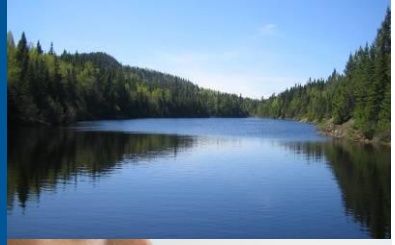




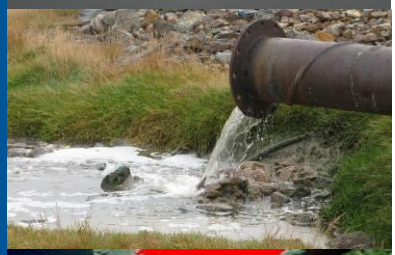


Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2015-10-06 to 2015-11-16

2015-12-15

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.
- There was discharge of effluent from Polishing Pond into the receiving waters (Tributary to Gills Pond Brook) from the beginning of the deployment period until October 20, 2015. Discharge rates were reduced to minimal flows from October 10, 2015 to October 12, 2015, with increased flows again from October 13, 2015 until October 20, 2015, when discharge ceased. Discharge resumed again on November 2, 2015 to the end of the deployment period, as the Polishing Pond was emptied prior to the onset of the winter season.

Maintenance and Calibration of Instrumentation

- **DataSonde®** s/n 43245 was deployed in Tributary to Gills Pond Brook on October 6, 2015 after being cleaned and freshly calibrated, and remained deployed continuously until November 10, 2015. Subsequently, **DataSonde®** s/n 62268 was deployed in Tributary to Gills Pond Brook on November 10, 2015 after being cleaned and freshly calibrated, and remained deployed continuously until November 16, 2015. These two deployments cover a 40 day period. **DataSonde®** s/n 62268 was deployed for less than a week, as turbidity values were unstable and deemed unreliable, from the onset. As a result, the unstable turbidity values have been deleted from the dataset.
- **DataSonde®**(s/n 43794) was deployed in East Pond Brook on October 6, 2015 after being cleaned and freshly calibrated, and remained deployed continuously until November 10, 2015. Subsequently, **DataSonde®**(s/n 62267) was deployed in East Pond Brook on November 10, 2015 after being cleaned and freshly calibrated, and remained deployed continuously until November 16, 2015. These two deployments cover a 40 day period. **DataSonde®** s/n 62267 was deployed for less than a week, as turbidity values were unstable and deemed unreliable, from the onset. As a result, the unstable turbidity values have been deleted from the dataset.
- **MiniSonde®** (s/n 47591) was used for QA/QC purposes during the installation of the instruments. This unit, having the same technical specifications as the **DataSondes®**, was cleaned and freshly calibrated prior to each use.
- **Quanta G®** (s/n 00035) was deployed on June 16, 20115 and remained deployed until October 7, 2015. Subsequently **Quanta G®** (s/n 000653) was deployed on October 7, 2015 and remained deployed until October 14, 2015. Unfortunately, this unit failed as the instrument became flooded, and all data from this period were deemed unreliable and have been removed from the dataset. Finally, the original **Quanta G®** (s/n 00035) was deployed again on October 14, 2015 and remains deployed past the end of the current 40 day reporting period.

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

- For the Surface Water Stations, upon deployment and removal, a QA/QC **MiniSonde®** is usually temporarily deployed along side the Field **DataSonde®**. Values for each recorded parameter are compared between the two instruments. Based upon the difference between the parameters recorded by the Field **DataSonde®** and QA/QC **MiniSonde®** a qualitative statement (Ranking) is usually made on the data.
- The rankings at the beginning and end of each deployment in this reporting period are shown in **Table 2** for Tributary to Gill's Pond Brook and **Table 3** for East Pond Brook.
- The rankings for Well After Tailings Dam (MW1) are shown in **Table 4**. Rankings can only be made for removal on October 10, 2015 and installation on October 14 2015, as the instrument deployed between those dates did not provide any reliable data. As the unit remains deployed past the end of the reporting period, rankings for removal will be documented in a subsequent report.
- Because the deployment set-up for Well After Tailings Dam (MW1) is different, comparison with another instrument is not possible. In this case, a grab sample is usually collected at the beginning and end of the deployment period, and the ranking is calculated for pH and Specific Conductivity based upon live data and laboratory data.
- For East Pond Brook, the pH values drifted slightly lower than anticipated (although ranking as 'Good'). It has been determined that the pH sensor was beginning to fail. It has subsequently been replaced.
- For East Pond Brook, Dissolved Oxygen ranking as 'Fair' upon removal on November 10, 2015. The difference between the two measurements was a mere 0.51 mg/L.
- For both Tributary to Gills Pond Brook and East Pond Brook, a turbidity ranking could not be calculated for either the installation or removal of the instruments for the second deployment (November 10, 2015 to November 16, 2015), as the turbidity sensors in both instruments provided unreliable data. Turbidity sensors in both instruments have been scheduled for replacement.
- For Well After Tailings Dam (MW1), a 'Fair' ranking was calculated for pH upon installation on October 14, 2015. The measured differences in pH are typical for all instrument installations in this well.

- With the exception of water quantity data (Stage and Flow), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Tributary to Gills Pond Brook Station (NF02YO0190)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2015-10-06 Installation	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent
2015-11-10 Removal	Temp (^{o}C)	Good
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent
2015-11-10 Installation	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA
2015-11-16 Removal	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA

Table 2

East Pond Brook Station (NF02YO0192)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2015-10-06 Installation	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Good
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent
2015-11-10 Removal	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Good
	Dissolved Oxygen (mg/L)	Fair
	Turbidity (NTU)	Excellent
2015-11-10 Installation	Temp (^{o}C)	Excellent
	pH (units)	Excellent
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA
2015-11-16 Removal	Temp (^{o}C)	Excellent
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	NA

Table 3

Well After Tailings Dam (MW1) Station (NF02YO0193)		
Date (yyyy-mm-dd)	**Parameter**	**Ranking**
2015-10-07 Removal	pH (units)	Good
	Sp. Conductivity (mS/cm)	Good
2015-10-14 Installation	pH (units)	Fair
	Sp. Conductivity (mS/cm)	Excellent

Table 4

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of -0.26˚C to a maximum of 14.11˚C.
- The water temperature decreased considerably over the deployment period, as one would expect with the onset of winter.
- There is no obvious correlation with stage.

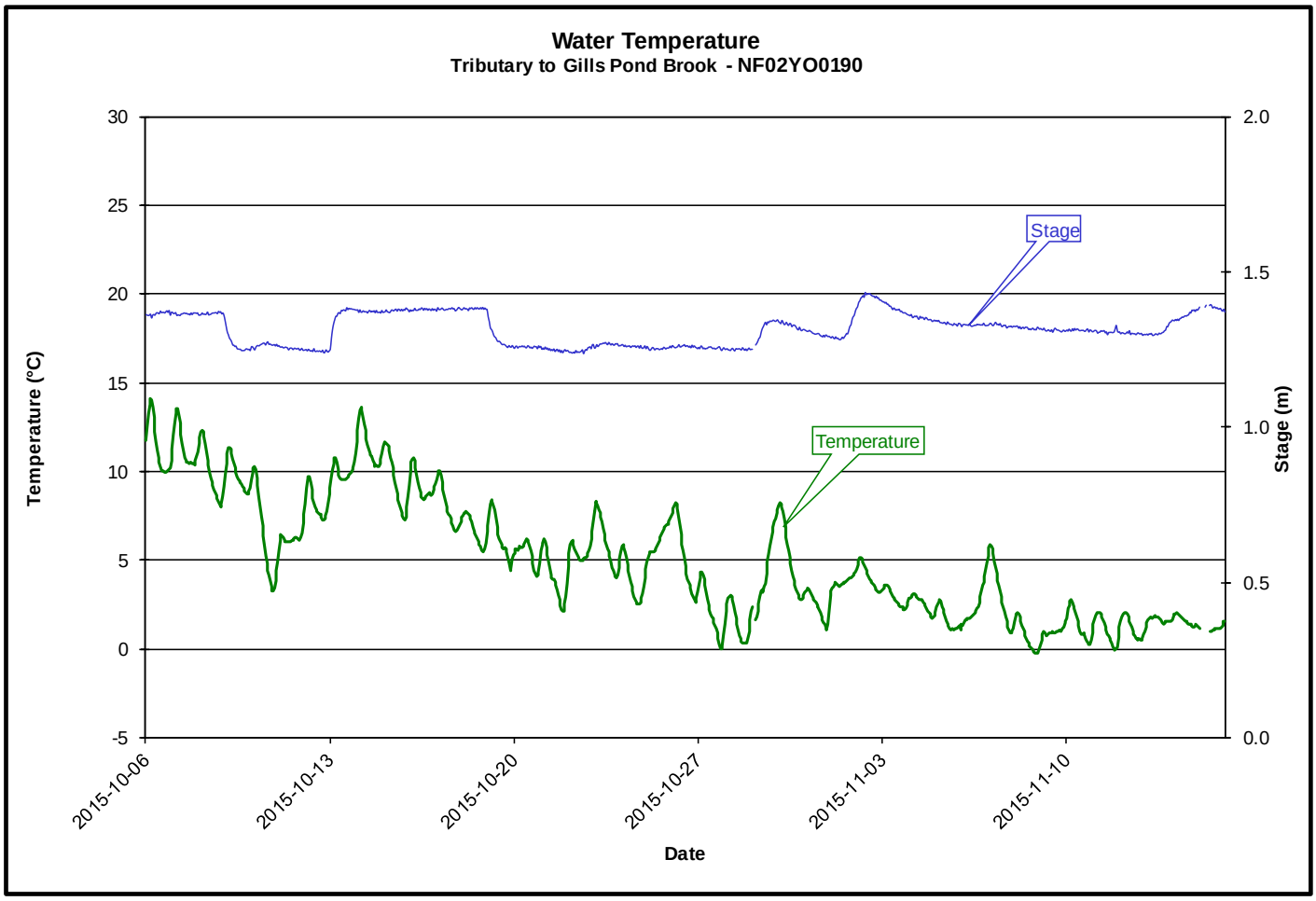

Figure 1

- Throughout the deployment period, pH values (**Figure 2**) ranged from a minimum of 6.65 to a maximum of 7.48.
- During this deployment period pH remained above the lower limit of the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- There is no obvious response in pH following changes in the discharge rate from Polishing Pond on October 10, 13 and 20, 2015.
- An inverse relationship with stage is obvious following a precipitation/runoff (increases in stage) in the latter half of the deployment period.
- On November 10, 2015, a brief decrease in pH was recorded, however, there is no obvious cause or explanation.

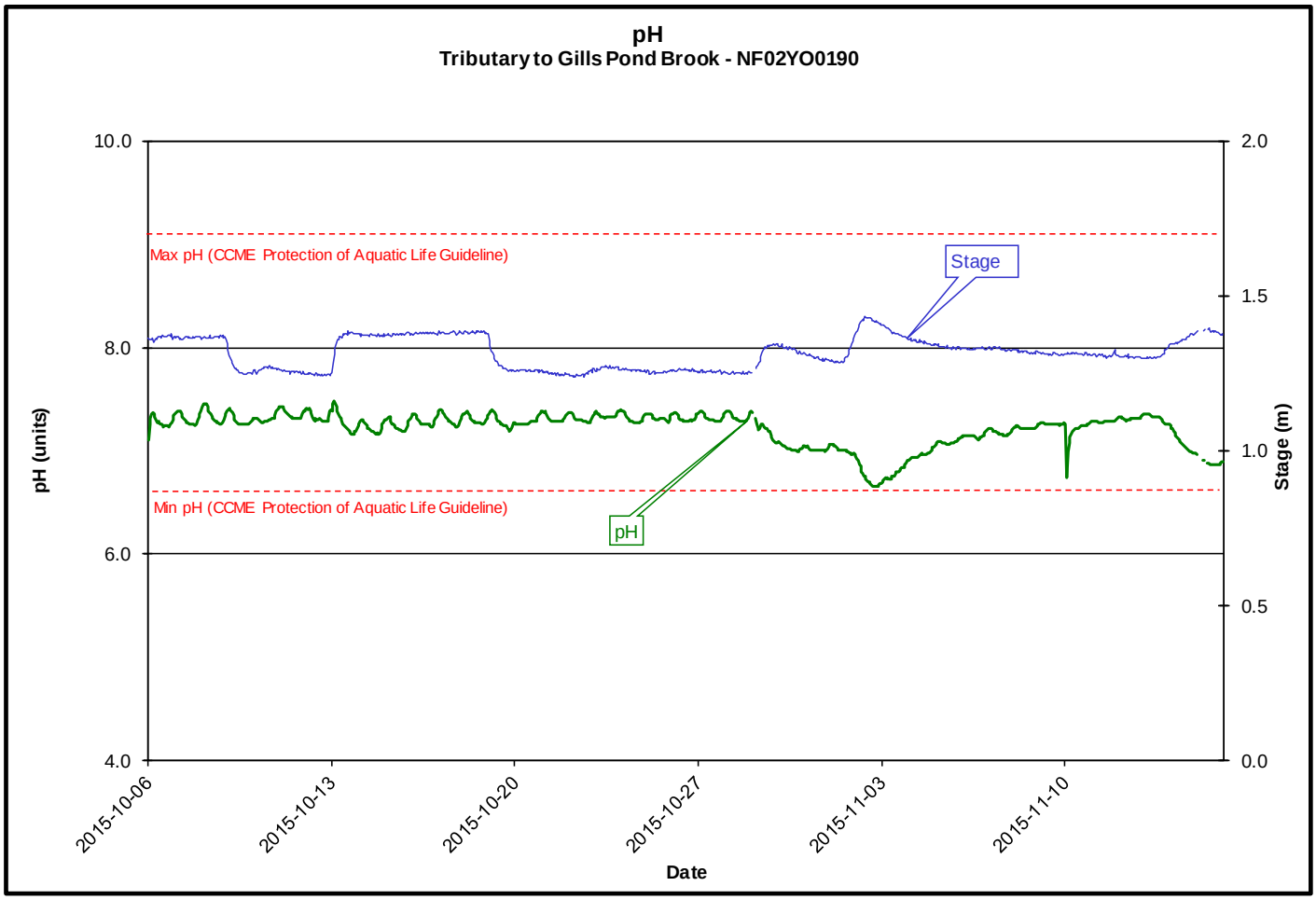

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 96.6 µS/cm to a maximum of 1559.0 µS/cm over the deployment period.
- Following changes in the discharge rate from Polishing Pond on October 10, 13 and 20, and November 2, 2015, corresponding changes in specific conductance are quite obvious.
- The specific conductance values after November 2, 2015 are much lower than at the beginning of the deployment period, as this event is merely the draining of the Polishing Pond prior to the winter season. There were no inputs from the Tailings Management Area.

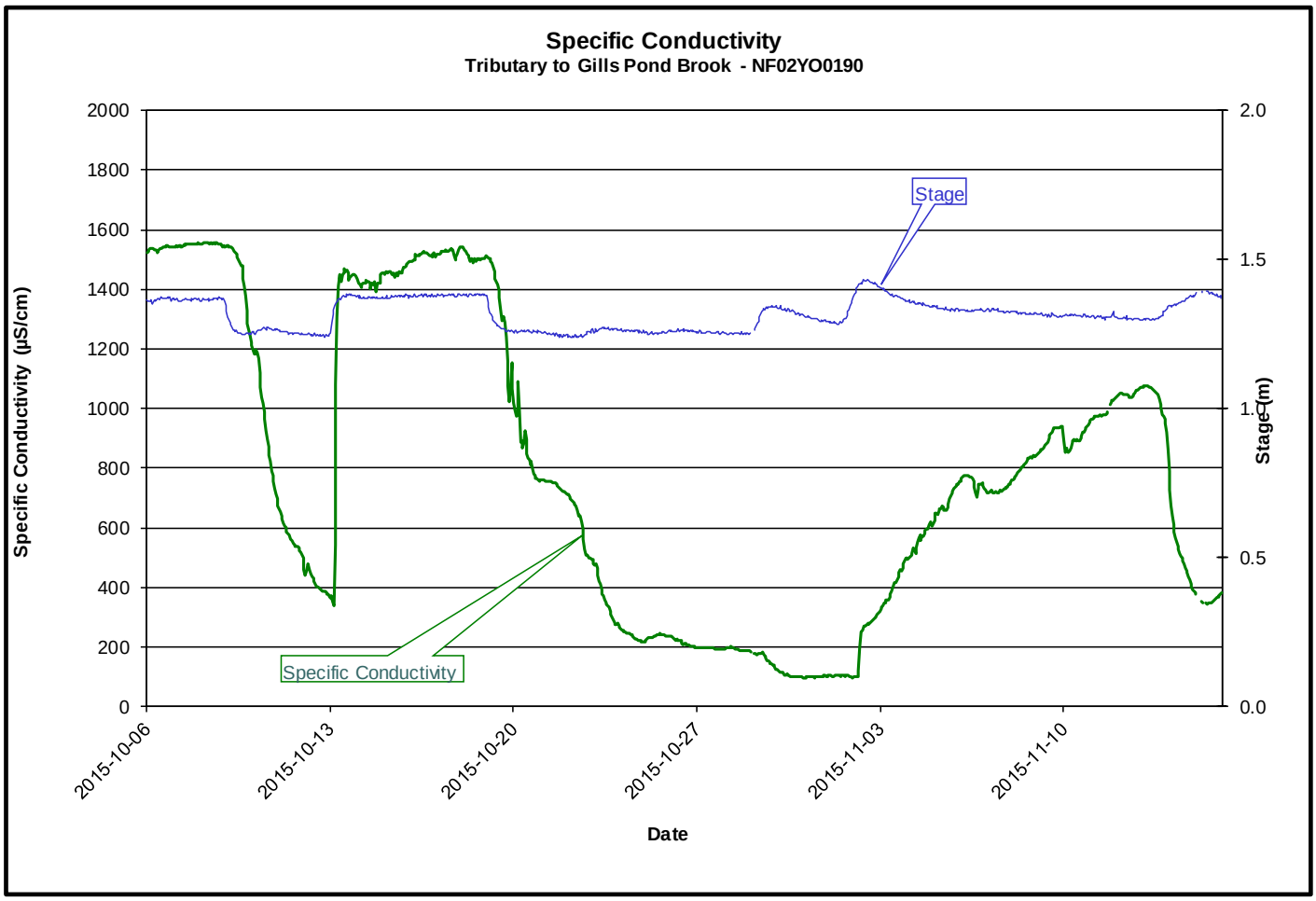

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 9.76 mg/L to a maximum of 13.66 mg/L over the deployment period, with the percent saturation ranging between 88.9 and 98.4.
- Dissolved oxygen (mg/L) levels increased throughout the deployment period, as one would expect with reduced water temperatures.
- All of the dissolved oxygen values fell above the minimum for Early Life Stages (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). This range is typical based upon water temperatures.
- Based upon the fact that dissolved oxygen % saturation had minimal and predictable change over the deployment period, we can be confident that the dissolved oxygen mg/L values are accurate.

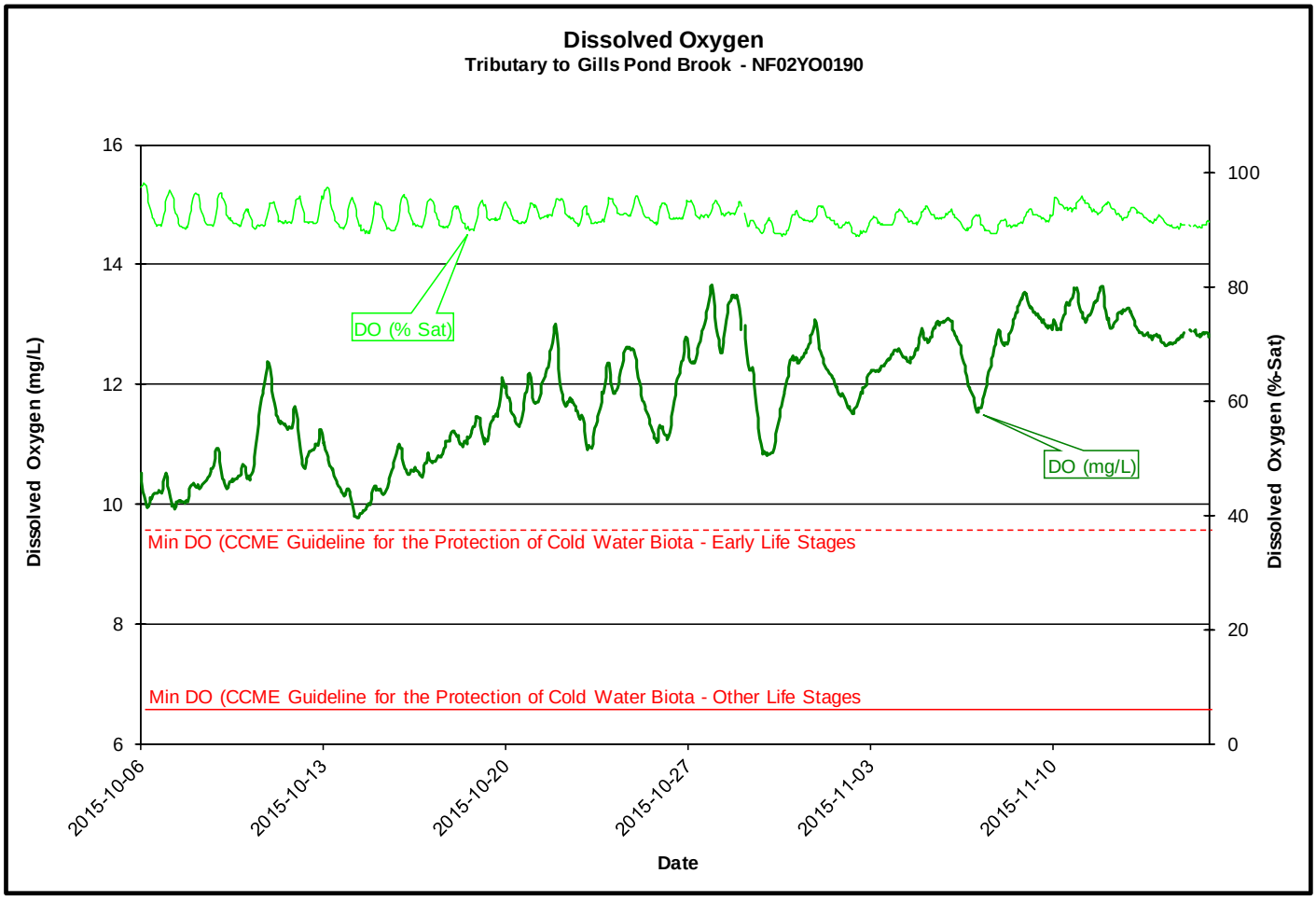

Figure 4

- The turbidity values **(Figure 5)** remained constant at 0.0 NTU throughout mostly of the deployment period. As the turbidity sensor failed on the unit deployed from November 10, 2015 to November 16, 2015, these unreliable turbidity values have been removed from the data set.
- No issues with turbidity were evident.

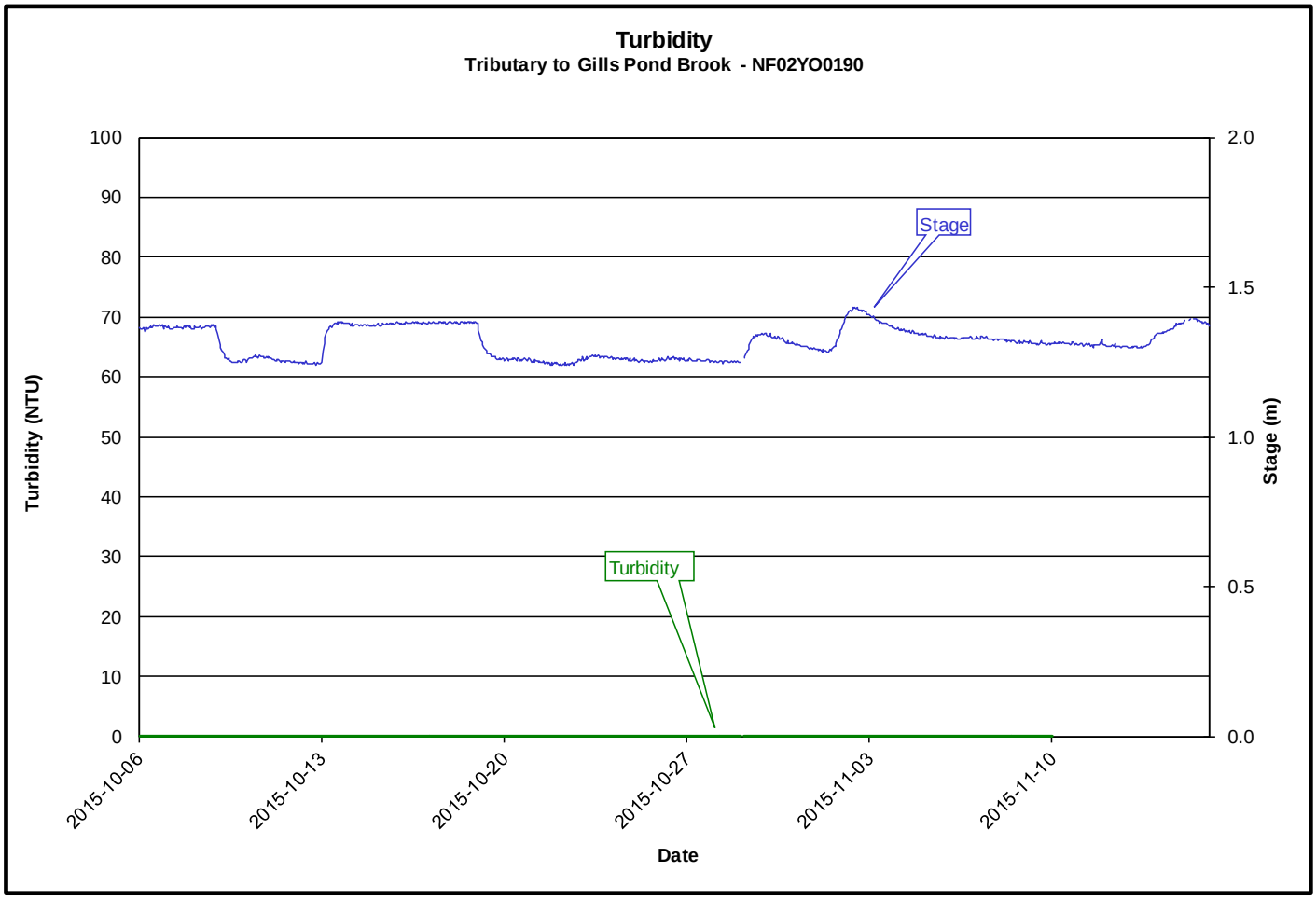

Figure 5

- The stage or water level ranged from a minimum of 1.24 m to a maximum of 1.43 m. The flow or discharge ranged from a minimum of 0.03 m^3/s to a maximum of 0.51 m^3/s (**Figure 6)**.
- Following changes in the discharge rate from Polishing Pond on October 10, 13 and 20, changes in Stage and Flow are obvious. Minimal increases in the volume from Polishing Pond on November 2, 2015 are essentially masked by increases in stage and flow resultant from precipitation and subsequent runoff.
- Stage and flow are all within normal ranges.
- Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

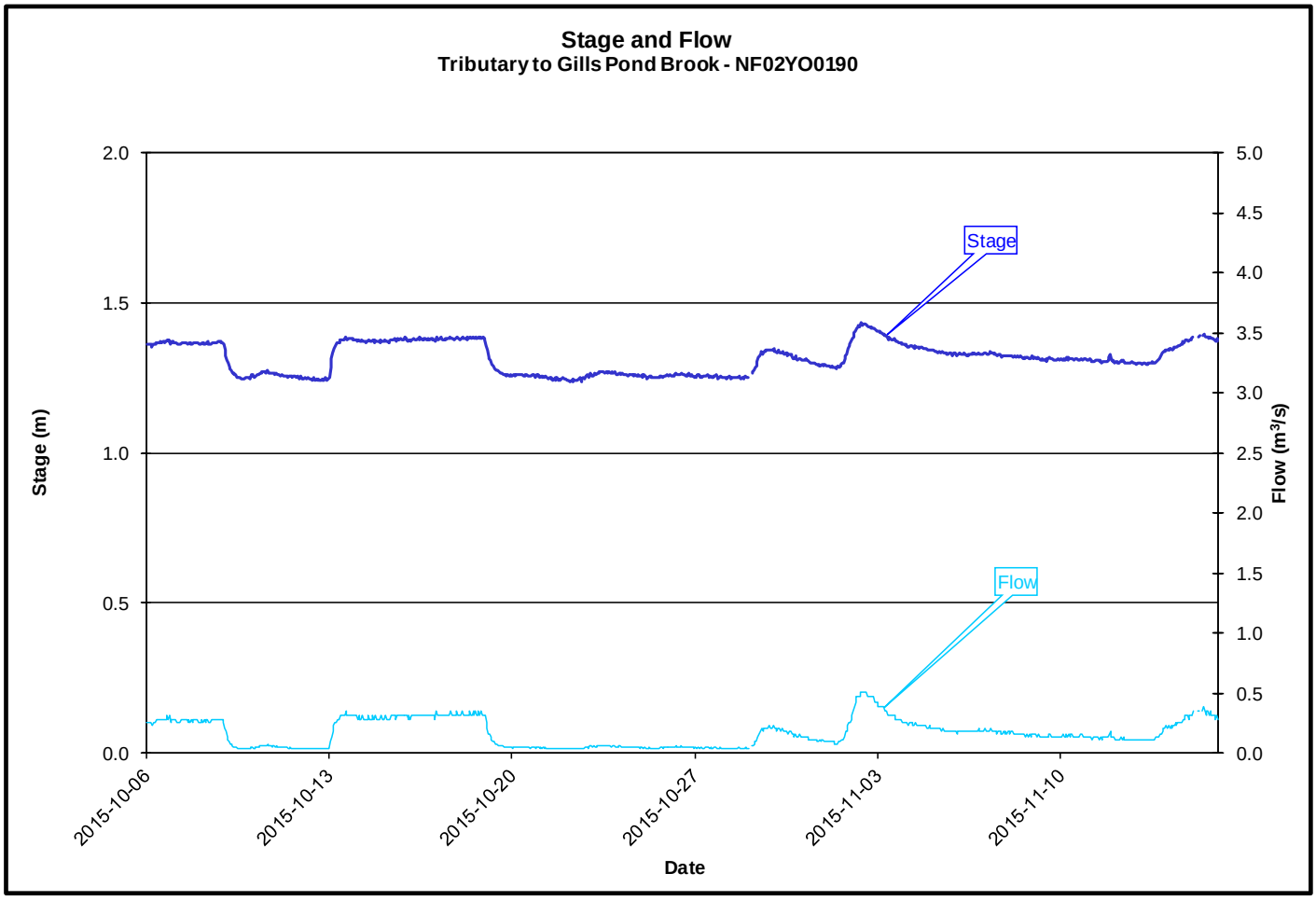

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of 0.03 ˚C to a maximum of 15.26 ˚C.
- The water temperature decreased considerably over the deployment period, as one would expect with the onset of winter.
- There is no obvious correlation with stage.

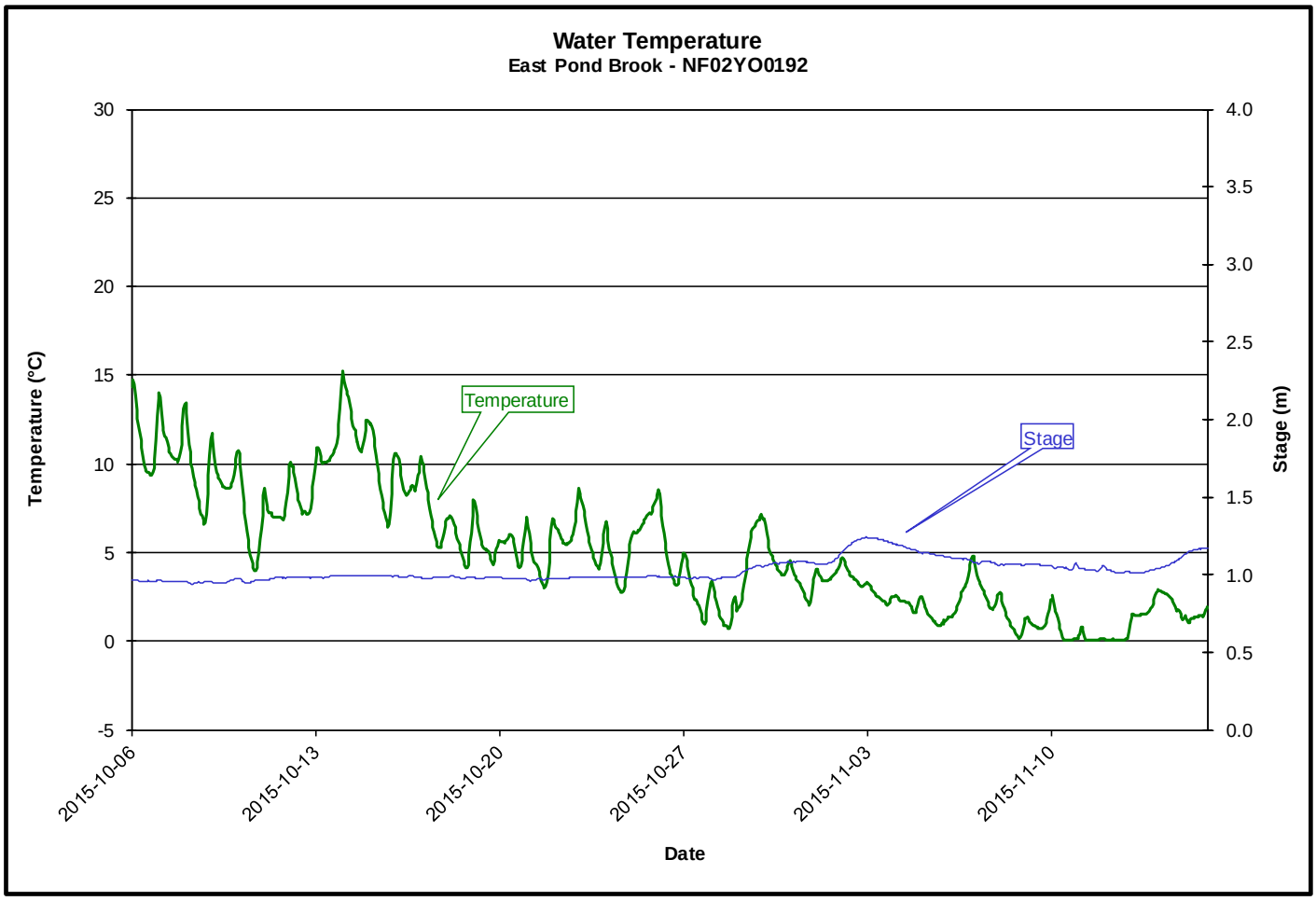

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 5.94 to a maximum of 7.47.
- Throughout the deployment period, pH values were right around the lower limit of the recommended range (6.5 – 9.0) for the CCME *Canadian Water Quality Guidelines for the Protection of Aquatic Life*.
- There is no evident correlation between pH and stage over this deployment period.
- The pH values drifted slightly lower than anticipated between October 6, 2015 and November 10, 2015. It has been determined that the pH sensor was beginning to fail, and has subsequently been replaced. However, the data are still within the technical specifications of the instrument, according they have not been removed from the dataset.
- The background pH of this stream is normally quite low, accordingly values near and below the lower limit are not unusual.

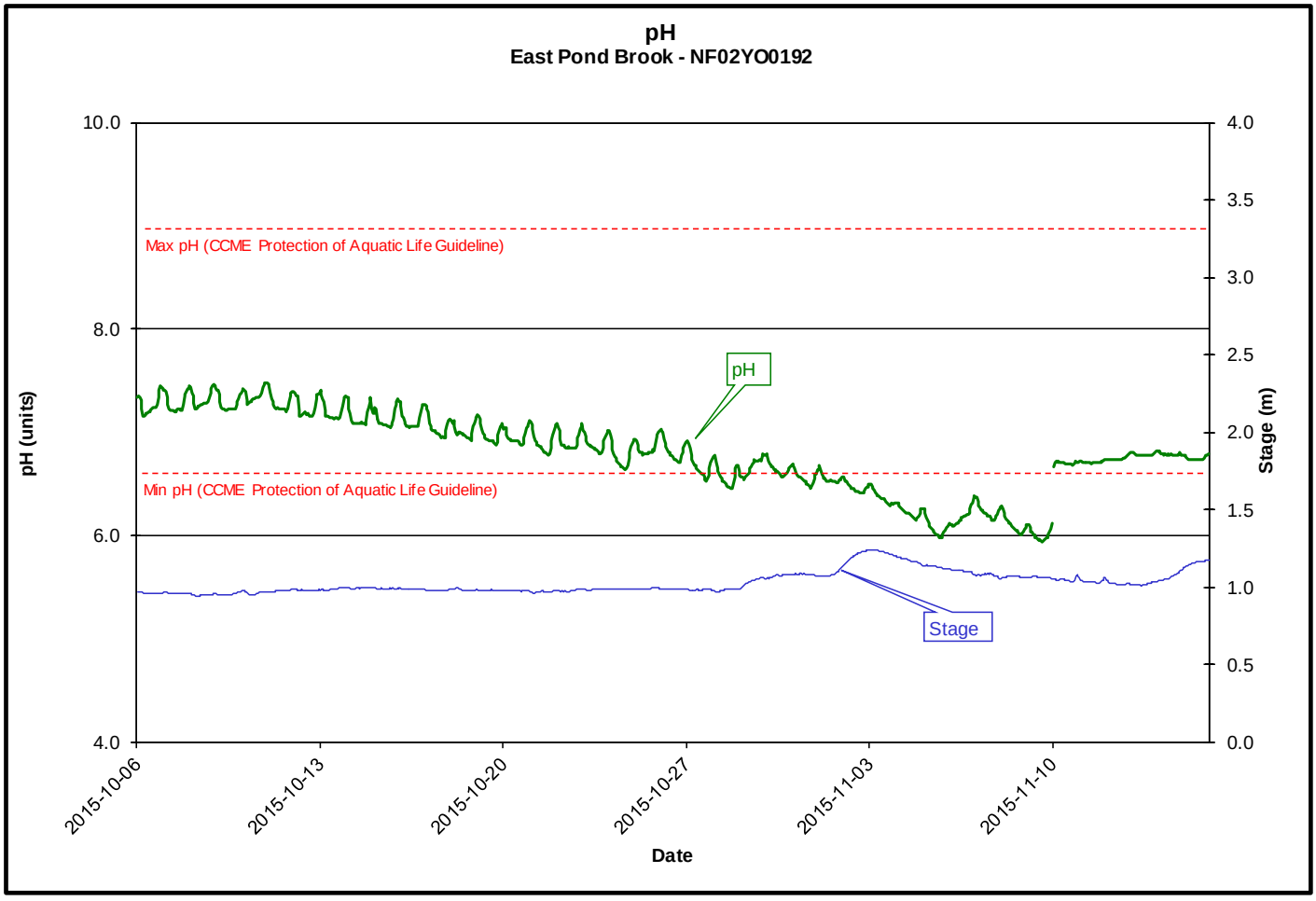

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 23.4 µS/cm to a maximum of 41.9 µS/cm.
- There is no obvious correlation with stage.
- Conductivity values in this range are typical for this stream.

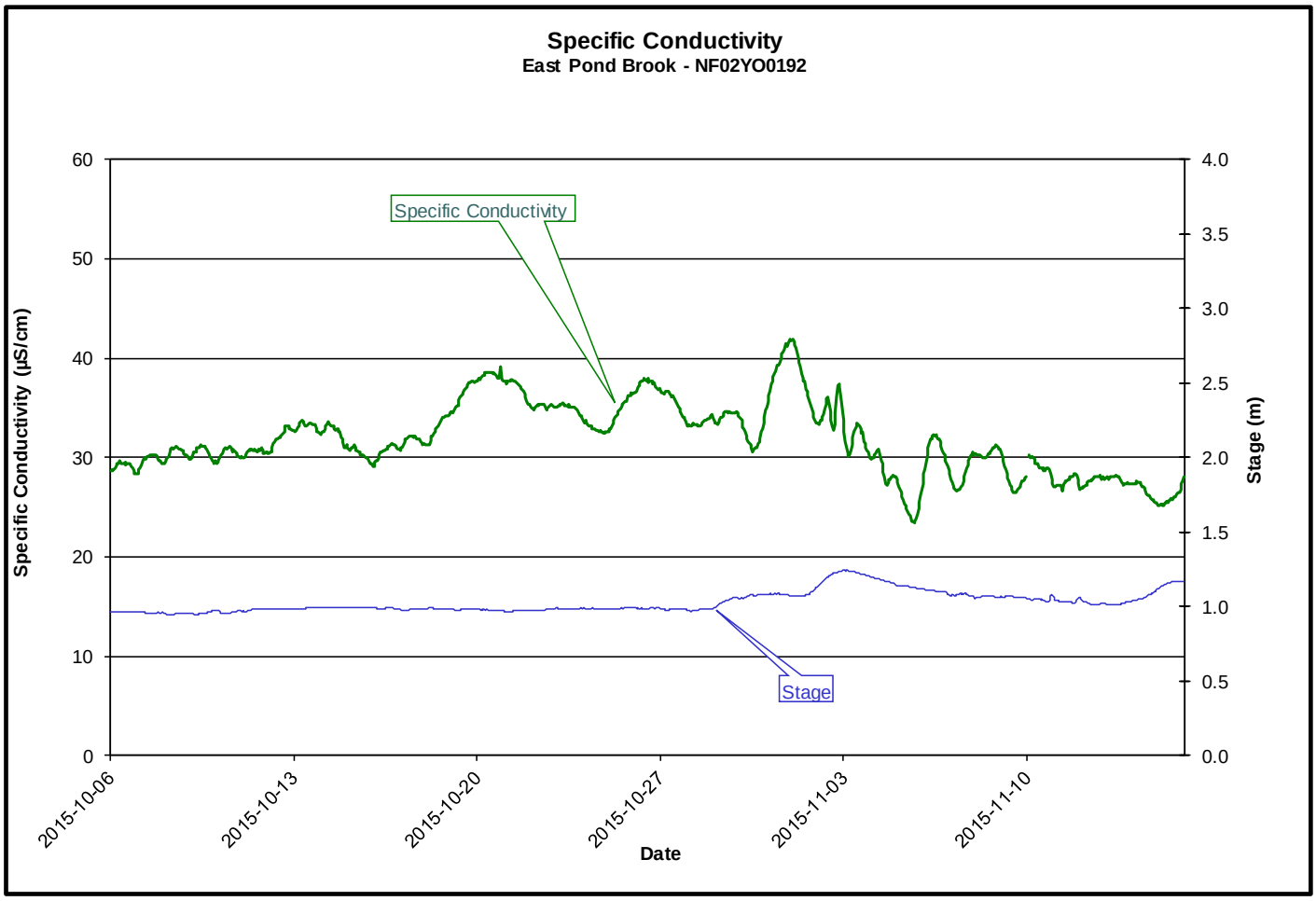

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 9.07 mg/L to a maximum of 13.79 mg/L over the deployment period, with the percent saturation ranging between 86.7 and 97.8.
- Dissolved oxygen (mg/L) levels increased throughout the deployment period, as one would expect with reduced water temperatures.
- Nearly all of the dissolved oxygen values fell above the minimum for Early Life Stages (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). This range is typical based upon water temperatures.
- Based upon the fact that dissolved oxygen % saturation had minimal and predictable change over the deployment period, we can be confident that the dissolved oxygen mg/L values are accurate.

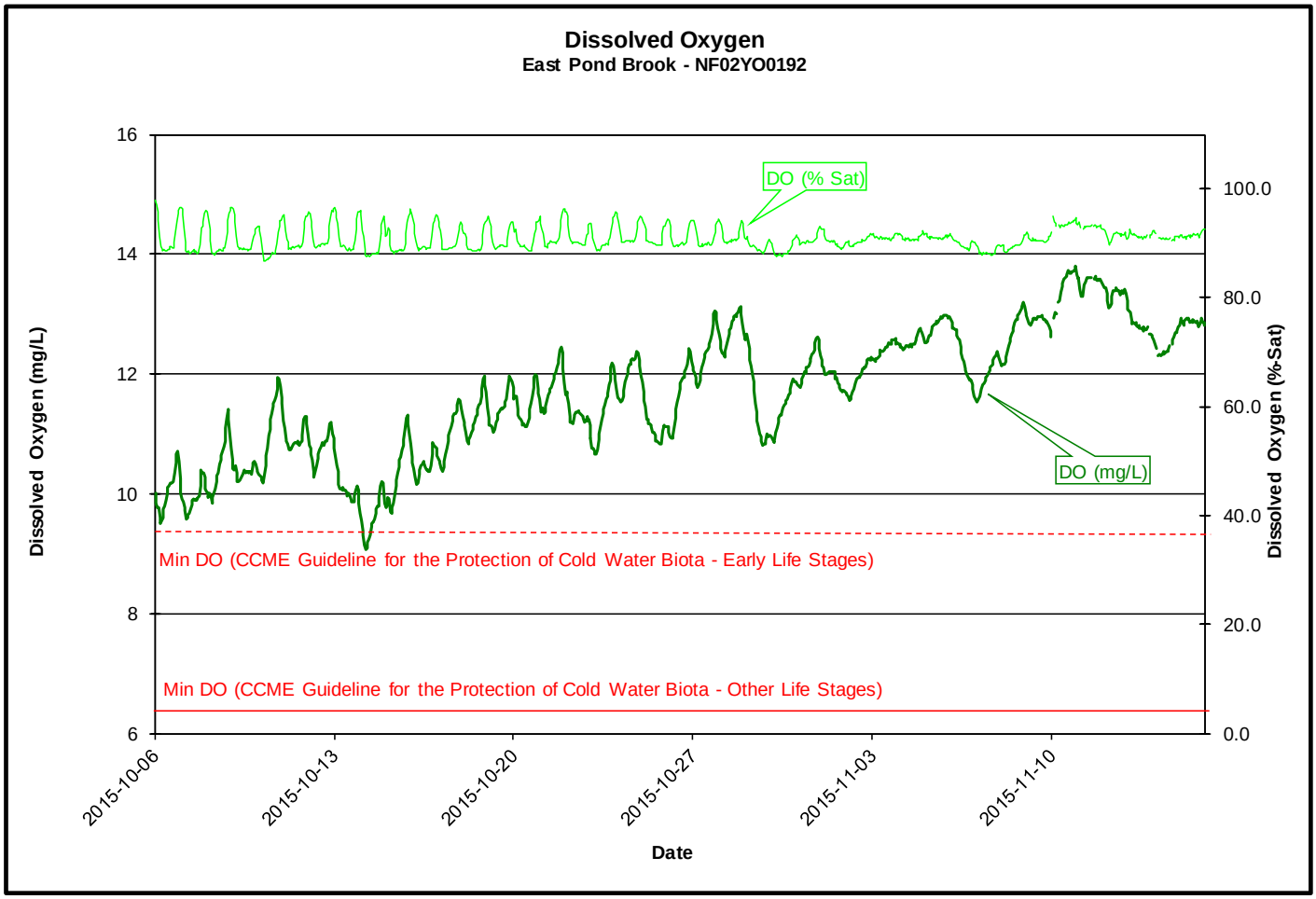

Figure 10

- The turbidity values **(Figure 11)** ranged from a minimum of 0.0 NTU to a maximum of 330.4 NTU.
- Upon removal at the end of the deployment period, it was noted that there was a significant accumulation of leaves near the sensor. This likely resulted in the numerous turbidity spikes throughout the deployment period between October 6, 2015 and November 10, 2015.
- As the turbidity sensor failed on the unit deployed from November 10, 2015 to November 16, 2015, these unreliable turbidity values have been removed from the data set.
- Very low turbidity values are typical in this stream. However, on field visits on November 10, 2015 and November 16, 2015, it was noted that some minor turbidity was visible in the water column. QA/QC Sonde readings ranged from 0.0 NTU to 13.06, while grab samples analysed at a commercial laboratory ranged from 0.5 to 1.1 NTU. Site investigations of commercial forestry operations in the East Pond Brook watershed, and a review of operations at Teck Duck Pond Operations did not reveal any source of turbidity. Turbidity will be closely monitored in the coming months.

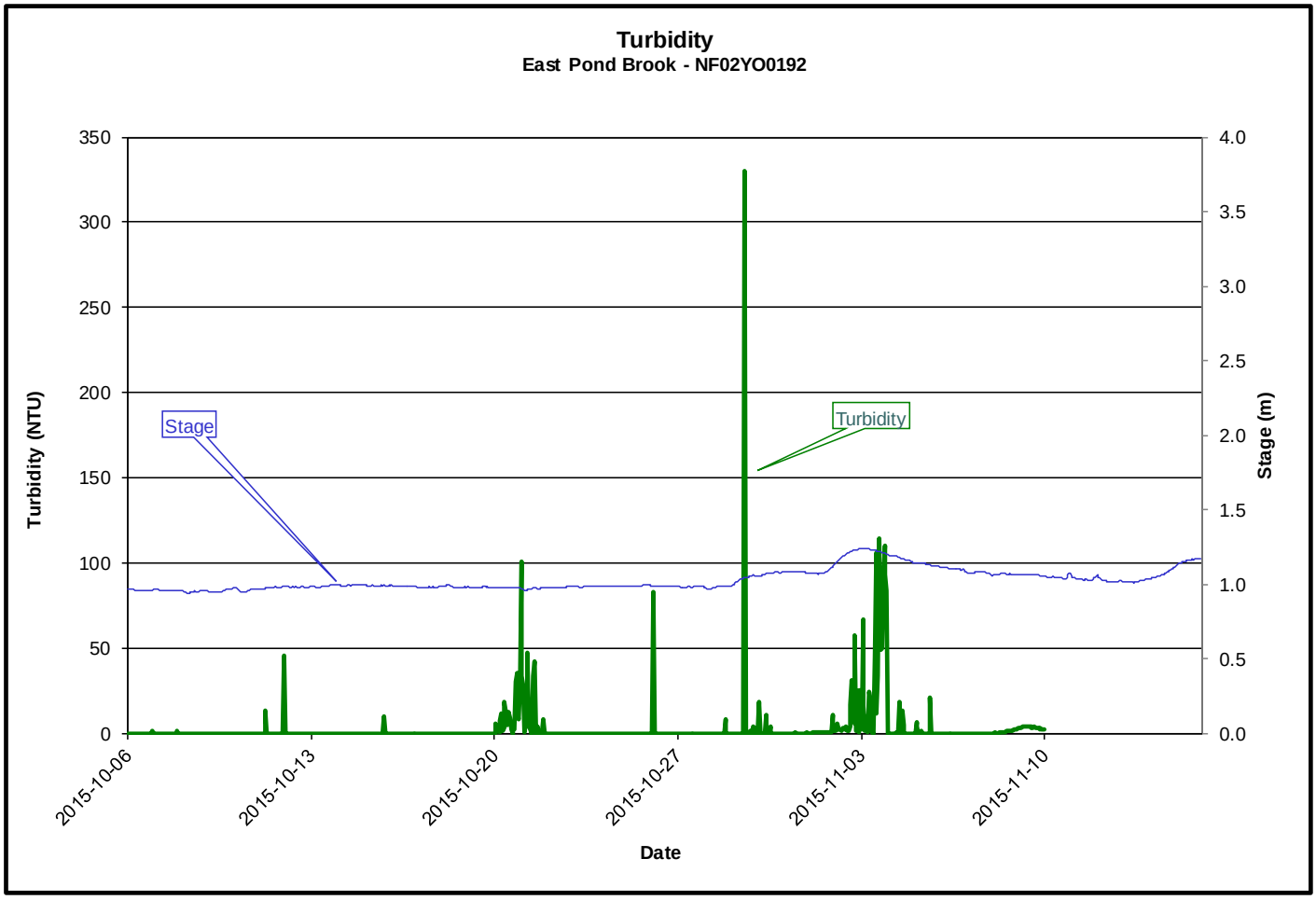

Figure 11

- The stage or water level ranged from a minimum of 0.94 m to a maximum of 1.24 m. The flow or discharge ranged from a minimum of 0.18 m^3/s to a maximum of 2.15 m^3/s **(Figure 12)**.
- The increase in stage and flow is the result of a precipitation/runoff event.
- Stage and flow are all within normal ranges.
- Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

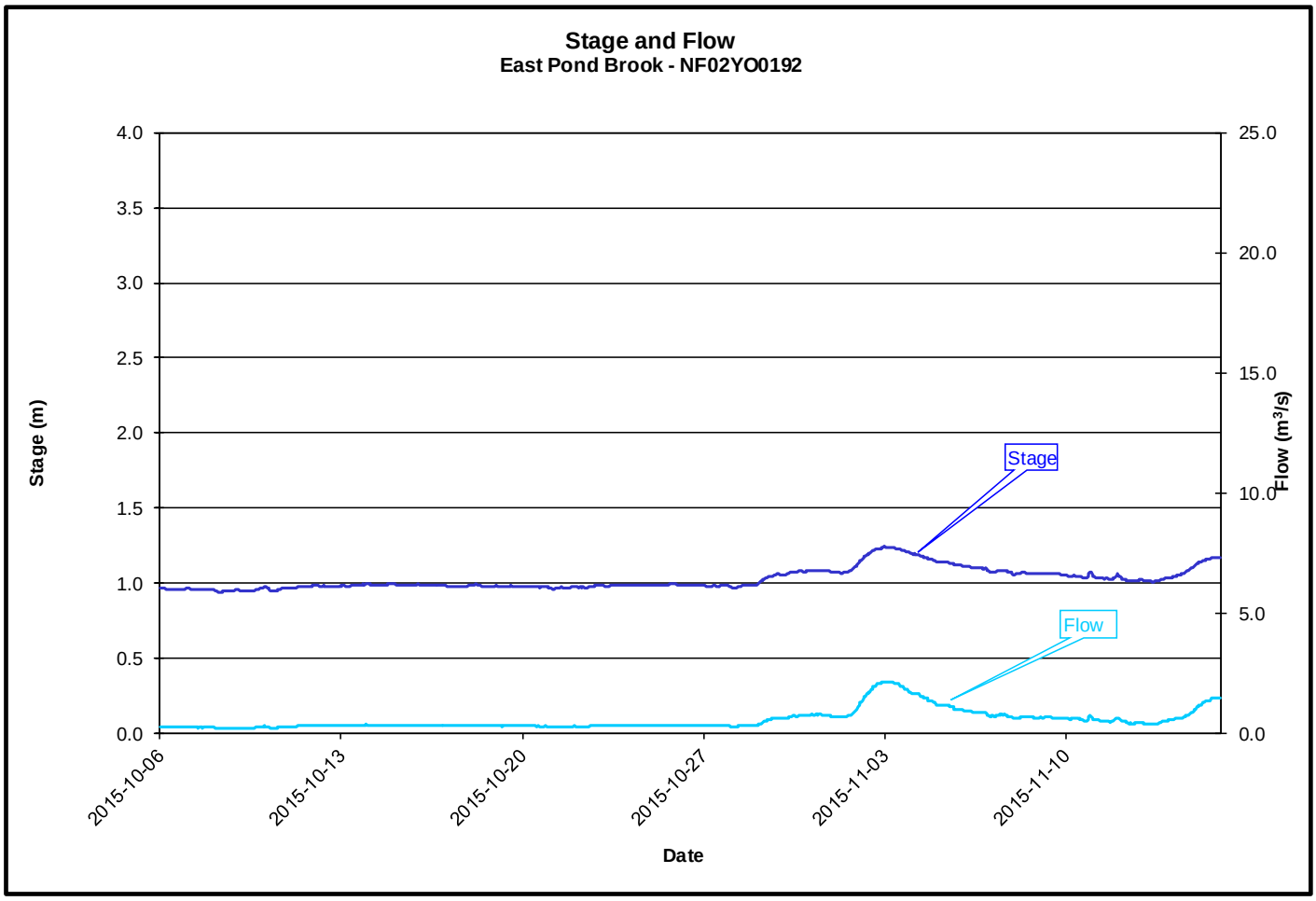

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.35 ˚C to a maximum of 5.71 ˚C with a slight increase over the reporting period.
- No data is available for the period between October 7, 2015 and October 14, 2015, as the Quanta G sensor deployed during that period failed.
- There appears to be no correlation with water elevation.

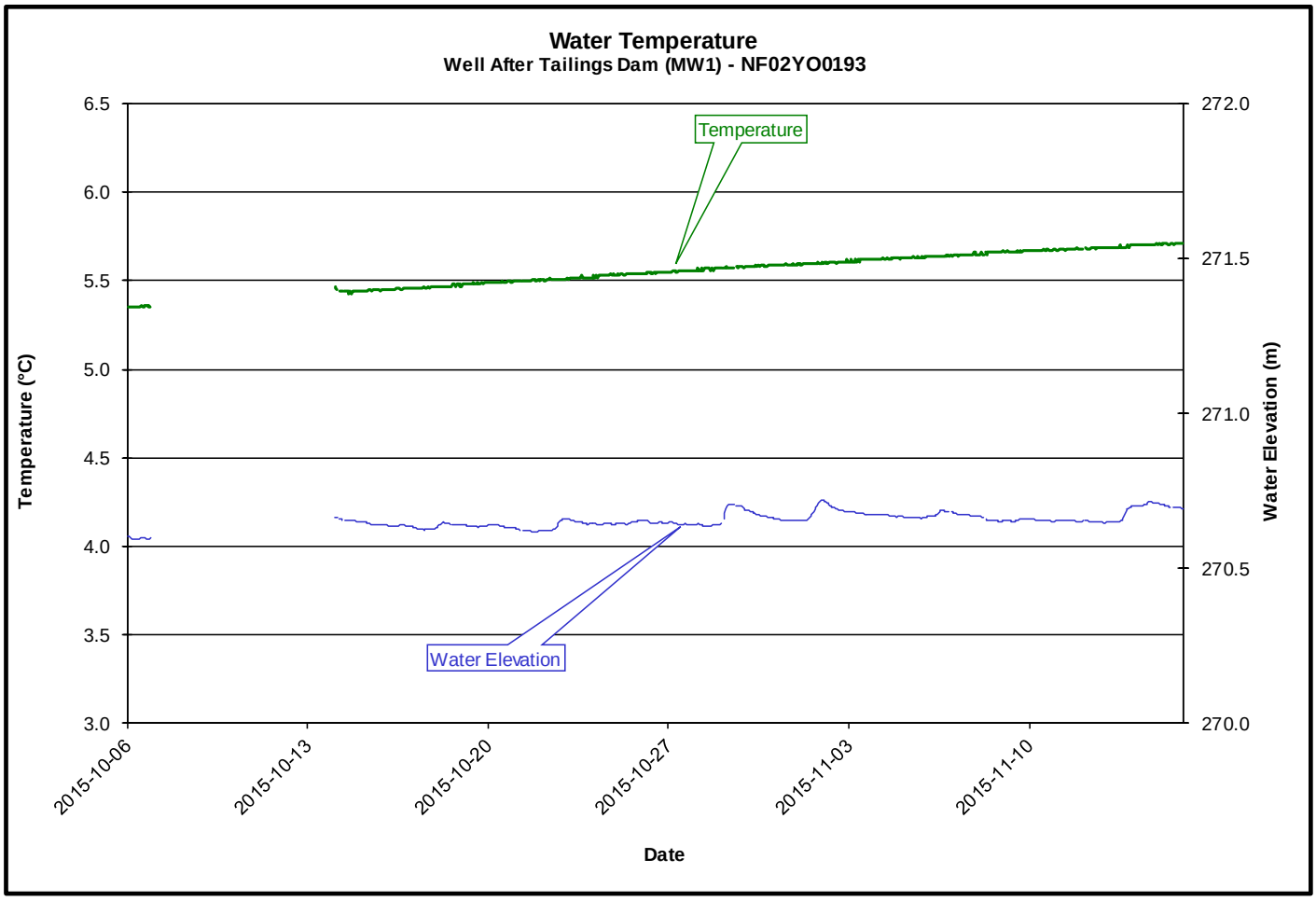

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 7.79 to a maximum of 8.50.
- No data is available for the period between October 7, 2015 and October 14, 2015, as the Quanta G sensor deployed during that period failed.
- The pH shows a rapid increase on October 14, 2015, followed by a gradual increase. This pH response is typical following deployment of an instrument in the narrow well casing.
- There does not appear to be any correlation with water elevation.

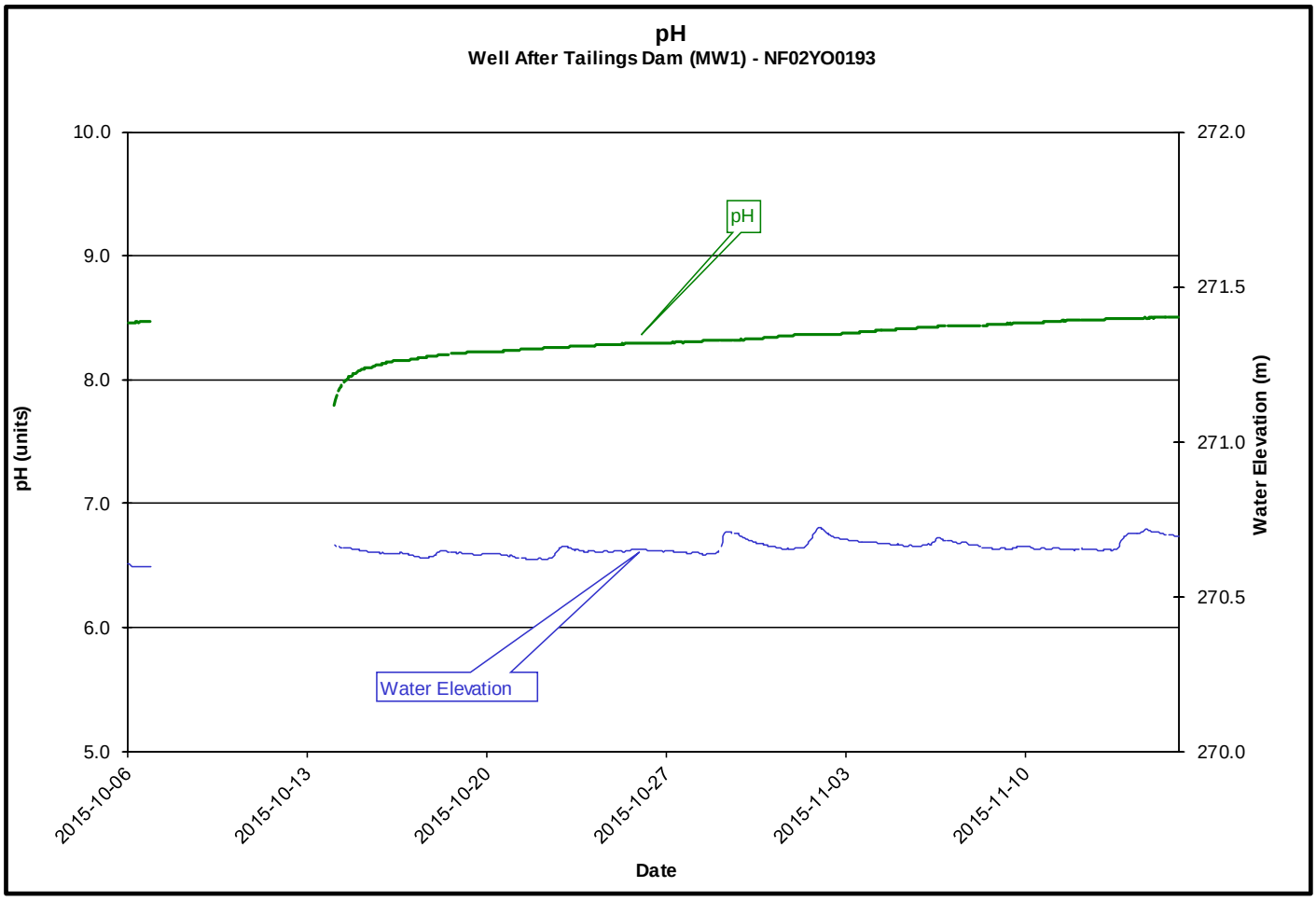

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.798 mS/cm to a maximum of 0.870 mS/cm.
- No data is available for the period between October 7, 2015 and October 14, 2015, as the Quanta G sensor deployed during that period failed.
- There was a slight increase in specific conductivity beginning on October 14, 2015, through to the end of the reporting period.
- Beginning on October 16, 2015 through to the end of the reporting period, waste rock from the mine was being placed into the Tailing Pond, in accordance with the mine closure plan. Prior to this, water levels in the Tailings Pond were reduced to minimum levels. Specific conductivity values will be monitored closely as this work is ongoing.
- There does not appear to be any correlation with water elevation.

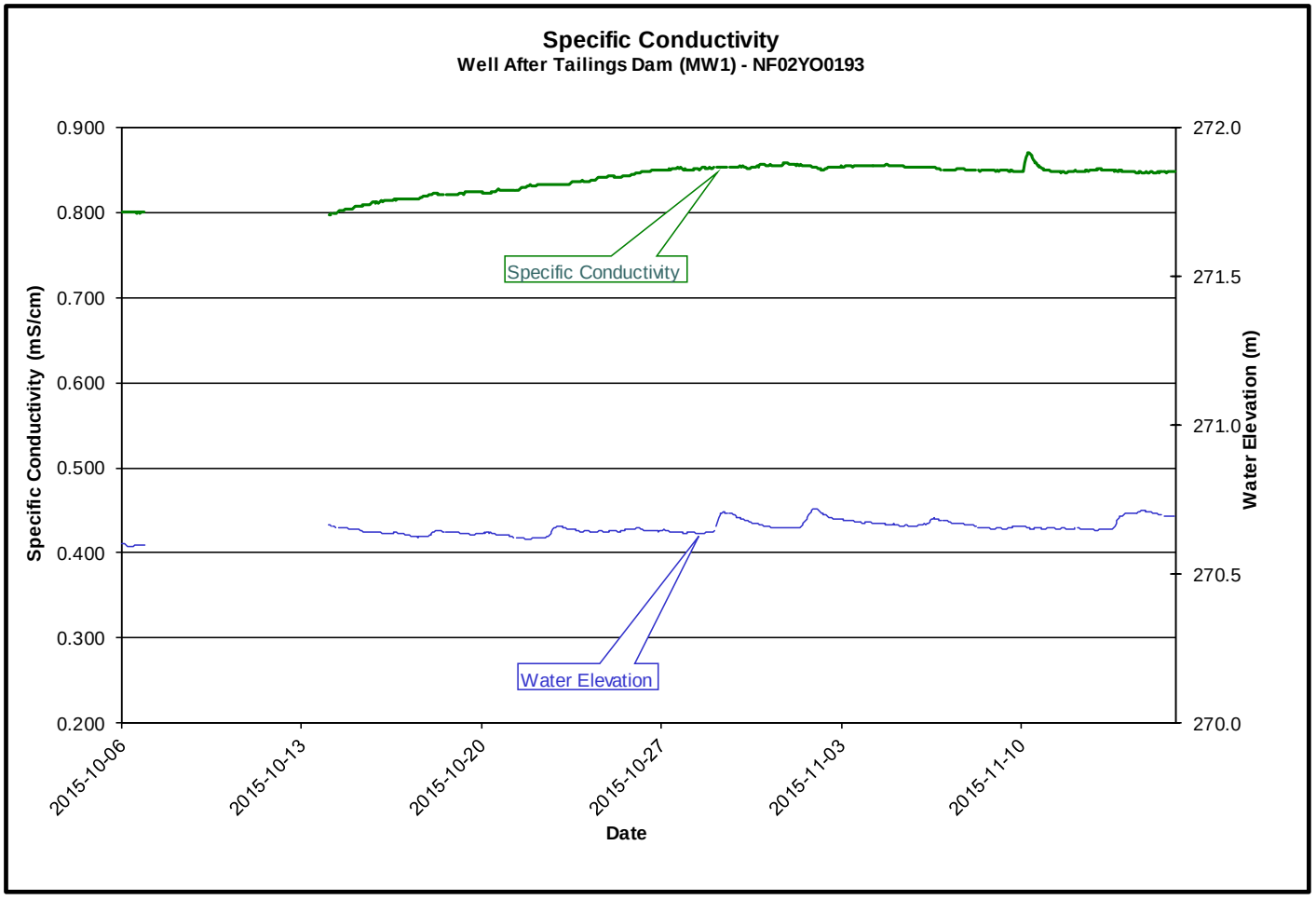

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.59 m to a maximum of 270.72 m.
- No data is available for the period between October 7, 2015 and October 14, 2015, as the Quanta G sensor deployed during that period failed.
- Water elevation in this well corresponds to increased water level in an adjacent stream, and is influenced by precipitation/runoff events, as well as the water elevation in the nearby Tailings Management Area.

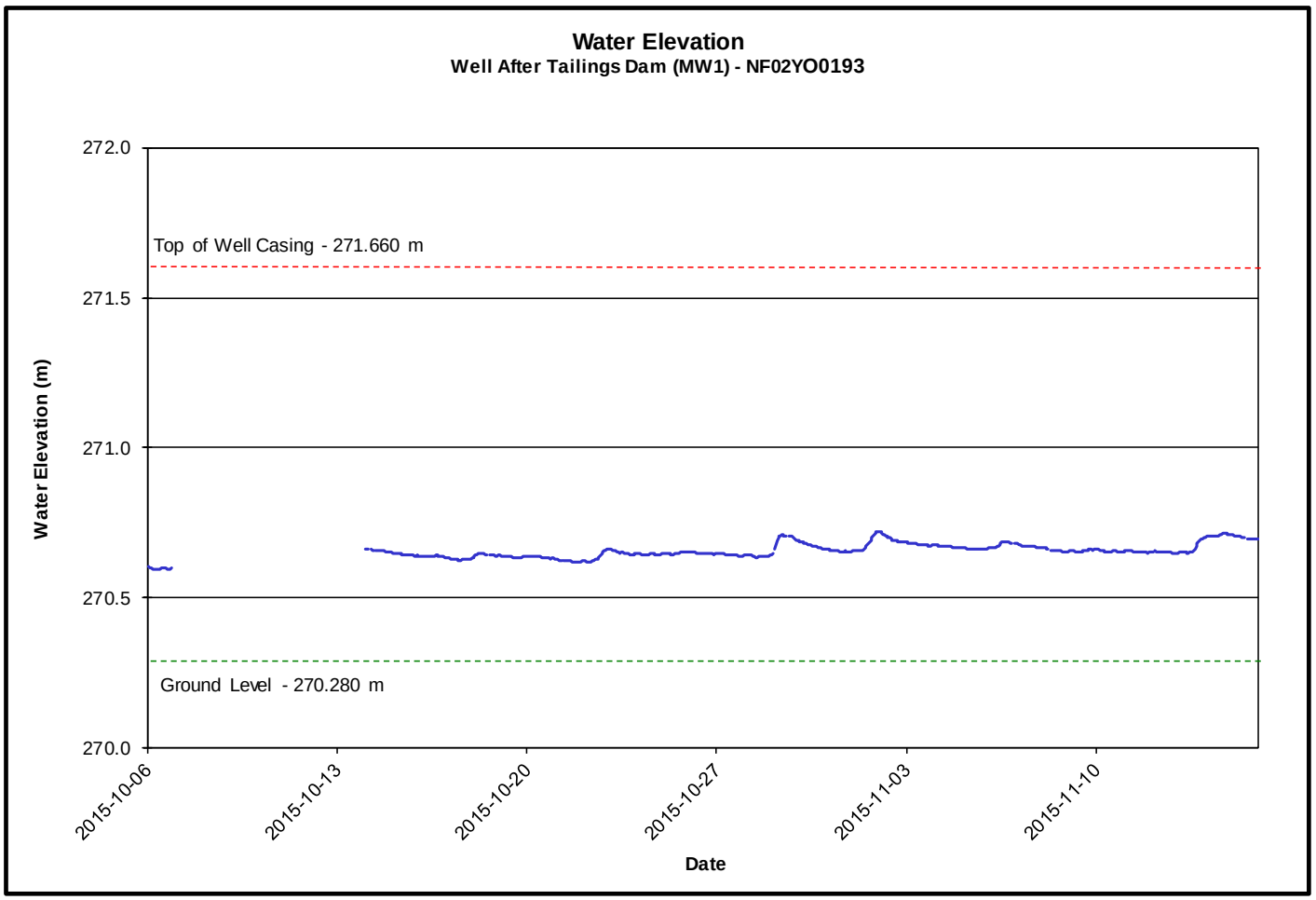

Figure 16

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