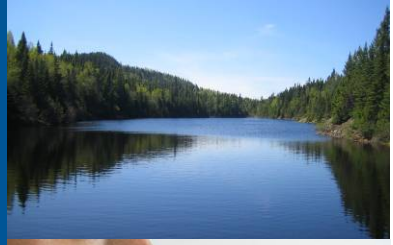




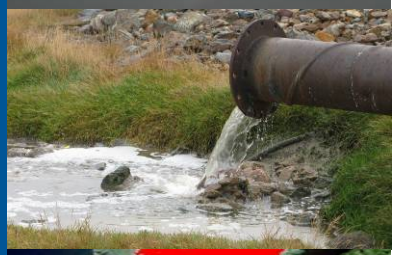


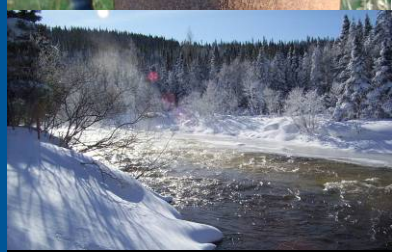

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2014-09-09 to 2014-10-06

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 September 9, 2014 to October 6, 2014.
- This was the final deployment for the 2014 field season for both of these stations and the instruments were removed on October 6, 2014, and the sites were secured for the winter months. Instruments will be redeployed in Spring 2015.

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	2014-09-10	2014-10-06		2014-09-09	2014-10-06
Temperature	Excellent	Excellent		Excellent	Excellent
pH	Fair	Good		Good	Good
Specific Conductivity	Excellent	Excellent		Excellent	Excellent
Dissolved Oxygen	NA	Good		Excellent	Good
Turbidity	Excellent	Excellent		Excellent	Excellent

The performances of all sensors were rated fair to excellent at the beginning of the deployment period and good to excellent at removal (Table 1). It should be noted that an issue with the dissolved oxygen sensor on the QA instrument at the deployment meant a comparison could not be made with the field instrument for this parameter.

Deployment Notes

- Water quality monitoring for this deployment period season started at Goodream Creek on September 09, 2014 at 2:11 pm and at Elross Creek on September 10 at 12:00 pm. Continuous real-time monitoring continued at both sites without any significant operational issues until October 06, 2014 when the instruments were removed for the end of the 2014 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 (^{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 1.18 m at Elross Creek and from 1.79 m to 2.04 m at Goodream Creek from September 09, 2014 to October 06, 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 the most pronounced shown inside red ovals. In both cases this spike builds from September 24to September 25 which coincides with a significant rainfall event (Climate data located in Appendix B).

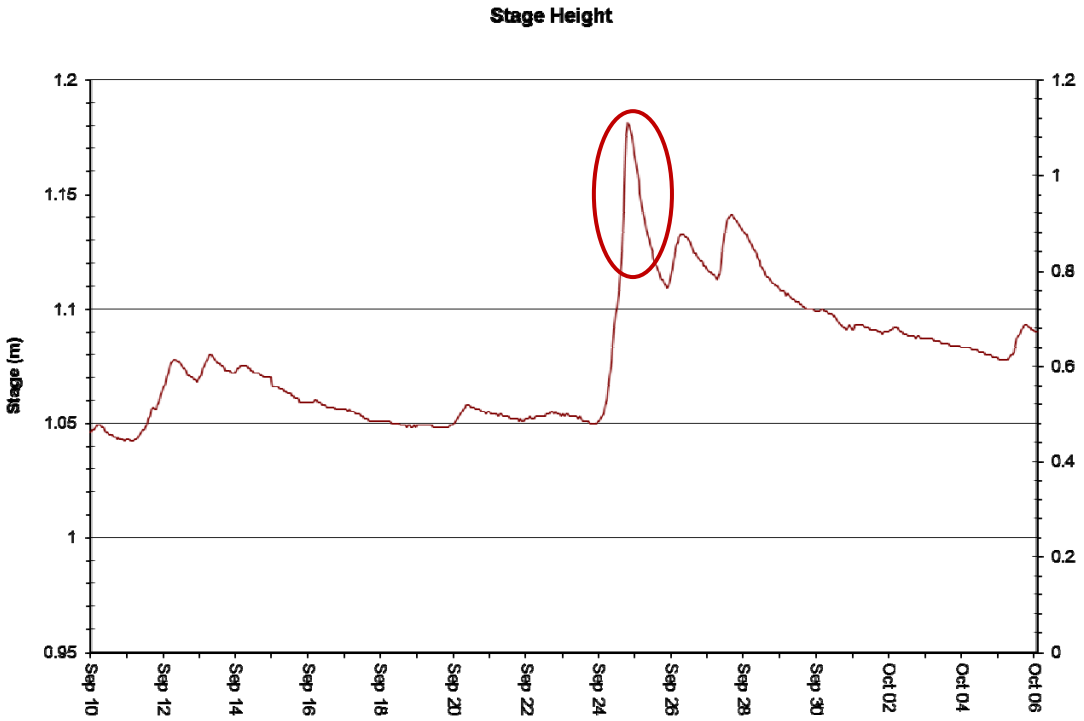

Figure 1: Stage Height (m) at Elross Creek –September 10, 2014 to October 06, 2014

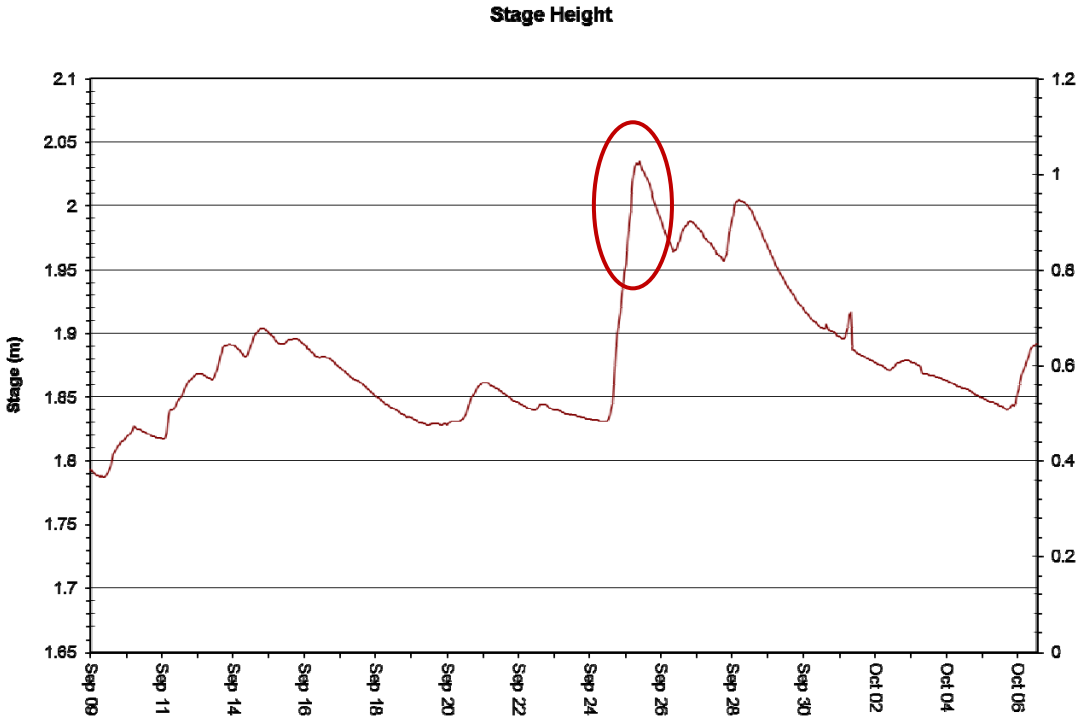

Figure 2: Stage Height (m) at Goodream Creek – September 09, 2014 to October 06, 2014

Temperature

- Water temperature ranged from 1.20˚C to 8.60˚C at Elross Creek and from 0.00˚C to 10.50˚C at Goodream Creek from September 09, 2014 to October 06, 2014 (Figures 3 & 4).
- For both Elross Creek and Goodream Creek temperature is relatively stable throughout the deployment period.
- Water temperatures at both stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.

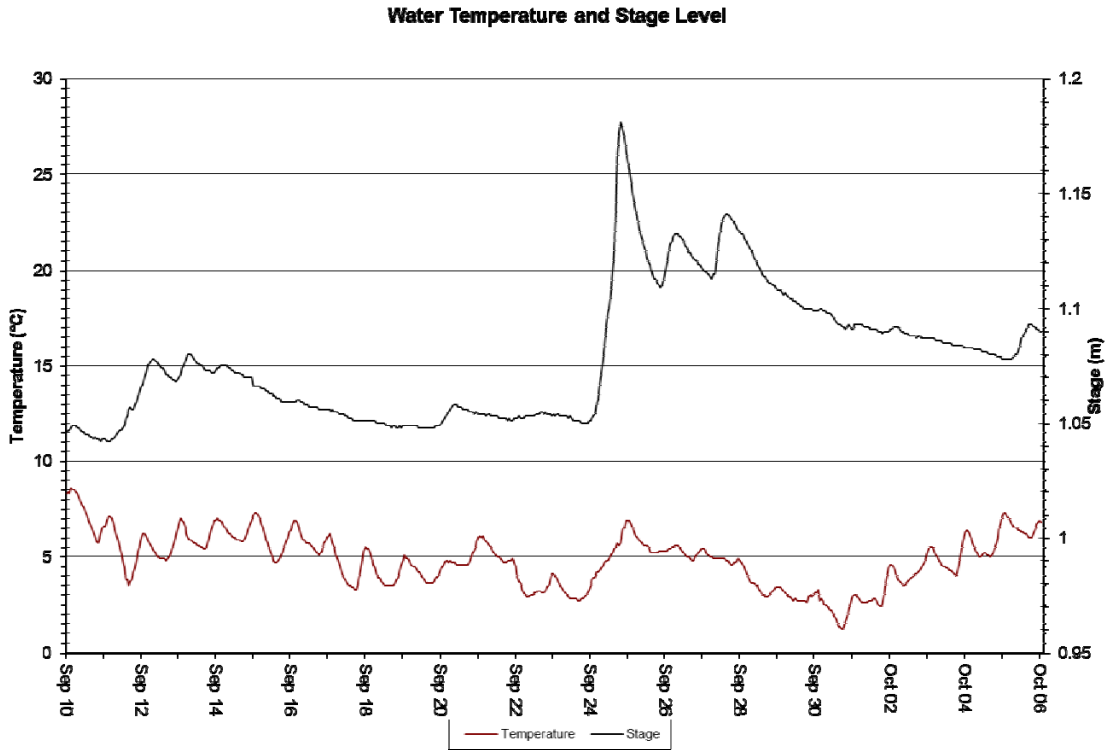

Figure 3: Temperature (°C) - Elross Creek – September 10, 2014 to October 06, 2014

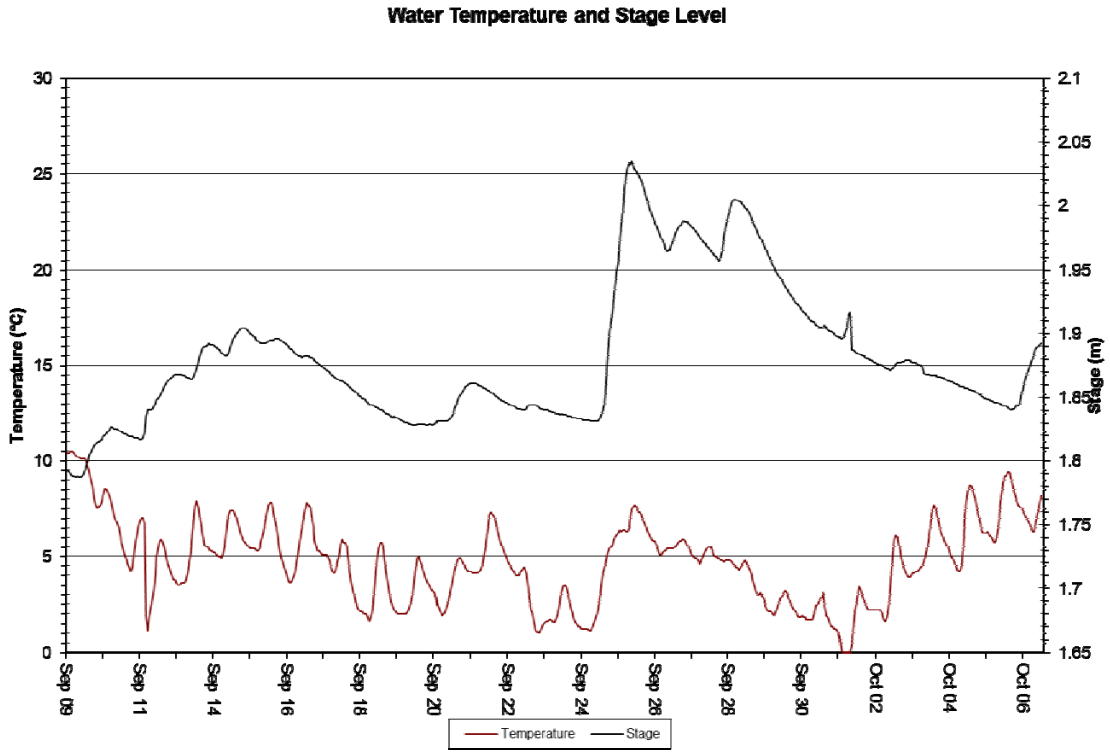

Figure 4: Temperature (°C) - Goodream Creek - September 09, 2014 to October 06, 2014

pH

- pH values ranged from 5.74 units to 6.71 units at Elross Creek and from 5.58 units to 6.39 units at Goodream Creek from September 09, 2014 to October 06, 2014 (Figures 5 & 6).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is quite weak during this deployment period but is still discernible for the Elross Creek data.
- At both Elross and Goodream Creeks it appears that pH is affected by significant changes in stream flow (see inside red ovals), with a distinct dip between September 24 and September 25 which is related to a significant increase in flow caused by precipitation events.
- With a mean value of 6.18, 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). With a mean value of 6.15, pH values recorded at Goodream Creek were all 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.

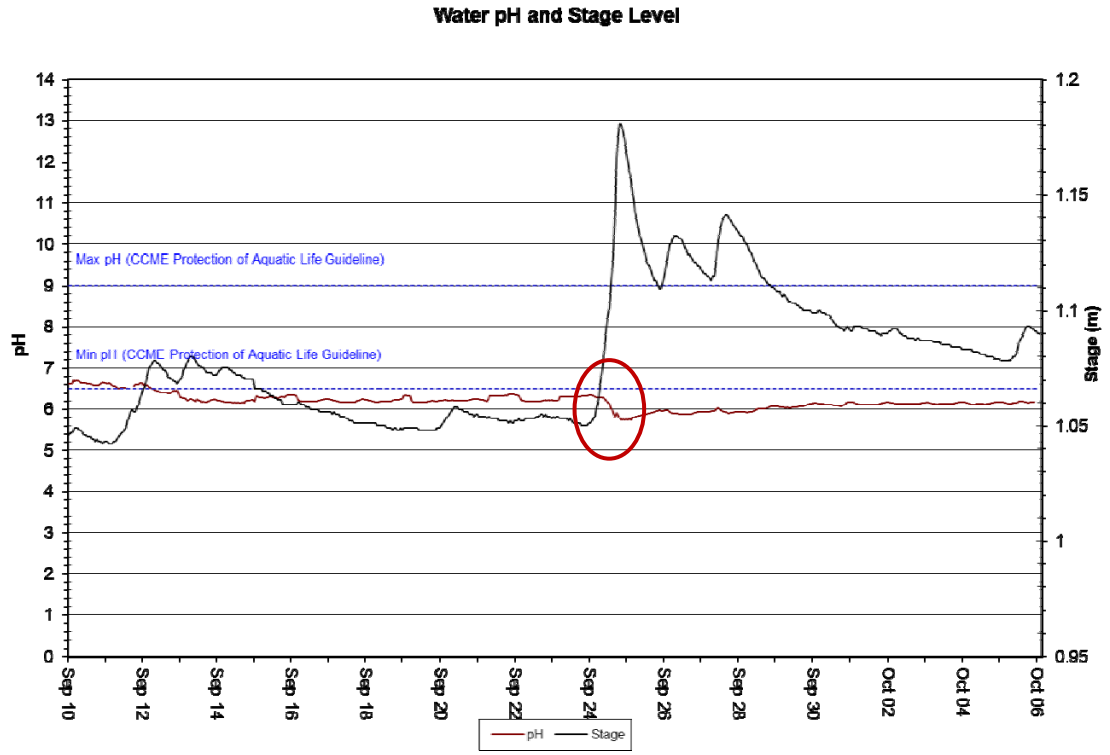

Figure 5: pH at Elross Creek – September 10, 2014 to October 06, 2014

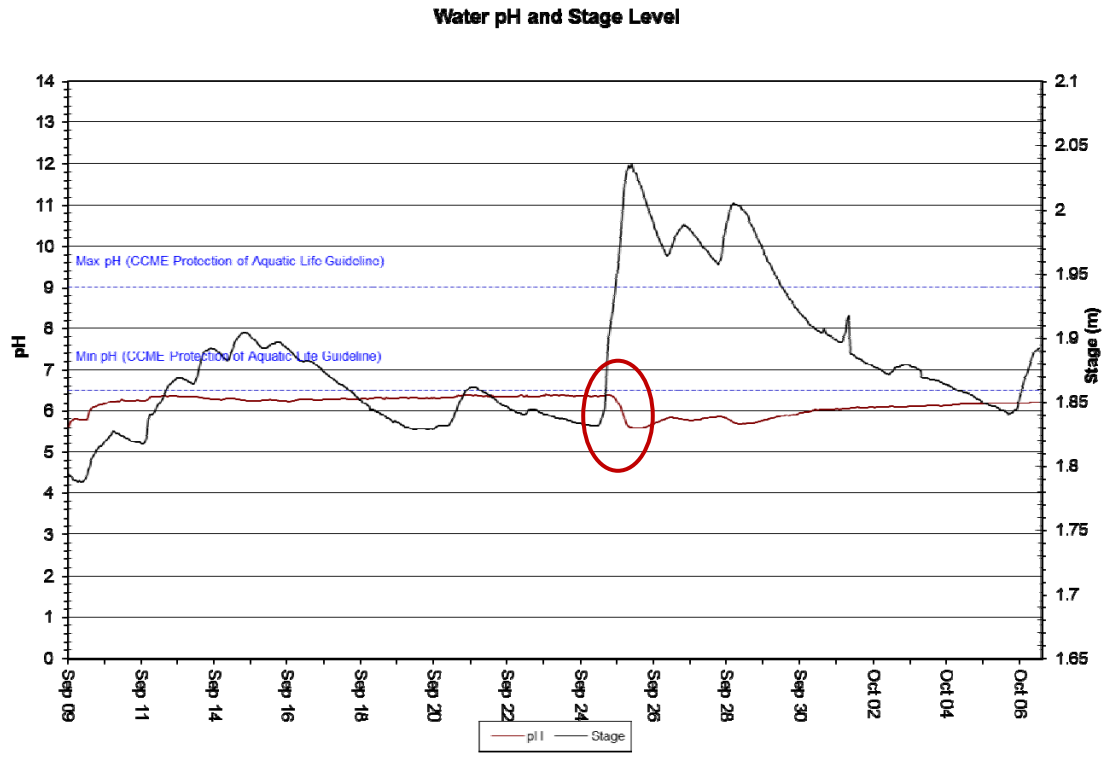

Figure 6: pH at Goodream Creek – September 09, 2014 to October 06, 2014

Specific Conductivity

- Specific Conductivity ranged from 5.3 µs/cm to 9.1 µs/cm at Elross Creek and from 4.0 µs/cm to 14.2 µs/cm at Goodream Creek from September 09, 2014 to October 06, 2014 (Figures 7 & 8).
- At Elross Creek sudden changes in flow appear to have a noticeable impact on specific conductivity (see inside red oval) with a distinct spike in specific conductivity around September 25 which coincides with a spike in stage height for the same time. At Goodream Creek the specific conductivity data is more variable making it more difficult to notice the impact of changes in flow.
- A significant spike in conductivity at the beginning of the deployment at Goodream Creek (see inside red oval) is most likely related to low flow conditions when groundwater, which normally has higher conductivity than surface water, makes up a larger portion of flow.

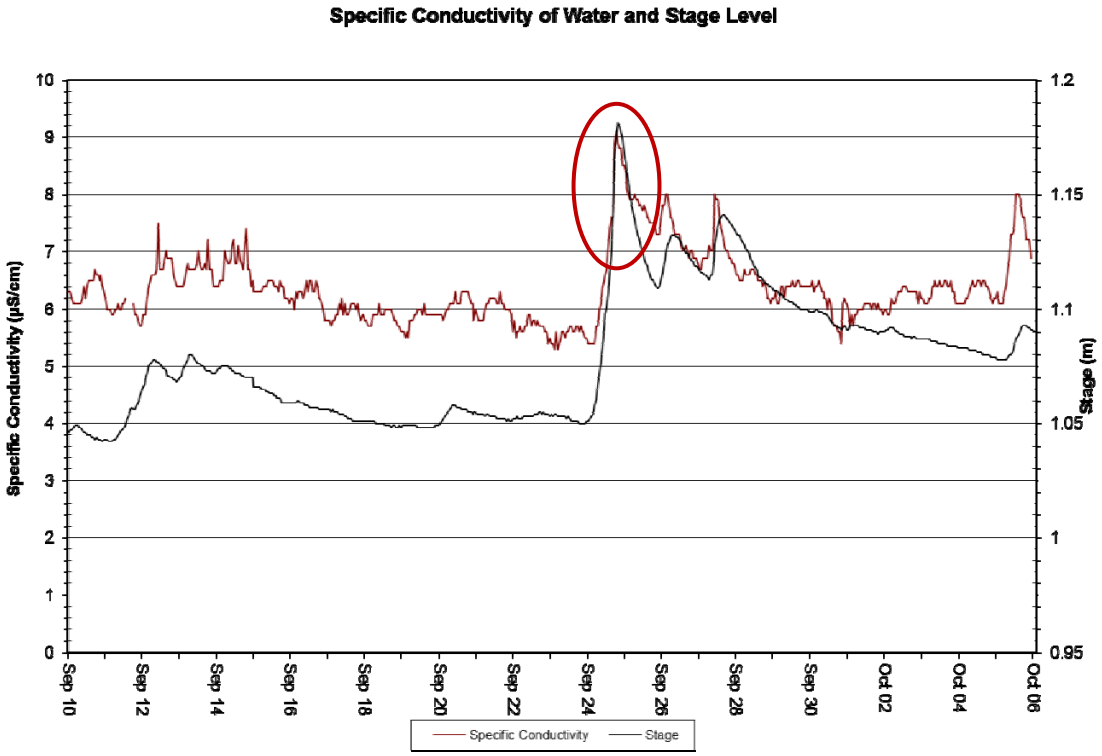

Figure 7: Specific conductivity (us/cm) - Elross Creek – September 10, 2014 to October 06, 2014

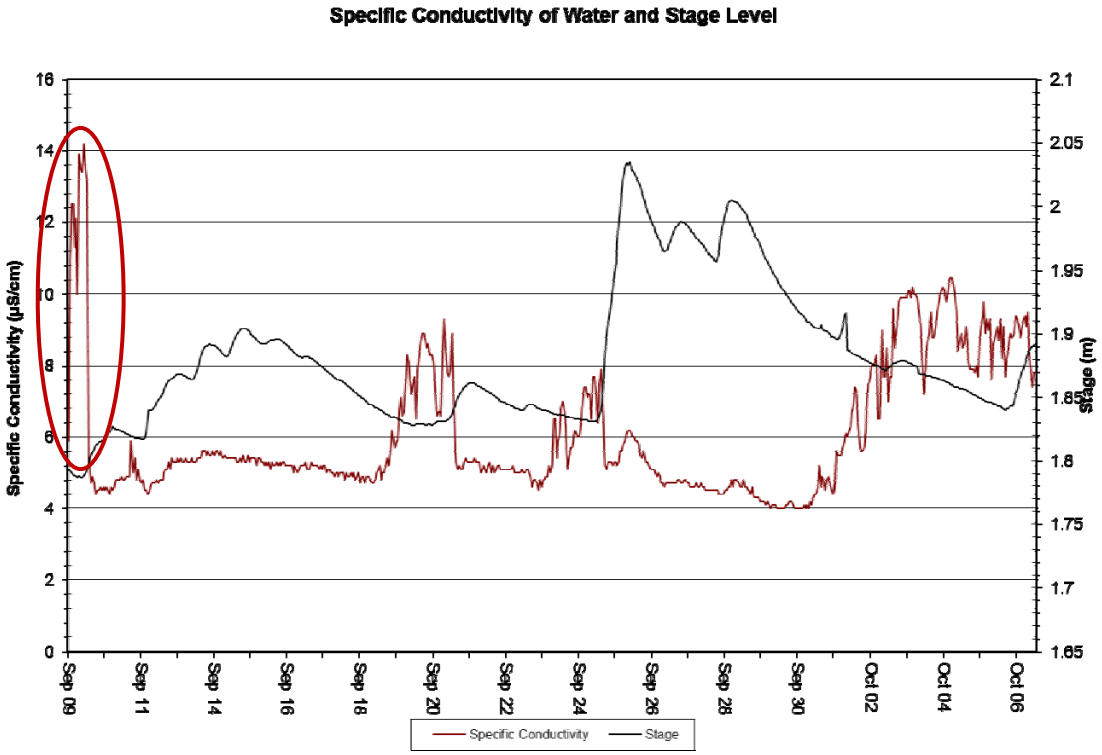

Figure 8: Specific conductivity (us/cm) - Goodream Creek – September 09, 2014 to October 06, 2014

Dissolved Oxygen

- Dissolved Oxygen (DO) values ranged from 10.01 mg/l (86.5% saturation) to 12.44 mg/l (95.9% saturation) at Elross Creek and from 6.72 mg/l (63.2% saturation) to 12.85 mg/l (103.6 % saturation) at Goodream Creek from September 09, 2014 to October 6, 2014 (Figures 9 & 10).
- Dissolved oxygen remains relatively stable over the deployment period for Elross Creek, however it shows considerably more variability for Goodream Creek. In particular there is a significant dip in oxygen at Goodream Creek at the beginning of the deployment period (see inside red oval) which can most likely be attributed to low flow conditions at the same time.
- There is a 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 dip at the beginning of the deployment at Goodream Creek, which is most likely due to low flow conditions, the DO values at both stations were 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).

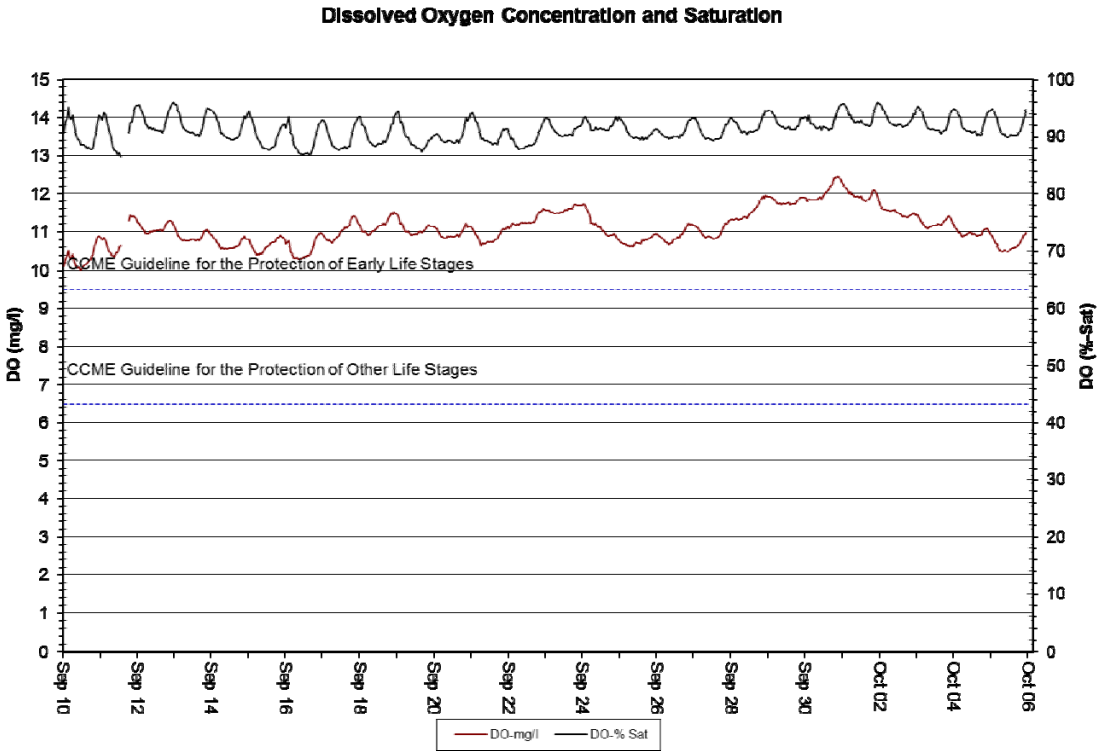

Figure 9: DO (mg/l & % saturation) at Elross Creek – Sept. 10, 2014 to October 06, 2014

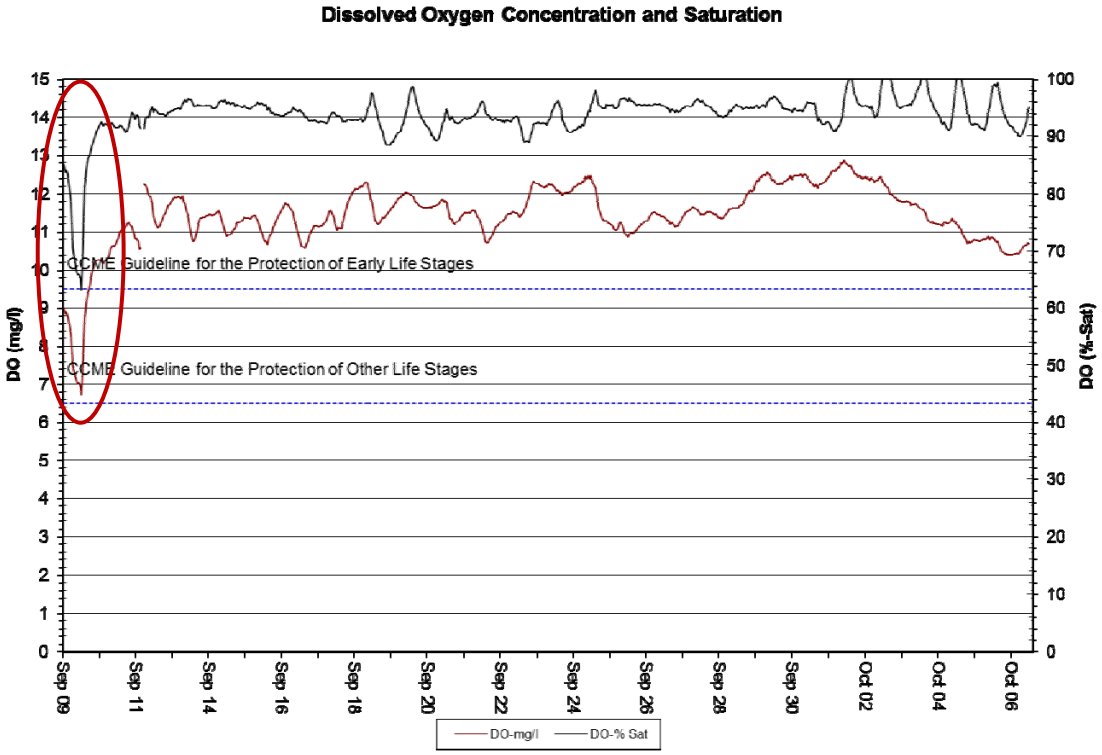

Figure 10: DO (mg/l & % saturation) at Goodream Creek – Sept. 09, 2014 to Oct. 06, 2014

Turbidity

- Turbidity values ranged from 0.0 NTU to 772.0 NTU at Elross Creek and from 0.0 NTU to 12.3 NTU at Goodream Creek from September 09, 2014 to October 6, 2014 (Figures 11 & 12).
- Spikes in turbidity at both Elross and Goodream Creeks (see inside red ovals) correspond with significant rainfall events and a subsequent increase in flow which took place around September 25, 2014.

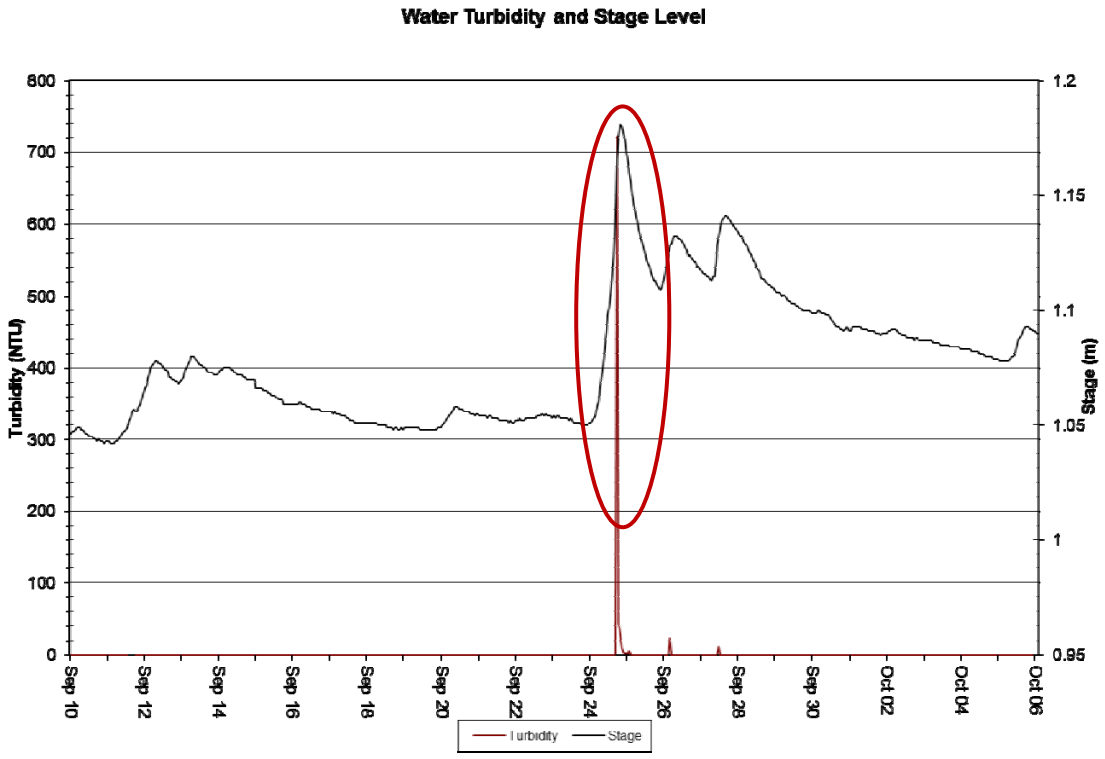

Figure 11: Turbidity (NTU) at Elross Creek – September 10, 2014 to October 06, 2014

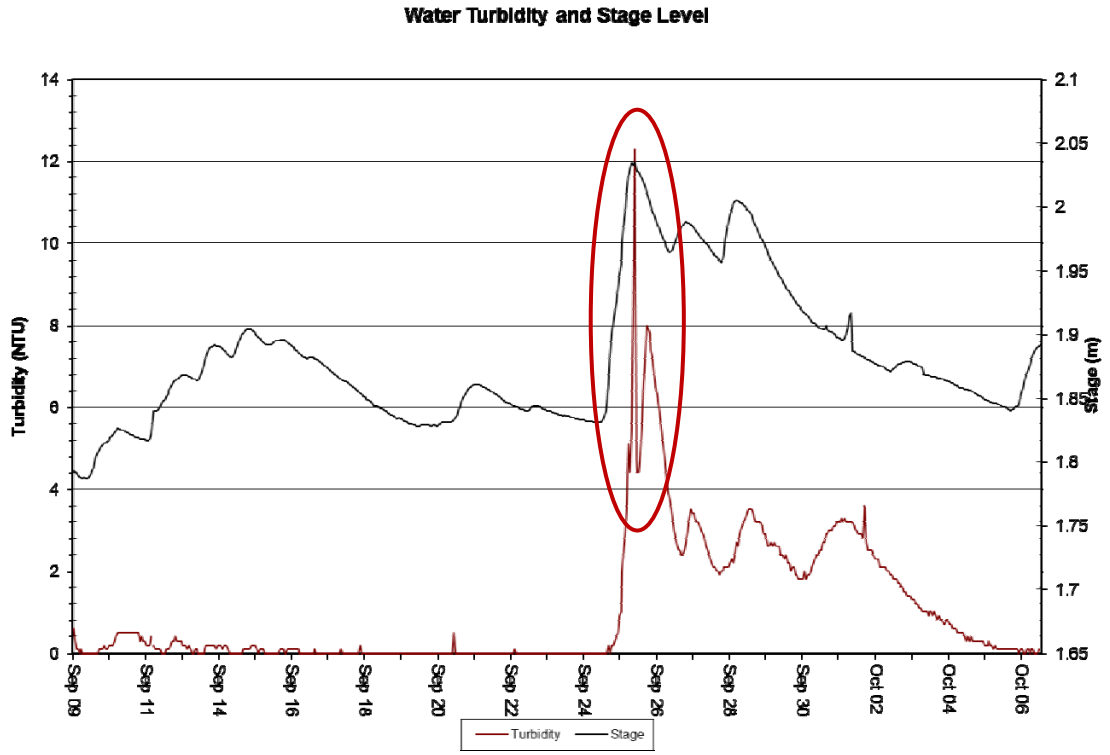

Figure 12: Turbidity (NTU) at Goodream Creek – September 09, 2014 to October 06, 2014

Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from September 09, 2014 to October 06, 2014.

- The performances of all sensors were rated fair to excellent at the beginning of the deployment period and good to excellent at removal (Table 1). It should be noted that an issue with the dissolved oxygen sensor on the QA instrument at the deployment meant a comparison could not be made with the field instrument for this parameter.
- 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. In both cases this spike builds from September 24to September 25 which coincides with a significant rainfall event.
    - For both Elross Creek and Goodream Creek temperature is relatively stable throughout the deployment period.
    - Water temperatures at both stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.

- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is quite weak during this deployment period but is still discernible for the Elross Creek data.
- At both Elross and Goodream Creeks it appears that pH is affected by significant changes in stream, with a distinct dip between September 24 and September 25 which is related to a significant increase in flow caused by precipitation events.
- With a mean value of 6.18, 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). With a mean value of 6.15, pH values recorded at Goodream Creek were all 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.
- At Elross Creek sudden changes in flow appear to have a noticeable impact on specific conductivity, with a distinct spike specific conductivity around September 25 which coincides with a spike in stage height for the same time. At Goodream Creek the specific conductivity data is more variable making it more difficult to notice the impact of changes in flow.
- A significant spike in conductivity at the beginning of the deployment at Goodream Creek is most likely related to low flow conditions when groundwater, which normally has higher conductivity than surface water, makes up a larger portion of flow.
- Dissolved oxygen remains relatively stable over the deployment period for Elross Creek; however it shows considerably more variability for Goodream Creek. In particular there is a significant dip in oxygen at Goodream Creek at the beginning of the deployment period, which can most likely be attributed to low flow conditions at the same time.
- There is a 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 dip at the beginning of the deployment at Goodream Creek which is most likely due to low flow conditions, the DO values at both stations were 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).
- Spikes in turbidity at both Elross and Goodream Creeks correspond with significant rainfall events and a subsequent increase in flow which took place around September 25, 2014.

- 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 (September 09, 2014 to October 06, 2014)

Date	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)
9/9/2014		3.6				M	M	
9/10/2014	7.7	1.5	4.6	13.4	0	M	M	
9/11/2014	5.5	-0.3	2.6	15.4	0	M	M	15.3
9/12/2014	5.5	-0.1	2.7	15.3	0	M	M	10.3
9/13/2014						M	M	
9/14/2014	8.2	3.6	5.9	12.1	0	M	M	0
9/15/2014	9.9	1.3	5.6	12.4	0	M	M	0
9/16/2014	10.5	0.6	5.6	12.4	0	M	M	0.5
9/17/2014	4.8	-2	1.4	16.6	0	M	M	
9/18/2014	4.8	-2.9	1	17	0	M	M	0
9/19/2014	5.1	-1	2.1	15.9	0	M	M	0
9/20/2014	7.6	0.3	4	14	0	M	M	5.1
9/21/2014	7.2	2.2	4.7	13.3	0	M	M	0.3
9/22/2014	2.6	-0.9	0.9	17.1	0	M	M	2.1
9/23/2014	0.3	-2.7	-1.2	19.2	0	M	M	3.1
9/24/2014	12.3	-1.2	5.6	12.4	0	M	M	18.5
9/25/2014	12.5	1.7	7.1	10.9	0	M	M	12.8
9/26/2014	8.6	1.6	5.1	12.9	0	M	M	9.8
9/27/2014		1.1				M	M	
9/28/2014	3.4	-3.5	-0.1	18.1	0	M	M	0.8
9/29/2014	-0.6	-4.1	-2.4	20.4	0	M	M	0
9/30/2014	3.1	-5	-1	19	0	M	M	0.3
10/1/2014	1.3	-7.3	-3	21	0	M	M	0.5
10/2/2014	13.8	-0.5	6.7	11.3	0	M	M	0
10/3/2014	15.1	8.2	11.7	6.3	0	M	M	0
10/4/2014	19	5.6	12.3	5.7	0	M	M	0
10/5/2014	16	7.4	11.7	6.3	0	M	M	8.8
10/6/2014	9.7	0.6	5.2	12.8	0	M	M	3.8