Real-Time Water Quality Deployment Report

Lower Churchill River Network

October 4 to
November 2, 2011

Newfoundland Labrador

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

Contents

Newfoundland Labrador

Real-Time Water Quality Deployment Report

Lower Churchill River Network

October 4 to November 2, 2011

General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at the four stations on the Lower Churchill River: below Metchin River, below Grizzle Rapids and above and below Muskrat Falls.
- On October 4-5, 2011, real-time water quality monitoring instruments were deployed at the four Lower Churchill River Stations for a period of 29 days. Instruments were removed on November 1-2.

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), 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.
  - ► At deployment and removal, a QA/QC Instrument is temporarily deployed along side the Field Instrument. 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 Instrument and QA/QC Instrument at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

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 instrument 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 instrument the entire instrument 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 Lower Churchill River stations deployed from October 4-5 to November 1-2, 2011 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, October 4-5 – November 1-2, 2011

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45701)	Oct 4, 2011	Deployment	Good	Fair	Excellent	Excellent	Excellent
	Nov 1, 2011	Removal	Good	Good	Good	Excellent	Excellent
Below Grizzle Rapids (45709)	Oct 4, 2011	Deployment	Good	Fair	Excellent	Excellent	Excellent
	Nov 1, 2011	Removal	Fair	Excellent	Excellent	n/a	n/a
Above Muskrat Falls (47590)	Oct 4, 2011	Deployment	Excellent	Good	Excellent	Excellent	Poor
	Oct 5, 2011	Removal	Excellent	Good	Excellent	Excellent	Poor
Above Muskrat Falls (47589)	Oct 5, 2011	Deployment	Excellent	Fair	Excellent	Good	Excellent
	Nov 1, 2011	Removal	Excellent	Excellent	Good	Marginal	Excellent
Below Muskrat Falls (45699)	Oct 5, 2011	Deployment	Good	Good	Excellent	Excellent	Excellent
	Nov 2, 2011	Removal	Fair	Good	Good	Excellent	Excellent

- At the station below Metchin River, temperature, specific conductivity, dissolved oxygen and turbidity all ranked 'good' or 'excellent' at deployment while pH ranked 'fair'. The field instrument read a value of 6.2 and the QA/QC instrument read a value of 6.83. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. At removal, all parameters ranked either 'good' or 'excellent'.
- At the station below Grizzle Rapids, temperature, specific conductivity, dissolved oxygen and turbidity all ranked 'good' or 'excellent' at deployment while pH ranked 'fair'. The field instrument read a value of 6.47 and the QA/QC instrument read a value of 7.09 pH. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. At removal, pH and specific conductivity both ranked 'excellent' while temperature ranked 'fair'. The field instrument read a value of 5.24°C while the QA/QC instrument read a value of 5.90°C. This discrepancy may be explained in part due to the positioning of the instruments side by side in the river and the amount of time allowed for stabilization. Dissolved oxygen and turbidity are not ranked due to a sensor failure almost immediately after deployment on October 4.
- At the station above Muskrat Falls, temperature, pH, specific conductivity and dissolved oxygen all ranked 'good' or 'excellent' at deployment while turbidity ranked 'poor' due to sensor failure. The field instrument read a value of 0.0NTU while the QA/QC instrument read a value of 6.7NTU. The average turbidity at this station is around 5.0NTU indicating that the QA/QC instrument was probably reporting the correct value at the time of deployment. ENVC staff returned to the station the next day on September 2 with a replacement instrument and removed the instrument with the turbidity sensor issue. At removal on

October 5, temperature, pH, specific conductivity all ranked either 'good' or 'excellent'. Turbidity continued to rank 'poor'.

- At the second deployment at the station above Muskrat Falls on October 5, temperature, specific conductivity, dissolved oxygen and turbidity all ranked either 'good' or 'excellent' while pH ranked 'fair'. The field instrument read a value of 6.12 and the QA/QC instrument read a value of 6.74. This discrepancy may be explained in part due to the positioning of the instruments side by side in the river and the amount of time allowed for stabilization. At removal, temperature, pH, specific conductivity, and turbidity all ranked either 'good' or 'excellent' while dissolved oxygen ranked 'fair'. The field instrument read a value of 11.74mg/l and the QA/QC instrument read a value of 12.68mg/l. This discrepancy may be explained in part due to the positioning of the instruments side by side in the river and the amount of time allowed for stabilization.
- At the station below Muskrat Falls, all parameters ranked either 'good' or 'excellent' at deployment on October 4. At removal, pH, specific conductivity, dissolved oxygen and turbidity all ranked either 'good' or 'excellent' while temperature ranked 'fair'. The field instrument read a value of 4.57°C and the QA/QC instrument read a value of 5.10°C. This discrepancy may be explained in part due to the positioning of the instruments side by side in the river and the amount of time allowed for stabilization.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from October 4-5 to November 1-2 in the Lower Churchill River Network.
- 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 QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Churchill River below Metchin River

- Water temperature ranged from 3.00°C to 8.60°C during this deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures in the fall season (Figure 2). Water temperature fluctuates diurnally.

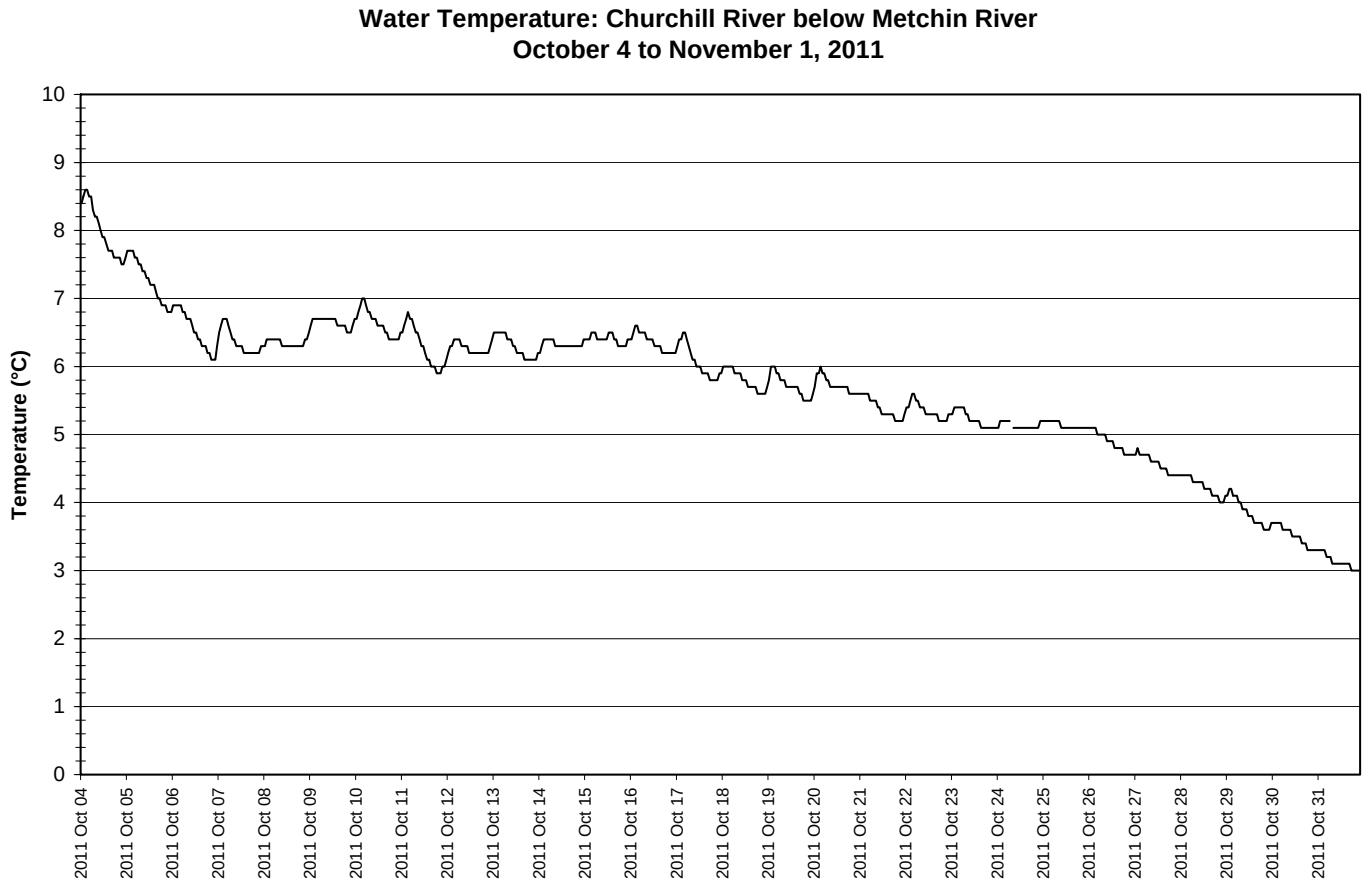


Figure 1: Water temperature at Churchill River below Metchin River

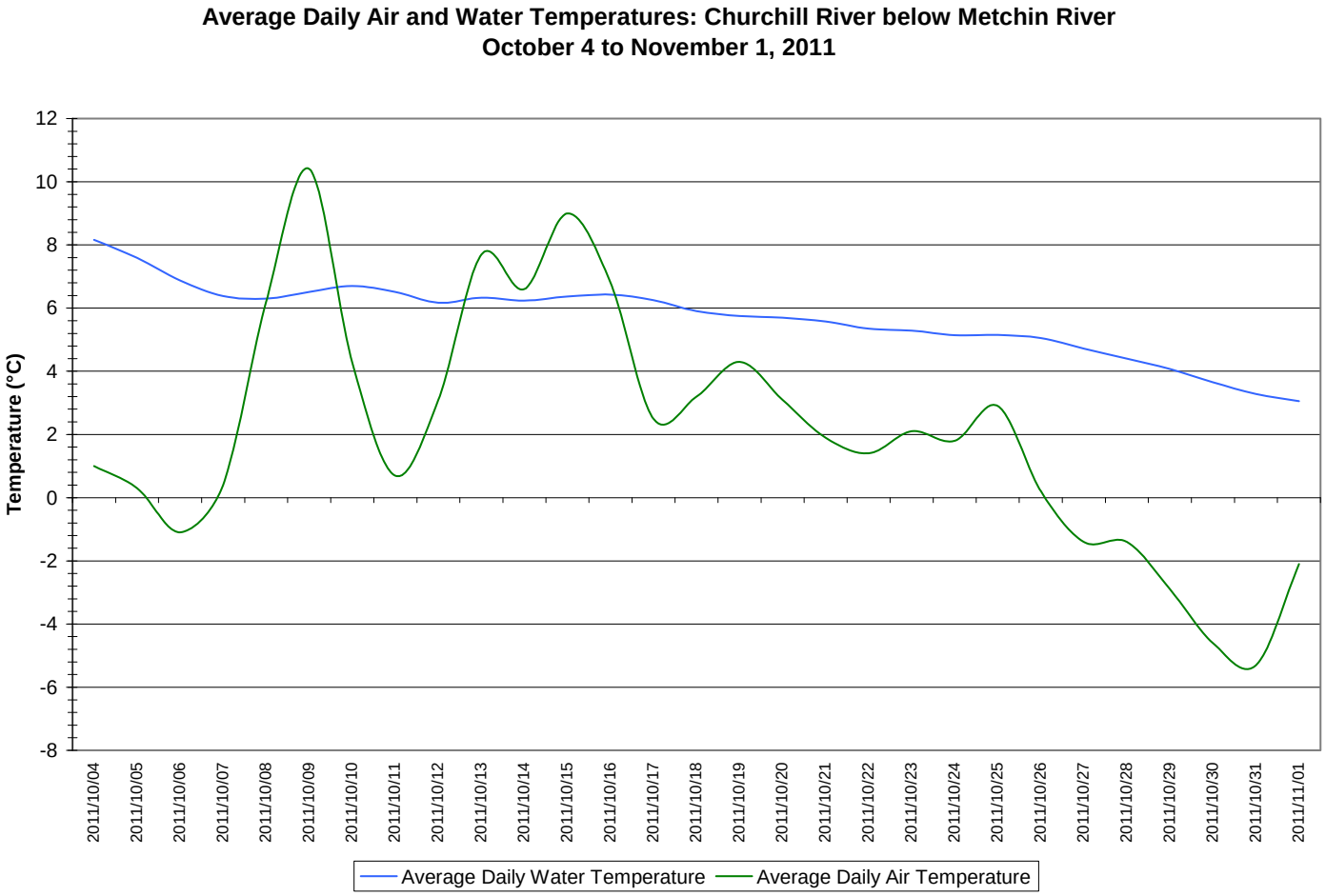


Figure 2: Average daily air and water temperatures at Churchill River below Metchin River (weather data recorded at Churchill Falls)

- pH ranges between 6.77 and 6.92 pH units and remains relatively stable throughout the deployment period (Figure 3).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

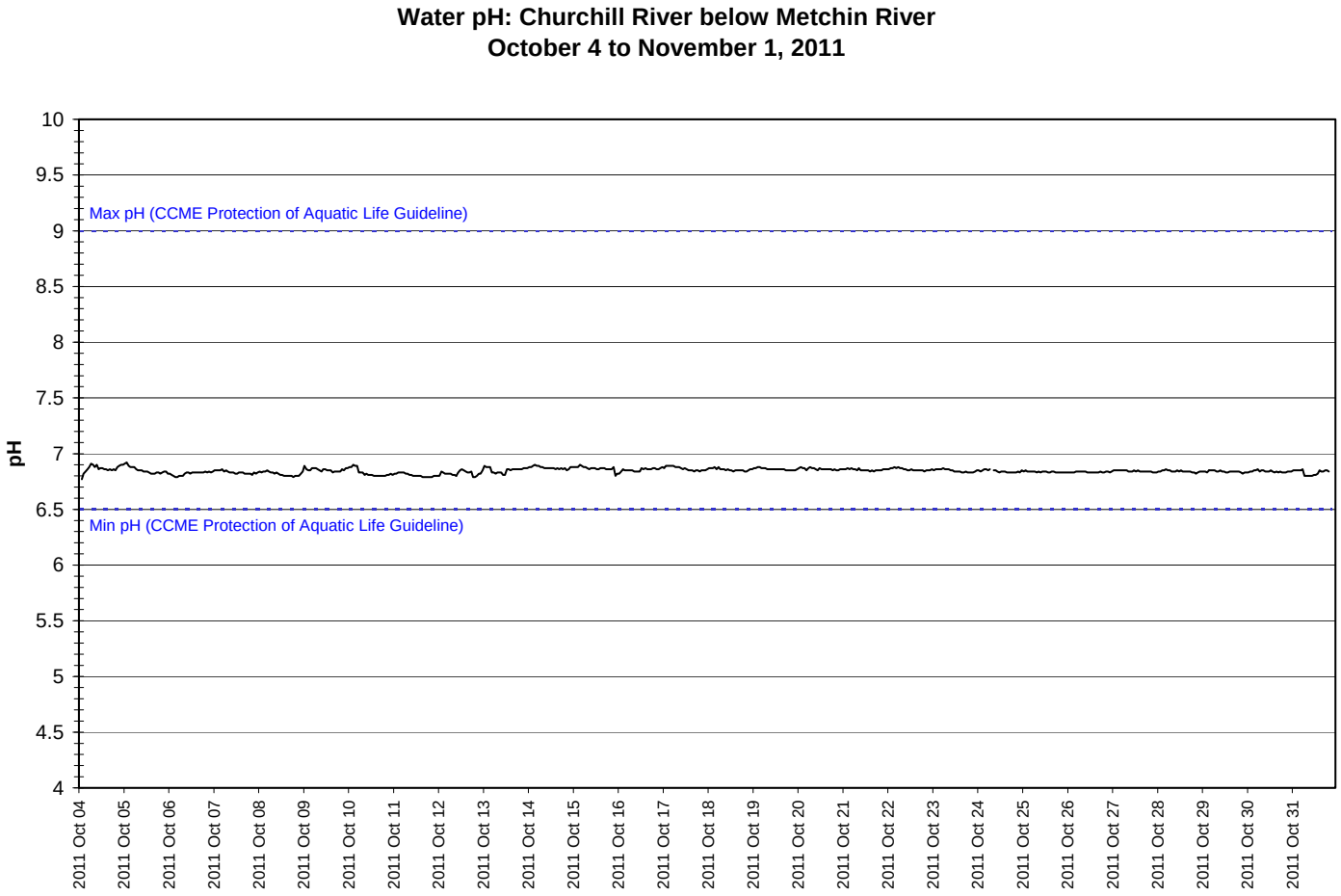


Figure 3: pH at Churchill River below Metchin River

- Specific conductivity ranges from 18.6 to 22.2µS/cm during the deployment period, averaging 19.5µS/cm (Figure 4). Specific conductivity decreases at the beginning of the deployment period.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is generally increasing throughout the deployment period with some significant fluctuations. As stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column. Inversely, when stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases.

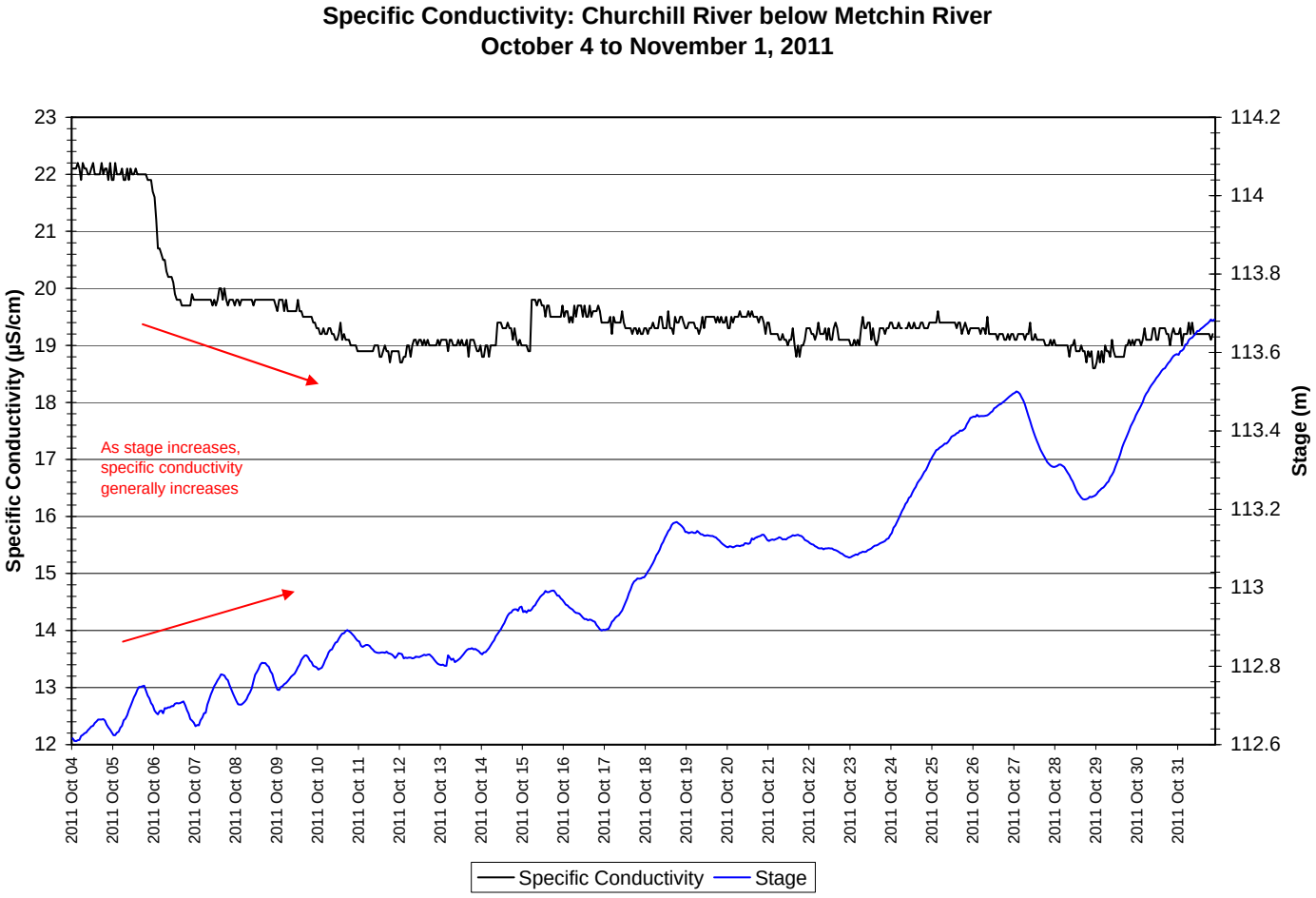


Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 90.7 to 93.9% and a range of 10.91 to 12.34mg/l was found in the concentration of dissolved oxygen with a median value of 11.53 mg/l (Figure 5).
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stage of 6.5 mg/l and at Early Life stages of 9.5mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is increasing slightly throughout the deployment period. This trend is expected given the increasingly colder air and water temperatures (Figure 2).

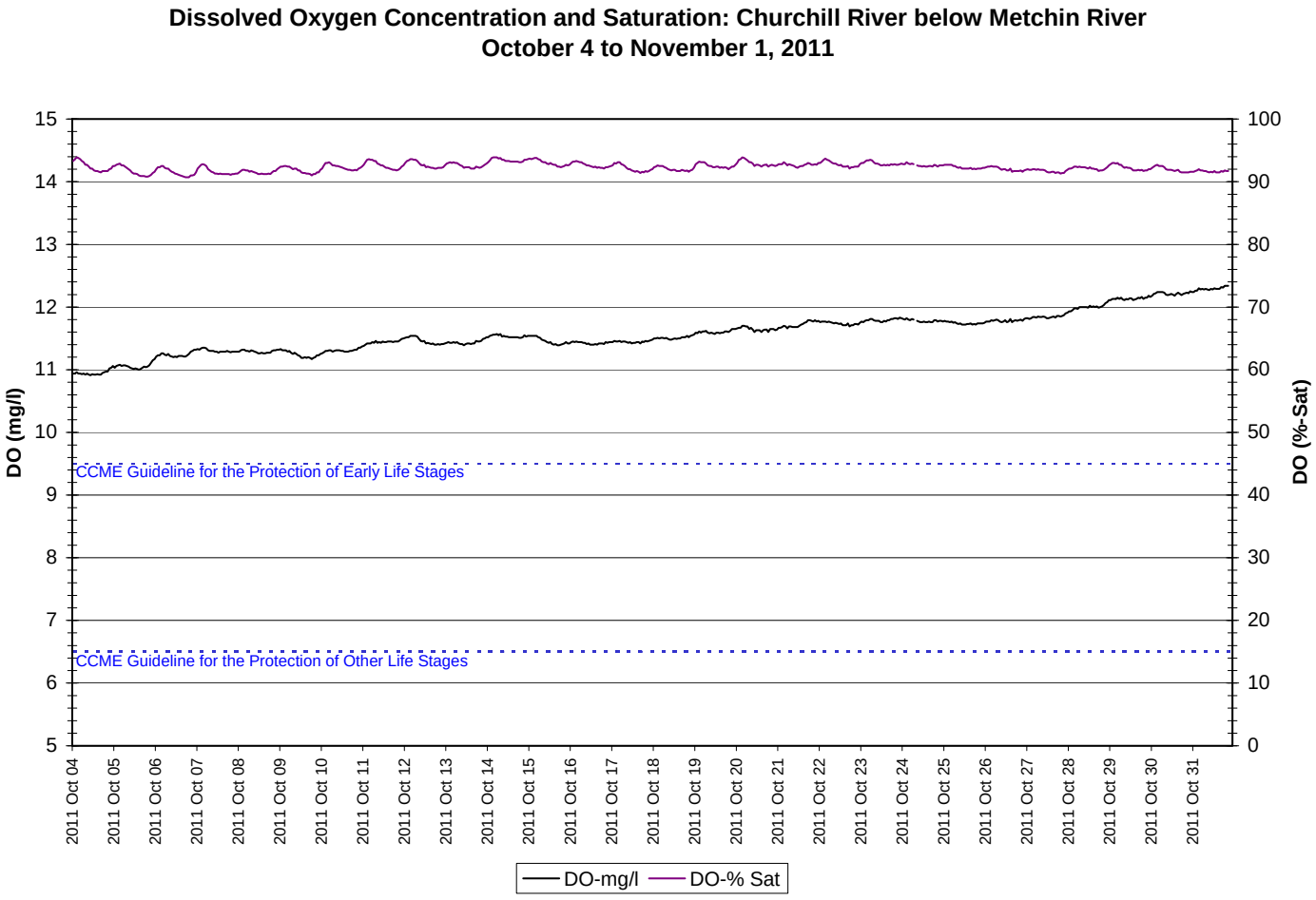


Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- Turbidity generally remains at 0NTU for the majority of the deployment period (Figure 6). A median value of 0 NTU indicates there is generally no natural background turbidity value at this station.
- There are a couple of instances where turbidity increases (to as high as 5.8NTU) for very short periods of time (1-3 hours). These are not considered water quality events as they are isolated and infrequent occurrences.

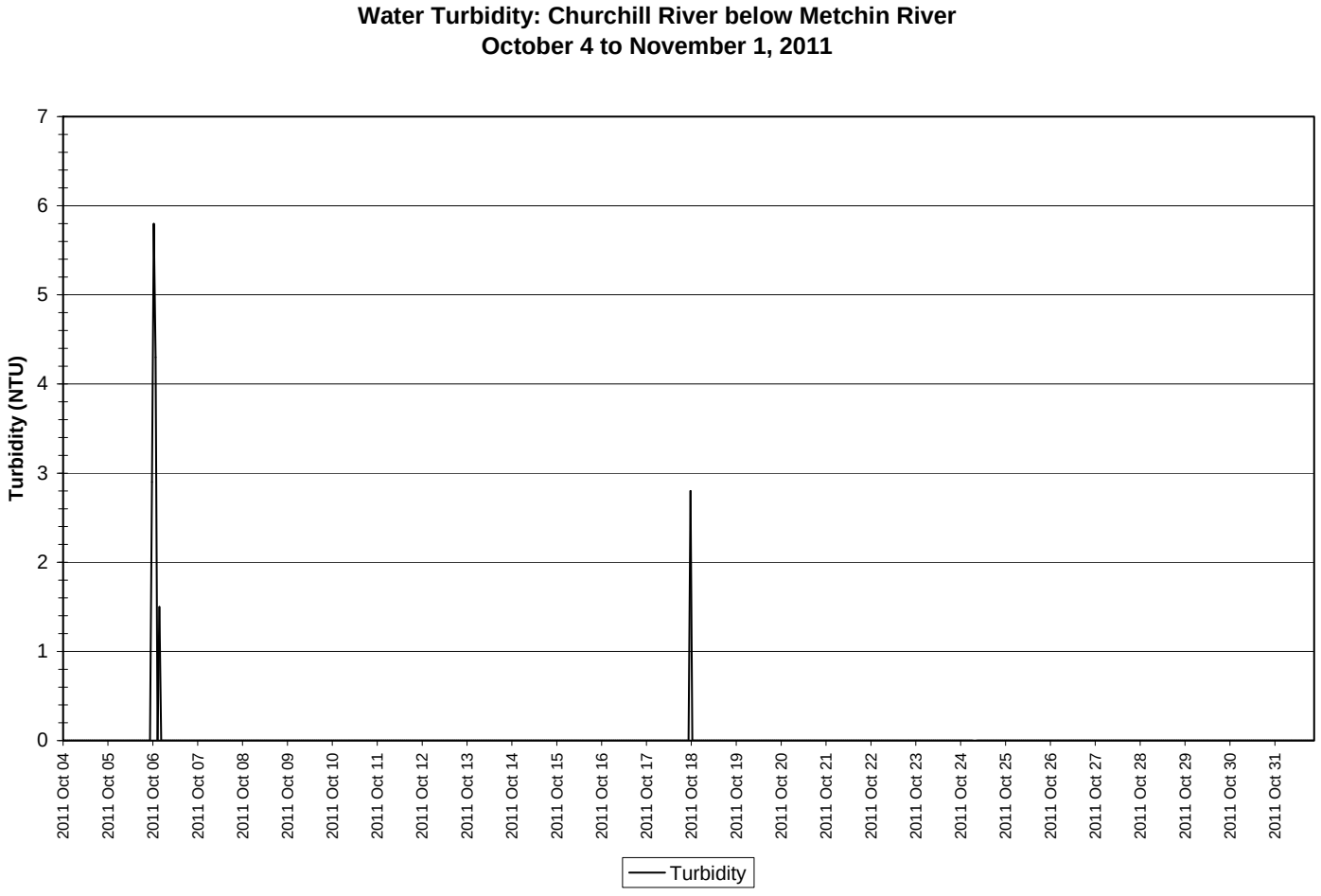


Figure 6: Turbidity at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is increasing throughout the deployment period and precipitation records vary.

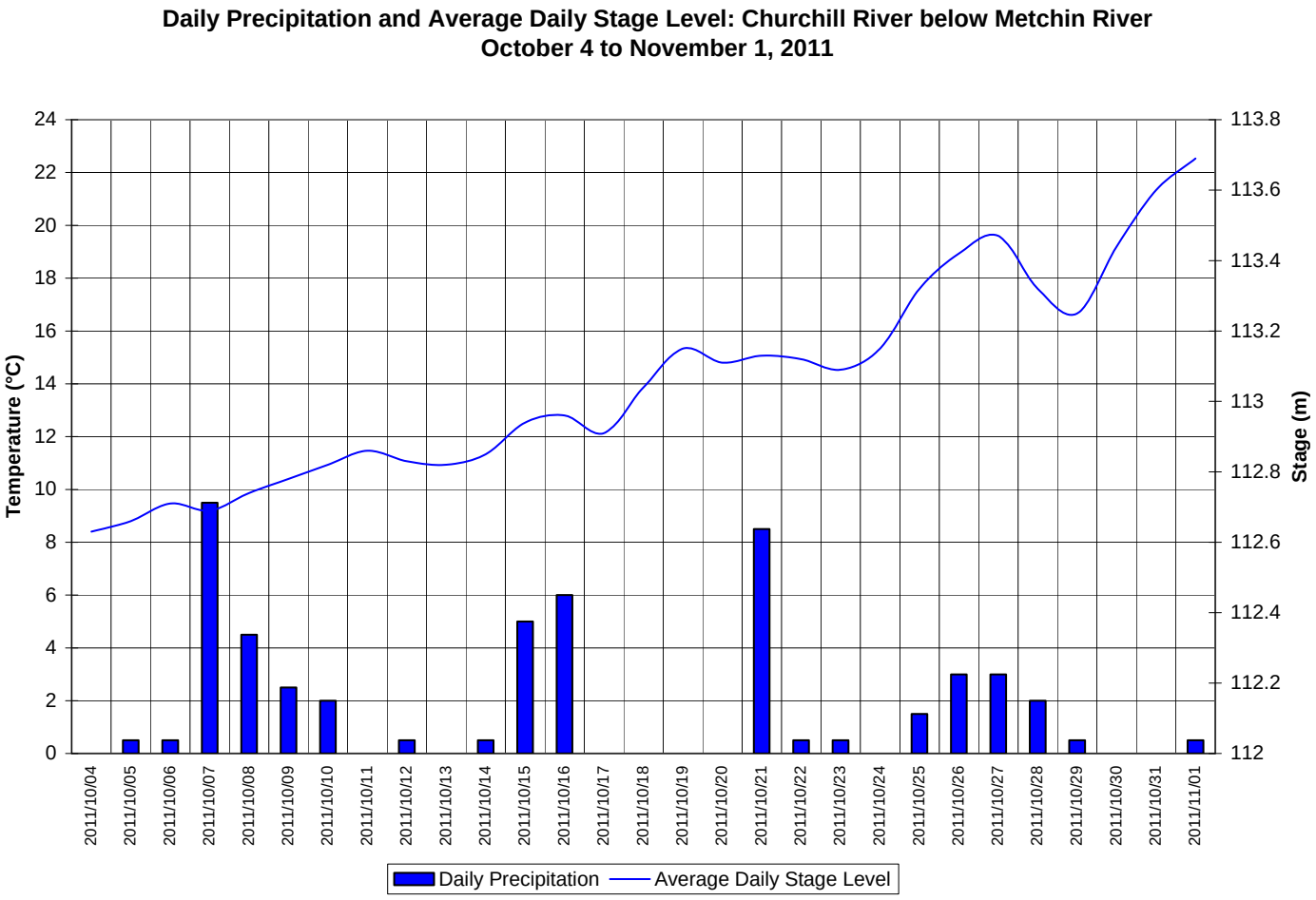


Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- Water temperature ranged from 5.00 to 9.80^{o}C during this deployment period (Figure 8).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures in the fall season (Figure 9). Water temperature fluctuates diurnally.

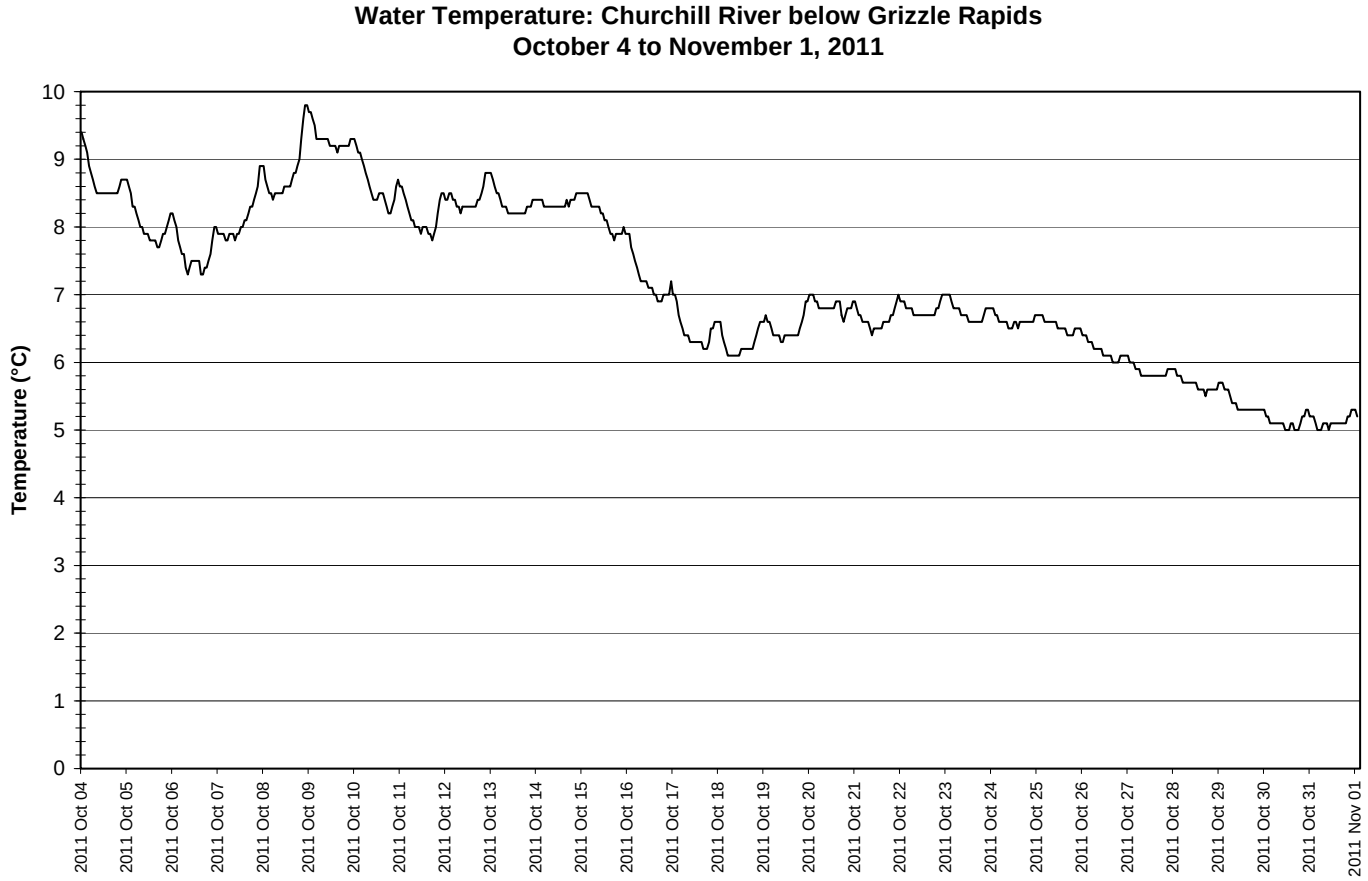


Figure 8: Water temperature at Churchill River below Grizzle Rapids

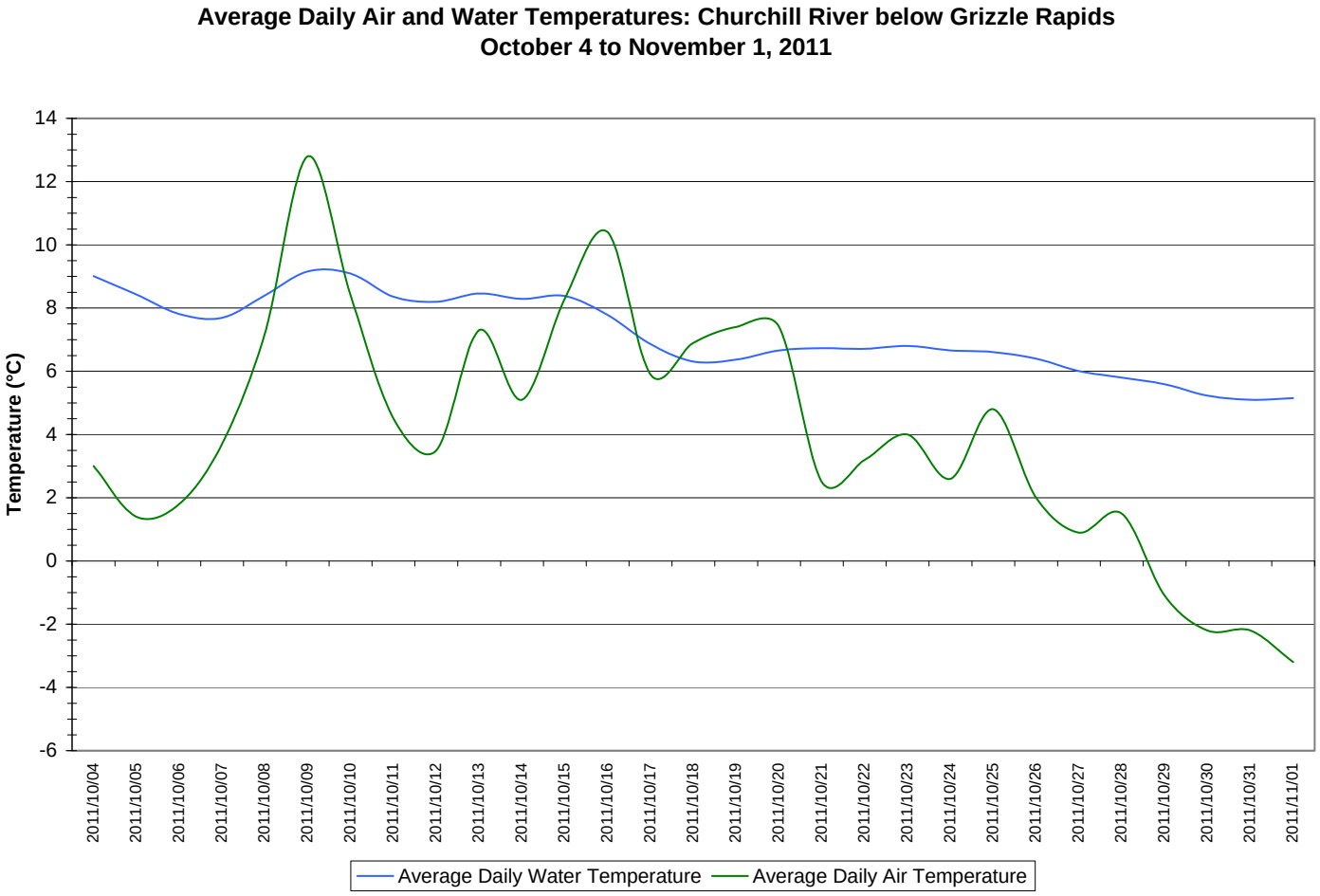


Figure 9: Average daily air and water temperatures at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 6.80 and 7.16 pH units and remains fairly consistent throughout the deployment period (Figure 10). pH fluctuates diurnally.
- There is a decrease in pH midway through the deployment period. This decrease corresponds with a small rainfall event however it is unknown if that is what caused the decrease. There are more significant rainfall events throughout the deployment period which do not have he same impact on the pH. The decrease also corresponds with a decrease in water temperature (Figure 9) and specific conductivity (Figure 11).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10).

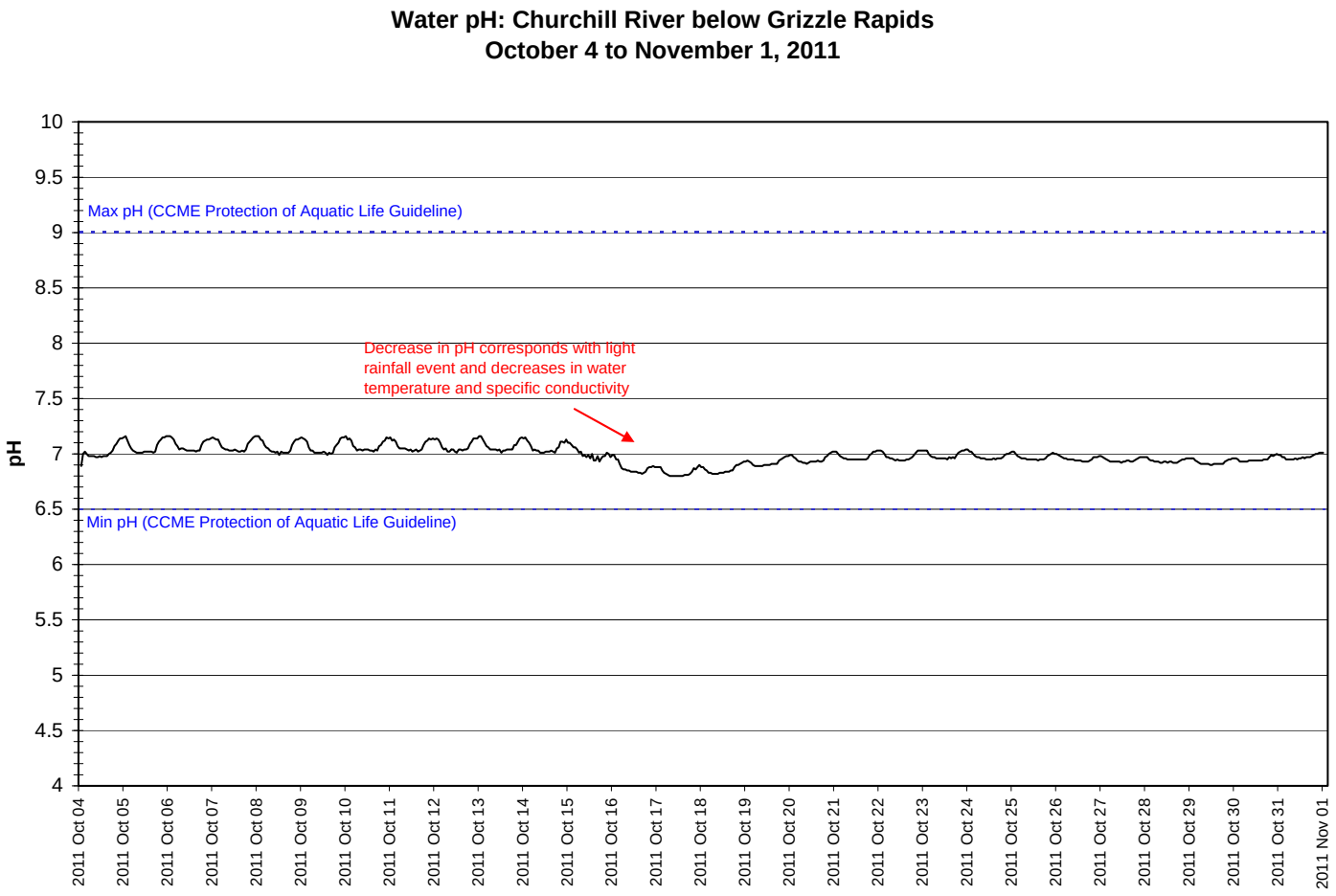


Figure 10: pH at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 18.6 to 21.9µS/cm during the deployment period (Figure 11).
- Specific conductance decreases and increases mid way through the deployment period. This decrease corresponds with increasing stage, a light rainfall event and decreases in pH and water temperature. Specific conductivity increases again after about five days.
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Stage is generally increasing throughout the deployment period with some significant fluctuations. As stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column. Inversely, when stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases.

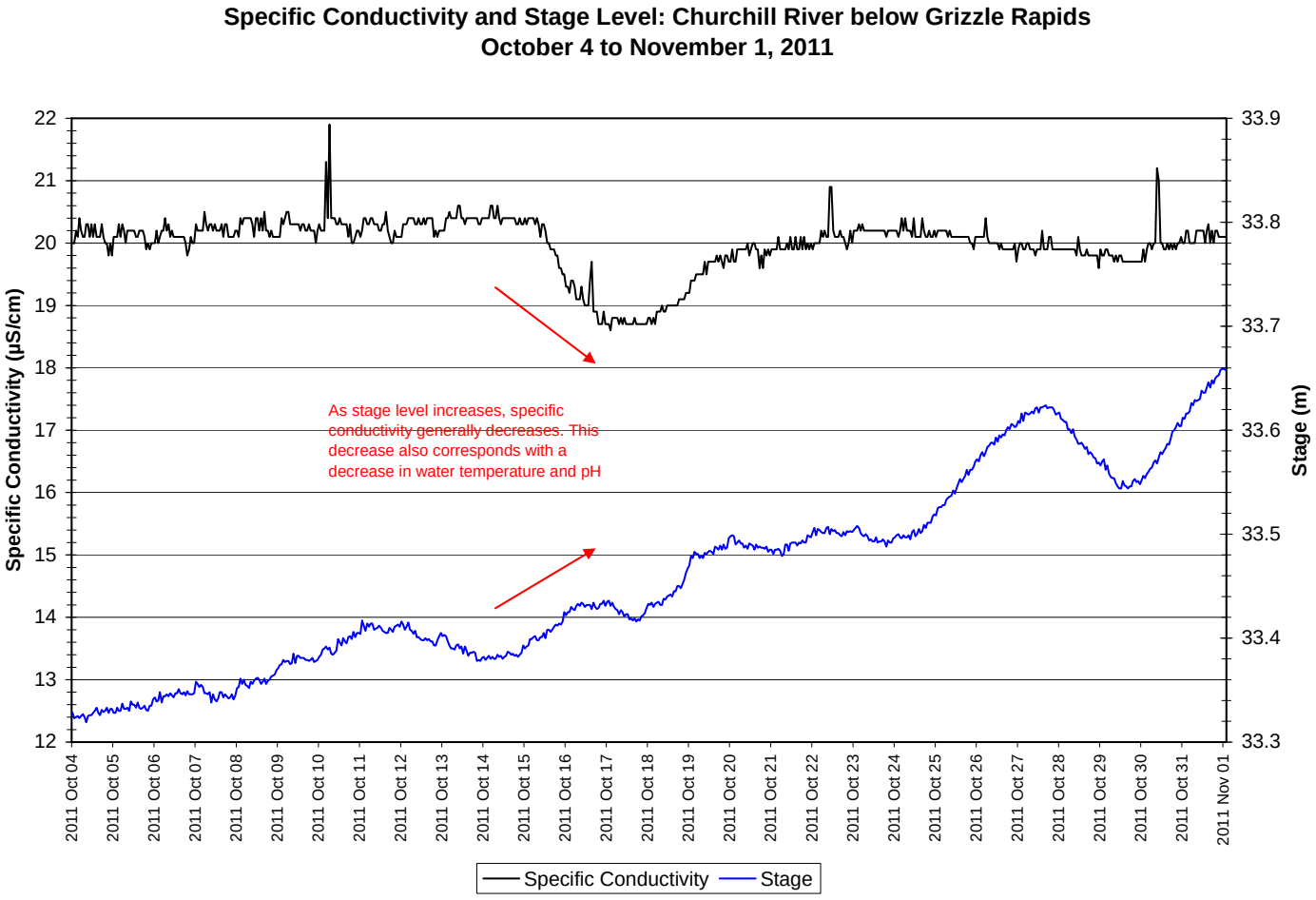


Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- The dissolved oxygen sensor failed almost immediately after the deployment of the instrument. When the instrument was checked in the field against the QA/QC instrument, the values were reading appropriately and dissolved oxygen ranked 'excellent'. At the first scheduled transmission from the station via the GOES satellite, the instrument's sensor had failed and reported 0mg/l for the remainder of the deployment period.
- Similarly, there is no turbidity data for this station during this time. At deployment, when the field instrument was checked against the QA/QC instrument, turbidity was reading appropriately and ranked 'excellent'. The dissolved oxygen sensor is closely related to the circuit wiring of the turbidity sensor. When the dissolved oxygen sensor failed shortly after deployment, the turbidity sensor experienced problems related to power consumption and caused the data to be erratic and inaccurate. Turbidity data values have been removed from the dataset.
- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 12). Stage is increasing throughout the deployment period and precipitation records vary.

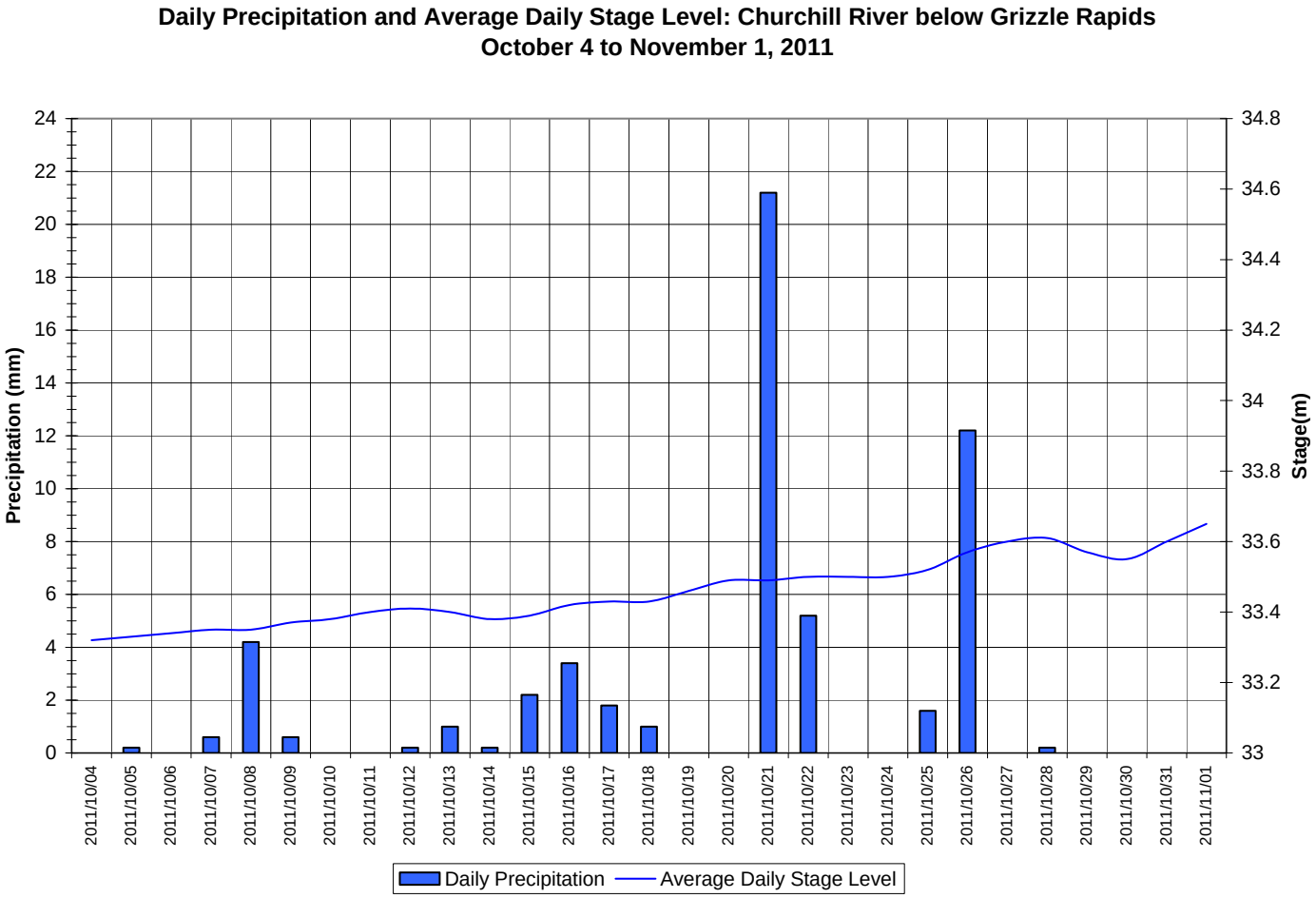


Figure 12: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids

(weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- The instrument deployed on October 4 experienced a turbidity sensor malfunction. The instrument was removed the following day, October 5, and replaced with a new instrument. Data collected for temperature, pH, specific conductivity and dissolved oxygen during October 4-5 is included in the discussion below. Turbidity values have been removed from the data set during this time as the instrument was reporting inaccurate values.
- Water temperature ranges from 3.99 to 9.28^{o}C during this deployment period (Figure 13).
- Water temperature is generally decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall (Figure 14). Water temperature fluctuates diurnally.

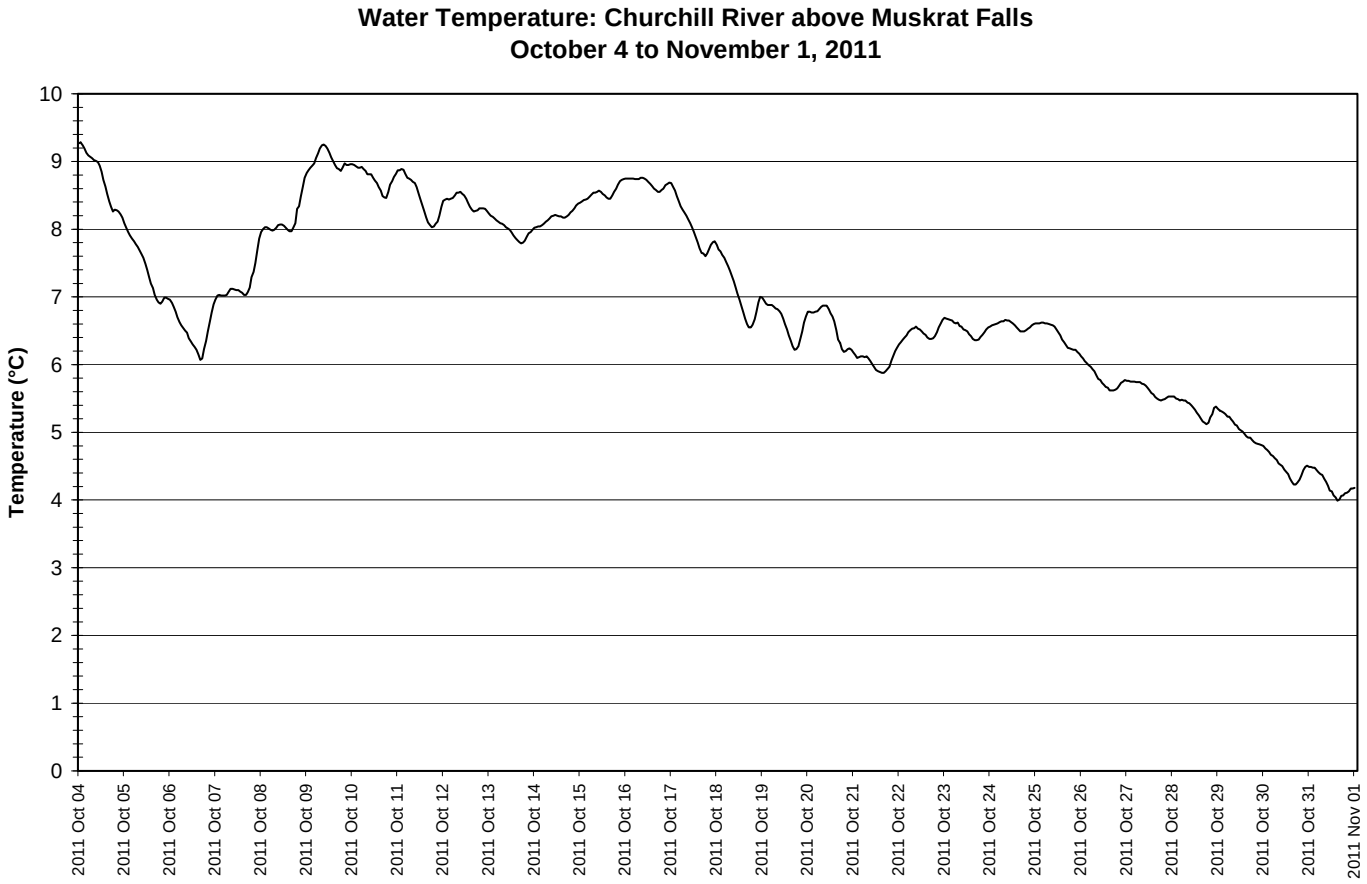


Figure 13: Water temperature at Churchill River above Muskrat Falls

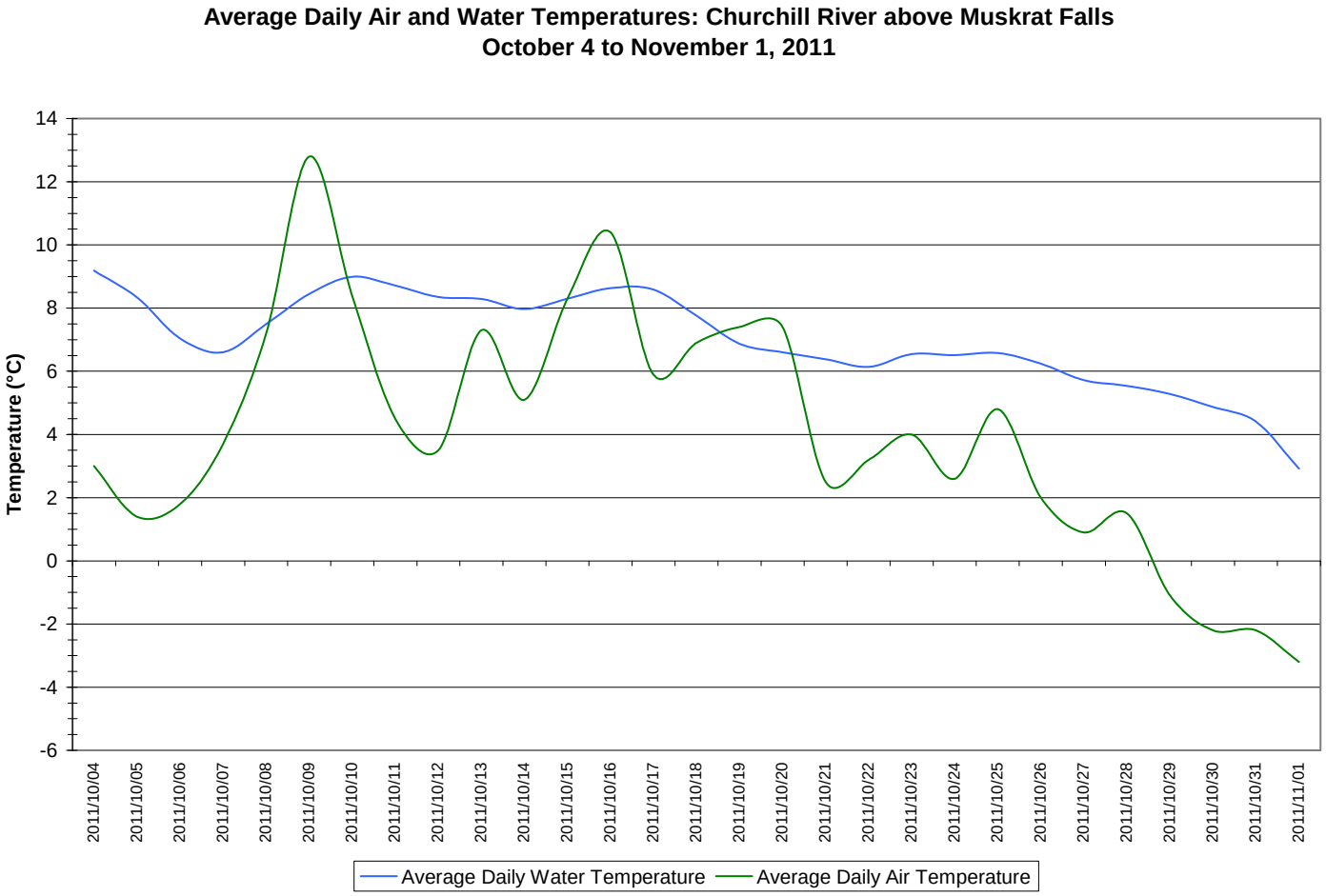


Figure 14: Average daily air and water temperatures at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.57 and 6.79 pH units (Figure 15). pH values are very stable throughout the deployment period however there is a slight decrease over September 17-21. This decrease corresponds with a decrease in pH further upstream at the station below Grizzle Rapids (Figure 10). This decrease also corresponds with a light rainfall event and decreases in water temperature (Figure 13) and specific conductivity (Figure 16)
- All values are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 15).

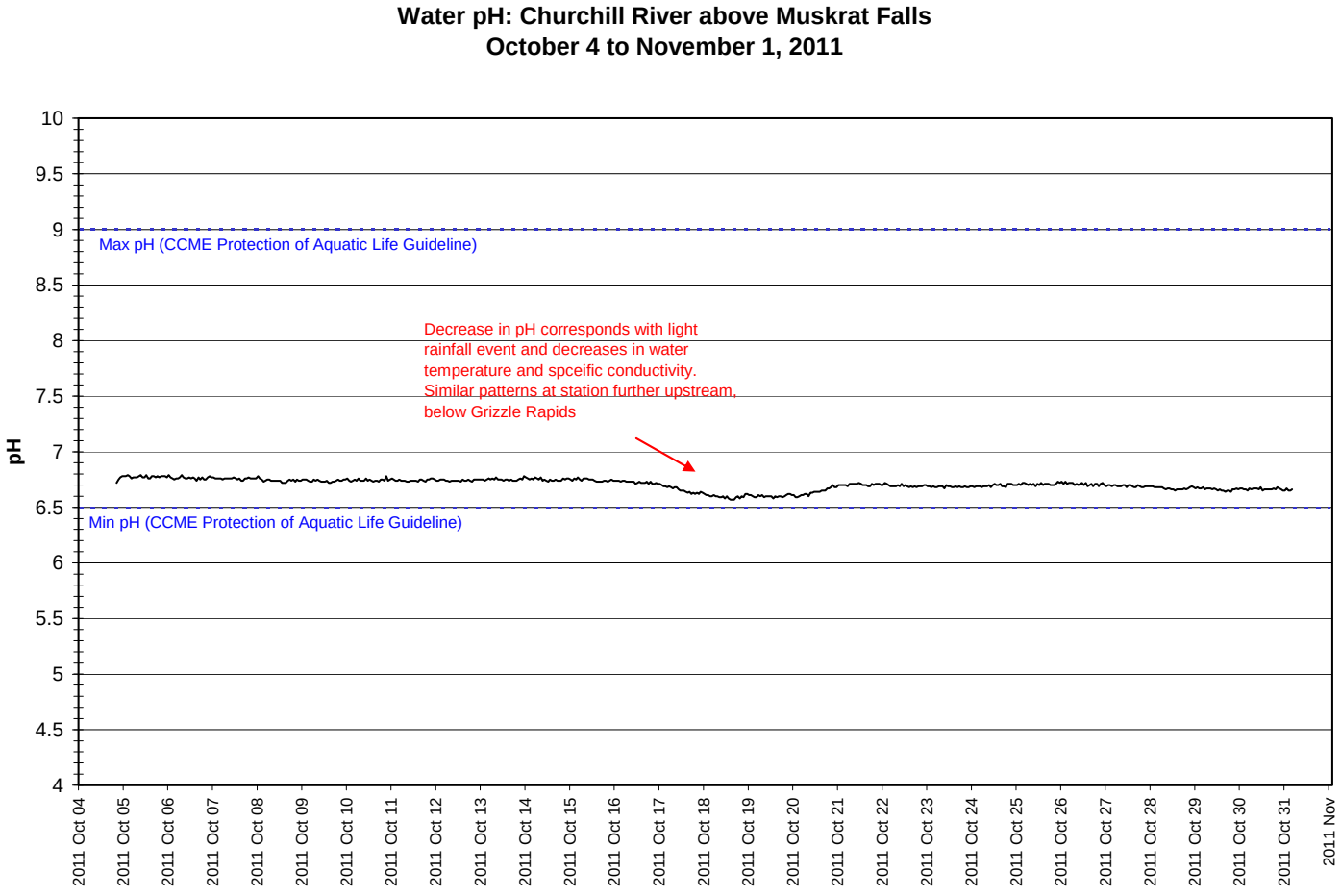


Figure 15: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges from 19.3 to 23.5µS/cm during the deployment period (Figure 16). Specific conductance is generally decreasing throughout the deployment period.
- Stage is included in Figure 16 to illustrate the inverse relationship between conductivity and water level. Stage is generally increasing throughout the deployment period with some significant fluctuations. As stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column. Inversely, when stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases.

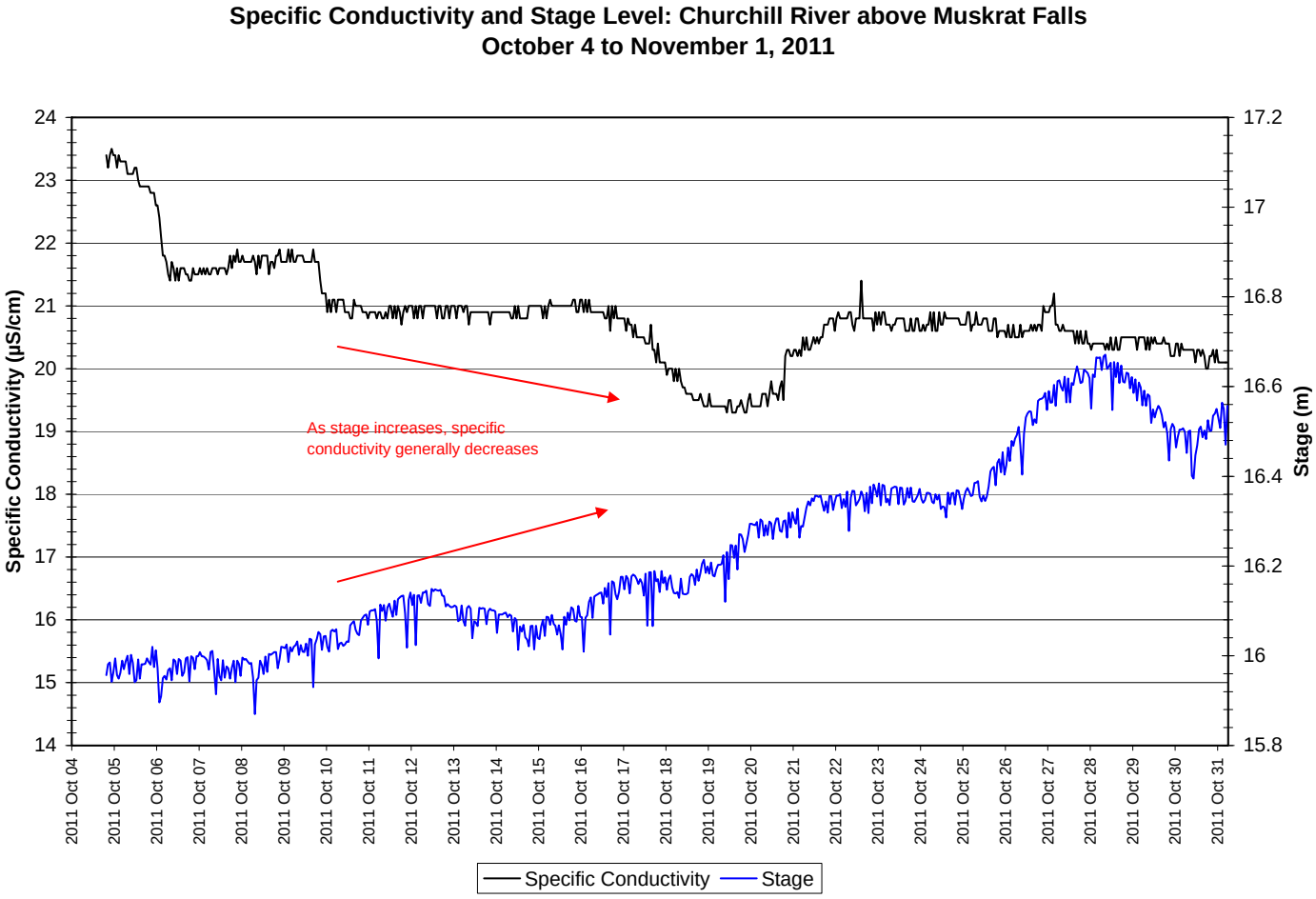


Figure 16: Specific conductivity and stage level at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 88.9 to 92.7% and a range of 10.55 to 11.68mg/l was found in the concentration of dissolved oxygen with a median value of 11.08mg/l (Figure 17).
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stage of 6.5mg/l and at Early Life stage of 9.5mg/l. The guidelines are indicated in blue on Figure 17.
- Dissolved oxygen content is increasing slightly throughout the deployment period. This trend is expected given the increasingly colder air and water temperatures (Figure 14).

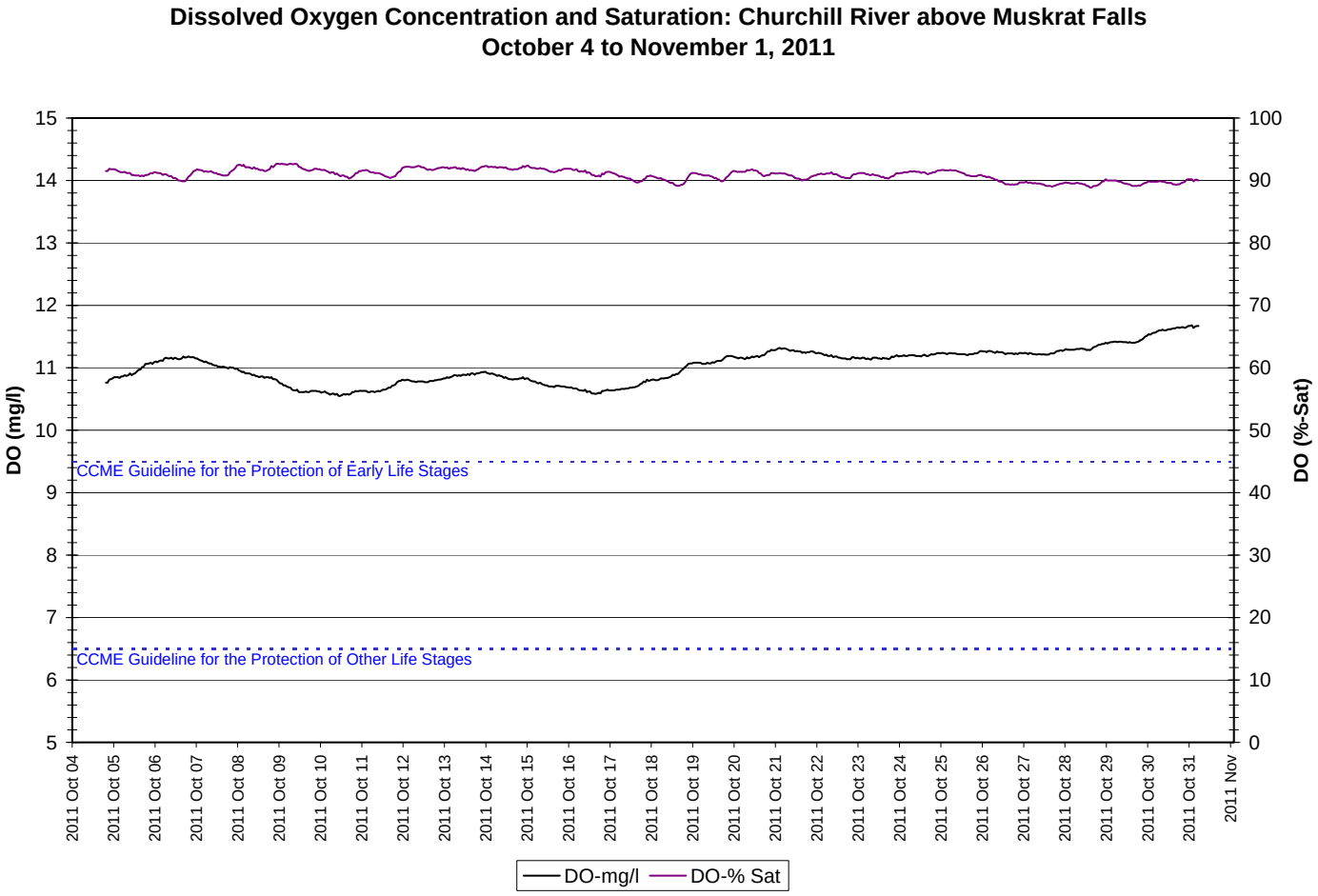


Figure 17: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity generally ranges between 0.0 and 30.0NTU, averaging 4.3NTU (Figure 18). A median value of 3.8NTU indicates there is a consistent natural background turbidity value at this station.
- From October 5 to 8, and October 10, there are increases in turbidity that do not correspond with any weather related events. From October 21 to 23, turbidity increases correspond with a rainfall event lasting from October 21-22. This station is typically has naturally high turbidity with frequent increases sometime not related to weather events.

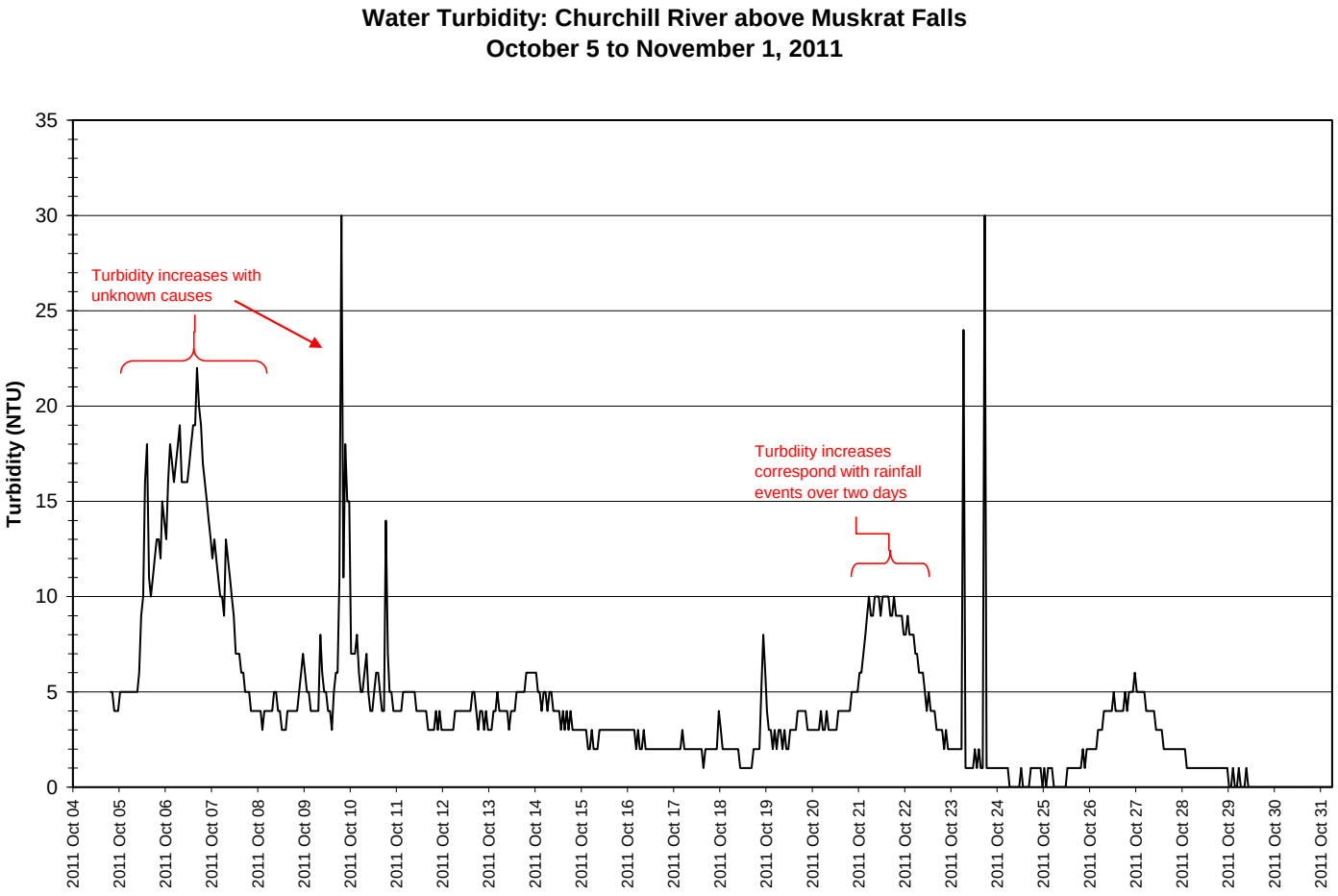


Figure 18: Turbidity at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 19). Stage is increasing throughout the deployment period and precipitation records vary.

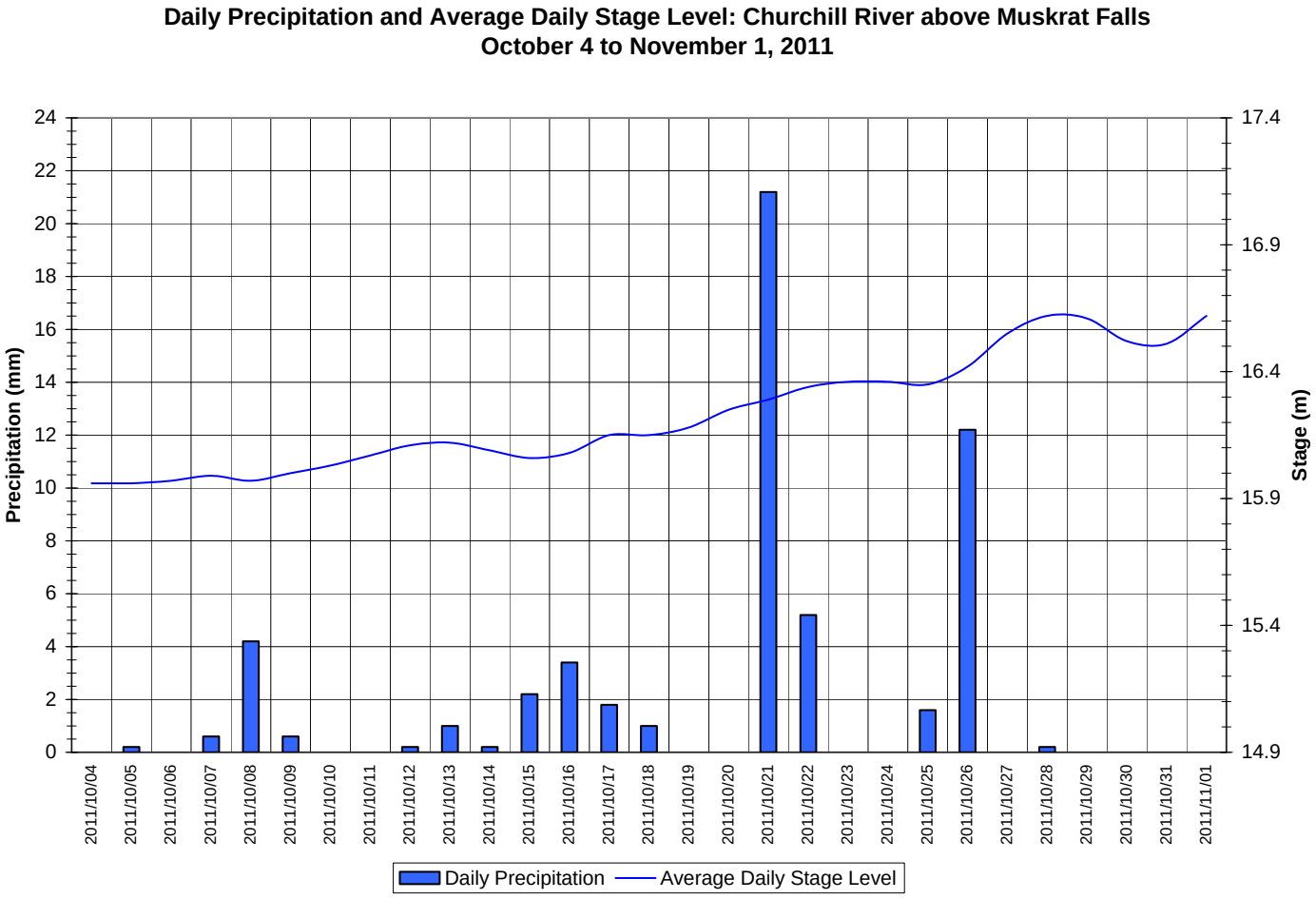


Figure 19: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls

(weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- Water temperature ranges from 4.30 to 9.20°C during this deployment period (Figure 20).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures in the fall season (Figure 21). Water temperature fluctuates diurnally.

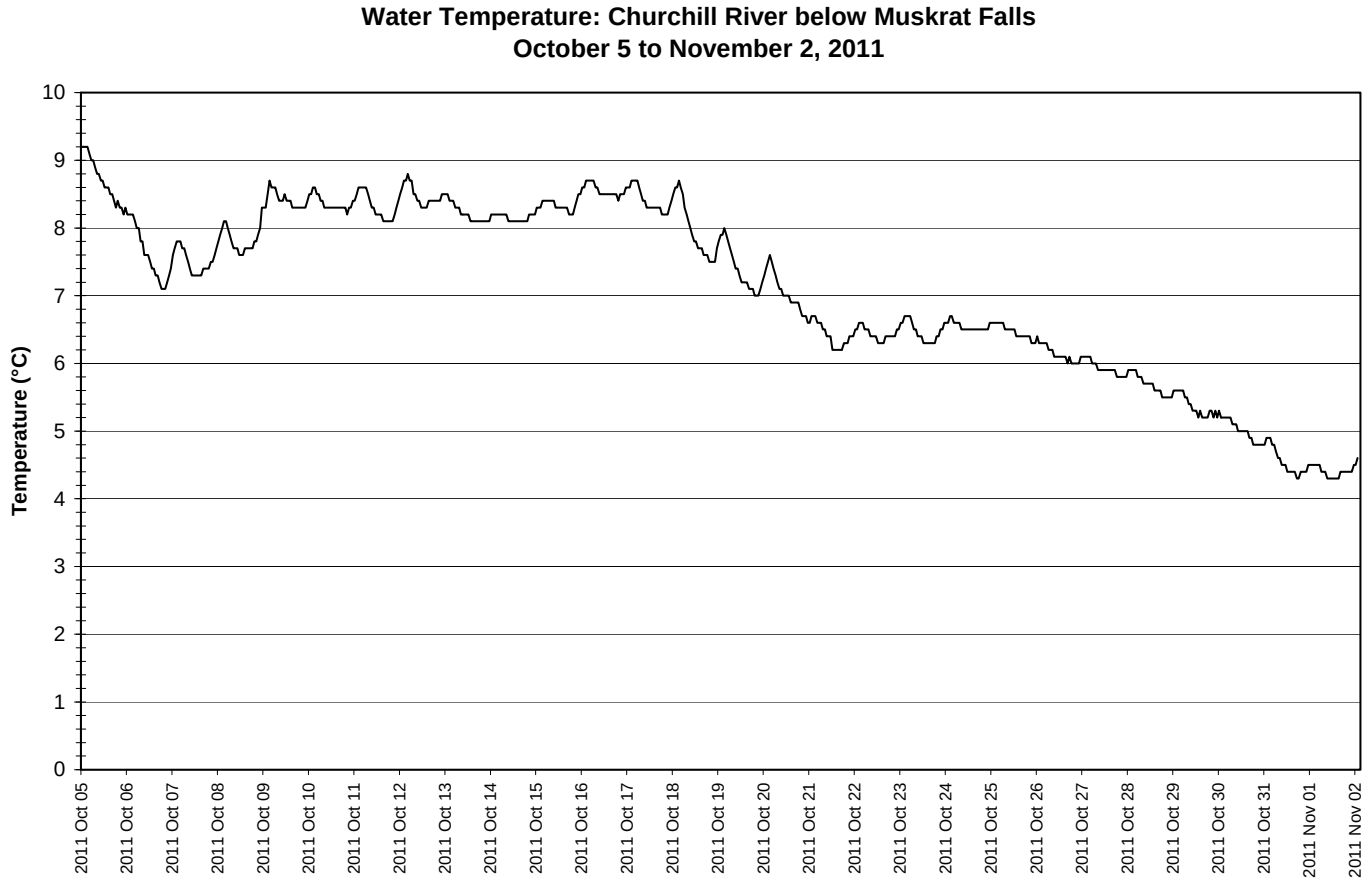


Figure 20: Water temperature at Churchill River below Muskrat Falls

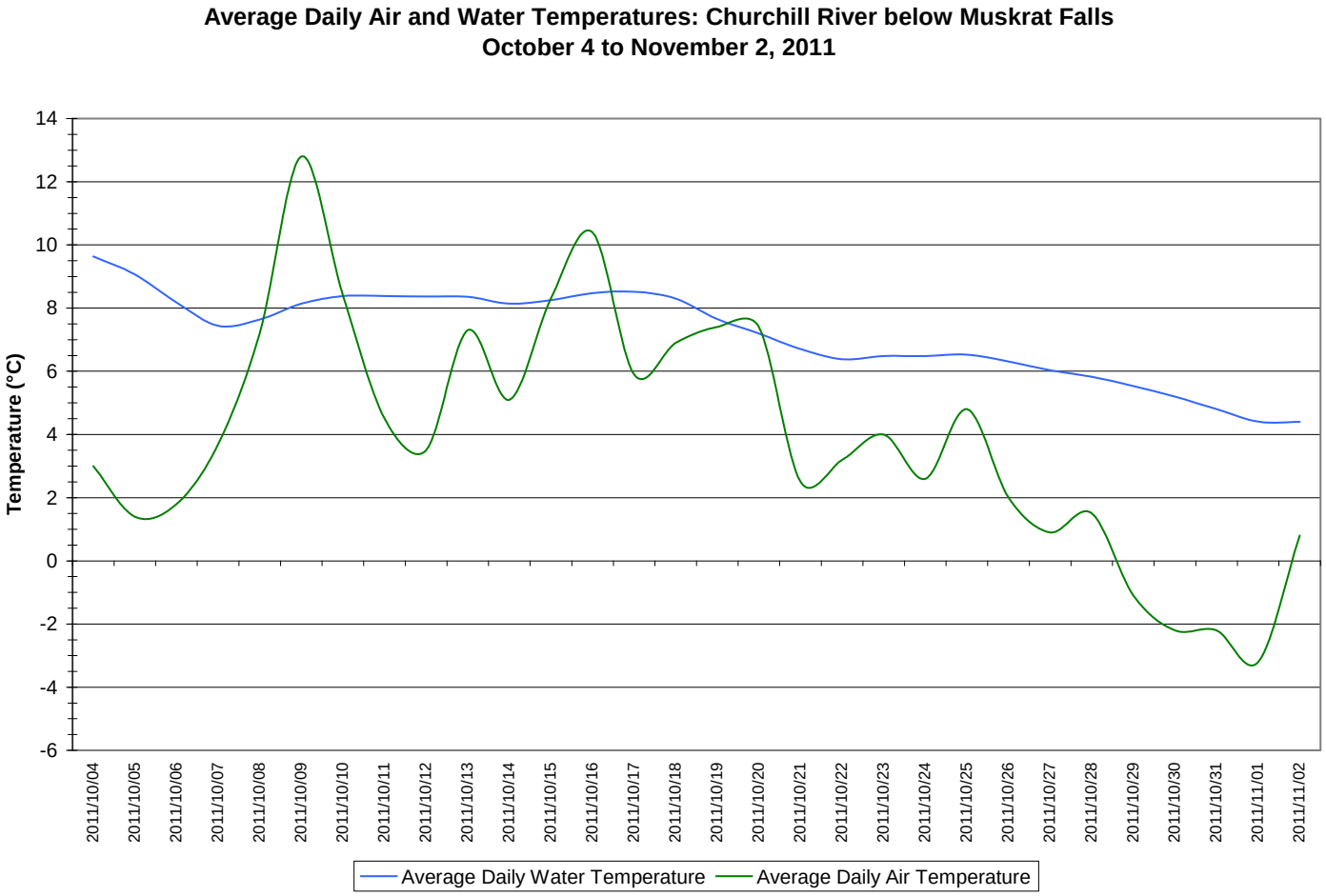


Figure 21: Average daily air and water temperatures at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

- pH ranges between 6.96 and 7.15 pH units (Figure 22). pH values generally remain very stable throughout the deployment period.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 22).

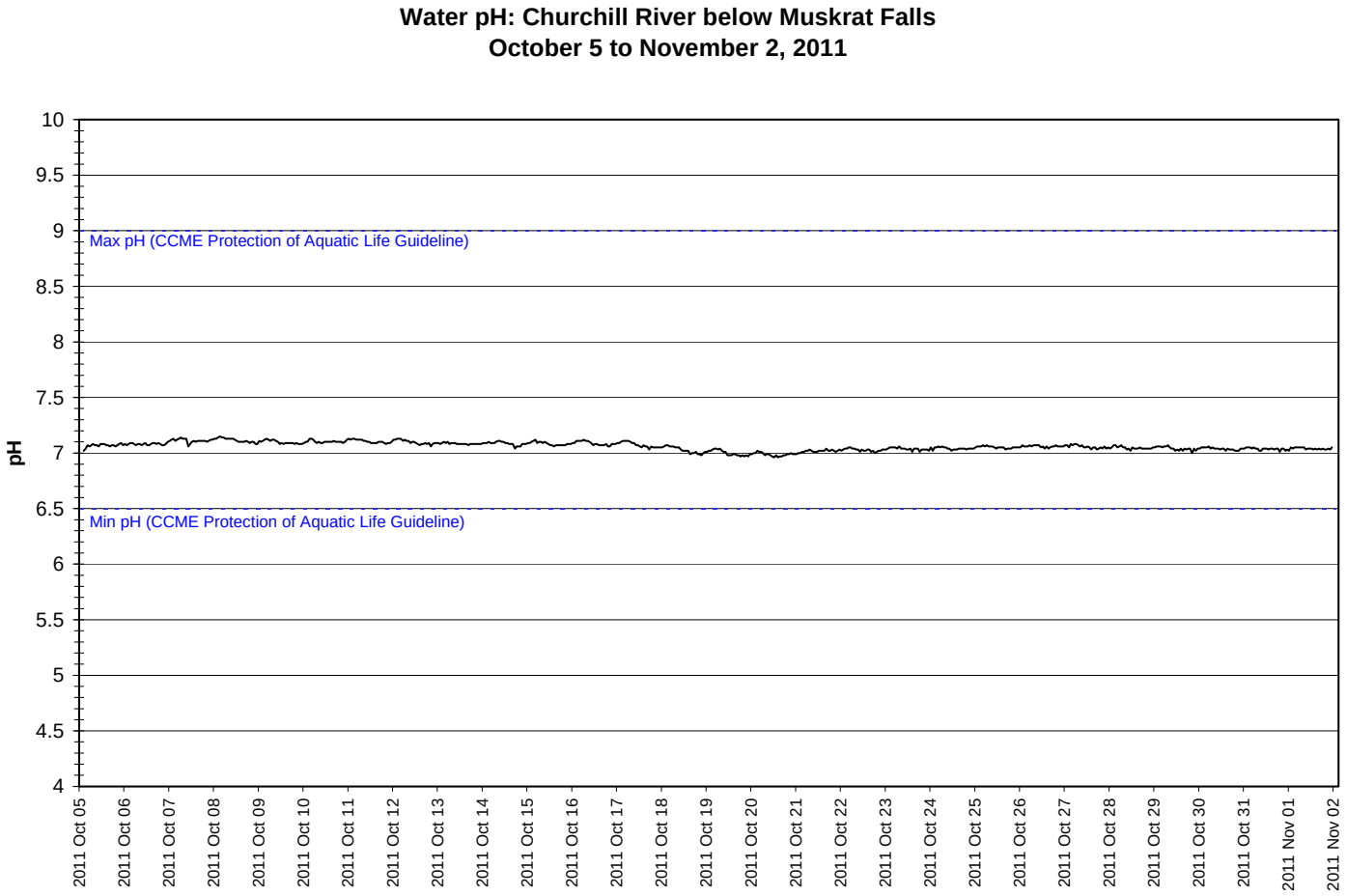


Figure 22: pH at Churchill River below Muskrat Falls

- Specific conductance generally remains between 18.6 and 22.0µS/cm, averaging 21.1µS/cm (Figure 23). Specific conductivity is generally decreasing throughout the deployment period.
- Specific conductivity appears to fluctuate significantly on a daily basis for the first week of the deployment period before becoming less variable for the remainder of the deployment. It is unknown what caused this significant diurnal fluctuation at the beginning however it does correspond with a period of increased turbidity values (Figure 25) and stage level increases.
- Stage is included in Figure 23 to illustrate the inverse relationship between conductivity and water level. Stage is generally increasing throughout the deployment period with some significant fluctuations. As stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column. Inversely, when stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases.

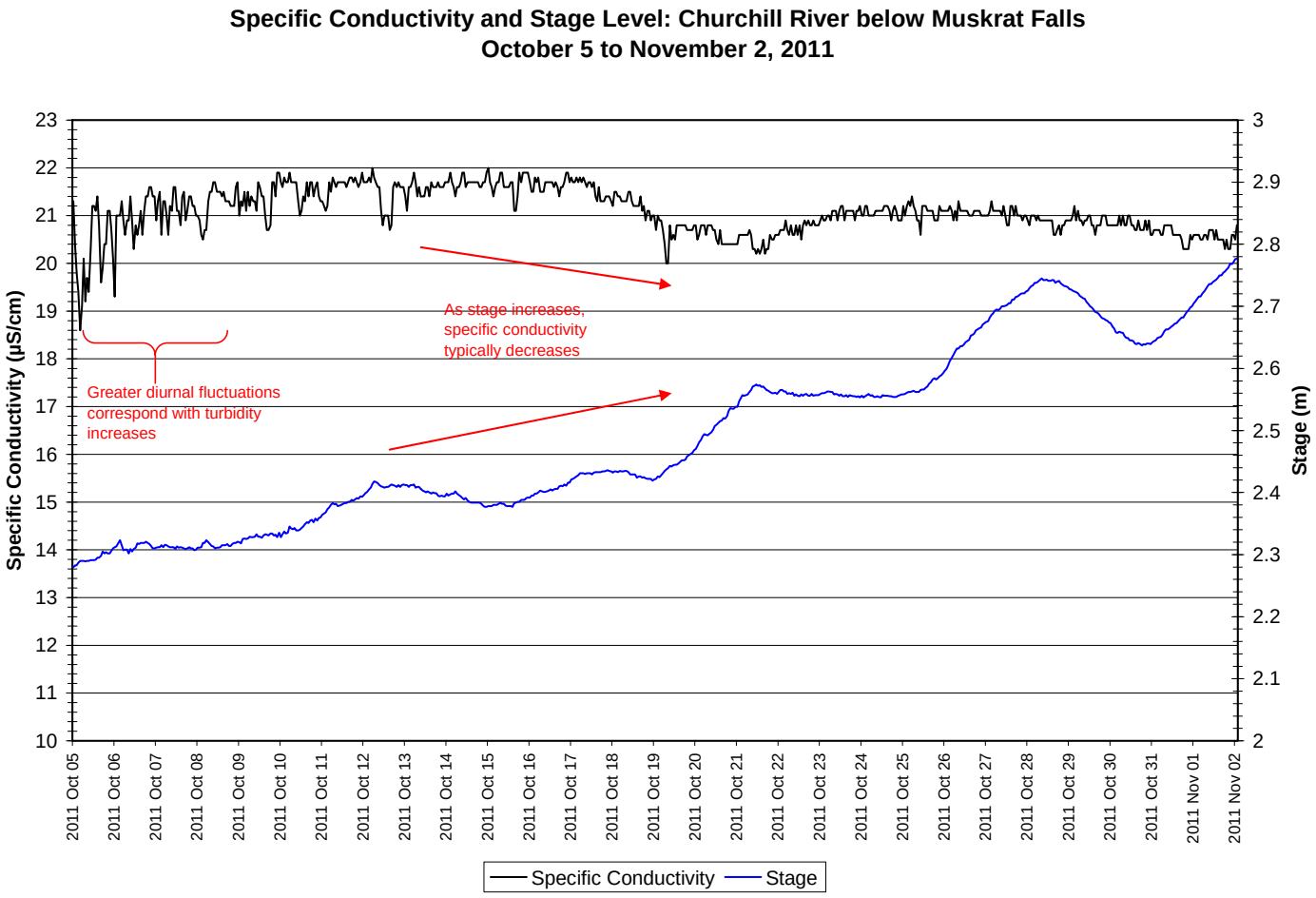


Figure 23: Specific conductivity and stage level at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen ranged from 100.9 to 108.3% and a range of 11.94 to 13.89mg/l was found in the concentration of dissolved oxygen with a median value of 12.57mg/l (Figure 24).
- All values were above both the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stage of 6.5 mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 24.
- Dissolved oxygen content is increasing slightly throughout the deployment period. This trend is expected given the increasingly colder air and water temperatures (Figure 21). Dissolved oxygen is typically higher at this station compared to the other stations further upstream due to the addition of oxygen to the water at Muskrat Falls.

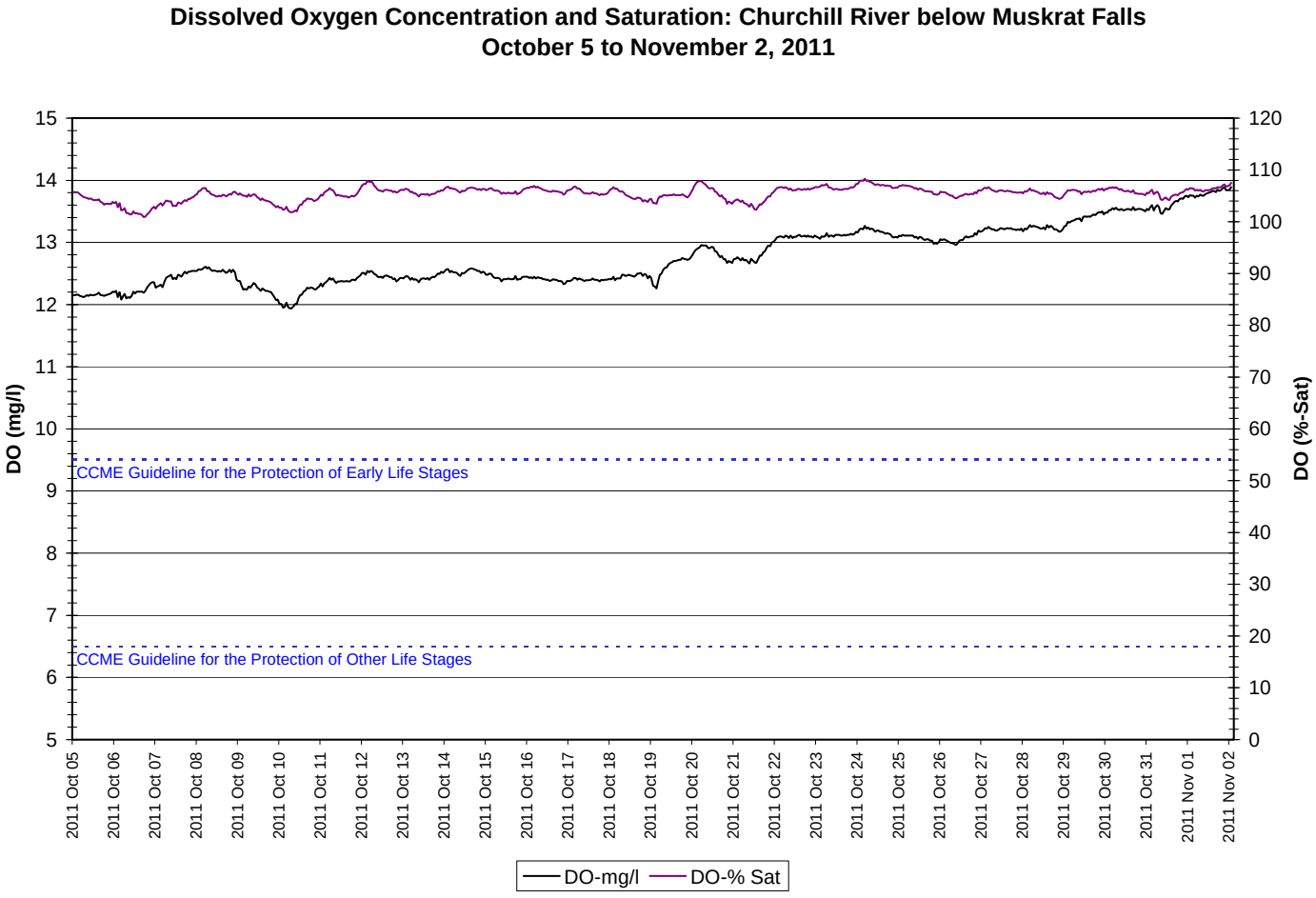


Figure 24: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- Turbidity generally remains at <7.0NTU throughout the deployment period (Figure 25). A median value of 1.2NTU indicates there is a consistent natural background turbidity value at this station.
- There are several instances where turbidity increases above average values however these increases are usually for very short periods of time (1-3 hours). From October 5 to 8, there is an increase in turbidity that does not correspond with a rainfall event however does correspond with fluctuating specific conductivity (Figure 23). It is unknown what caused this increase in turbidity. A rainfall event over two days (October 21-22) corresponds with an increase in turbidity from October 21-24. At the end of the deployment period, turbidity values increase to values up to 35NTU multiple times. It is unknown what caused these increases.

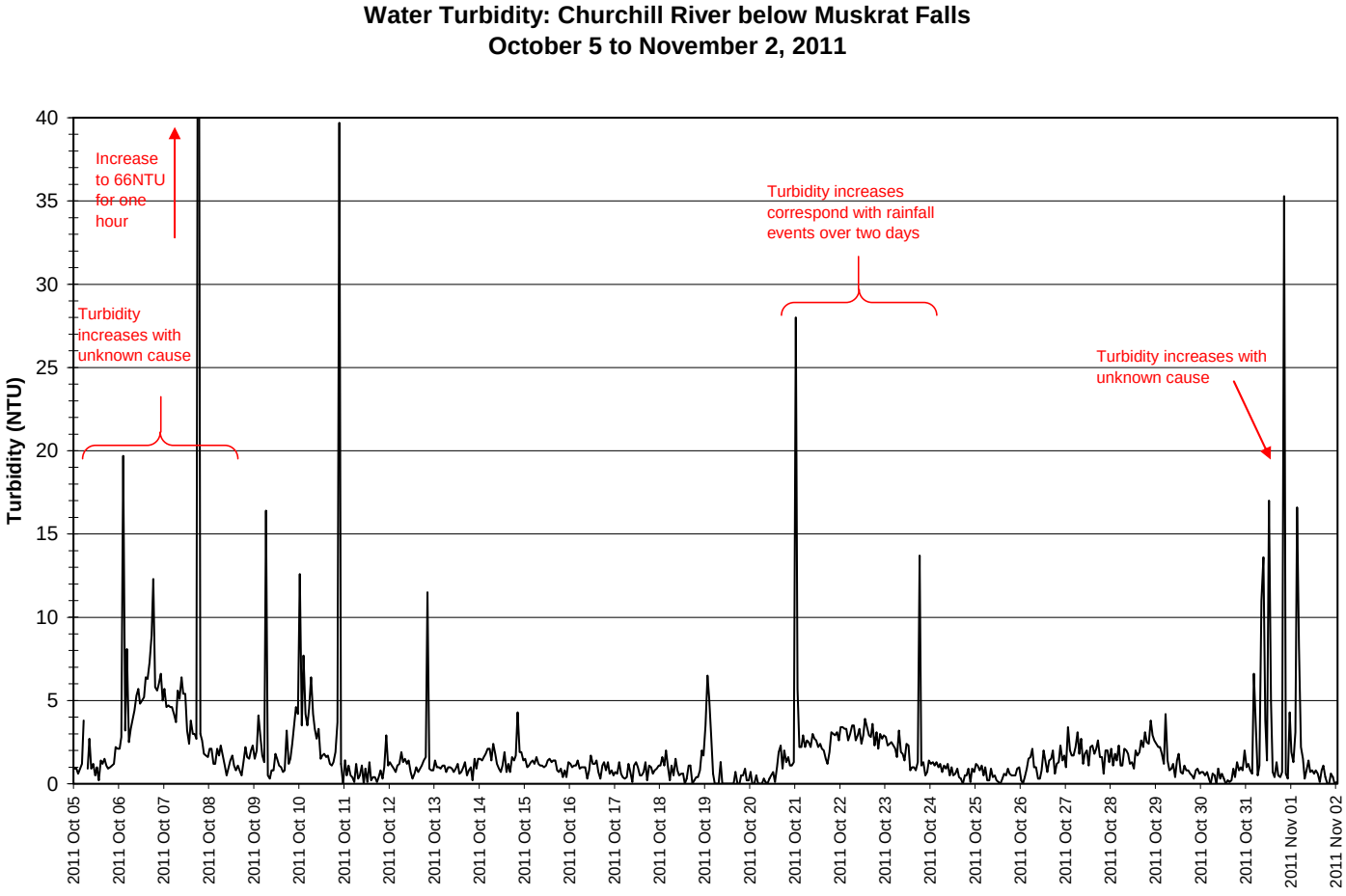


Figure 25: Turbidity at Churchill River below Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 26). Stage is increasing throughout the deployment period and precipitation records vary.

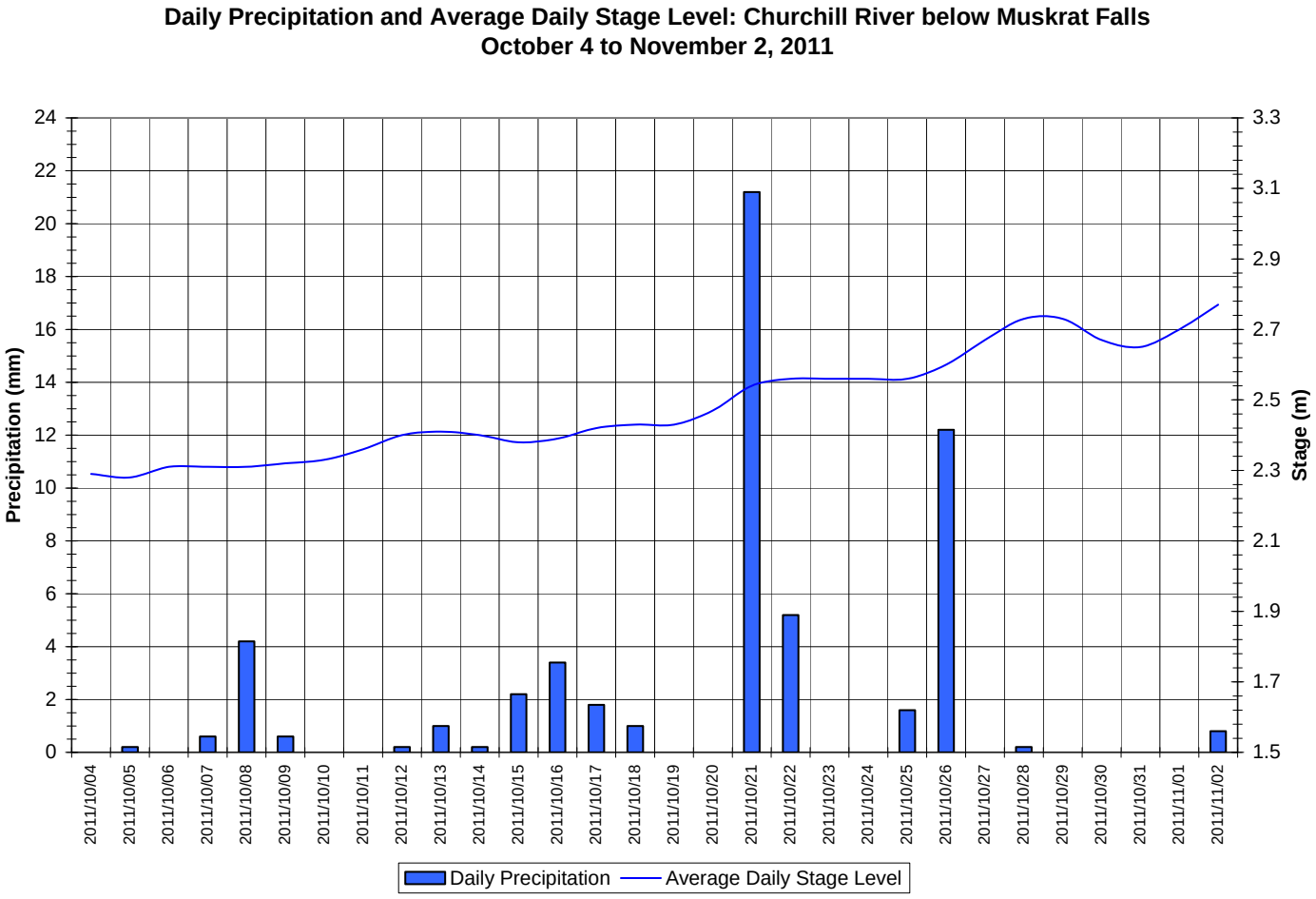


Figure 26: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

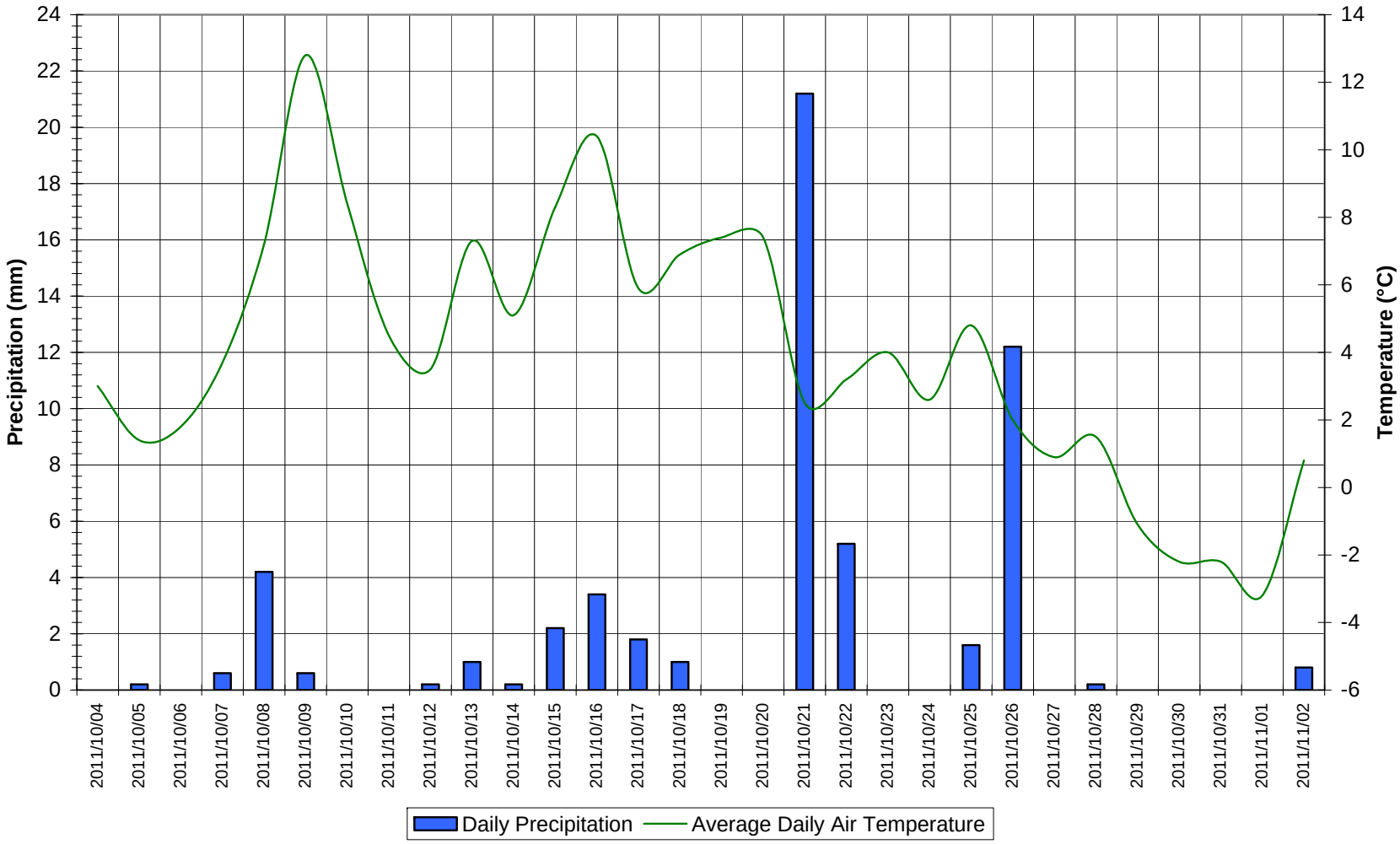
Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from October 4-5 to November 1-2, 2011. No significant water quality events were captured during this time. In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations.
- Stage levels generally increased throughout the deployment period at all stations.
- Water temperature was decreasing consistently at all stations throughout the deployment period due to the increasingly colder ambient air temperatures in the region during the fall season. Water temperature typically ranged between 4°C and 9°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life and very consistent at all stations. There was a decrease in pH lasting for about 4 days at stations below Grizzle rapids and above Muskrat Falls. pH is generally very stable at all stations along the Lower Churchill River.
- Specific conductivity was fluctuating at all stations, typically ranging between 18 and 20µS/cm. Specific conductance decreased near the beginning of the deployment period stations below Metchin River, below Grizzle Rapids and above Muskrat Falls as stage was increasing. Specific conductivity is less variable on average at the station below Muskrat Falls.
- Dissolved oxygen content was increasing throughout the deployment period at stations below Metchin River and above and below Muskrat Falls. All values were above both the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at other life stages and early life stages. The station below Muskrat Falls consistently has high dissolved oxygen content due to the location of the Muskrat Falls, 6km upstream. There is no dissolved oxygen data for the station below Grizzle Rapids due to sensor failure on October 4.
- Turbidity events were infrequent and of low magnitude at the station below Metchin River which is typical for this site. At the station above and below Muskrat Falls, there is a consistent natural background turbidity value. These stations are also more susceptible to turbidity increases during rainfall and weather events. Recovery periods for turbidity events range depending on the size of the disturbance and vary from 1 to 8 days. There is no turbidity data for this deployment period at the station below Grizzle Rapids due to turbidity sensor failure on October 4.

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

Appendix 1

Average Daily Air Temperature and Daily Precipitation: Happy Valley Goose Bay, NL
October 4 to November 2, 2011



Average Daily Air Temperature and Daily Precipitation: Churchill Falls, NL
October 4 to November 2, 2011