Real Time Water Quality Report

Labrador Iron Mines
Schefferville Network

Deployment Period
2015-07-07 to 2015-08-03

Newfoundland Labrador

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 Labrador Iron Mines Ltd. and Environment Canada, maintain two real-time water quality/quantity stations in close proximity to the James Property deposits, near Schefferville, QC, and one real-time water quality/quantity station in close proximity to the Houston Property deposits.
- The official name of each station is *James Creek Above Bridge*, *Unnamed Tributary Below Settling Pond*, and *Houston Creek above Road Culvert,* hereafter referred to as the James Creek station, the Unnamed Tributary station, and the Houston Creek station respectively.
- The Unnamed Tributary station was idled at the end of 2013 when dewatering operations ceased and the brook ran dry.
- The Houston Creek station was idled at the end of 2014 as plans for developing the ore body in that area were delayed and there was to be no activity in the area during 2015.
- James Creek station monitors water outflow from the multi-cell retention and settling pond system as well as from Ruth Pit. The retention and settling pond system was designed with four smaller man-made ponds that received water primarily from groundwater wells constructed along the periphery of the James Property, in addition to storm water from the beneficiation area, flush water from the reject rock pipeline, and in case of pump failure, reject rock inside the pipeline that was destine to Ruth Pit. At present none of these pumping systems are operational and outflow from the retention and settling pond system is directed into James Creek.
- Ruth Pit is used as a settling pond for reject rock originating from the beneficiation area at the Silver Yard, as well as receives water from pit dewatering pumps. The outflow from Ruth Pit is the start of James Creek.
- The Water Resources Management Division will inform Labrador Iron Mines Ltd. 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 James Creek from July 7, 2015, to August 3, 2015.
- It should be noted that during the 2015 field season there were technical issues with the power supply at the James Creek station which affected data logging and data transmissions. As a result there is missing data.

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.

- **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 shows the performance ratings of five water quality parameters (i.e., temperature, pH, specific conductivity, dissolved oxygen and turbidity) measured by the instrument deployed at the water monitoring station.

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

	James Creek	
Stage of deployment	**Beginning**	**End***
Date	2015-07-2	2015-08-03
Temperature	Excellent	Excellent
pH	Good	Excellent
Specific Conductivity	Excellent	Good
Dissolved Oxygen	Excellent	Excellent
Turbidity	NA	NA

*note: log file data was used for comparison at the end of the deployment period

- The performance of the temperature, specific conductivity and dissolved oxygen sensors was rated excellent, and the performance of the pH sensor was rated good, at James Creek at the beginning of the deployment period (Table 1). At the time of removal the performance of the temperature, pH and dissolved oxygen sensors was rated excellent and the performance of the specific conductivity sensor was rated good. Unfortunately, due to technical issues the turbidity sensor was not operational during this deployment period.

Deployment Notes

- Water quality monitoring for this deployment period started at James Creek on July 7, 2015 at 10:30 am. Continuous real-time monitoring continued until July 29, 2015, when technical issues with the power supply affected data transmissions. Data from internal logging in the deployed hydrolab was used to provide data for the last few days of the deployment until the instrument was removed on August 3, 2015 at 5:00 pm.
- Technical issues with the turbidity sensor meant that no turbidity data was collected during this deployment period.

Data Interpretation

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

  (i.) Stage (m)
  (ii.) Temperature (^{o}C)
  (iii.) pH
  (iv.) Specific conductivity (µS/cm)
  (v.) Dissolved oxygen (mg/l)

Stage

- Stage values ranged from 515.76 m to 515.82 m at James Creek (Figure 1) from July 7, 2015 to July 29, 2015, while the corresponding flow for the same period ranged from 0.49 m^3/sec to 0.64 m^3/sec. Due to technical issues no stage or flow data was available from July 29, 2015 until the end of the deployment period. 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 James Creek there appears to be an overall gentle declining trend in flow throughout the deployment period.
- Daily fluctuations in stage height and flow observed at James Creek are related to variations in the local climate. Two significant peaks at around July 8th and July 14th (see inside red ovals) correspond with significant rainfall events at the corresponding times (see climate data in appendix B).
- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.

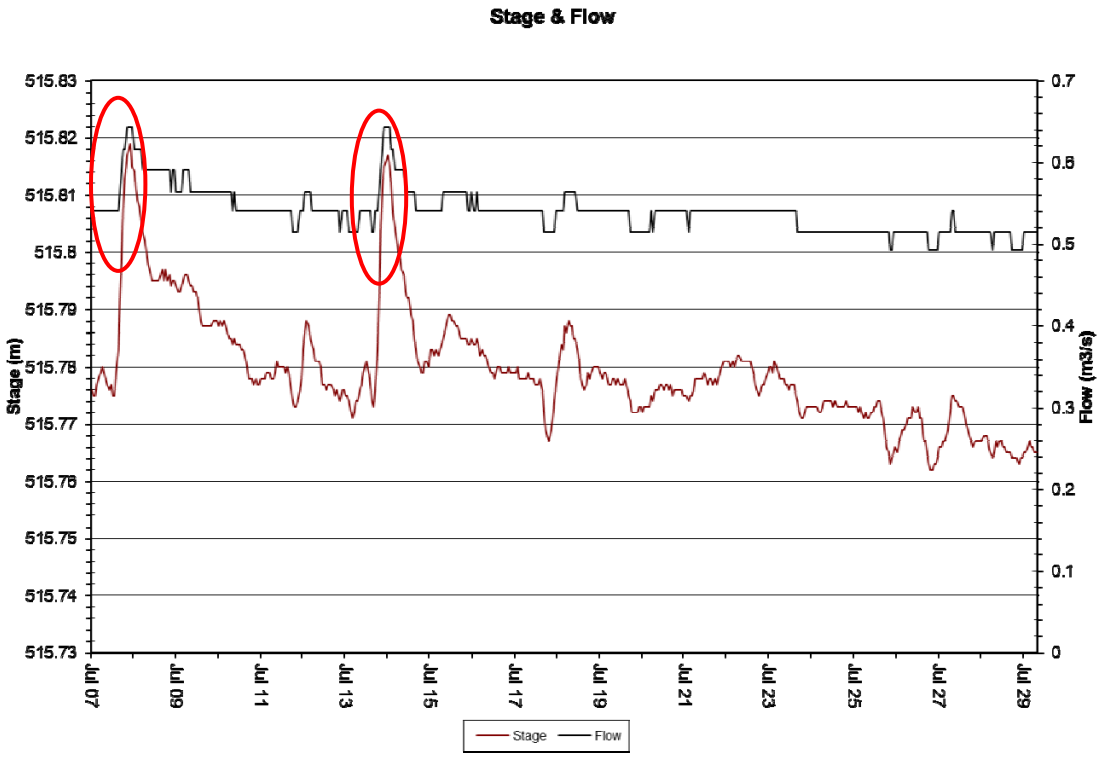

Figure 1: Stage Height (m) at James Creek from July 7, 2015 to July 29, 2015

Temperature

- Water temperature ranged from 9.30˚C to 17.00˚C at James Creek (Figure 2) from July 7, 2015 to August 3, 2015.
- Water temperature at James Creek shows significant diurnal variations. This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
- Temperature at James Creek was relatively stable over the first half of the deployment period and for the latter half shows a gentle increasing trend which is related to a period of warmer summer weather (see climate data in appendix B).

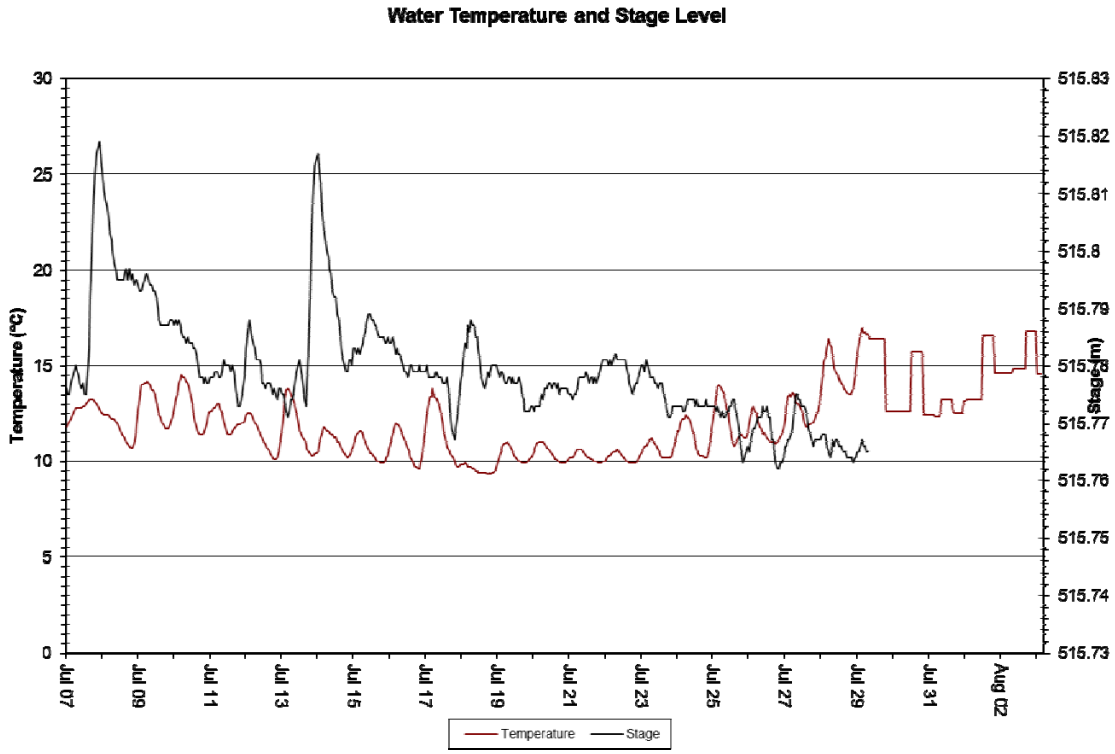

Figure 2: Temperature (°C) at James Creek from July 7, 2015 to August 3, 2015

pH

- pH values ranged from 7.93 units to 8.77 units at James Creek (Figure 3) from July 7, 2015 to August 3, 2015.
- pH values at James Creek station shows regular diurnal fluctuations which are related to the diurnal temperature fluctuations.
- pH at James Creek was relatively stable throughout the deployment period and with a median value of 8.28, pH values recorded at James Creek were within the guidelines for pH for the protection of aquatic life (i.e., 6.5 to 9.0 units), as defined by the Canadian Council of Ministers of the Environment (2007).

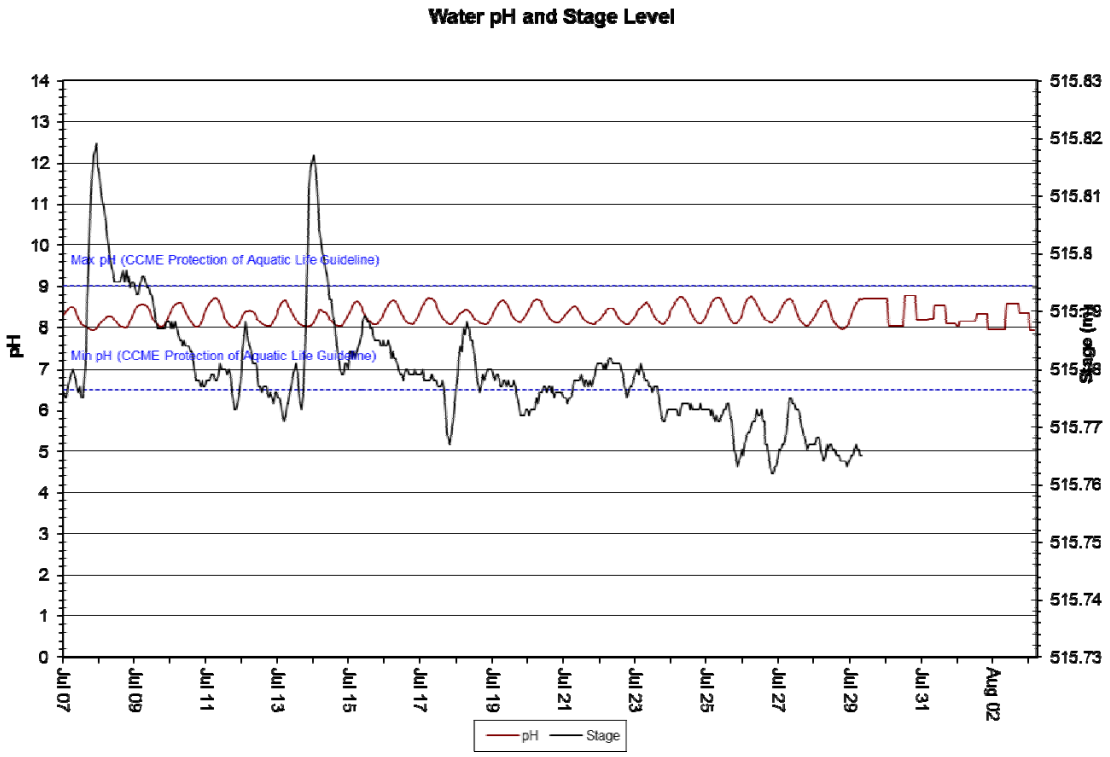

Figure 3: pH values recorded at James Creek from July 7, 2015 to August 3, 2015

Specific Conductivity

- Specific Conductivity ranged from126.0 µS/cm to 147.0 µS/cm at James Creek (Figure 4) from July 7, 2015 to August 3, 2015.
- Specific conductivity readings show a noticeable drop early in the deployment around July 8, 2015 (see inside red oval), which corresponds with an increase in flow due to significant rainfall on July 7th and 8th (see climate data in appendix B).
- Over the deployment period there is a gentle increasing trend in the specific conductivity at James Creek which is related to the increasing temperature trend for the same period.
- There are noticeable diurnal fluctuations in the specific conductivity at James Creek which are related to the diurnal temperature fluctuations.

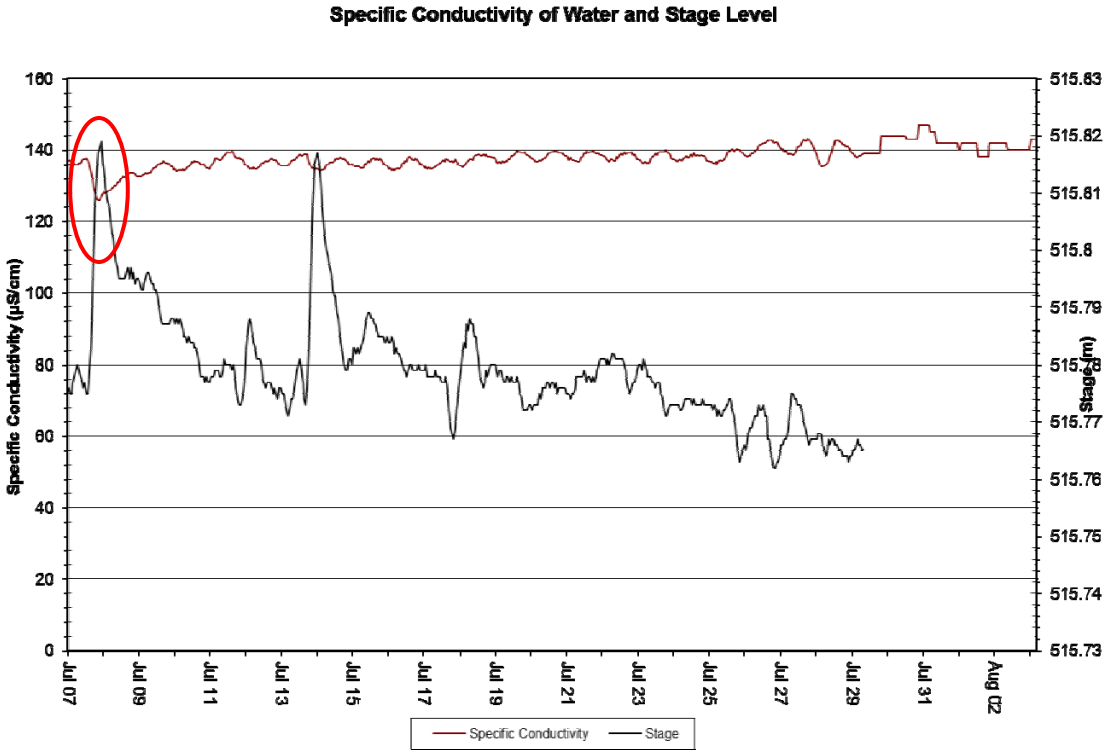

Figure 4: Specific conductivity (µs/cm) at James Creek from July 7, 2015 to August 3, 2015

Dissolved Oxygen

- Dissolved Oxygen [DO] values ranged from 8.63 mg/l (86.5% saturation) to 10.99 mg/l (101.7% saturation) at James Creek (Figure 5) from July 7, 2015 to August 3, 2015. Due to technical issues there is a small gap with missing data on July 30th.
- DO (mg/l & % saturation) shows clear diurnal fluctuations which can be attributed to the diurnal temperature fluctuations.
- DO (mg/l) is relatively stable for the first two thirds of the deployment period after which there is a gentle declining trend which is related to the increasing temperature trend for the same period.
- The DO values were near or above the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and well above minimum guideline set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).

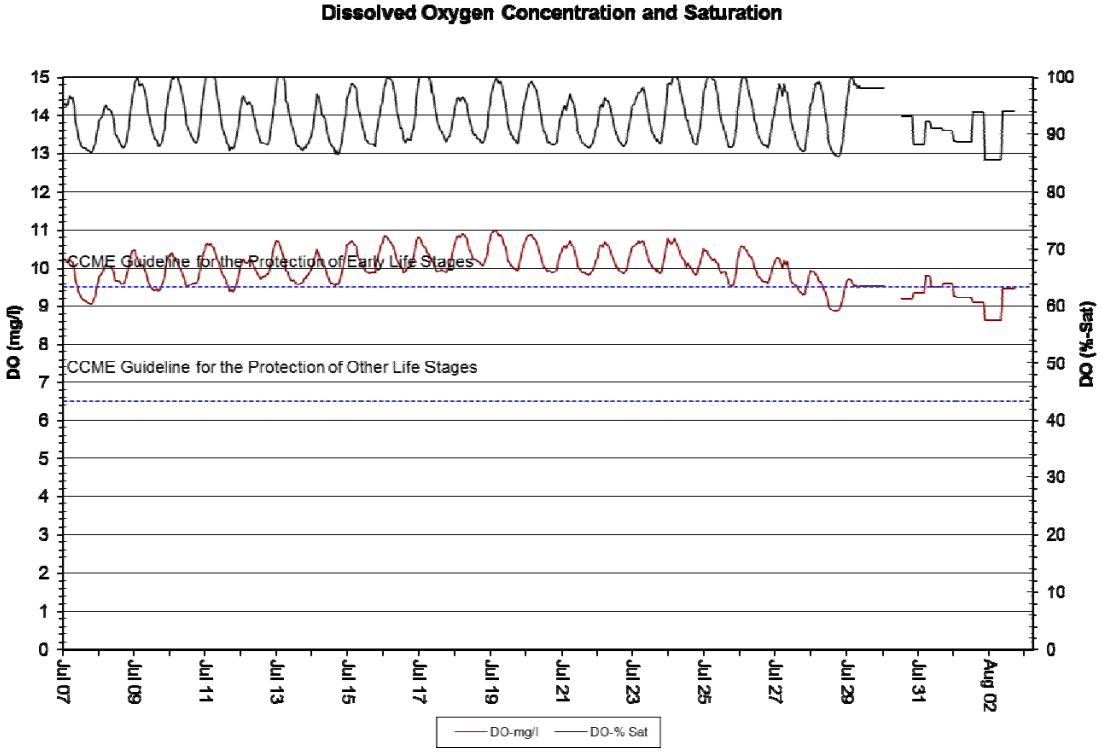

Figure 5: DO (mg/l & % saturation) at James Creek from July 7, 2015 to August 3, 2015

Turbidity

- Due to technical issues at the James Creek station, turbidity readings were not available during this deployment period.

Conclusions

- This monthly deployment report presents water quality and water quantity data recorded at the James Creek station from July 7, 2015 to August 3, 2015.
- At the beginning of the deployment period the performance of the temperature, specific conductivity and dissolved oxygen sensors was rated excellent, and the performance of the pH sensor was rated good. At the time of removal, the performance of the temperature, pH and dissolved oxygen sensors was rated excellent and the performance of the specific conductivity sensor was rated good.
- Unfortunately, due to technical issues the turbidity sensor was not operational during this deployment period.
- Variations in water quality/quantity values recorded at James Creek station are summarized below:
    - With the exception of water quantity data (stage height), all data used in the preparation of the graphs and subsequent discussion adhere to a 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.
    - For James Creek flow ranged from 0.49 m^3/sec to 0.64 m^3/sec, with an overall gentle declining trend throughout the deployment period. Due to technical issues no stage or flow data was available from July 29, 2015 until the end of the deployment period.
    - Water temperature at James Creek shows significant diurnal variations. This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
    - Temperature at James Creek was relatively stable over the first half of the deployment period and for the latter half shows a gentle increasing trend which is related to a period of warmer summer weather.
    - pH values at James Creek station shows regular diurnal fluctuations which are related to the diurnal temperature fluctuations.
    - pH at James Creek was relatively stable throughout the deployment period and with a mean value of 8.28, pH values recorded at James Creek were within the guidelines for pH for the protection of aquatic life (i.e., 6.5 to 9.0 units), as defined by the Canadian Council of Ministers of the Environment (2007).

- Over the deployment period there is a gentle increasing trend in the specific conductivity at James Creek which is related to the increasing temperature trend for the same period.
- There are noticeable diurnal fluctuations in the specific conductivity at James Creek which are related to the diurnal temperature fluctuations.
- DO (mg/l & % saturation) shows clear diurnal fluctuations which can be attributed to the diurnal temperature fluctuations.
- DO (mg/l) is relatively stable for the first two thirds of the deployment period after which there is a gentle declining trend which is related to the increasing temperature trend for the same period.
- The DO values were near or above the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and well above minimum guideline set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007).
- Unfortunately, due to technical issues at the James Creek station, turbidity readings were not available for this deployment period.

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*

APPENDIX B
Environment Canada Weather Data – Schefferville (June 2, 2015 to July 7, 2015)

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)
7/7/2015	20.3	14.3	17.3	0.7	0	M	M	23.9
7/8/2015	14.4	7.2	10.8	7.2	0	M	M	15
7/9/2015	21.7	8.7	15.2	2.8	0	M	M	0.3
7/10/2015	18	7.9	13	5	0	M	M	0
7/11/2015	18.5	7.2	12.9	5.1	0	M	M	0
7/12/2015	13.3	6.6	10	8	0	M	M	4
7/13/2015	17.1	6.3	11.7	6.3	0	M	M	2.2
7/14/2015	18.2	8.7	13.5	4.5	0	M	M	22.8
7/15/2015	12.8	6.4	9.6	8.4	0	M	M	2
7/16/2015	11.6	6.1	8.9	9.1	0	M	M	0
7/17/2015	19	3.7	11.4	6.6	0	M	M	0
7/18/2015	11.6	9.3	10.5	7.5	0	M	M	8.8
7/19/2015	14.1	8.9	11.5	6.5	0	M	M	0.4
7/20/2015	14.4	9	11.7	6.3	0	M	M	0.6
7/21/2015	11.6	9.2	10.4	7.6	0	M	M	1.7
7/22/2015	12.9	10.1	11.5	6.5	0	M	M	4.7
7/23/2015	16.9	10	13.5	4.5	0	M	M	1.7
7/24/2015	17.7	8.8	13.3	4.7	0	M	M	0
7/25/2015	21.4	8.2	14.8	3.2	0	M	M	0
7/26/2015	21.4	9.2	15.3	2.7	0	M	M	0
7/27/2015	21.5	12.6	17.1	0.9	0	M	M	1.3
7/28/2015	22.5	9.8	16.2	1.8	0	M	M	0
7/29/2015	24.3	8.9	16.6	1.4	0	M	M	0.2
7/30/2015	27.4	13.1	20.3	0	2.3	M	M	1.5
7/31/2015	21.2	13.6	17.4	0.6	0	M	M	25.4
8/1/2015	19.8	9.1	14.5	3.5	0	M	M	2.3
8/2/2015	20.2	9.4	14.8	3.2	0	M	M	0
8/3/2015	20.8	11.6	16.2	1.8	0	M	M	16.5