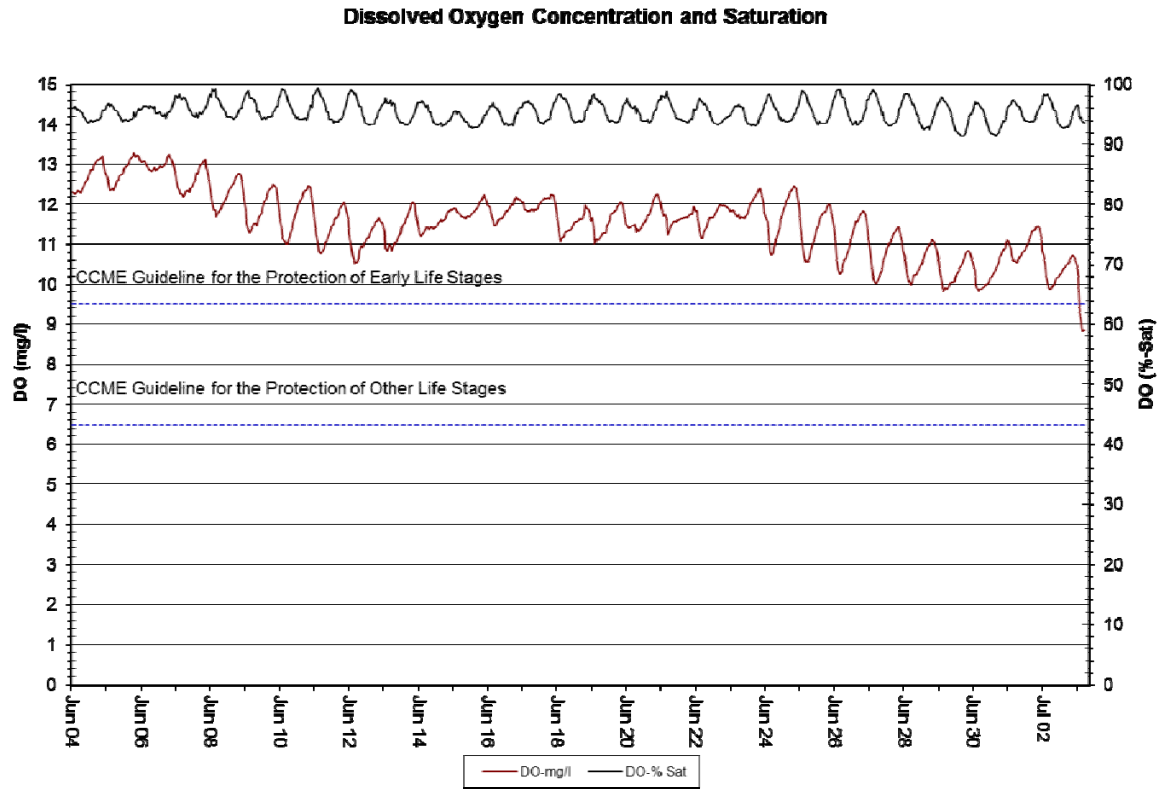

Figure 9: Dissolved Oxygen (mg/l) at Elross Creek – June 4, 2013 to July 3, 2013.

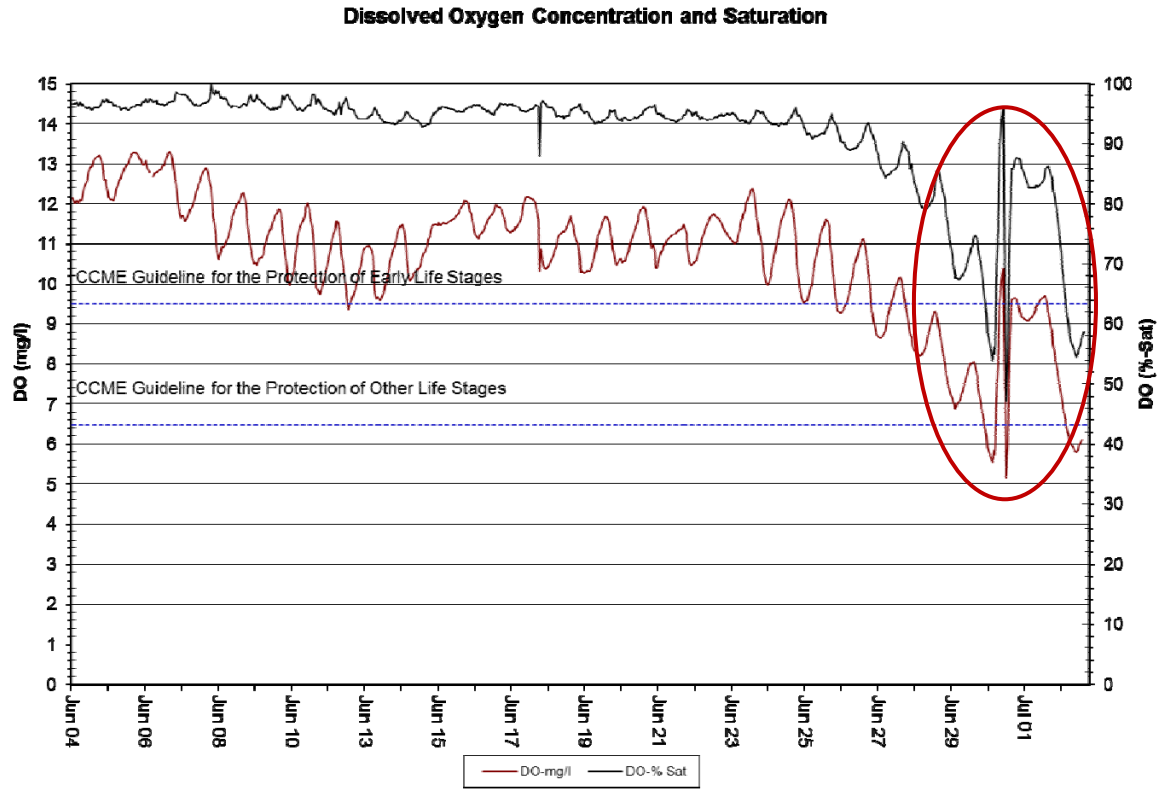

Figure 10: Dissolved Oxygen (mg/l) at Goodream Creek – June 4, 2013 to July 3, 2013.

Turbidity

- Turbidity values ranged from 5.9 NTU to 1159.0 NTU at Elross Creek and from 0.0 NTU to 9.3 NTU at Goodream Creek from June 4, 2013 to July 3, 2013 (Figures 11 & 12).
- The large spike in turbidity recorded at Elross Creek around June 15 coincided with a significant rainfall event and subsequent rapid increase in flow.

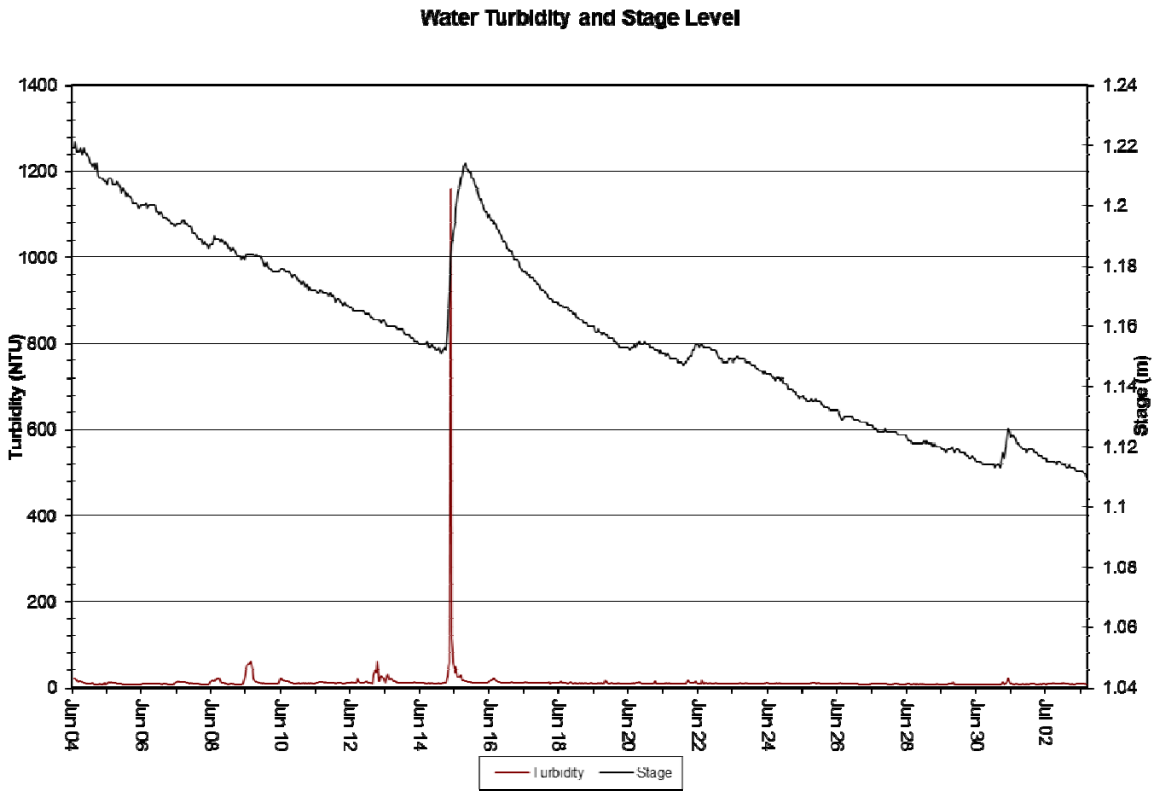

Figure 11: Turbidity (NTU) at Elross Creek – June 4, 2013 to July 3, 2013.

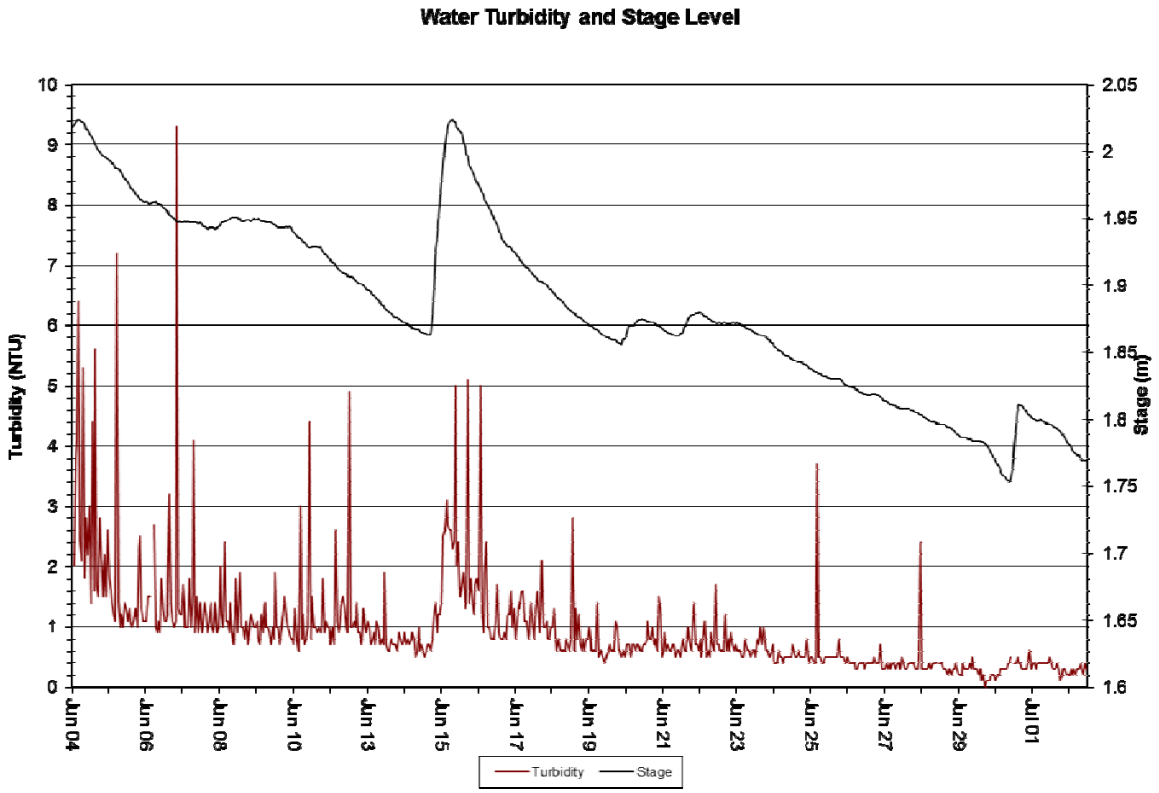

Figure 12: Turbidity (NTU) at Goodream Creek – June 4, 2013 to July 3, 2013.

Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from June 4, 2013 to July 3, 2013.
- Flow levels in Goodream Creek were critically low during the last 7 to 10 days of the deployment and dissolved oxygen readings were affected. Flows were so low that the instrument could not be redeployed for the following deployment period.
- The performances of all sensors were rated in the range of good to excellent at the beginning of the deployment and fair to excellent at the end. Oxygen, which was only ranked fair at the end of the deployment was affected by extremely low flows for the last 7 to 10 days of the deployment.

Variations in water quality/quantity values recorded at each station are summarized below:

- The general declining trend in stage height over the deployment period was consistent with the transition from spring to summer. Short term fluctuations recorded at both stations coincided well with precipitation events for the deployment period.

- Both Elross Creek and Goodream Creek show a general warming trend throughout the deployment period which corresponds with the warming air temperatures associated with the onset of summer.

- Diurnal fluctuations in water temperature corresponded with fluctuations in air temperature. This diurnal temperature trend is reflected in similar diurnal trends for pH, specific conductivity and dissolved oxygen.
- The one major turbidity event at Elross Creek coincided with a rainfall event, which likely caused an increase in stream sediment loads.

- 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*

APPENDIX B

Environment Canada Weather Data – Schefferville (June 4, 2013 to July 3, 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)
6/4/2013	6.2	-2.3	2	16	0	M	M	1.1
6/5/2013	3.9	-2.7	0.6	17.4	0	M	M	0
6/6/2013	4.7	-1.7	1.5	16.5	0	M	M	0.8
6/7/2013	11.5	-0.5	5.5	12.5	0	M	M	0
6/8/2013	17.7	-0.4	8.7	9.3	0	M	M	0
6/9/2013	18.8	-0.2	9.3	8.7	0	M	M	0
6/10/2013	16.5	2.5	9.5	8.5	0	M	M	0
6/11/2013	19.4	1.2	10.3	7.7	0	M	M	0
6/12/2013	20.7	3.5	12.1	5.9	0	M	M	0
6/13/2013	21.4	3.9	12.7	5.3	0	M	M	0
6/14/2013	12.6	0.5	6.6	11.4	0	M	M	0
6/15/2013	7.2	2.7	5	13	0	M	M	23.9
6/16/2013	7.1	0	3.6	14.4	0	M	M	0.5
6/17/2013	7.7	-0.3	3.7	14.3	0	M	M	0
6/18/2013	14.4	-0.6	6.9	11.1	0	M	M	
6/19/2013	16.7	3.9	10.3	7.7	0	M	M	0
6/20/2013	17.4	3.1	10.3	7.7	0	M	M	3.6
6/21/2013	13	0.5	6.8	11.2	0	M	M	0
6/22/2013	10.1	4	7.1	10.9	0	M	M	7.1
6/23/2013	11.1	0.2	5.7	12.3	0	M	M	2
6/24/2013	12.3	-1.1	5.6	12.4	0	M	M	0
6/25/2013	14.1	-0.8	6.7	11.3	0	M	M	0
6/26/2013	18.8	0.8	9.8	8.2	0	M	M	0
6/27/2013	23.3	3.1	13.2	4.8	0	M	M	0
6/28/2013	24.9	5.6	15.3	2.7	0	M	M	0
6/29/2013	23.9	6.1	15	3	0	M	M	0
6/30/2013	23.4	8.5	16	2	0	M	M	0.5
7/1/2013	11.3	5.2	8.3	9.7	0	M	M	4.6
7/2/2013	23.6	6.1	14.9	3.1	0	M	M	0
7/3/2013	23.6	10.3	17	1	0	M	M	0