Real-Time Water Quality Deployment Report

Lower Churchill River Network

August 12/14 to
Sept 30/Oct 1, 2014

Newfoundland Labrador

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

Contents

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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 August 12/14 2014, real-time water quality monitoring instruments were deployed at four of the Lower Churchill River Stations for periods of 47-49 days. The station below Lower Muskrat Falls was not deployed this period due to continued issues with sand at the site which could damage the instrument. Instruments at all other stations were removed on Sept 30/Oct 1, 2014.

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 August 12/14 to Sept 30/Oct 1, 2014 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, August 12/14 to Sept 30/Oct 1, 2014

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45709)	August 12, 2014	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	September 30,2014	Removal	Excellent	Poor	Excellent	Excellent	Excellent
Below Grizzle Rapids (45699)	August 12, 2014	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	October 1, 2014	Removal	Excellent	Excellent	Excellent	Good	Excellent
Above Muskrat Falls (45708)	August 14, 2014	Deployment	Excellent	Excellent	Excellent	N/A*	Good
	October 1, 2014	Removal	Good	Good	Excellent	Good	Poor
Below Muskrat Falls (n/a)	August 14, 2014	Deployment	N/A**	N/A**	N/A**	N/A**	N/A**
	October 1, 2014	Removal	N/A**	N/A**	N/A**	N/A**	N/A**
At English Point (45042)	August 14, 2014	Deployment	Excellent	Good	Excellent	Excellent	Good
	October 1, 2014	Removal	Good	Excellent	Excellent	Good	Good

* Dissolved oxygen on QA/QC instrument not working, thus ranking not available.

** Sonde not installed this deployment period due to excessive sand in the area which produces false readings and can damage the sonde sensors.

- At the station below Metchin River, temperature, pH, specific conductivity, dissolved oxygen and turbidity all rank either 'good' or 'excellent' at deployment.

  At removal, temperature, specific conductivity, dissolved oxygen and turbidity all rank 'excellent', while pH ranks 'poor'. The pH field value was 6.29 while the QA/QC value was 5.71. This discrepancy is likely due to the QA/QC value being recorded before the sensor had stabilized.
- At the station below Grizzle Rapids, temperature, pH, specific conductivity, dissolved oxygen and turbidity all rank either 'good' or 'excellent' at deployment.

At removal, temperature, pH, specific conductivity, dissolved oxygen and turbidity all rank 'excellent' or 'good'.

- At the station above Muskrat Falls, temperature, specific conductivity, pH rank 'excellent' while turbidity ranks 'good' at deployment. Dissolved oxygen could not be ranked as the DO sensor on the QA/QC was not functioning.

  At removal, specific conductivity ranked 'excellent' while temperature, pH and dissolved oxygen all rank 'good'. Turbidity ranked 'poor'. The field value for turbidity was 73.4NTU while the QA/QC value was 6.1NTU. This discrepancy may be due to sedimentation of the sensor, as the field turbidity reading had steadily increased for several dayss before removal.

- 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 and turbidity ranked 'good' at deployment.

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

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring between August 12/14 and September 30/October 1 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.
- Due to low water levels during this deployment period, instruments were out of the water for short periods of time August 15-24 at below Metchin River, below Grizzle Rapids and above Muskrat Falls stations. As the data recorded during this timeframe is inaccurate, it has been removed from the dataset.

Churchill River below Metchin River

- Water temperature ranges from 6.40°C to 20.10°C during the deployment period (Figure 1).
- Water temperature is generally decreasing throughout the deployment period. This trend is expected due to the cooling air temperatures into the fall season (Figure 2).

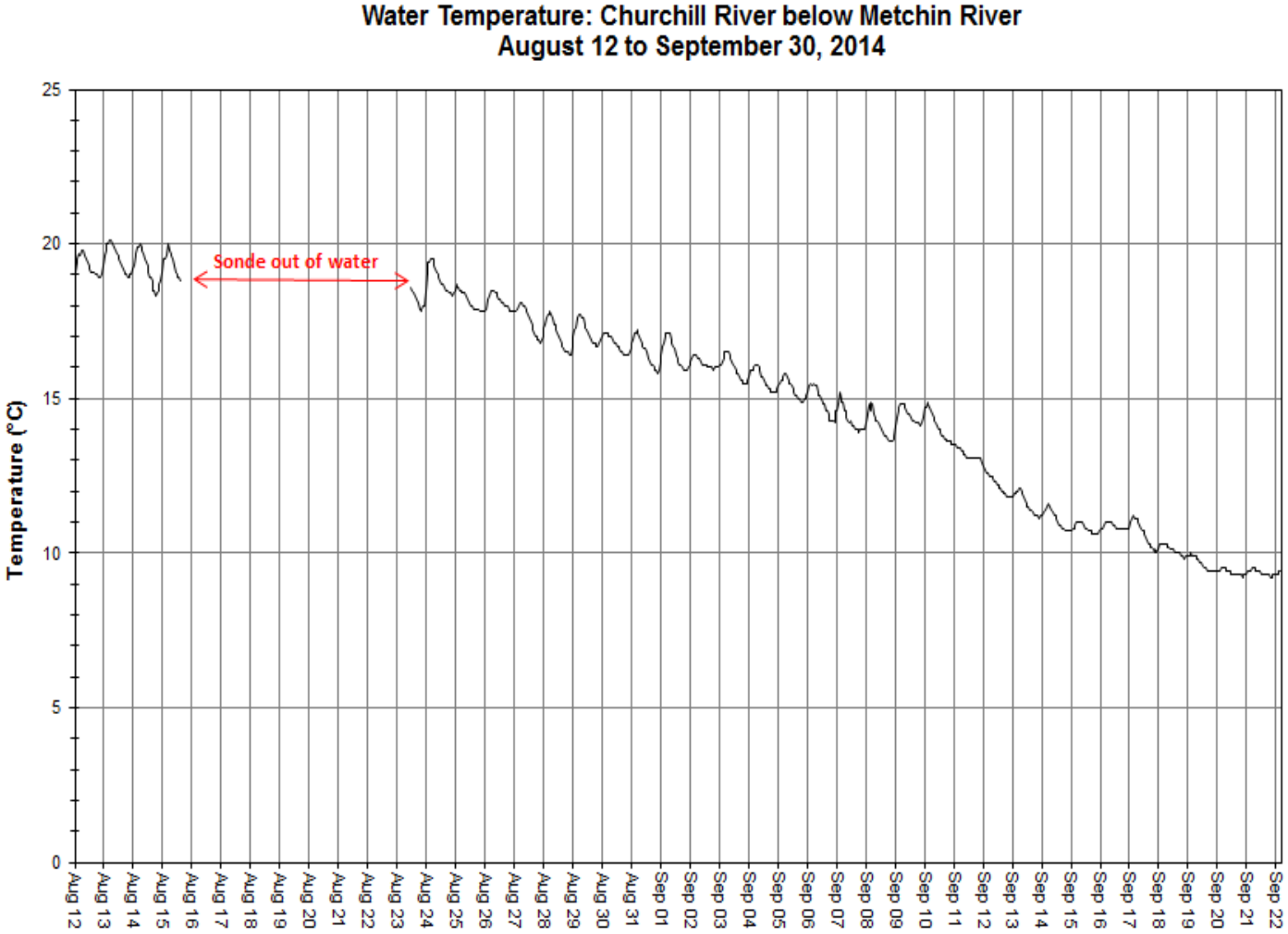

Figure 1: Water temperature at Churchill River below Metchin River

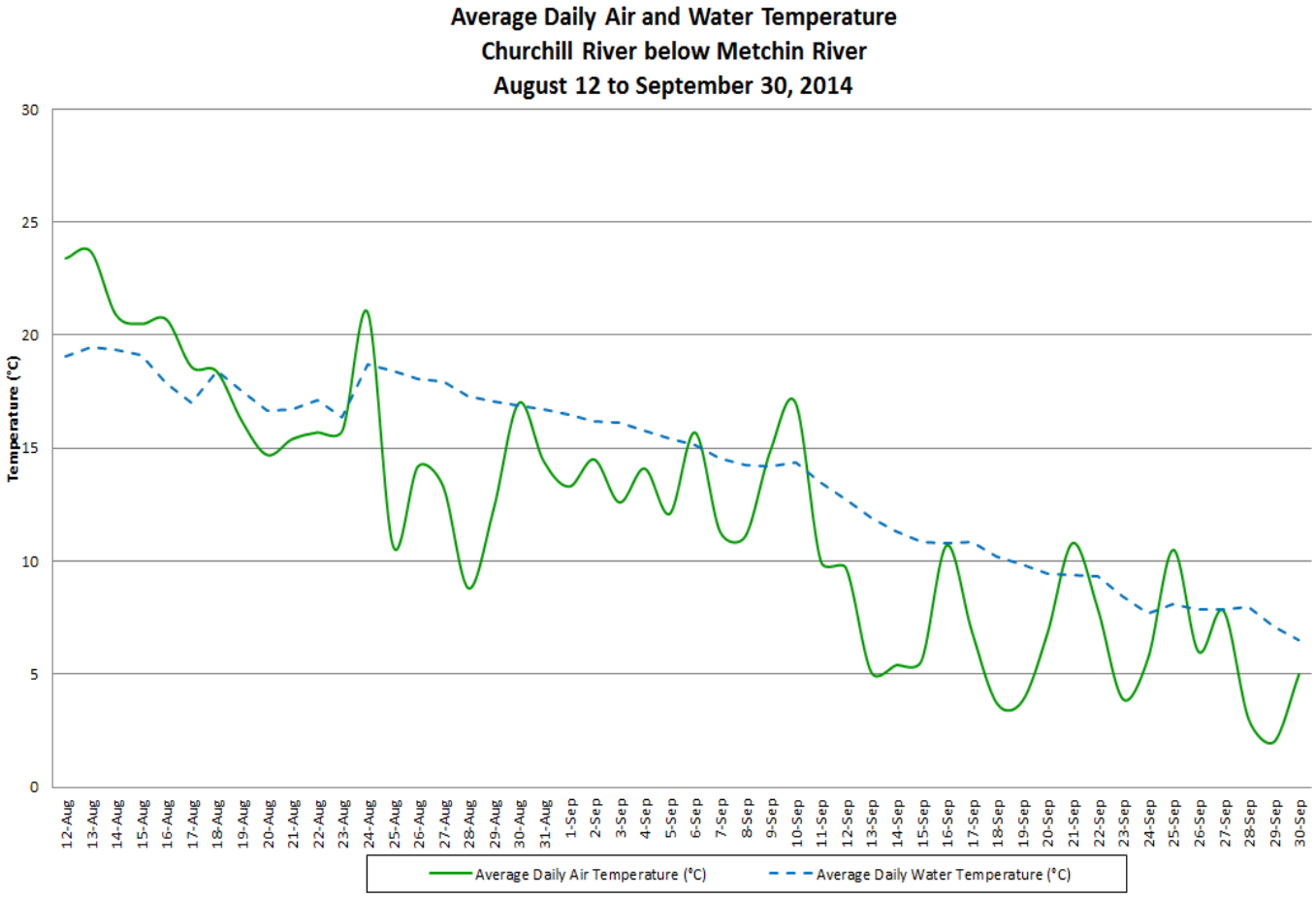

Figure 2: Average daily air and water temperature at Churchill River below Metchin River (weather data recorded at Goose Bay, NL; Churchill Falls data unavailable)

- pH ranges between 6.65 and 7.30 pH units and is relatively stable throughout the deployment period regardless of the changing stage levels (Figure 3).
- All pH values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

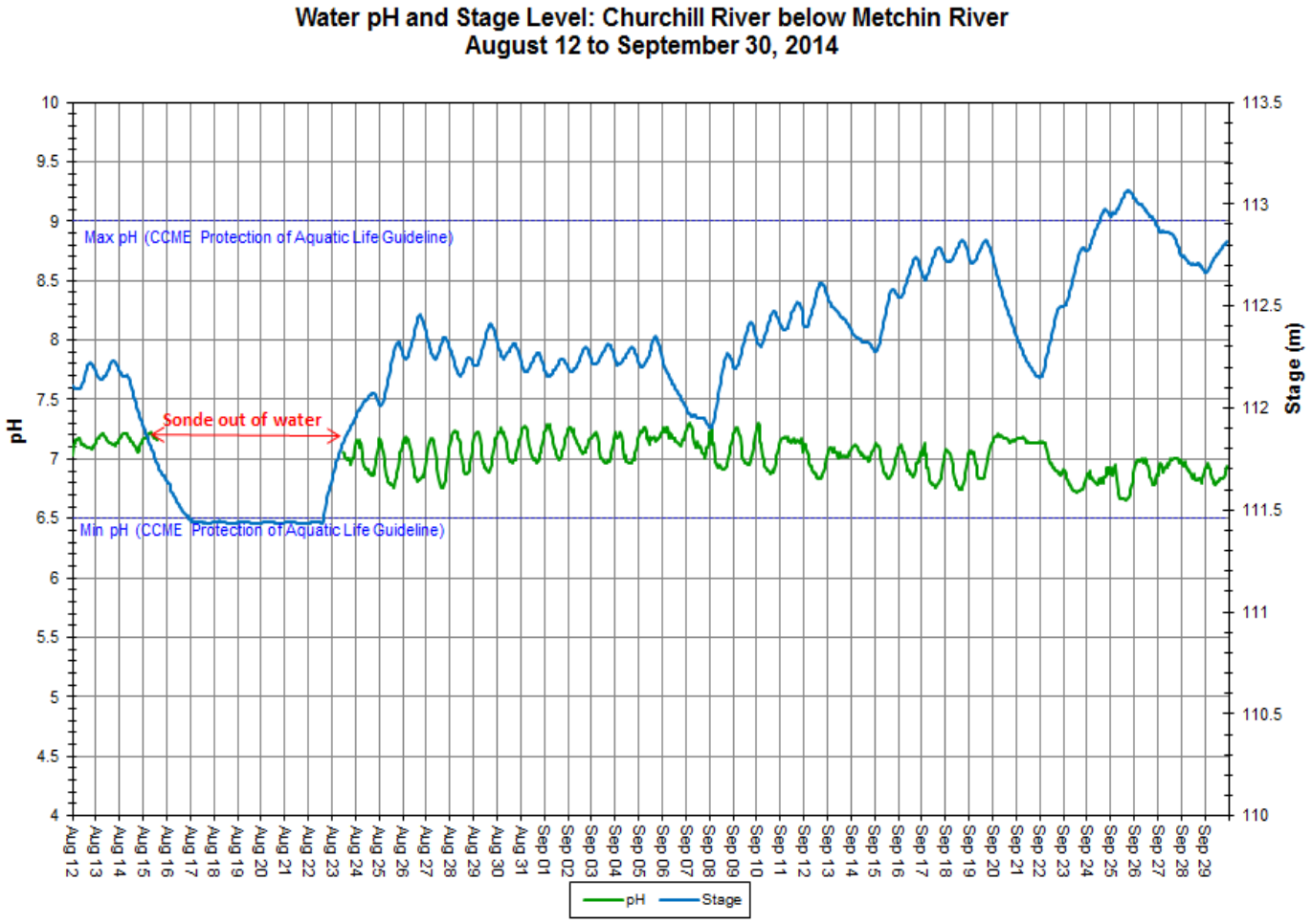

Figure 3: pH and stage level at Churchill River below Metchin River

- Specific conductivity ranges between 18.1µS/cm to 23.3µS/cm during the deployment period, with a median of 21.6µS/cm (Figure 4).
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is fluctuating significantly throughout the deployment period. Generally, as stage levels decrease, specific conductivity generally increases due to the increasing concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted. This trend is not visible in the data collected during the deployment period as specific conductivity is relatively stable during this period.

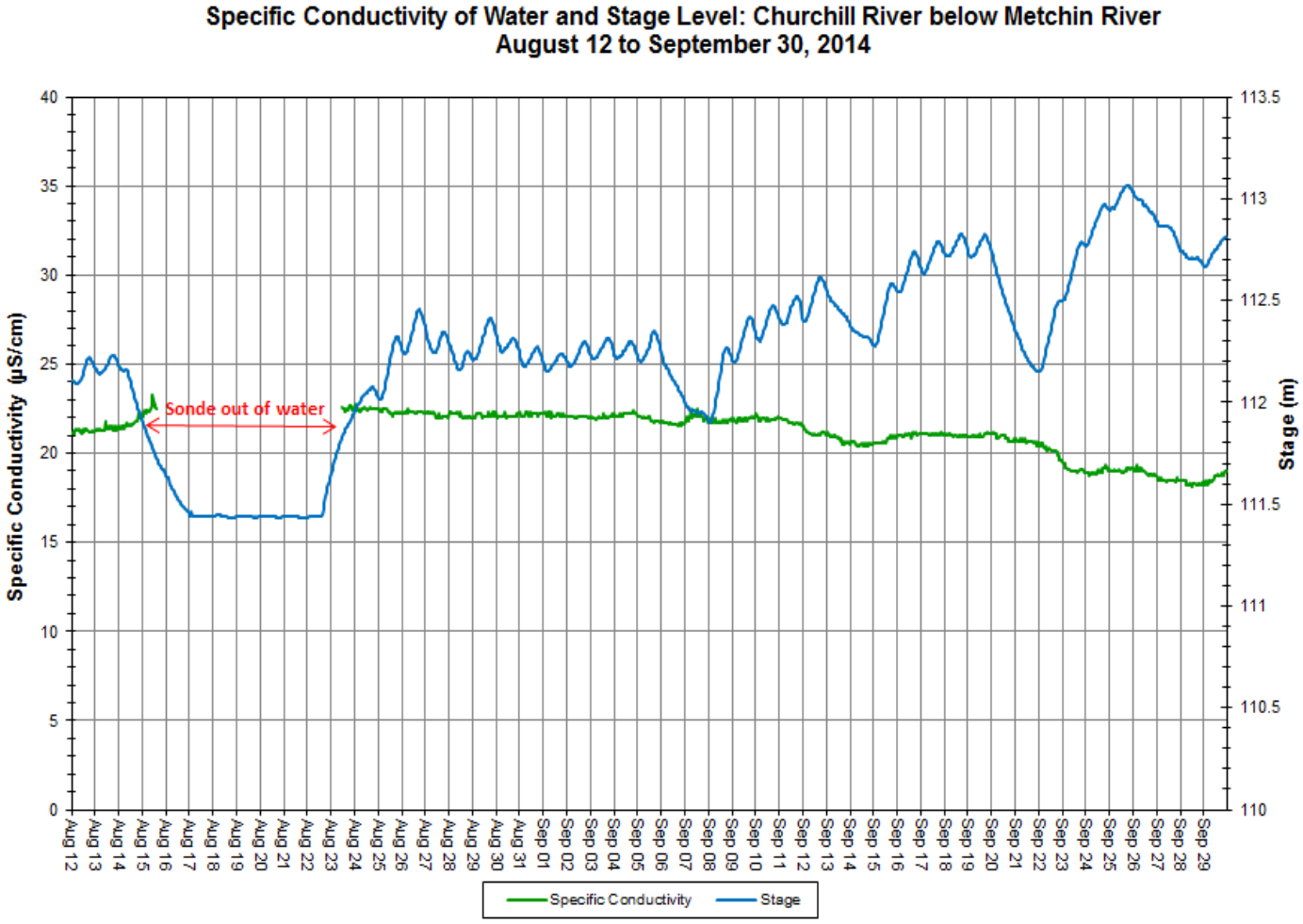

Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- Dissolved oxygen content ranges between 8.76mg/l and 11.70mg/l. The saturation of dissolved oxygen ranges from 91.7% to 99.3% (Figure 5).
- All values are above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l, and half of the values are above the CCME Guidelines for the Protection of Early Life Stages of 9.5mg/l. 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 throughout late summer and fall, and colder water holds more oxygen. (Figure 2).

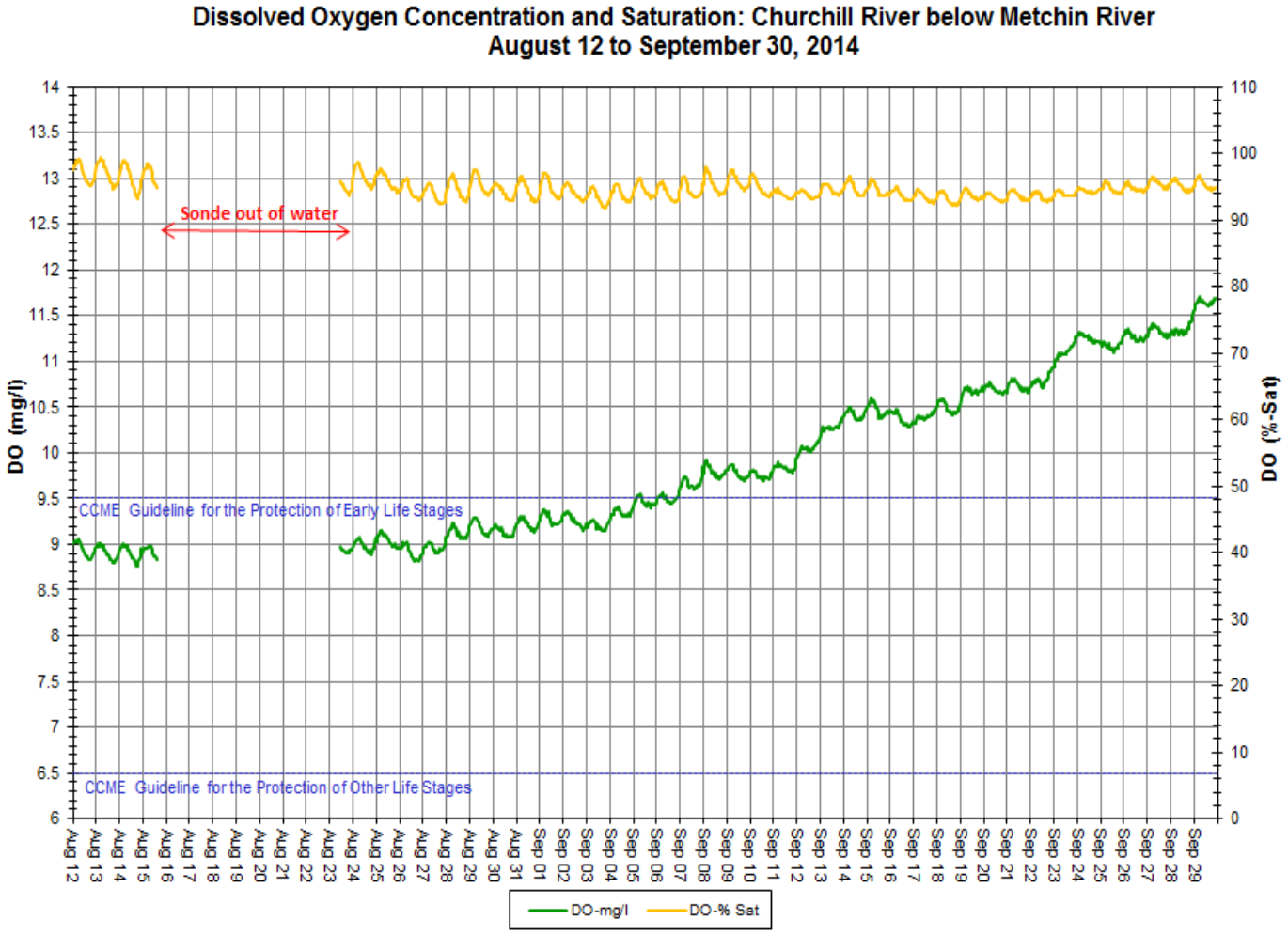

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- Turbidity generally remains at 0NTU for the majority of the deployment period (Figure 6). A median value of 0NTU indicates there is no natural background turbidity value at this station.
- During this deployment period, turbidity rarely increases to values >0NTU. These events are generally low in magnitude and drop again rapidly, likely from debris passing the turbidity sensor. The large increase on September 16 is likely associated with debris as it was of a short duration.

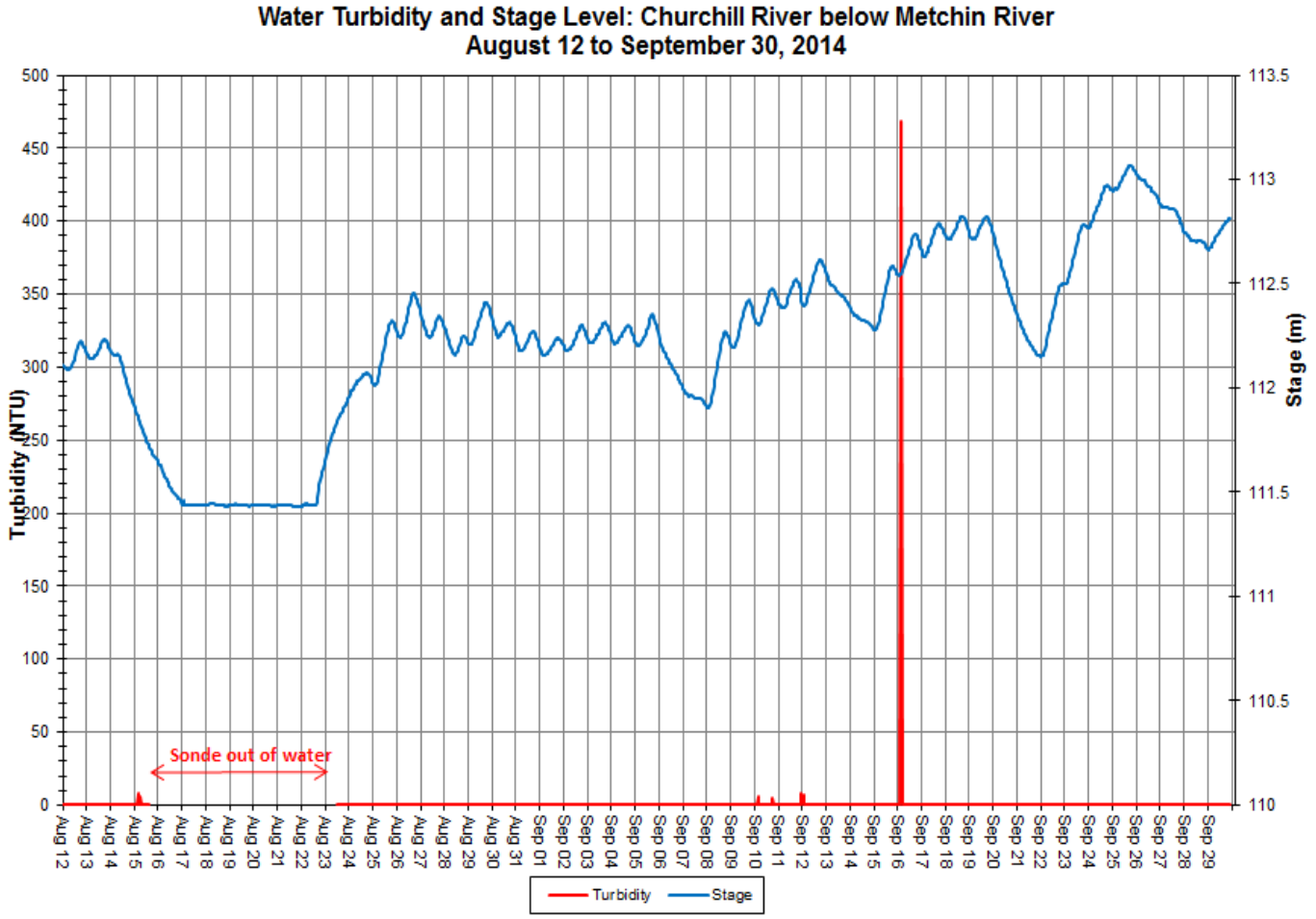

Figure 6: Turbidity and stage level at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is generally increasing throughout the deployment period. Due to low stage and flows, the sonde was out of the water August 15-23. Precipitation occurs on 30 of the days in the deployment period. Precipitation amounts are generally low, peaking at 54.6mm on September 3. Stage ranges between 111.43m and 113.07m, a difference of 1.64m.

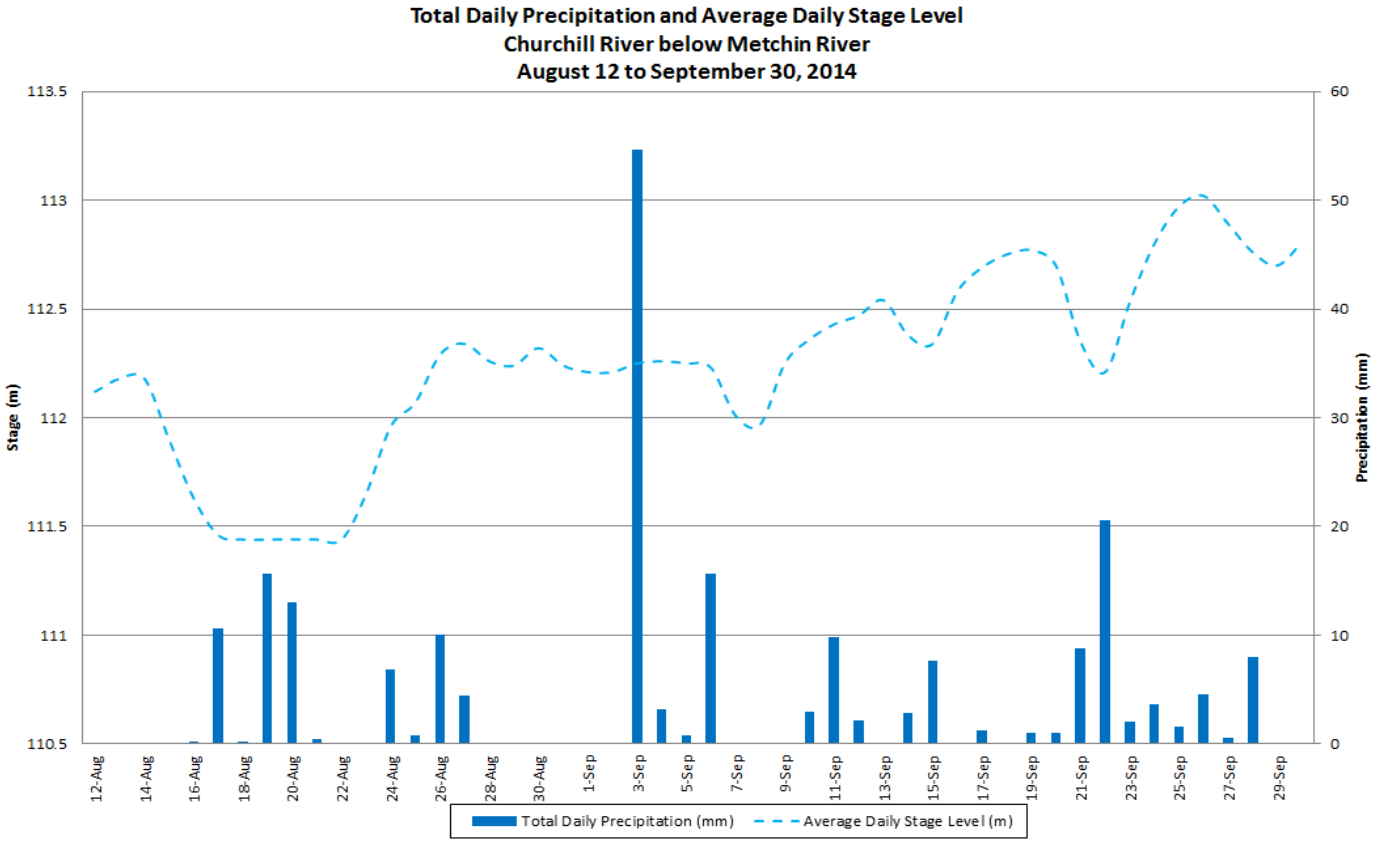

Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- Water temperature ranges from 8.40°C to 21.90°C during the deployment period (Figure 8).
- Water temperature is gradually decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures in late summer and into the fall season (Figure 9).

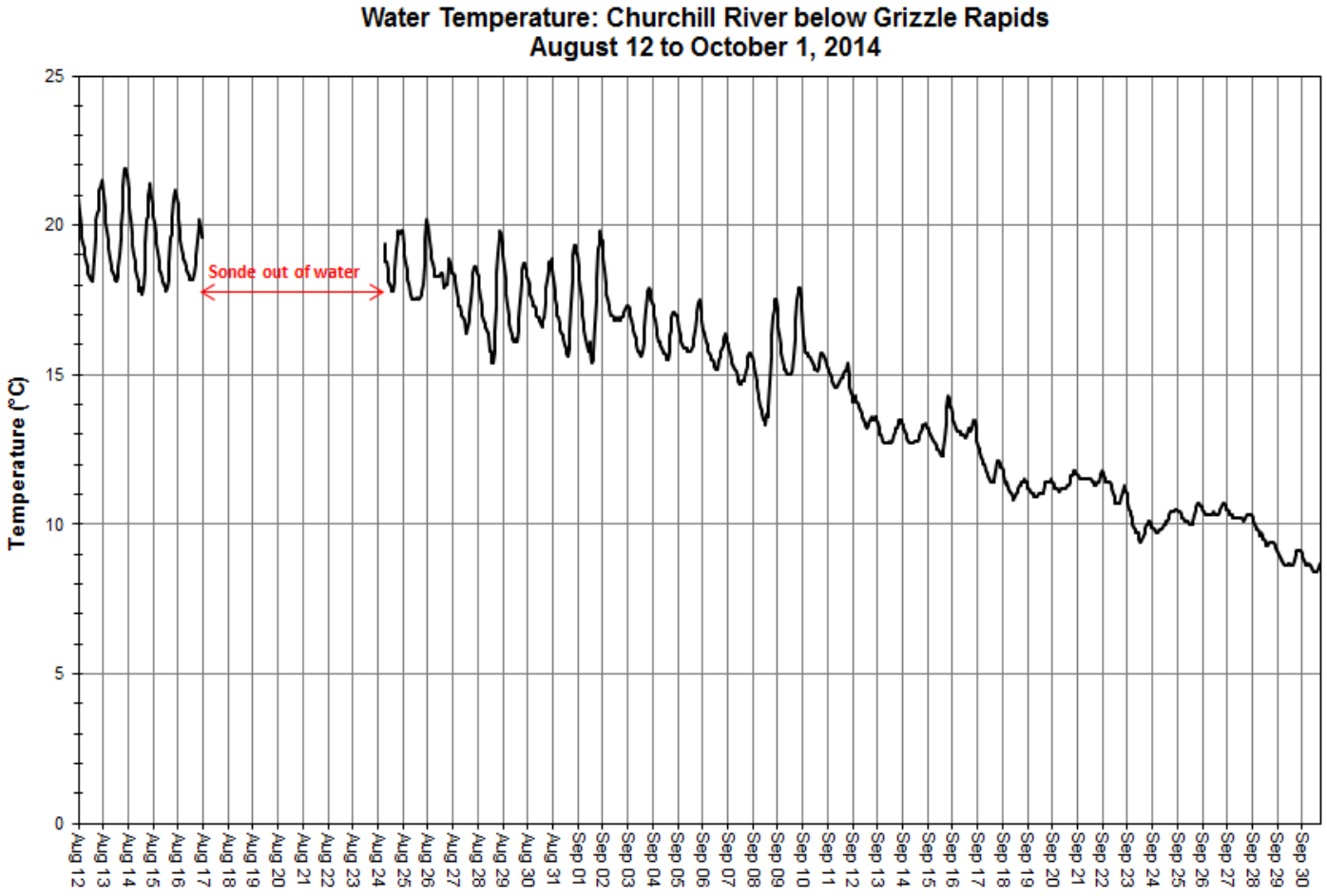

Figure 8: Water temperature at Churchill River below Grizzle Rapids

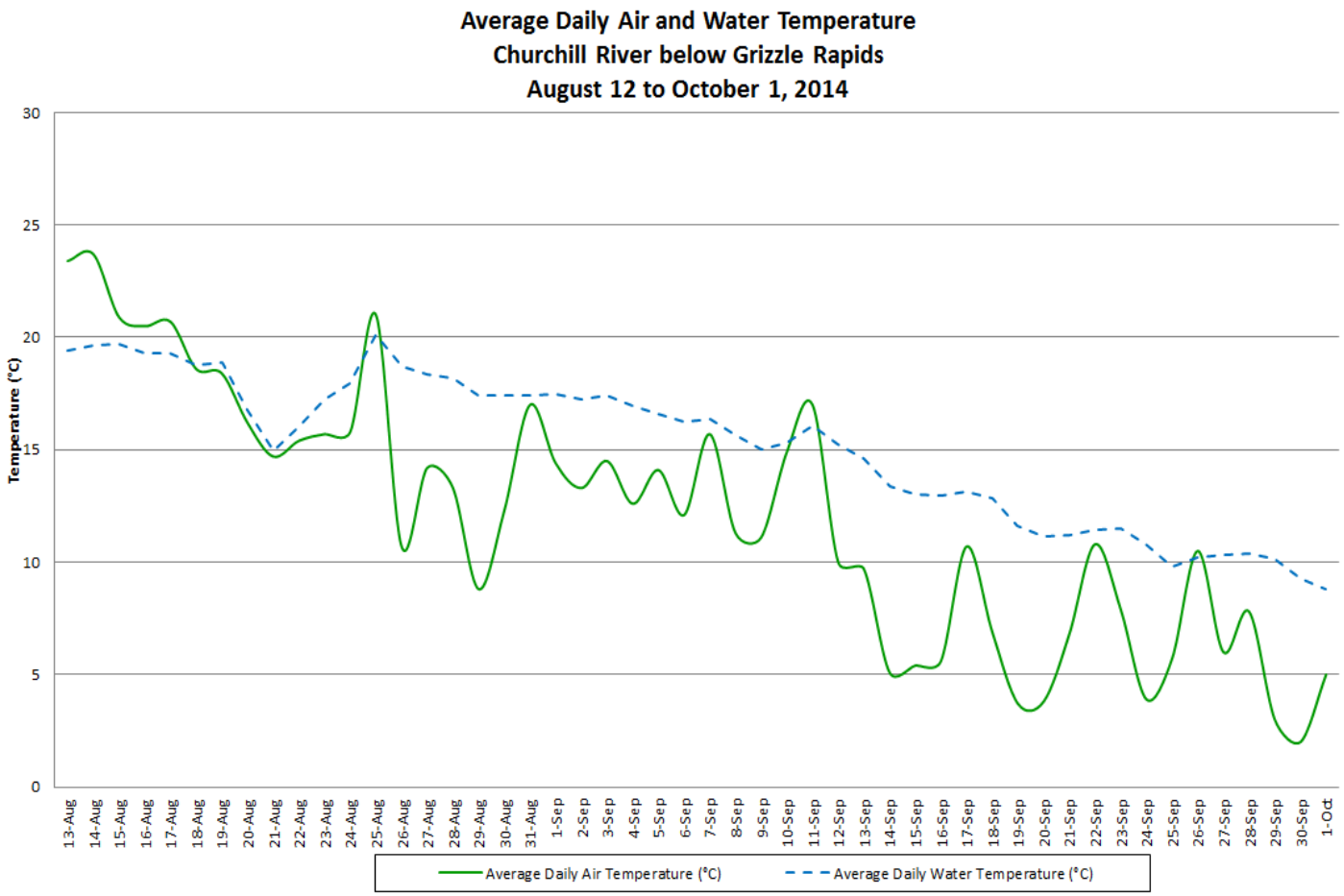

Figure 9: Average daily air and water temperature at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 6.52 and 7.50 pH units (Figure 10). pH values are relatively stable throughout the deployment period regardless of changing water levels. pH values generally fluctuate on a daily basis. Towards the end of the deployment, the fluctuations are decreasing. This is normal at this station into the fall months.
- A rise in water levels during the end of the deployment period (September 23-30) 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 10).

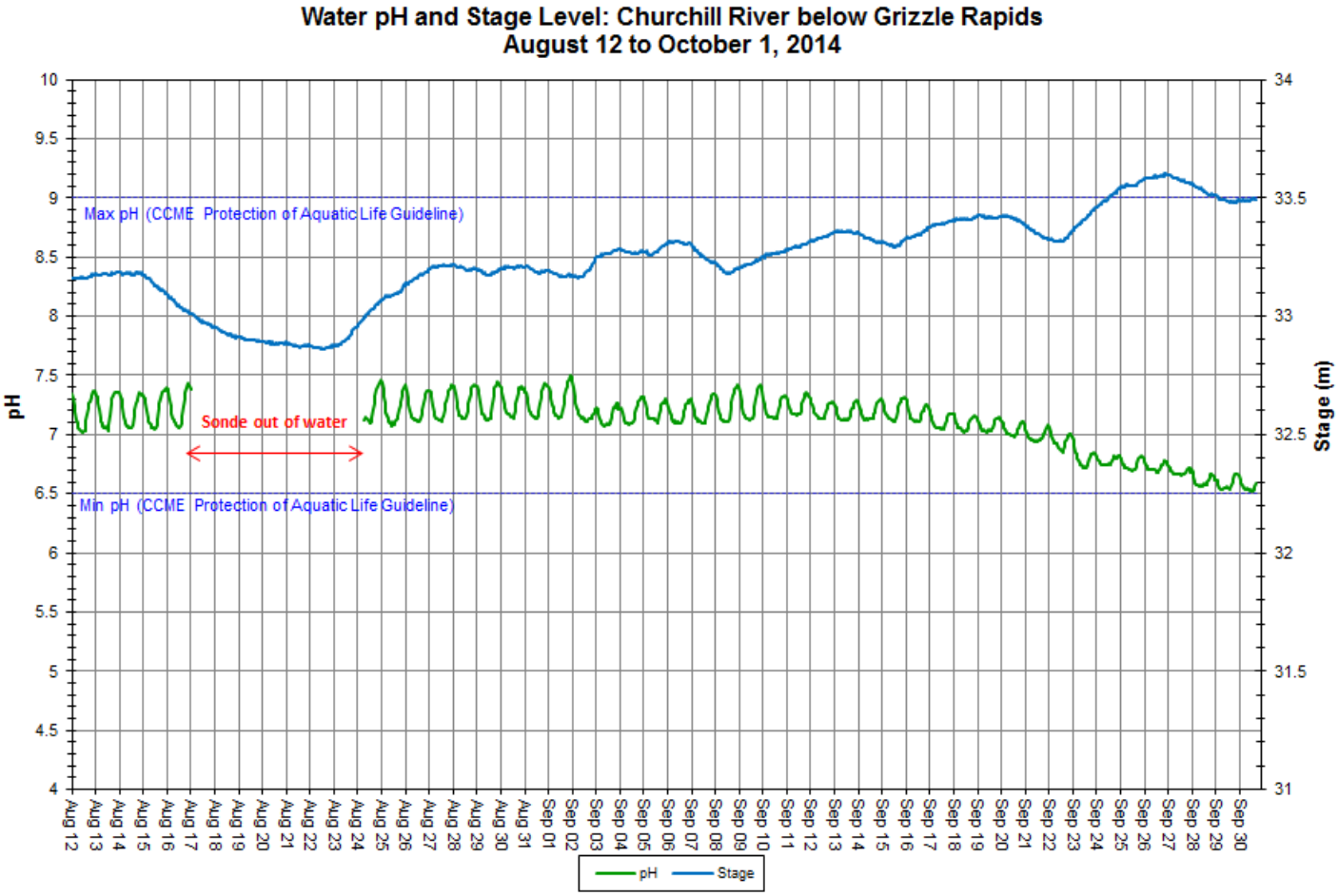

Figure 10: pH and stage level at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 18.4µS/cm to 21.9µS/cm during the deployment period, with a median of 20.2µS/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, especially on September 2; as water levels increase due to rainfall, specific conductivity decreases.

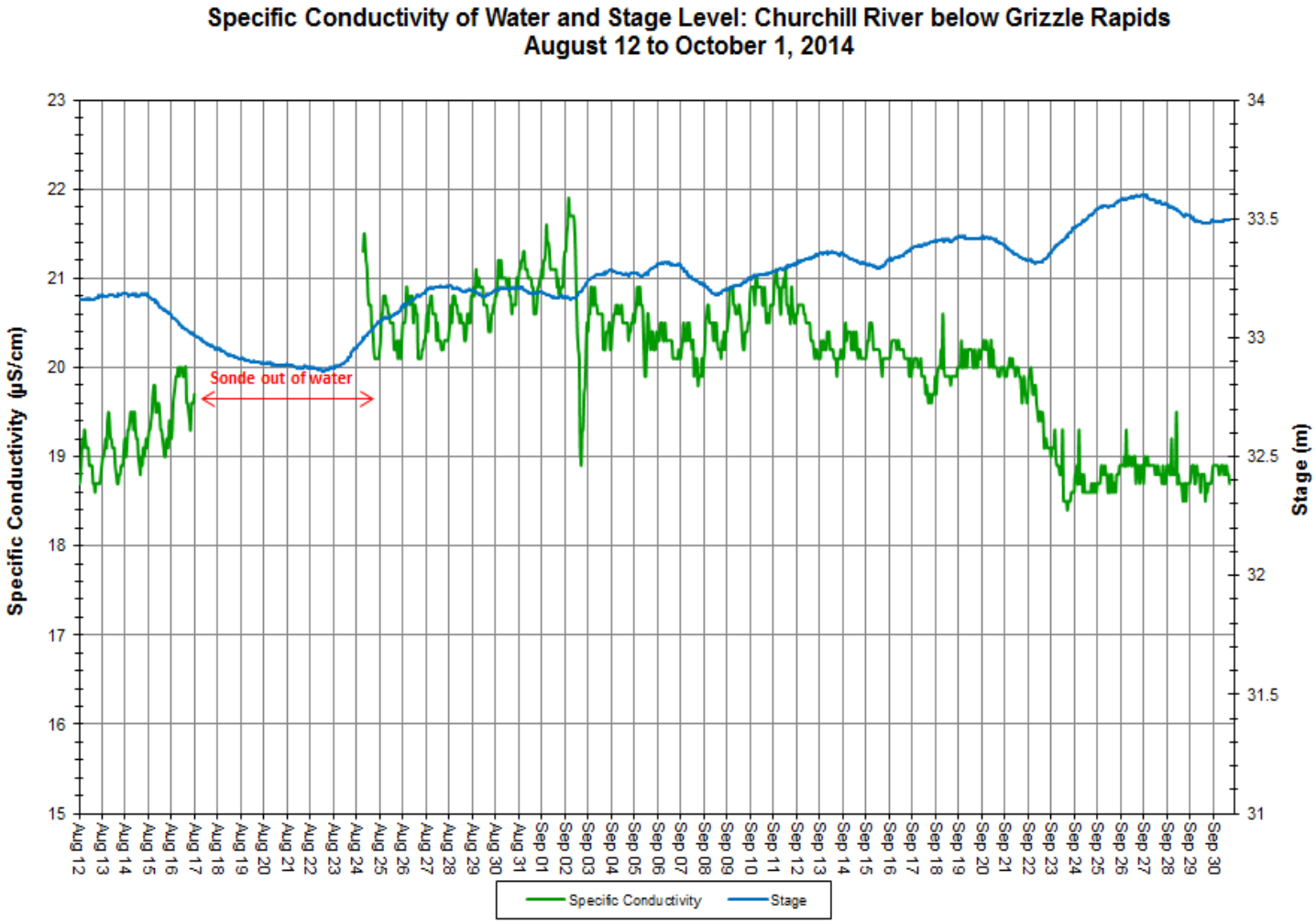

Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- Dissolved oxygen content ranges between 8.70mg/l and 11.16mg/l. The saturation of dissolved oxygen ranges from 91.8% to 104.4% (Figure 12).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l. The values hover below the CCME Guideline for the Protection of Early Life Stages of 9.5mg/l for the first half of the deployment when water temperatures were warm. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected as the air and water temperatures are decreasing throughout late summer and fall, and colder water holds more oxygen. (Figure 9).

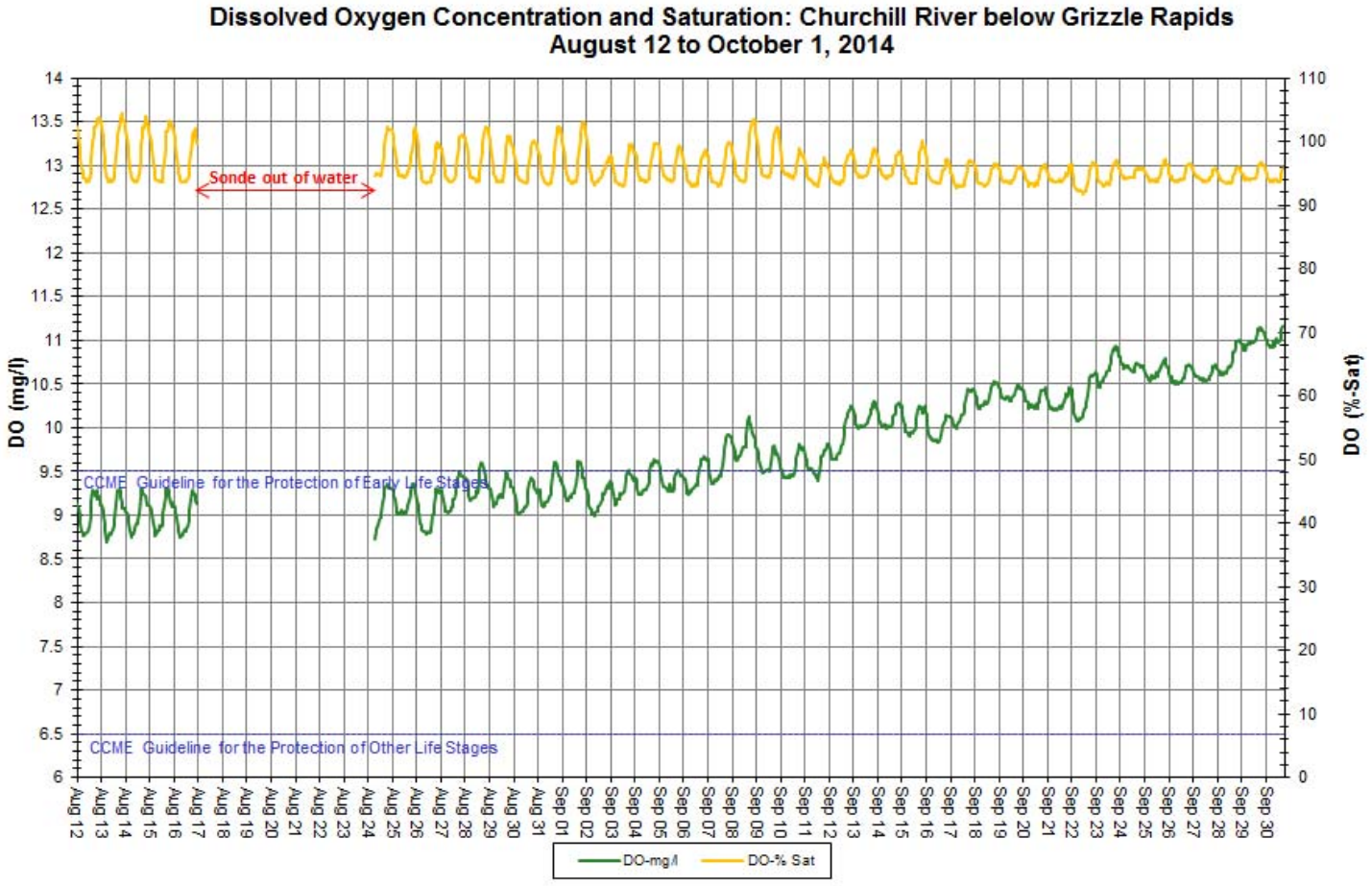

Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values remain at 0NTU for most of the deployment period (Figure 13). A median value of 0NTU at this station indicates there is no natural background turbidity. This trend is typical of this station as the river reach runs clearly and quickly though Grizzle Rapids.
- Turbidity increases up to 5NTU for a brief period on September 3. As turbidity was elevated for several hours and occurred at the same time as a large precipitation event (Figure 14) the readings are likely due to suspended sediment from the precipitation event.

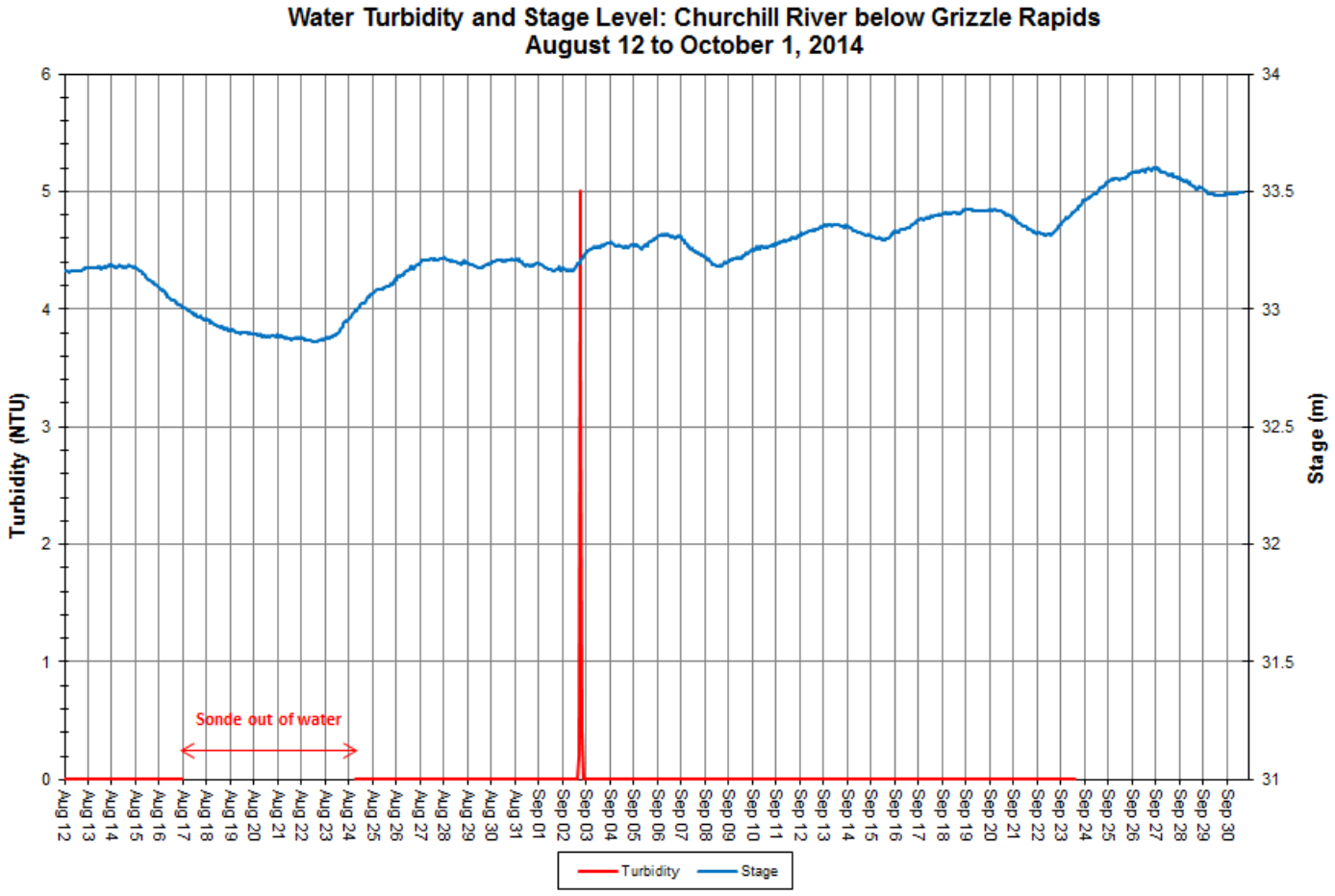

Figure 13: Turbidity and stage level at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Overall, stage is increasing throughout the deployment period. Precipitation occurs on 30 days of the deployment period and amounts are generally low, with the exception of the largest event on September 3 with 54.6mm of rain. Stage ranges between 32.86m and 33.60m, a difference of 0.74m.

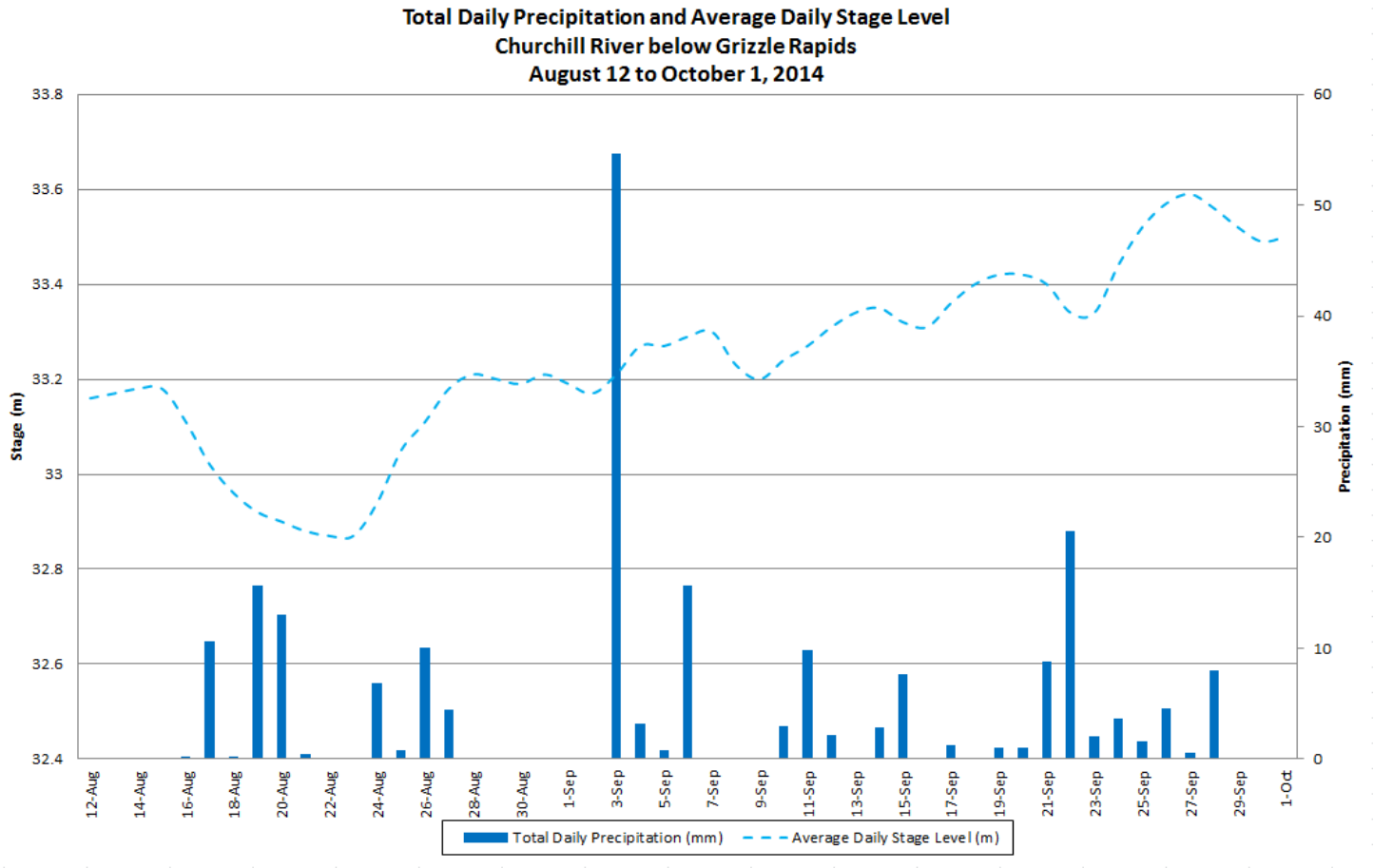

Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 7.24°C to 20.68°C during the deployment period (Figure 15).
- Water temperature is gradually decreasing throughout the deployment period (Figure 16). This trend is expected as air temperatures during the late summer and fall months are steadily decreasing.

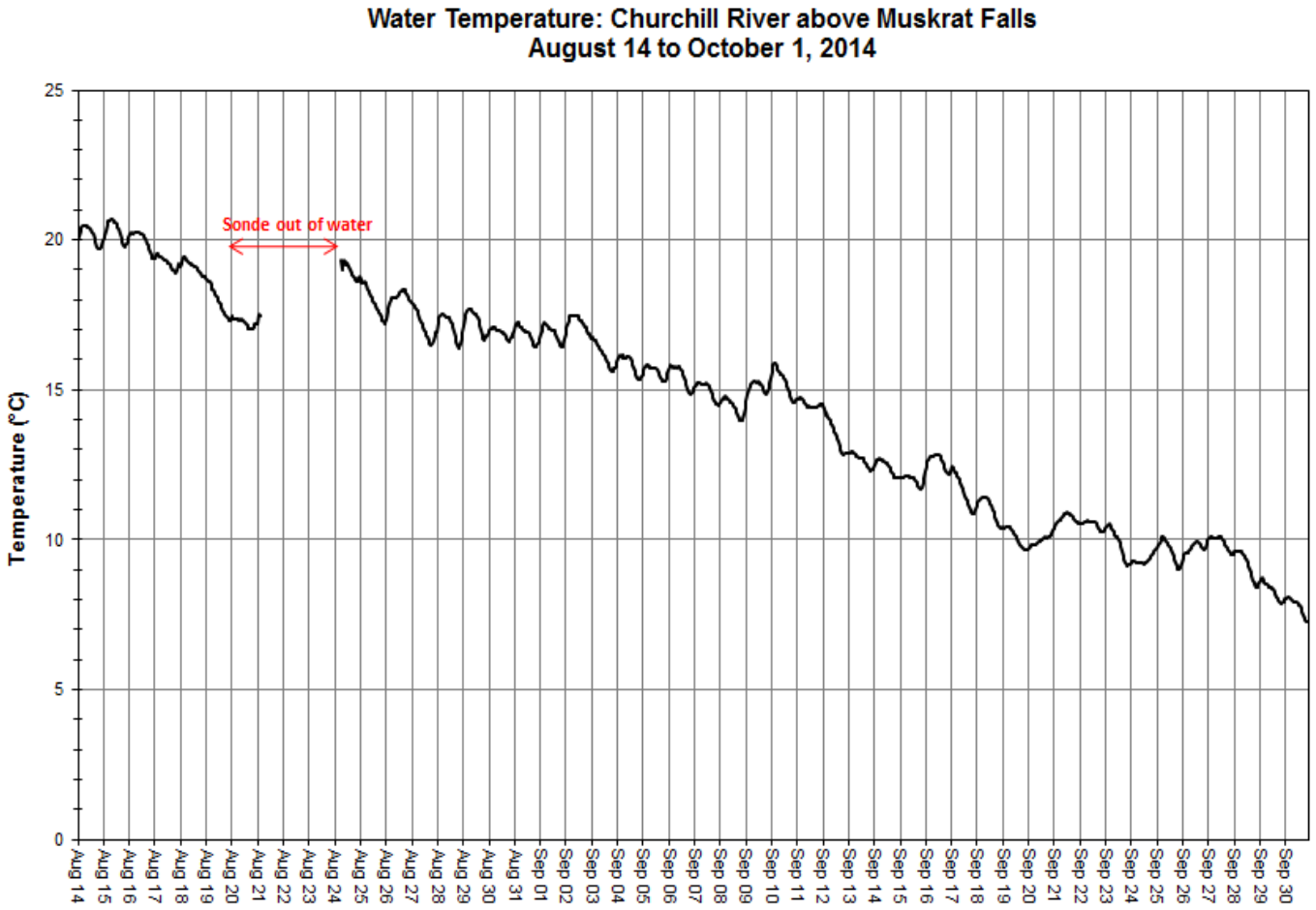

Figure 15: Water temperature at Churchill River above Muskrat Falls

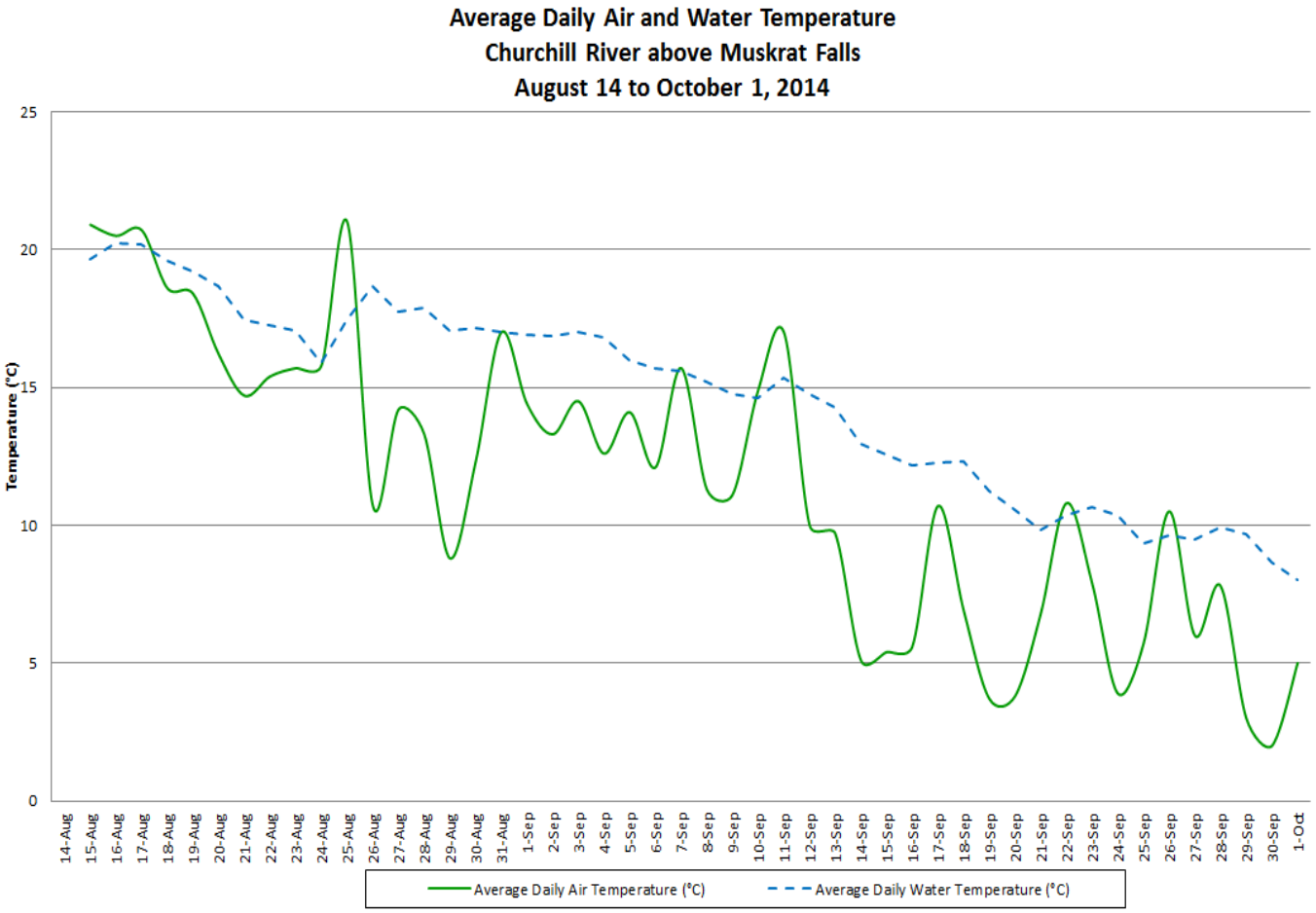

Figure 16: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.99 and 7.35 pH units (Figure 17). pH values are relatively stable throughout the deployment period, dropping slightly when stage levels rise due to the addition of acidic rain, as on September 4.
- All pH values recorded are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

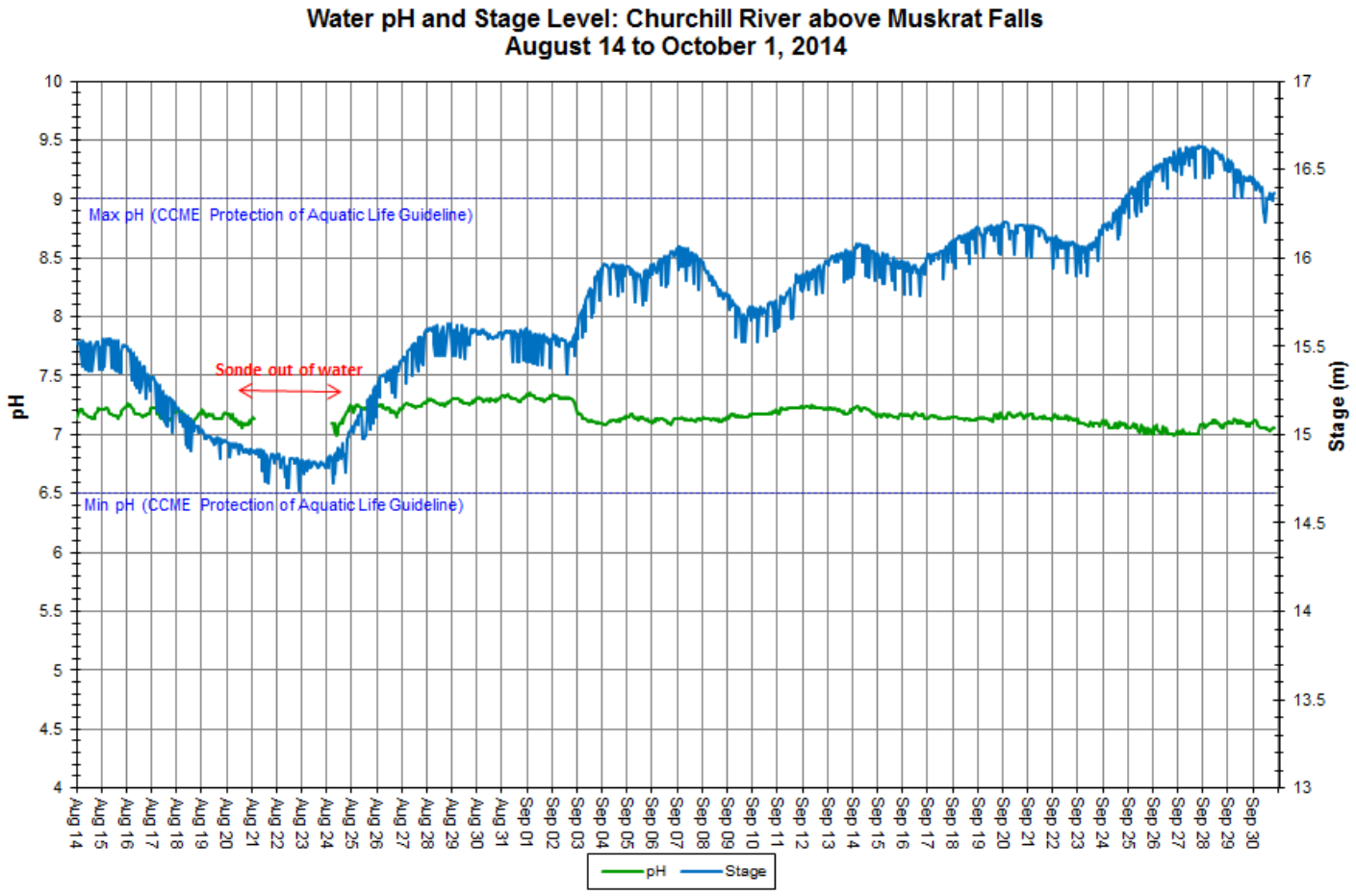

Figure 17: pH and stage at Churchill River above Muskrat Falls

- Specific conductivity ranges from 17.5µS/cm to 23.4µS/cm during the deployment period, with a median of 19.1µS/cm. (Figure 18).
- Stage is included in Figure 18 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 September 23-30.

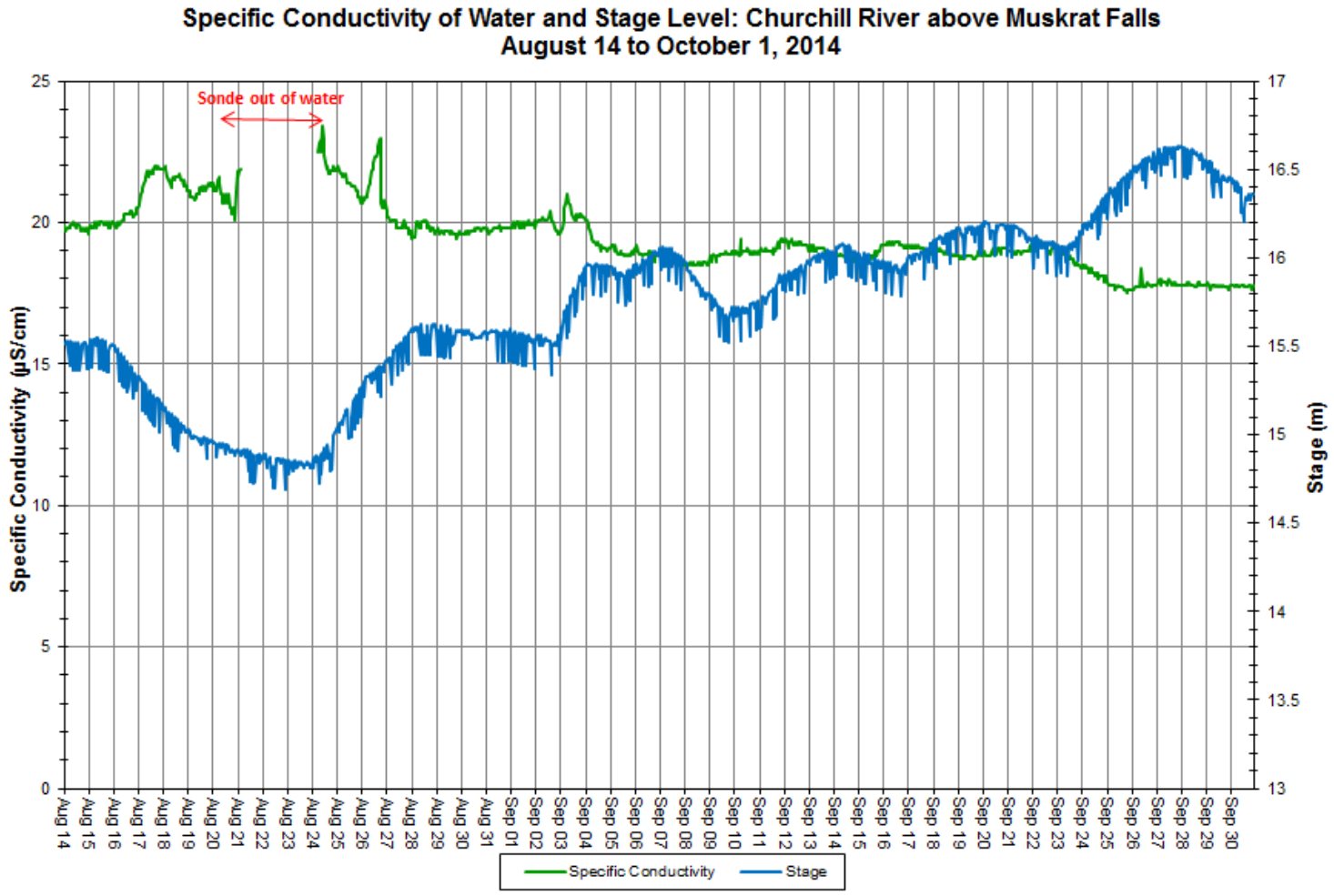

Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls

- Dissolved oxygen content ranges between 8.83mg/l and 11.35mg/l. The saturation of dissolved oxygen ranges from 93% to 101.1% (Figure 19).
- All values are above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l. Values taken during the first half of the deployment are below the CCME Guidelines for the Protection of Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 19.
- Dissolved oxygen content is steadily increasing throughout the deployment period. This trend is expected as the air and water temperatures are decreasing as fall approaches. (Figure 16).

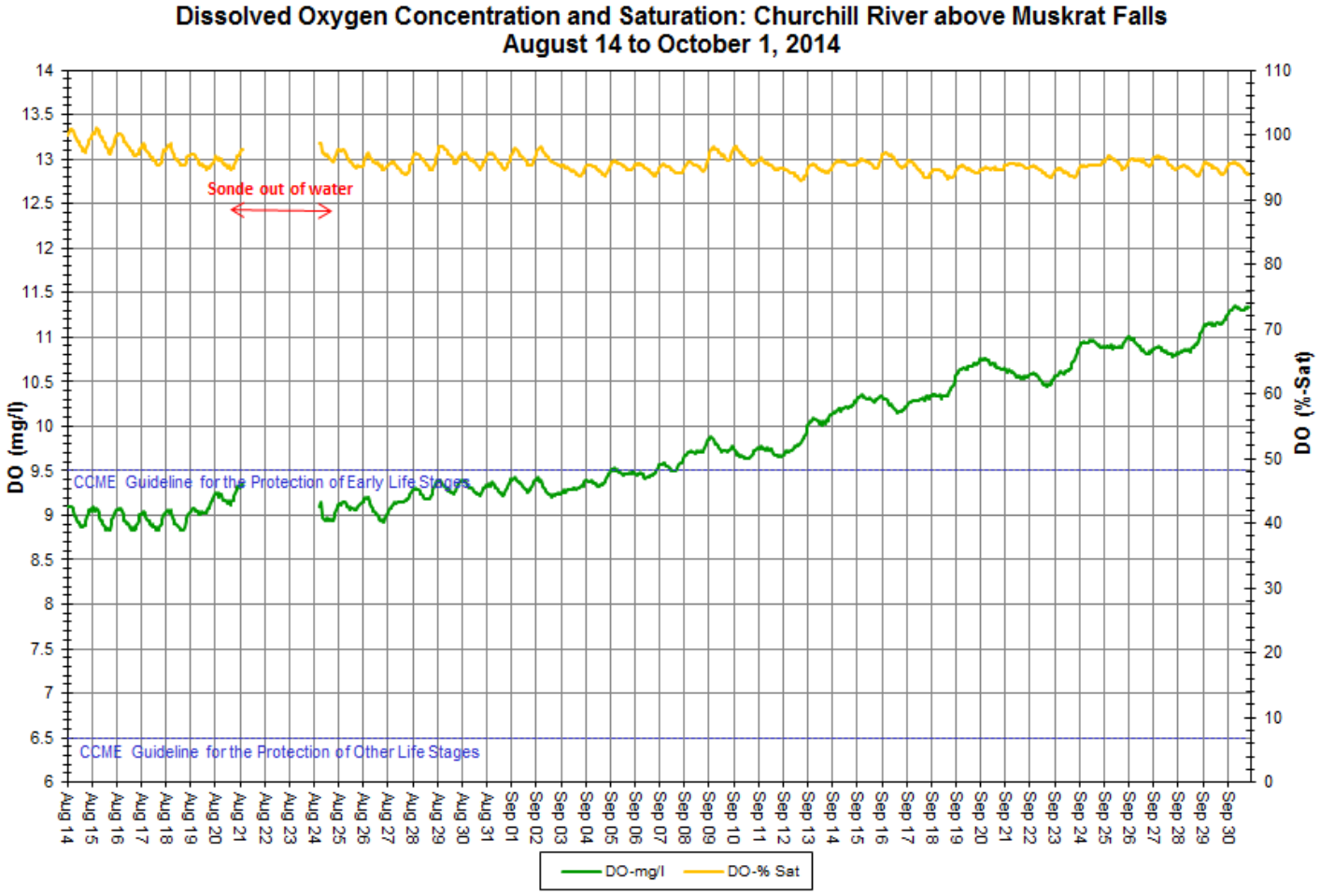

Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity ranges between 4.0NTU and 258.7NTU during the deployment (Figure 20). A median value of 29.9NTU suggests there is consistent natural background turbidity. This trend is typical at this station, though background values recorded were higher during this deployment than other deployment periods.
- Upon removal, the QA/QC ranking for the turbidity sensor was 'poor'. The field value was 73.4NTU while the QA/QC value was 6.1NTU. This discrepancy may be due to sedimentation of the sensor as the field turbidity reading had steadily increased for several days before removal.
- The majority of turbidity events are of small magnitude. The maximum value of 258.7NTU was a single elevated reading, and thus was likely due to debris passing the sensor. A gradual increase in turbidity September 15 to October 1 indicates there may be some fouling of the turbidity sensor by sediment or debris.

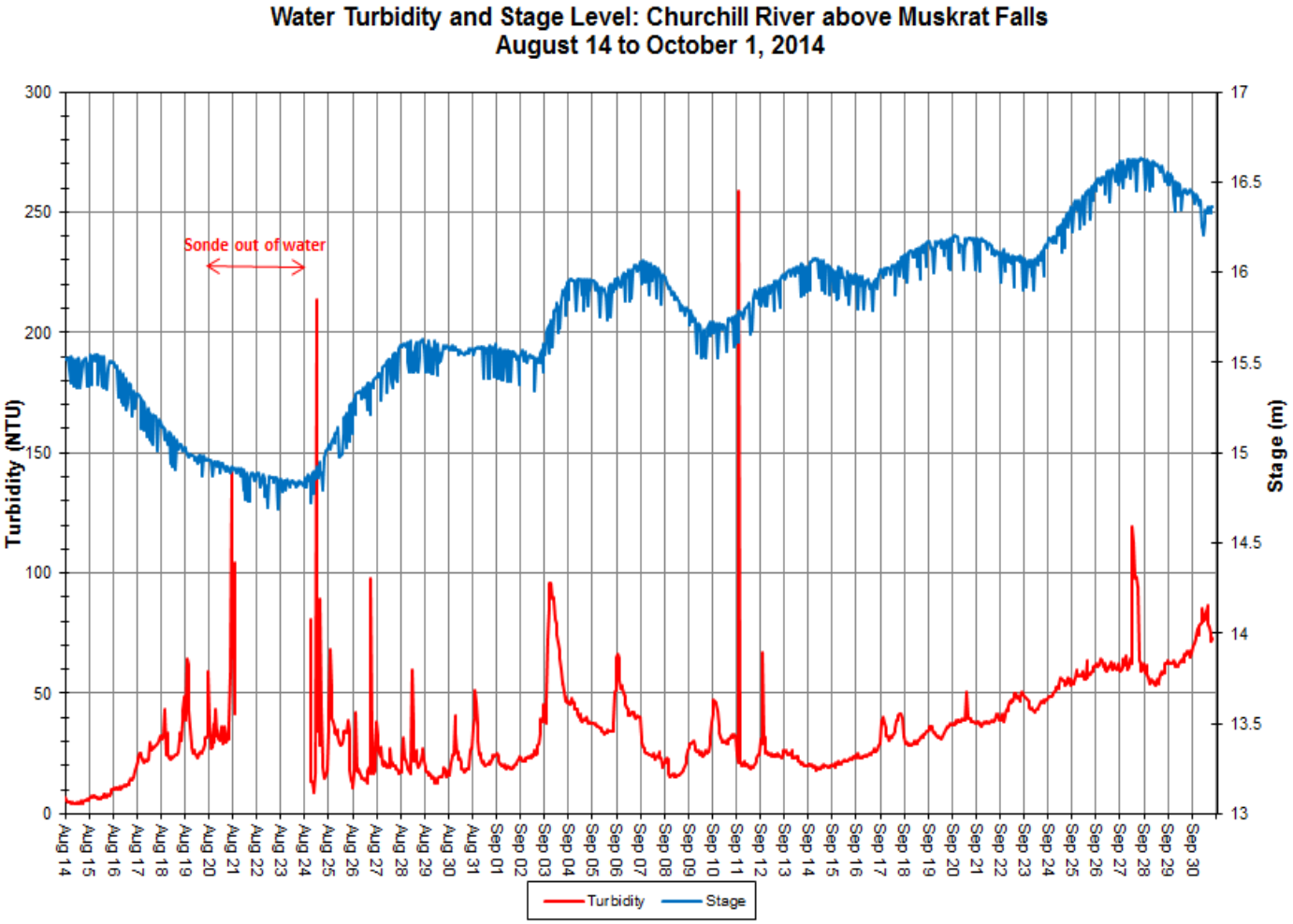

Figure 20: Turbidity and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). Stage is gradually increasing throughout the majority of the deployment period. Precipitation events led to increases in stage. Precipitation occurs on 30 days of the deployment period and amounts are generally low, with the exception of the largest event on September 3 with 54.6mm of rain. Stage ranges between 14.69m and 16.63m, a difference of 1.94m. Discharge ranges from 686m^3/s to 1670m^3/s.

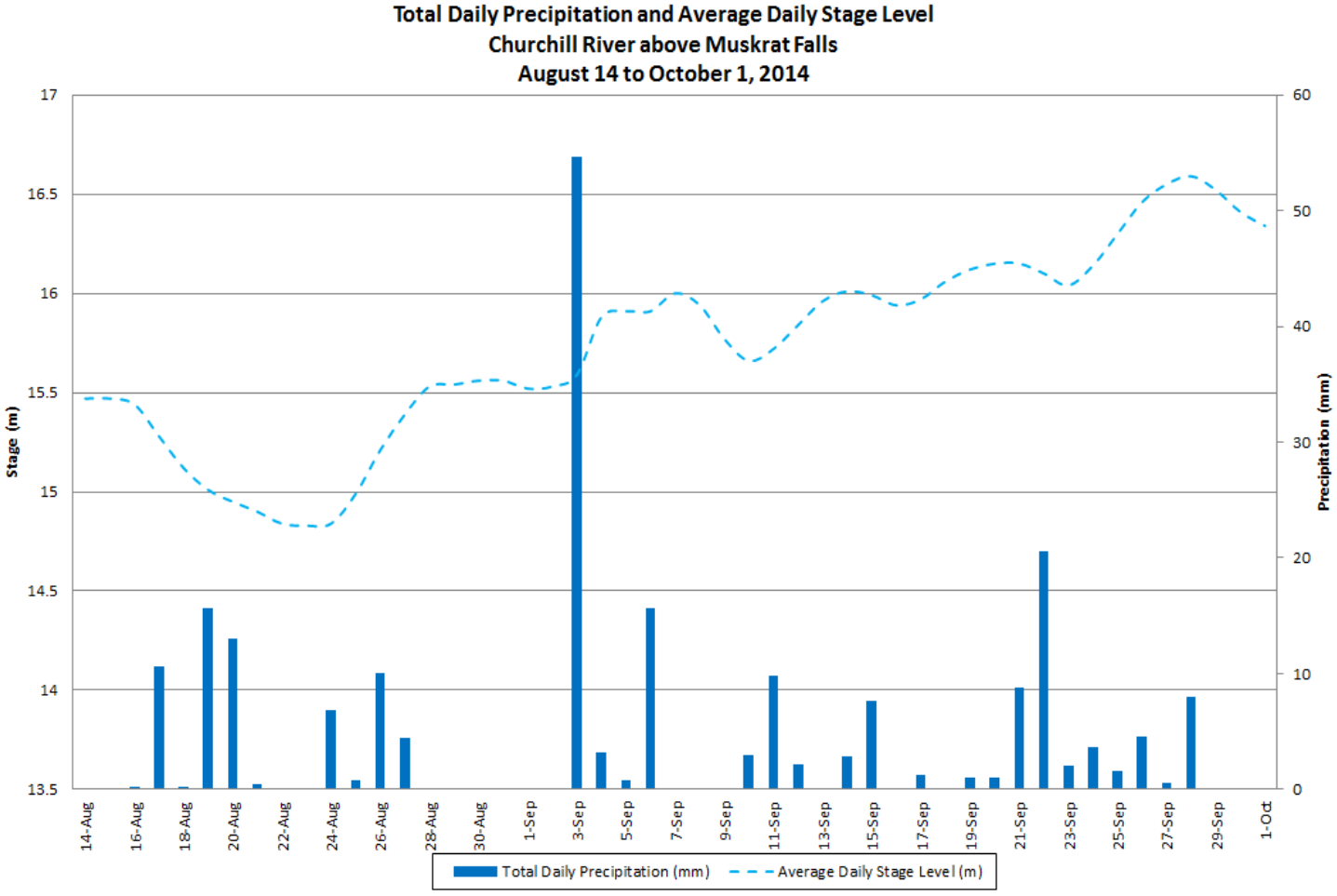

Figure 22: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- The sonde located at this station has been repeatedly buried in sand during 2014. When the station was visited by field staff on August 14, the decision to not redeploy the sonde was made as sand conditions in the area had not improved and the deployed sonde was again buried. Continued attempts to operate while buried in sand could cause serious damage to the instrument.
- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 23). Stage increases gradually during the deployment period. Precipitation occurs on 30 of the days in the deployment period and amounts are generally low, with the exception of the largest event on September 3 with 54.6mm of rain. Stage ranges between 1.45m and 2.89m, a difference of 1.44m.
- The photographs (Figure 24) show the extent of the sand in the area of the station on October 1, 2014. 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.

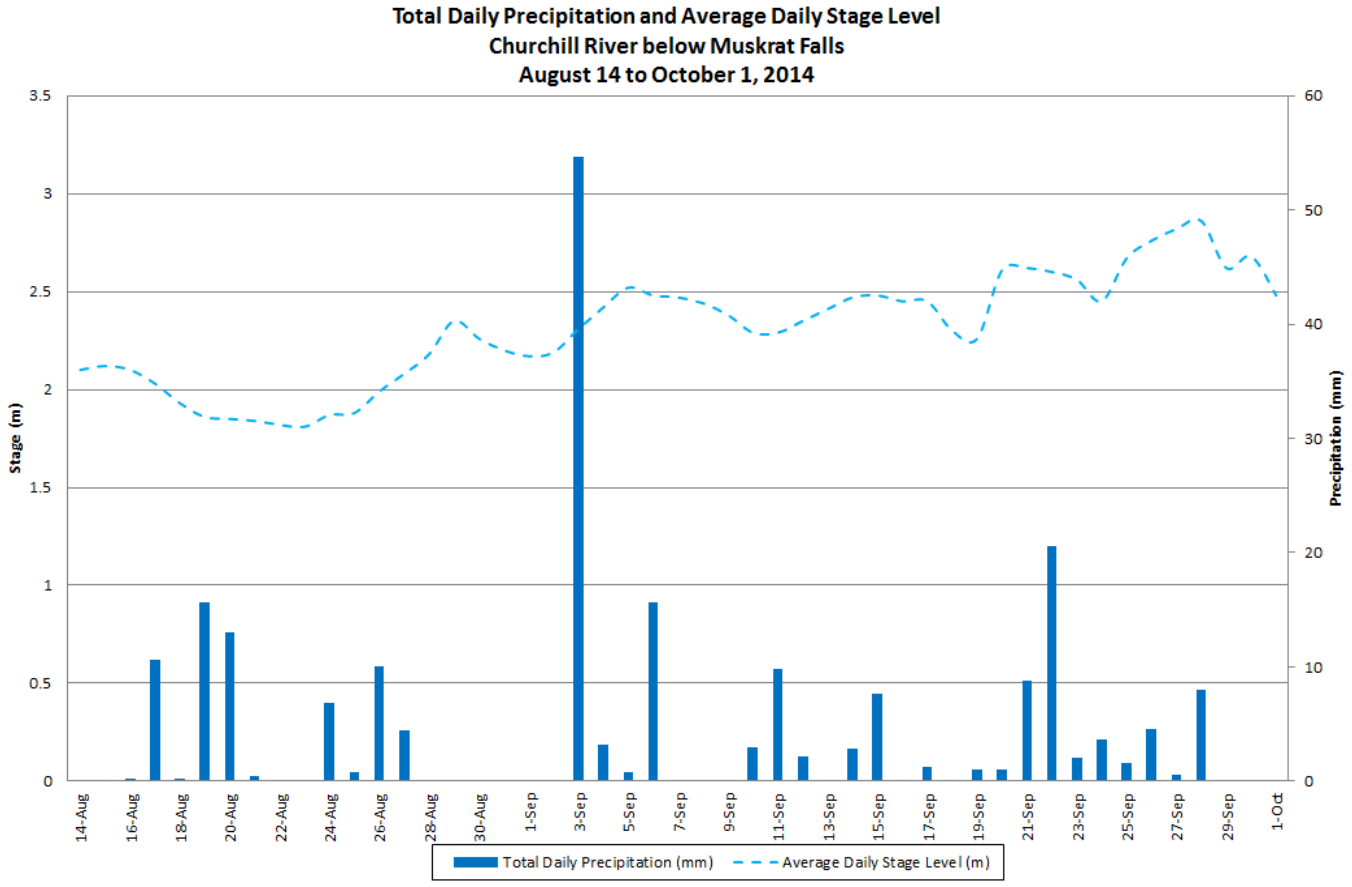

Figure 23: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

(a) **(b)**

(c)

(d)

Figure 24: Photographs of the below Lower Muskrat Falls station on October 1, 2014(a-d)

Churchill River at English Point

- Water temperature ranges from 6.50°C to 22.60°C during the deployment period (Figure 25).
- Water temperature is steadily decreasing throughout this deployment period. This trend is expected as ambient air temperatures cool in late summer and into the fall (Figure 26). Water temperature fluctuates diurnally.

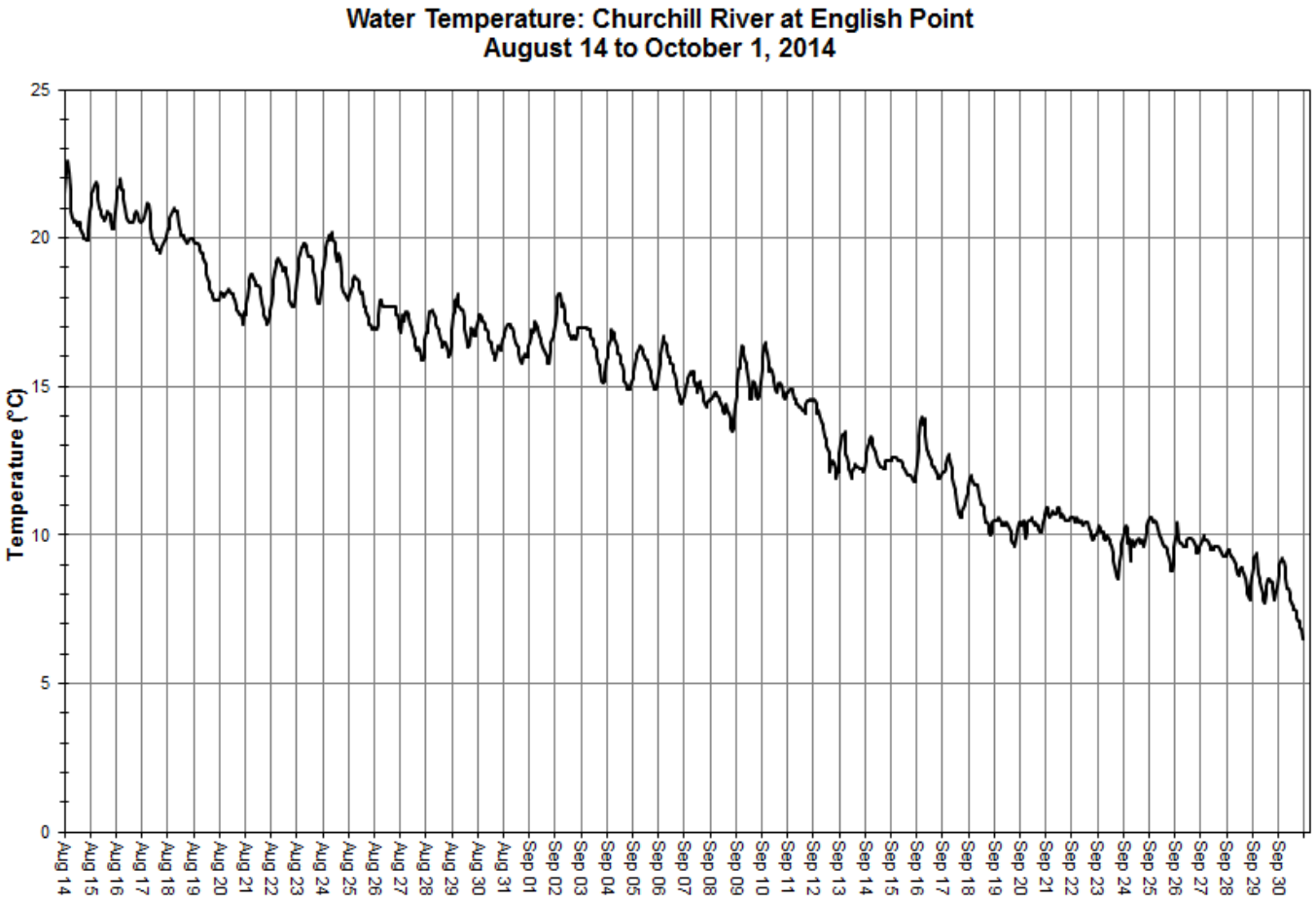

Figure 25: Water temperature at Churchill River at English Point

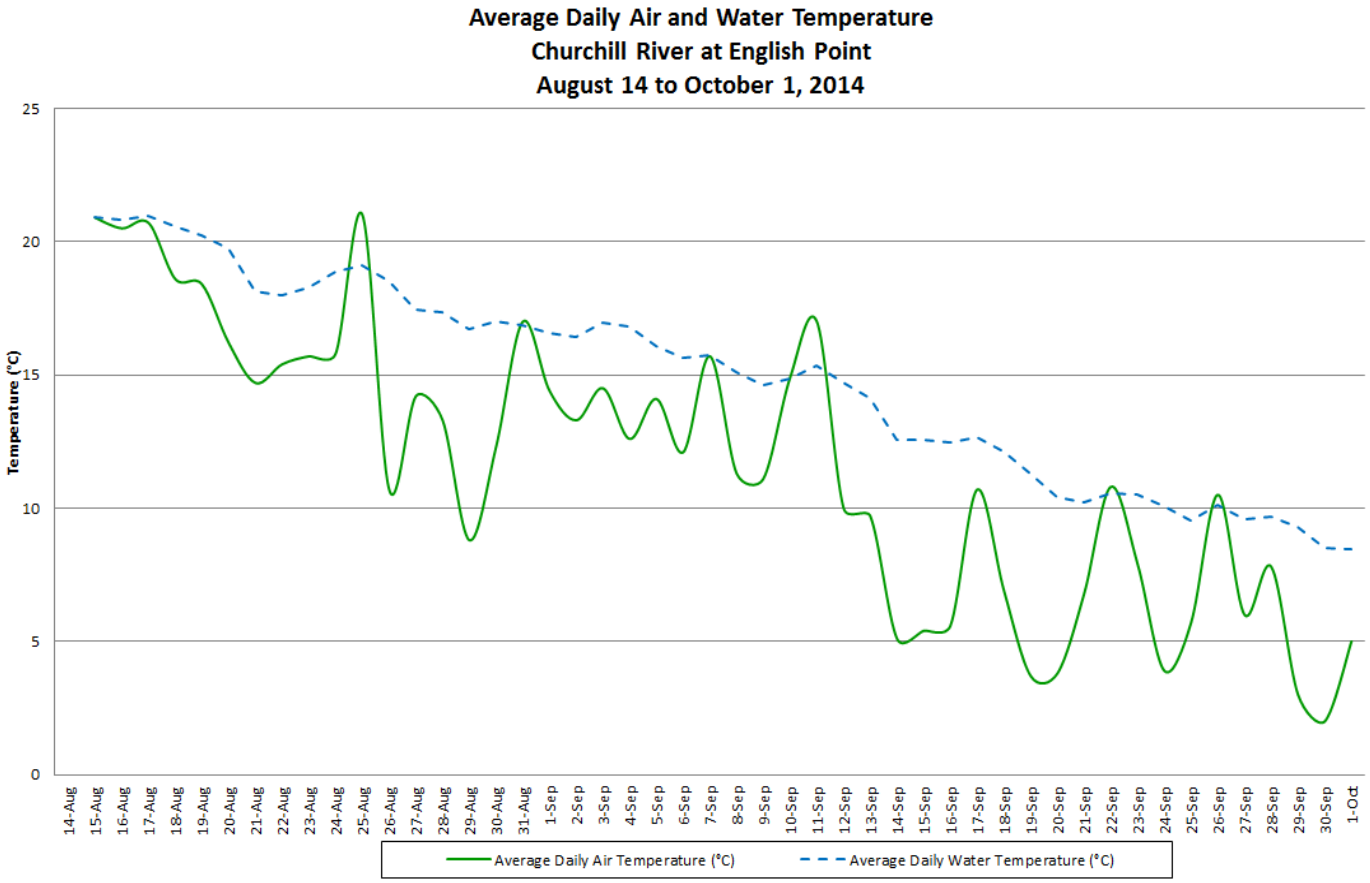

Figure 26: Average daily air and water temperature at Churchill River at English Point

(weather data recorded at Goose Bay)

- pH ranges between 6.55 and 7.51 pH units during the deployment period (Figure 27).
- All pH values recorded are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 27).

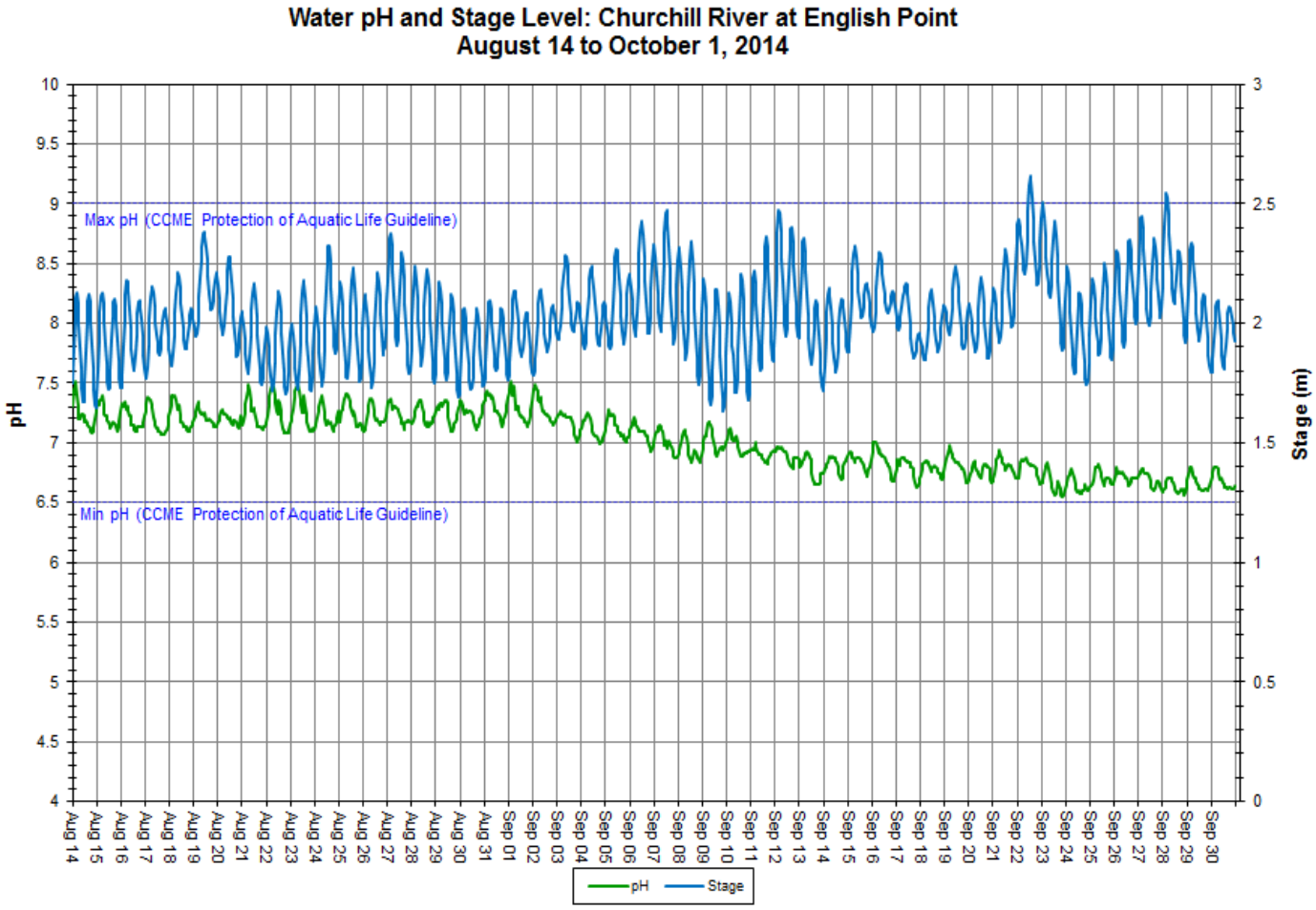

Figure 27: pH and stage level at Churchill River at English Point

- Specific conductance ranged between 20.6µS/cm and 69.7µS/cm during the deployment period, with a median of 32.3µS/cm (Figure 28).
- 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.

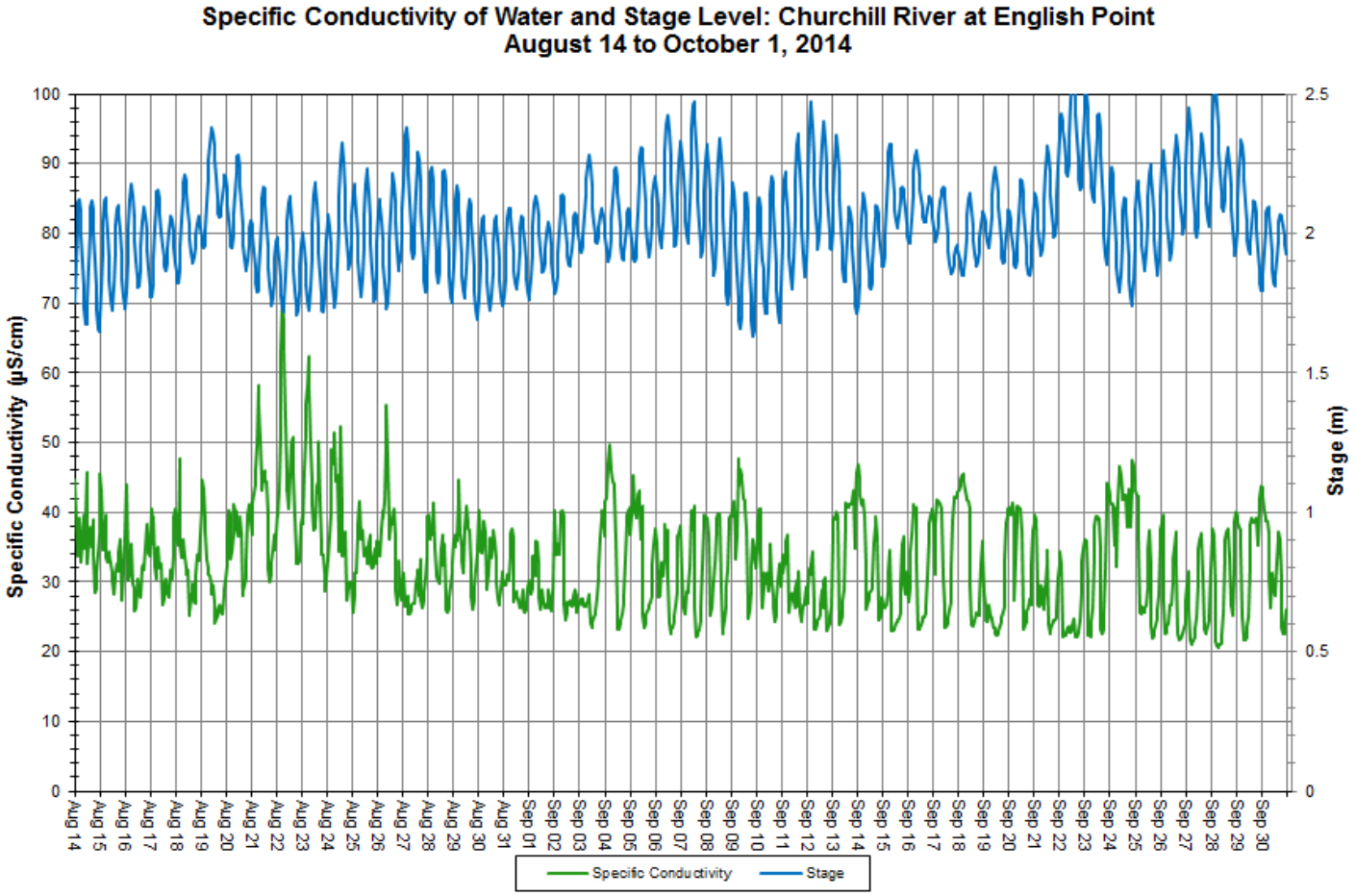

Figure 28: Specific conductivity and stage level at Churchill River at English Point

- Dissolved oxygen content ranges between 8.72mg/l and 11.75mg/l during the deployment period. The saturation of dissolved oxygen ranges from 85.4% to 109.5% (Figure 29).
- The majority of 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 29. The values dropped below the Early Life Stages Guideline when the water was warm and could carry less oxygen.
- 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 fall approaches and colder air can hold more oxygen (Figure 26).

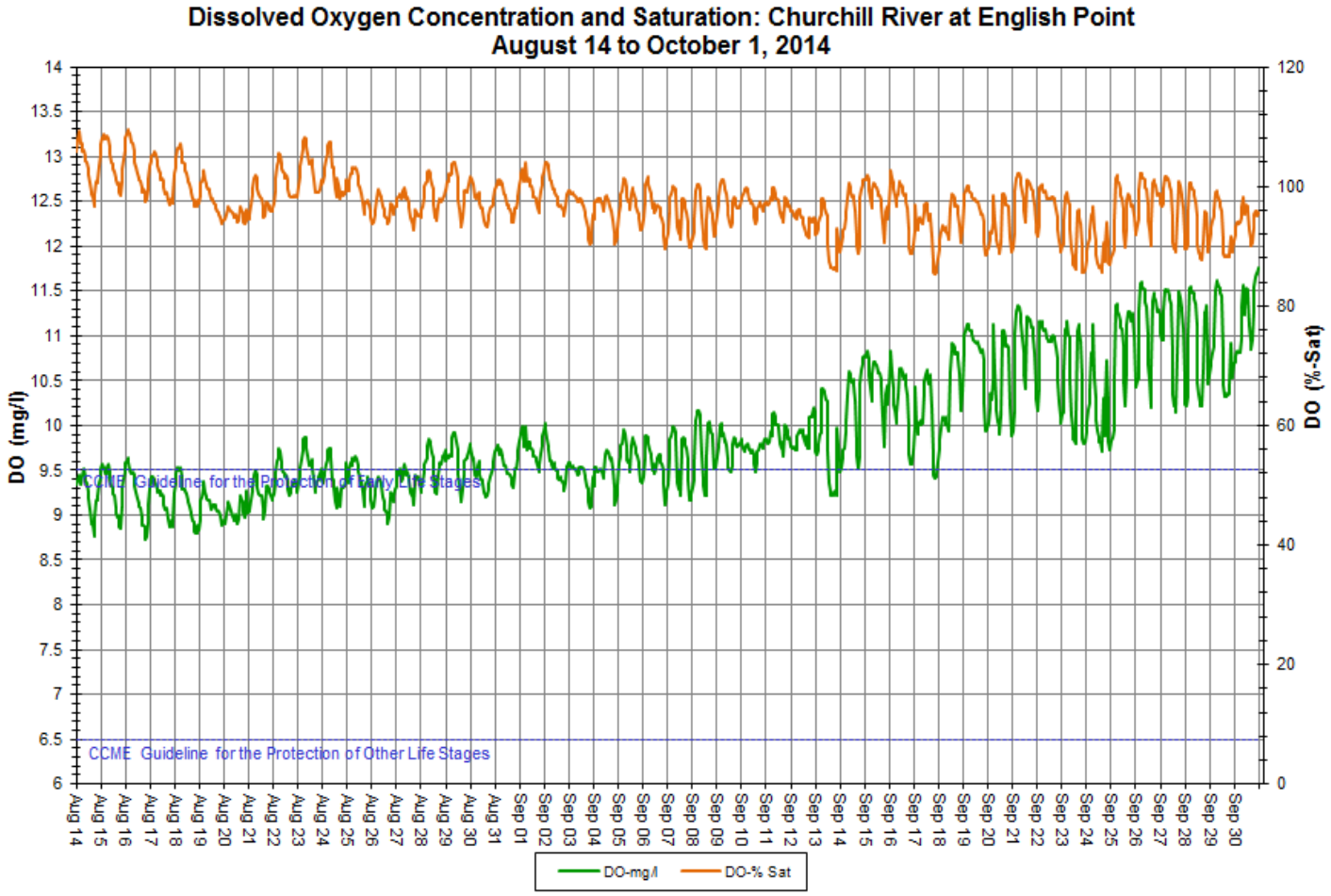

Figure 29: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity ranges from 3.6NTU to 81NTU during the deployment period (Figure 30).
- Turbidity increases on September 9th and 10th occur at the same time as the lowest stage values recorded during this deployment, indicating that the high turbidity values are likely due to the low stage levels at this time, possibly from sediment being suspended into the water column by wave action.

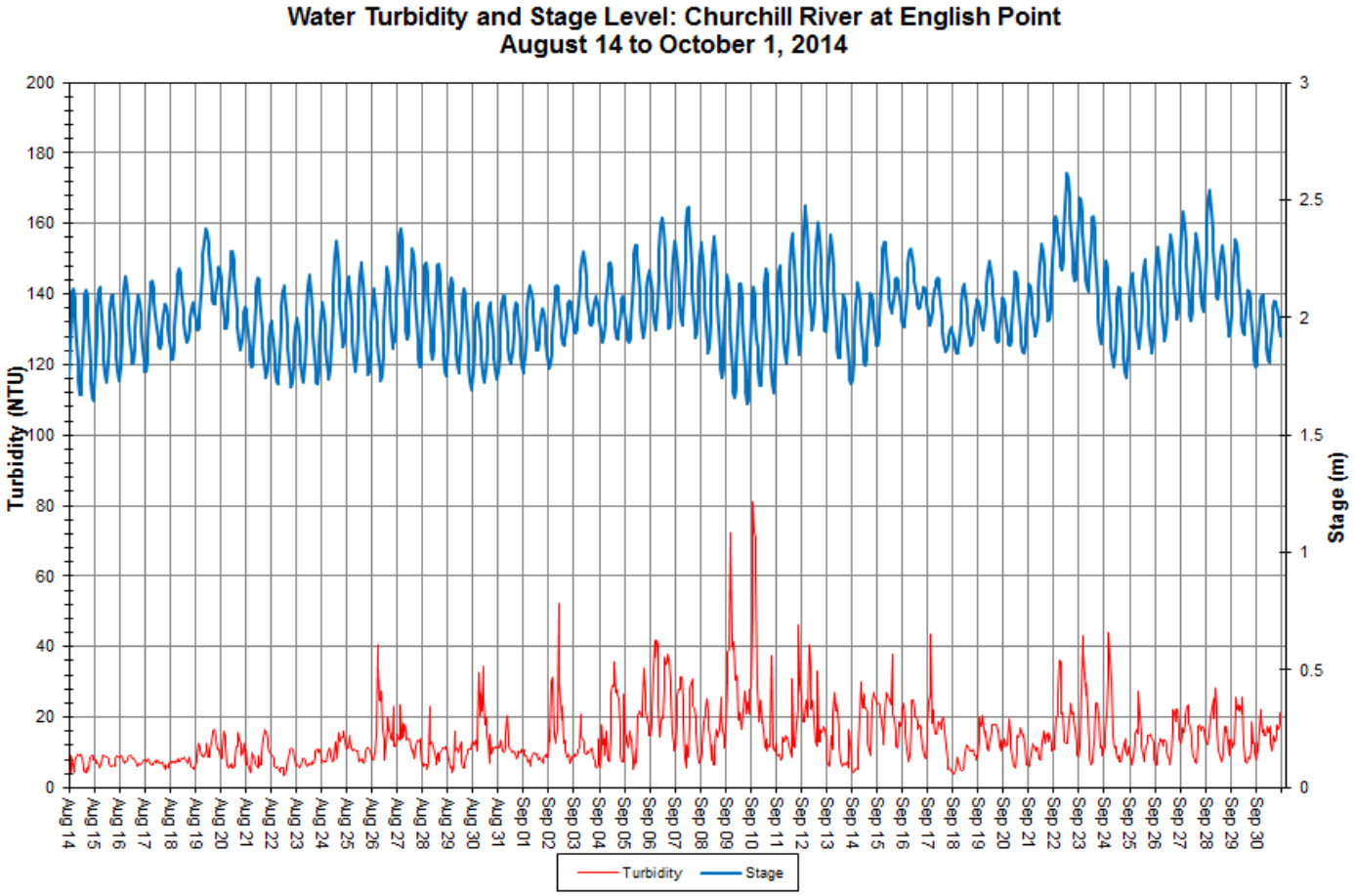

Figure 30: Turbidity and stage level at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 31). Stage is fluctuating throughout the deployment period, with a gradual increase during the last week of September. Precipitation occurs on 30 days during the deployment period and amounts are small in magnitude, with the exception of the largest event on September 3 with 54.6mm of rain. Stage ranges between 1.63m and 2.62m, a difference of 0.99m.

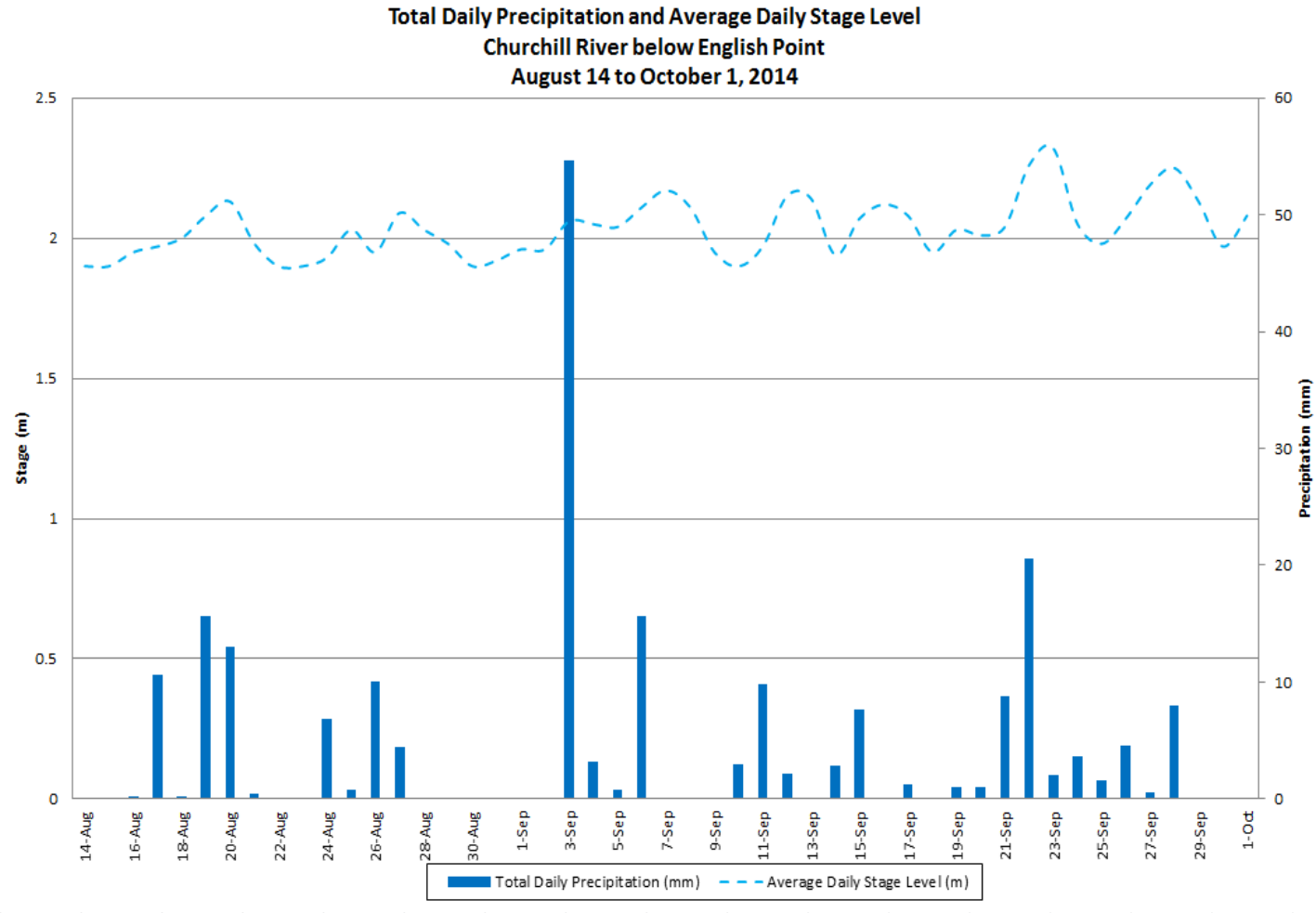

Figure 31: Daily precipitation and average daily stage level at Churchill River at English Point (weather data recorded at Goose Bay)

Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from August 12/14 to September 30/October 1, 2014. The below Lower Muskrat Falls station was 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 0.74m and 1.94m.
- Water temperature was decreasing gradually at all stations throughout the deployment period due to the decreasing ambient air temperatures in the region as the fall season approaches. Water temperature typically ranged between 6.40°C and 22.60°C.
- pH is generally neutral and stable at stations along the Lower Churchill River ranging between 6.52 and 7.51 pH units. All pH values at all stations were within the recommended CCME Guidelines for the Protection of Aquatic Life.
- 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 17.5µS/cm and 23.4µS/cm at the stations below Metchin River, below Grizzle Rapids and above Muskrat Falls. Specific conductivity values at the station at English Point ranged higher at 20.6µS/cm to 69.7µS/cm .
- Dissolved oxygen content was constantly increasing throughout the deployment period as it is inversely related to water temperatures, which were warm at the beginning of deployment and gradually cooled. Values ranged between 8.70mg/l and 11.75mg/l. All values were above the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages at 6.5mg/l, but dipped below the Guideline for Early Life Stages of 9.5mg/l when water temperatures were high.
- Turbidity data at the stations below Metchin River and below Grizzle Rapids remained mostly at 0NTU throughout the deployment period which is typical of these stations. Turbidity values at the stations above Muskrat Falls and at English Point were typical for the stations, reporting background values of 29.9NTU and 11.6NTU respectively.

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