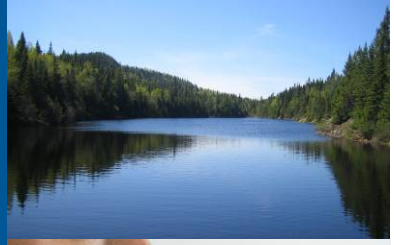
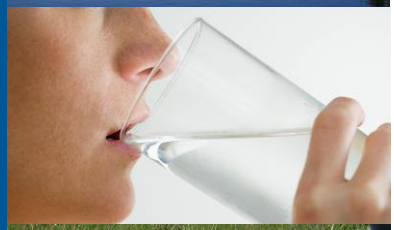



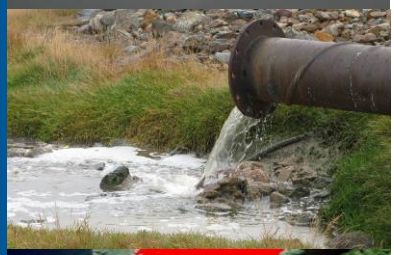


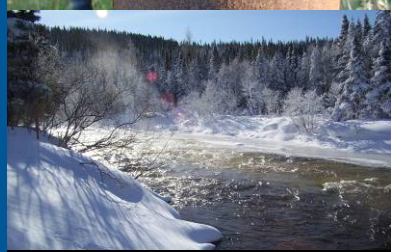

Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2009-11-25 to 2010-04-26

2010-05-14

Newfoundland Labrador

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

General

- Water Resources Management Division (WRMD) staff monitors the real-time web page on a daily basis. Any unusual observations are investigated, with site visits being carried out as warranted.
- Management at Teck Duck Pond Operations are informed of any significant water quality events or instrumentation problems by WRMD.
- The graphs below may sometimes show vertical lines from the data string to zero or the bottom of the graph. These lines should be ignored, as they are an artefact of individual missing data points. We are working to resolve this issue.
- There was effluent from Polishing Pond into the receiving waters (Tributary to Gills Pond Brook) numerous times throughout the deployment period, as there were short term batch discharges.

Maintenance and Calibration of Instrumentation

- After being cleaned and freshly calibrated the **DataSondes®** for Tributary to Gills Pond Brook and East Pond Brook were installed on November 25, 2009, and remained deployed continuously until April 26, 2010, a 152 day period. On February 2, 2010, both probes were checked *in situ* against a freshly calibrated **MiniSonde®** to verify that they were functioning properly, and had no significant drift.
- After being deployed all winter, there was no damage to the instruments, nor was there any significant fouling or instrument drift.
- The **Quanta G®** was removed from Monitoring Well After Tailings Dam Station (MW1) on October 30, 2009 prior to winter freeze-up to be sent to the vendor for its bi-annual service.

Quality Assurance / Quality Control (QA/QC) Measures

- As part of the QA/QC protocol, 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. See **Table 1**.

	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

Table 1

- Upon deployment, a QA/QC **MiniSonde®** is temporarily deployed along side the Field **DataSonde®**. Values for temperature and dissolved oxygen are compared between the two instruments. A grab sample is taken to compare with the Field **DataSonde®** for specific conductivity, pH and turbidity parameters. Based on the difference between parameters recorded by the Field **DataSonde®**, QAQC **MiniSonde®** and grab sample a qualitative statement is made on the data quality upon deployment.
- At the end of a deployment period, readings are taken in the water body from the Field **DataSonde®** 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. Based on the value for T_e, a qualitative statement is also made on the data quality upon removal.
- The ranking at the beginning and end of the deployment period are shown in **Table 2** for Tributary to Gill's Pond Brook and **Table 3** for East Pond Brook.

- 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 Quality Assurance and Quality Control (QA/QC) protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request. Where appropriate, corrected data for water quality parameters are indicated.

Tributary to Gills Pond Brook Station (NF02YO0190)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2009-11-25 Deployment	Temp (°C)	Good
	pH (units)	Good
	Sp. Conductivity (uS/cm)	Fair
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent
2010-04-26 Removal	Temp (°C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (%)	Good
	Turbidity (NTU)	Excellent

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2009-11-25 Deployment	Temp (°C)	Excellent
	pH (units)	Good
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent
2010-04-26 Removal	Temp (°C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (uS/cm)	Excellent
	Dissolved Oxygen (%)	Excellent
	Turbidity (NTU)	Excellent

Table 3

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of -0.38 ˚C to a maximum of 7.76 ˚C.
- Under stable ice conditions from mid January to the end of February, there was little variability in the water temperature.
- There appears to be little correlation with stage.
- As fouling and instrument drift were negligible, no data corrections were required for temperature.

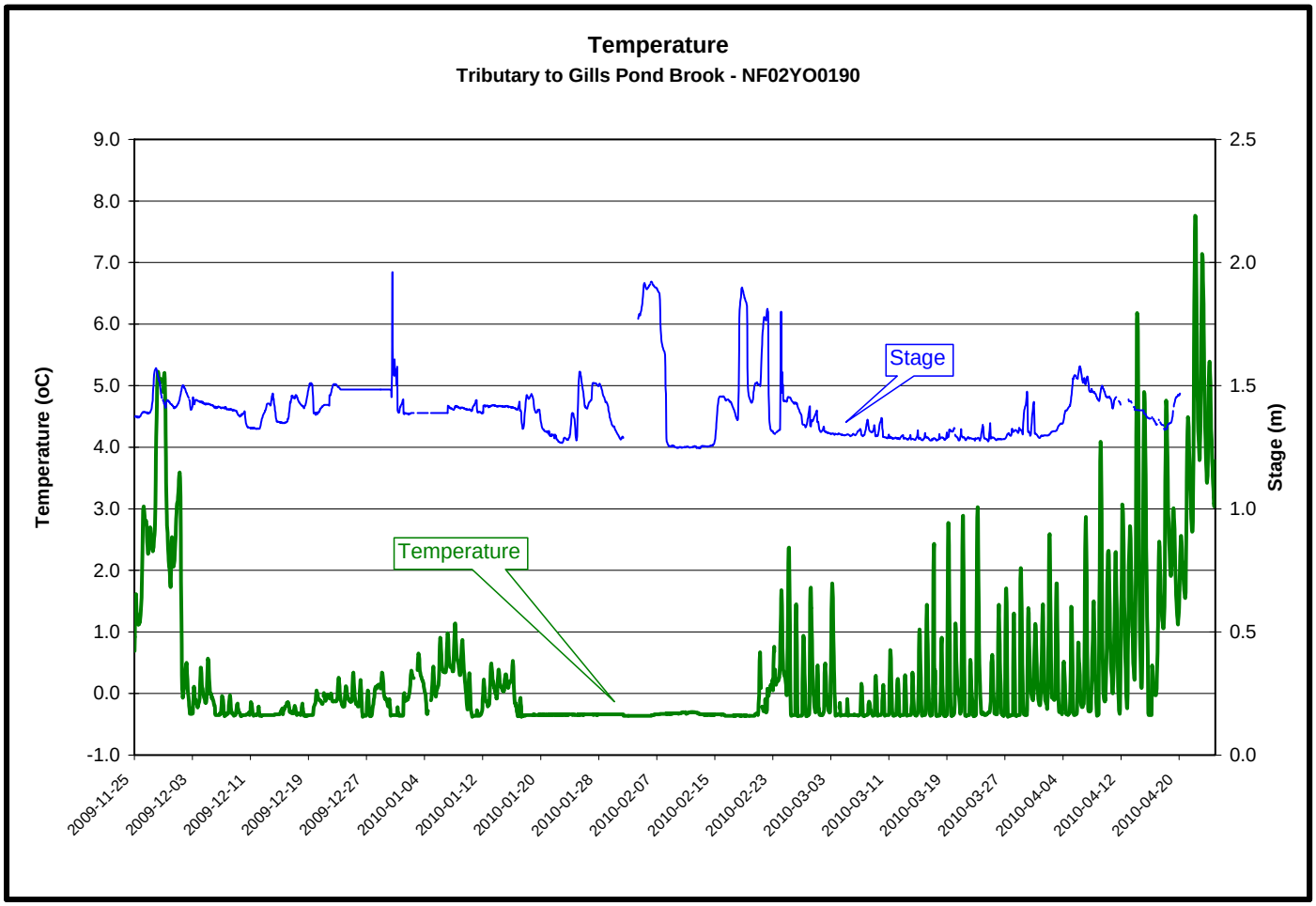

Figure 1

- Throughout the deployment period pH values (**Figure 2**) ranged from a minimum of 5.88 to a maximum of 7.29 with a some of the values falling below the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. The background pH of this stream is normally around the lower limit of the recommended range. pH varies with periods of discharge from Polishing Pond, as discharge water has a slightly higher pH than the background water quality.
- There is an inverse correlation with discharge.
- As fouling and instrument drift were negligible, no data corrections were required for pH.

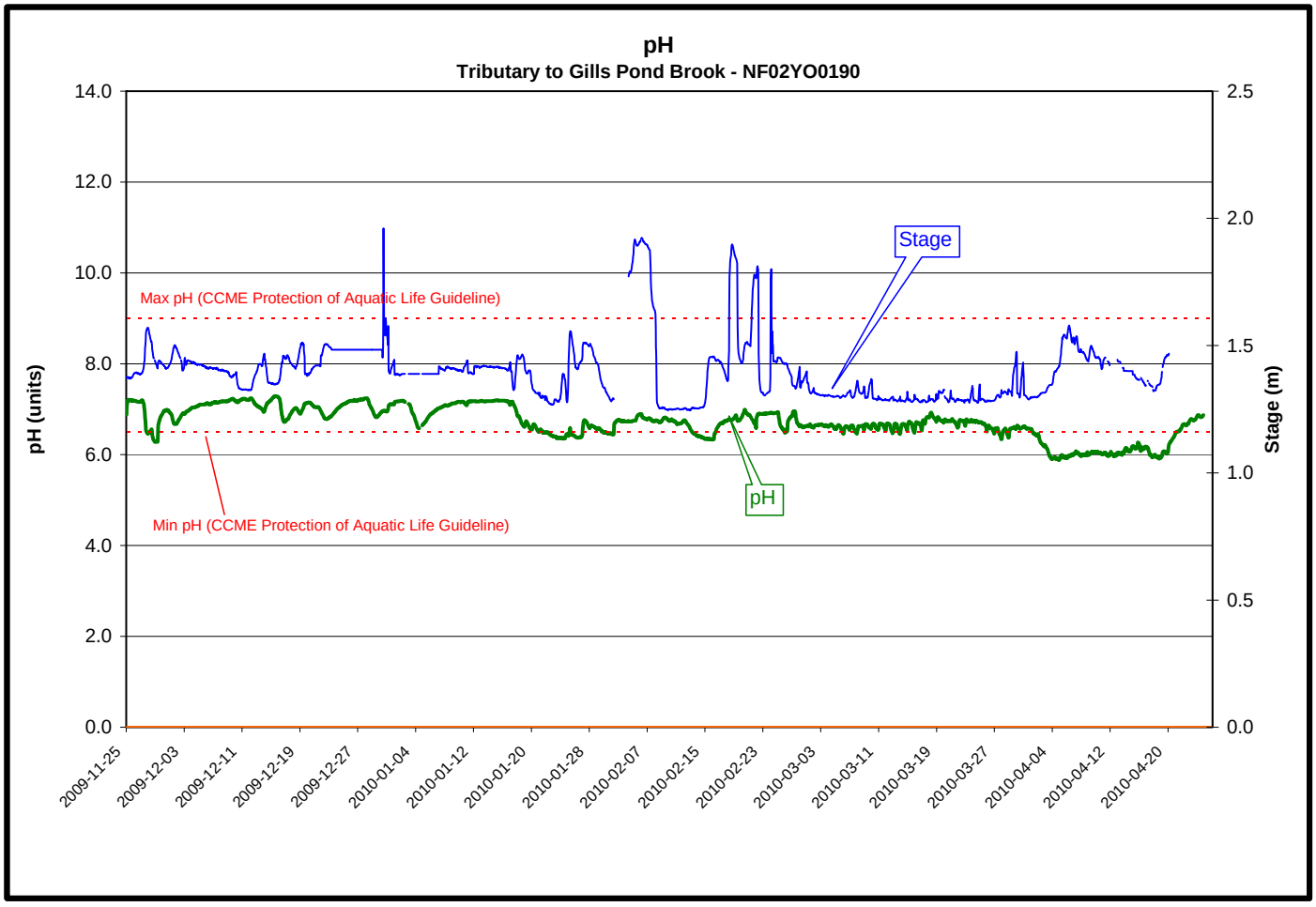

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 17.0 µS/cm to a maximum of 981.0 µS/cm over the deployment period. During the multiple discharge periods from Polishing Pond there are marked increases in conductivity. The 'V' shaped dips during some of the higher periods of specific conductivity are the result of dilution caused by precipitation events.
- As fouling and instrument drift were negligible, no data corrections were required for Specific Conductance.

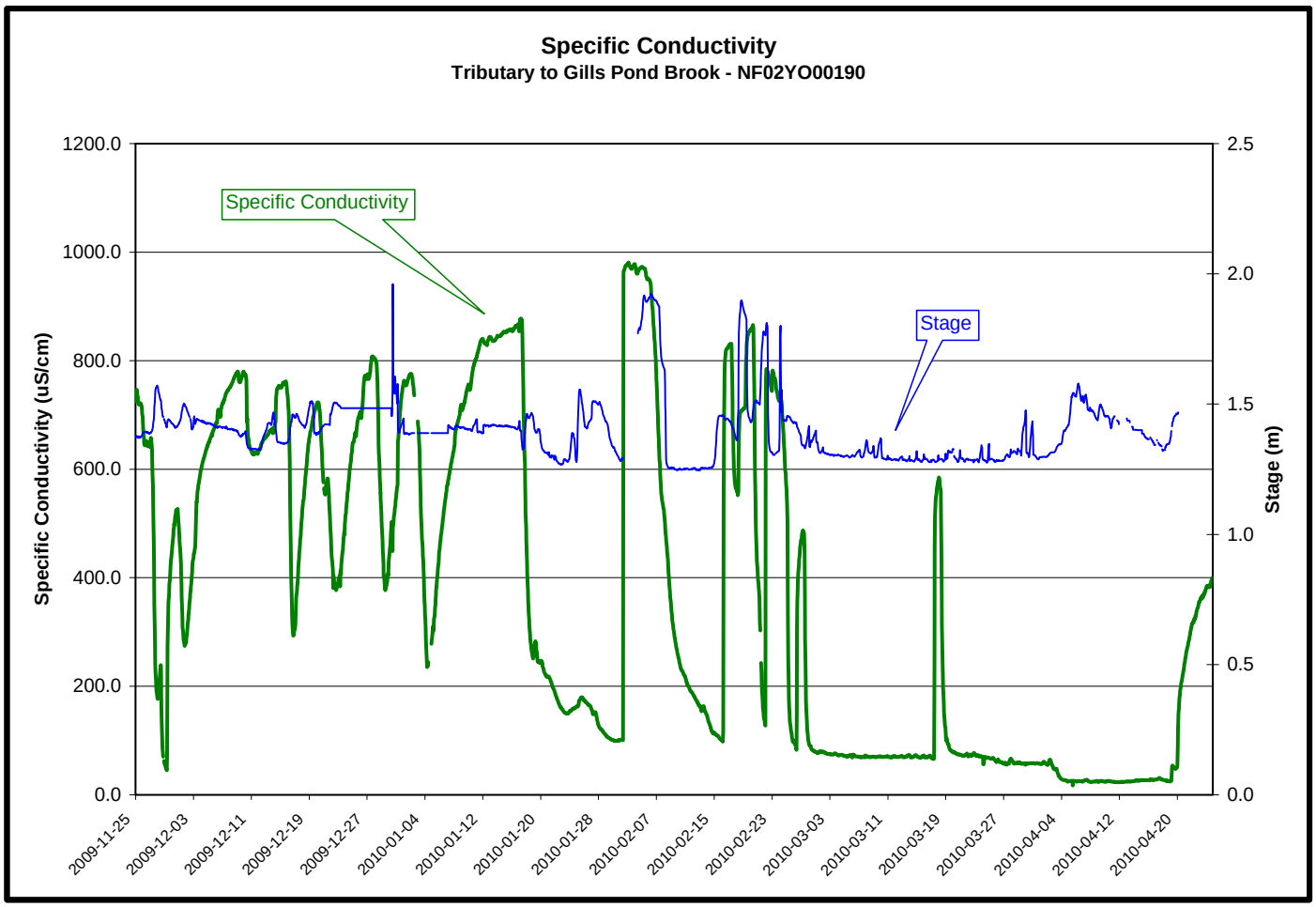

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 9.58 mg/L to a maximum of 13.76 mg/L over the deployment period. Dissolved oxygen is inversely proportional to water temperature. Throughout the deployment period, all dissolved oxygen values fell above the limits recommended by CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (cold water/other life stages – above 6.5 mg/L; cold water/early life stages – above 9.5 mg/L).
- The QA/QC protocol revealed a decrease of 7 % in the Dissolved Oxygen (% Sat) over the 152 day deployment period. The majority (6.8 %) of this decrease was due to instrument drift. Accordingly the correction factor has been applied to the raw data.
- Based upon the fact that Dissolved Oxygen % Saturation had minimal drift, we can be confident that the Dissolved Oxygen mg/L values are reasonably accurate.

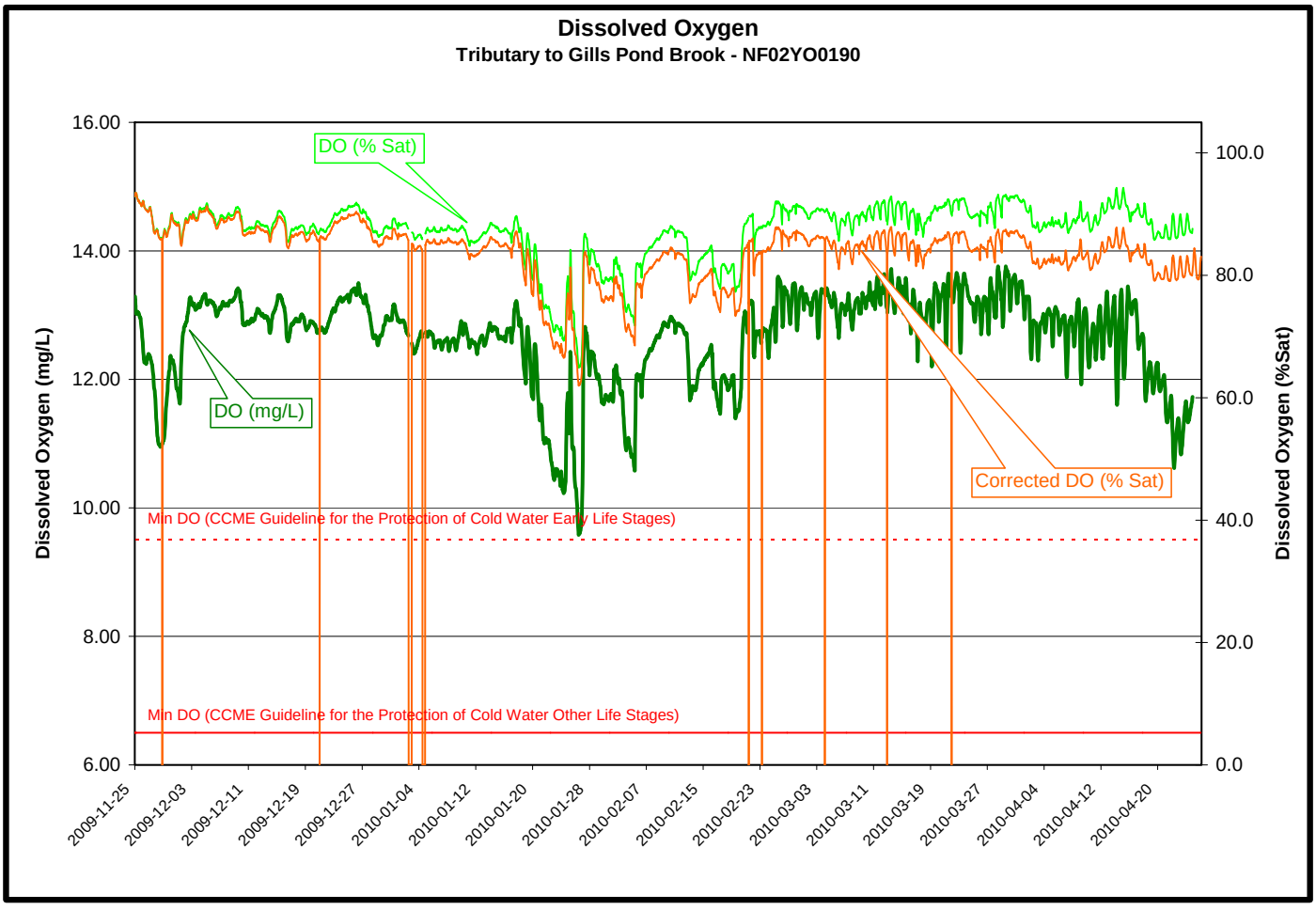

Figure 4

- The turbidity values **(Figure 5)** ranged from a minimum of 0.0 NTU to a maximum of 852.9 NTU. Higher turbidity values correspond to periods of discharge from the Polishing Pond, precipitation events and high stage. Based upon previous investigation, it has been determined that turbidity values may be artificially increased due to air entrainment during high flows.
- Neither *in situ* nor grab sample measurements nor visual observations indicated turbidity issues.
- The QA/QC protocol revealed an increase of 1.0 NTU over the 152 day deployment period. All of this increase was due to instrument drift. Accordingly the correction factor has been applied to the raw data.
- Because the spread (correction factor) is so small, the corrected data obscure the raw data.

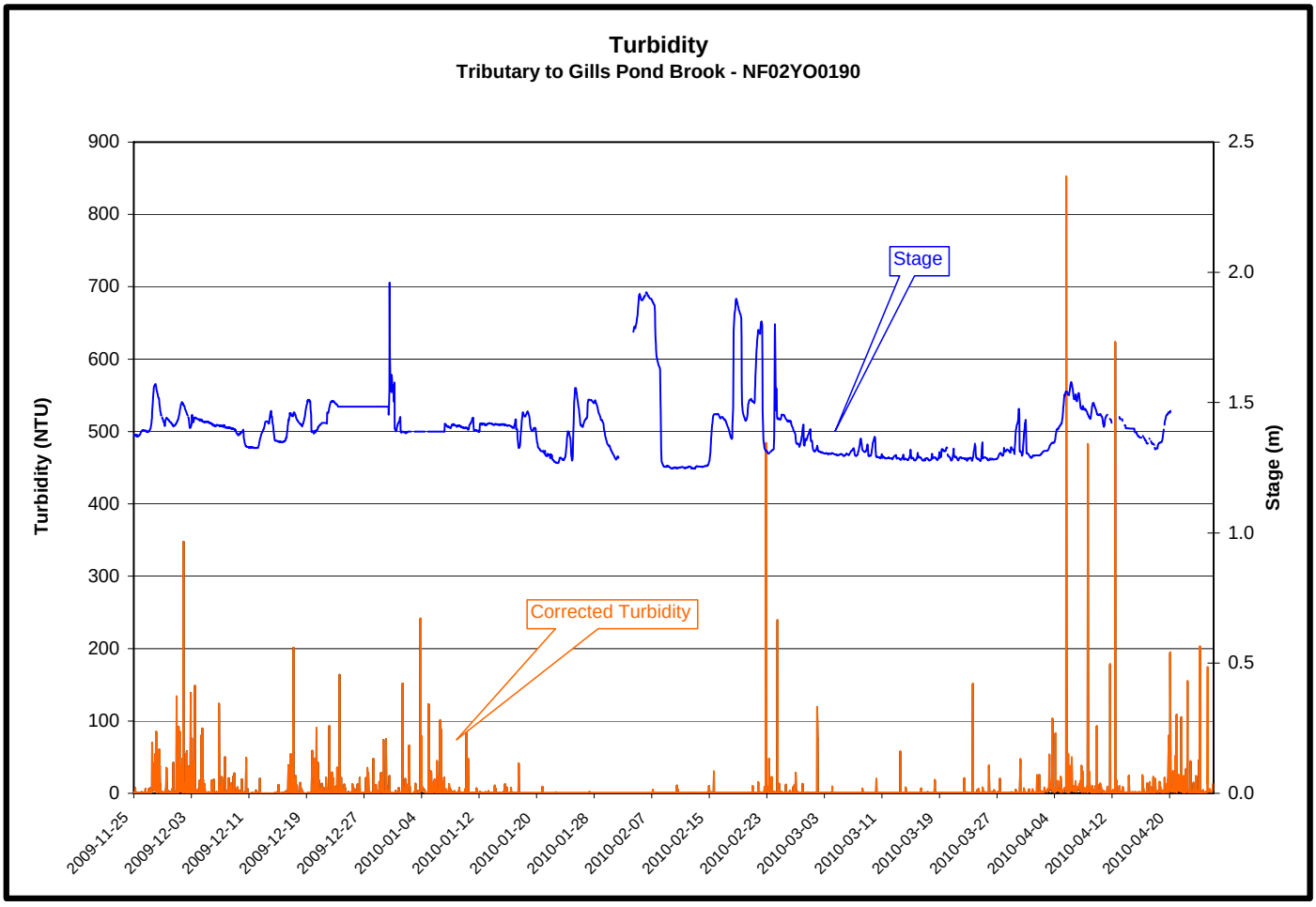

Figure 5

- The stage (**Figure 6)** or water level ranged from a minimum of 1.25 m to a maximum of 1.96 m with the highest peaks corresponding to discharge from Polishing Pond and precipitation events.

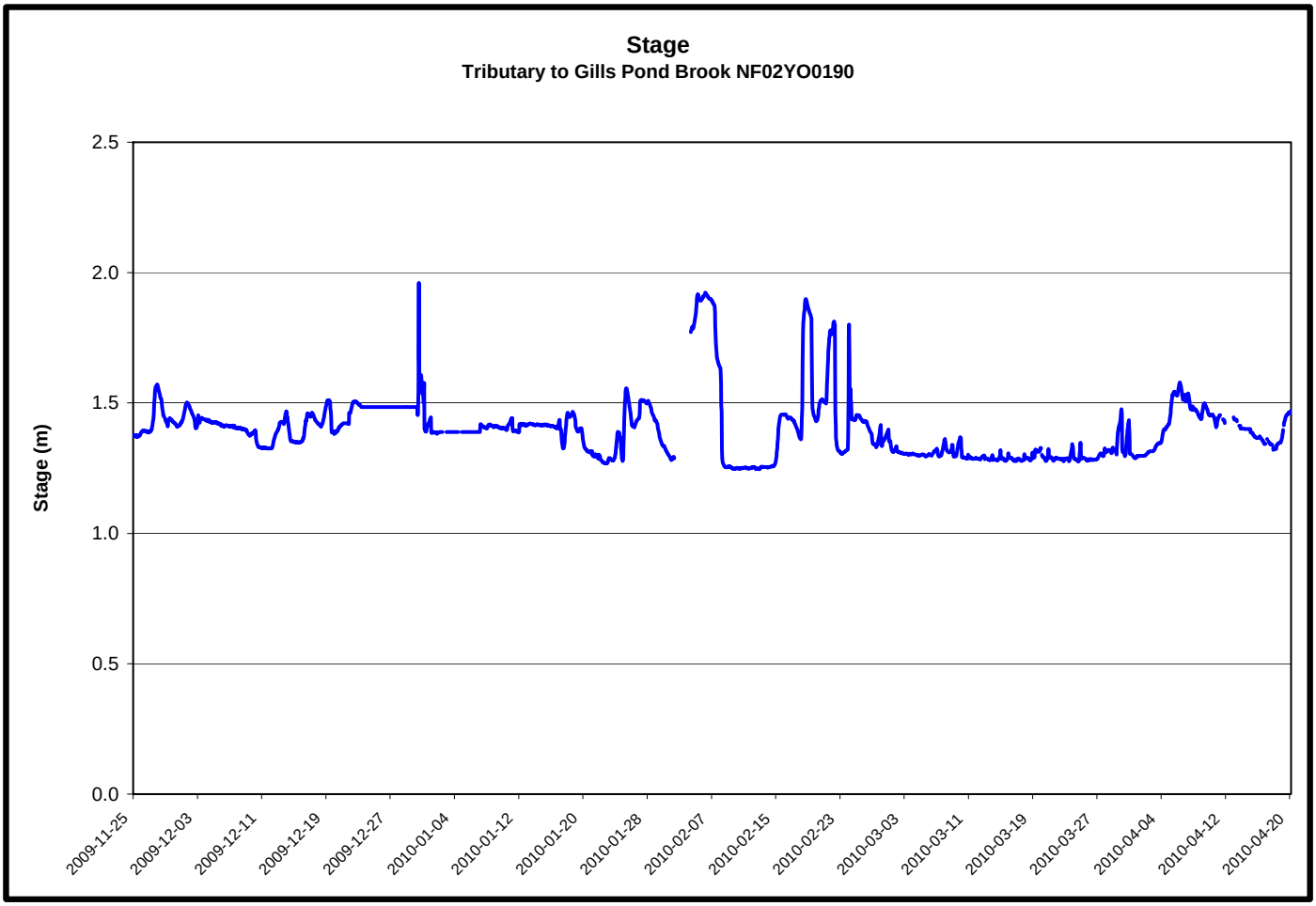

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of -0.14 ˚C to a maximum of 7.53 ˚C.
- Under stable ice conditions from mid January to the mid March, there was little variability in the water temperature.
- There appears to be little correlation with stage.
- As fouling and instrument drift were negligible, no data corrections were required for temperature.

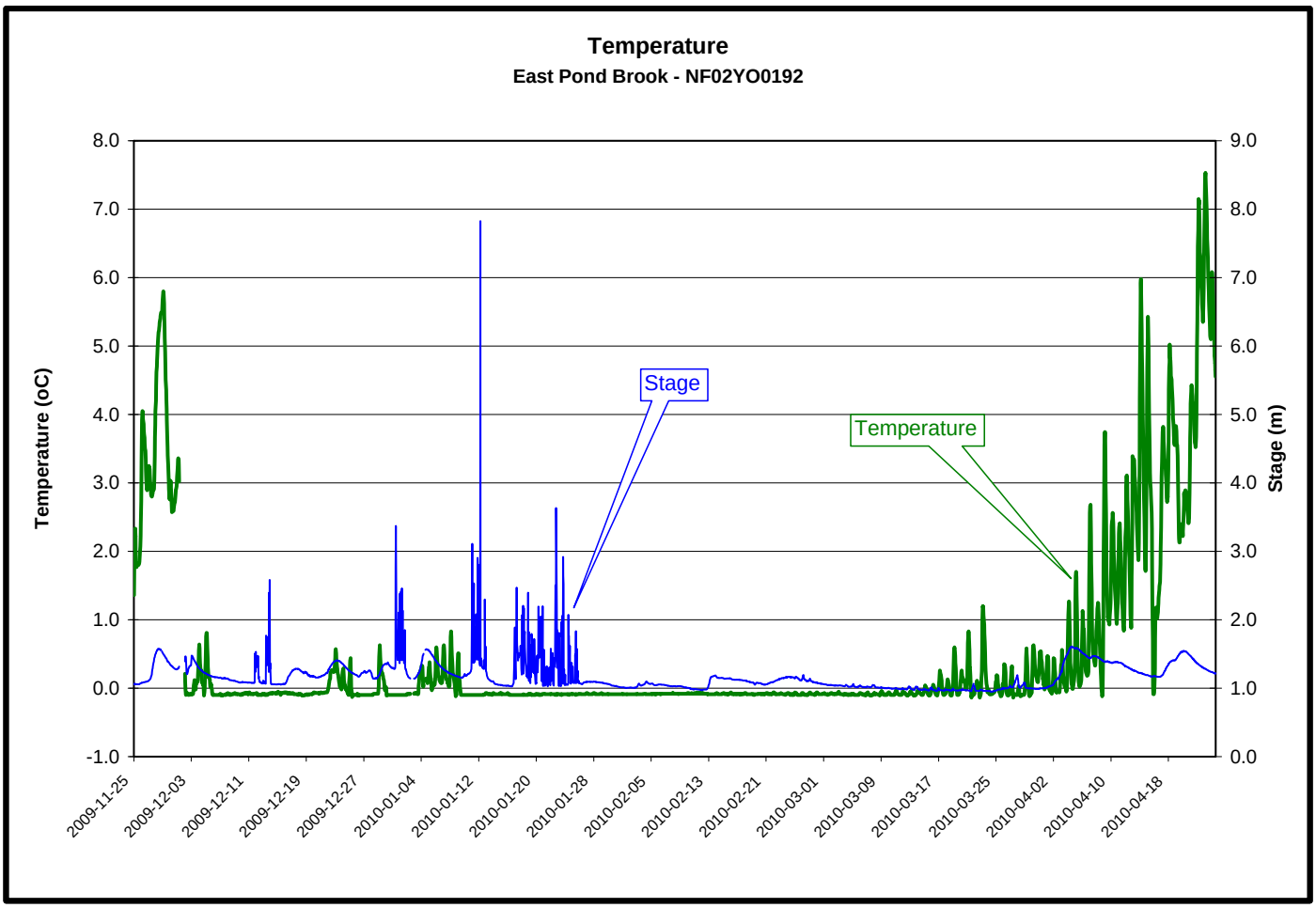

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.14 to a maximum of 7.00 with a many of the values falling below the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*. The background pH of this stream is normally quite low, and values near and below the limit are not unusual.
- There is an inverse correlation with discharge.
- As fouling and instrument drift were negligible, no data corrections were required for pH.

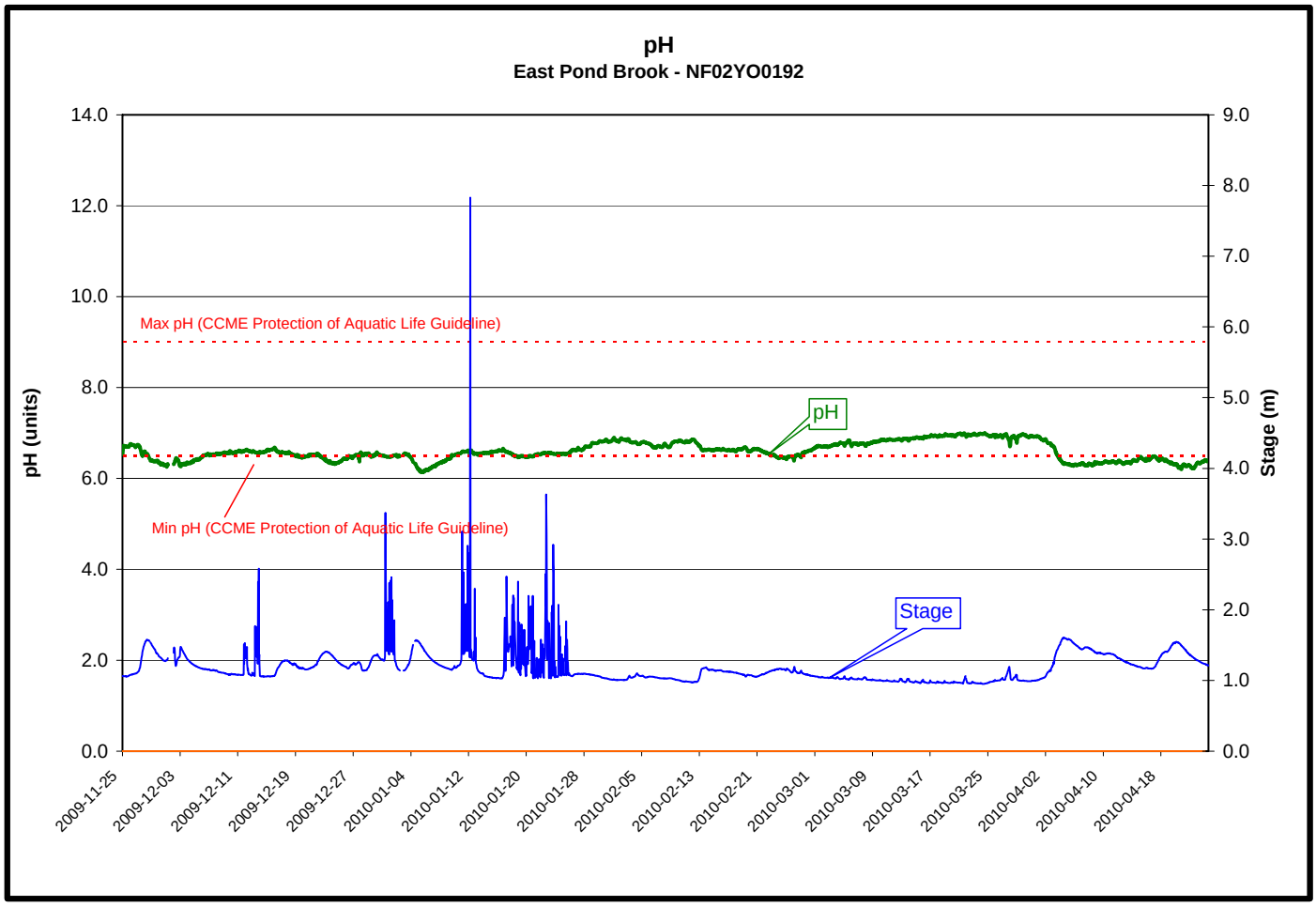

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 9.5 µS/cm to a maximum of 47.7 µS/cm.
- Lowest conductivity values correspond to periods of precipitation and high runoff. Highest conductivity values correspond to groundwater inflow during the coldest winter months, when surface flow is minimal.
- The QA/QC protocol revealed an increase of 2.6 µS/cm over the 152 day deployment period. The majority (2.5 µS/cm) of this increase was due to instrument drift. Accordingly the correction factor has been applied to the raw data.

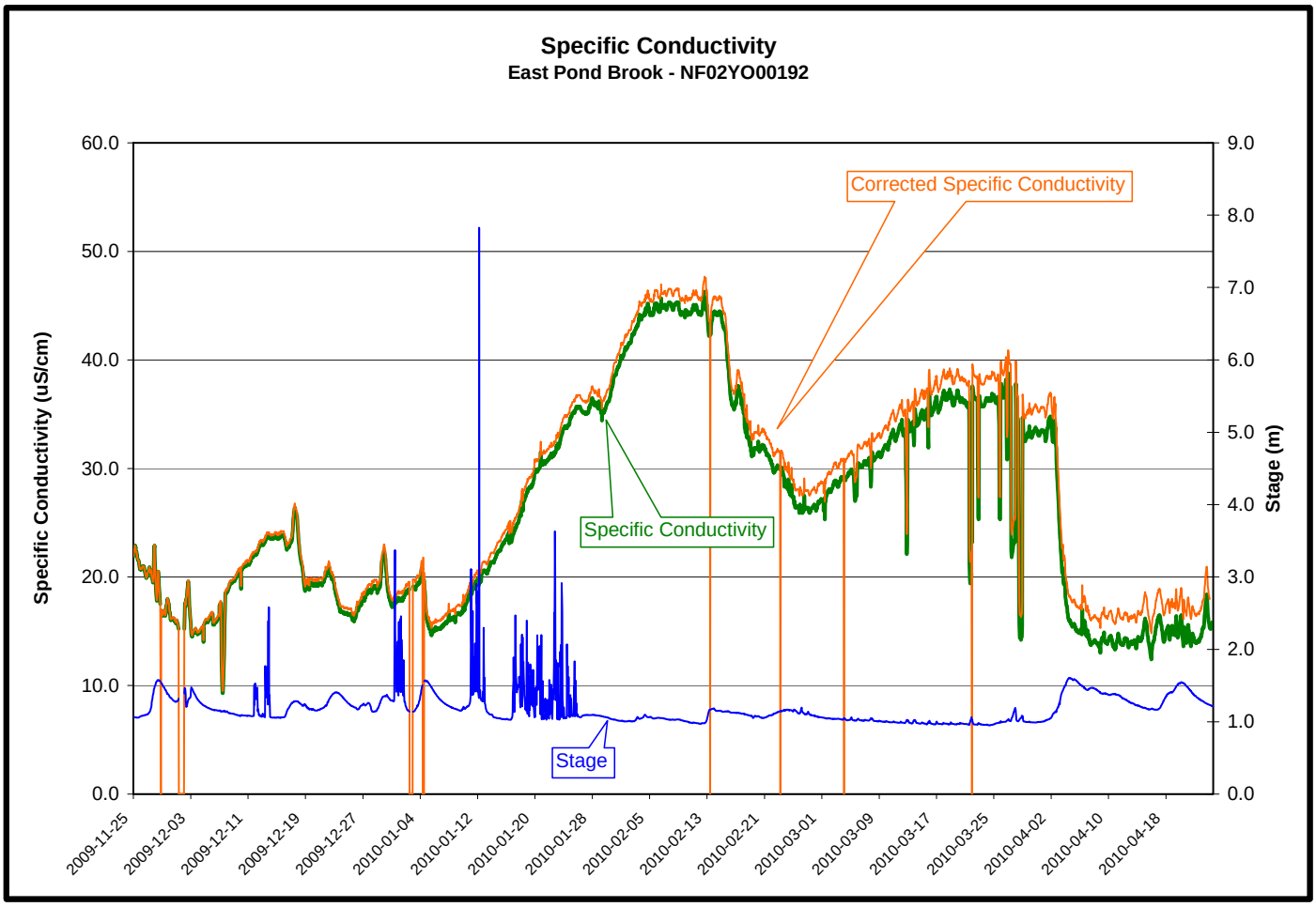

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 11.07 mg/L to a maximum of 14.02 mg/L over the deployment period.
- Dissolved oxygen is inversely proportional to water temperature.
- Throughout the deployment period, all dissolved oxygen values fell above the limits recommended by CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (cold water/other life stages – above 6.5 mg/L; cold water/early life stages – above 9.5 mg/L).
- The QA/QC protocol revealed an increase of 0.6 % in the Dissolved Oxygen (% Saturation) over the 152 day deployment period. All of this increase was due to instrument drift. Accordingly the correction factor has been applied to the raw data.
- Based upon the fact that Dissolved Oxygen % Saturation had minimal drift, we can be confident that the Dissolved Oxygen mg/L values are accurate.

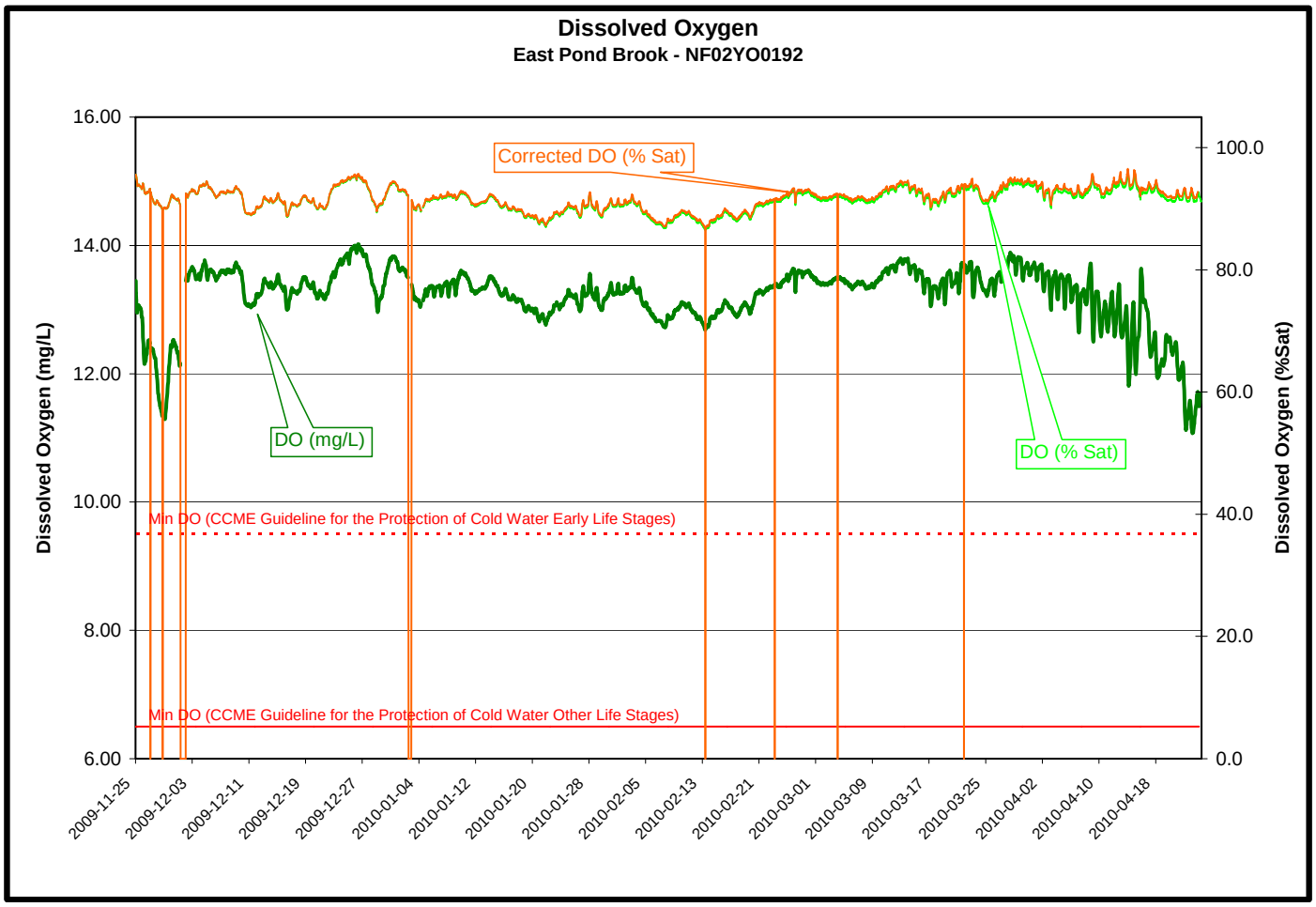

Figure 10

- The turbidity values **(Figure 11)** ranged from a minimum of 0.0 NTU to a maximum of 668.3 NTU.
- The high turbidity values around the middle and end of December are likely the result of ice formation in the stream.
- Typically, turbidity values in this stream are near zero.
- Neither *in situ* nor grab sample measurements nor visual observations indicated turbidity issues.
- The QA/QC protocol revealed an increase of 1.2 NTU over the 152 day deployment period. All of this increase was due to instrument drift. Accordingly the correction factor has been applied to the raw data.
- Because the spread (correction factor) is so small, the corrected data obscure the raw data.

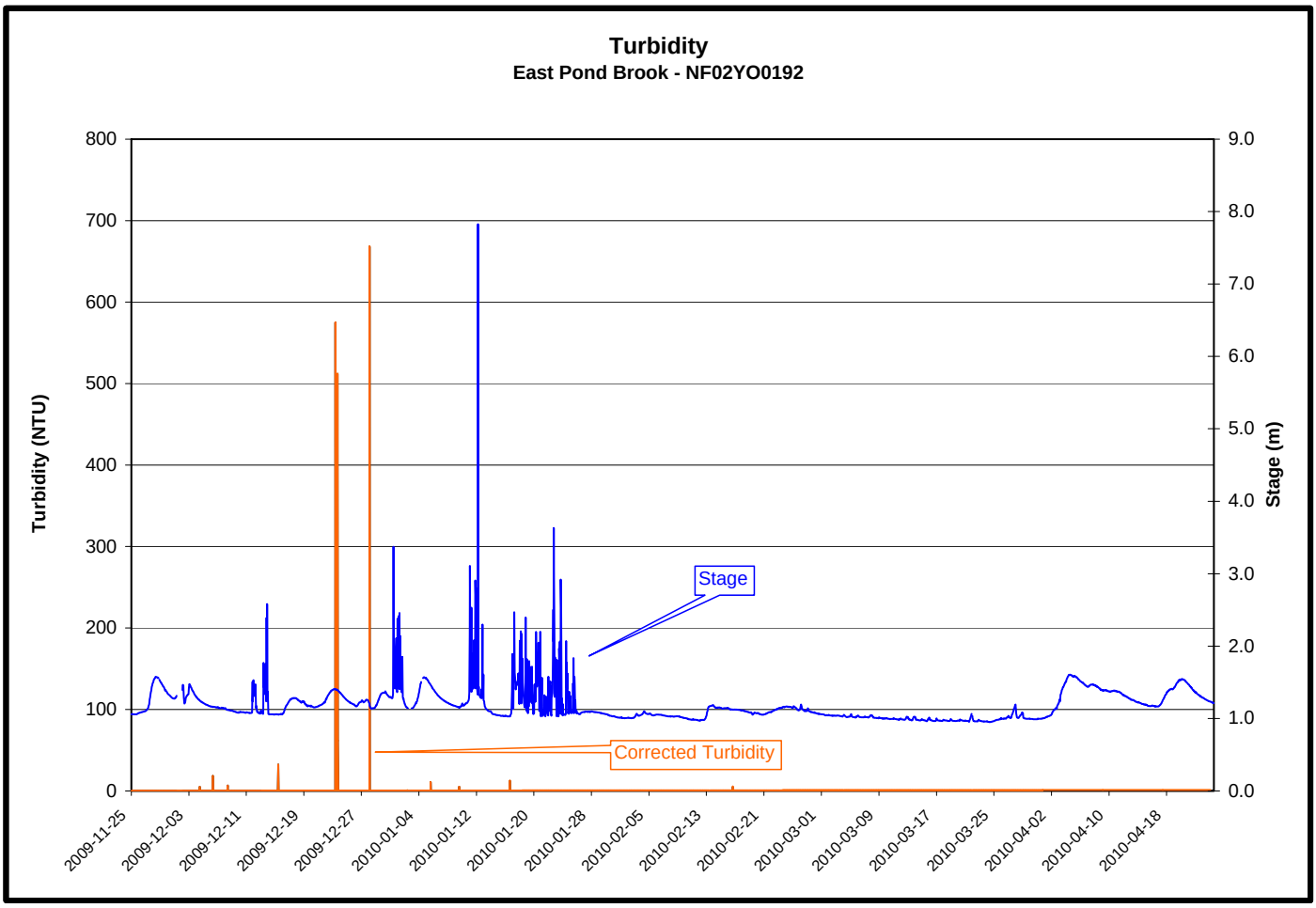

Figure 11

- The stage **(Figure 12)** or water level ranged from a minimum of 0.95 m to a maximum of 7.83 m. The highest peak on January 12, 2010 is likely due to the backwater effect of ice in the stream. A value of over 7 meters is erroneous, as water would never reach this high in this stream.
- Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.
- Other peaks correspond to precipitation and snowmelt events.

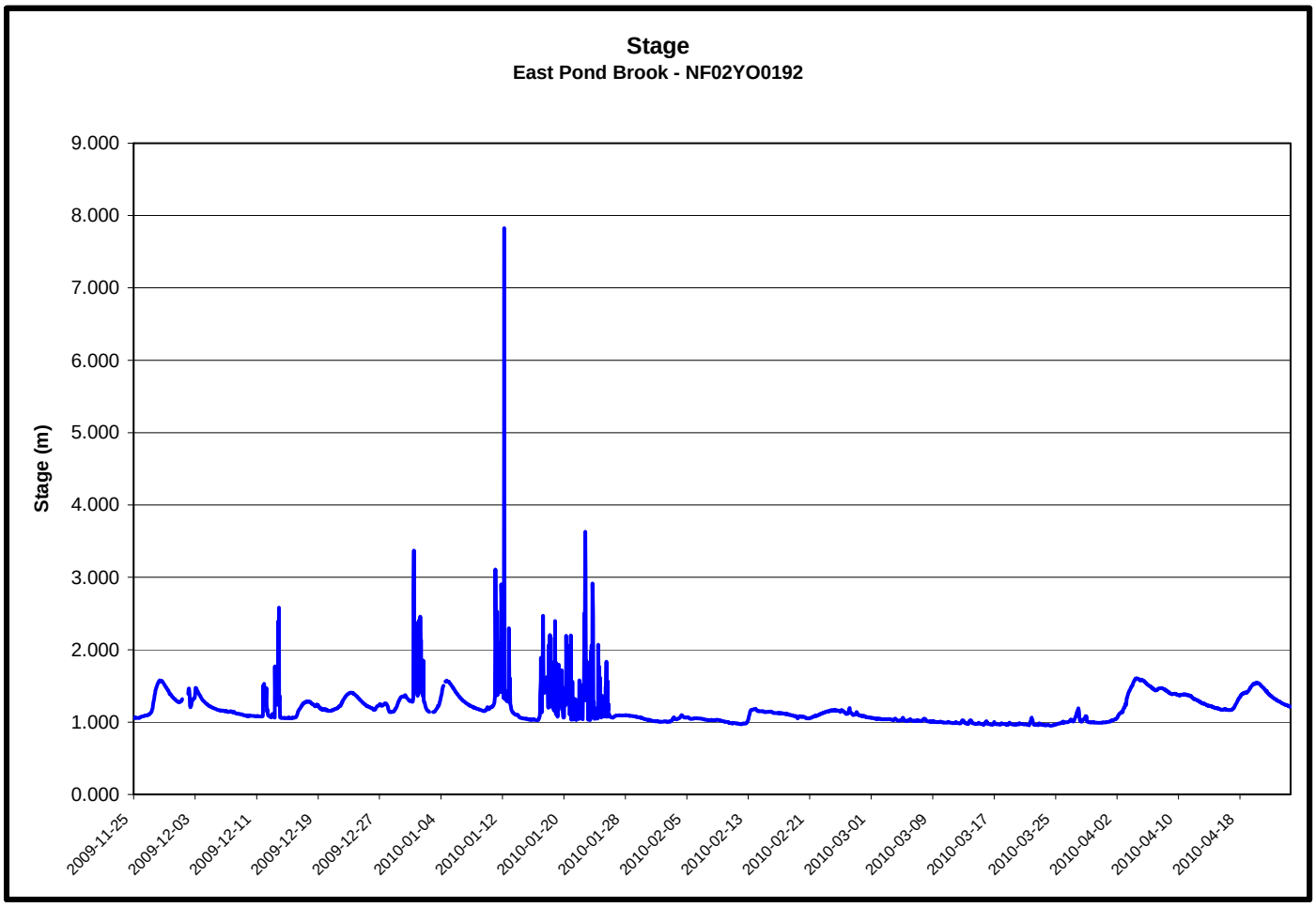

Figure 12

Prepared by:

Robert Wight
Environmental Scientist
Water Resources Management Division
Department of Environment and Conservation
Tel: 709-292-4280
Fax: 709-292-4365
e-mail: robertwight@gov.nl.ca