General

- The Water Resources Management Division staff monitors the real-time web page on a daily basis.
- NALCOR Energy will be informed of any significant water quality events in the form of a monthly deployment report.
- This monthly deployment report interprets the data from 3 of 4 water quality monitoring stations along the Lower Churchill River. These stations are located 6.15km below Lower Muskrat Falls, above Upper Muskrat Falls and below Metchin River. The 3 real time water quality stations were deployed for the period of June 1 to June 24, 2009, a period of 24 days. The fourth station, below Grizzle Rapids, did not have an instrument deployed during the month of June due to a large ice wall along the river edge creating unsafe conditions for deployment.
- The Lower Muskrat station experienced a short data transmission error between 9:30am on June 3 at and 7:30am on June 4, and again between 4:30pm and 5:30pm on June 4.
- During the deployment period, the Upper Muskrat Falls station and the Lower Muskrat Falls station both experienced a dramatic decrease in stage level, leaving the instrument exposed to air on the beach. Data collected between June 15 and 24 at the Upper Muskrat Falls station and between June 21 and 24 for the Lower Muskrat Falls station is extraneous.
- There were no reported errors at the station below Metchin River.

Quality Assurance and Quality Control

- As part of the installation and removal process, parameters are recorded from both the field sonde (in situ) and a similar, newly-calibrated QA sonde (placed side by side). The parameters from both instruments are compared and their variability is ranked as part of the QA/QC protocol (see Table 1).
- Upon installation of Datasonde 5X s/n 45042 on June 1, 2009 at the Upper Muskrat Falls station, temperature, pH, conductivity and dissolved oxygen were ranked ‘good’ or ‘excellent’. Turbidity was ranked ‘poor’. This is most likely caused by the disturbance to the silty bottom when entering the water to retrieve the QA/QC values.
- Installation of Datasonde 5X s/n 45701 on June 1, 2009 at the Lower Muskrat Falls station, temperature, dissolved oxygen and turbidity are ranked ‘poor’. The temperature sensor on both instruments will be checked upon return to the lab. The dissolved oxygen sensor continued to have errors throughout the deployment period, reporting 50mg/L for dissolved oxygen and 500% for percent saturation. Upon discussing this error with instrument manufacturers, this problem is likely caused by waster under the DO sensor cap. This issue will be addressed before the instrument is deployment again. The discrepancy in turbidity readings between the instruments is again likely due to the disturbance of the silty bottom while retrieving the QA measurements. pH and conductivity were ranked ‘excellent’. There are no QA/QC values for removal at this station because the instrument was exposed to the air.

- Below Metchin River station reported 'excellent' or 'good' rankings for all parameters during installation and removal except for dissolved oxygen. The sensors on both instruments will be checked before any future use or deployment.

Table 1: QA/QC Data Comparison Rankings upon installation on June 24 and removal on July 20, 2009

				Instrument Comparison Ranking				
Churchill River Station	Date	Action	Instrument Serial Number	Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Above Muskrat Falls	01-Jun-09	Installation	45042	Good	Good	Excellent	Excellent	Poor
	24-Jun-09	Removal		Instrument out of water. No QA/QC taken.				
Below Metchin River	01-Jun-09	Installation	45708	Excellent	Excellent	Excellent	Poor	Excellent
	24-Jun-09	Removal		Good	Good	Excellent	Fair	Excellent
6.15km Below Muskrat Falls	01-Jun-09	Installation	45701	Poor	Excellent	Excellent	Poor	Poor
	24-Jun-09	Removal		Instrument out of water. No QA/QC taken.				
Below Grizzle Rapids	Instrument not deployed in June due to ice wall.							

Data Interpretation

Churchill River 6.15km below Lower Muskrat Falls

All values collected between June 21 and 24 at this stations will not be include in the summary statistics as the instrument was exposed to air, not water. Each graph is marked with a red line indicating the approximate time the instrument became exposed.

Temperature

The temperature shows a general increasing trend and diurnal fluctuations throughout the deployment period (Figure 1). This trend is expected as the average daily temperature is also increasing during this period (Appendix 1).

The maximum reported water temperature is 11.01°C, and the minimum 1.69°C. The average water temperature between June 1 and 21 is 4.96°C.

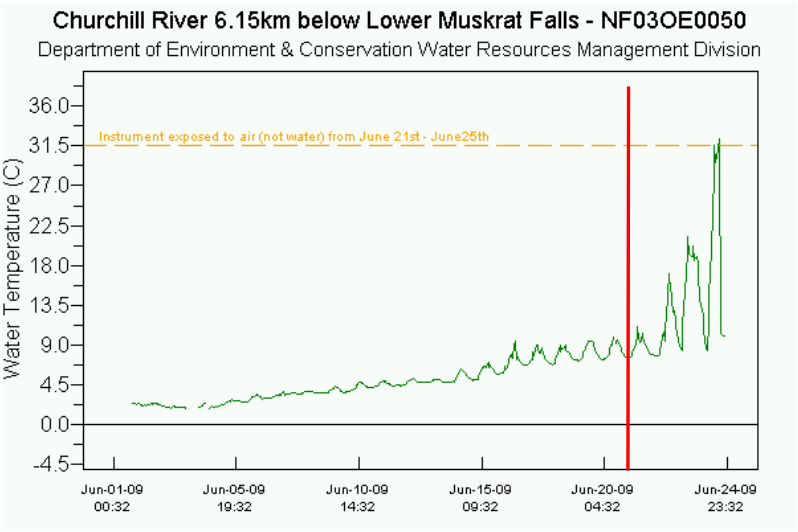

Figure 1: Water temperature for Lower Muskrat Falls Station, June 1 to June 24, 2009.

pH

pH remains relatively stable throughout the deployment period just inside the lower acceptable limit for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (Figure 2). The spike at the beginning is during the instrument switch out on June 24. pH ranges between 6.1 and 7.1 units, averaging at 6.6 units.

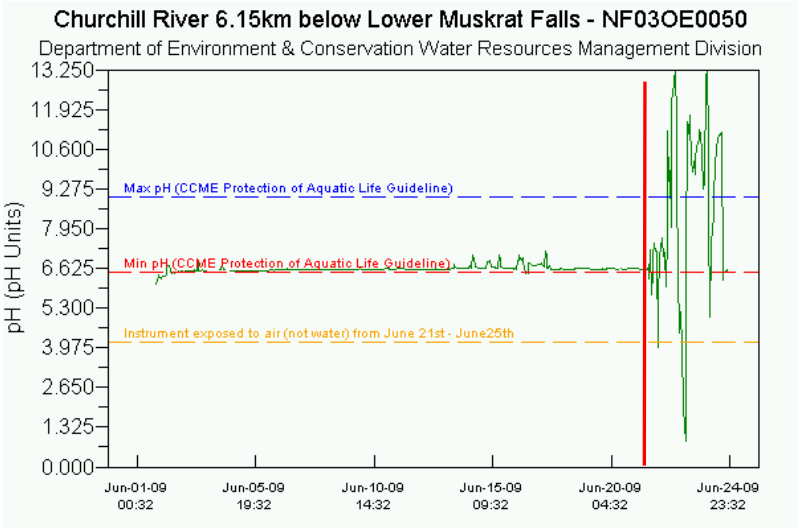

Figure 2: pH for Lower Muskrat Falls Station, June 1 to June 24, 2009.

Specific Conductivity

Specific conductance shows a general increasing trend throughout the deployment period with values ranging from 11.7µS/cm to 16.1µS/cm (Figure 3). Specific conductance drops to 0 µS/cm immediately when the instrument is exposed to air on June 21, 2009.

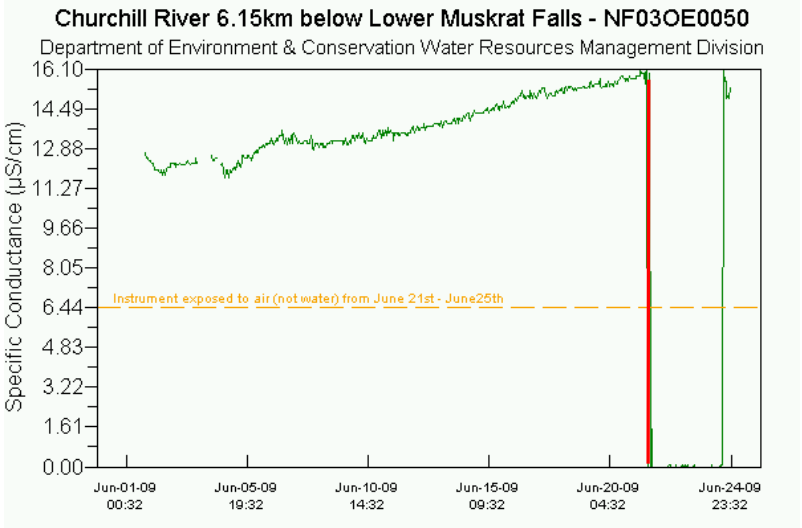

Figure 3: Specific Conductivity for Lower Muskrat Falls Station, June 1 to June 24, 2009.

Dissolved Oxygen and Percent Saturation

Neither of these parameters was accurately measured during this deployment period. Dissolved oxygen reported 50mg/L and percent saturation reported 500% for the entire deployment period. After discussion with Campbell Scientific Canada Corp. technical support, it was determined that water trapped under the luminescent dissolved oxygen sensor was the cause of the error. This error has since been rectified and instrument is successfully measuring these parameters, ready for future deployment.

Turbidity

Turbidity ranges between 6.7 and 105.4NTU for the first 16 days of the deployment (Figure 4). This is expected as this site is particularly silty and water is visibly cloudy due to the amount of suspended solids. On June 16, 2009, a significant spike in turbidity is recorded with values reaching nearly 700NTU. It is only a short time after this significant spike (which lasted more than 4 hours before dropping to around 200NTU), that the instrument became exposed to the air. This significant spike in turbidity may be linked to the instrument being just under the surface of the water. Turbidity values remain elevated until the instrument is fully exposed to air. Wave action at the shore may have resulted in error with the turbidity sensor readings as the instrument came out of the water. This event is not likely due to changes in water quality.

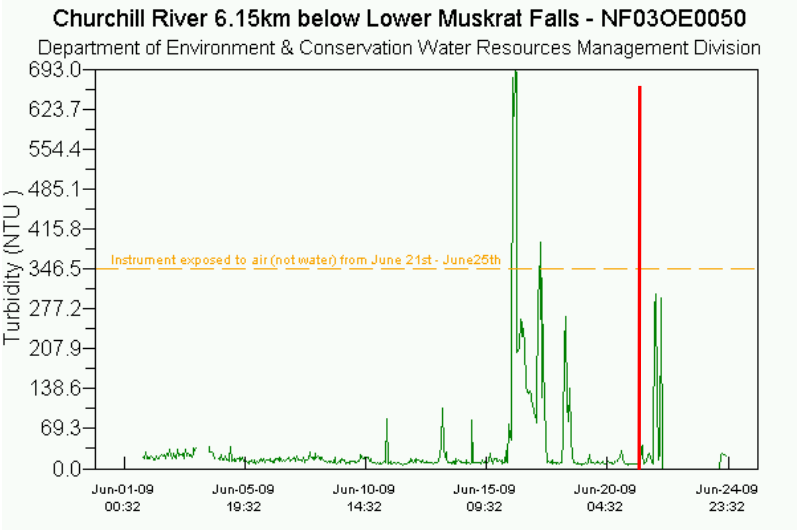

Figure 4: Turbidity for Lower Muskrat Falls Station, June 1 to 24, 2009

Stage

It is clearly evident stage levels fluctuated significantly during this deployment leading to exposure of the instrument on June 21, 2009. When the instrument was deployed, stage levels were reported at 3.993m. When the instrument was fully exposed to air, the stage level had dropped just over a meter to 2.929m. By the time the instrument was retrieved on June 24, the stage had dropped another 30cm to 2.63m. Hot and dry weather in the area is suspected to have contributed to the stage level decrease. This significant decrease in water level is being carefully noted for future deployment years.

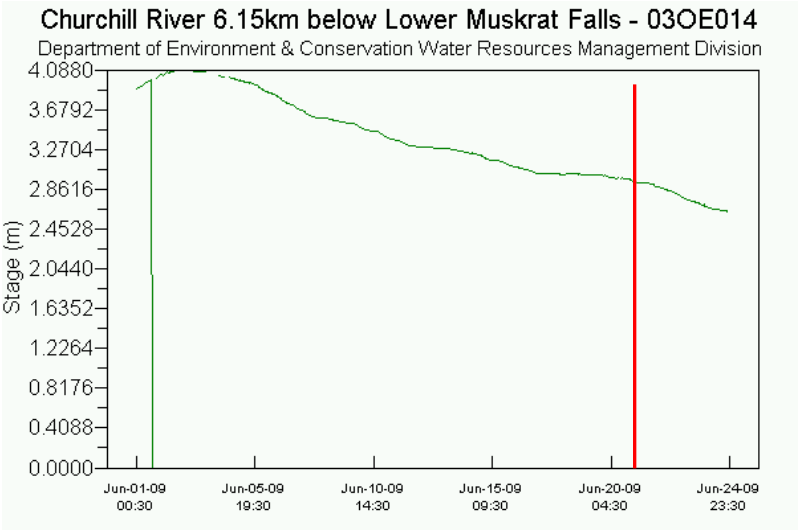

Figure 5: Stage Level for Lower Muskrat Falls Station, June 1 to 24, 2009.

Churchill River above Upper Muskrat Falls

All data collected between June 15 and June 24 at this station will not be included in the summary statistics as the instrument was exposed to air, not water.

Temperature

Temperature values recorded above Upper Muskrat Falls show a slight increasing trend and diurnal fluctuations between June 1 and June 15, 2009. Temperature values range between 3.3°C and 13.4°C, averaging at 5.3°C during this time.

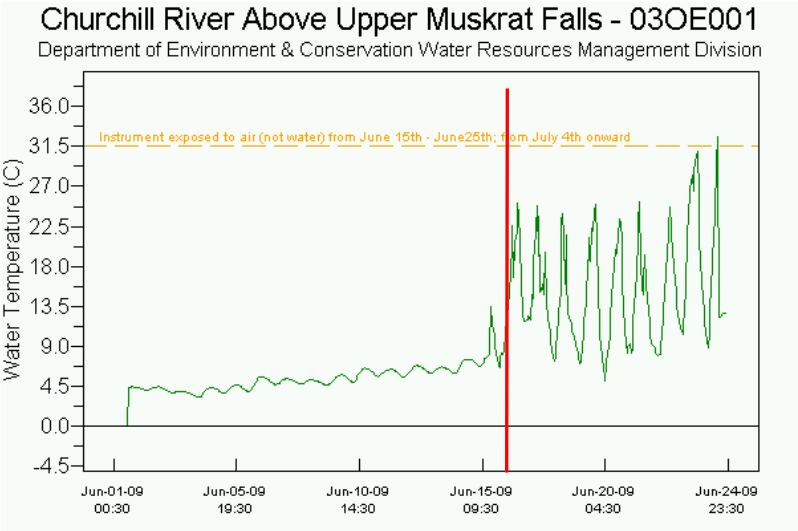

Figure 6: Water Temperature for Upper Muskrat Falls Station, June 1 to 24, 2009

pH

pH values are similar to those collected at the station below Lower Muskrat Falls (Figure 7). pH values range between 6.46 and 6.78 units, which is just above the lower acceptance value for pH as stated by the CCME Guidelines for the Protection of Aquatic Life.

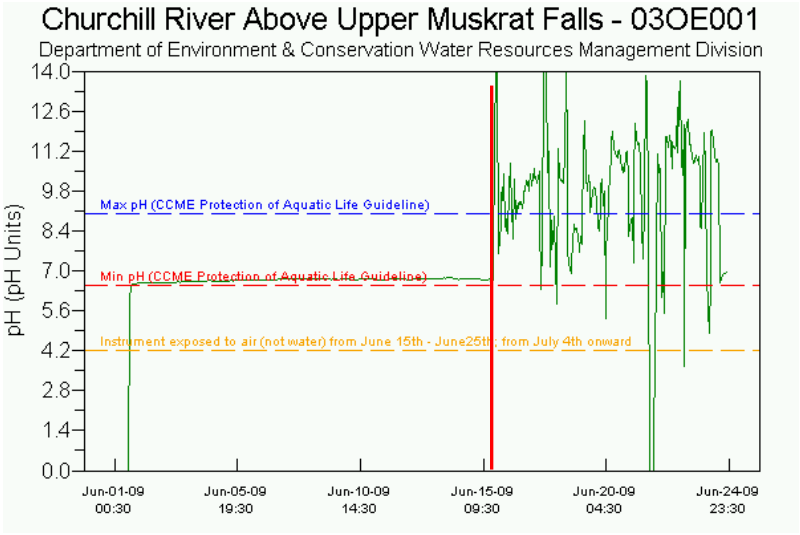

Figure 7: pH for Upper Muskrat Falls Station, June 1 to 24, 2009.

Specific Conductivity and Total Dissolved Solids

Specific conductance shows a general increasing trend throughout the deployment period with values ranging from 11.4 µS/cm to 14.7 µS/cm (Figure 8). Specific conductance is directly related to the total dissolved solids in the water.

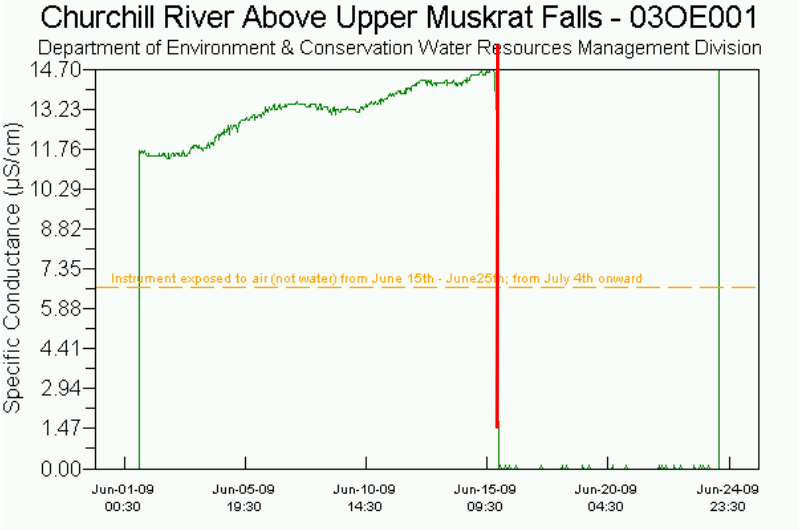

Figure 8: Specific Conductance for Upper Muskrat Falls Station, June 1 to 24, 2009.

Dissolved Oxygen and Percent Saturation

Dissolved Oxygen data between June 1 and June 15, 2009 displays a slight decreasing trend which is expected with the increase in water temperature (Figure 6, 10). Values range between 12.93 mg/L and 9.91mg/L. All values recorded are with in the acceptable range for dissolved oxygen concentration as stated by the CCME Guidelines for the Protection of Aquatic Life. The Guidelines state dissolved oxygen (for cold water) must be at least 9.5 mg/L for early life stages.

Percent Saturation values show a slight diurnal increasing/decreasing pattern but generally remain stable between 103.4% and 94.9% (Figure 11).

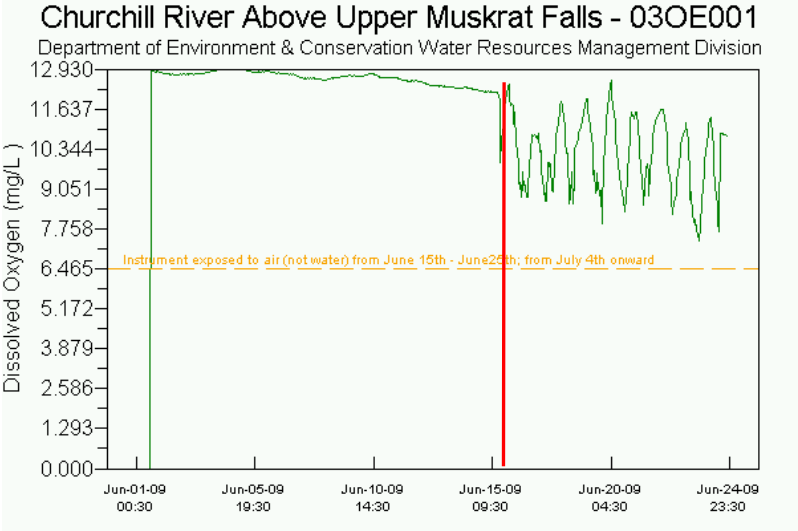

Figure 10: Dissolved Oxygen for Upper Muskrat Falls Station, June 1 to 24, 2009.

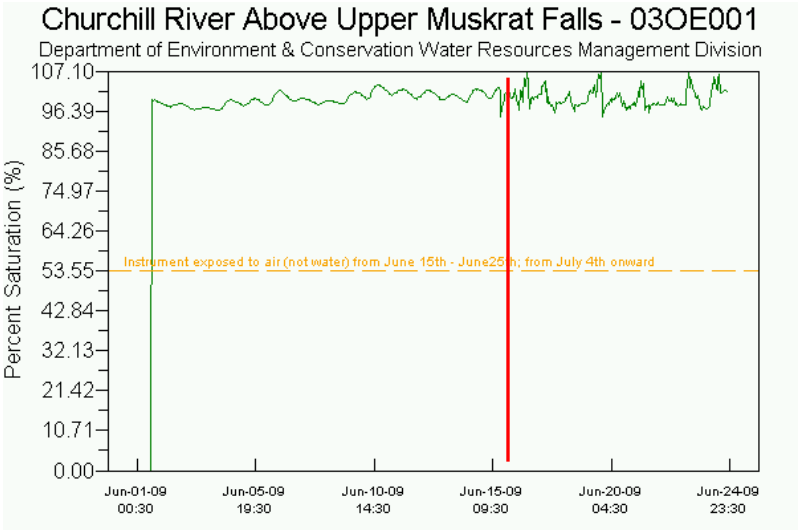

Figure 11: Percent Saturation for Upper Muskrat Falls Station, June 1 to 24, 2009.

Turbidity

Turbidity values fluctuate throughout the beginning of the deployment until June 15, 2009 (Figure 12). Values range between 1 and 36 NTU. These values are considered normal as the silty river bottom at this station contribute to dynamic turbidity values.

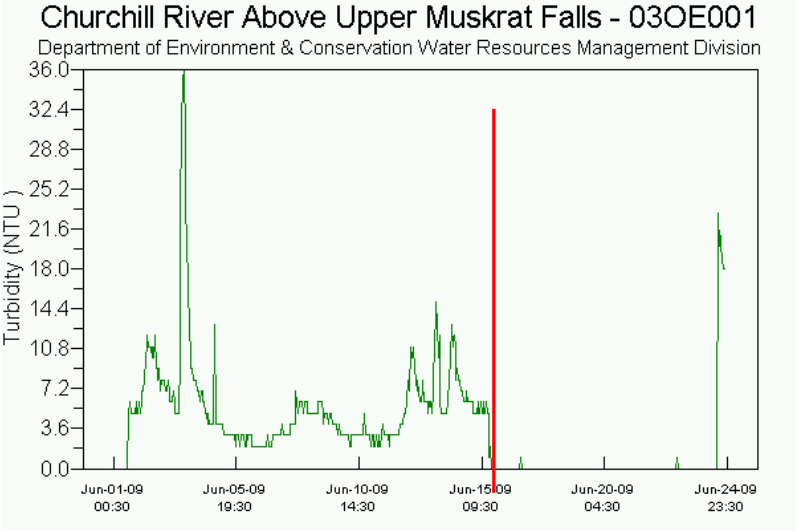

Figure 12: Turbidity for Upper Muskrat Falls Station, June 1 to 24, 2009.

Stage

Similar to the station below Lower Muskrat Falls, stage levels played a significant roll in the deployment period between June 1 and 24, 2009. When the instrument was deployed, the stage level was at 18.482m. Over the following 2 weeks, the stage level dropped nearly 1.5m to 17.05m. By the time the instrument was retrieved on June 24, the stage had dropped another 80cm to 16.17m. These occurrences are being closely monitored and noted to avoid similar situations during future deployment.

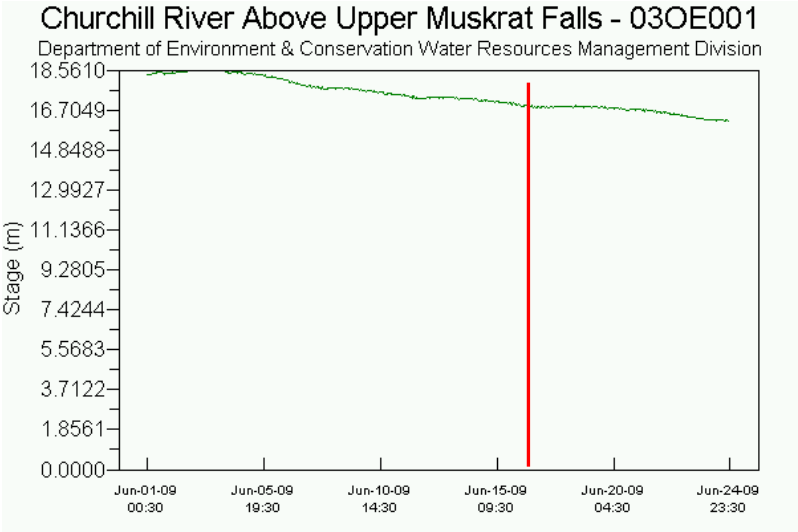

Figure 13: Stage level for Upper Muskrat Falls Station, June 1 to 24, 2009

Churchill River below Metchin River

Temperature

Temperature values show a general increasing trend and a more significant diurnal fluctuation developing throughout the deployment period between June 1 and 24, 2009 (Figure 14). The drop in temperature near the end of the deployment is due to the switch out of the instrument on June 24. Temperature ranges between 2.67°C and 13.56°C, averaging at 6.33°C.

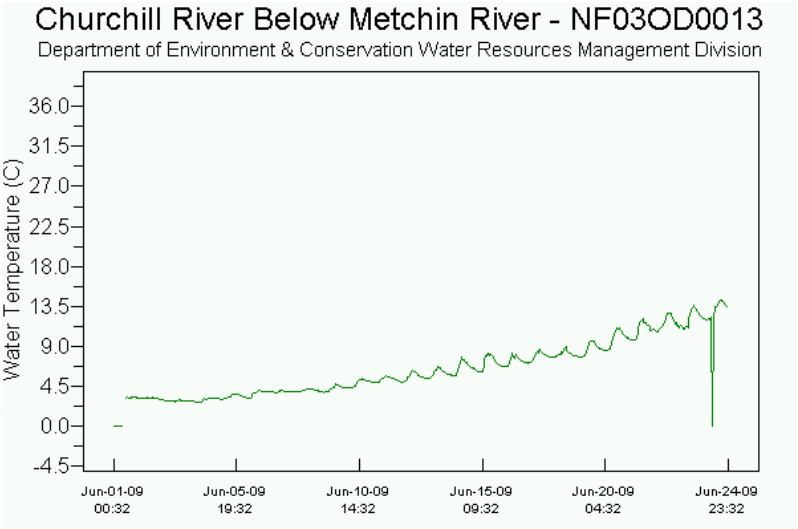

Figure 14: Water Temperature below Metchin River, June 1 to 24, 2009

pH

pH values remain constant throughout the deployment period ranging between 6.5 and 7.1 units (Figure 15). These values are within the acceptable limits for pH according to the CCME Guideline for the Protection of Aquatic Life.

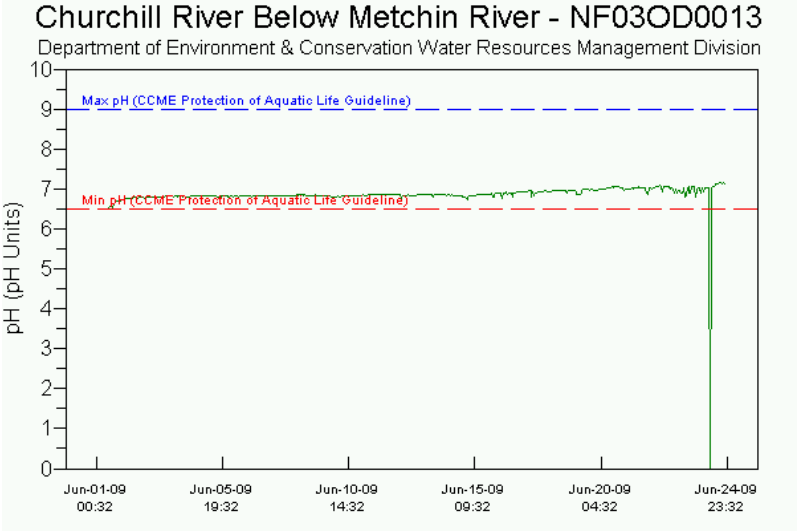

Figure 15: pH below Metchin River, June 1 to 24, 2009.

Specific Conductivity

Specific conductivity values display a slight increasing trend throughout the deployment period. Values range between 14.7 µS/cm and 29.3 µS/cm (Figure 16). Total dissolved solid concentration mirror the increases in specific conductance (Figure 17).

There are a few occurrences of increasing spikes in specific conductivity. The first occurs on June 10 when conductance increases to 18uS/cm. The second spike is on June 16, when the conductance reaches 21.4 µS/cm. The third and most significant event lasts between June 21 and June 24, with specific conductance reaching 29.3 µS/cm. Ideally, weather data from Churchill Falls would be used to infer related fluctuations in water quality at this particular station; however, weather data for this area is unavailable from the Environment Canada's National Climate Data and Information Archive for this time period. It is expected that precipitation events were the cause of these fluctuations.

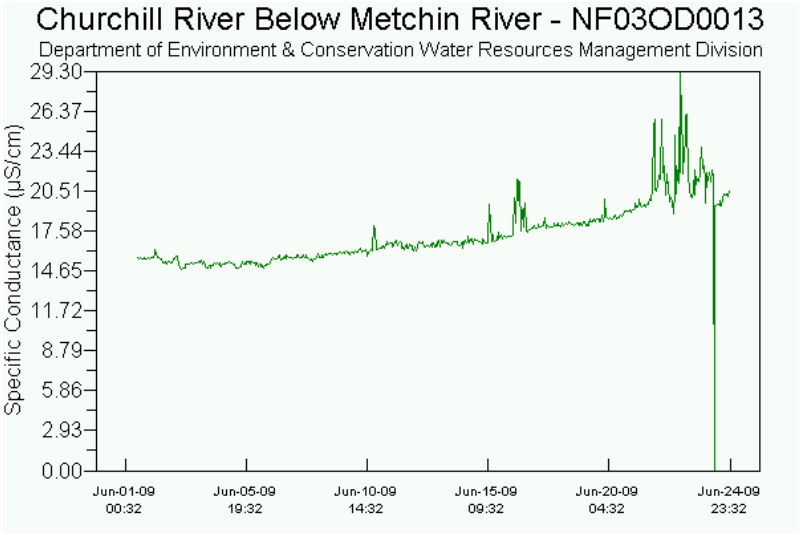

Figure 16: Specific Conductance below Metchin River, June 1 to 24, 2009.

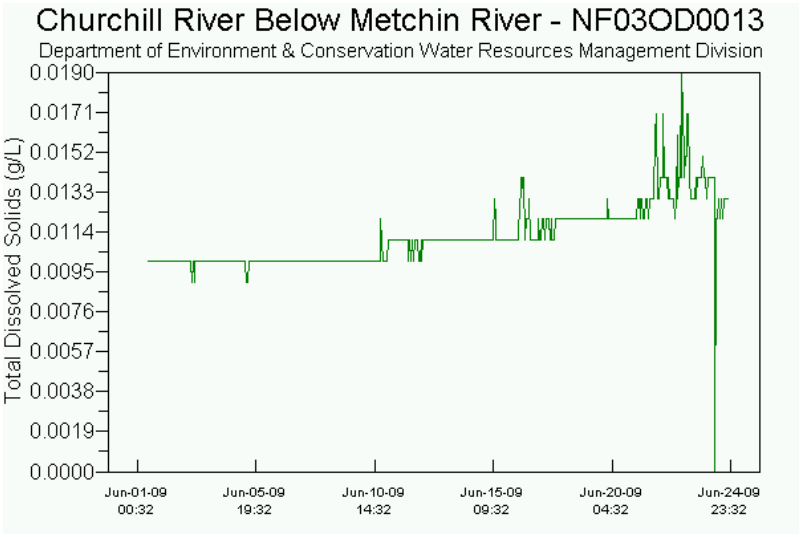

Figure 17: Total Dissolved Solids below Metchin River, June 1 to 24, 2009.

Dissolved Oxygen and Percent Saturation

Dissolved oxygen values show a decreasing trend which is expected due to the increasing water temperature (figure 14, 18). Dissolved oxygen values range between 13.3mg/L and 11.8mg/L. This is above the lower acceptable limit for dissolved oxygen content in cold waters (9.0mg/L).

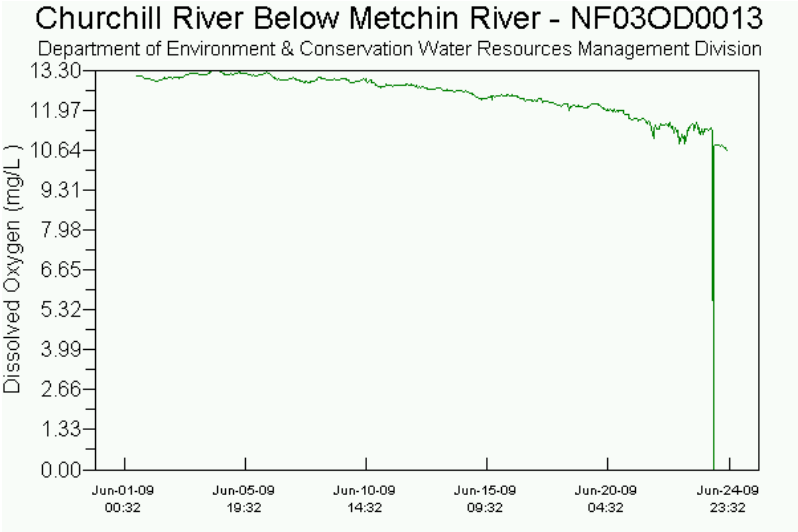

Figure 18: Dissolved Oxygen below Metchin River, June 1 to 24, 2009.

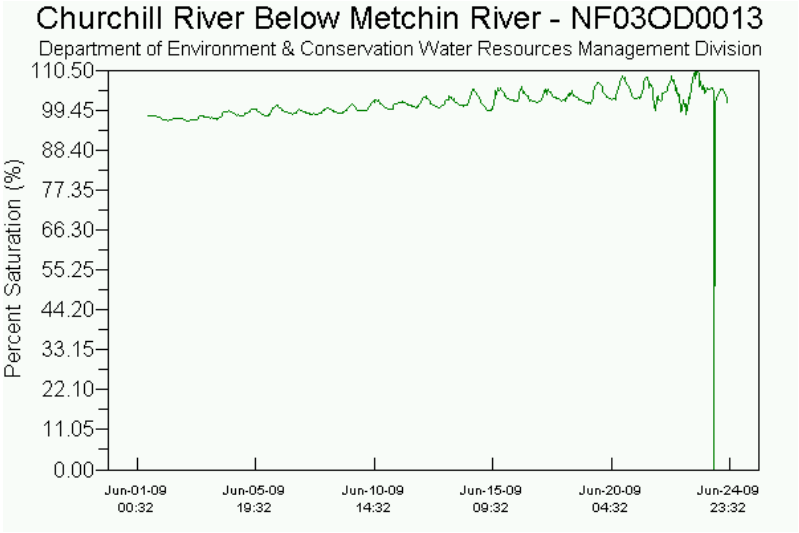

Figure 19: Percent Saturation below Metchin River, June 1 to 24, 2009.

Turbidity

Turbidity values generally remained at 0NTU throughout the deployment period (Figure 20). This is expected as the river bottom is rocky and water is clear at this site. Towards the end of the deployment period, turbidity values spike on several occasions reaching as high as 928NTU on one occasion. Turbidity is not sustained at this high level so likely these spikes can be contributed to floating debris in the water affecting the sensor readings. Rain events in the region on June 21 and 22 may also have affected the turbidity for a short time during and following these dates. Early in the morning on June 23, turbidity values drop again to 0NTU for the remainder of the deployment period.

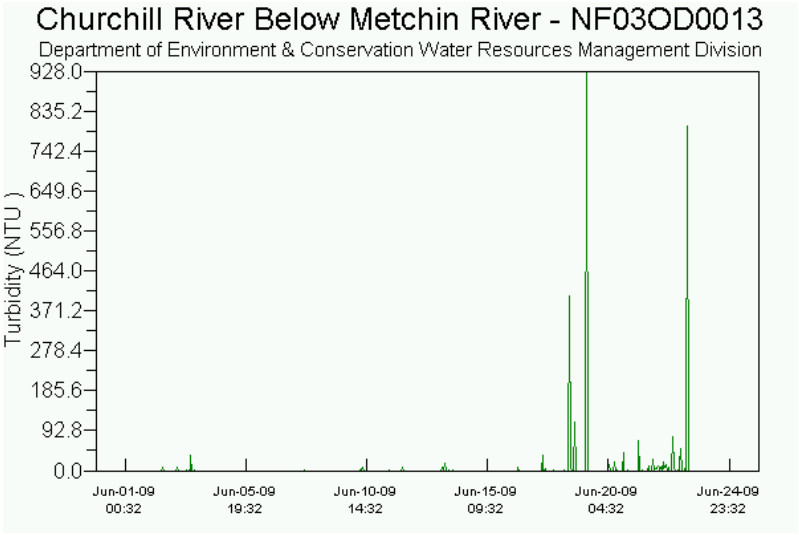

Figure 20: Turbidity below Metchin River, June 1 to 24, 2009.

Stage

Stage levels at this station appear to have dropped as much as the stations below Lower Muskrat Falls and above Upper Muskrat Falls (Figure 21). However, the instrument was still submerged in water and was not at risk of being exposed in the near future when retrieved. When the instrument was deployed, stage level was recorded at 114.106m. When the instrument was retrieved the stage had dropped 1.4m to 112.71m. At this station, a boat, made available by Environment Canada was used to deploy the instrument out as far as possible from the shoreline. Because this method was used, the instrument remained in the water for the entire deployment period. This method will be considered during future deployments to ensure instruments do not become exposed to the air during scheduled deployments.

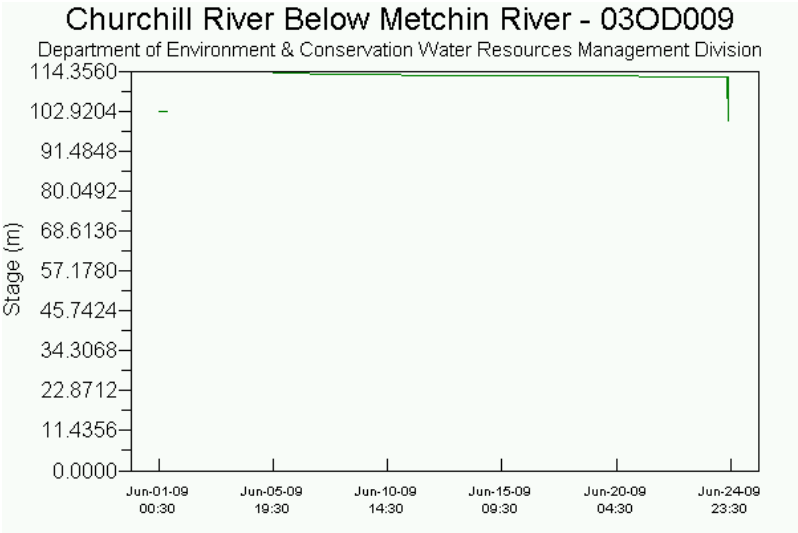

Figure 21: Stage level below Metchin River, June 1 to 24, 2009.

Conclusions

Three of four real time stations on the Churchill River Network were deployed from June 1 to June 24, 2009. The station below Grizzle Rapids was not installed for the month of June due to a large ice wall on the beach preventing safe access to the water.

A significant drop in the river stage levels left 2 instruments exposed to air. The station below Lower Muskrat Falls was exposed on June 21 while the Upper Muskrat Falls station had been exposed since June 16. Both instruments were retrieved and do not appear to have been damaged.

No water quality events were identified throughout the deployment period. Most fluctuations in turbidity, specific conductance and total dissolved solids can likely be attributed to precipitation events as recorded by Environment Canada. Temperature and dissolved oxygen at the three stations show typical seasonal patterns for this time of year. All measurements for dissolved oxygen and pH were with in the CCME guidelines for the Protection of Aquatic Life.

Appendix 1 – Weather Data

Table A-1: Weather for Happy Valley Goose Bay – June 1 to 24th, 2009

Date	Max Temp °C	Min Temp °C	Mean Temp °C	Heat Deg Days °C	Cool Deg Days °C	Precipitation (mm)	Wind Direction	Wind Speed (km.h)
1-Jun-09	16.8	4.7	10.8	7.2	0	14.6	7	50
2-Jun-09	10.7	3.6	7.2	10.8	0	0.8	26	44
3-Jun-09	7.8	3.2	5.5	12.5	0	1.2	29	57
4-Jun-09	13.1	2.3	7.7	10.3	0	T	27	46
5-Jun-09	9.9	3.1	6.5	11.5	0	0.6	32	37
6-Jun-09	18.1	3.2	10.7	7.3	0	0.8	6	39
7-Jun-09	11.3	6.1	8.7	9.3	0	13.2		<31
8-Jun-09	9.2	3.6	6.4	11.6	0	0.6	5	39
9-Jun-09	10.6	3.6	7.1	10.9	0	0.2	7	32
10-Jun-09	13.7	2.7	8.2	9.8	0	0		<31
11-Jun-09	16.3	3.8	10.1	7.9	0	8	18	35
12-Jun-09	13.7	5.6	9.7	8.3	0	7		<31
13-Jun-09	9.9	2.9	6.4	11.6	0	0.8	35	39
14-Jun-09	15	2.6	8.8	9.2	0	0		<31
15-Jun-09	20.7	1.8	11.3	6.7	0	0		<31
16-Jun-09	25.3	11.4	18.4	0	0.4	2.4	32	59
17-Jun-09	26.7	10	18.4	0	0.4	3.2	27	50
18-Jun-09	27.5	9.1	18.3	0	0.3	5.2	28	65
19-Jun-09	20.6	7.1	13.9	4.1	0	0		<31
20-Jun-09	18.7	7.1	12.9	5.1	0	0		<31
21-Jun-09	22.7	8.2	15.5	2.5	0	5		<31
22-Jun-09	18.6	7.1	12.9	5.1	0	0.8	35	37
23-Jun-09	25.4	12.1	18.8	0	0.8	0		<31
24-Jun-09	32.7	11.1	21.9	0	3.9	0	20	35
Extreme	**32.7**	**1.8**						**65**
Average			**11.5**					
Sum						**64.4**		

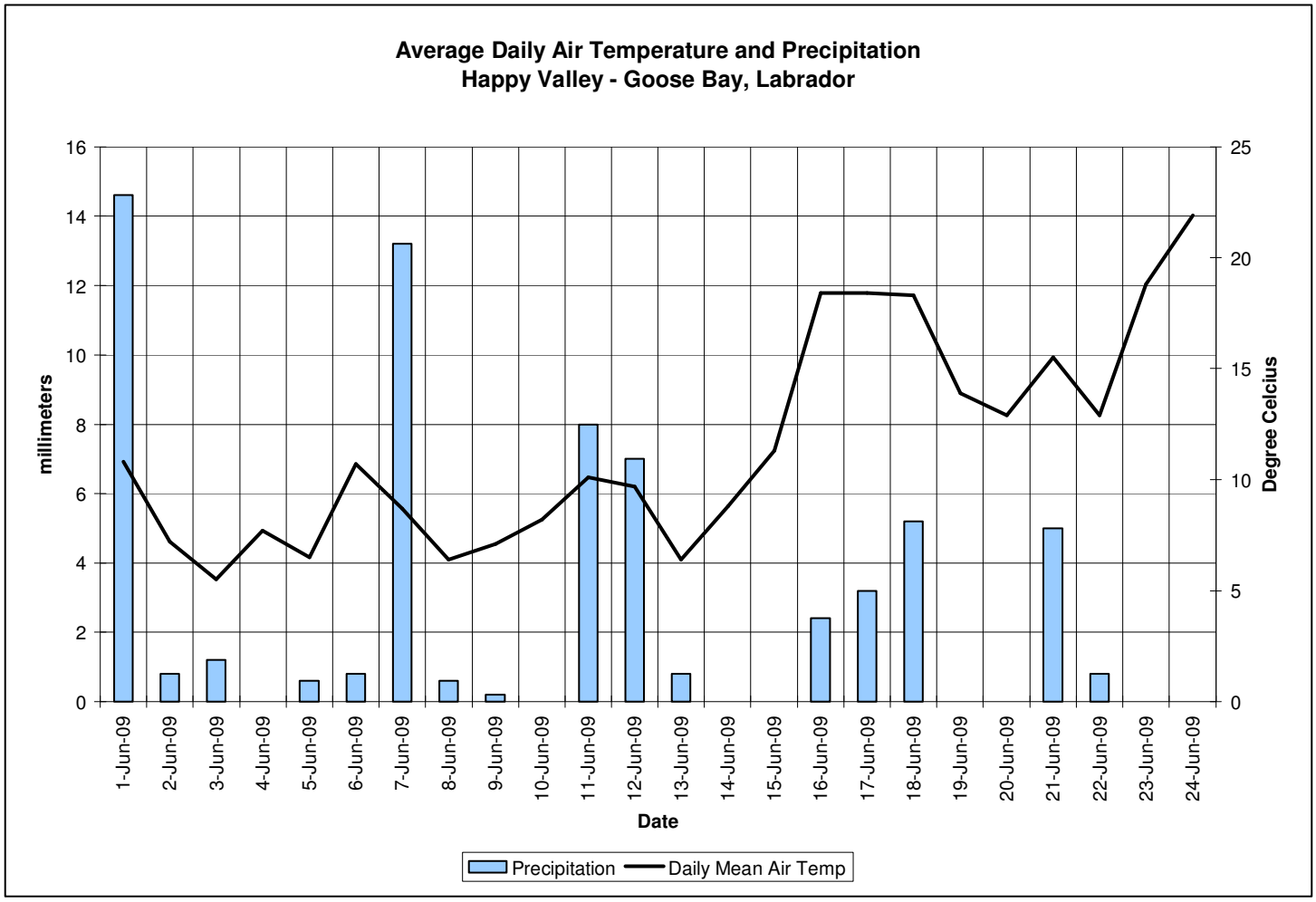

Figure A-1: Mean daily air temperature and precipitation for Happy Valley Goose Bay area, June 1 to 24, 2009.