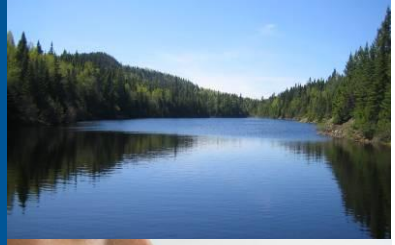




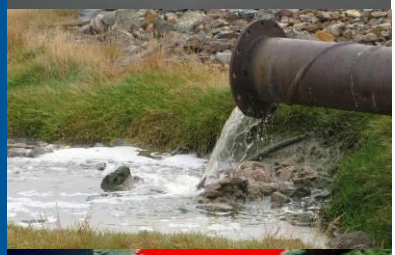


Real Time Water Quality Report
Teck Duck Pond Operations

Deployment Period 2015-11-16 to 2015-12-31

2016-03-23

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.
- 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 December 9, 2015. Discharge rates increased from December 1, 2015 through December 3, 2015, and again on December 8, prior to cessation for the winter season. The Polishing Pond was lowered to minimal levels 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 November 16, 2015 after being cleaned and freshly calibrated, and remained deployed continuously until after the end of the reporting period on December 31, 2015; a 45 day period.
- **DataSonde®**(s/n 60394) was deployed in East Pond Brook on November 16, 2015 after being cleaned and freshly calibrated, and remained deployed continuously until after the end of the reporting period on December 31, 2015; a 45 day period.
- **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 October 14, 2015 (prior to the current reporting period) after being cleaned and freshly calibrated, and remained deployed continuously until after the end of the reporting period on December 31, 2015. This report covers a 45 day period from November 16, 2015 through December 31, 2015.

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. There are no rankings for Well After Tailings Dam (MW1) as the instrument was neither deployed nor removed during this reporting period.
- 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.
- As **Quanta G®** (s/n 00035) was deployed in this well, prior to the beginning of this reporting period, the ranking for the initial deployment is documented in a previous report. As the unit remains deployed, rankings for removal will be documented in a subsequent report.

- For Tributary to Gill's Pond Brook, from December 12, 2015 until the end of the reporting period, multiple false-positive turbidity readings were recorded, due to icing in the stream and on the instrument. As a result, these incorrect turbidity values have been deleted from the dataset.
- 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**
2015-11-16 Installation	Temp (^{o}C)	Good
	pH (units)	Good
	Sp. Conductivity (µS/cm)	Excellent
	Dissolved Oxygen (mg/L)	Excellent
	Turbidity (NTU)	Excellent

Table 2

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

Table 3

Data Interpretation

TRIBUTARY TO GILLS POND BROOK

- The water temperature (**Figure 1**) ranged from a minimum of -0.28˚C to a maximum of 6.77˚C.
- The water temperatures were somewhat variable until December 14, 2015, after which they remained stable near zero degrees Celsius.
- There is no obvious correlation with stage.

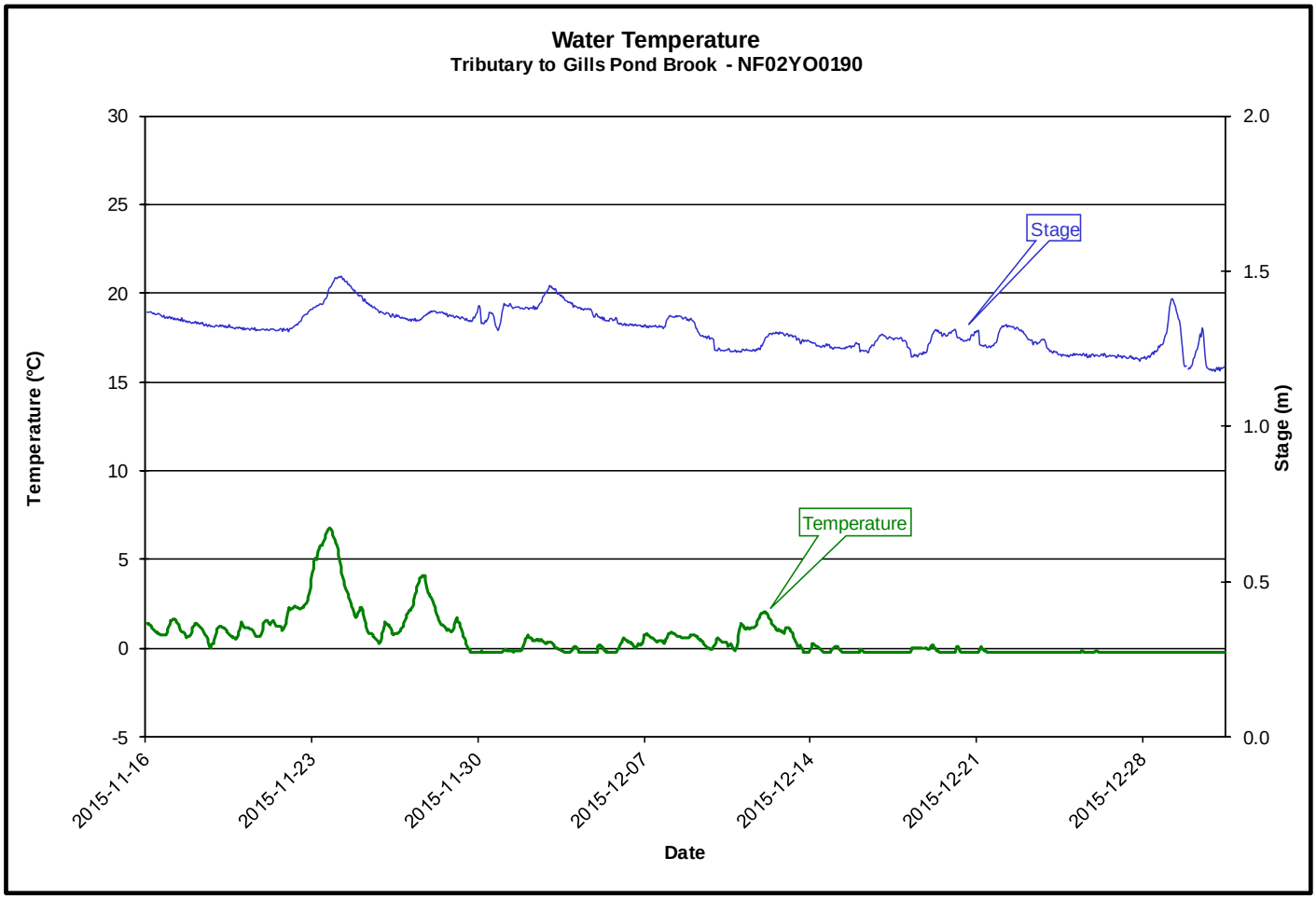

Figure 1

- Throughout the deployment period, pH values (**Figure 2**) ranged from a minimum of 6.39 to a maximum of 7.26.
- For most of 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*.
- An inverse relationship with stage is obvious following a number of precipitation/runoff events (increases in stage) throughout the deployment period.
- There is no obvious significant response in pH following changes in the discharge rate from Polishing Pond on December 1, 2015 through December 3, 2015, on December 8, 2015, nor following cessation of discharge on December 9, 2015.

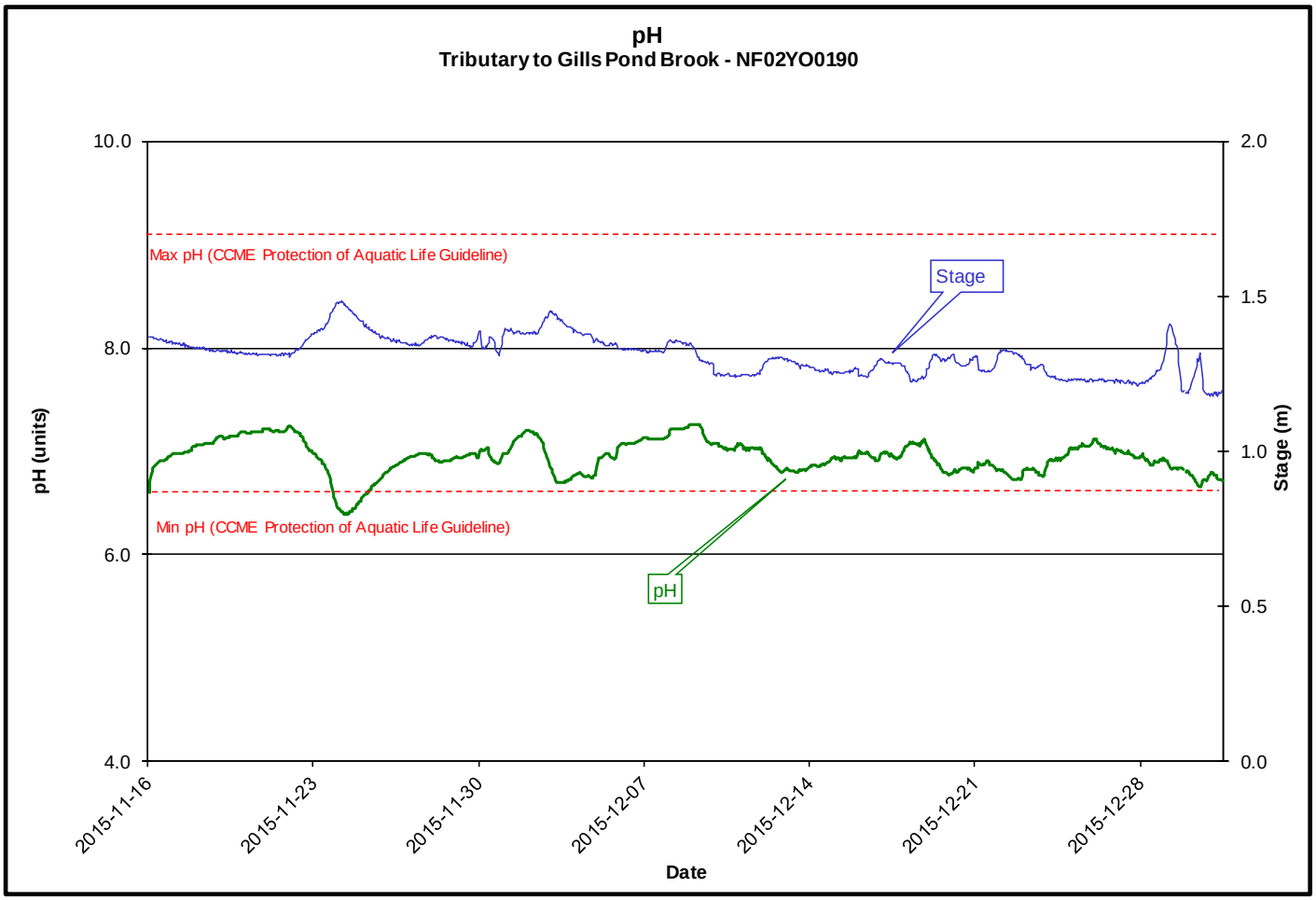

Figure 2

- The specific conductivity **(Figure 3)** ranged from a minimum of 55.1 µS/cm to a maximum of 1085.0 µS/cm over the deployment period.
- Following increases in the discharge rate from Polishing Pond on December 1, 2015 through December 3, 2015 and December 8, 2015, corresponding changes in specific conductance are quite obvious. Note the two red ellipses.
- Other changes in specific conductance prior to December 9, 2015 are the result of the dilution effect of precipitation-runoff events, on the more highly conductive discharged water.
- The specific conductance values after December 9, 2015 are much lower than at the beginning of the deployment period, as values quickly return to normal background levels, as there were no inputs from the Tailings Management Area.

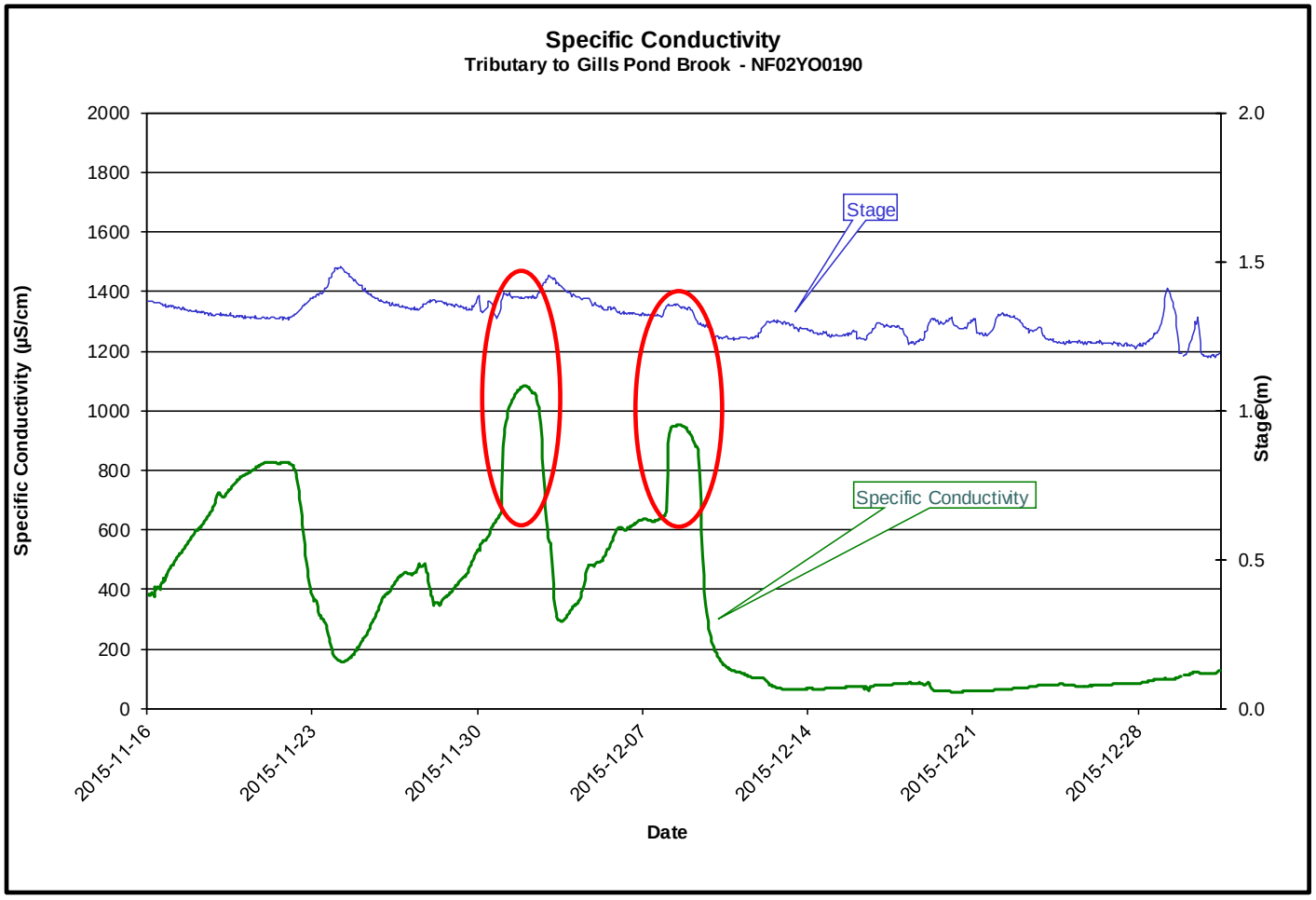

Figure 3

- The dissolved oxygen (**Figure 4**) values ranged from a minimum of 11.14 mg/L to a maximum of 13.96 mg/L over the deployment period, with the percent saturation ranging between 81.8 and 98.0.
- Dissolved oxygen (mg/L) remained fairly constant throughout the deployment period. The one major drop in dissolved oxygen on November 23, 2015 is associated with a significant precipitation-runoff event, and warmer water temperatures. See Figure 1.
- 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.

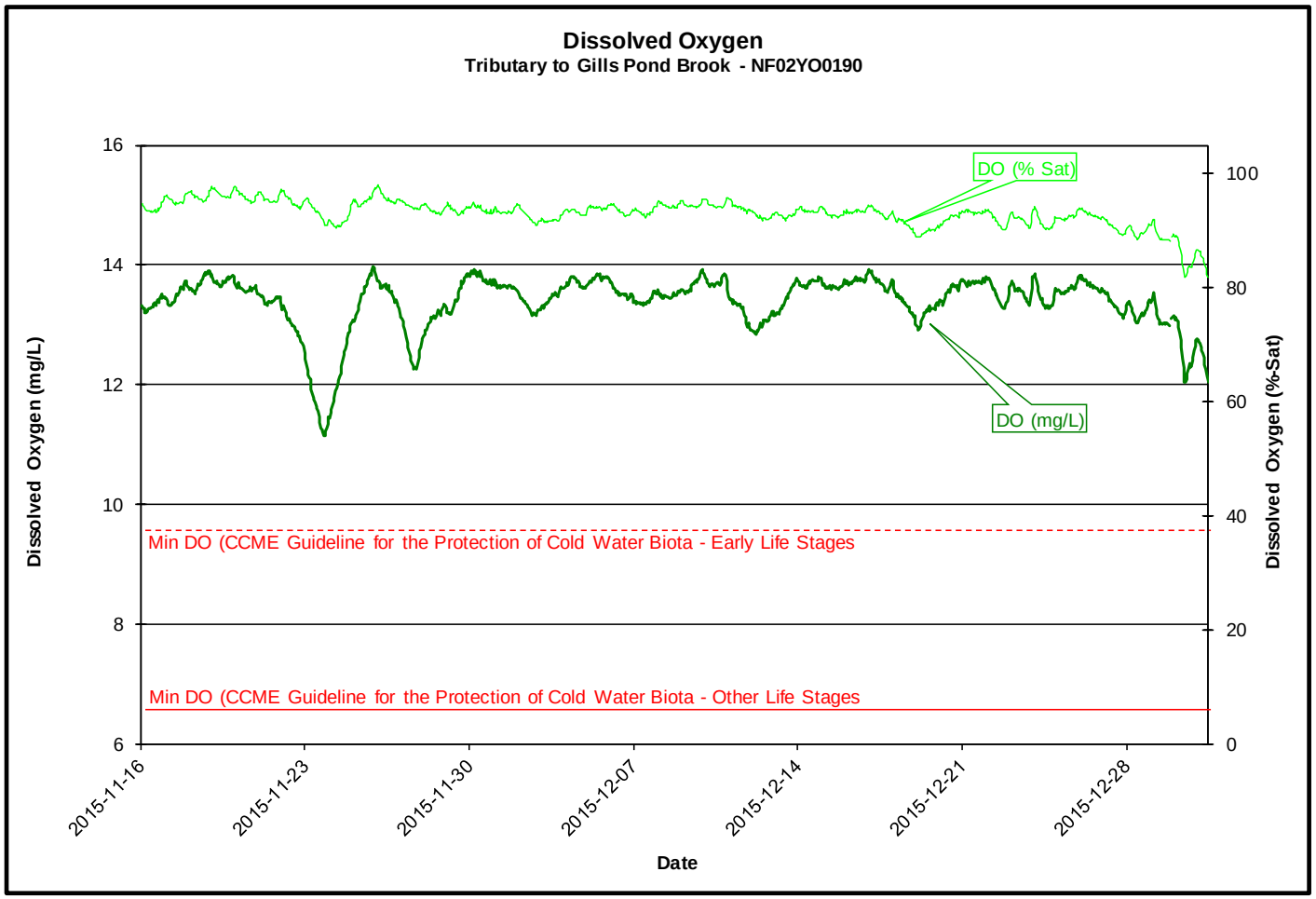

Figure 4

- The turbidity values **(Figure 5)** remained constant at 0.0 NTU throughout most of the deployment period.
- From December 12, 2015 until the end of the reporting period, multiple false-positive turbidity readings were recorded, due to icing in the stream and on the instrument. As a result, these incorrect turbidity values have been deleted from the dataset.
- No other issues with turbidity were evident.

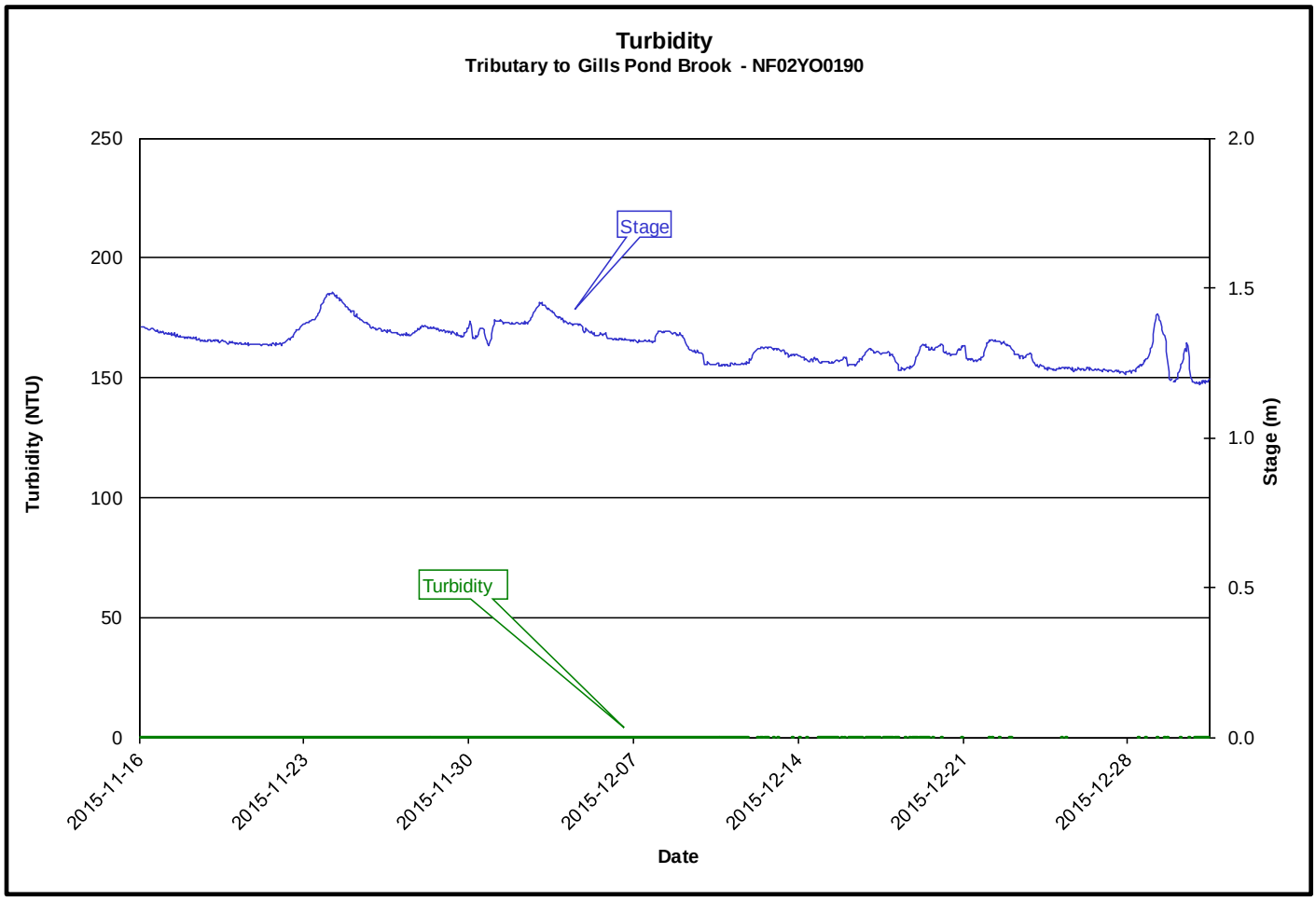

Figure 5

- The stage or water level ranged from a minimum of 1.18 m to a maximum of 1.48 m. The flow or discharge ranged from a minimum of 0.01 m^3/s to a maximum of 0.78 m^3/s (**Figure 6)**.
- Changes in the discharge rate from Polishing Pond on December 1, 2015 through December 3, 2015 and December 8, 2015, and the cessation on December 9, 2015, are not obvious unless depicted against changes in other water quality parameters. They 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.

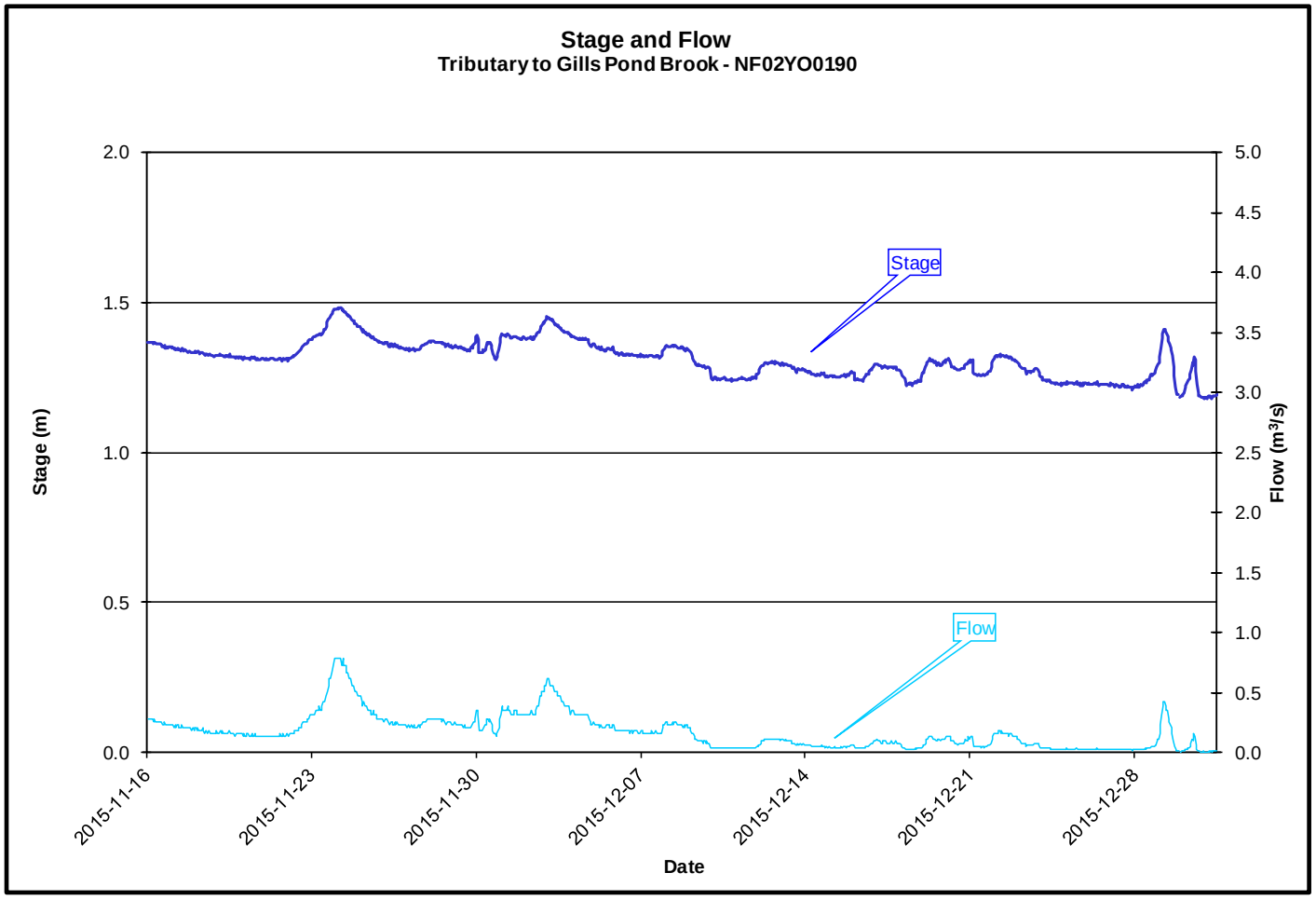

Figure 6

EAST POND BROOK

- The water temperature (**Figure 7**) ranged from a minimum of -0.02 ˚C to a maximum of 6.52 ˚C.
- The water temperatures were somewhat variable until December 14, 2015, after which they remained stable near zero degrees Celsius.
- There is some correlation with stage during some events during the first half of the deployment period. Water temperatures were higher for several days following a precipitation-runoff event which started on November 23, 2015. Water temperatures were at or near zero from November 29, 2015 to December 2, 2015 and again from December 3, 2015 to December 7, 2015. These periods correspond with higher recorded stage measurements, which are characteristic of backwater effects as ice builds into the stream during colder weather events. As noted above, after December 14, 2015, water temperatures remained near zero, despite increases in stage which again were due to the ice's backwater effect.

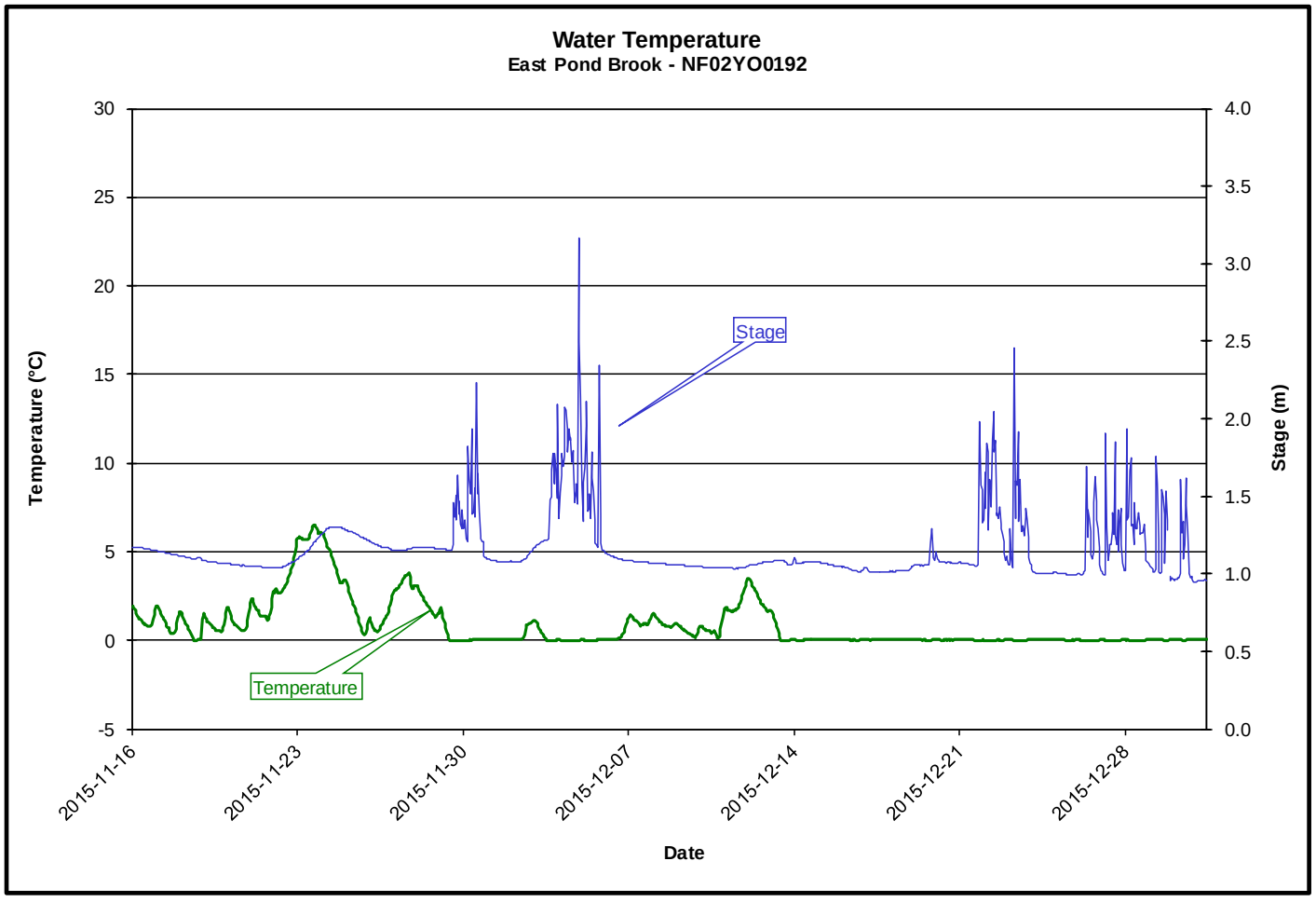

Figure 7

- Throughout the deployment period pH values (**Figure 8**) ranged from a minimum of 6.68 to a maximum of 7.37.
- Throughout the deployment period, pH values were just 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 evident correlation between pH and stage over this deployment period.
- The background pH of this stream is normally quite low, accordingly values near and below the lower limit are not unusual.

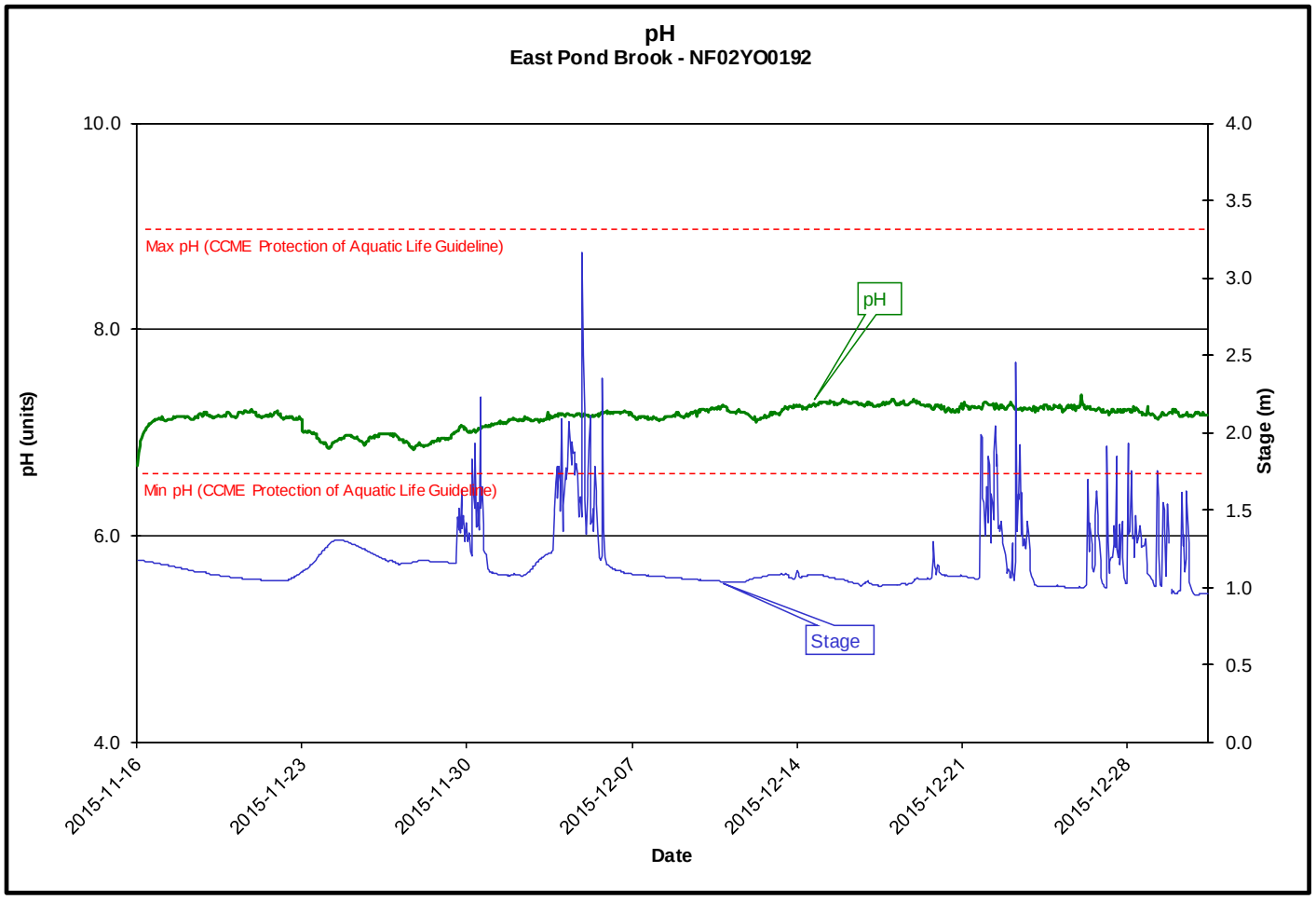

Figure 8

- The specific conductivity **(Figure 9)** ranged from a minimum of 20.5 µS/cm to a maximum of 44.6 µS/cm.
- There are several instances during this reporting period, when there is a positive correlation with stage.
- Specific conductivity tended to increase after December 14, 2015, once stream temperatures remained constant around zero degrees Celsius. Basal groundwater inputs during the colder winter months when there are less surface water inputs tend to cause the increase in specific conductance.
- Conductivity values in this range are typical for this stream.

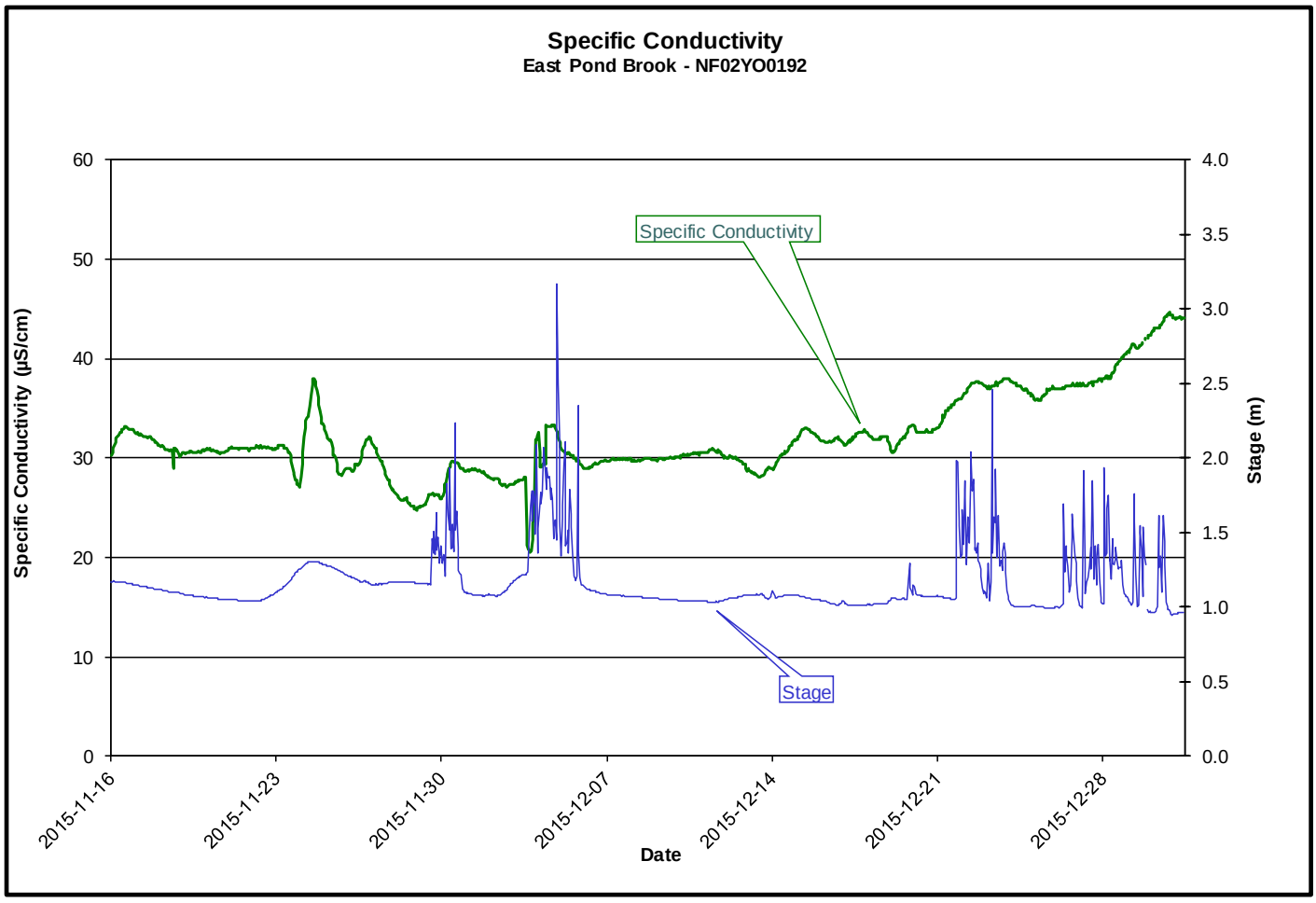

Figure 9

- The dissolved oxygen (**Figure 10**) values ranged from a minimum of 11.57 mg/L to a maximum of 14.28 mg/L over the deployment period, with the percent saturation ranging between 89.2 and 99.2.
- Dissolved oxygen (mg/L) remained fairly constant throughout the deployment period. The one major drop in dissolved oxygen on November 23, 2015 is associated with a significant precipitation-runoff event, and warmer water temperatures. See Figure 7.
- 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.

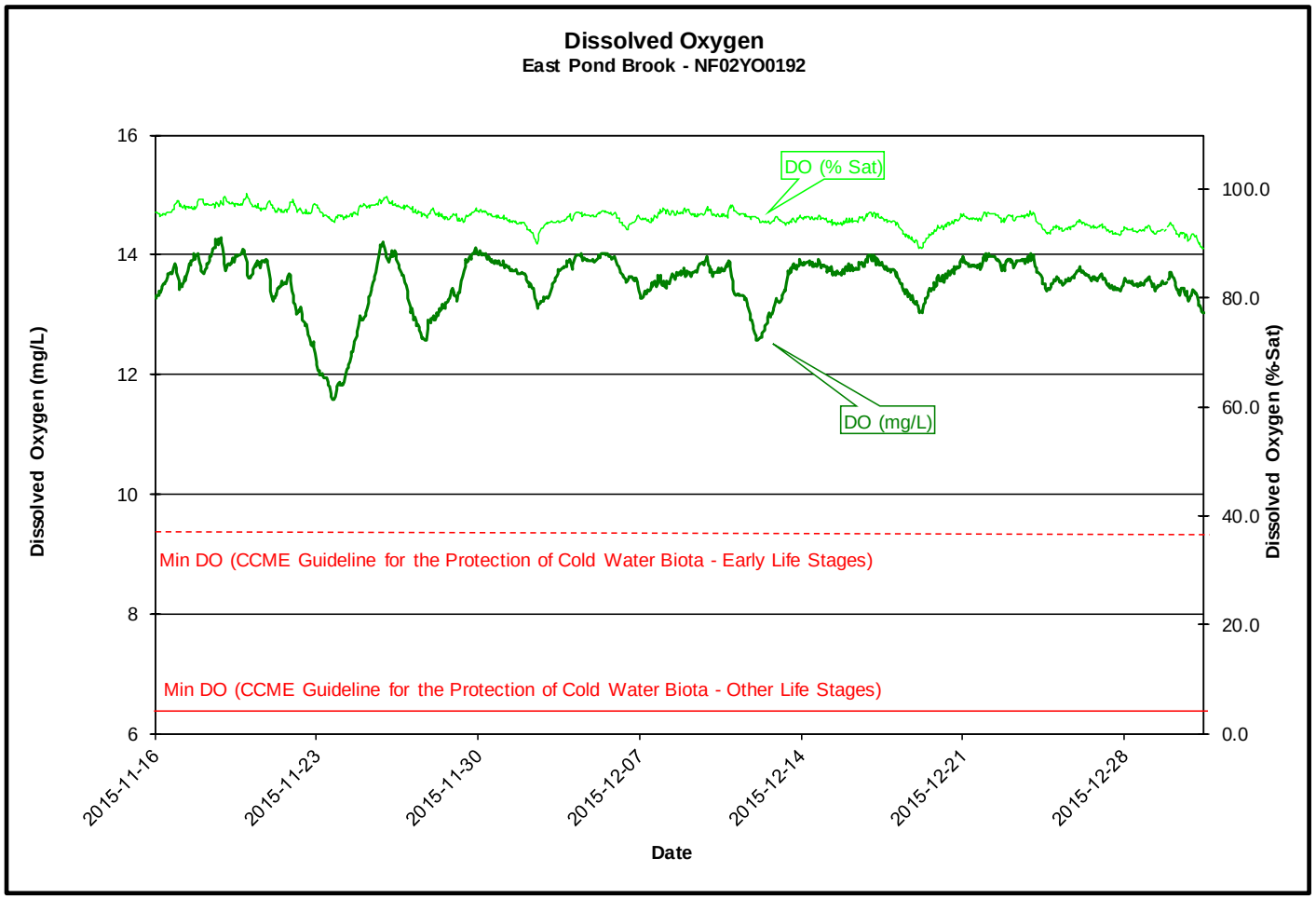

Figure 10

- The turbidity values **(Figure 11)** ranged from a minimum of 0.0 NTU to a maximum of 29.7 NTU.
- Very low turbidity values are typical in this stream. However, on the field visit on November 16, 2015, it was noted that some minor turbidity was visible in the water column. QA/QC and deployed Sonde readings ranged from 0.0 NTU to 0.3 NTU, while a grab samples analysed at a commercial laboratory reported 3.0 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.
- A peak in turbidity (one reading) on December 24, 2015, corresponds with one of the peaks in stage resultant from the backwater effect of the ice buildup in the stream. While this is the likely cause, a single higher than normal turbidity value is not of any consequence.
- Turbidity will be closely monitored in the coming months.

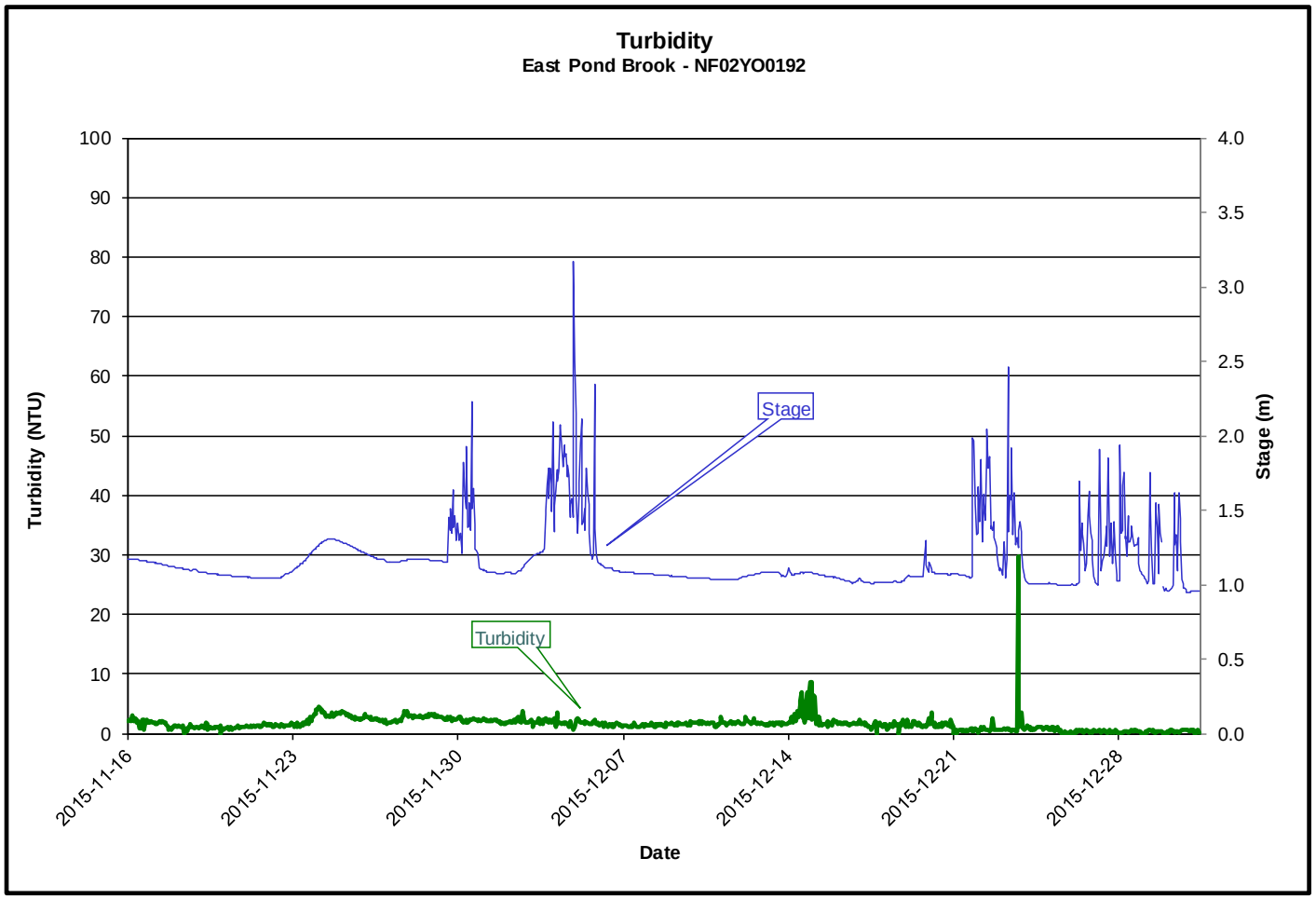

Figure 11

- The stage or water level ranged from a minimum of 0.95 m to a maximum of 3.17 m. The flow or discharge ranged from a minimum of 0.20 m^3/s to a maximum of 22.24 m^3/s **(Figure 12)**.
- As referenced in a number of sections above, the four periods of increased stage (and flow) are typical of the backwater effect as ice forms (and reforms) in the stream.
- 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.

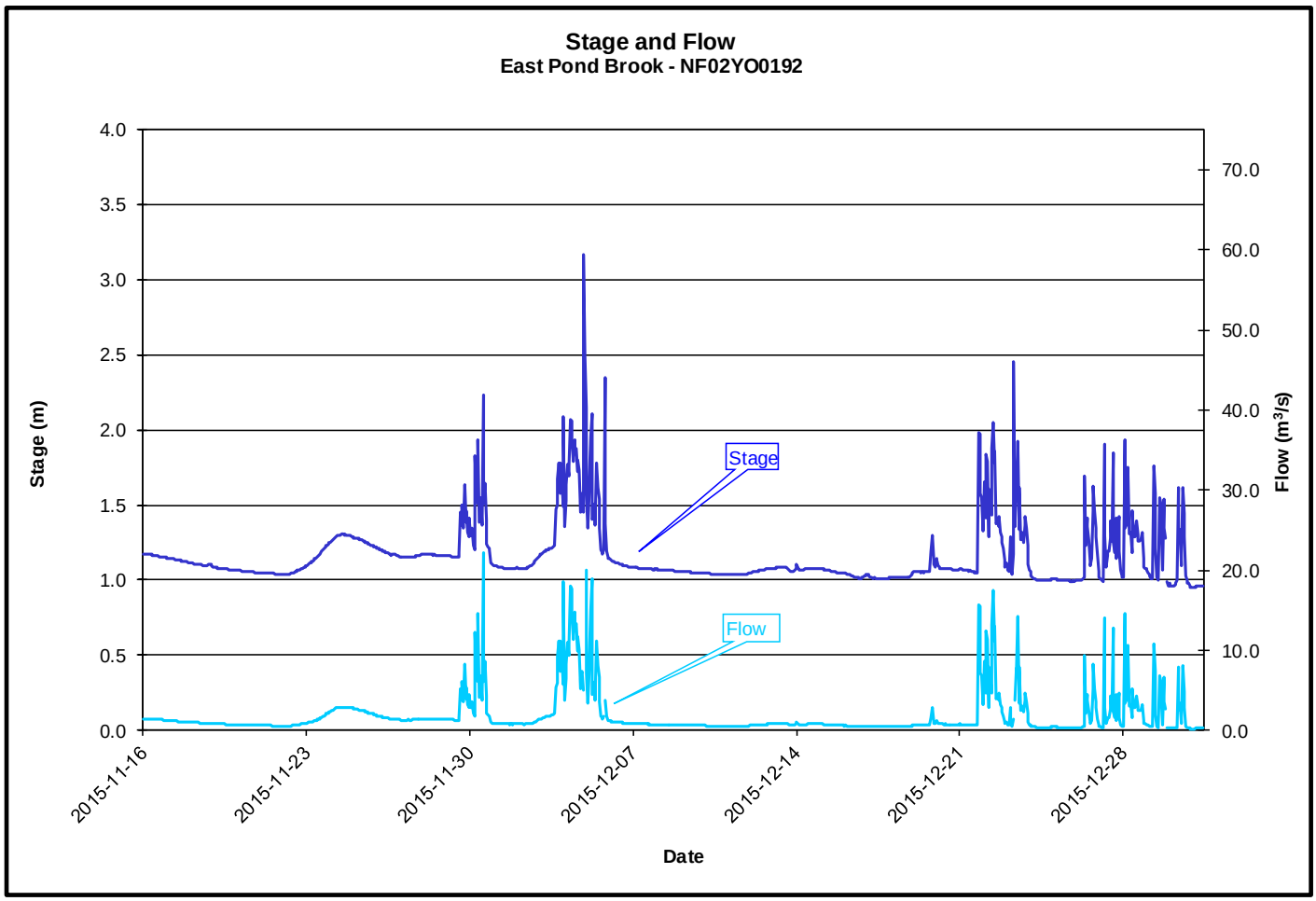

Figure 12

WELL AFTER TAILING DAM (MW1)

- The water temperature (**Figure 13**) ranged from a minimum of 5.71 ˚C to a maximum of 5.83 ˚C with a slight increase over the reporting period.
- There appears to be no correlation with water elevation.

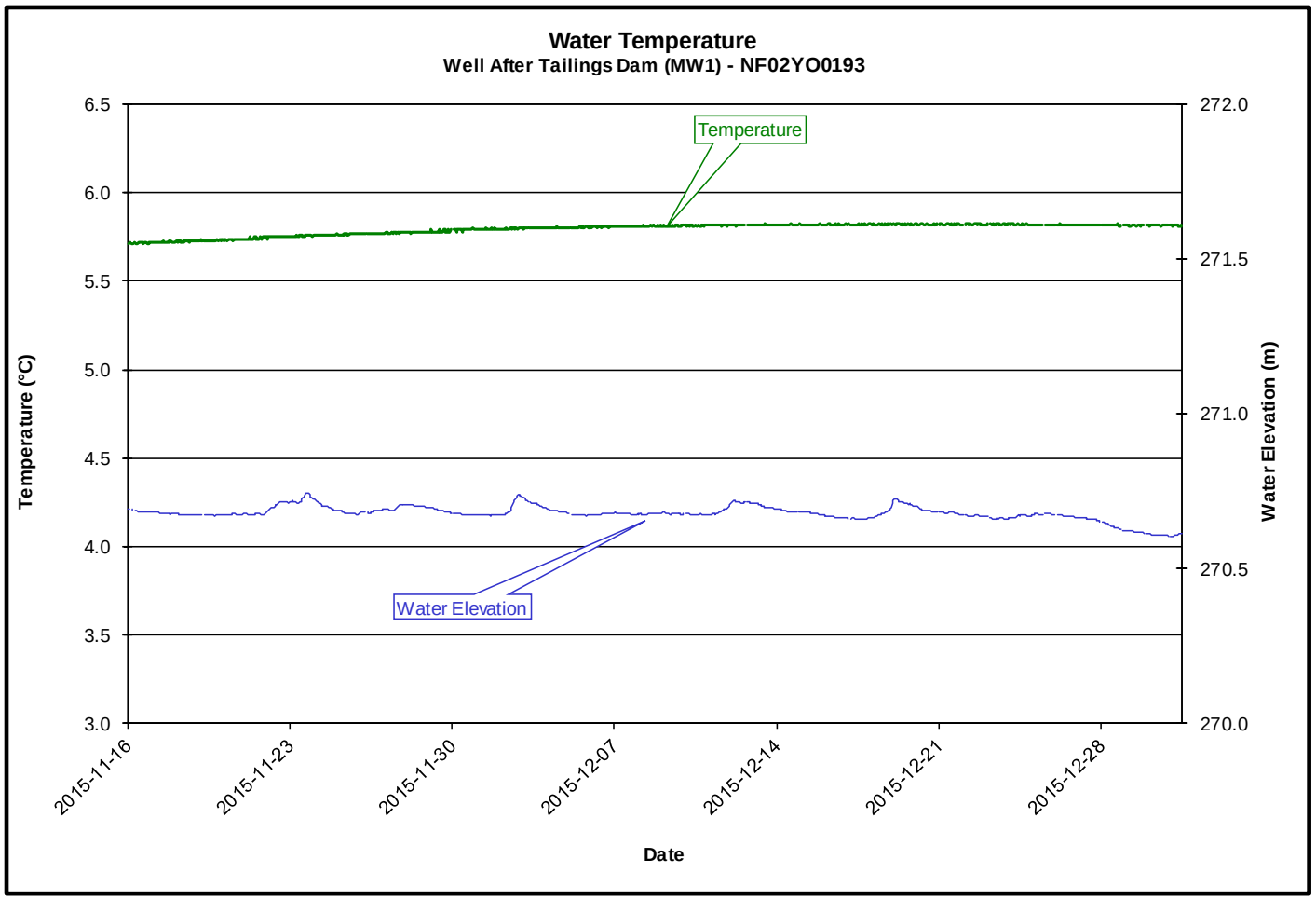

Figure 13

- The pH (**Figure 14**) ranged from a minimum of 8.50 to a maximum of 8.70.
- There is a gradual increase in pH over the deployment period.
- There does not appear to be any correlation with water elevation.

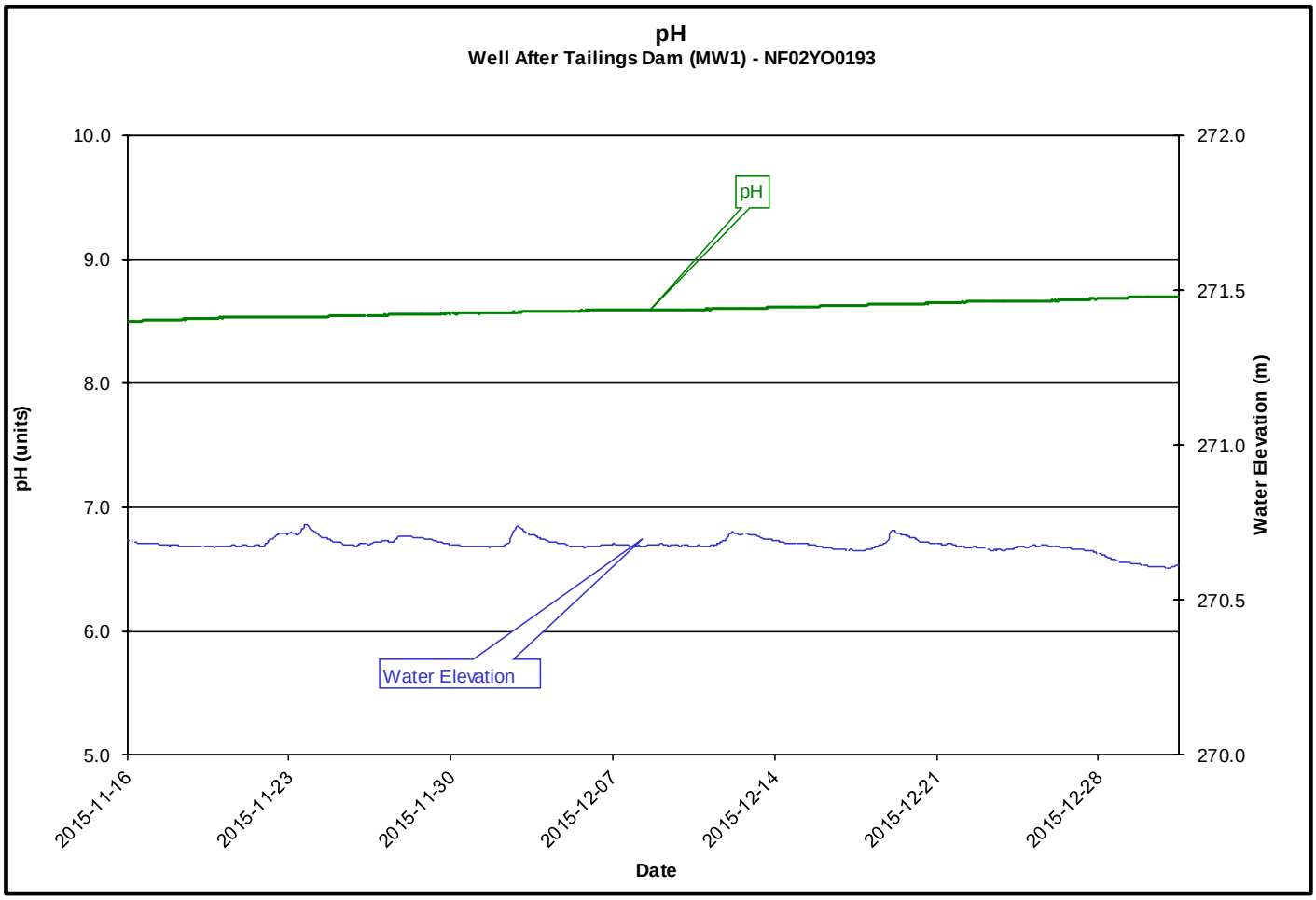

Figure 14

- The specific conductivity **(Figure 15)** ranged from a minimum of 0.829 mS/cm to a maximum of 0.848 mS/cm.
- There was a gradual decrease in specific conductance over the deployment period.
- There does not appear to be any correlation with water elevation.

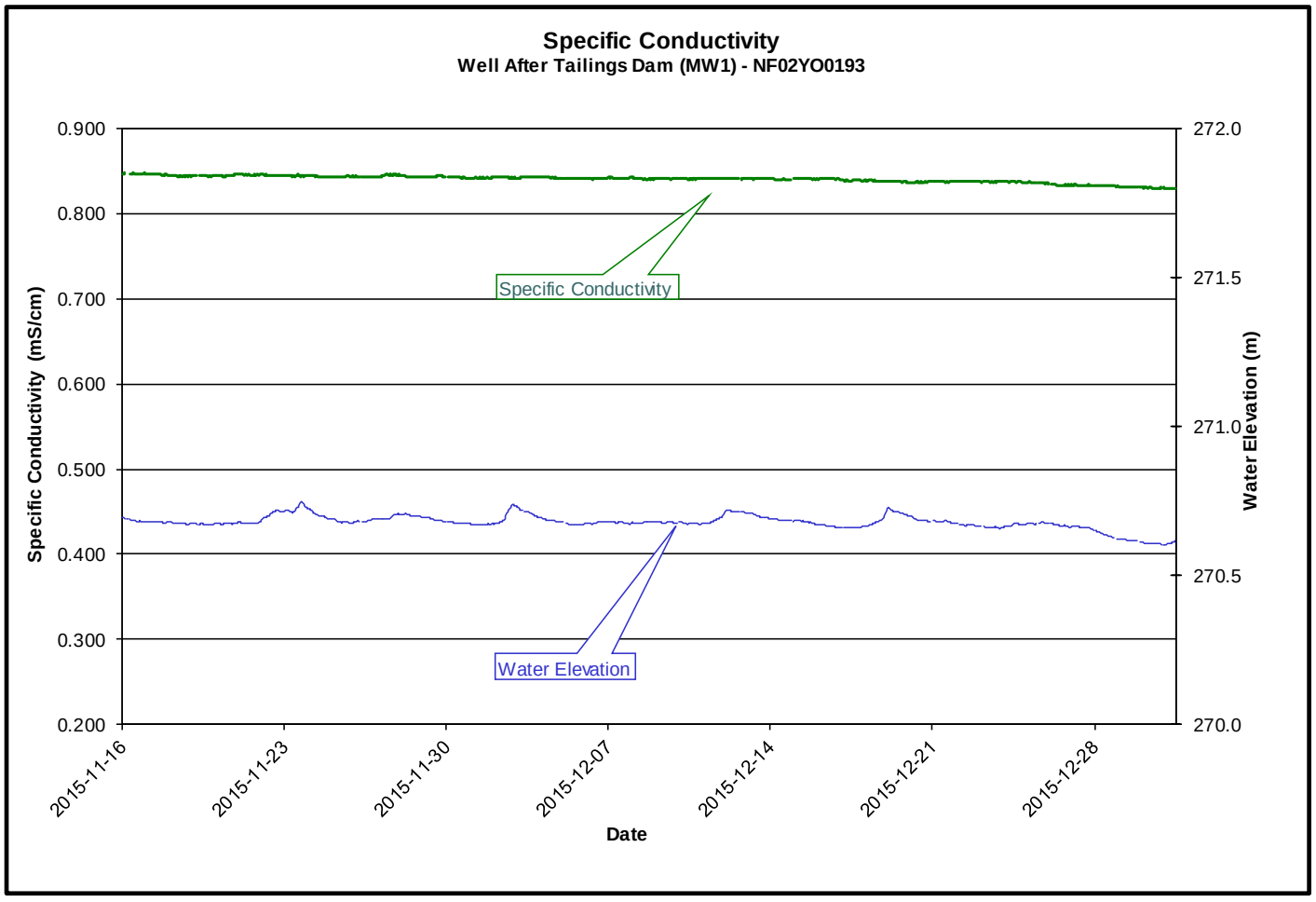

Figure 15

- The Water Elevation **(Figure 16)** ranged from a minimum of 270.60 m to a maximum of 270.75 m.
- There was little change over the deployment period.
- 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.

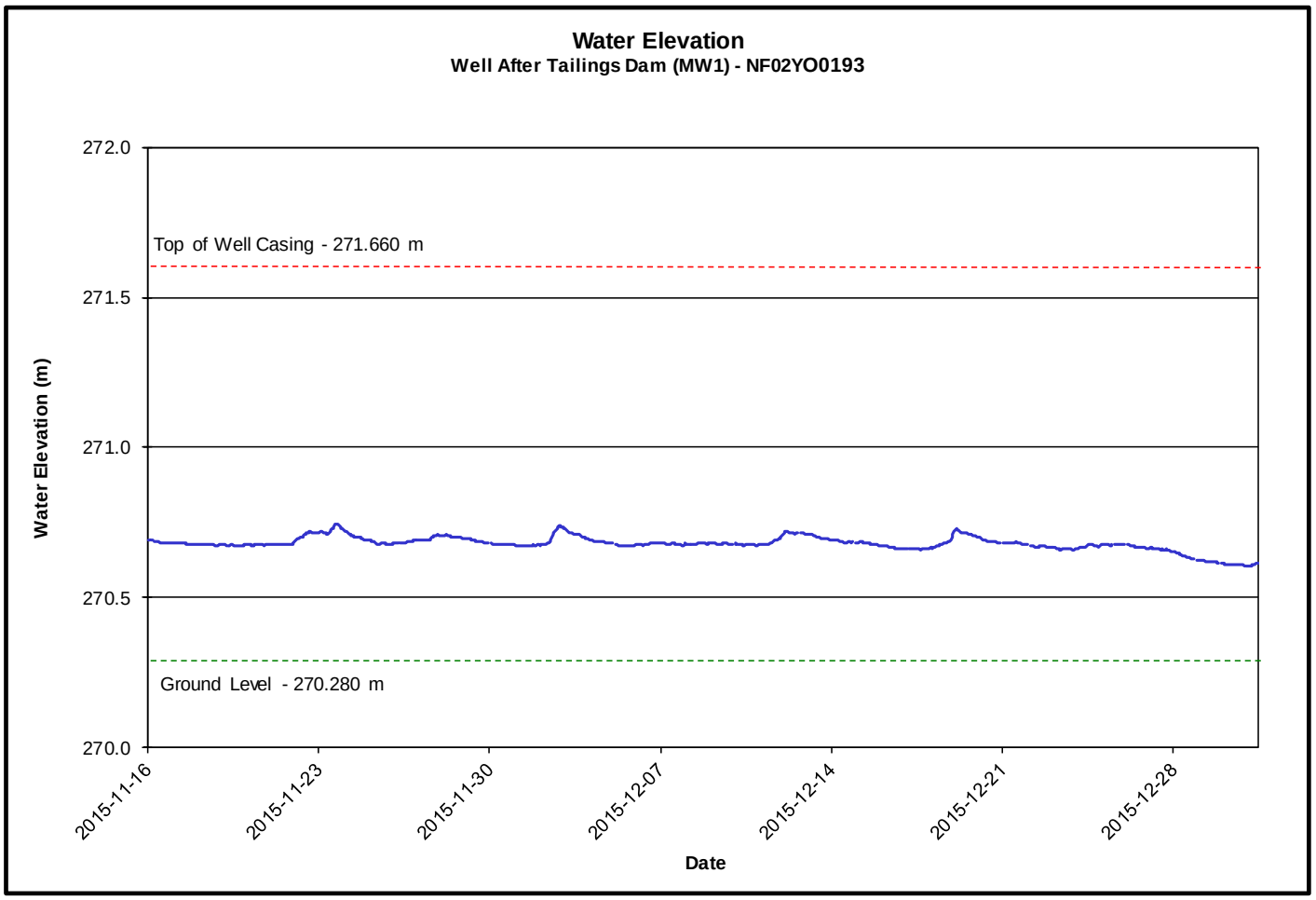

Figure 16

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