

## Real Time Water Quality Monthly Report for Vale Inco Newfoundland and Labrador Ltd. September & October 2009

### General

- DOEC staff (Renee Paterson) travelled to Voisey’s Bay on September 14 to assist with the cleaning/calibration and to ensure proper procedures were being followed.
- On September 15, the Vale Inco staff and DOEC staff reinstalled the four Datasondes after having cleaned/calibrated the instruments the day prior.
- The real-time data (and subsequently the water quality graphs) logged, transmitted and graphed successfully for all four stations over the deployment period.
- This report interprets the real-time data collected over the deployment period from September 15 until the instruments were removed on October 27<sup>th</sup> for the winter months.

### Maintenance and Calibration of Instrumentation

- Vale Inco staff on-site removed instruments from all stations for cleaning/calibration on October 27 (after 43 day deployment period). The instruments were removed for the winter months at this point in time since the water bodies were beginning to freeze.
- As part of the removal and reinstallation 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 reinstallation of the Datasondes in September, QA/QC readings were ranked “Excellent” or “Good” for all parameters at all stations with the exception of pH at Upper Reid Brook which was ranked “Fair”.
- Upon removal of the Datasondes at the end of October, temperature ranked “Excellent” or “Good” at all stations. pH was ranked “Fair” to “Poor” at the end of the deployment and could have in part been caused by the extended deployment period and sensor calibration drift. Specific Conductance was ranked “Fair” to “Excellent” and Dissolved Oxygen was “Fair” to “Good” at removal.

**Table 1: QA/QC Data Comparison Rankings upon reinstallation on September 15<sup>th</sup>, 2009 to October 27<sup>th</sup>, 2009.**

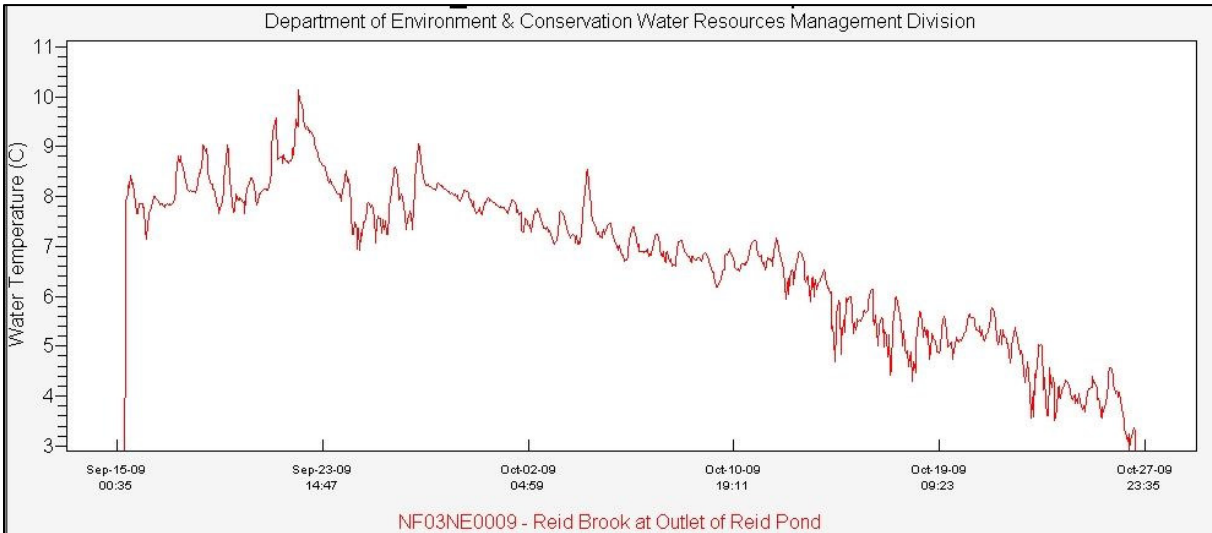
Station	Date	Action	Instrument Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Upper Reid Brook	Sep 15/09	Installation	Excellent	Fair	Excellent	Good	NA
	Oct 27/09	Removal	Good	Poor	Excellent	Fair	NA
Lower Reid Brook	Sep 15/09	Installation	Excellent	Good	Excellent	Excellent	NA
	Oct 27/09	Removal	Excellent	Poor	Excellent	Marginal	NA
Camp Pond Brook	Sep 15/09	Installation	Excellent	Good	Good	Excellent	NA
	Oct 27/09	Removal	Excellent	Fair	Good	Marginal	NA
Tributary to Lower Reid Brook	Sep 15/09	Installation	Excellent	Excellent	Good	Excellent	NA
	Oct 27/09	Removal	Excellent	Marginal	Fair	Good	NA

NA – QA readings were not recorded therefore no ranking available

## Data Interpretation

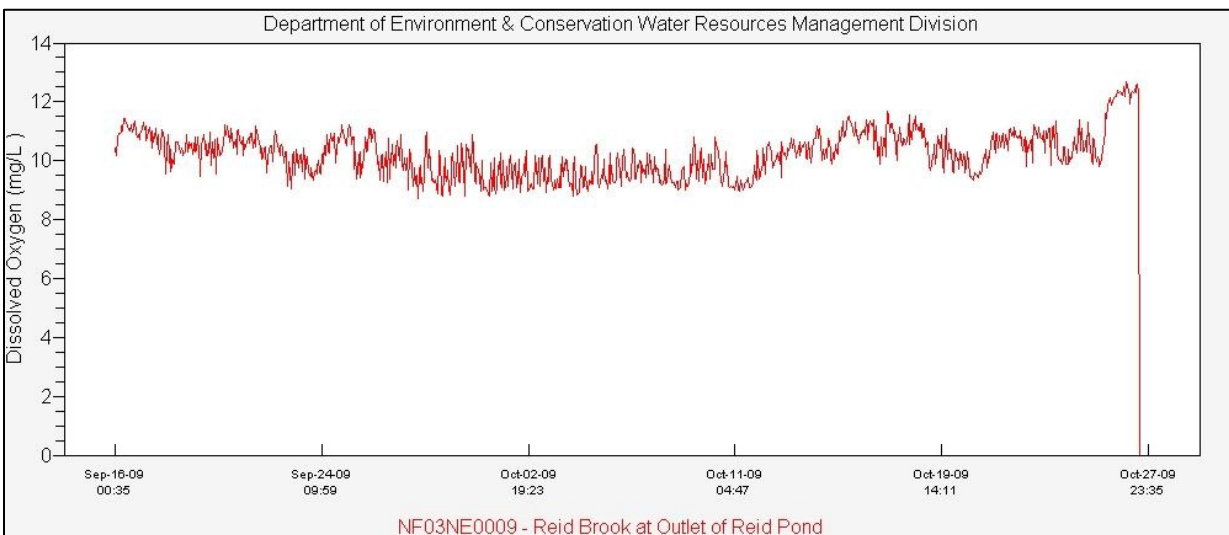
### REID BROOK AT OUTLET OF REID POND (UPPER REID BROOK)

- The water temperature (**Figure 1**) decreased throughout the deployment period. The water temperatures ranged from 10.13°C to 2.91°C.



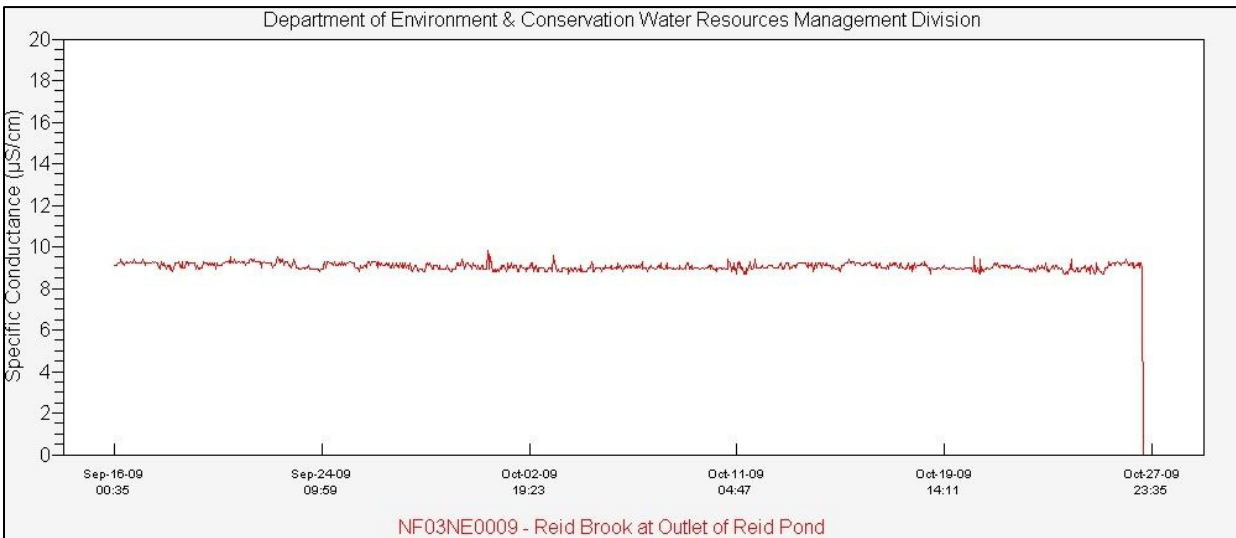
**Figure 1: Water Temperature at Reid Brook at Outlet of Reid Pond, September 15 to October 27, 2009.**

- The dissolved oxygen values (**Figure 2**) fluctuate daily and generally remain stable throughout the deployment period. The dissolved oxygen values ranged from 8.71 mg/L to 12.68 mg/L. Most values recorded (80%) are within 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. Twenty percent of the time, values are just below this guideline recorded as low as 8.71mg/L.



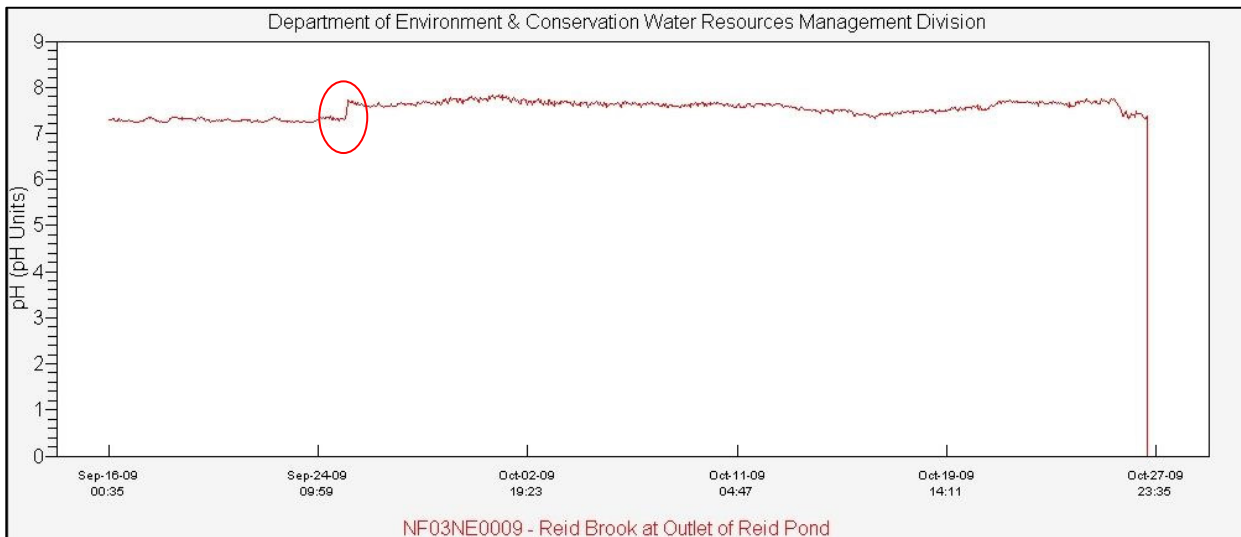
**Figure 2: Dissolved Oxygen at Reid Brook at Outlet of Reid Pond, September 15 to October 27, 2009.**

- The conductivity values (**Figure 3**) remained consistent throughout the deployment period at a very low background level ranging from 8.70uS/cm to 9.80uS/cm. The Upper Reid station is fairly pristine with very little development as seen by the naturally low specific conductivity values. There were no significant water quality events captured.



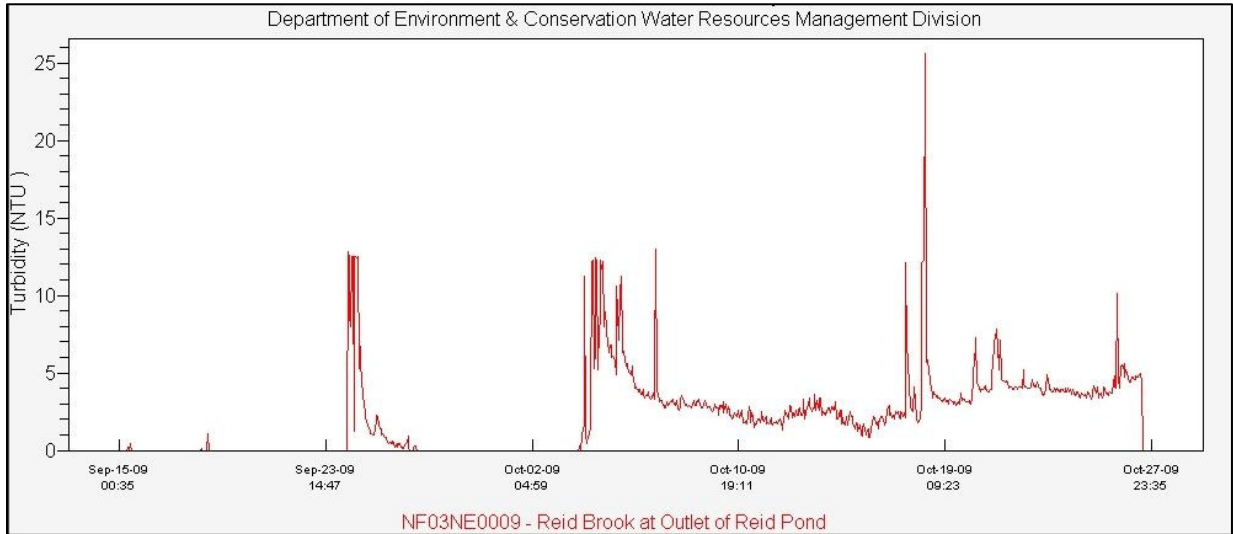
**Figure 3: Specific conductance at Reid Brook at Outlet of Reid Pond, September 15 to October 27, 2009.**

- The pH values (**Figure 4**) remain relatively consistent throughout the deployment period with one increasing ‘jump’ occurring on September 25 (circled in red). Up until this increase, pH values averaged 7.31. After this event, pH values averaged 7.60 until the end of deployment. There is no related precipitation event recorded at this time and it is unknown what caused this event to occur. The pH values ranged from 7.82 to 7.23. The pH values are all within the recommended pH guidelines for the CCME Water Quality Guidelines for Aquatic Life (>6.5 and < 9.0).

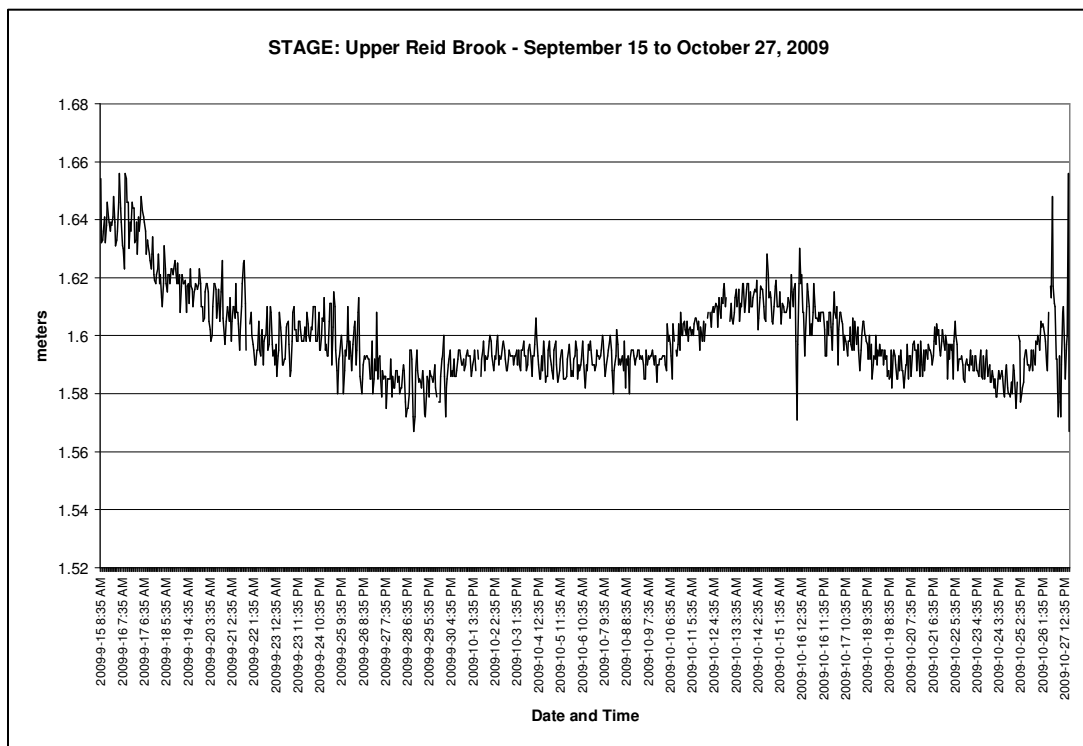


**Figure 4: pH at Reid Brook at Outlet of Reid Pond, September 15 to October 27, 2009.**

- Turbidity values fluctuate throughout the deployment period especially during the second half (**Figure 5**). Values range between 0 NTU and 26 NTU. The average turbidity reading between October 4 and 27 is 3.65NTU. There is a slight fluctuation in stage during this time (**Figure 6**) however it is unknown whether or not this caused the sustained turbidity values. Precipitation events recorded in the area do not tend to correspond with turbidity peaks. Small rain events occur often and regularly throughout the deployment period.



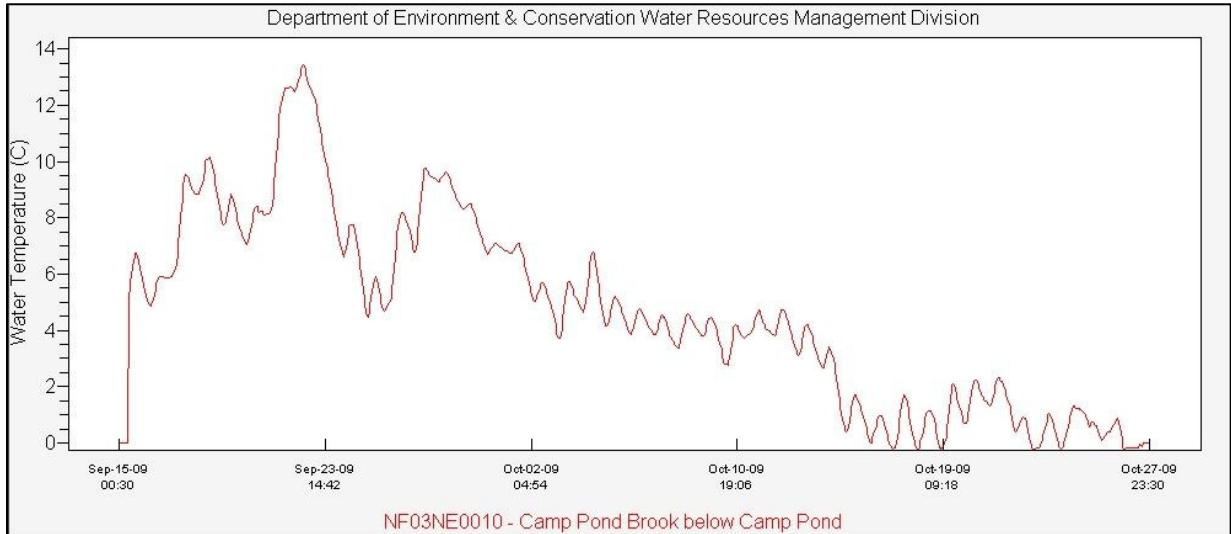
**Figure 5: Turbidity at Reid Brook at Outlet of Reid Pond, September 15 to October 27, 2009.**



**Figure 6: Stage level at Reid Brook at Outlet of Reid Pond, September 15 to October 27, 2009.**

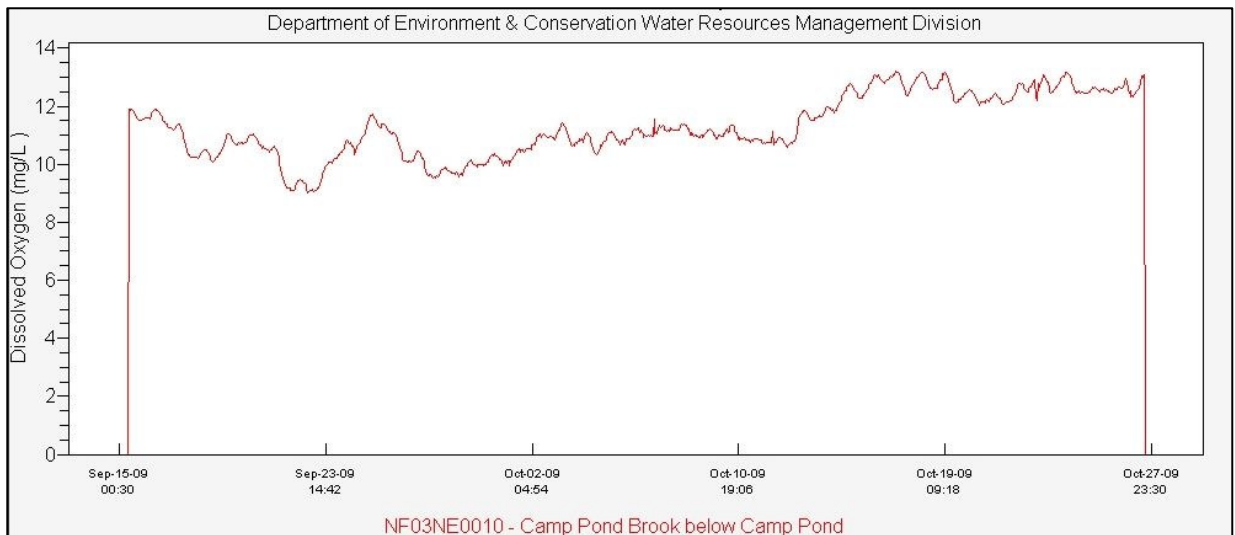
## CAMP POND BROOK BELOW CAMP POND

- The water temperature (**Figure 7**) decreases throughout the deployment period and shows a diurnal pattern. The water temperature ranges from 13.42°C to -0.24°C.



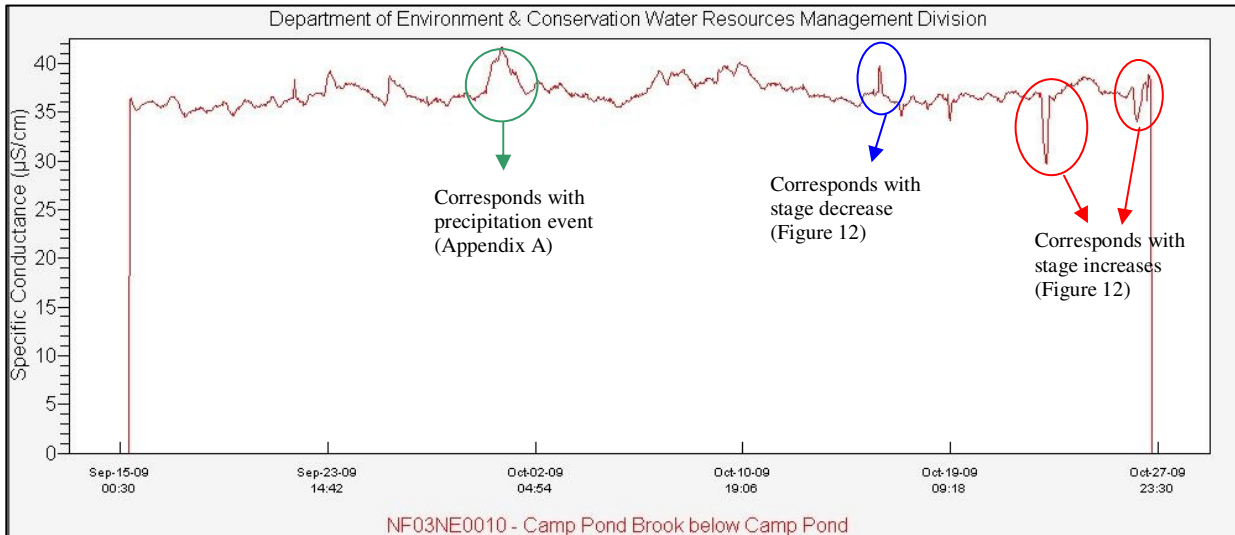
**Figure 7: Water temperature at Camp Pond Brook, September 15 to October 27, 2009.**

- The dissolved oxygen values (**Figure 8**) increase slightly throughout the deployment period corresponding to the above mentioned decrease in water temperature (**Figure 7**). Dissolved oxygen values range between 9.03 and 13.21mg/L. All values recorded are within the acceptable range for dissolved oxygen concentration as per 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.



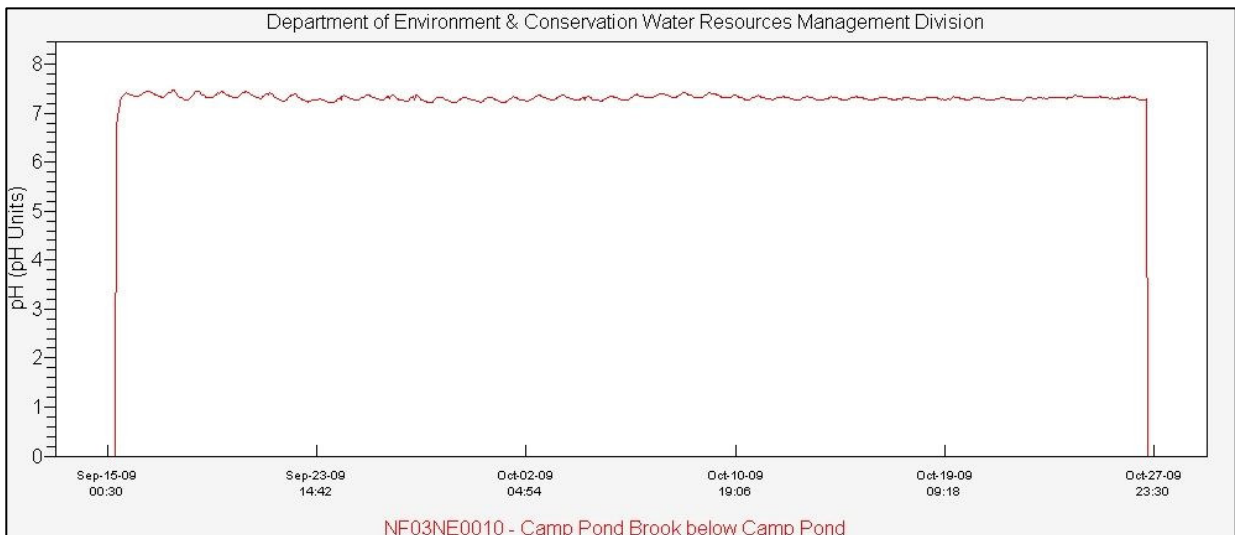
**Figure 8: Dissolved Oxygen at Camp Pond Brook, September 15 to October 27, 2009.**

- The conductivity values (**Figure 9**) fluctuated slightly throughout the deployment period. Values range between 29.7  $\mu\text{S}/\text{cm}$  and 41.6  $\mu\text{S}/\text{cm}$ . Sharp increases and decreases tended to correspond with changes in stage level and precipitation events recorded in the area.



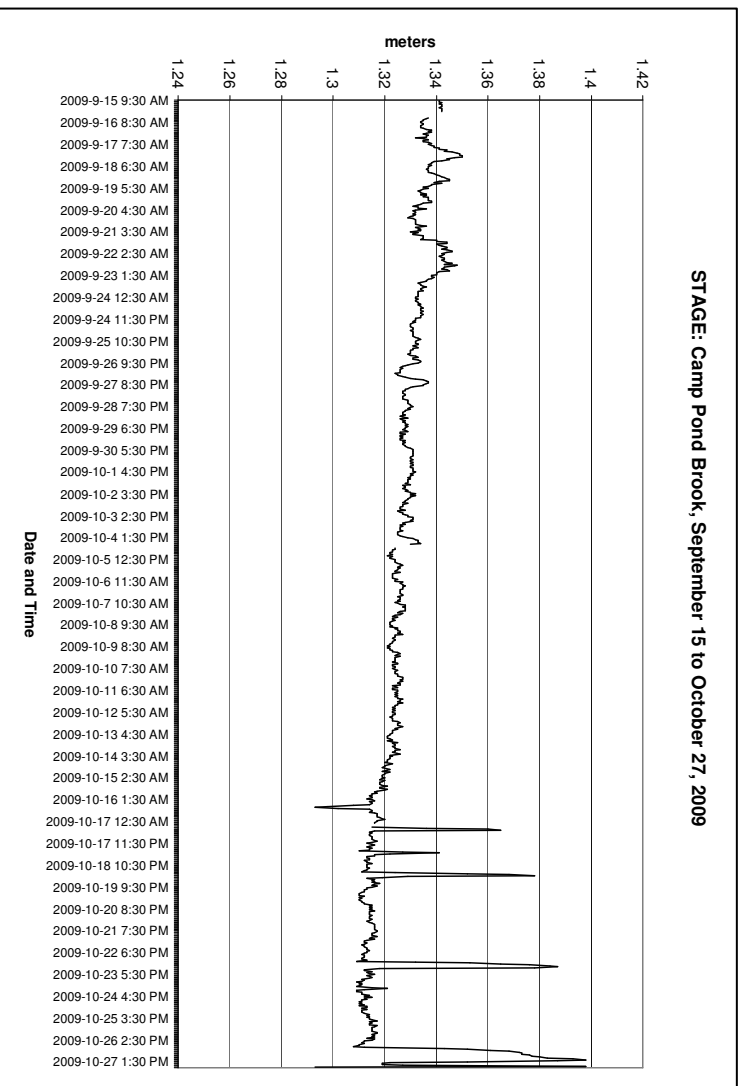
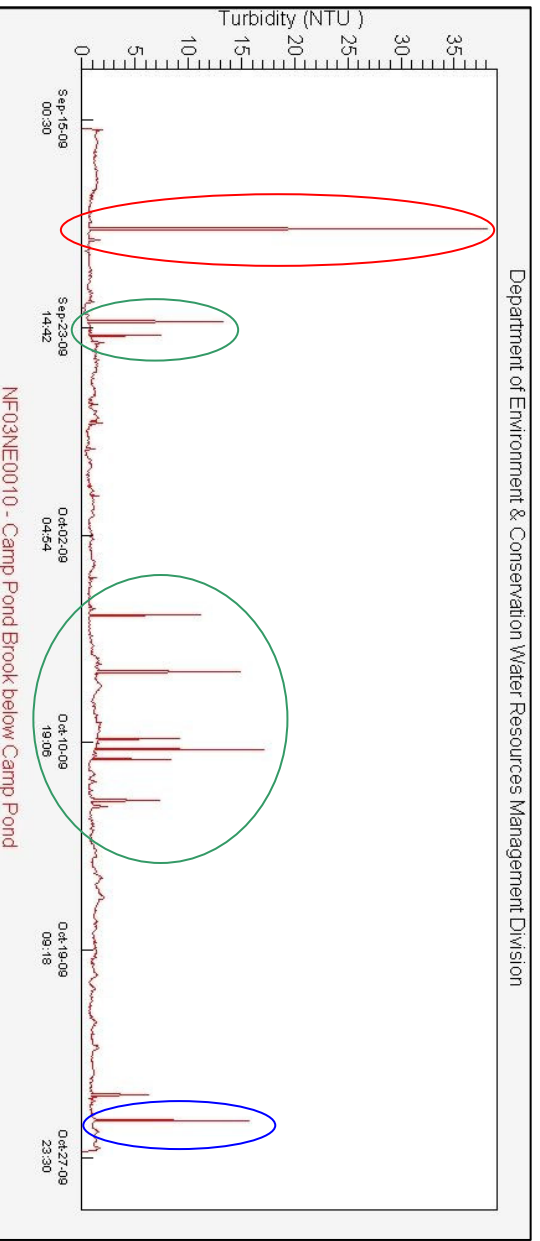
**Figure 9: Specific Conductivity at Camp Pond Brook, September 15 to October 27, 2009.**

- The pH values (**Figure 10**) remained very consistent throughout the deployment period. The pH values ranged from 6.69 to 7.47. All the pH values fell within the recommended CCME Water Quality Guidelines for the Protection of Aquatic Life ( $>6.5$  and  $<9.0$ ).



**Figure 10: pH at Camp Pond Brook, September 15 to October 27, 2009.**

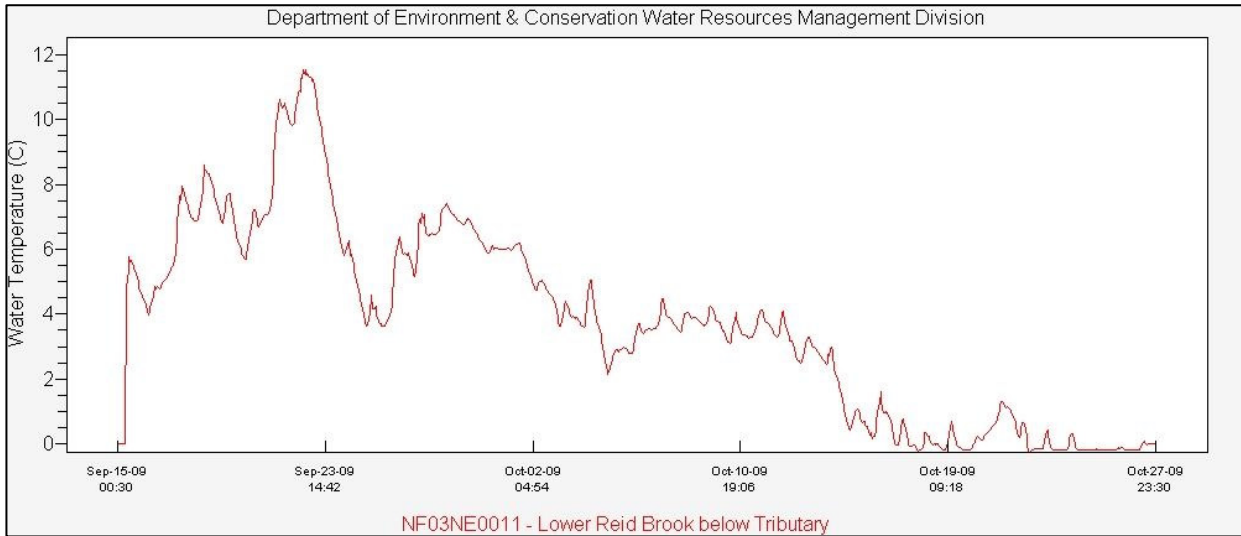
- Turbidity values (**Figure 11**) spiked several times throughout the deployment period. On average, turbidity values were recorded at 1NTU with 11 spikes recorded ranging between 6.3 and 38.1 NTU. The first spike occurred on September 19 and can be related to a stage increase in the days prior (circled in blue). Similarly, the last spike on October 25 can also be related to a stage increase (circled in blue). All other spikes (circled in green) correspond well with precipitation events recorded on September 23, and October 6-12.





### LOWER REID BROOK BELOW TRIBUTARY

- The water temperature (**Figure 13**) decreased throughout the deployment period. The water temperatures ranged from 11.54°C to -0.24°C.



**Figure 13: Water Temperature at Lower Reid Brook, September 15 to October 27, 2009.**

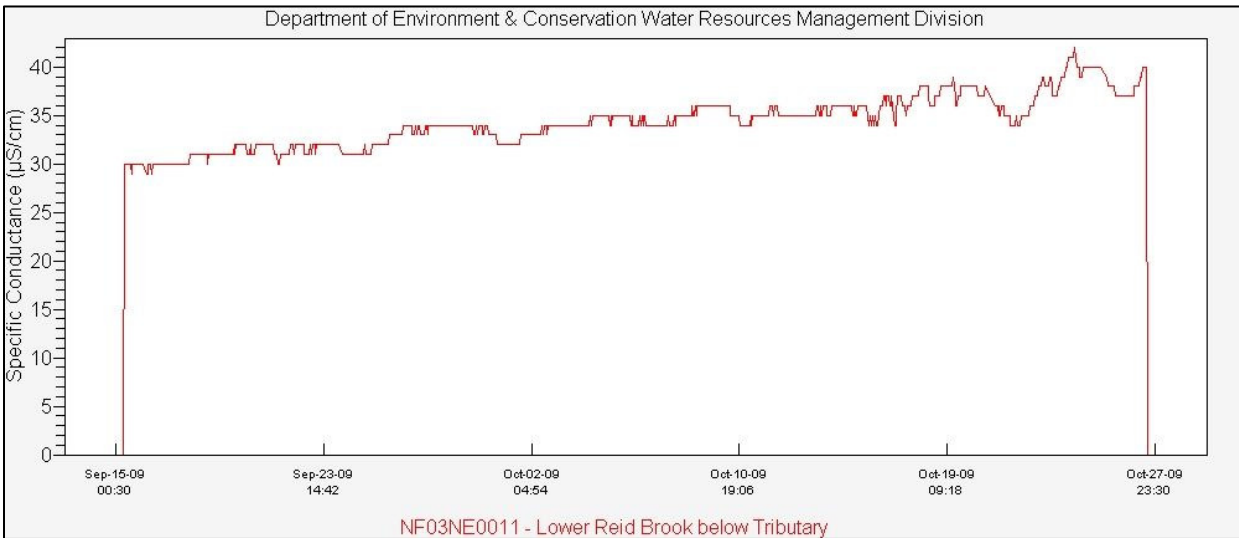
- The dissolved oxygen values (**Figure 14**) increase slightly throughout the deployment period corresponding to the above mentioned decrease in water temperature. Dissolved oxygen values range between 9.48 and 13.21mg/L. All values recorded are within the acceptable range for dissolved oxygen concentration as per 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.



**Figure 14: Dissolved Oxygen at Lower Reid Brook, September 15 to October 27, 2009.**

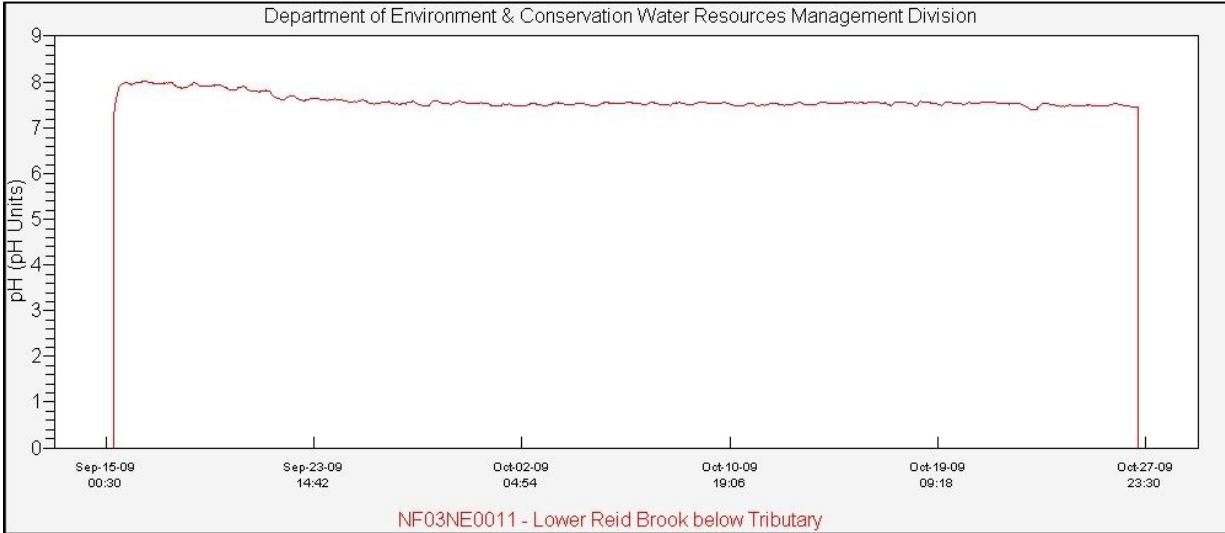


- The conductivity values (**Figure 15**) demonstrated a slight increasing trend throughout the deployment period. The conductivity values ranged from 29.0 uS/cm to 42.0 uS/cm. There are no major fluctuations in conductivity values throughout the deployment period.



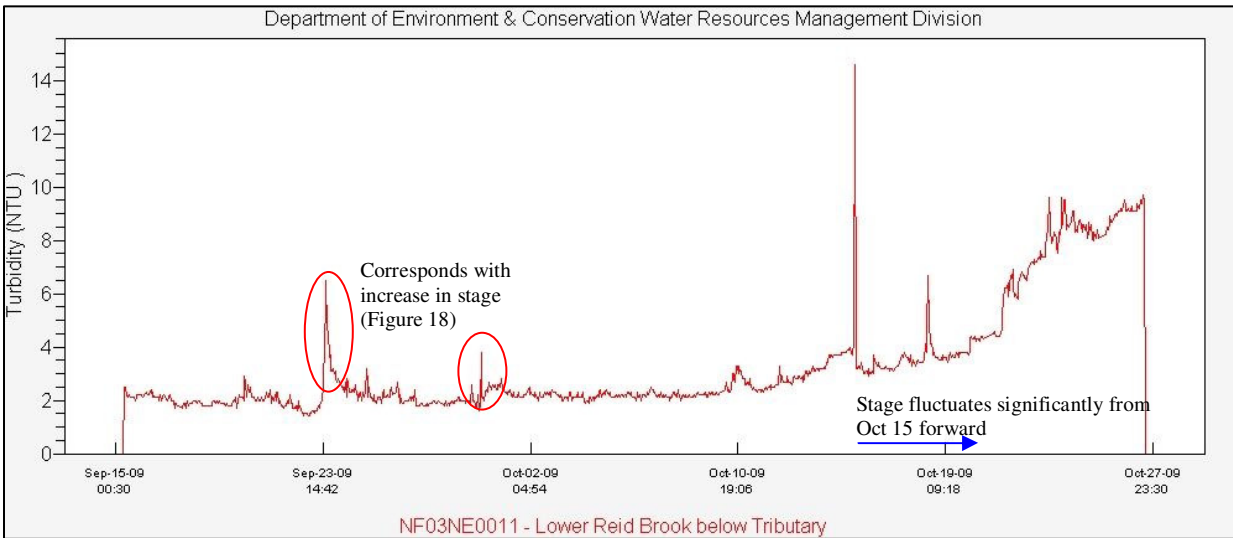
**Figure 15: Specific Conductivity at Lower Reid Brook, September 15 to October 27, 2009.**

- The pH values (**Figure 16**) are very stable throughout the deployment period. The pH values ranged from 7.22 to 8.04. All the pH values fell within the recommended CCME Water Quality Guidelines for the Protection of Aquatic Life (>6.5 and <9.0).

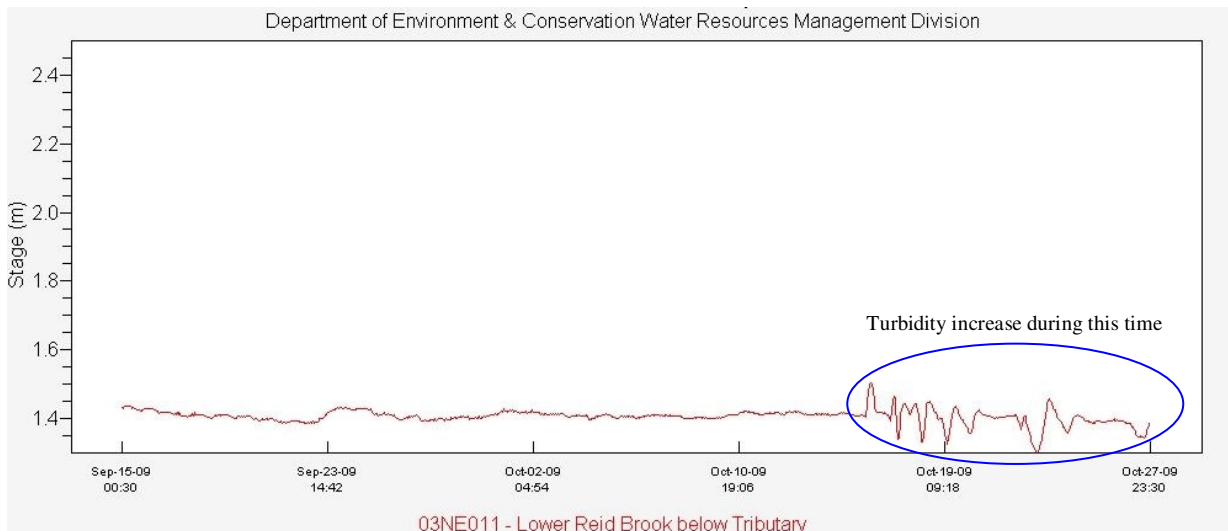


**Figure 16: pH at Lower Reid Brook, September 15 to October 27, 2009.**

- Turbidity values (**Figure 17**) vary throughout the deployment period. The average turbidity value between September 15 and October 15 is 2.27NTU. Only a couple of spikes occur during this time. On October 15, there is a significantly large spike up to 14.1NTU. After this date the turbidity values begins to increase gradually up to around 9.5NTU until removal on October 27. Also during this time stage fluctuates significantly (**Figure 18**) and is likely the cause of the turbidity increase. Small precipitation events occur throughout the deployment period however specific events do not tend to correspond to the turbidity increase during the last week of deployment.



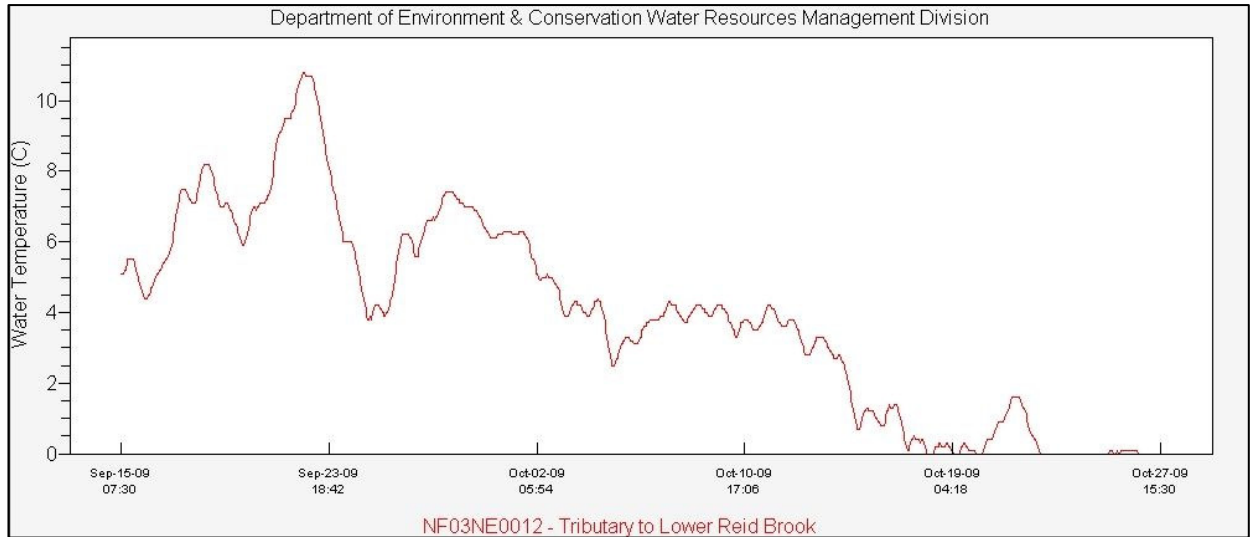
**Figure 17: Turbidity at Lower Reid Brook, September 15 to October 27, 2009.**



**Figure 18: Stage at Lower Reid Brook, September 15 to October 27, 2009.**

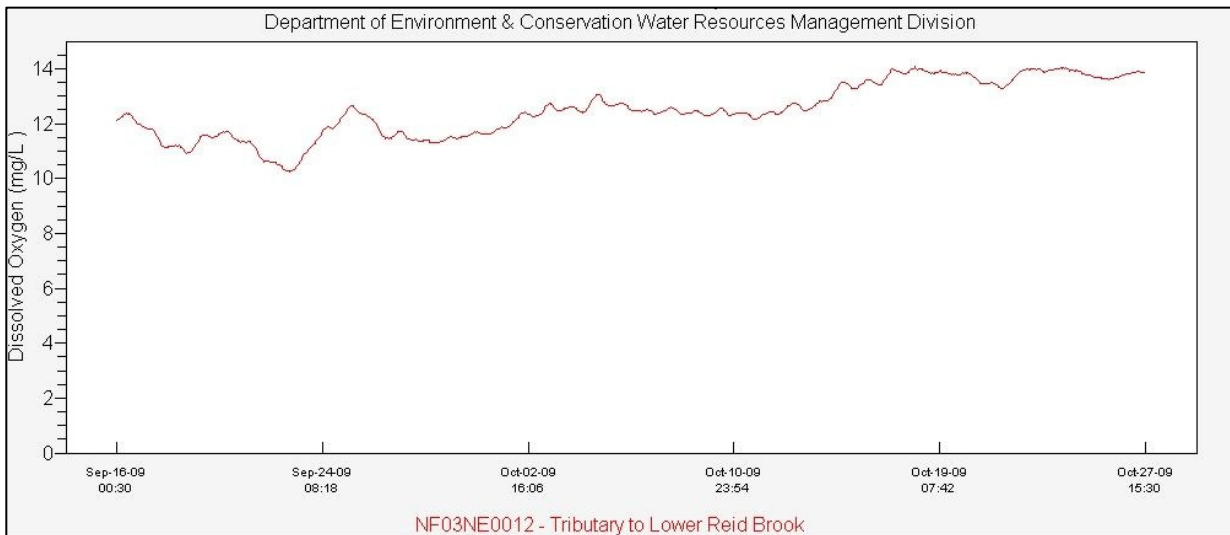
## TRIBUTARY TO REID BROOK

- The water temperature (**Figure 19**) decreases throughout the deployment period and shows diurnal patterns. The water temperatures ranged from 10.7°C to -0.1°C.



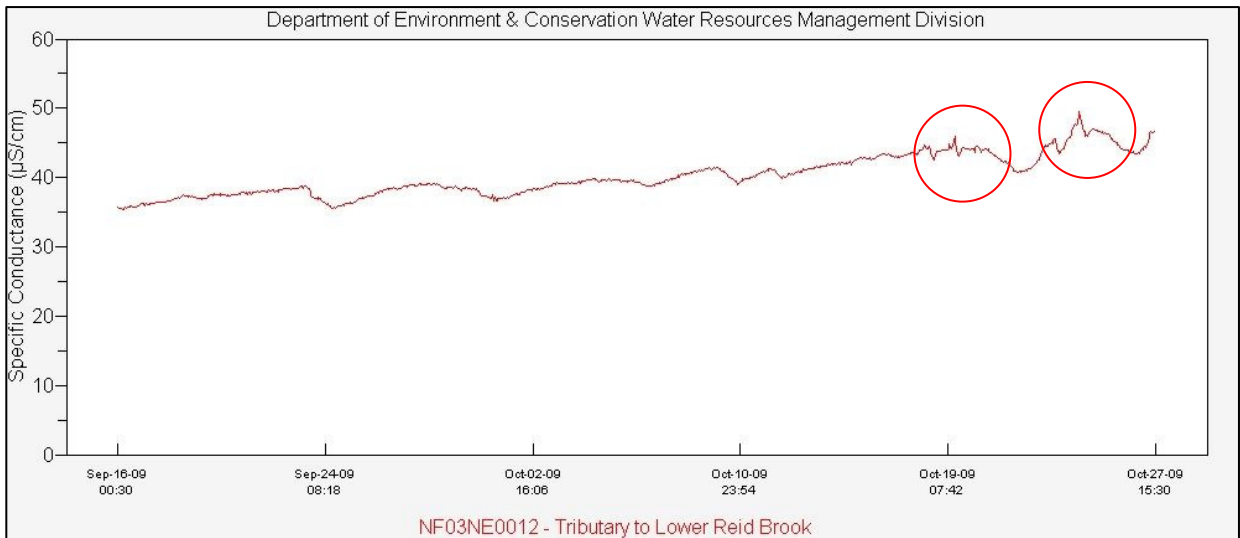
**Figure 19: Water Temperature at Tributary to Lower Reid Brook, September 15 to October 27, 2009.**

- The dissolved oxygen values (**Figure 20**) increased slightly throughout the deployment period corresponding to the above mentioned decrease in water temperature. The dissolved oxygen values ranged from 10.25 mg/L to 14.25 mg/L. All values recorded are within 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.



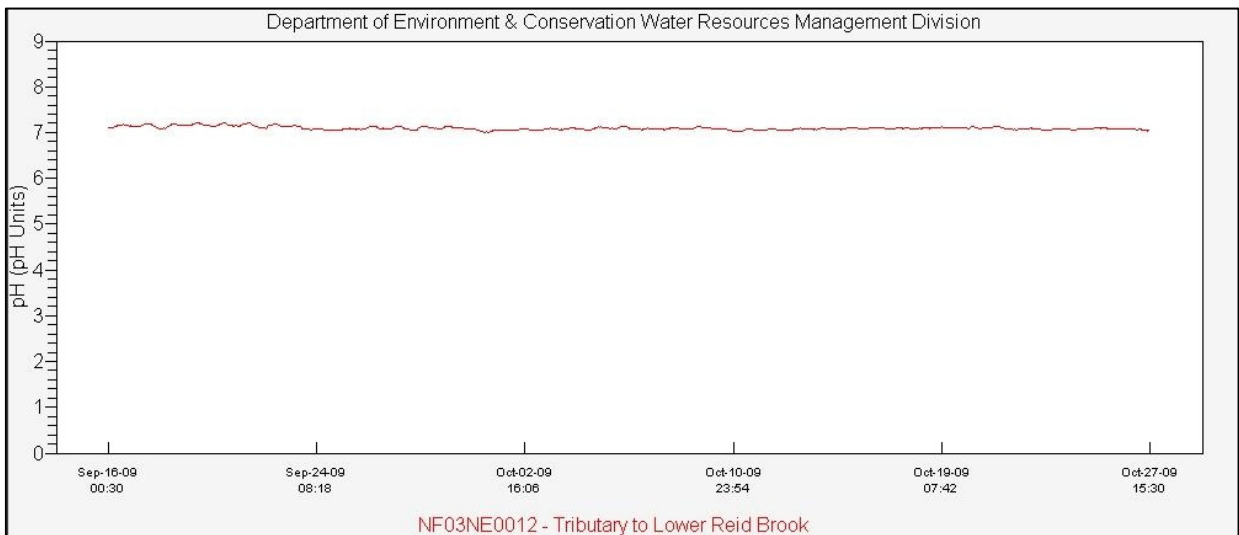
**Figure 20: Dissolved Oxygen at Tributary to Lower Reid Brook, September 15 to October 27, 2009.**

- The conductivity values (**Figure 21**) demonstrated a slight increasing trend throughout the deployment period. The conductivity values ranged from 35.4 uS/cm to 49.5 uS/cm. The two increases (circled in red) near the end of the deployment period correspond with stage increases (**Figure 24**).



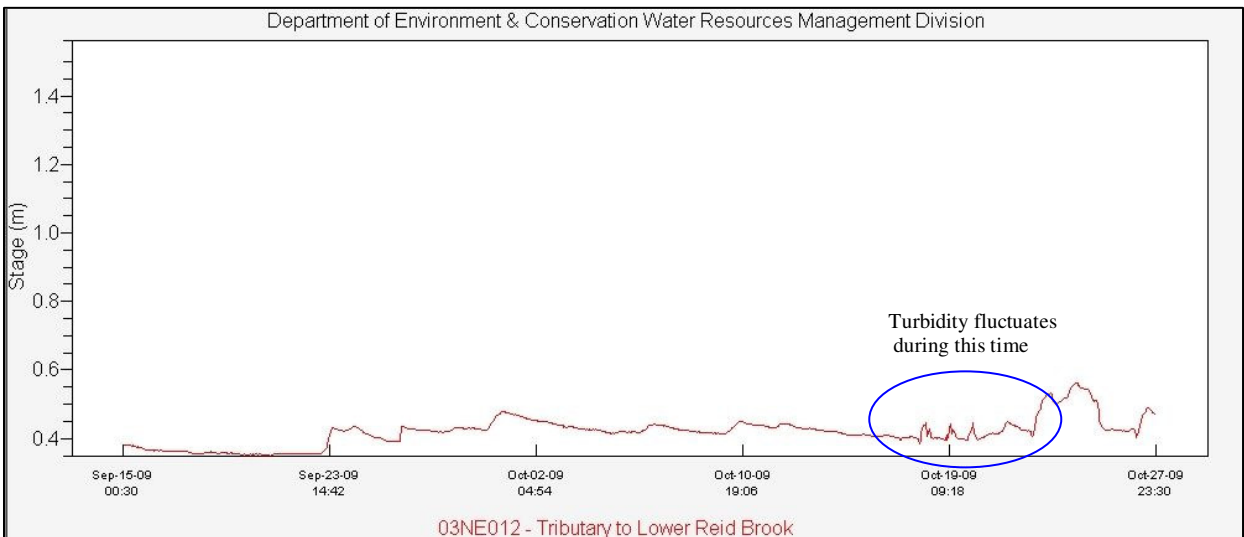
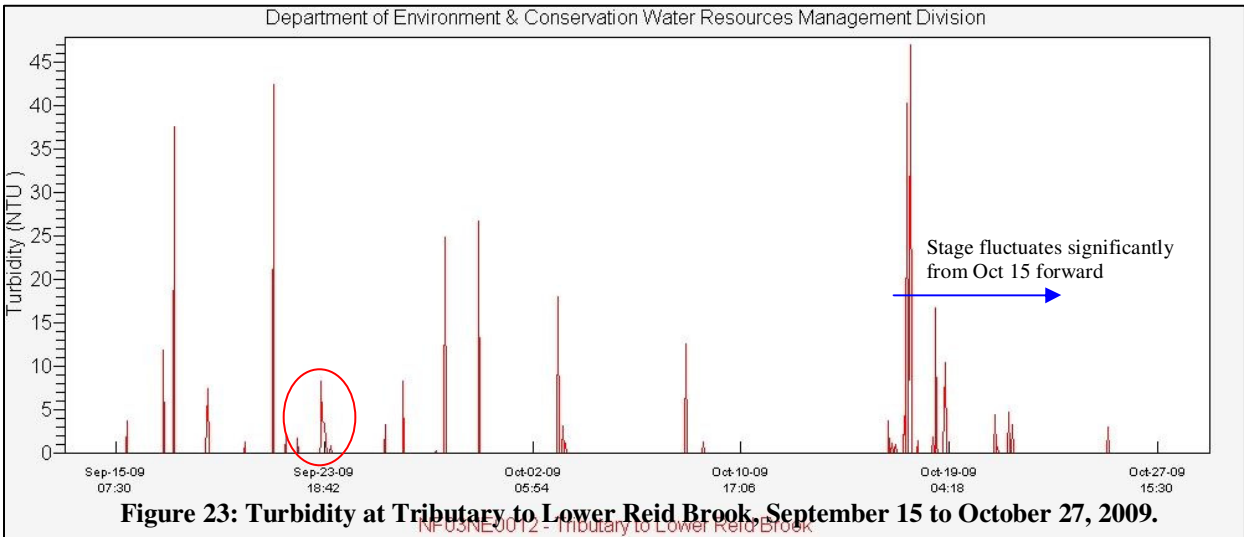
**Figure 21: Specific Conductance at Tributary to Lower Reid Brook, September 15 to October 27, 2009.**

- The pH values (**Figure 22**) remained very consistent throughout the deployment period ranging from 6.81 to 7.21. All the pH values fell within the recommended CCME Water Quality Guidelines for the Protection of Aquatic Life (>6.5 and < 9.0).



**Figure 22: pH at Tributary to Lower Reid Brook, September 15 to October 27, 2009.**

- Turbidity values (**Figure 23**) were variable over the deployment period ranging from 0.0 NTU to 46.9 NTU. Most spikes last for only 1-2 hours. On October 23, one event which spikes up to 8.2NTU lasts for 7 hours (circled in red). There is no real correspondence between the spikes and changes in stage level. Stage values do however begin to fluctuate significantly from October 15 onward which does correspond somewhat with the quick peaks in turbidity near the end of the deployment. Precipitation events do not tend to correspond with the turbidity increase between October 16 and 19.



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 Department of Environment and Conservation

**Appendix A: Weather Data for Nain, NL, September 15 to October 27, 2009 as recorded by Environment Canada.**

Daily Data Report for September - October 2009											
	Max Temp °C	Min Temp °C	Mean Temp °C	Total Rain mm	Total Snow cm	Total Precip mm	Dir of Max Gust 10's Deg	Spd of Max Gust km/h			
15-Sep-09	5.8	0.7	3.3	0	0	0	1	69			
16-Sep-09	9.9	0.7	5.3	0.2	0	0.2	30	57			
17-Sep-09	16.8	7.5	12.2	0.8	0	0.8	29	44			
18-Sep-09	16.8	4.1	10.5	0.4	0	0.4	1	59			
19-Sep-09	7.7	2.9	5.3	1.2	0	1.2	2	59			
20-Sep-09	12.9	4.3	8.6	0.2	0	0.2	30	57			
21-Sep-09	21.6	7.7	14.7	2	0	2	29	54			
22-Sep-09	21.8	6.3	14.1	0.8	0	0.8	27	46			
23-Sep-09	6.3	1.1	3.7	9.2	0.4	9.6	9	43			
24-Sep-09	5.6	-0.7	2.5	0	2.4	2.4	31	46			
25-Sep-09	5.7	-0.7	2.5	0	0	0	30	56			
26-Sep-09	13.5	0.5	7	4	0	4	30	56			
27-Sep-09	15.3	4	9.7	T	0	T	29	33			
28-Sep-09	8	5	6.5	1.4	0	1.4		<31			
29-Sep-09	7.4	4.2	5.8	1.8	0	1.8	5	44			
30-Sep-09	6.7	3.2	5	6.4	0	6.4	4	50			
1-Oct-09	6.9	2.1	4.5	0.4	0	0.4	4	56			
2-Oct-09	5.3	-0.8	2.3	T	0	T	7	39			
3-Oct-09	7.2	-1.6	2.8	0	0	0		<31			
4-Oct-09	9.5	-0.8	4.4	0	0	0		<31			
5-Oct-09	3.7	0.4	2.1	0.2	T	0.2		<31			
6-Oct-09	4.3	1	2.7	2	0.4	2.4	8	37			
7-Oct-09	5.8	2.4	4.1	0	0	0	8	37			
8-Oct-09	7	1	4	1.6	T	1.6		<31			
9-Oct-09	5.7	1.7	3.7	1.4	0	1.4	15	50			
10-Oct-09	11.8	-0.9	5.5	1	T	1	15	39			
11-Oct-09	5.1	1.6	3.4	7.2	0	7.2	31	37			
12-Oct-09	7.4	0.6	4	0.8	0	0.8	30	43			
13-Oct-09	6.6	0.1	3.4	0	0	0	27	39			
14-Oct-09	3.6	-1.7	1	0	0	0	31	56			
15-Oct-09	3.8	-2	0.9	T	T	T	31	65			
16-Oct-09	4.7	-2.5	1.1	0	0	0	29	54			
17-Oct-09	4.7	-2.9	0.9	0	0	0	28	44			
18-Oct-09	3.5	-1.5	1	0	0	0	28	41			
19-Oct-09	8.1	-4.7	1.7	0	0	0		<31			
20-Oct-09	4.4	-0.6	1.9	3	2.6	5.6		<31			
21-Oct-09	2.6	-0.5	1.1	0.2	3.6	3.8	33	43			
22-Oct-09	-0.3	-5	-2.7	0	T	T	29	46			
23-Oct-09	2.2	-8.2	-3	0	T	T	28	33			
24-Oct-09	1	-8.2	-3.6	0	0	0	15	41			
25-Oct-09	1	-1.4	-0.2	0	8.2	8.2	16	69			
26-Oct-09	2.9	-1.9	0.5	0	1.4	1.4	30	95			
27-Oct-09	-0.6	-6.1	-3.4	0	0	0	31	93			

Average Daily Air Temperature and Precipitation for Nain, NL - September 15 to October 27, 2009

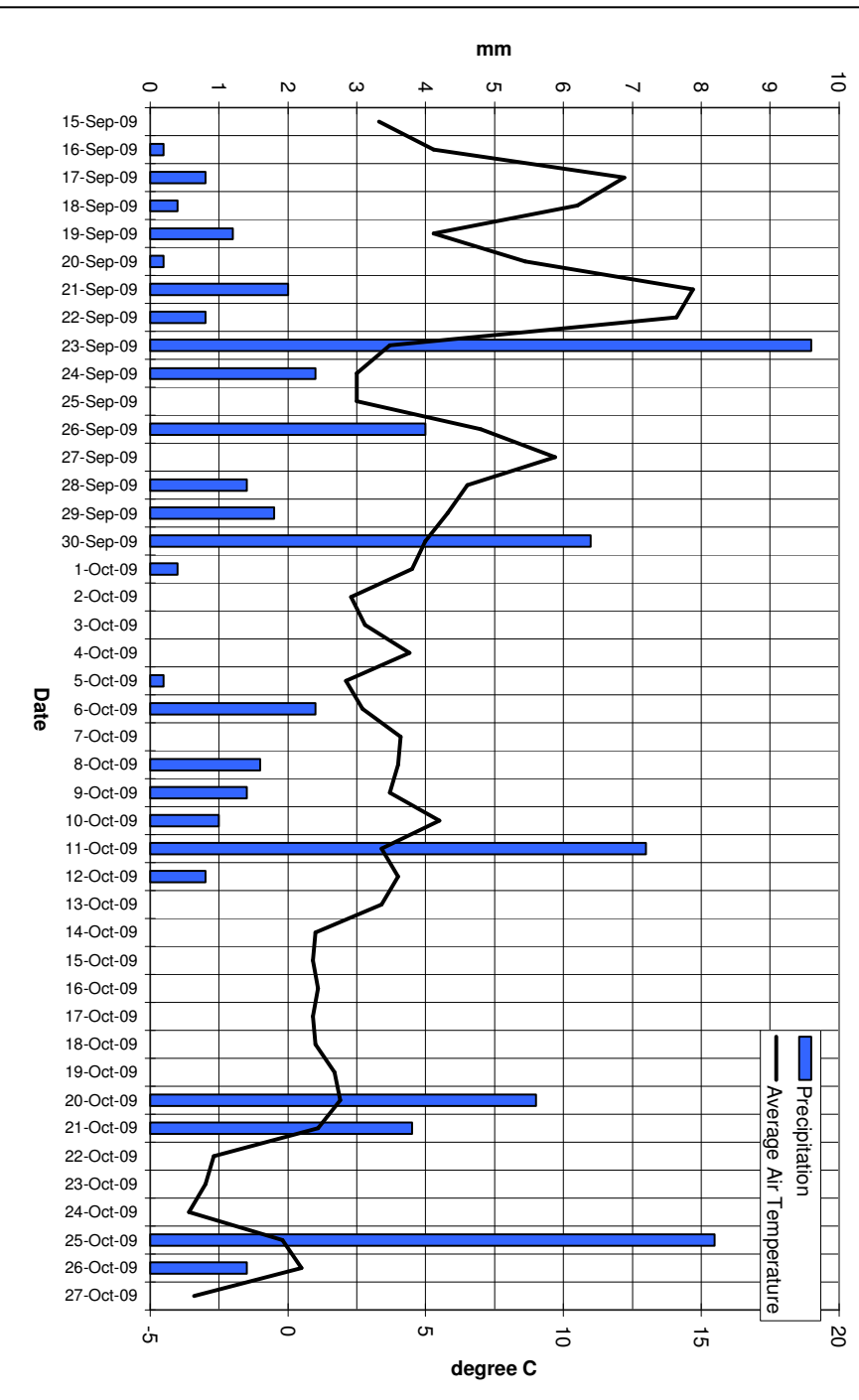


Figure A-1: Average daily air temperature and precipitation as recorded by Environment Canada in Nain, NL, between September 15 and October 27, 2009.