Real-Time Water Quality Deployment Report

Labrador Iron Mines Schefferville

September 28 to October 21, 2010

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division

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Introduction

- In fall 2010, the Real Time Water Monitoring Network was successfully established by Department of Environment and Conservation (ENVC) and Environment Canada (EC) staff in cooperation with Labrador Iron Mines (LIM). The objective of the network is to identify and track any emerging water quality or quantity management issues and ensure protection of ambient water resources downstream from the James North and South pit mining sites at Labrador Iron Mines operations, near Schefferville, QC.
- The network consists of water quality and quantity monitoring at 2 locations downstream from James North and South pits in the Bean Lake watershed. One station is located on James Creek, and the other on an unnamed tributary below the settling pond (Figure 1).
- Both stations measure water quality parameters including water temperature, pH, specific conductivity, dissolved oxygen, and turbidity. Percent saturation and total dissolved solids are calculated from the measured parameters. Water quality monitoring is the primary responsibility of ENVC.
- Both stations also monitoring water quantity including stage and flow. Water quantity monitoring is the primary responsibility of EC. ENVC staff reporting on water quality will have access to water quantity information if necessary to understand and explain water quality fluctuations.
- Instruments were deployed at both stations from late September to October. Instruments were removed for the winter months on October 21, 2010. Even though this was a very short deployment at the end of the field season, the deployment was important to test communication at the stations and ensure the stations were functioning properly. Instruments will be redeployed in spring 2011 when snow and ice conditions permit.
- All equipment was installed in each hut over September 28-29 (Appendix 1). Stations were added to the ENVC website in early October. Data is updated approximately every three hours on the website.

General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report illustrates and discusses water quality related events from September 28/29 to October 21, 2010; a period of 23 days.

Maintenance and Calibration of Instrument

- As part of the Quality Assurance and Quality Control protocol (QAQC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
  - Upon deployment and removal, a QA/QC Sonde is temporarily deployed along side the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the Field Sonde and QAQC Sonde at deployment, a qualitative statement is made on the data quality (Table 1).

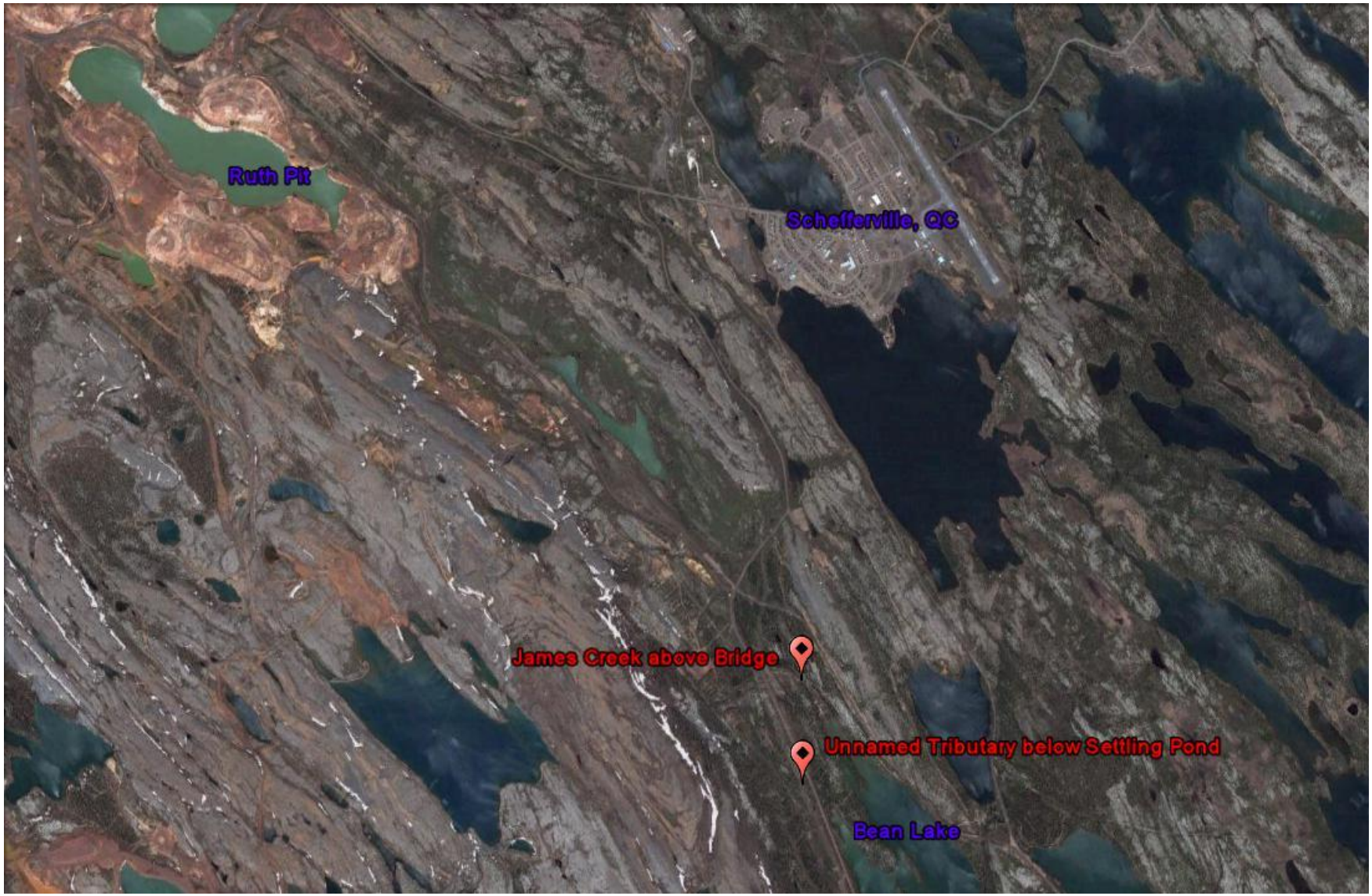

Figure 1: Map of real time water quality monitoring sites in relation to Schefferville, Ruth Pit and Bean Lake.

- At the end of a deployment period, readings are taken in the water body from the Field Sonde before and after a thorough cleaning in order to assess the degree of biofouling. During calibration in the laboratory, an assessment of calibration drift is made and the two error values are combined to give Total Error (T_e). If T_e exceeds a predetermined data correction criterion, a correction based on T_e is applied to the dataset using linear interpolation.

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (oC)	<=+/-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

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups, temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.
- Deployment and removal comparison rankings for the Churchill River stations deployed between May 20 and June 23, 2010 are summarized in Table 2.

Table 2: Comparison rankings for James site stations, September 28/29 – October 21, 2010

Station	**Date 2010**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
James Creek above Bridge	September 28	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	October 21	Removal	Good	Marginal	Excellent	Fair	Excellent
Unnamed Tributary below Settling Pond	September 29	Deployment	Excellent	Fair	Excellent	Excellent	Excellent
	October 21	Removal	Good	Fair	Excellent	Fair	Excellent

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events in the Bean Lake watershed, downstream of the James North and South pit mining sites, near Schefferville, QC.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request. Where appropriate, corrected data for water quality parameters are indicated.

James Creek above Bridge

- Transmission is intermittent during the deployment period. The instruments internal log file was recovered to provide a more complete dataset for the following discussion.
- Water temperature ranges from 0.65 to 6.40^{o}C during this deployment period (Figure 2).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the decreasing ambient air temperature in the fall (Appendix 2). Water temperature fluctuates diurnally.

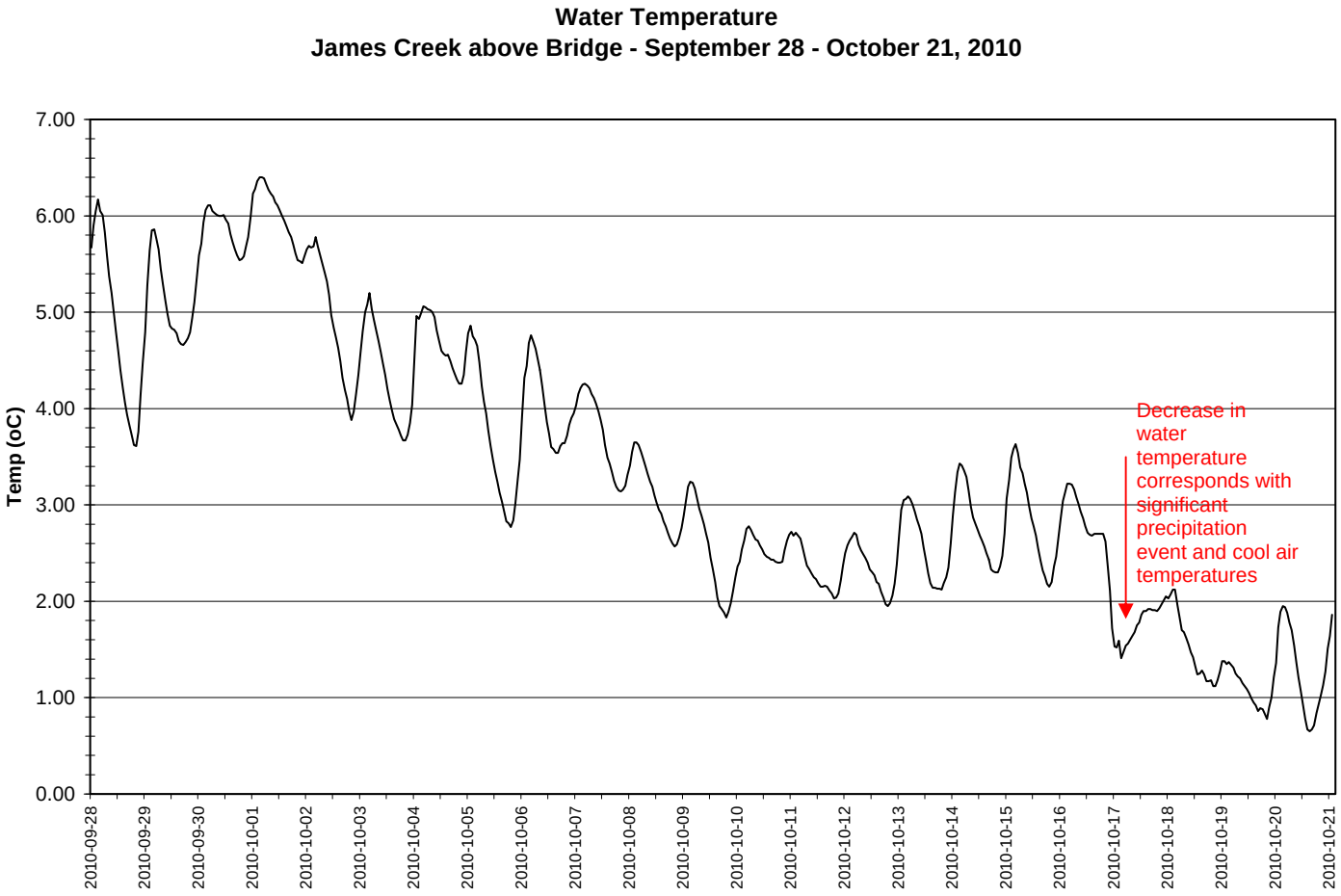

Figure 2: Water temperature at James Creek above Bridge

- pH ranges between 7.83 and 8.29 pH units (Figure 3) and are consistent throughout the deployment period.
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

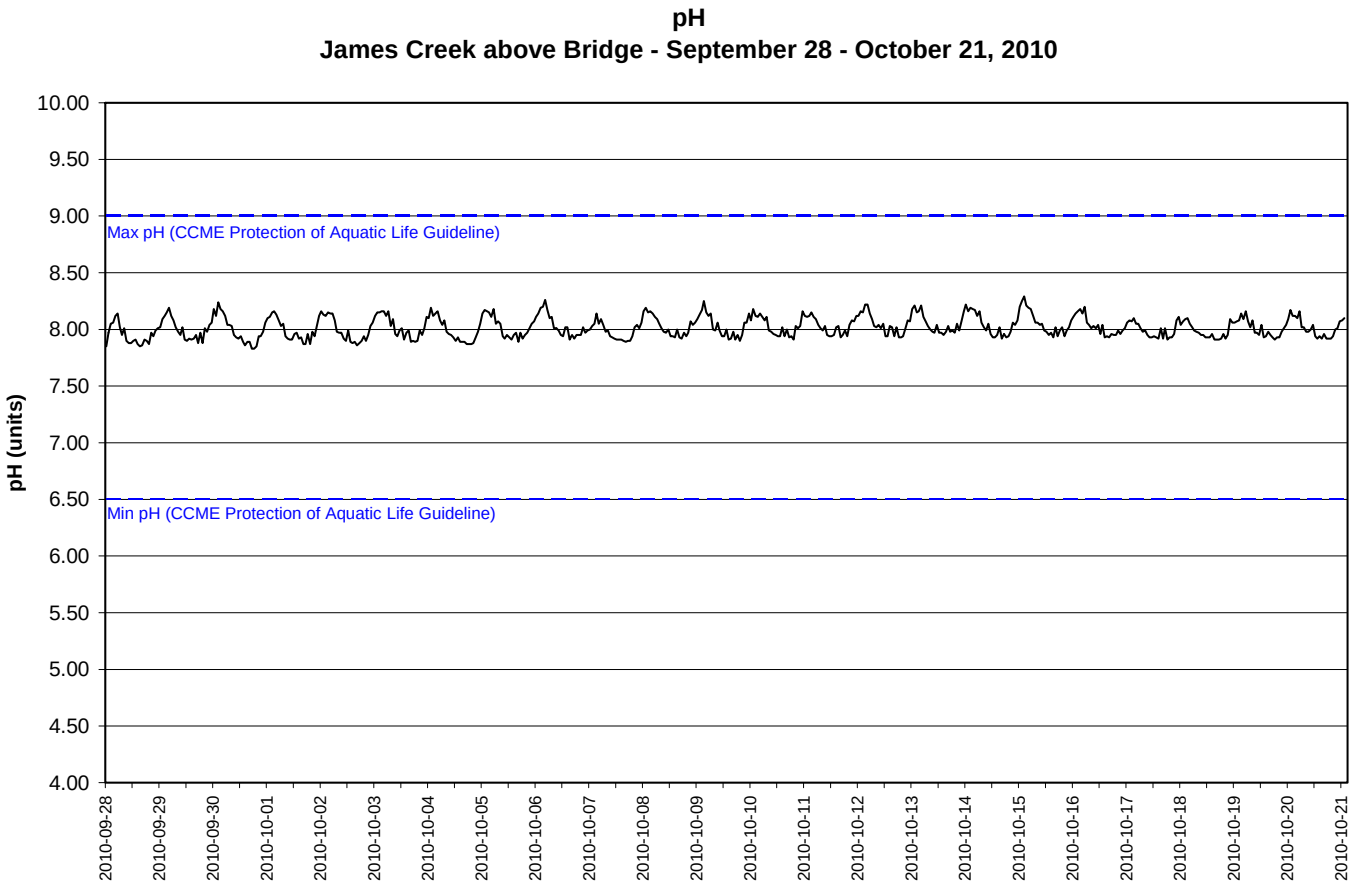

Figure 3: pH at James Creek above Bridge

- The instruments internal log file only measures specific conductivity to 0 decimal places.
- Specific conductivity ranges from 145 to 152µS/cm during the deployment period (Figure 4).
- There is a sharp decrease in conductivity on October 17. This decrease corresponds with a significant precipitation event recorded in the area over October 17-18.

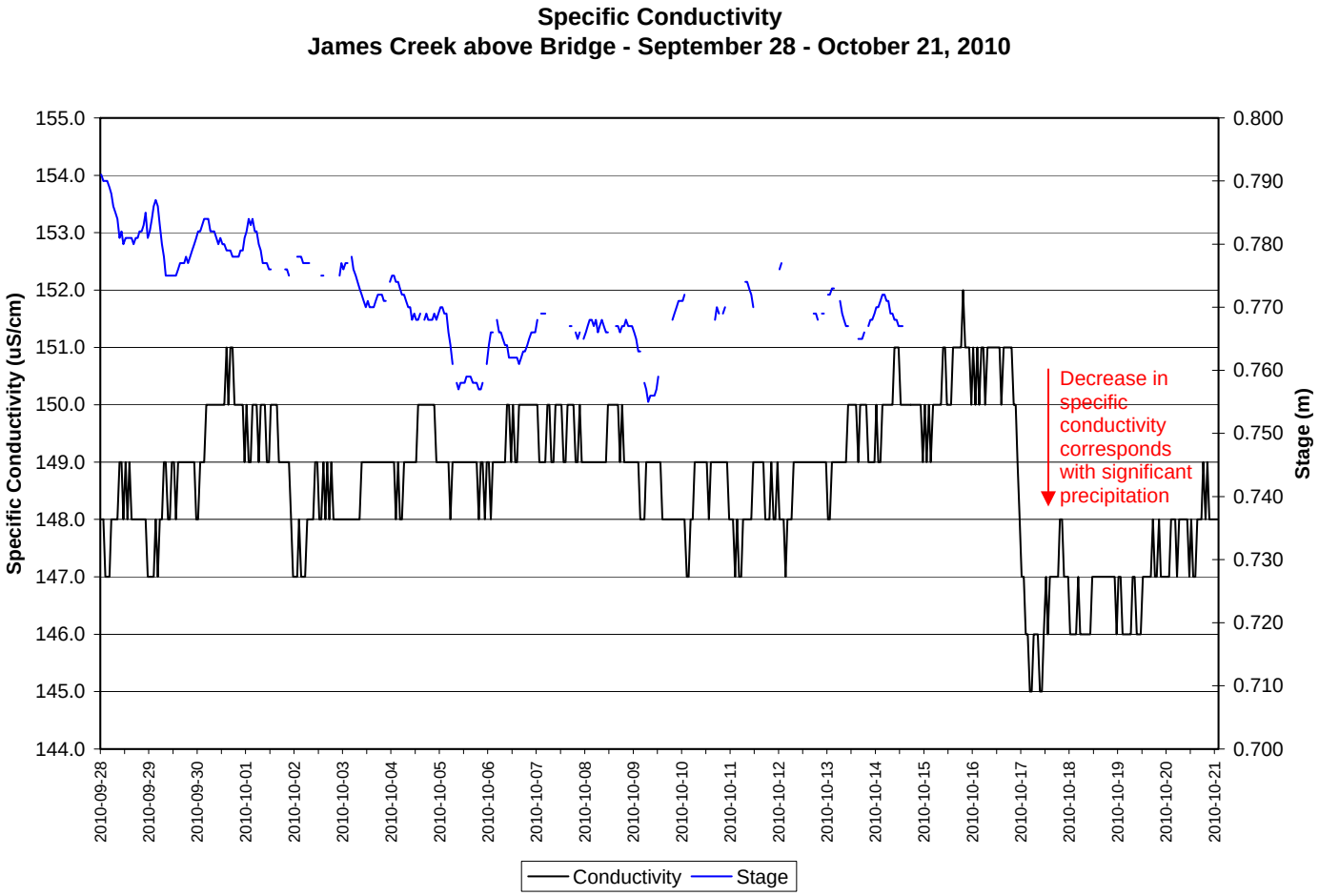

Figure 4: Specific conductivity at James Creek above Bridge

- The saturation of dissolved oxygen ranged from 92.1 to 103.7% and a range of 11.72 to 14.06mg/l was found in the concentration of dissolved oxygen with a median value of 13.04 mg/l (Figure 5).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 5.
- Dissolved oxygen content increases slightly throughout the deployment period. This trend is expected given the decreasing water and air temperatures (Figure 2, Appendix 2).

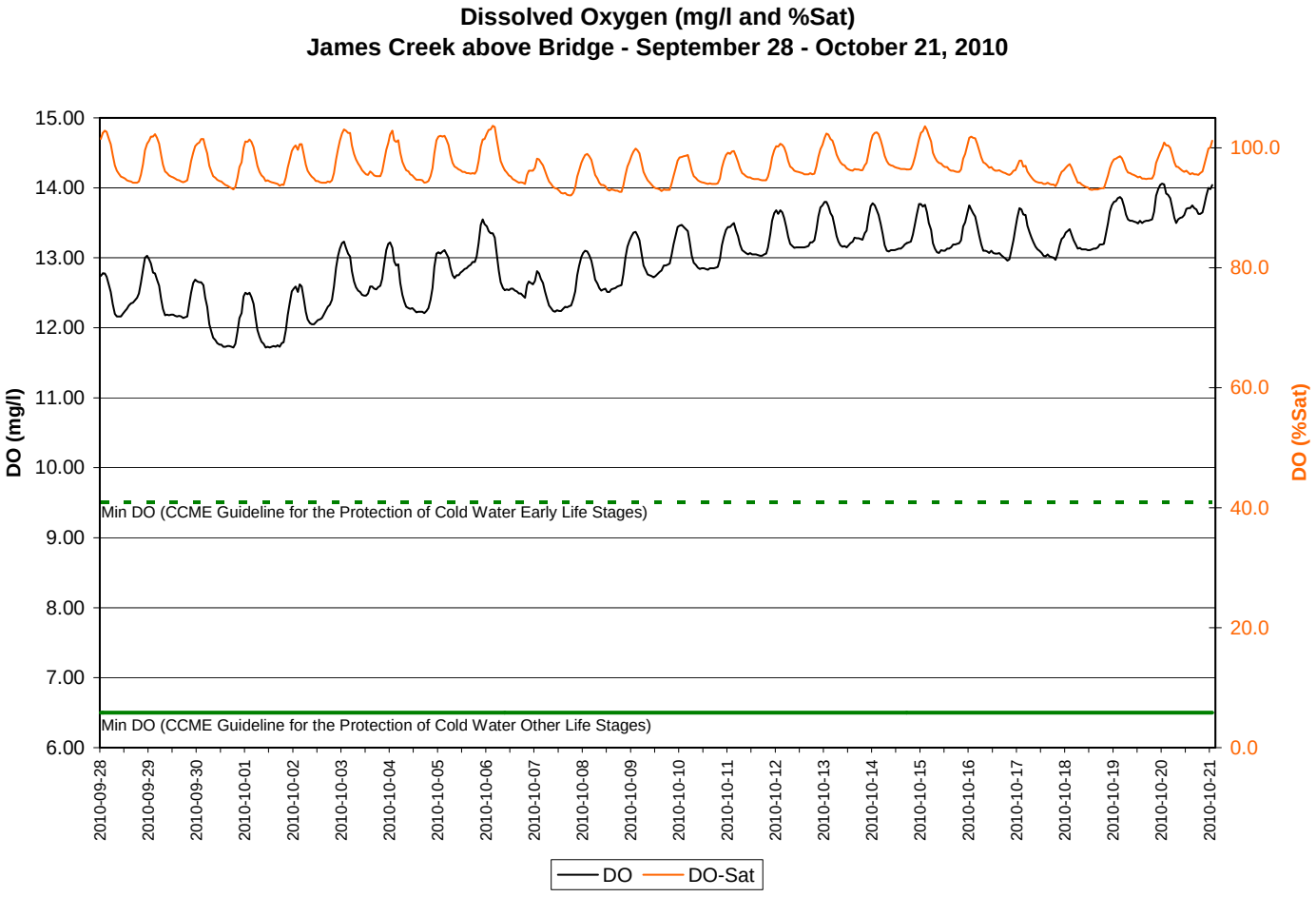

Figure 5: Dissolved oxygen at James Creek above Bridge

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- A range of 0.0 to 3.8NTU was recorded for turbidity for this deployment period (Figure 6).
- Turbidity spikes are of minimal length, frequency and magnitude (<4NTU).

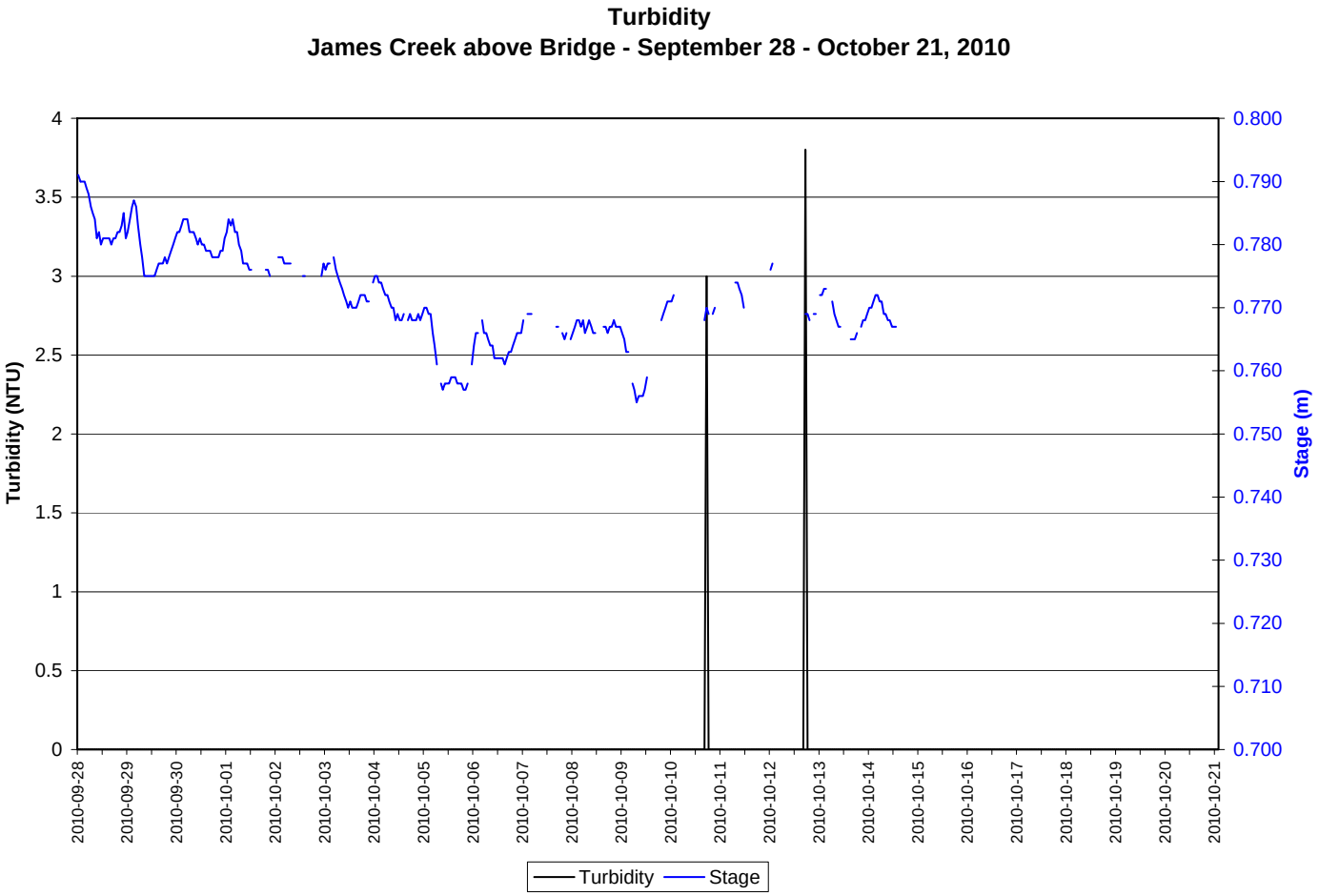

Figure 6: Turbidity at James Creek above Bridge

Unnamed Tributary below Settling Pond

- Transmission is intermittent during the deployment period. The instruments internal log file was recovered to provide a more complete dataset for the following discussion.
- Water temperature ranges from 0.32 to 5.91^{o}C during this deployment period (Figure 7).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the decreasing ambient air temperature in the fall (Appendix 2). Water temperature fluctuates diurnally.

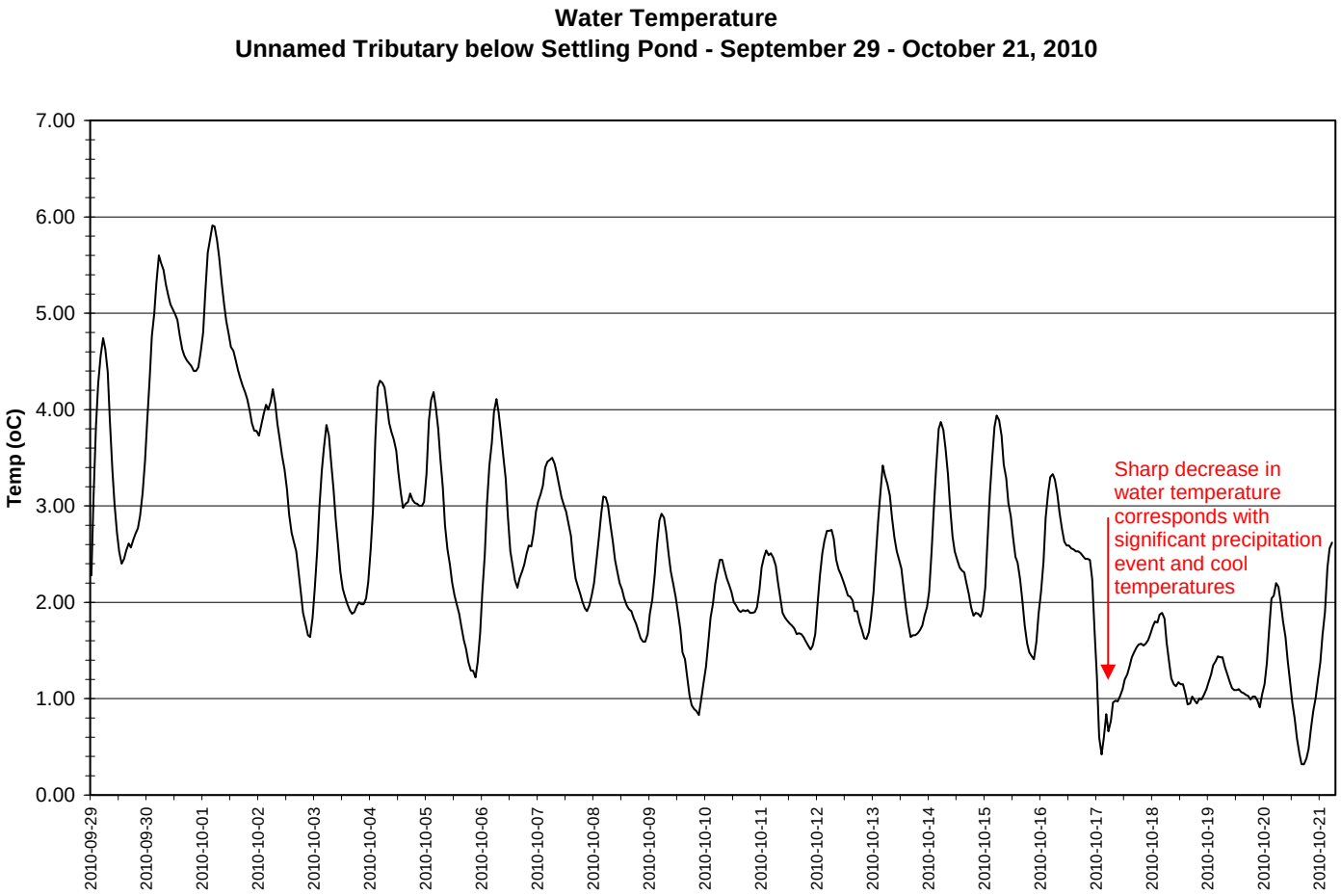

Figure 7: Water temperature at Unnamed Tributary below Settling Pond

- pH ranges between 7.00 and 7.42 pH units (Figure 8).
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 8).

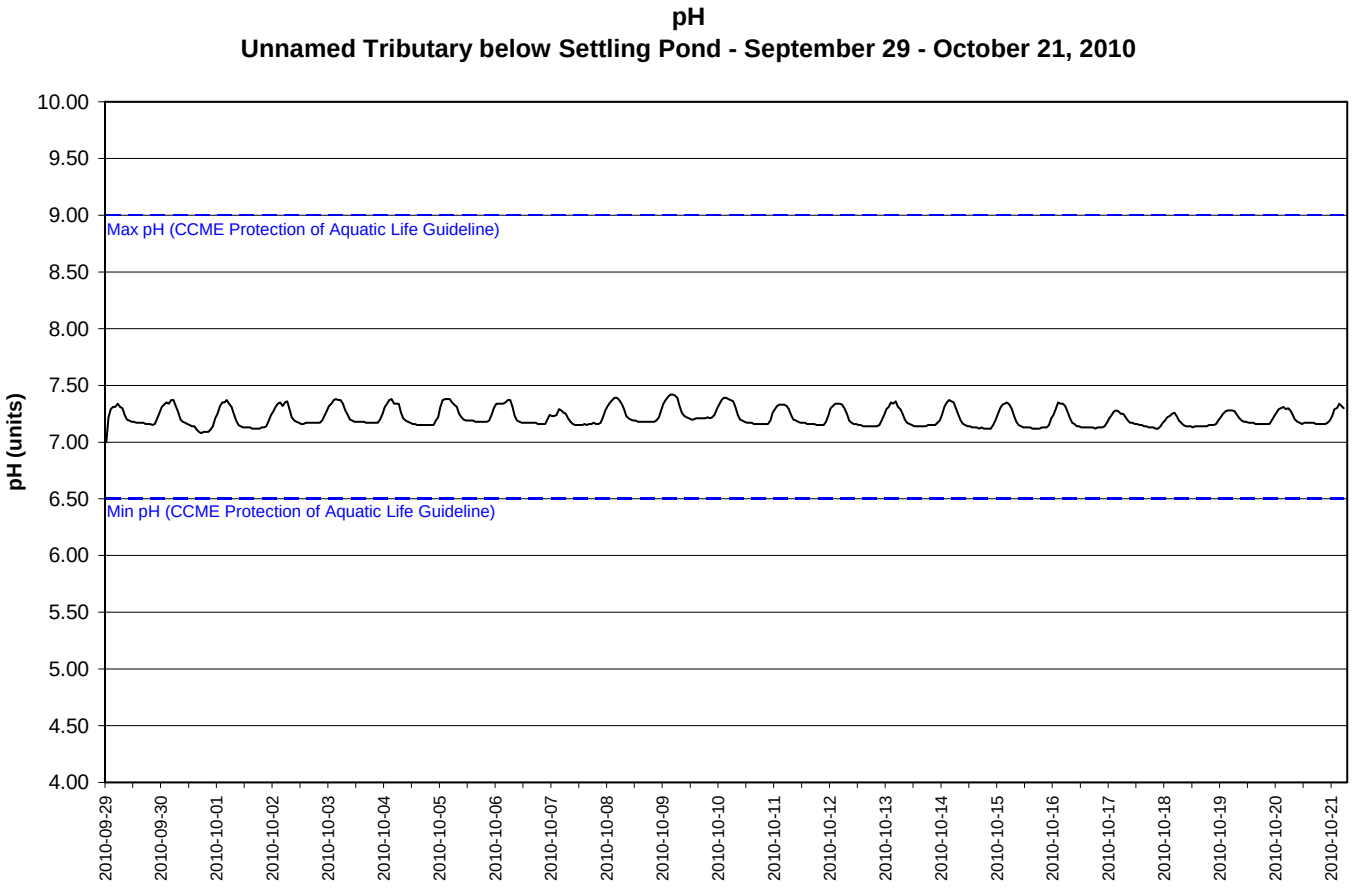

Figure 8: pH at Unnamed Tributary below Settling Pond

- The instruments internal log file on only measures specific conductivity to 0 decimal places.
- Specific conductivity ranged from 41 to 44µS/cm during the deployment period (Figure 9). Specific conductance fluctuates slightly throughout the deployment period but generally remains consistent.
- A precipitation event on October 17-18 causes specific conductivity to drop sharply on October 17 (indicated in red on Figure 9).

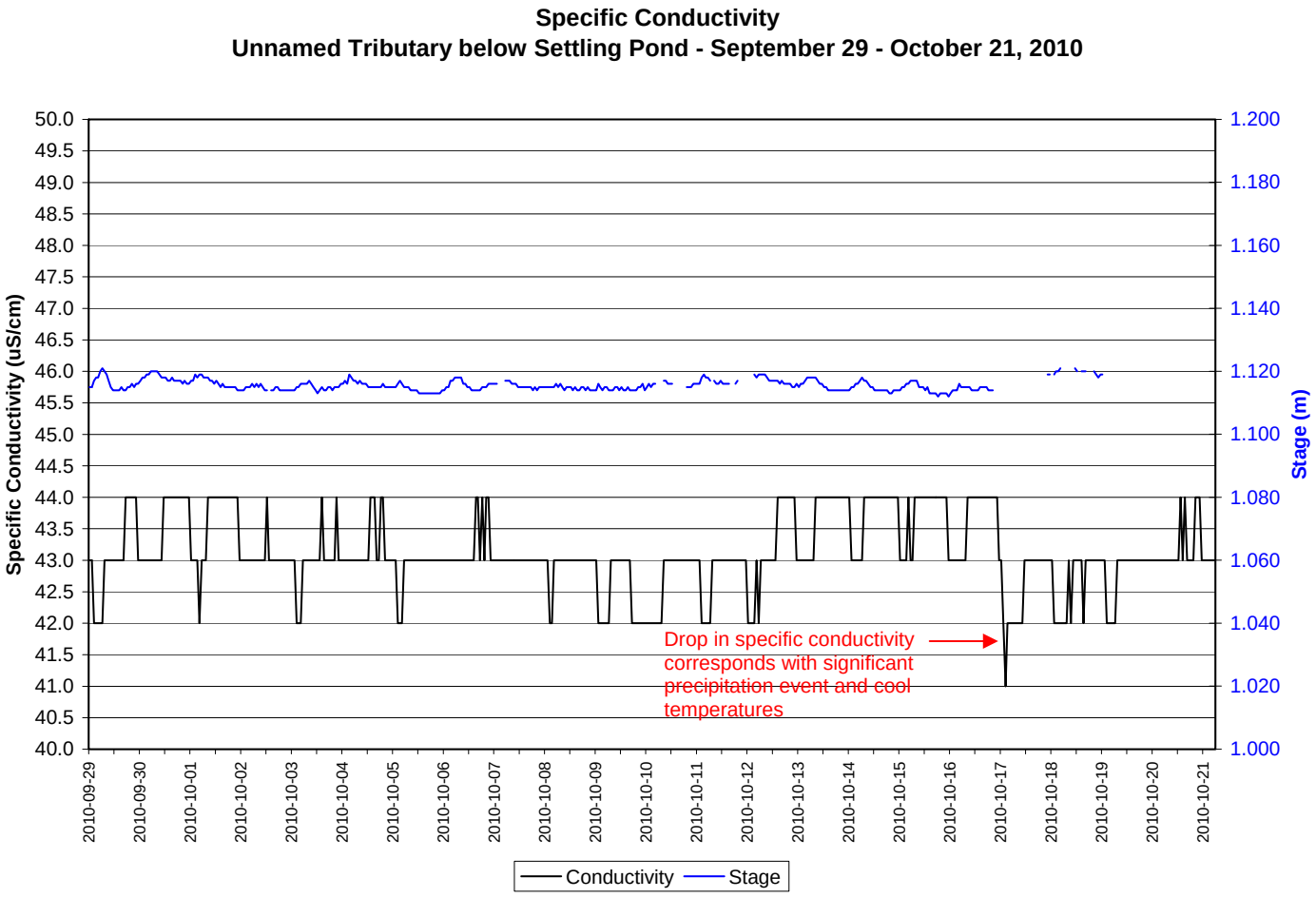

Figure 9: Specific conductivity at Unnamed Tributary below Settling Pond

- The saturation of dissolved oxygen ranged from 87.8 to 102.8% and a range of 11.50 to 13.87mg/l was found in the concentration of dissolved oxygen with a median value of 12.70 mg/l (Figure 10).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 10.
- Dissolved oxygen content is stable and consistent, fluctuating diurnally, throughout the deployment period.

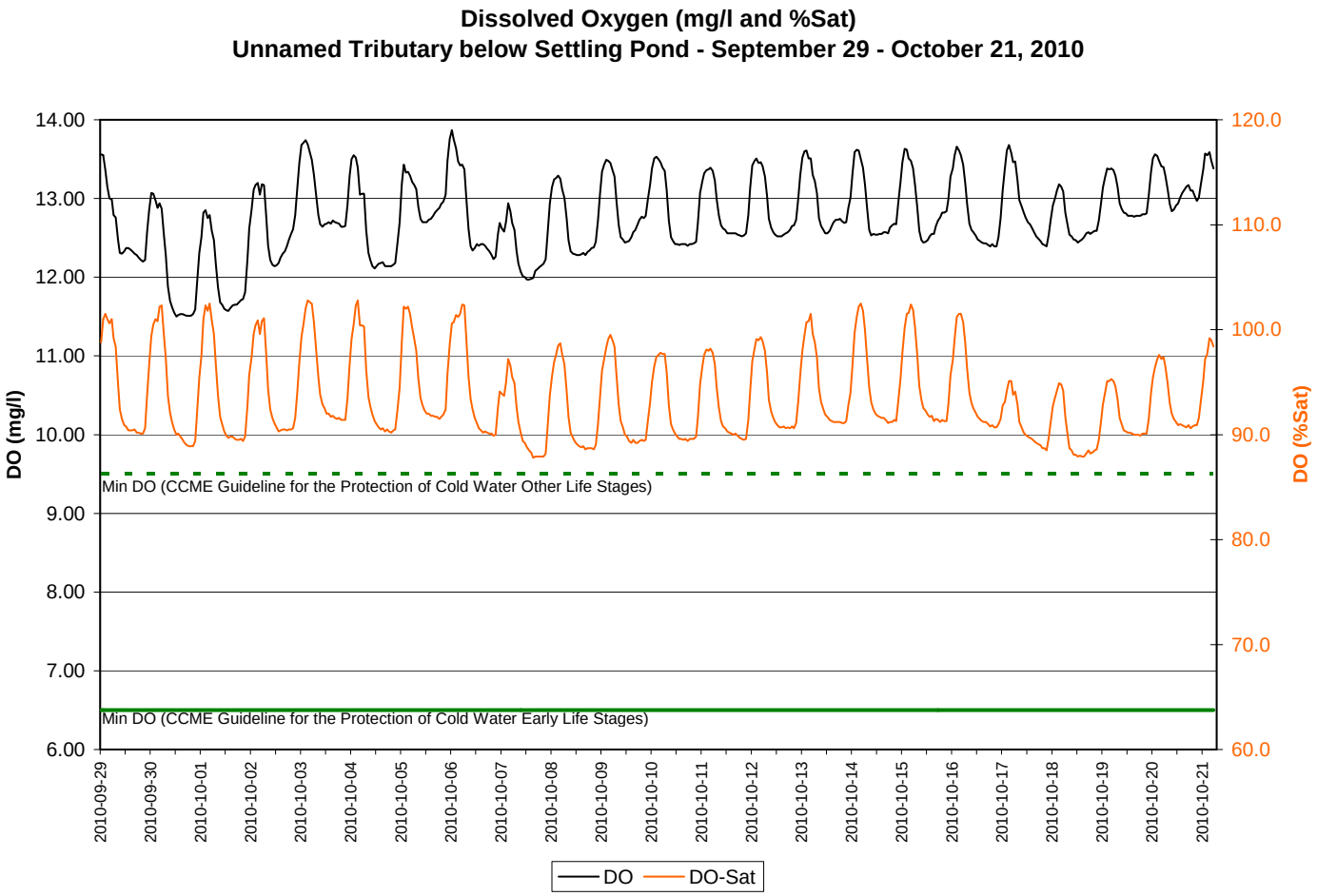

Figure 10: Dissolved oxygen at Unnamed Tributary below Settling Pond

- A range of 0.0 to 12.1 NTU was recorded for turbidity during this deployment period (Figure 11).
- Turbidity values up to 12.1 NTU were recorded at this site for the first 2 days of the deployment before dropping off to 0.0NTU. At site installation and instrument deployment, the water was visually a cloudy grey color. It is unknown what caused this event. Increases in turbidity after October 1 are of minimal frequency, length and magnitude (<7.5NTU, < 1 hour).

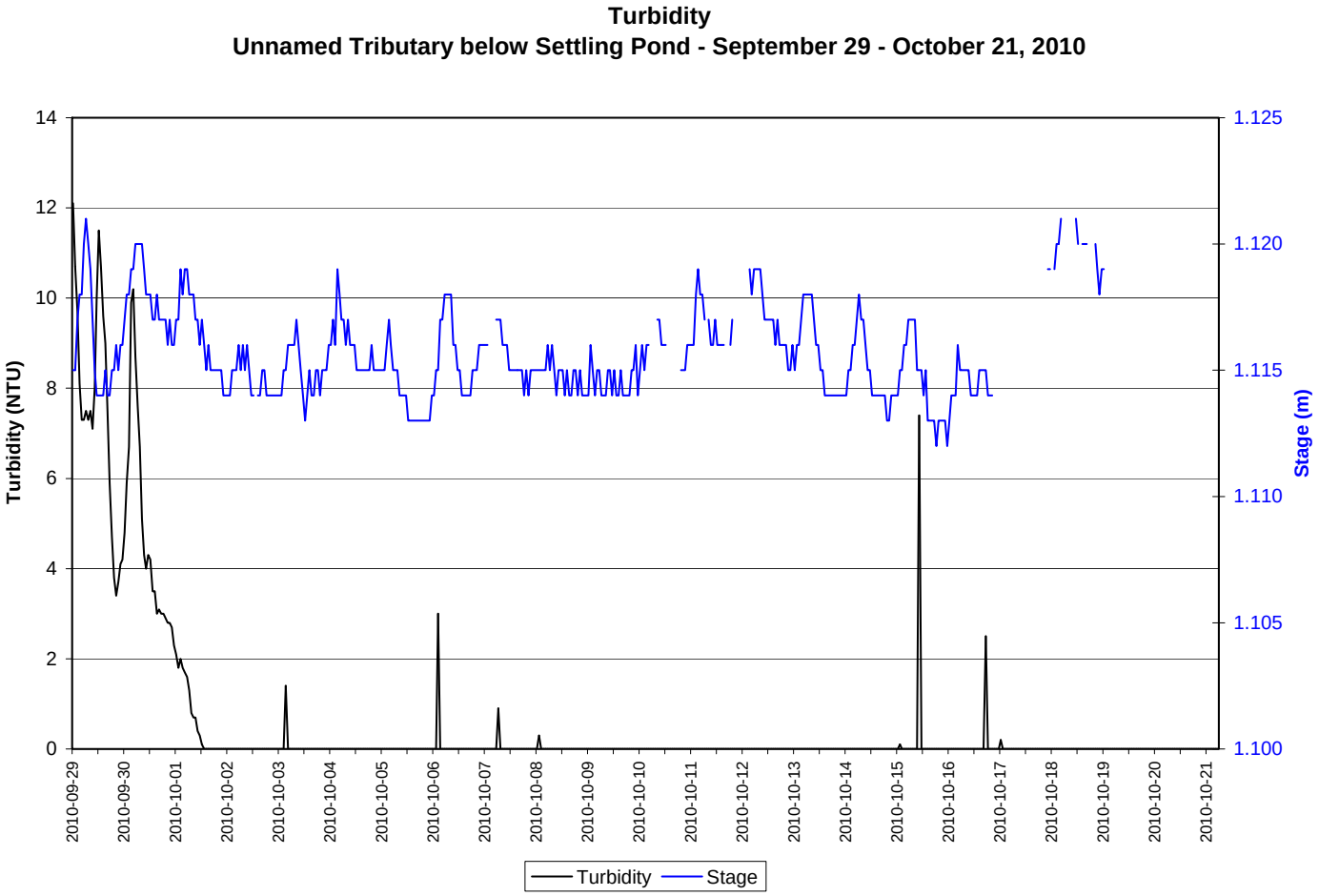

Figure 11: Turbidity at Unnamed Tributary below Settling Pond

Conclusions

- Two real time water monitoring stations were installed at James Creek and an unnamed tributary on September 28 – 29 downstream from the LIM James North and South pit mining sites. Stations will be used to collect water quality and quantity data in near real time, to catch emerging water issues associated with the LIM James pit mining operations near Schefferville, QC.
- Water quality monitoring instruments were successfully deployed at the station between September 28/29 and October 21, 2010 before being removed for the winter season. Although the deployment period was short, it was necessary to ensure stations were working and communicating properly. Water quality monitoring will commence again in spring 2011.

Path Forward

- In order for this agreement to be successful, it is essential to continually evaluate and move forward. The 2010 deployment season was just the beginning of what is likely to be a strong and successful network and collection of water quality and quantity data for all parties involved.

The following is a list of activities to be carried out in the upcoming year.

- Continue to maintain open communication lines between ENVC, EC and LIM employees involved with the agreement.
- Deploy real time water quality instruments in spring 2011 when ice and snow conditions allow.
- ENVC staff will perform regular site visits throughout the 2011 deployment season for calibration and maintenance of the instruments.
- EC staff will perform regular site visits to ensure water quantity instrumentation is correctly calibrated and providing accurate measurements.
- LIM will continue to be informed of data trends and any significant water quality event in the form of a monthly deployment report when the deployment season begins.
- LIM will also receive an annual report summarizing the events of the deployment season.
- ENVC, EC and LIM staff will reassess potential for real-time water quality and quantity monitoring near the Redmond site.
- ENVC will provide hands on training for LIM staff in St. John's for maintenance and calibration of real time water quality monitoring instrumentation as well as deployment and removal procedures.
- ENVC will begin development of models using real time water quality monitoring data and grab sample data to estimate a variety of additional water quality parameters (*i.e.* TSS, major ions *etc*.)

Prepared by:
Grace Gillis
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.896.5542
Fax: 709.896.9566

Appendix 2

James Creek above Bridge

Station shelter on edge of James Creek

James Creek looking upstream from station

Macrophyte growth at James Creek in late September

Protective conduit and connection cable for real time water quality monitoring equipment

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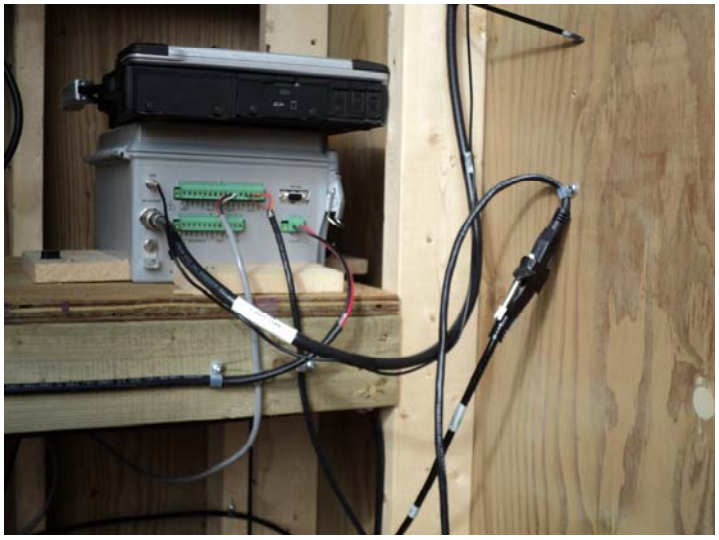
Protective conduit houses the connection cable and is securely fastened to the station shelter



Data logger and connections at James Creek

Unnamed Tributary below Settling Pond

Unnamed tributary looking downstream from station

Hydrolab deployed on September 29, 2010

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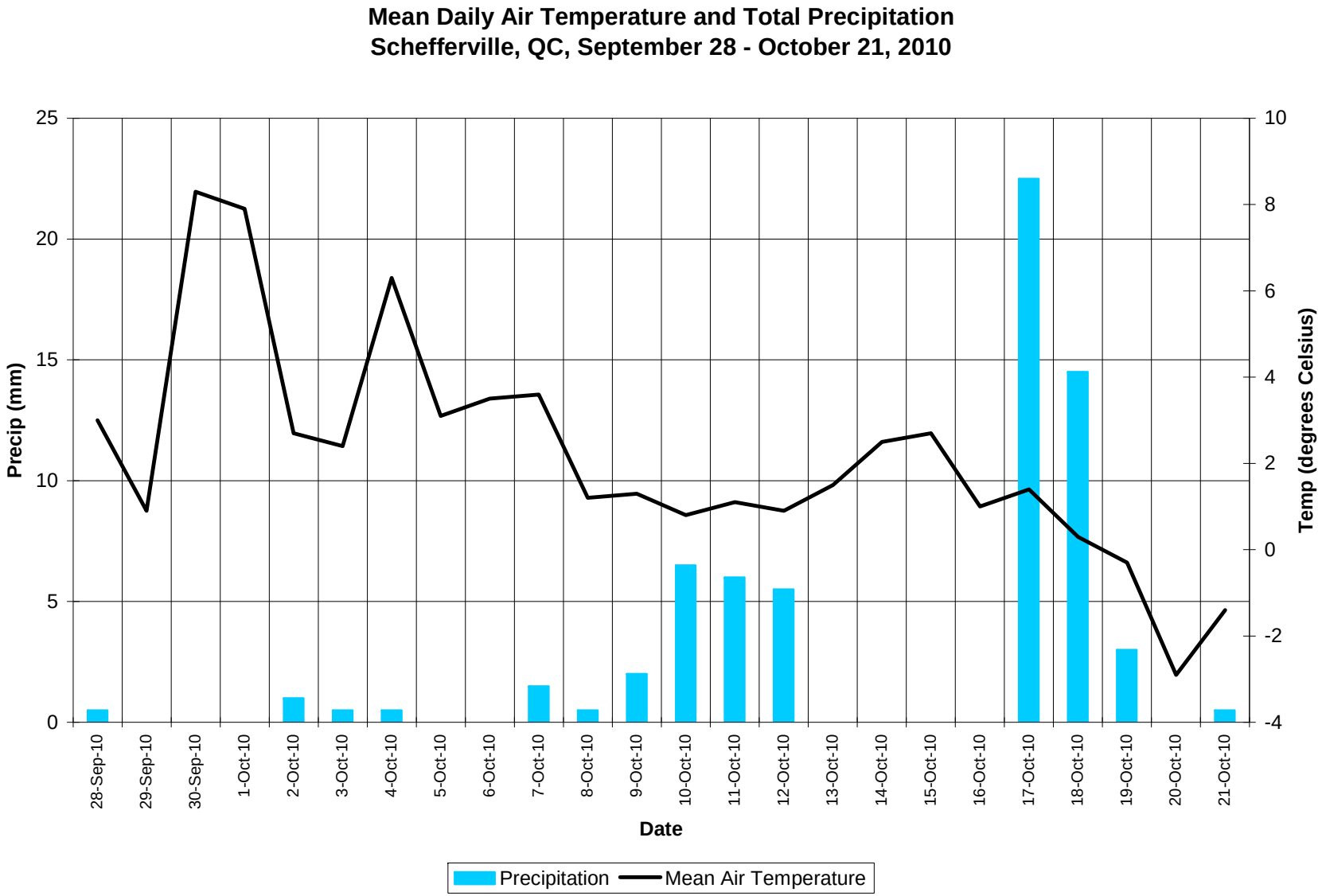
Protective conduit house the connection cable which runs from the hut to the river

Boom truck moves station shelter into place

Protective conduit is securely fastened to the station

Data loggers at unnamed tributary

Appendix 2


Mean Daily Air Temperature and Total Precipitation
Schefferville, QC, September 28 - October 21, 2010
Precip (mm)
Temp (degrees Celsius)
Date
25
20
15
10
5
0
10
8
6
4
2
0
-2
-4
28-Sep-10
29-Sep-10
30-Sep-10
1-Oct-10
2-Oct-10
3-Oct-10
4-Oct-10
5-Oct-10
6-Oct-10
7-Oct-10
8-Oct-10
9-Oct-10
10-Oct-10
11-Oct-10
12-Oct-10
13-Oct-10
14-Oct-10
15-Oct-10
16-Oct-10
17-Oct-10
18-Oct-10
19-Oct-10
20-Oct-10
21-Oct-10
Precipitation
Mean Air Temperature