Real-Time Water Quality Deployment Report

Lower Churchill River Network

October 1 to
November 5, 2014

Newfoundland Labrador

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

Contents

Prepared by:
Kyla Brake – Environmental Scientist
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.729.3899
Fax: 709.729.0320

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Real Time Water Quality Monitoring

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at five stations on the Lower Churchill River: below Metchin River, below Grizzle Rapids, above and below Muskrat Falls and at English Point.
- There was no instrument deployed at the station on Lake Melville east of Little River. Instrument deployments at this station have been suspended until a buoy system can be established at this site.
- On October 1, 2014, real-time water quality monitoring instruments were deployed at three of the Lower Churchill River Stations for a period of 34 days. The station below Lower Muskrat Falls was not deployed due to continued issues with sand at the site which could damage the instrument. The station below Metchin River was not deployed as this station has been discontinued. Instruments at all other stations were removed on November 5, 2014 and will not be reinstalled until ice break-up in Spring 2015.

Quality Assurance and Quality Control

- 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.
  - ► At deployment and removal, a QAQC 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 QAQC 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 (C)	<=+/-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 > 35µS/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 1 to November 5, 2014 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, October 1 to November 5, 2014

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	Discontinued	Deployment	N/A	N/A	N/A	N/A	N/A
	Discontinued	Removal	N/A	N/A	N/A	N/A	N/A
Below Grizzle Rapids (45701)	October 1, 2014	Deployment	Fair	Good	Excellent	Fair	Excellent
	November 5, 2014	Removal	Excellent	Poor	Good	Excellent	Excellent
Above Muskrat Falls (45700)	October 1, 2014	Deployment	Good	Good	Excellent	Good	Excellent
	November 5, 2014	Removal	Fair	Excellent	Excellent	Excellent	Excellent
Below Muskrat Falls	Not deployed	Deployment	N/A	N/A	N/A	N/A	N/A
	Not deployed	Removal	N/A	N/A	N/A	N/A	N/A
At English Point (47384)	October 1, 2014	Deployment	Excellent	Fair	Excellent	Excellent	Poor
	November 5, 2014	Removal	Good	Good	Excellent	Excellent	Good

- The station below Metchin River was not deployed during this period. The station has been discontinued, with all equipment removed from service.
- At the station below Grizzle Rapids, pH, specific conductivity and turbidity all rank either ‘good’ or ‘excellent’ at deployment. Temperature and dissolved oxygen rank as ‘fair’. The temperature discrepancy is likely due to the sensors not having fully stabilized before readings were taken. The discrepancy with dissolved oxygen values is likely due to the placement of the sondes in the river.

  At removal, temperature, specific conductivity, dissolved oxygen and turbidity all rank ‘excellent’ or ‘good’. The pH sensor ranks ‘poor’. The discrepancy with the pH sensor is likely due to the pH value on the QA/QC being recorded before the sensor had stabilized. The initial stabilization of the pH sensor at the start of deployment took 4 hours, so it is likely that the QA/QC sonde may have needed longer to stabilize in the water during the removal process.

- At the station above Muskrat Falls, specific conductivity and turbidity rank 'excellent' while temperature, pH and dissolved oxygen rank 'good' at deployment.

  At removal, pH, specific conductivity, dissolved oxygen and turbidity ranked 'excellent' while temperature, ranks 'fair'. The field value for temperature was 2.94°C while the QA/QC value was 3.53°C. This discrepancy is likely due to the QA/QC temperature sensor not having stabilized before the value was recorded.

- At the station below Muskrat Falls, the sonde could not be deployed as the sand in the area continues to bury the sonde, which could damage the sensors. A grab sample was taken to analyze water quality parameters.

- At the station at English Point, temperature, specific conductivity and dissolved oxygen ranked 'excellent', pH ranked 'fair' and turbidity ranked 'poor' at deployment. The pH field value was 6.25, while the QA/QC value was 7.00. As the QA/QC sonde value was closer to the grab sample value of 7.07, the pH sensor on the field sonde was likely slow to stabilize before being recorded. This slow acclimation is noticeable in the data. The field turbidity value was 8NTU and the QA/QC value was 18.3NTU, while the grab sample value was 6.8NTU. This discrepancy is likely due to sediment being suspended around the QA/QC sonde as the value was being recorded.

  At removal, specific conductivity and dissolved oxygen ranked 'excellent' while temperature, pH and turbidity ranked 'good'.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring between October 1 and November 5 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 QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request.
- The below Muskrat Falls station is experiencing issues with the sediment in the area. The sonde has been repeatedly buried in sand during deployment. To prevent damage to the sonde, this station was not deployed during this period. The instrument will be redeployed should conditions improve in Spring 2015.
- The below Metchin station has been discontinued within the real-time network. All equipment was removed from this station on September 30, 2014.

Churchill River below Metchin River

- This station was discontinued and all equipment was removed on September 30, 2014.

Churchill River below Grizzle Rapids

- Water temperature ranges from 3.80°C to 9.40°C during the deployment period (Figure 1).
- Water temperature is gradually decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures as winter approaches (Figure 2).

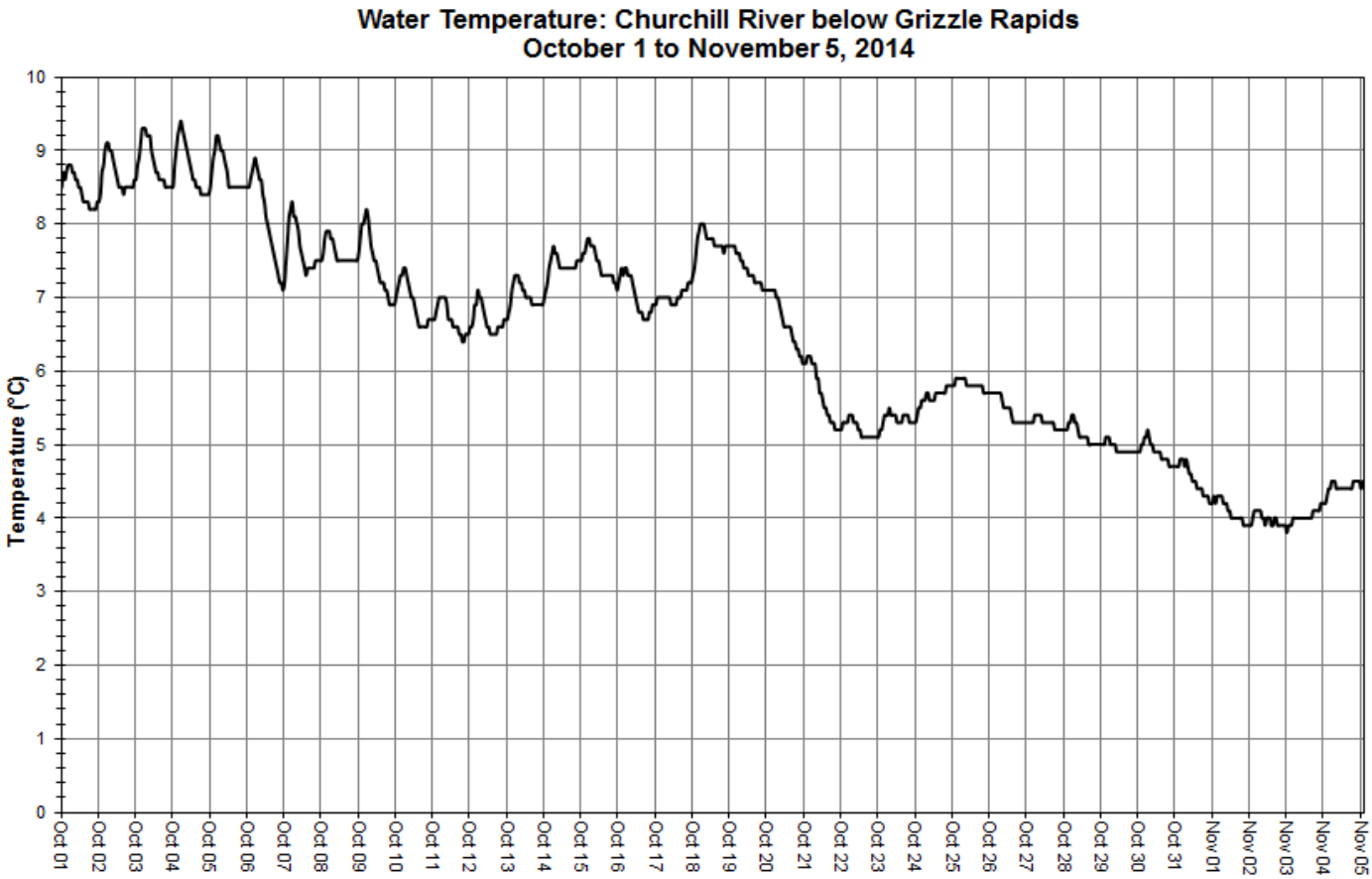

Figure 1: Water temperature at Churchill River below Grizzle Rapids

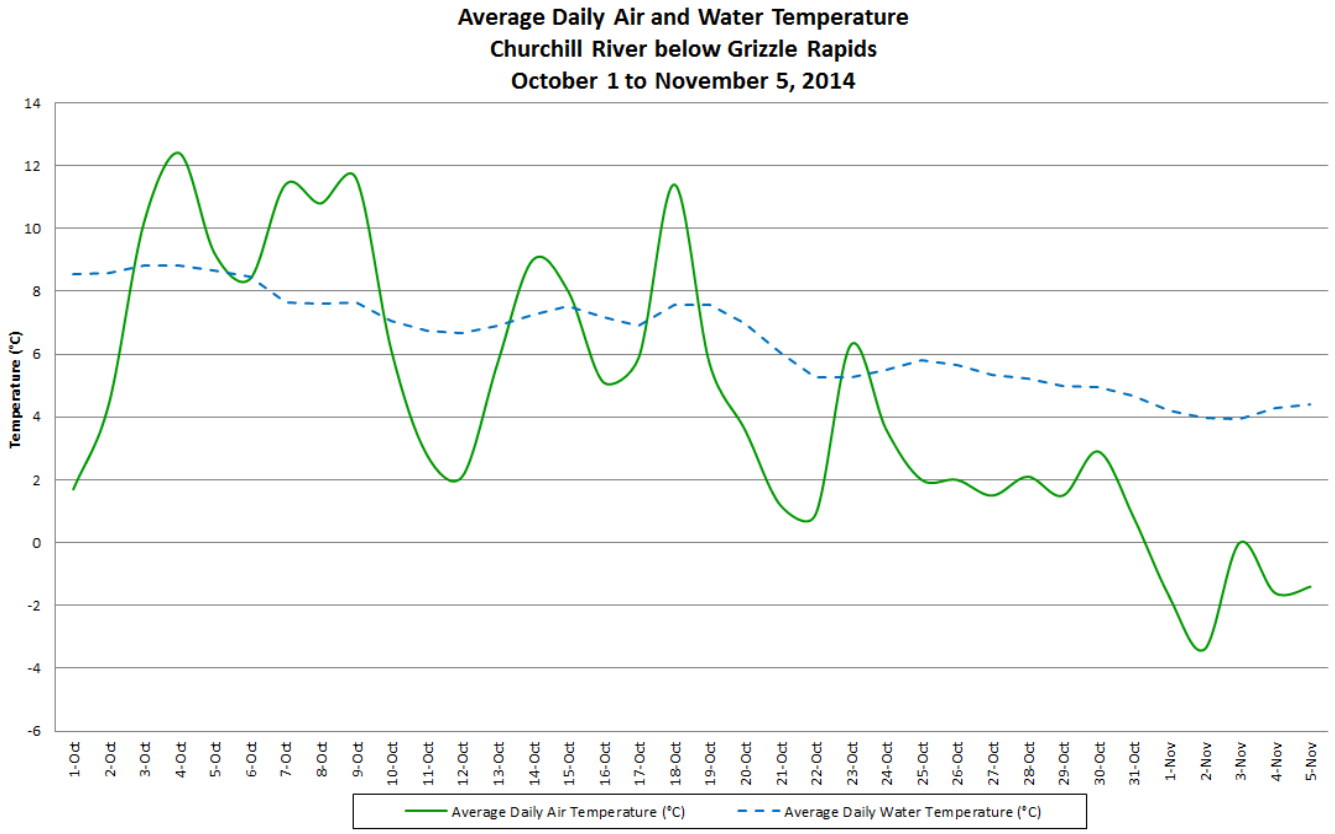

Figure 2: Average daily air and water temperature at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 6.56 and 7.26 pH units (Figure 3). pH values are relatively stable throughout the deployment period. pH values generally fluctuate on a daily basis. Towards the end of the deployment, this daily fluctuation is decreasing. This trend has been seen at this station in previous deployments as winter approaches.
- A rise in water levels October 20-23 resulted in lower pH values due to the addition of acidic rainwater into the system.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

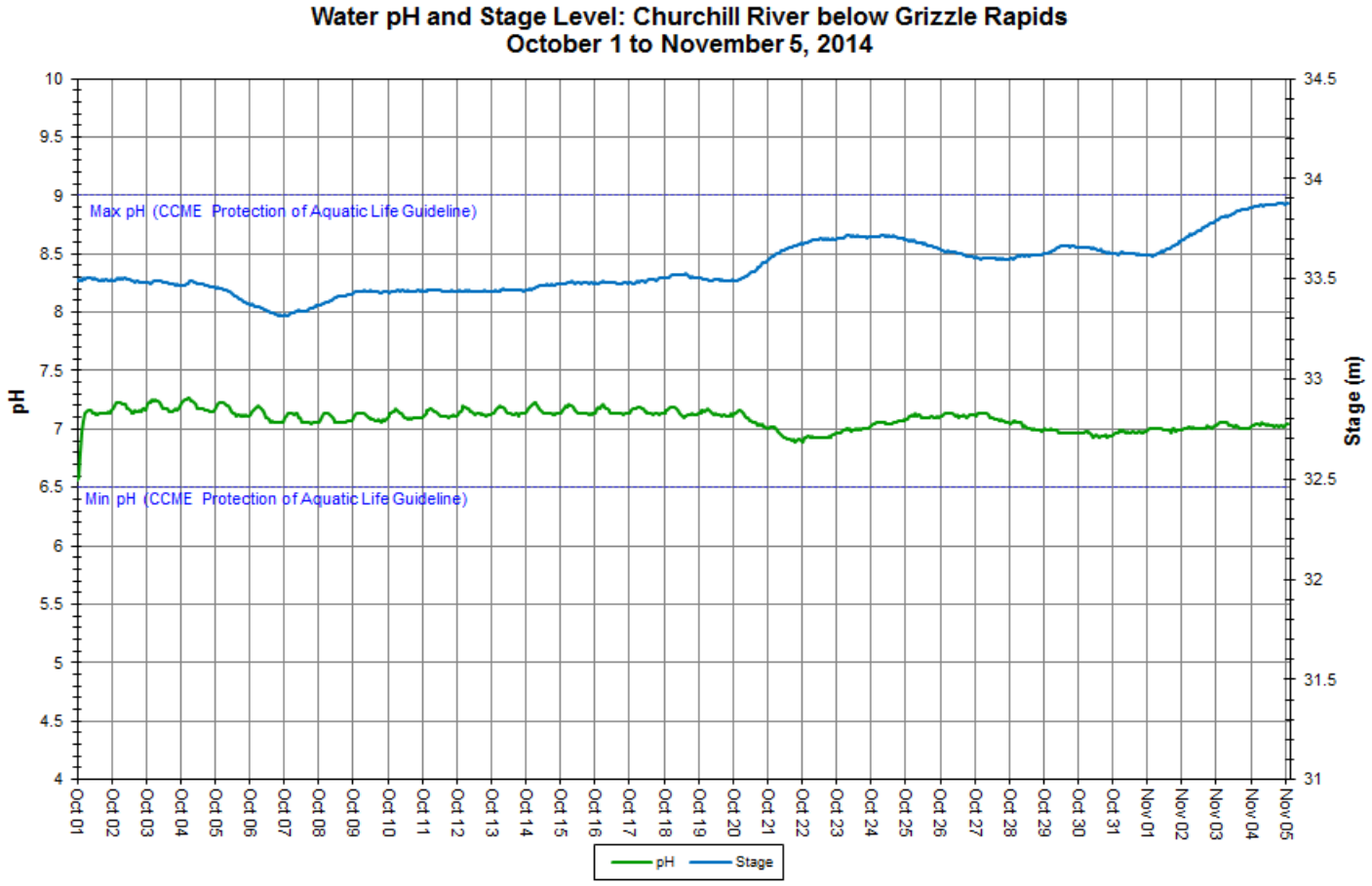

Figure 3: pH and stage level at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 15.8µS/cm to 19.0µS/cm during the deployment period, with a median of 17.6µS/cm (Figure 4).
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Generally, as stage levels increase, specific conductivity 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 is increased. This trend is visible in the data collected during the deployment period on October 21-23; as stage levels increase due to rainfall, specific conductivity decreases.

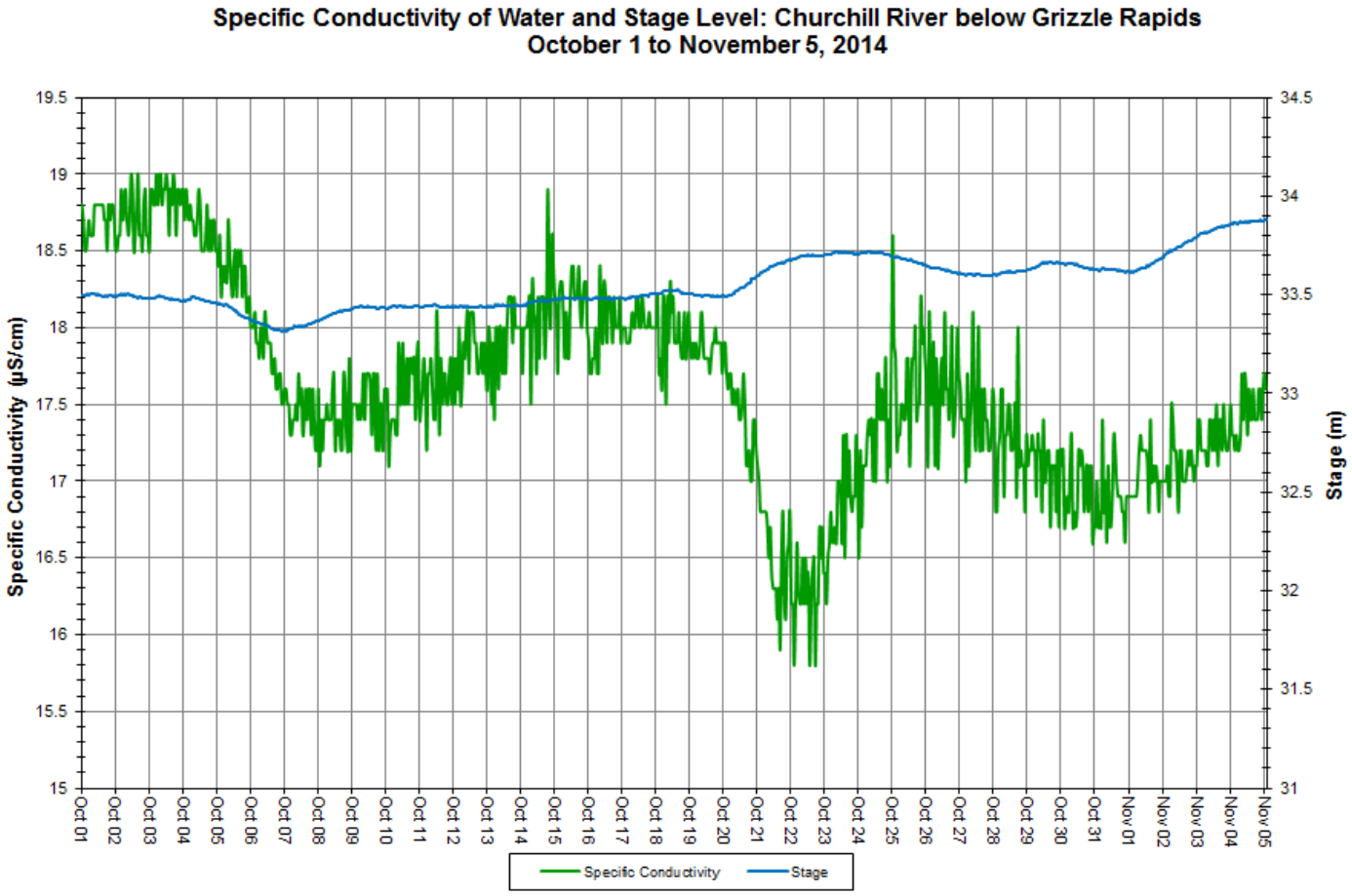

Figure 4: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- Dissolved oxygen content ranges between 10.86mg/l and 12.11mg/l. The saturation of dissolved oxygen ranges from 89.4% to 97.2% (Figure 5).

- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and the CCME Guideline for the Protection of Early Life Stages of 9.5mg/l for the duration of the deployment. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected as the air and water temperatures are decreasing gradually into the winter season and colder water holds more oxygen. (Figure 2).

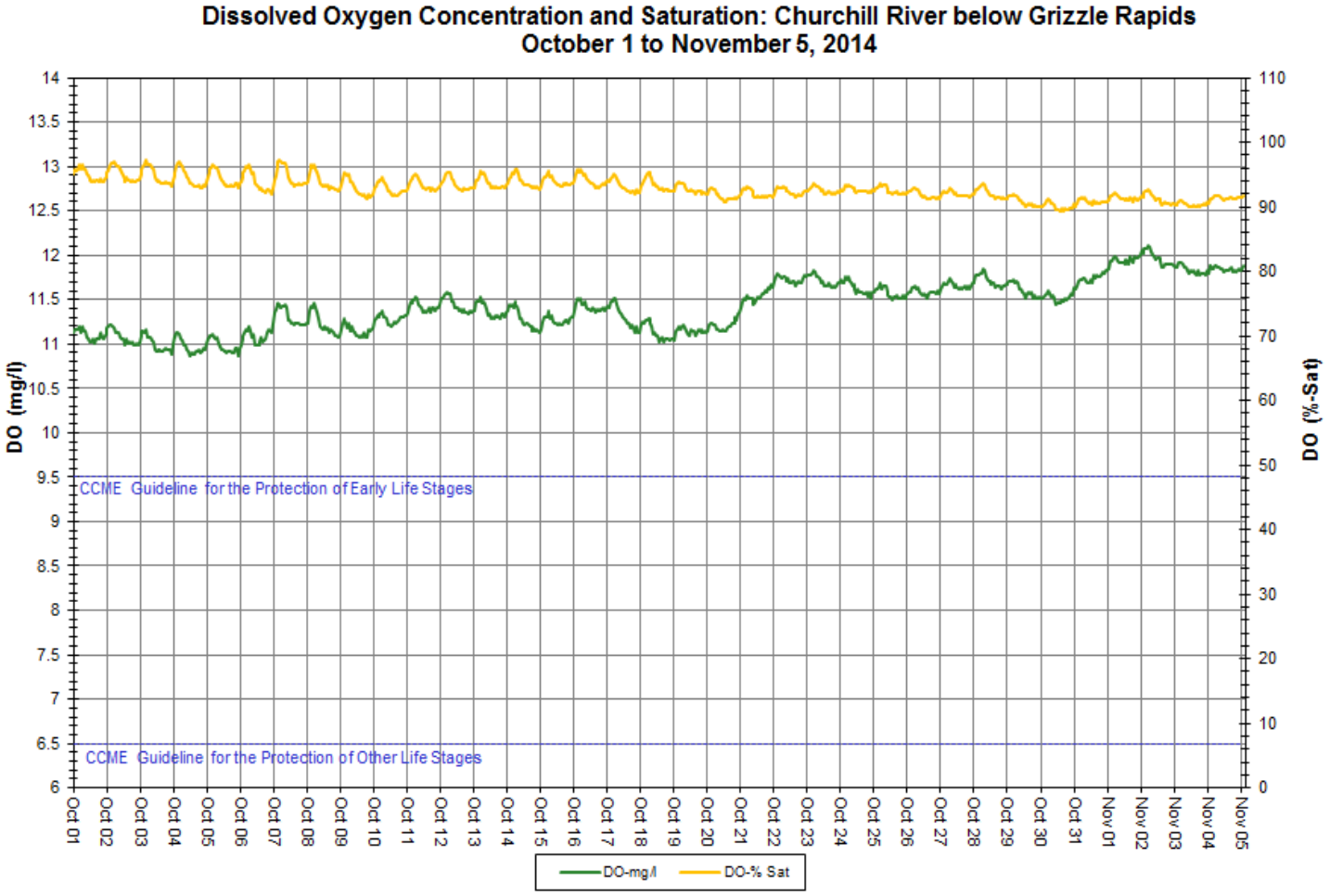

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values at this station generally remain at or near 0NTU, indicating that there is no natural background turbidity. During this deployment period, turbidity did fluctuate slightly after the first week (Figure 6). Turbidity ranged between 0NTU and 14.8NTU, with a median value of 4NTU.
- The fluctuating turbidity values during this deployment period steadily rise for several days, before dropping again after precipitation events increased the volume of water in the system. This indicates that debris or sediment may be a factor, and the increased water is flushing the debris from the sensor after precipitation events.

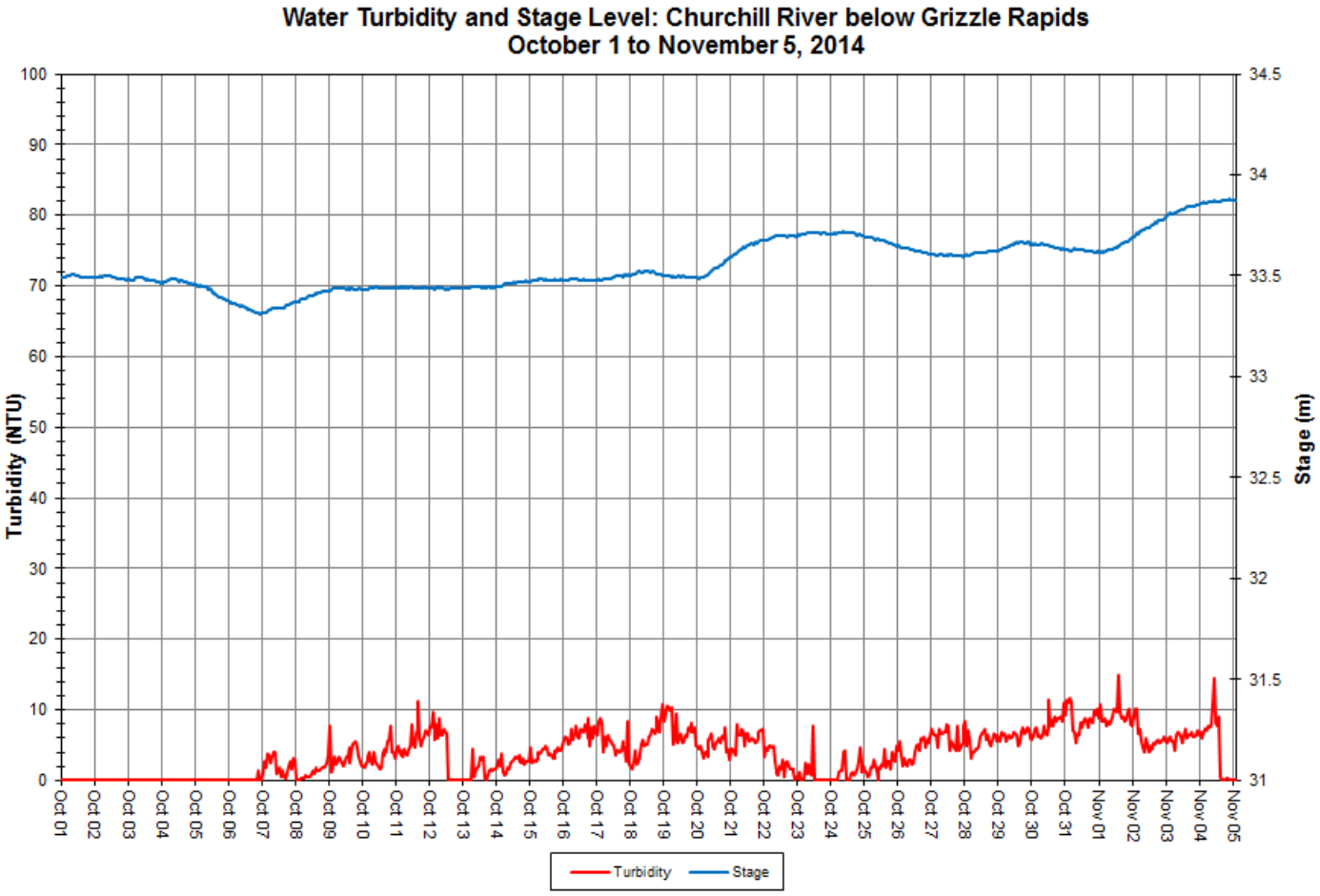

Figure 6: Turbidity and stage level at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Overall, stage is increasing throughout the deployment period. Precipitation occurs on 19 days of the deployment period and amounts are generally low, with the exception of the largest event on October 20 with 50.2mm of rain. Stage ranges between 33.31m and 33.88m, a difference of 0.57m.

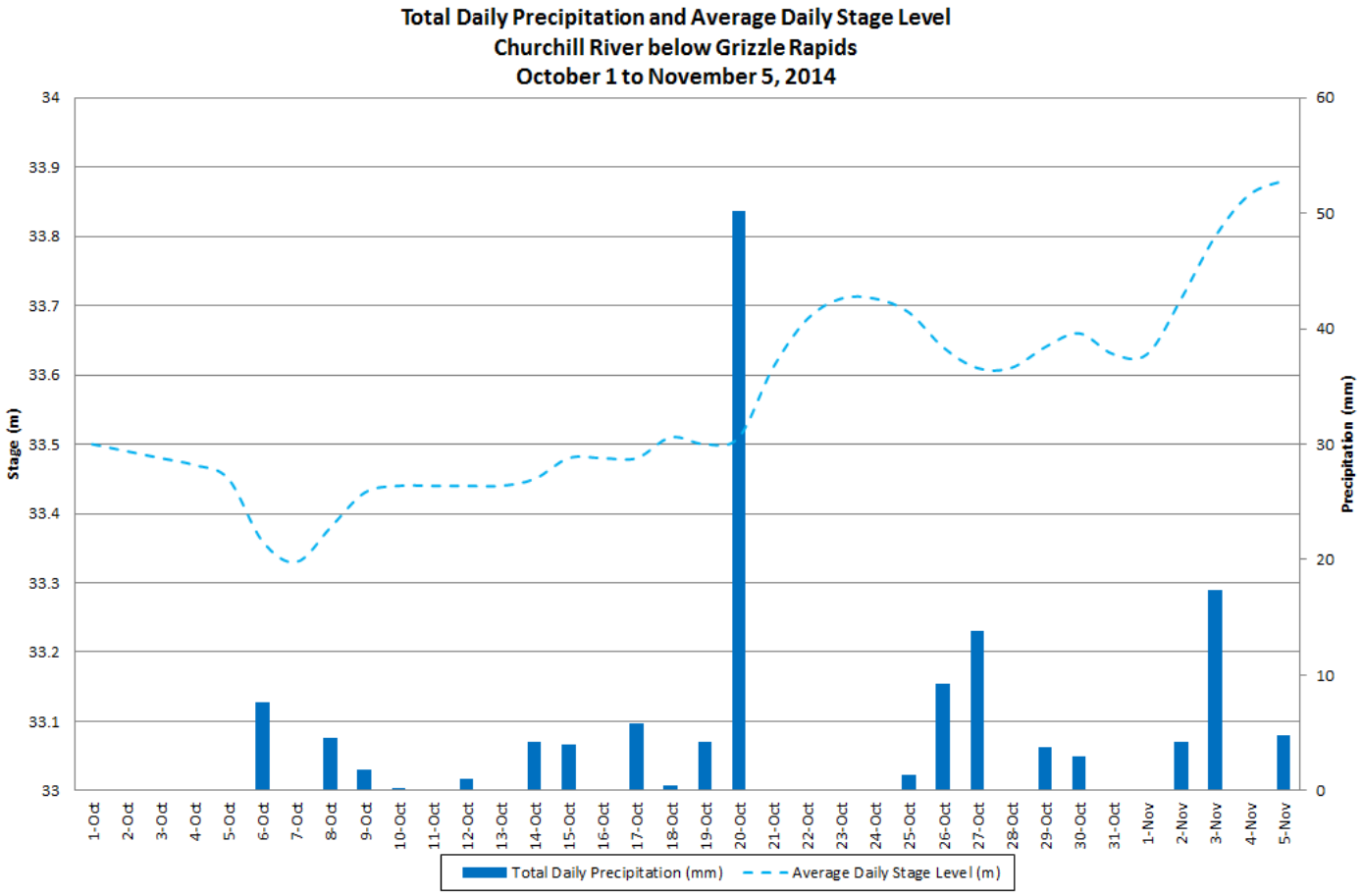

Figure 7: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 1.81°C to 9.17°C during the deployment period (Figure 8).
- Water temperature is gradually decreasing throughout the deployment period (Figure 9). This trend is expected as air temperatures cool into the winter months.

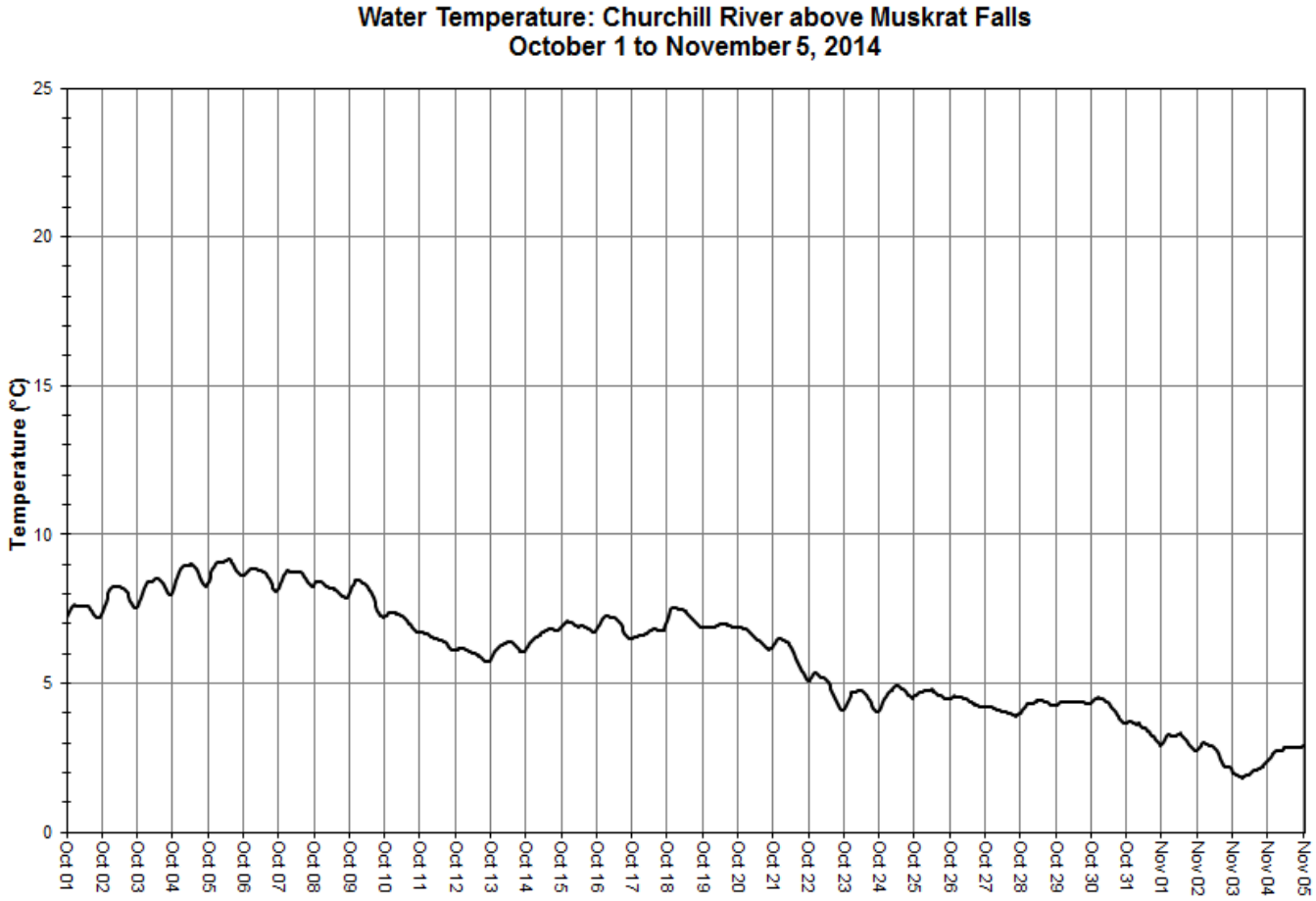

Figure 8: Water temperature at Churchill River above Muskrat Falls

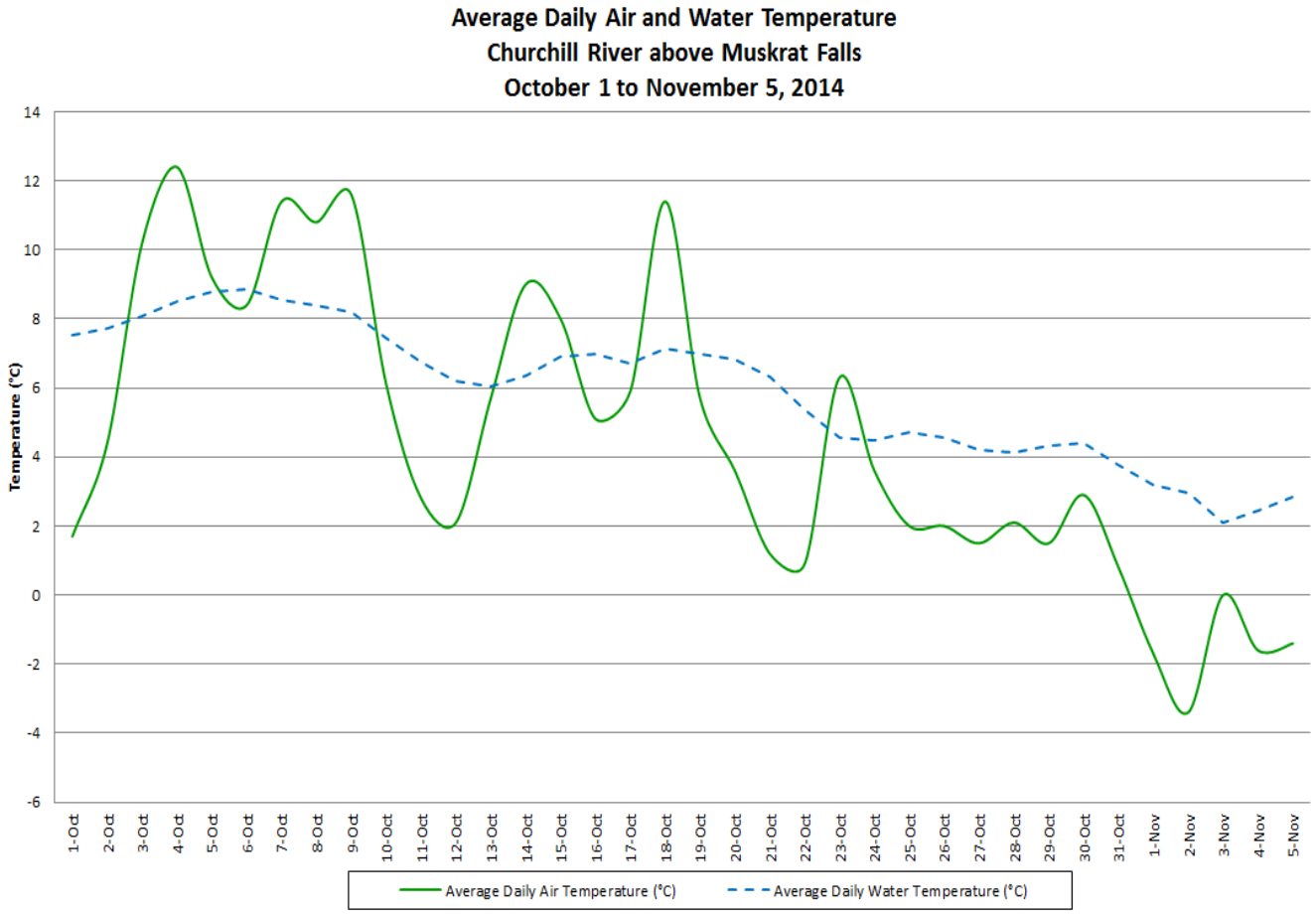

Figure 9: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.96 and 7.28 pH units (Figure 10). pH values are relatively stable throughout the deployment period, dropping slightly when stage levels rise due to the addition of acidic rain, as on October 21-24.
- All pH values recorded are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10).

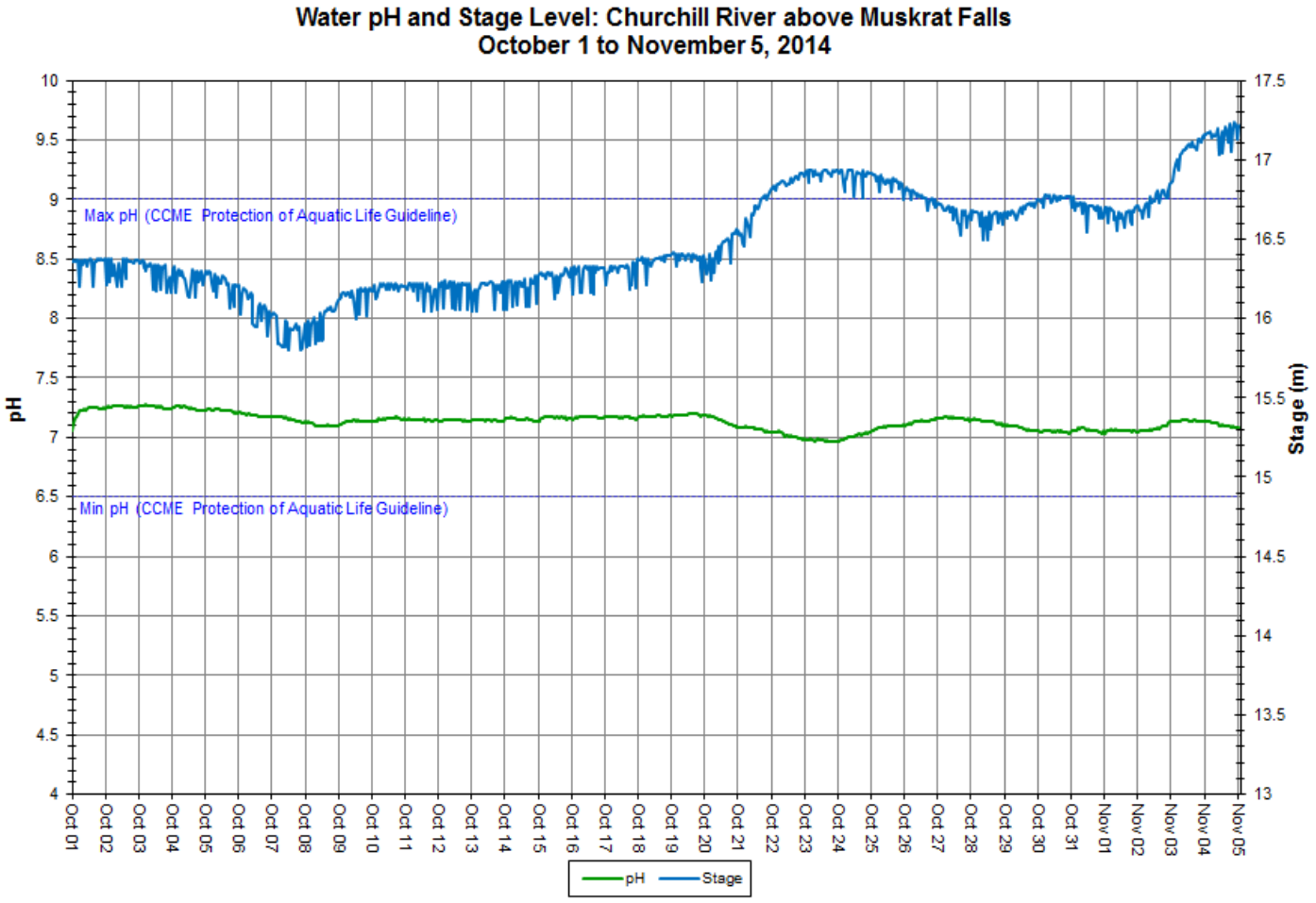

Figure 10: pH and stage at Churchill River above Muskrat Falls

- Specific conductivity ranges from 15.8µS/cm to 19.5µS/cm during the deployment period, with a median of 18.4µS/cm. (Figure 11).
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Generally, as stage levels increase, specific conductivity 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 is increased. This trend is visible in the data collected during the deployment period, particularly during the rise in stage and drop in conductivity October 21-24.

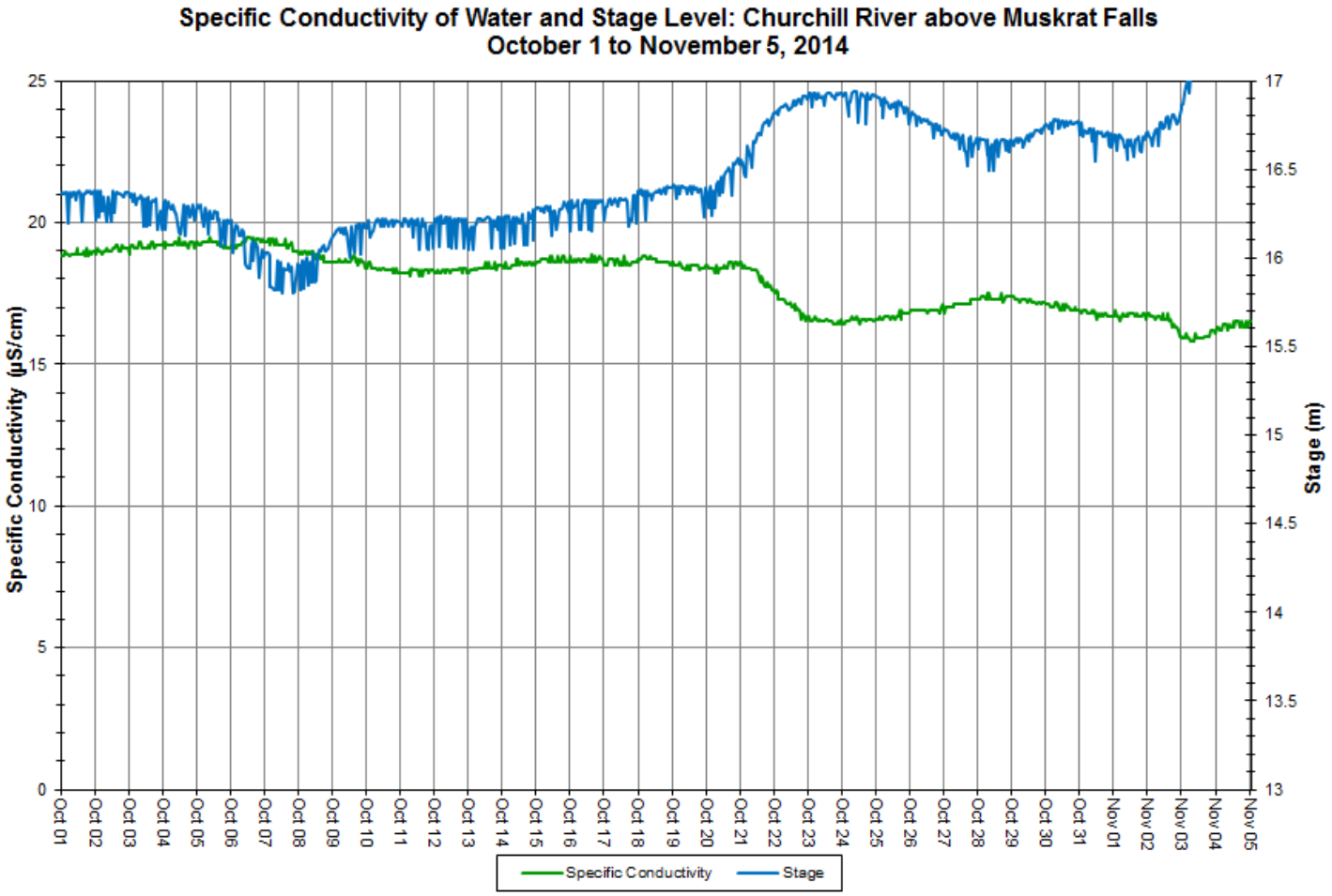

Figure 11: Specific conductivity and stage level at Churchill River above Muskrat Falls

- Dissolved oxygen content ranges between 10.98mg/l and 12.90mg/l. The saturation of dissolved oxygen ranges from 90.8% to 96.8% (Figure 12).
- All values are above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and the CCME Guidelines for the Protection of Early Life Stages Guideline of 9.5mg/l. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is steadily increasing throughout the deployment period. This trend is expected as the air and water temperatures are decreasing as winter approaches. (Figure 9).

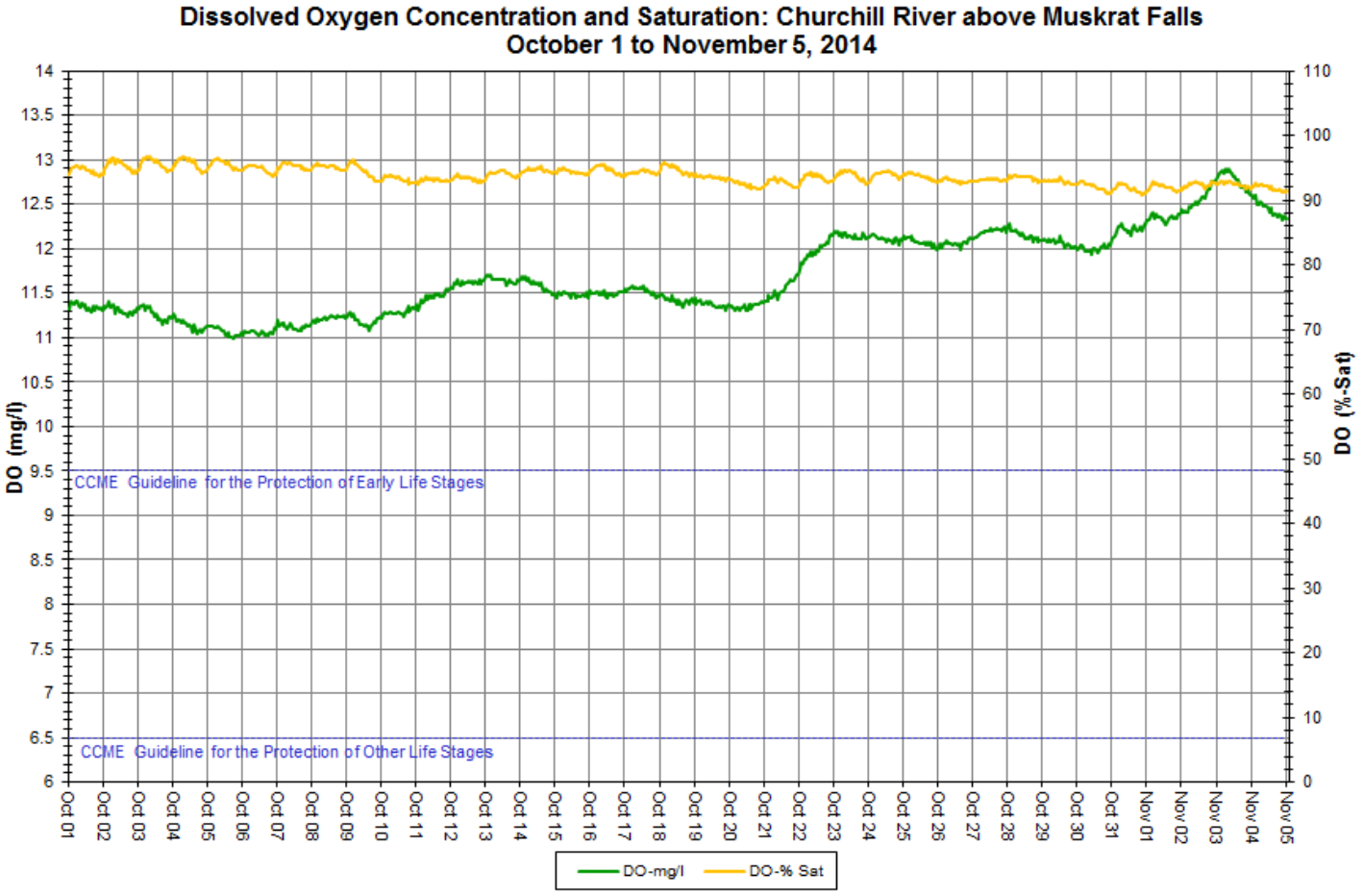

Figure 12: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity ranges between 0.0NTU and 88.3NTU during the deployment (Figure 13). A median value of 4.3NTU suggests there is consistent natural background turbidity. This trend is typical at this station.
- The majority of turbidity events are of small magnitude. The maximum value of 88.3NTU on November 3 and another peak on October 20 occur after precipitation events and thus are the result of increases in stage.

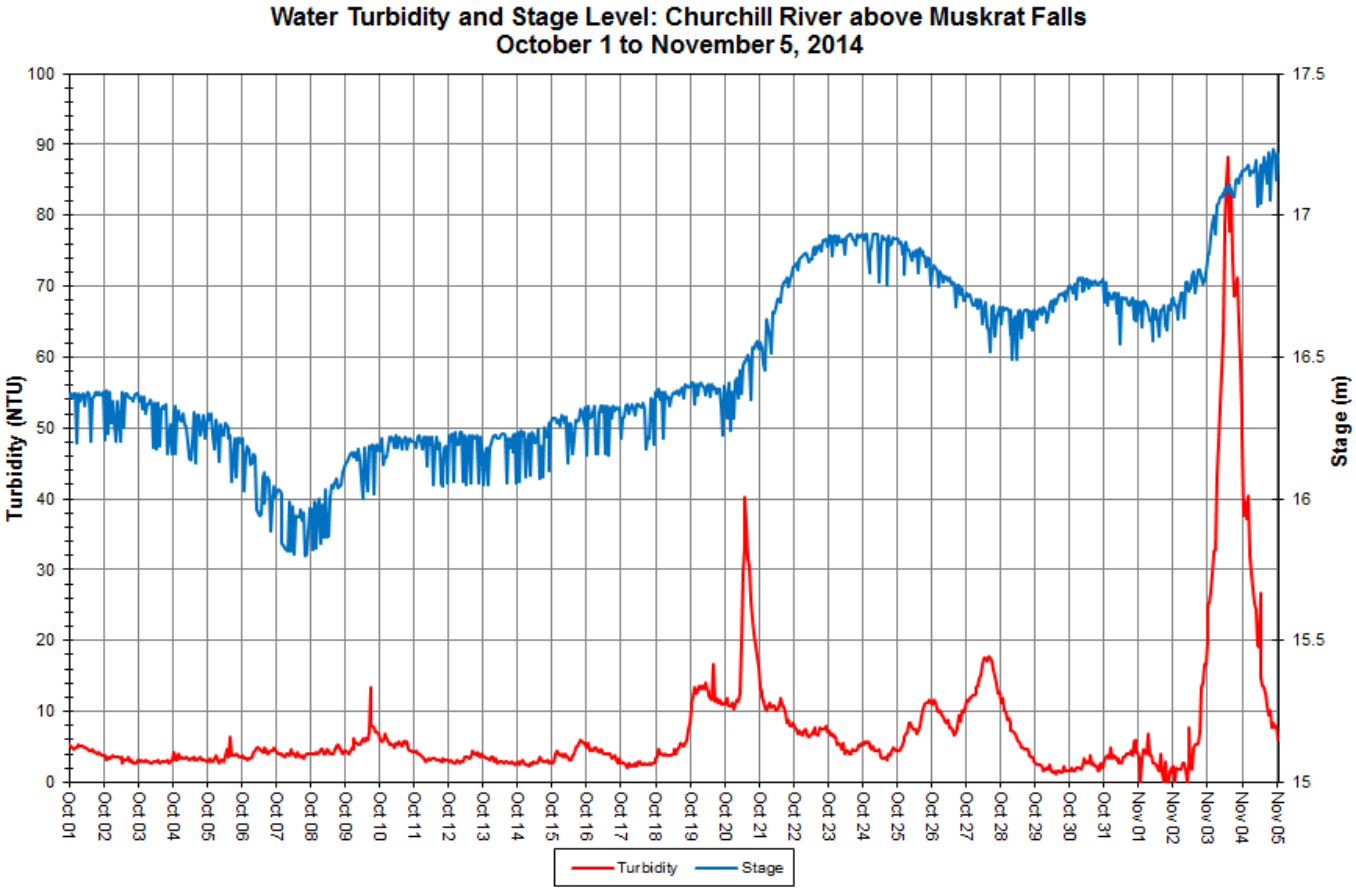

Figure 13: Turbidity and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is gradually increasing throughout the majority of the deployment period. Precipitation events led to increases in stage. Precipitation occurs on 19 days of the deployment period and amounts are generally low, with the exception of the largest event on October 20 with 50.2mm of rain. Stage ranges between 15.80m and 17.24m, a difference of 1.44m. Discharge ranges from 1210m^3/s to 2055m^3/s.

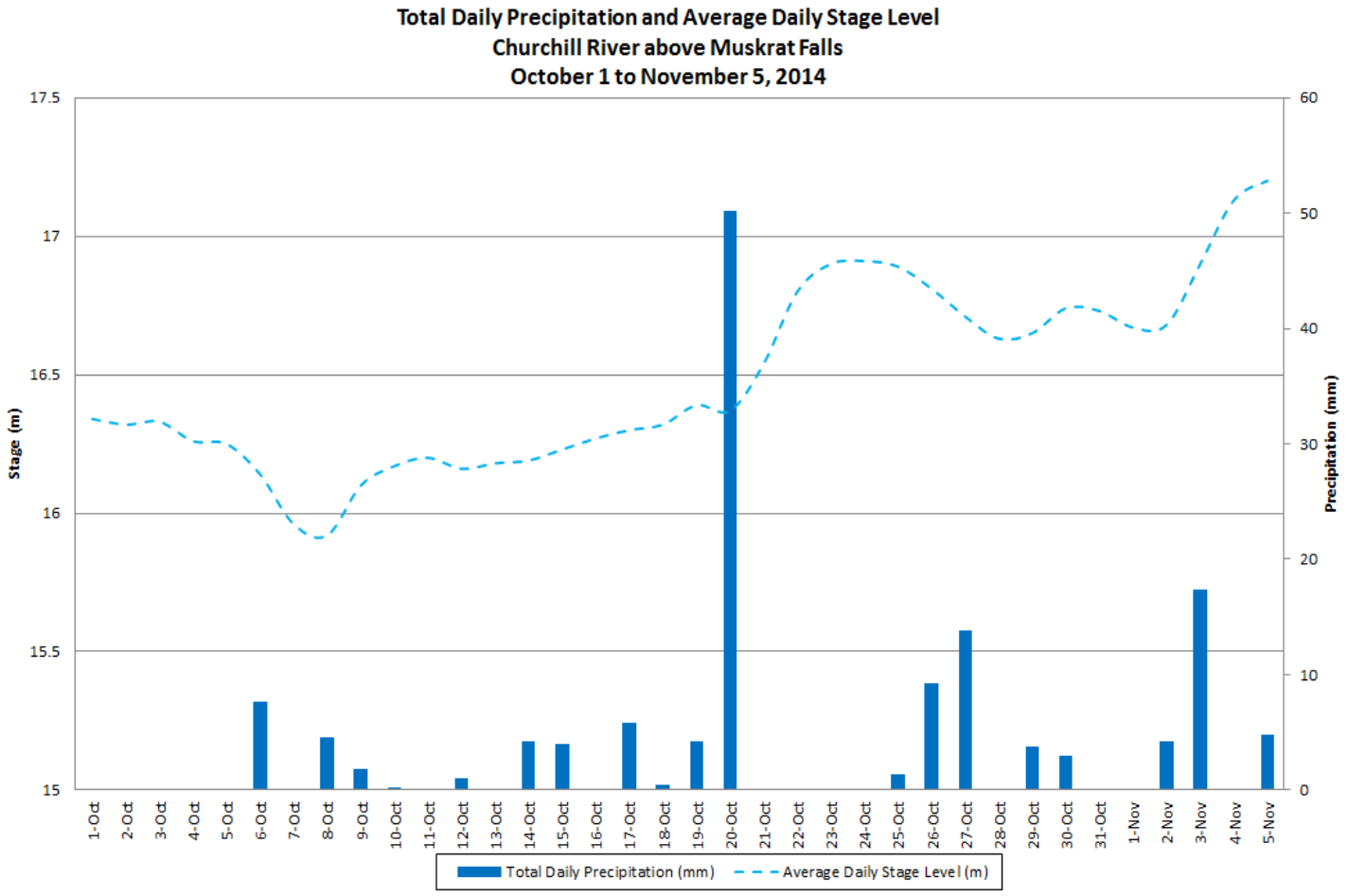

Figure 14: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- The sonde located at this station has been repeatedly buried in sand during 2014. The decision to not redeploy the sonde until sand conditions in the area improve was made in August. The station will be redeployed Spring 2015 if conditions have improved enough to permit deployment.
- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 15). Stage increases gradually during the deployment period. Precipitation occurs on 19 of the days in the deployment period and amounts are generally low, with the exception of the largest event on October 20 with 50.2mm of rain. Stage ranges between 0.96m and 3.19m, a difference of 2.23m.
- The photographs (Figure 16) show the extent of the sand in the area of the station on November 5. Currently, the helicopter is landing on the beach area as the landing pad has not been repaired. However, the sand is constantly moving, and thus the beach area may not exist from day to day.

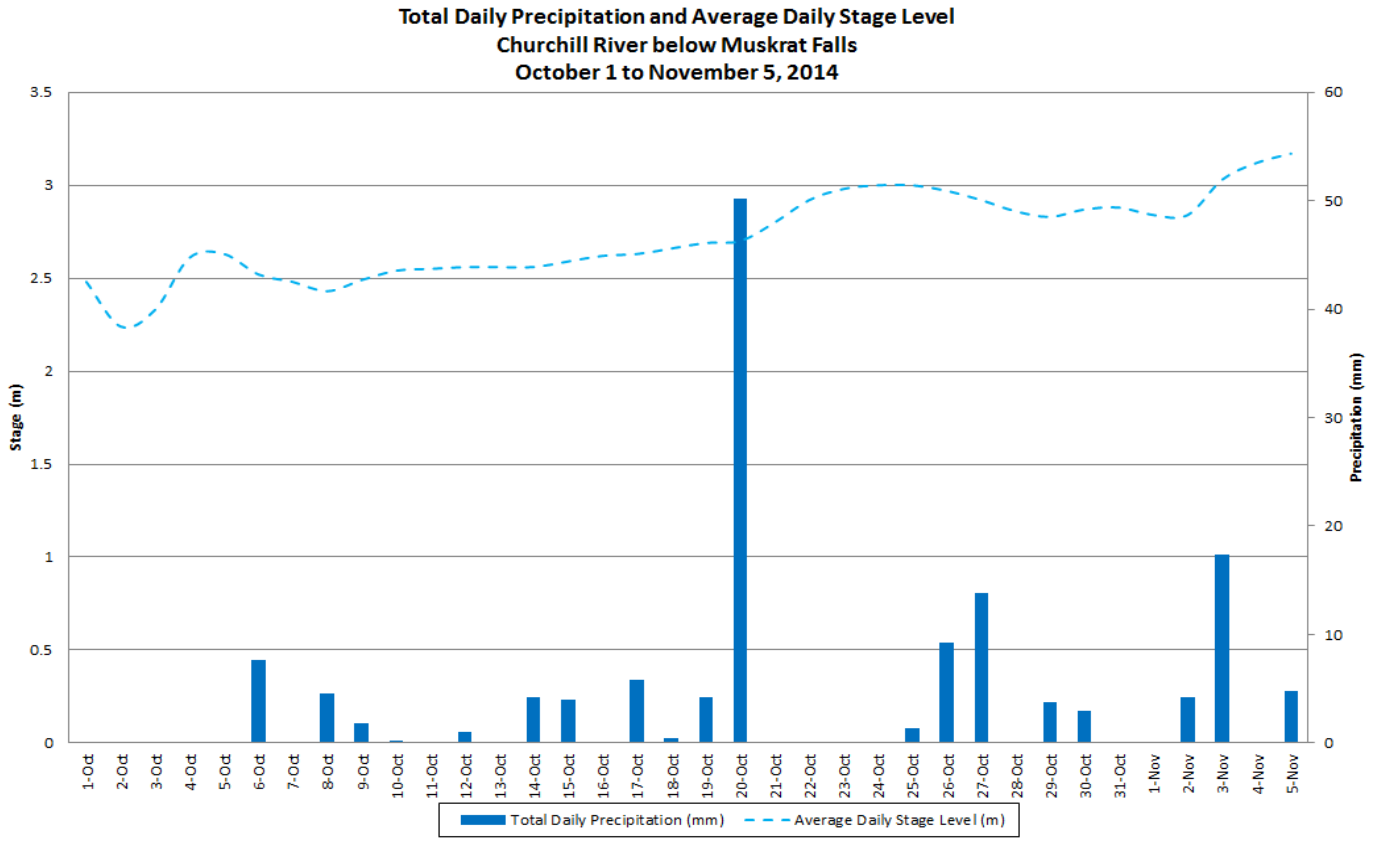

Figure 15: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

(a)

(b)

(c)

(d)

Figure 16: Photographs of the below Lower Muskrat Falls station on November 5, 2014(a-d)

Churchill River at English Point

- Water temperature ranges from 2.30°C to 10.10°C during the deployment period (Figure 17).
- Water temperature is steadily decreasing throughout this deployment period. This trend is expected as ambient air temperatures cool into the winter months (Figure 18). Water temperature fluctuates diurnally.

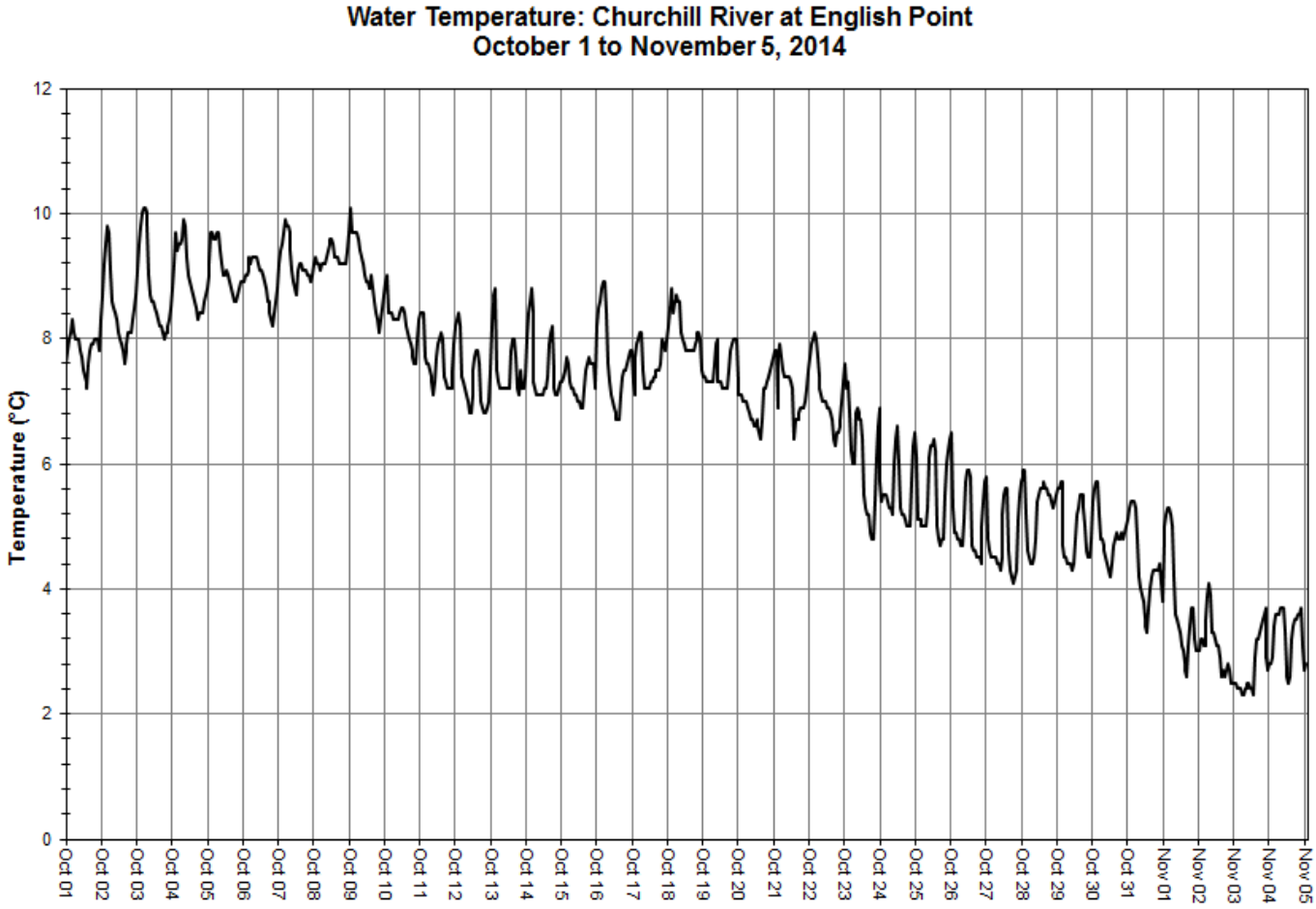

Figure 17: Water temperature at Churchill River at English Point

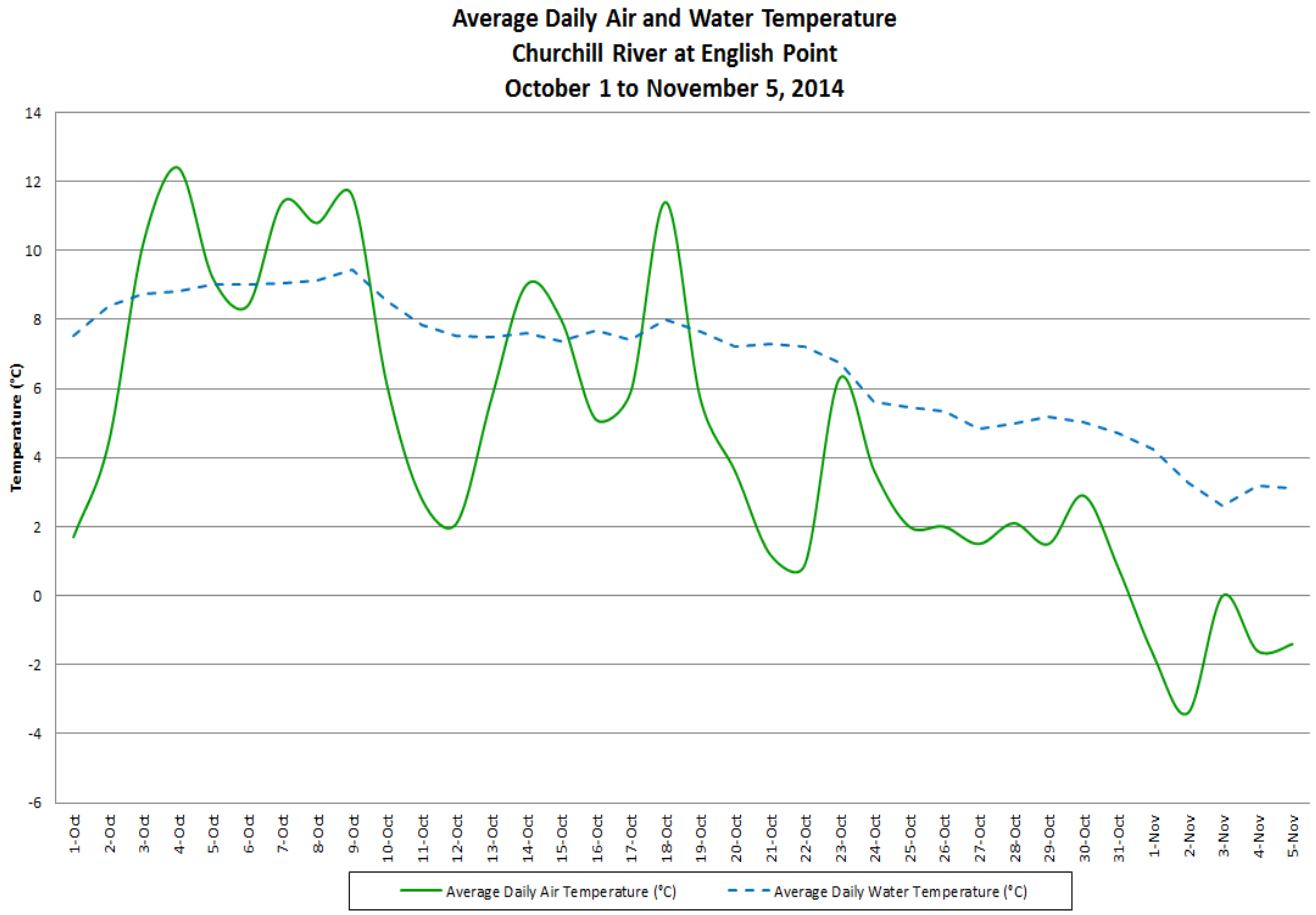

Figure 18: Average daily air and water temperature at Churchill River at English Point

(weather data recorded at Goose Bay)

- pH ranges between 5.97 and 7.30 pH units during the deployment period (Figure 19).
- All pH values recorded Oct 1-29 are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 19). After Oct 29, pH values fall below the minimum guideline. A grab sample taken on November 5 when the sonde was removed had a pH value of 7.04 while the field value was 6.11. Thus there may be some sensor drift lowering values at the end of this deployment.
- During deployment the QA/QC ranking for the pH sensor was 'fair' with a field value of 6.25 compared to the QA/QC sonde's 7.00, and the grab sample's 7.07. However, Figure 19 shows that pH was slow to acclimate, rising slowly to around 7.00 pH units over the first 24 hours of deployment. This slow acclimation period of the deployed field sonde resulted in the 'fair' ranking.

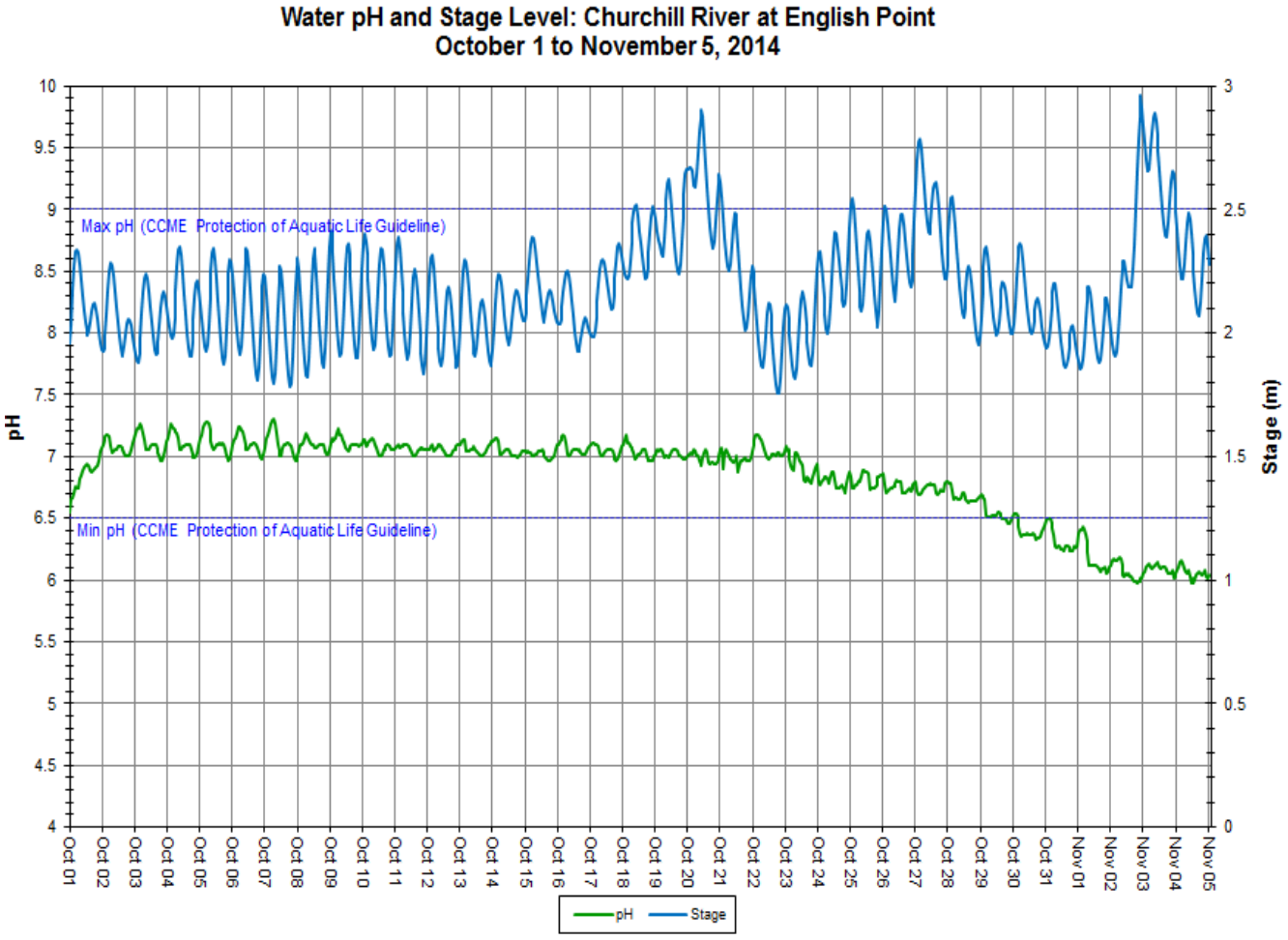

Figure 19: pH and stage level at Churchill River at English Point

- Specific conductance ranged between 17.7µS/cm and 55.0µS/cm during the deployment period, with a median of 31µS/cm (Figure 20).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the specific conductivity increases as the dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period.

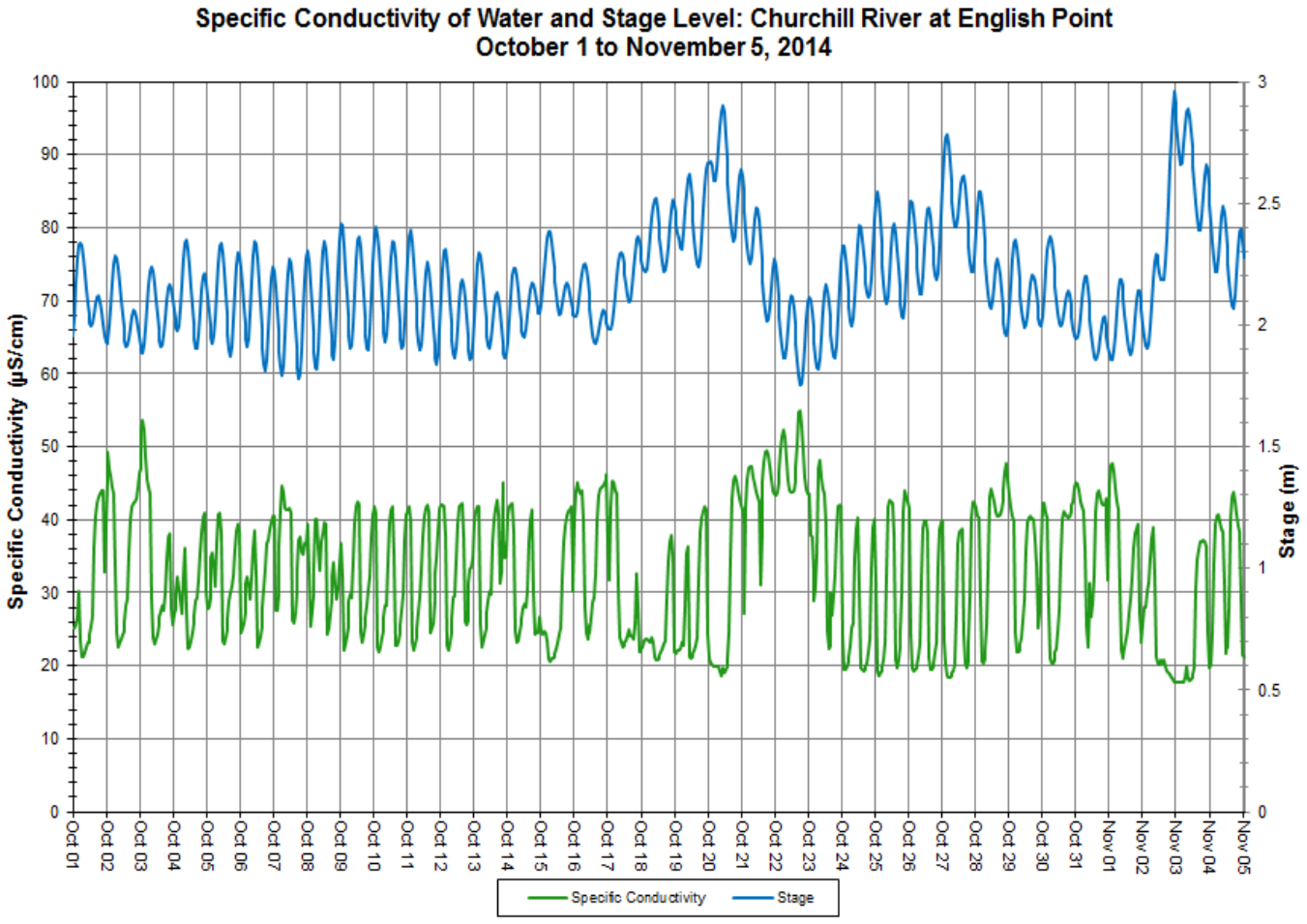

Figure 20: Specific conductivity and stage level at Churchill River at English Point

- Dissolved oxygen content ranges between 10.61mg/l and 13.83mg/l during the deployment period. The saturation of dissolved oxygen ranges from 89.5% to 109.8% (Figure 29).
- All values were above both the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stage of 6.5mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 21.
- Dissolved oxygen content is gradually increasing throughout the deployment period. This trend is expected as ambient air and water temperatures are decreasing during this deployment period as winter approaches and colder water can hold more oxygen (Figure 18).

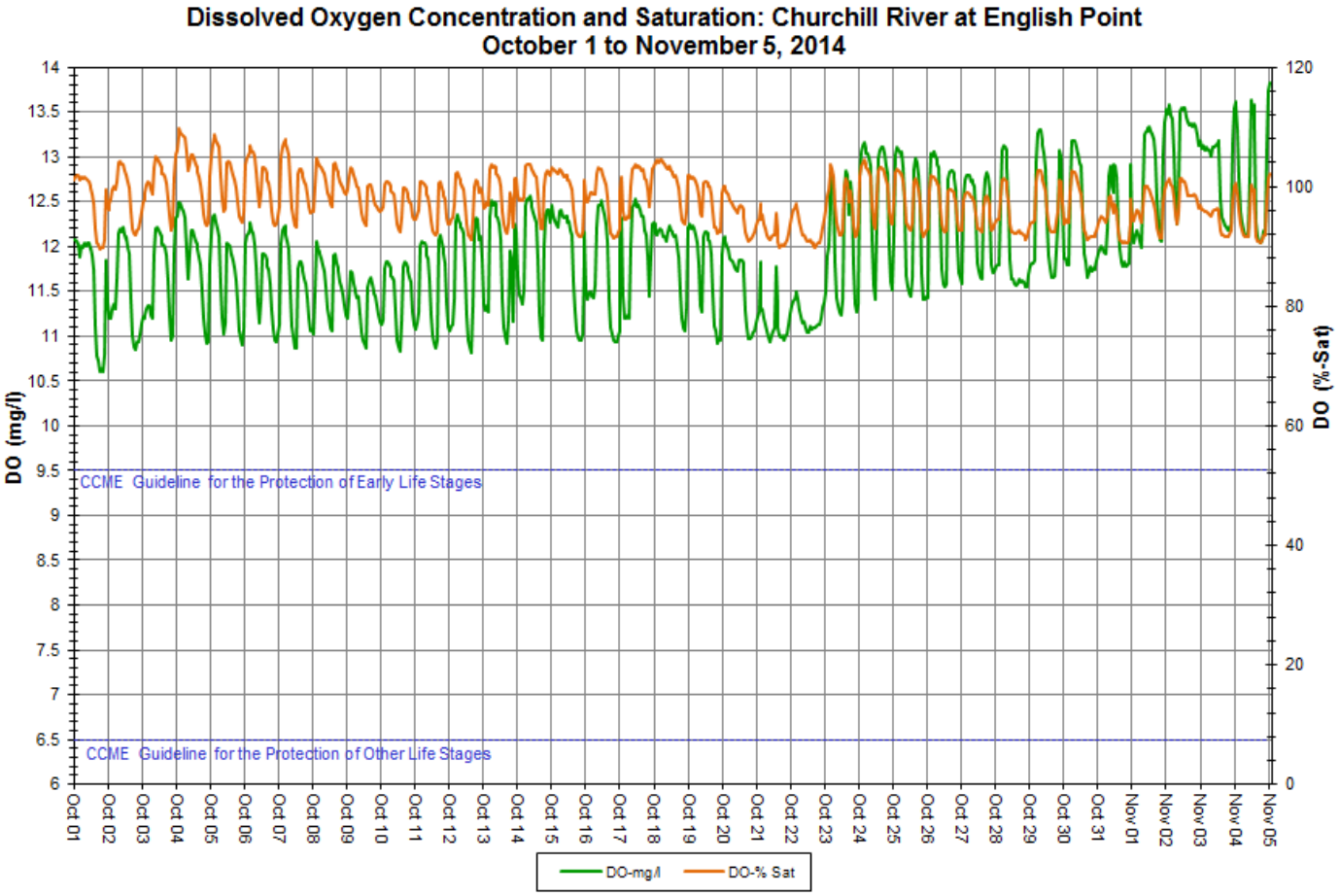

Figure 21: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity ranges from 0.0NTU to 708NTU during the deployment period, with a median value of 64.9NTU (Figure 22).
- Turbidity increases on October 20th and November 3rd occur during precipitation events and corresponding increases in stage. This is likely due to sediment becoming suspended in the water column or ice and slush forming around the turbidity sensor.
- The constant rise in turbidity October 26-November 2 indicates that biofouling or debris interference may have been an issue during this period.

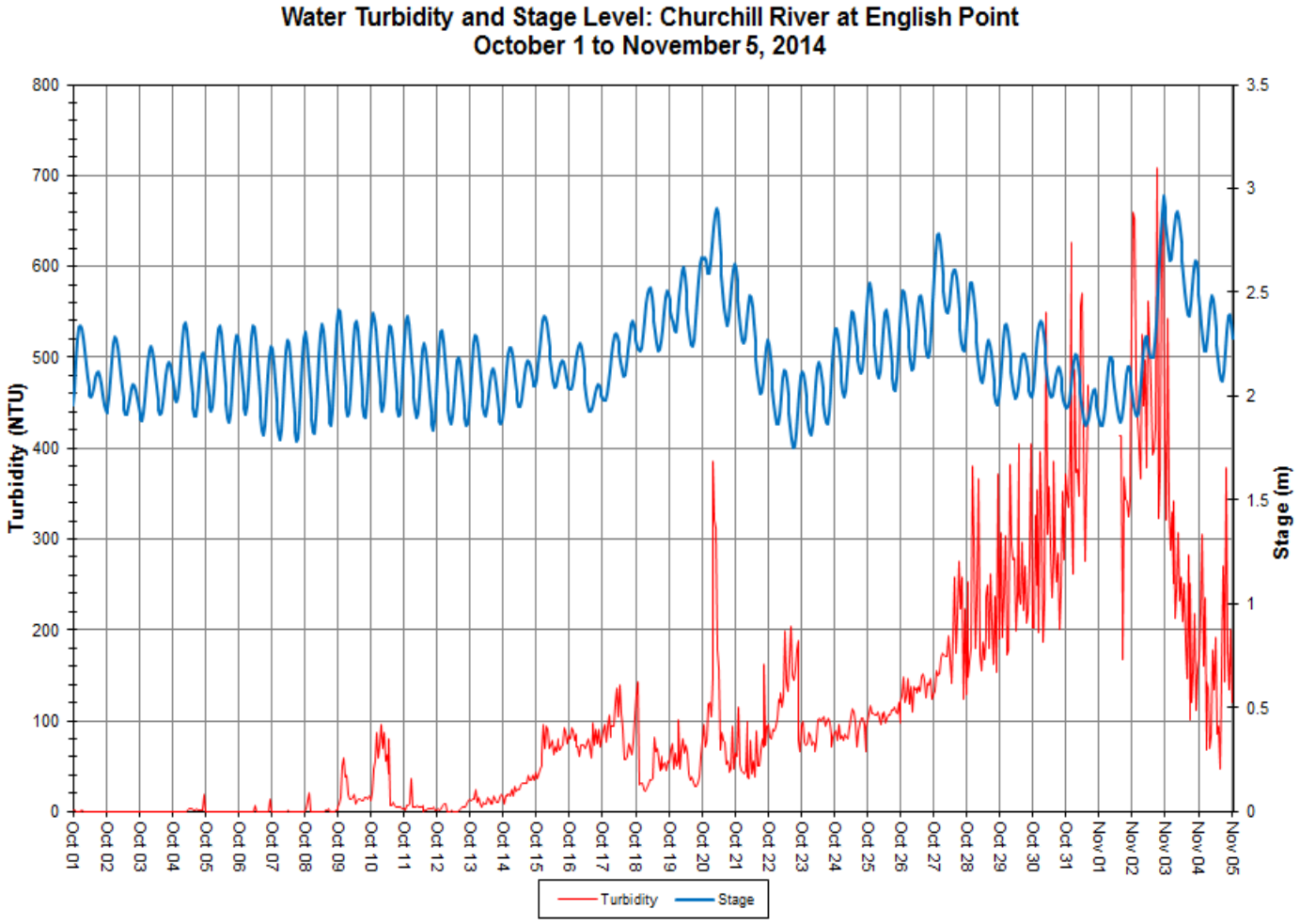

Figure 22: Turbidity and stage level at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 23). Stage is fluctuating throughout the deployment period, but peaks after precipitation events. Precipitation occurs on 19 days during the deployment period and amounts are small in magnitude, with the exception of the largest event on October 20 with 50.2mm of rain. Stage ranges between 1.75m and 2.96m, a difference of 1.21m.

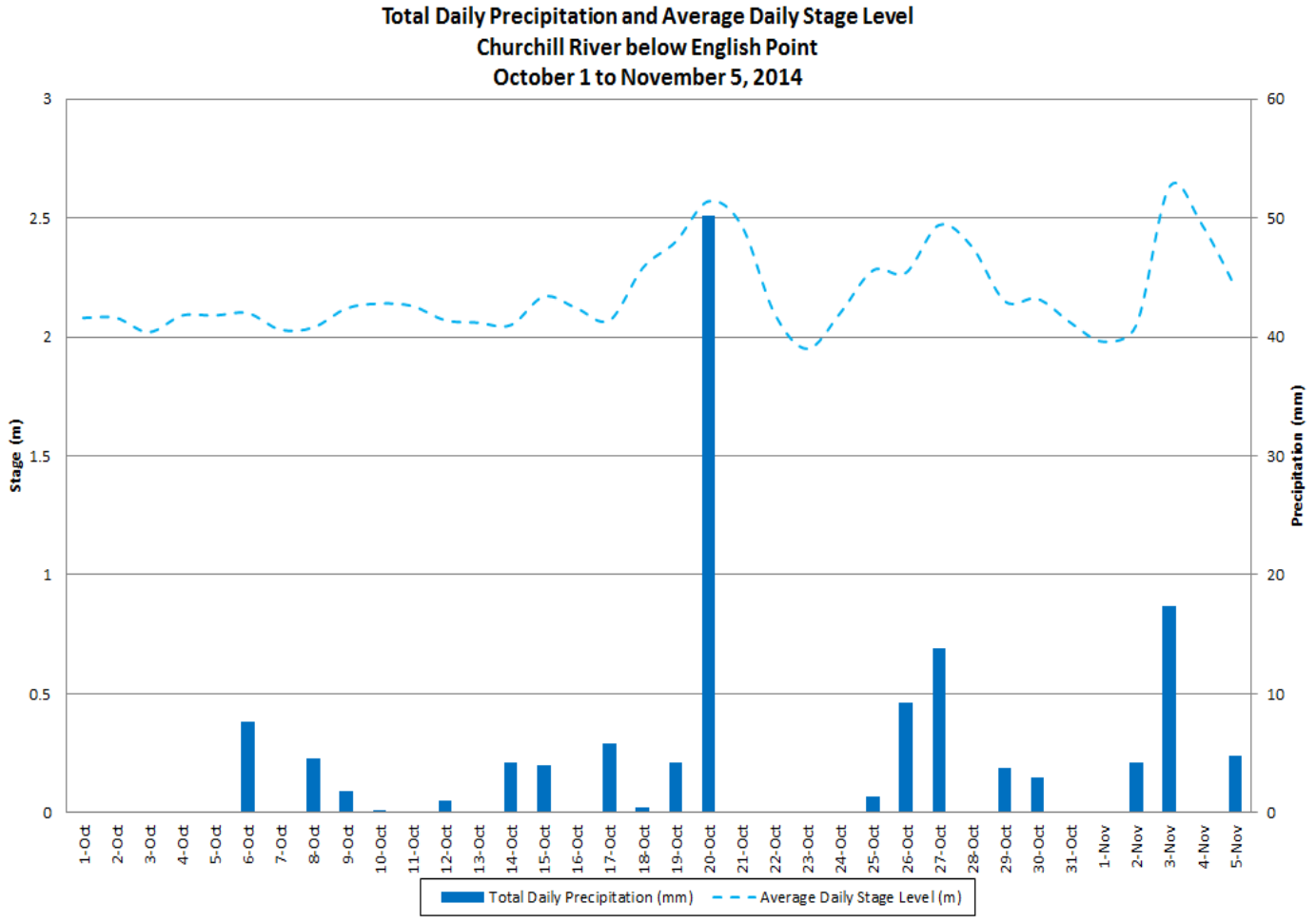

Figure 23: Daily precipitation and average daily stage level at Churchill River at English Point (weather data recorded at Goose Bay)

Conclusions

- Instruments at three water quality monitoring stations on the Lower Churchill River were deployed from October 1 to November 5, 2014. The below Lower Muskrat Falls station and below Metchin River stations were not deployed.
- Stage levels are generally increasing at all stations throughout the deployment as there are numerous precipitation events occurring, adding more water to the system and raising the stage levels. Water level changes at the each of the stations ranged between 0.57m and 2.23m.
- Water temperature was decreasing gradually at all stations throughout the deployment period due to the decreasing ambient air temperatures in the region as winter approaches. Water temperature typically ranged between 1.81°C and 10.10°C.
- pH is generally neutral and stable at stations along the Lower Churchill River ranging between 5.97 and 7.30 pH units. The majority of pH values at all stations were within the recommended CCME Guidelines for the Protection of Aquatic Life. Values dropped below the minimum guideline near the end of deployment at English Point, but this is likely due to sensor drift.
- Specific conductivity was relatively stable at all stations regardless of the fluctuating stage levels. All stations showed little variation in values except at English Point, which is influenced by the tides in Lake Melville. Specific conductivity ranged between 15.8µS/cm and 19.5µS/cm at the stations below Grizzle Rapids and above Muskrat Falls. Specific conductivity values at the station at English Point ranged higher at 17.7µS/cm to 55.0µS/cm .
- Dissolved oxygen content was constantly increasing throughout the deployment period as it is inversely related to water temperatures, which were gradually decreasing as winter approaches. Values ranged between 10.61mg/l and 13.83mg/l. All values were above both the CCME Guidelines for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages and for Early Life Stages.
- Turbidity data at the below Grizzle Rapids station was atypical, with a median of 4.0NTU instead of the usual 0NTU, indicating turbidity was fluctuating more than normal. Turbidity values at the above Muskrat Falls station were typical for the station, reporting a background value of 4.3NTU. English Point experienced more turbidity than normal with a background median value of 64.9NTU. However, several of the rises in turbidity are clearly linked to precipitation events and ice formation appears to have been an issue during this deployment.

Appendix 1 – Weather Data – Environment Canada Historical Weather and Climate Database