Real-Time Water Quality Deployment Report

Lower Churchill River Network

July 24 to
August 21-22, 2012

Newfoundland Labrador

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

Contents

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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 July 24, 2012, real-time water quality monitoring instruments were deployed at the four Lower Churchill River Stations for a period of 28-29 days. Instruments were removed on August 21-22.

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 > 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 July 24 to August 21-22, 2012 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, July 24 – August 21-22, 2012

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45701)	Jul 24, 2012	Deployment	Excellent	Poor	Excellent	Excellent	Excellent
	Aug 21, 2012	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Below Grizzle Rapids (45042)	Jul 24, 2012	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	Aug 21, 2012	Removal	Excellent	Poor	Excellent	Excellent	Excellent
Above Muskrat Falls (47589)	Jul 24, 2012	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Aug 21, 2012	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Below Muskrat Falls (47590)	Jul 24, 2012	Deployment	Excellent	Poor	Excellent	Excellent	Poor
	Aug 22, 2012	Removal	Excellent	Good	Excellent	n/a*	Poor

*Comparison ranking unavailable due to sensor malfunction on the QAQC instrument

- At the station below Metchin River, temperature, specific conductivity, dissolved oxygen and turbidity all ranked 'excellent' while pH ranked 'poor'. For pH, the field sonde read a value of 6.80 and the QAQC instrument read a value of 7.87. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. The QAQC instrument continued to read high pH values for the remainder of the day and this discrepancy is noted at other stations downstream. At removal, all parameters ranked 'excellent'.
- At the station below Grizzle Rapids, all parameters ranked either 'good' or 'excellent' at deployment. At removal, temperature, specific conductivity, dissolved oxygen and turbidity all ranked 'excellent' while pH ranked 'poor'. For pH, the field sonde read a value of 7.33 and the QAQC instrument read a value of 6.30. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period.
- At the station above Muskrat Falls, all parameters ranked either 'good' or 'excellent' at deployment and removal.
- At the station below Muskrat Falls, temperature, specific conductivity, and dissolved oxygen all ranked 'excellent' while pH and turbidity both ranked 'poor'. For pH, the field instrument read a value of 6.75 and the QAQC instrument read a value of 7.86. This difference is likely related to insufficient stabilization time for the field instrument at the beginning of the deployment period. The QAQC instrument continued to read high pH values for the remainder of the day and this discrepancy is noted at other stations visited on that day. For turbidity, the field instrument read a value of 21.9NTU and the QAQC instrument read a value of 43.1NTU. This discrepancy may in part be caused by the disturbance of silt on the bottom of the river bed at this station. At removal, temperature, pH, and specific conductivity all ranked either 'good' or 'excellent' while dissolved oxygen was not ranked and turbidity was ranked 'poor'. For dissolved oxygen,

the field instrument read a value of 10.43mg/l however a comparison reading from the QAQC instrument was unavailable due to sensor malfunction. For turbidity, the field instrument read a value of 23.3NTU and the QAQC instrument read a value of 3.3NTU. This discrepancy may in part be caused by the disturbance of silt on the bottom of the river bed at this station.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from July 24 to August 21-22 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.

Churchill River below Metchin River

- Water temperature ranges from 16.60°C to 18.70°C during the deployment period (Figure 1).
- Water temperature is generally stable throughout the deployment period. This trend is expected due to the consistently warm air temperatures in the summer season (Figure 2). Water temperature fluctuates diurnally.

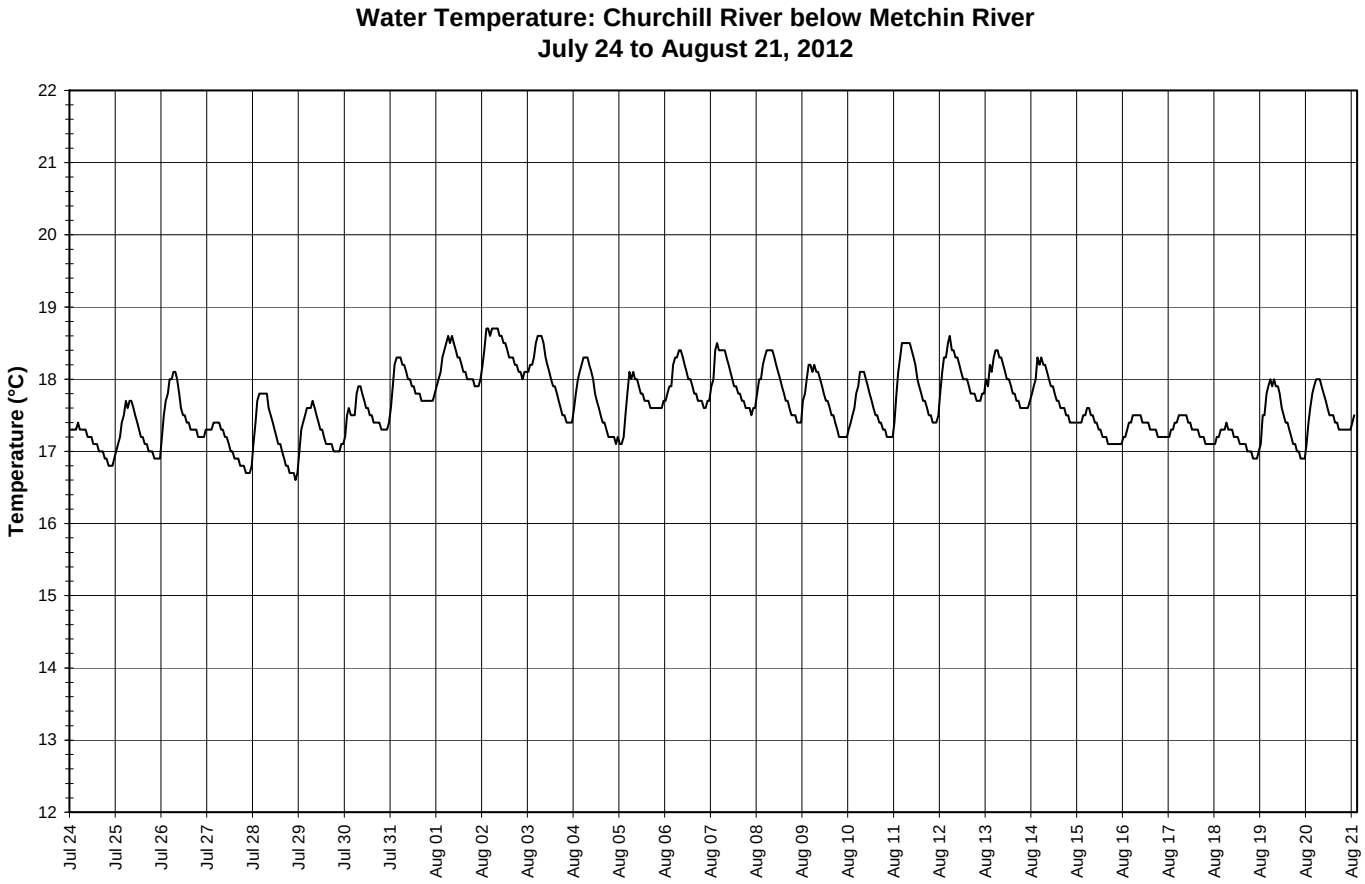

Figure 1: Water temperature at Churchill River below Metchin River

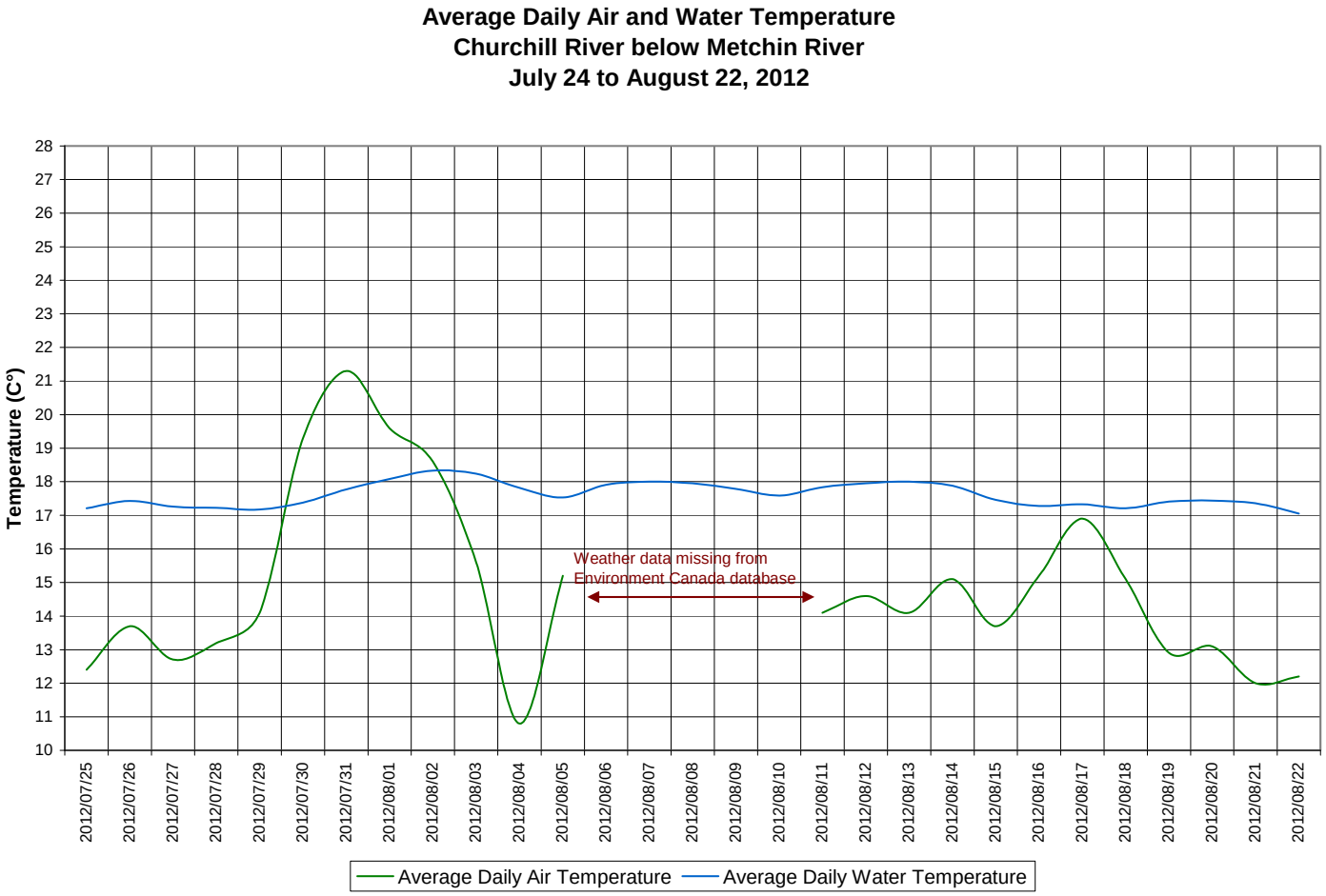

Figure 2: Average daily air and water temperature at Churchill River below Metchin River (weather data recorded at Churchill Falls, NL)

- pH ranges between 6.94 and 7.15 pH units and remains very 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).

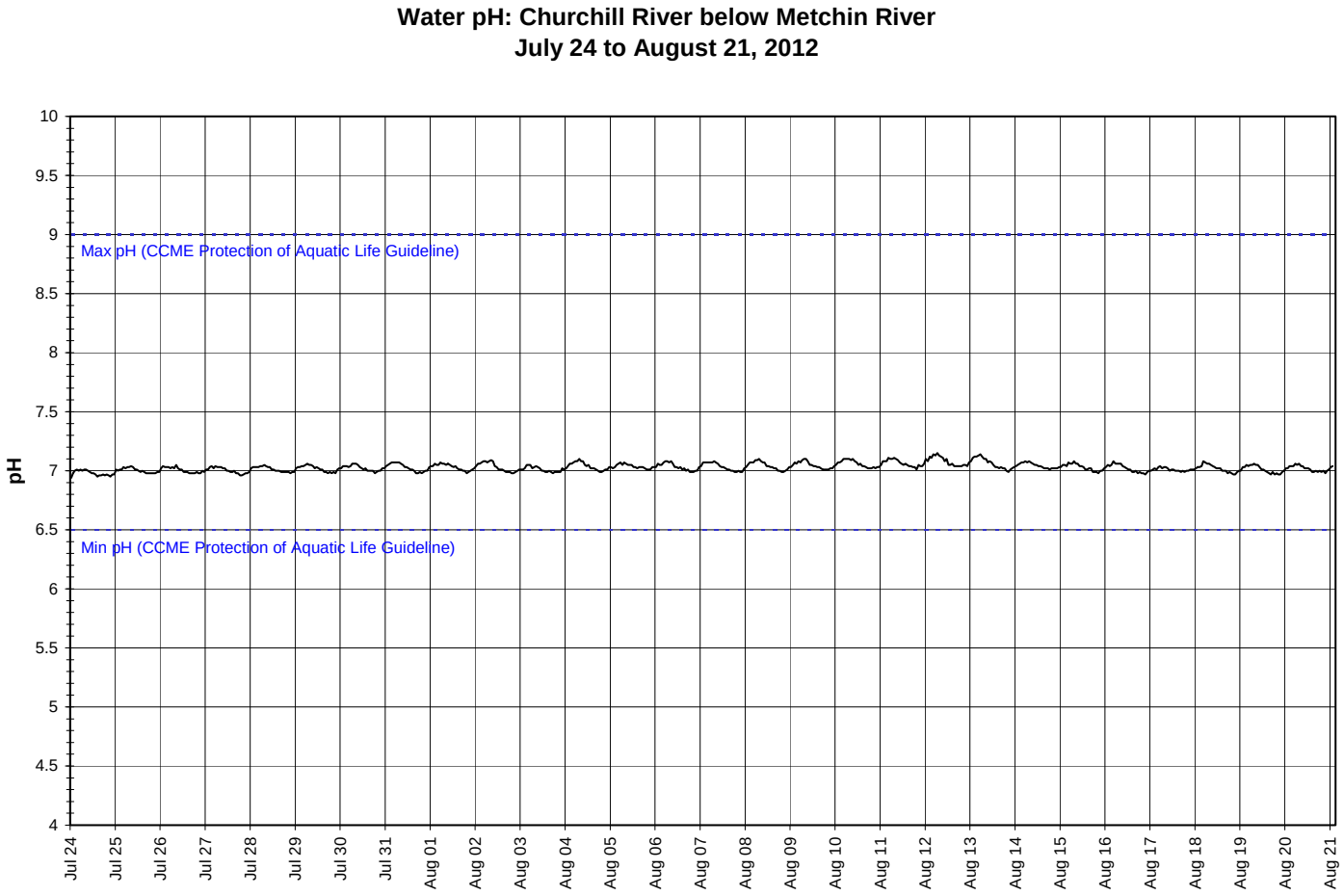

Figure 3: pH at Churchill River below Metchin River

- Specific conductivity generally ranges between 21.2 to 24.5µS/cm during the deployment period, averaging 22.8µS/cm (Figure 4).
- Specific conductivity is generally increasing throughout the deployment period.
- There are 2 instances where specific conductivity increase above this typical range for a 1 hour period. Specific conductivity increases to 25.5µS/cm on August 6 and to 49.5µS/cm on August 9. It is unknown what caused these increases.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is generally decreasing throughout the deployment period with some fluctuations, increasing near the end. As stage decreases, specific conductivity generally increases due to the increasing concentrations of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

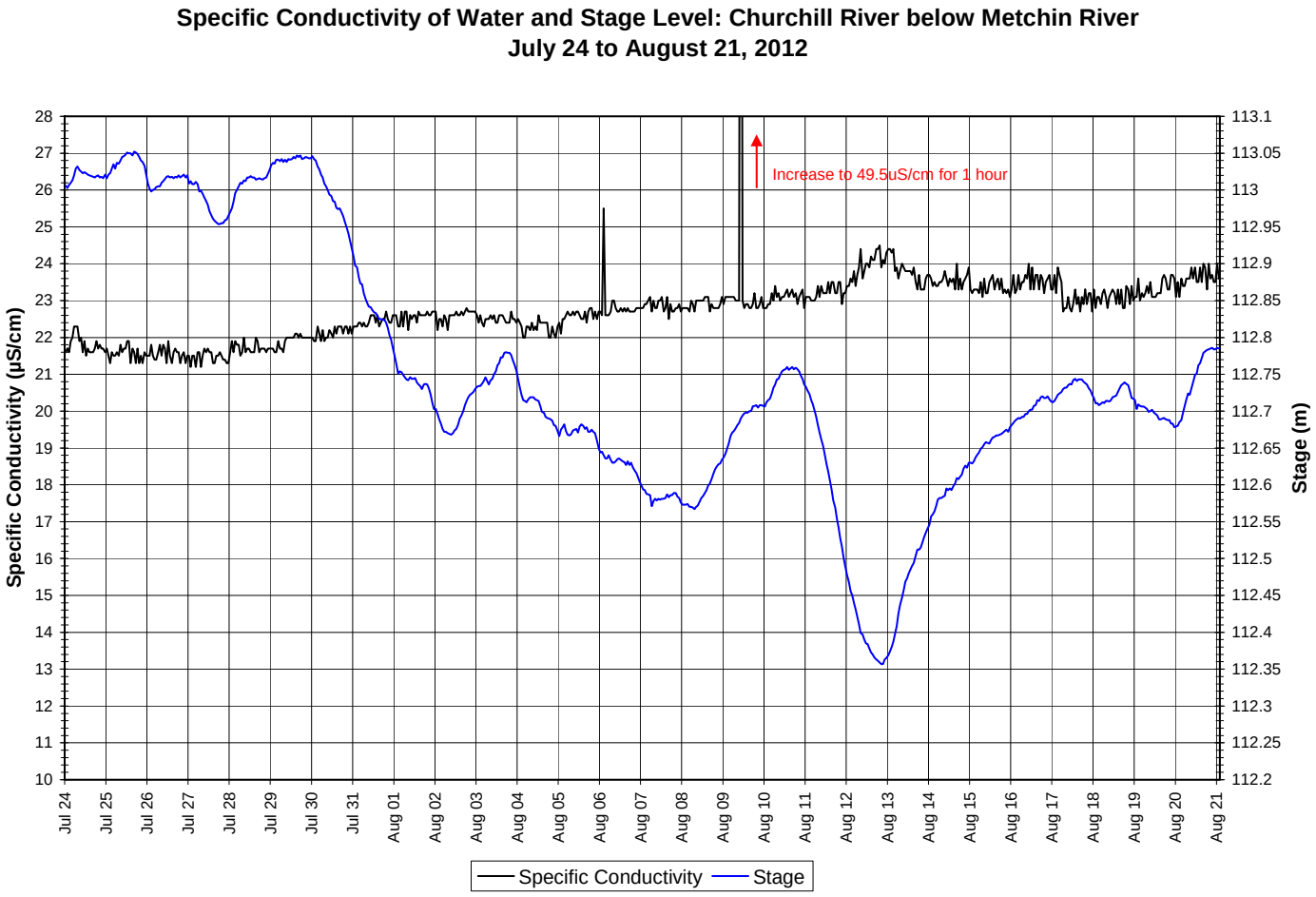

Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 93.4 to 99.3% and a range of 8.99 to 9.34mg/l was found in the concentration of dissolved oxygen with a median value of 9.17mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l. All values were just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is very stable throughout the deployment period. This trend is expected given the consistent air and water temperatures (Figure 2).

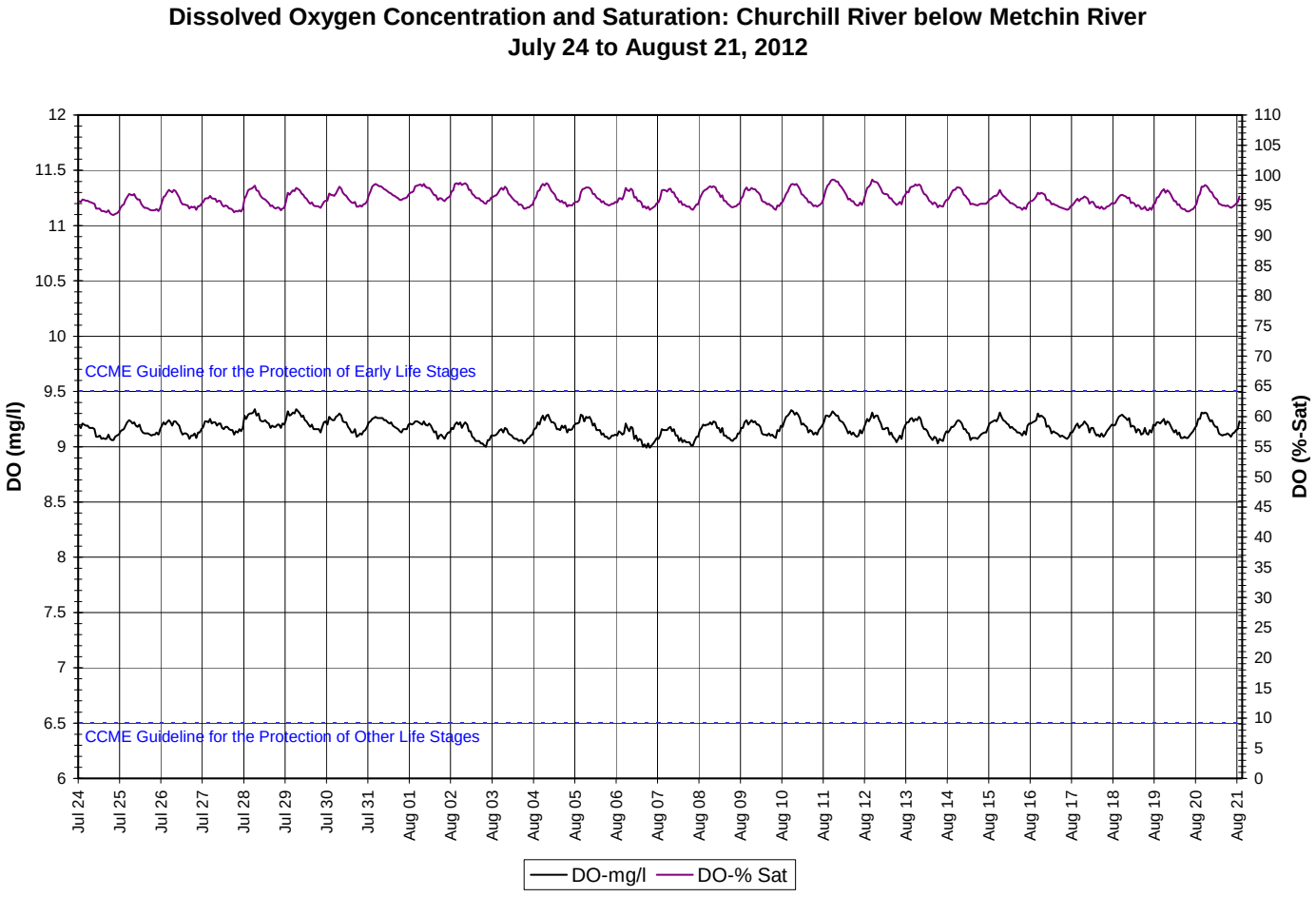

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- Turbidity generally remains at 0NTU for the entirety of the deployment period (Figure 6). A median value of 0NTU indicates there is no natural background turbidity value at this station.
- There are three instances when turbidity increases above 0NTU, each time lasting only for an hour. These increases are infrequent and of low magnitude (<15.5NTU).

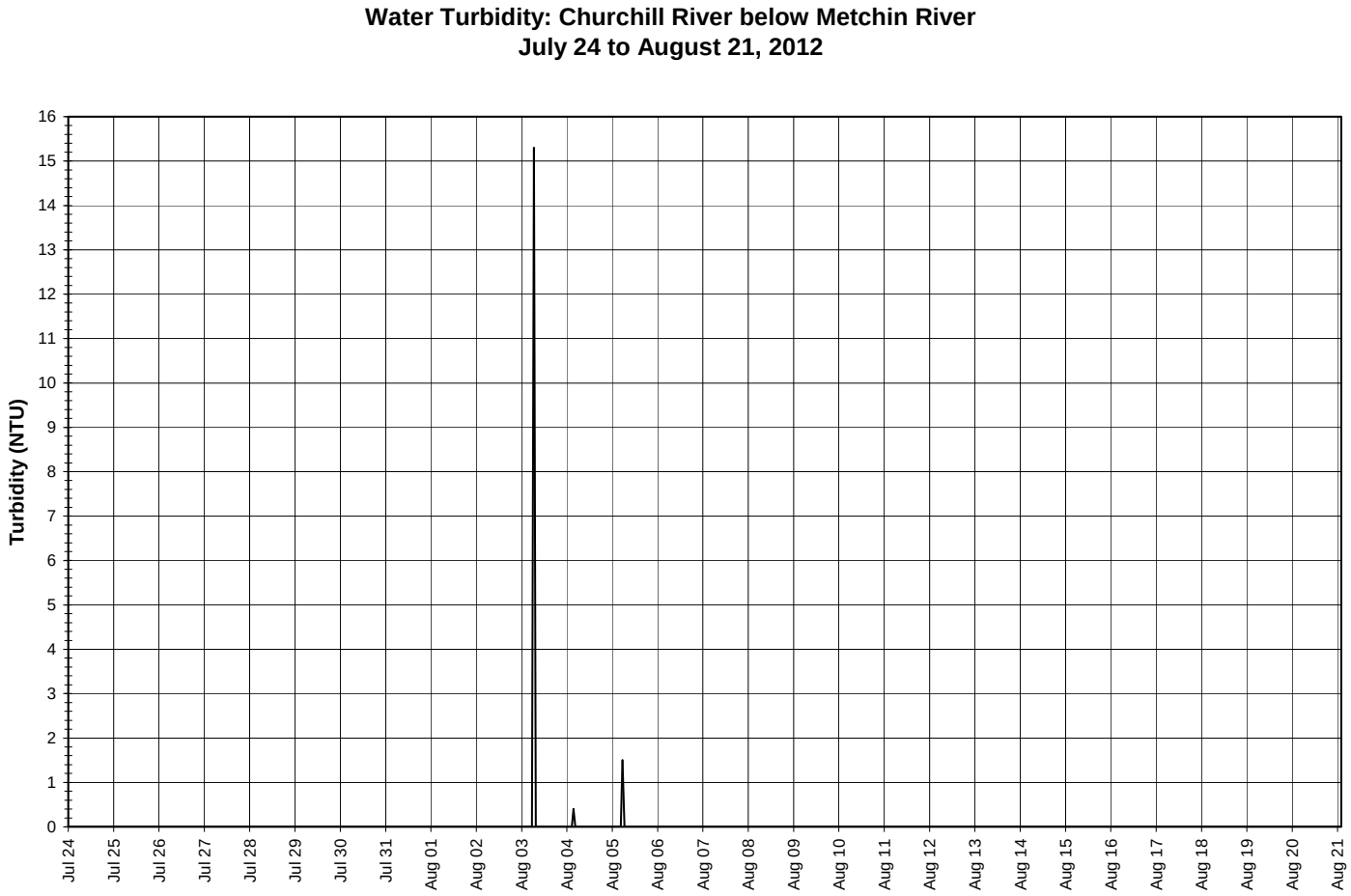

Figure 6: Turbidity at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is generally decreasing throughout the deployment period with some fluctuations and increasing near the end. Precipitation records vary. Stage ranges between 112.36and 113.05m, a difference of 0.69m.

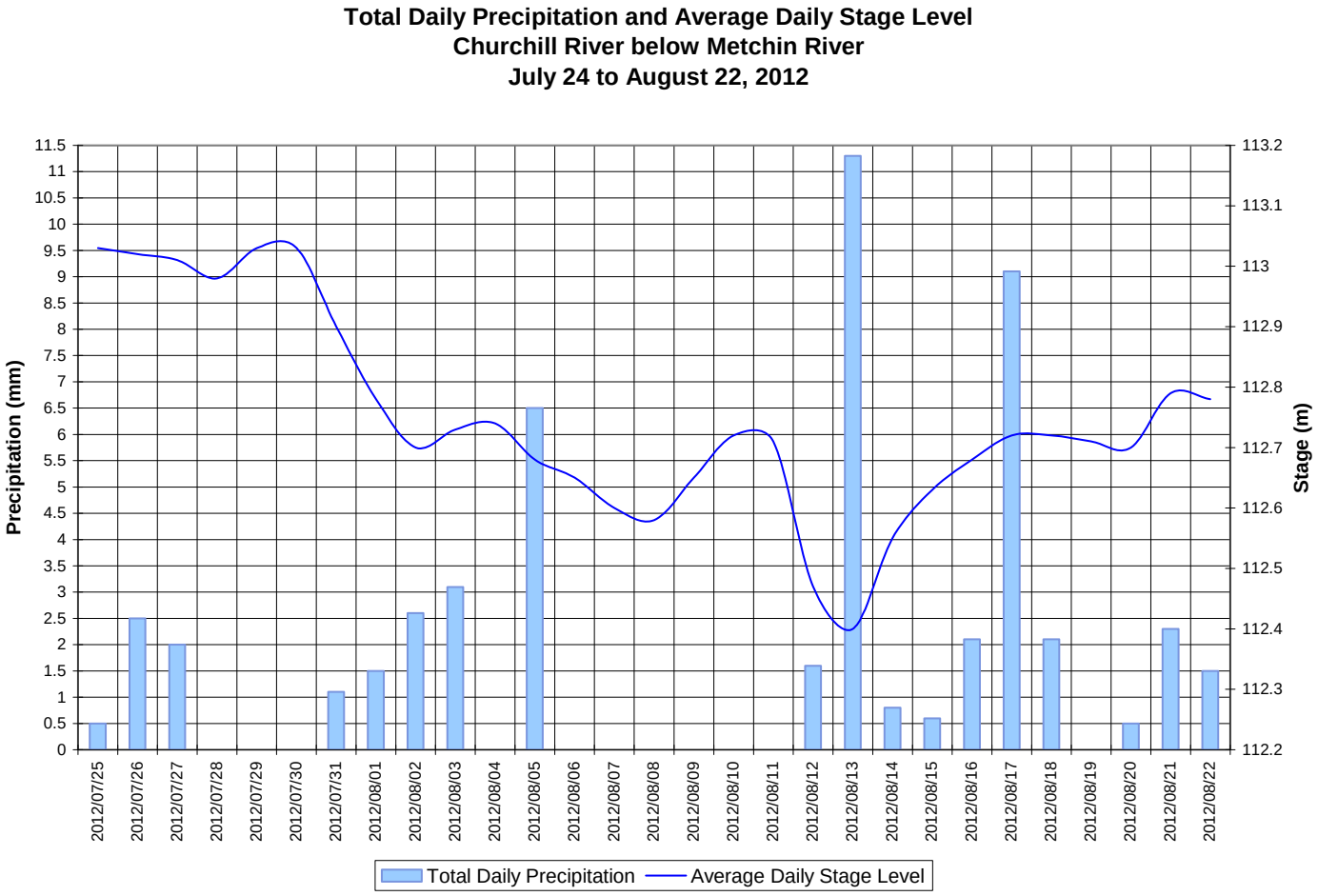

Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River

(weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- Water temperature ranges from 16.50 to 20.00^{o}C during the deployment period (Figure 8).
- Water temperature is stable throughout the deployment period. This trend is expected due to the consistent warm ambient air temperatures in the summer season (Figure 9). Water temperature fluctuates diurnally.

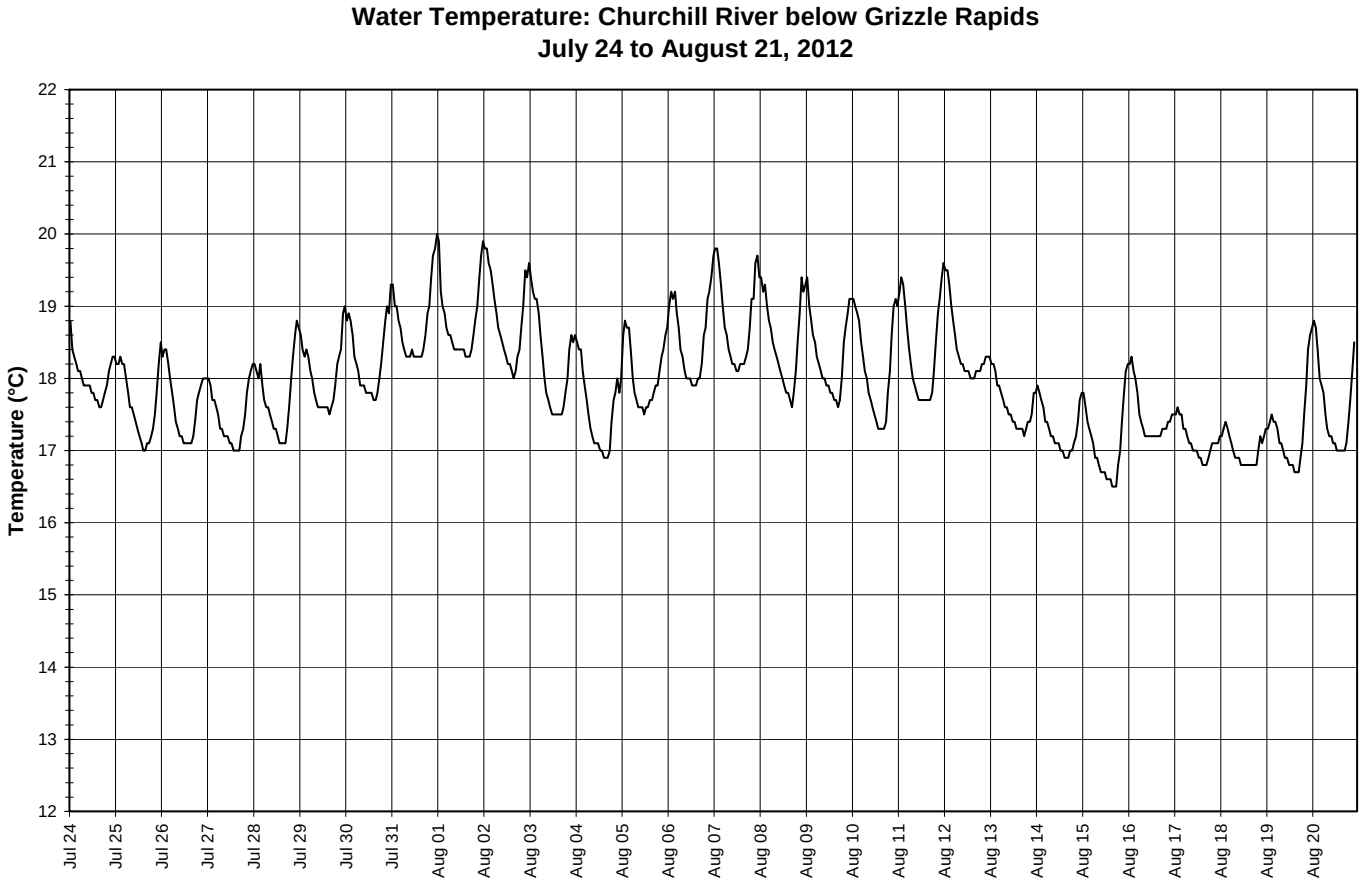

Figure 8: Water temperature at Churchill River below Grizzle Rapids

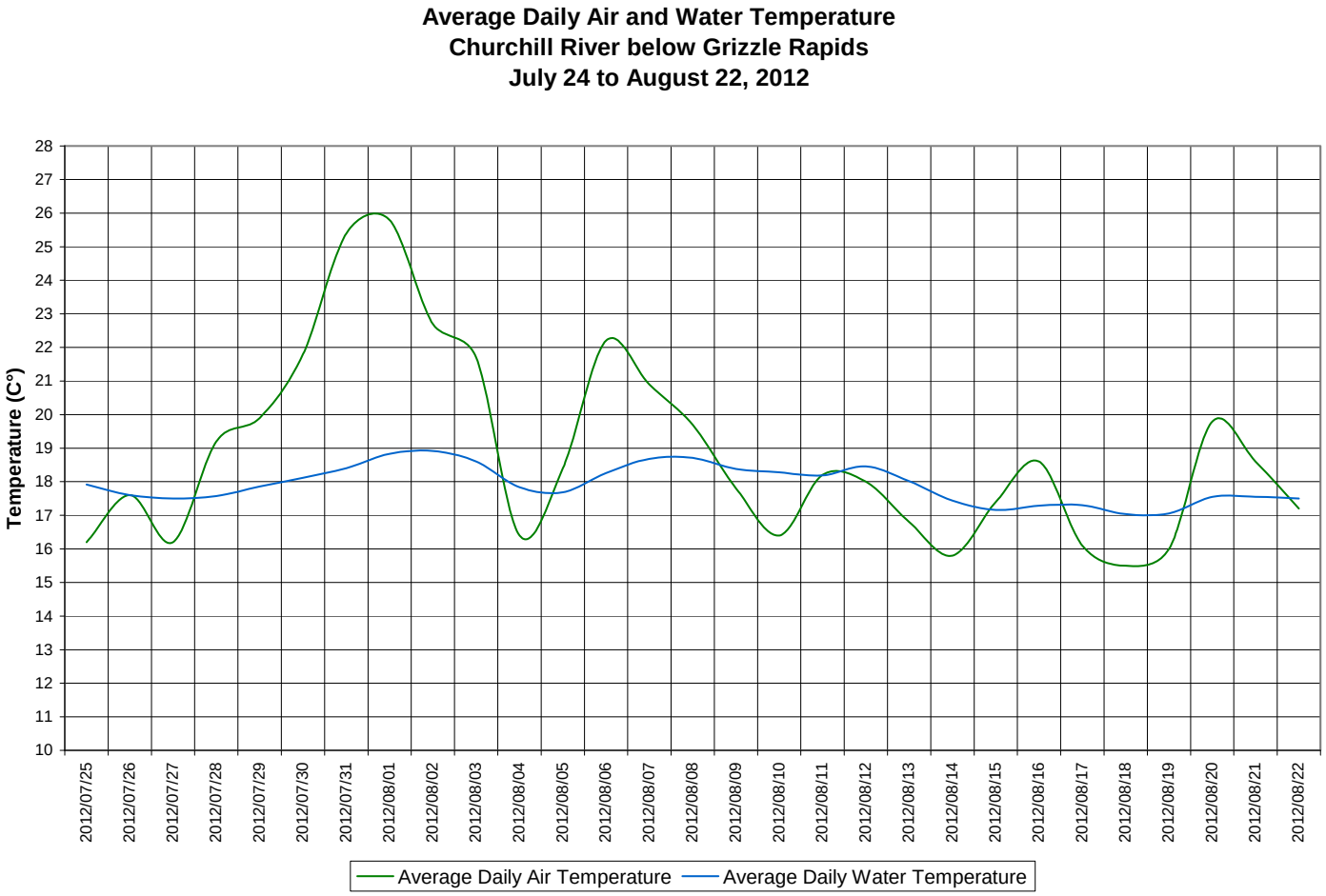

Figure 9: Average daily air and water temperature at Churchill River below Grizzle Rapids

(weather data recorded at Goose Bay)

- pH ranges between 7.08 and 7.37 pH units and remains very consistent throughout the deployment period (Figure 10).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10).

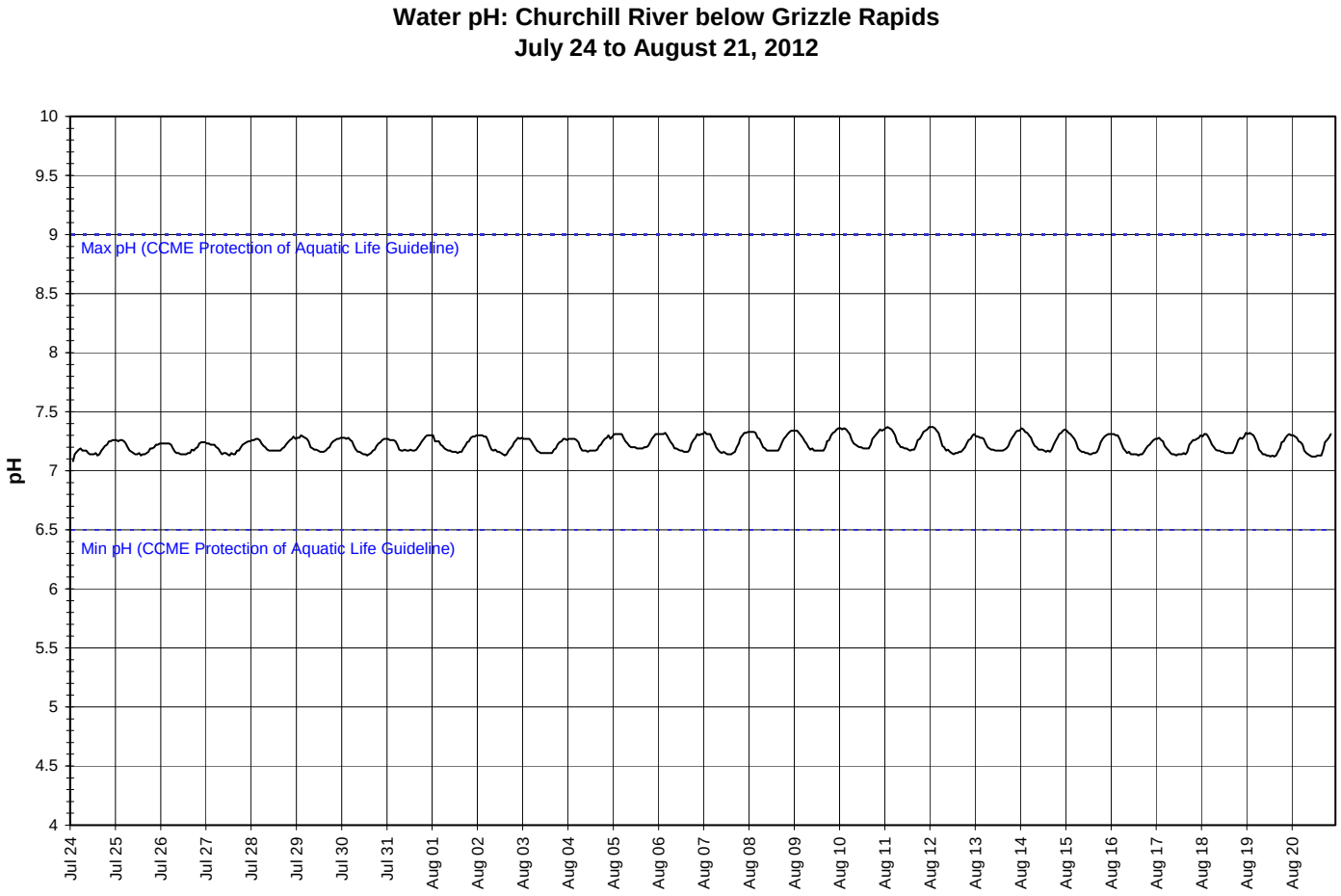

Figure 10: pH at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 20.5 to 22.5µS/cm during the deployment period, averaging 21.5µS/cm (Figure 11).
- Specific conductance is increasing slightly throughout the deployment period.
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Stage is decreasing slightly throughout the deployment period. As stage decreases, specific conductivity generally increases due to the increased concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

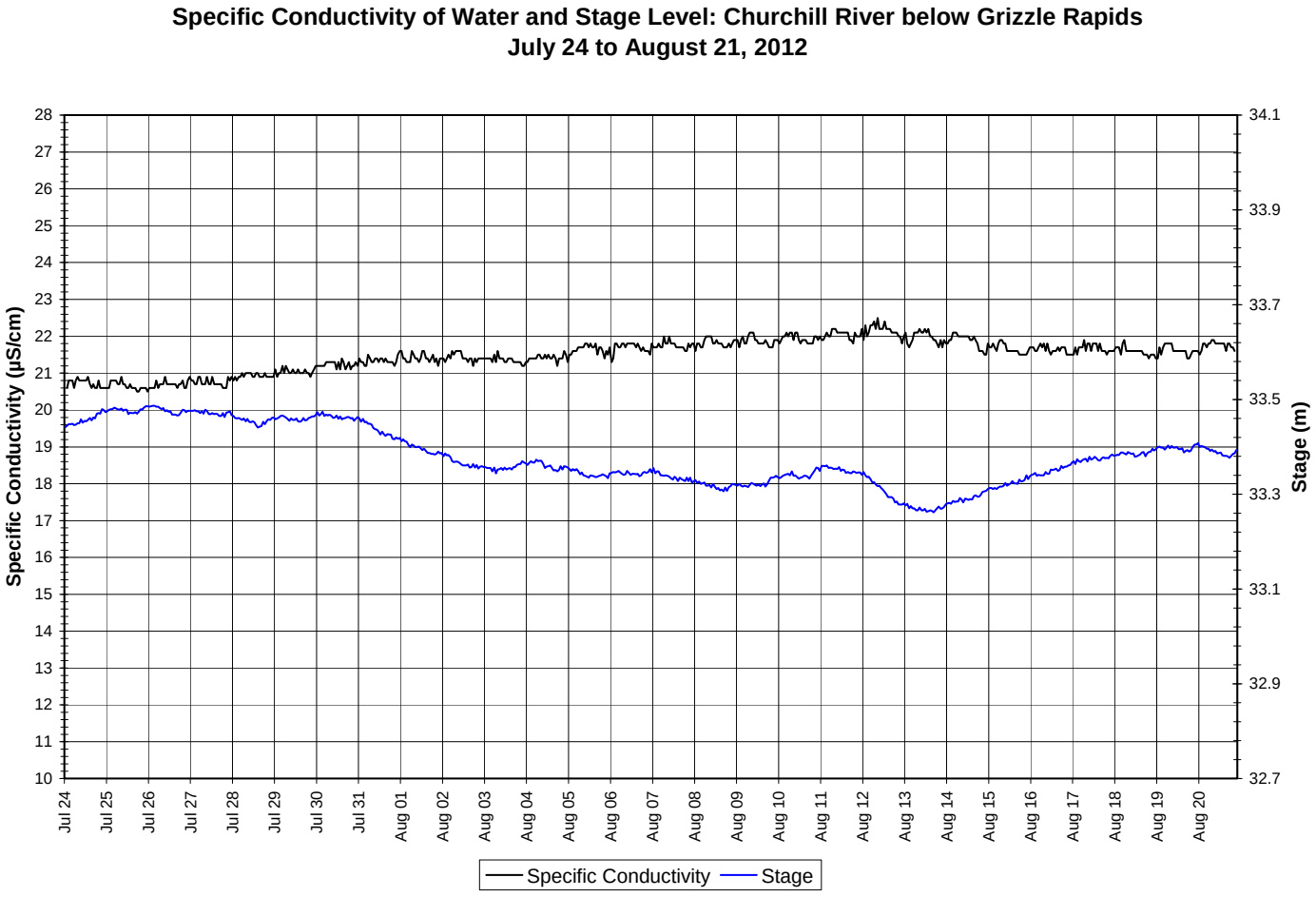

Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- The saturation of dissolved oxygen ranged from 95.4 to 102.6% and a range of 9.06 to 9.65mg/l was found in the concentration of dissolved oxygen with a median value of 9.32mg/l (Figure 12).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l. Most values recorded were either just above or just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is stable throughout the deployment period. This trend is expected given the consistent ambient air and water temperatures (Figure 9).

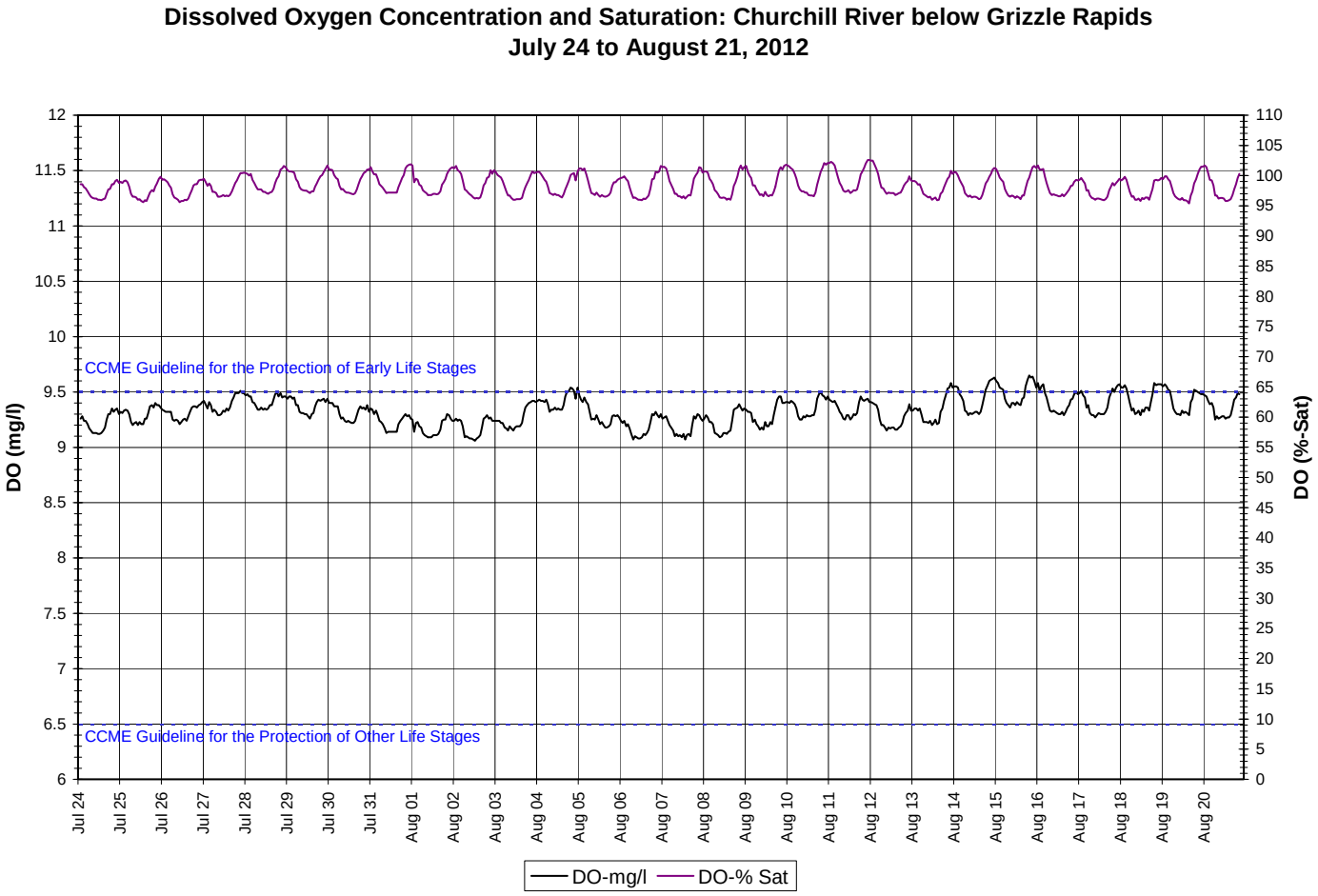

Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values remained at 0NTU for the entirety of the deployment period (Figure 13). This trend has been experienced in the past. The river reach at this station runs clear and quickly though Grizzle Rapids. It is not unusual to have no turbidity measurement recorded.

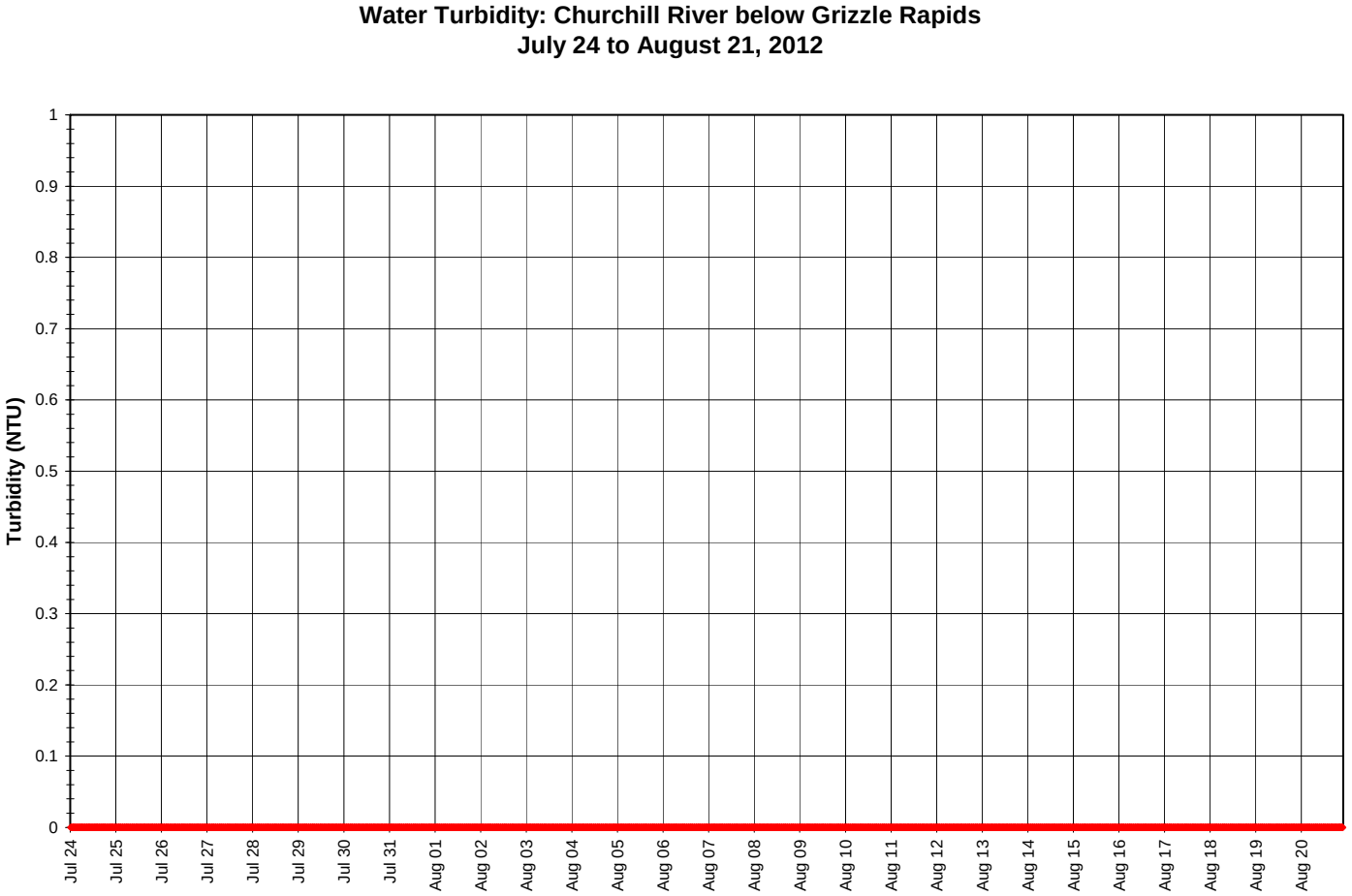

Figure 13: Turbidity at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is generally decreasing throughout the deployment period with some fluctuations and increasing near the end. Precipitation records vary. Stage ranges between 33.26 and 33.49m, a difference of 0.23m.

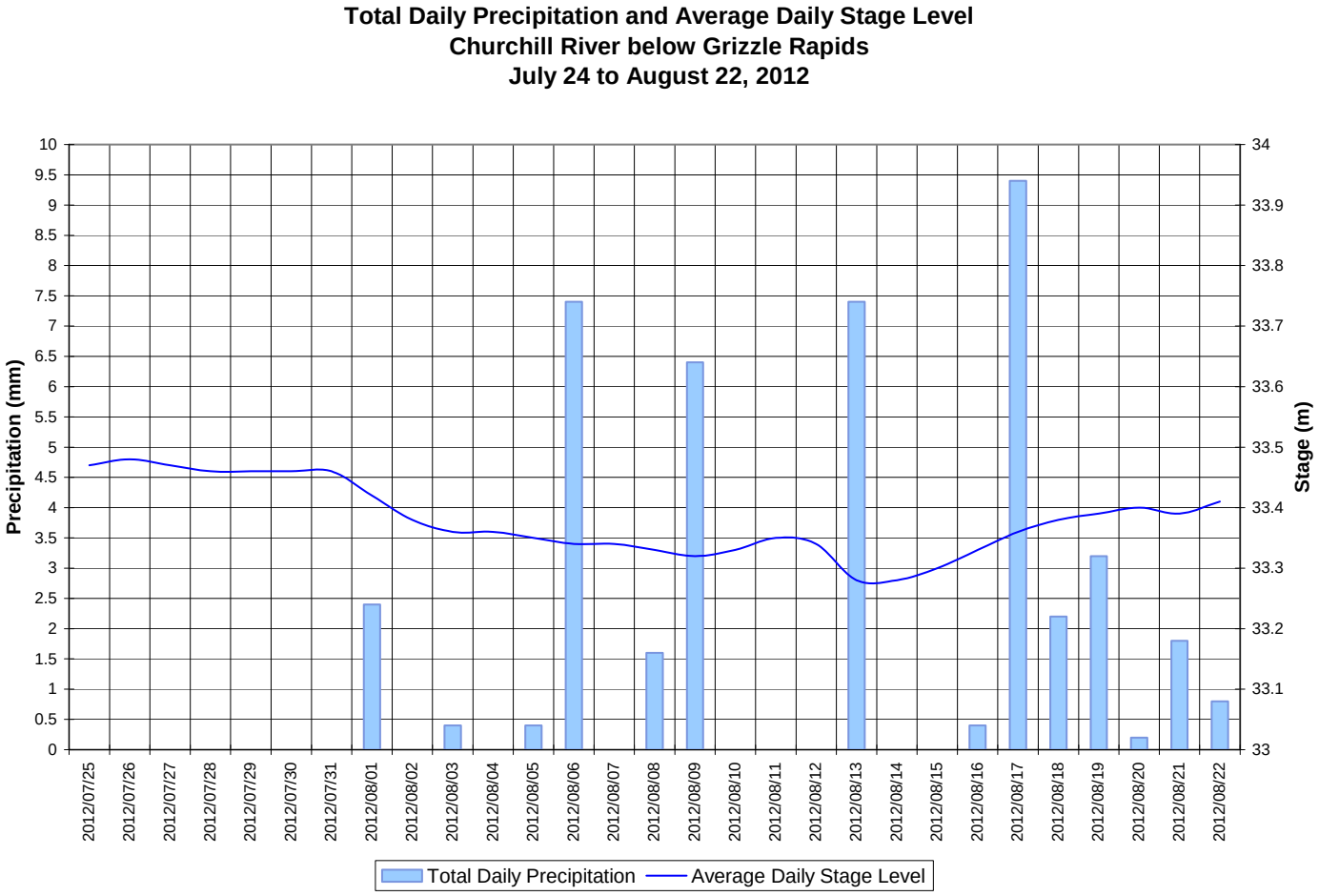

Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 17.24 to 20.59^{o}C during the deployment period (Figure 15).
- Water temperature is generally stable throughout the deployment period. This trend is expected given the consistent warm ambient air temperatures in the summer season (Figure 16). Water temperature fluctuates diurnally.

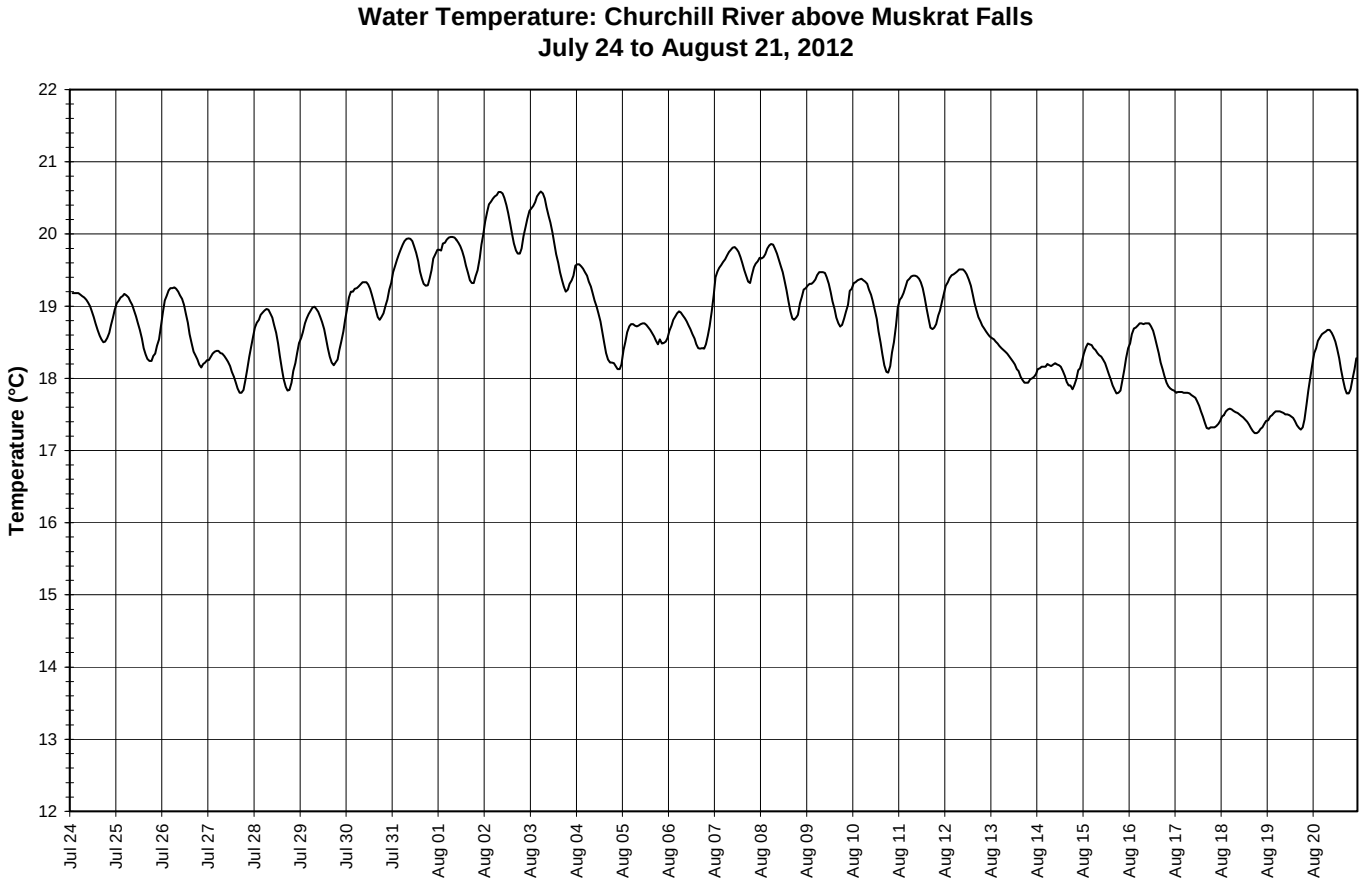

Figure 15: Water temperature at Churchill River above Muskrat Falls

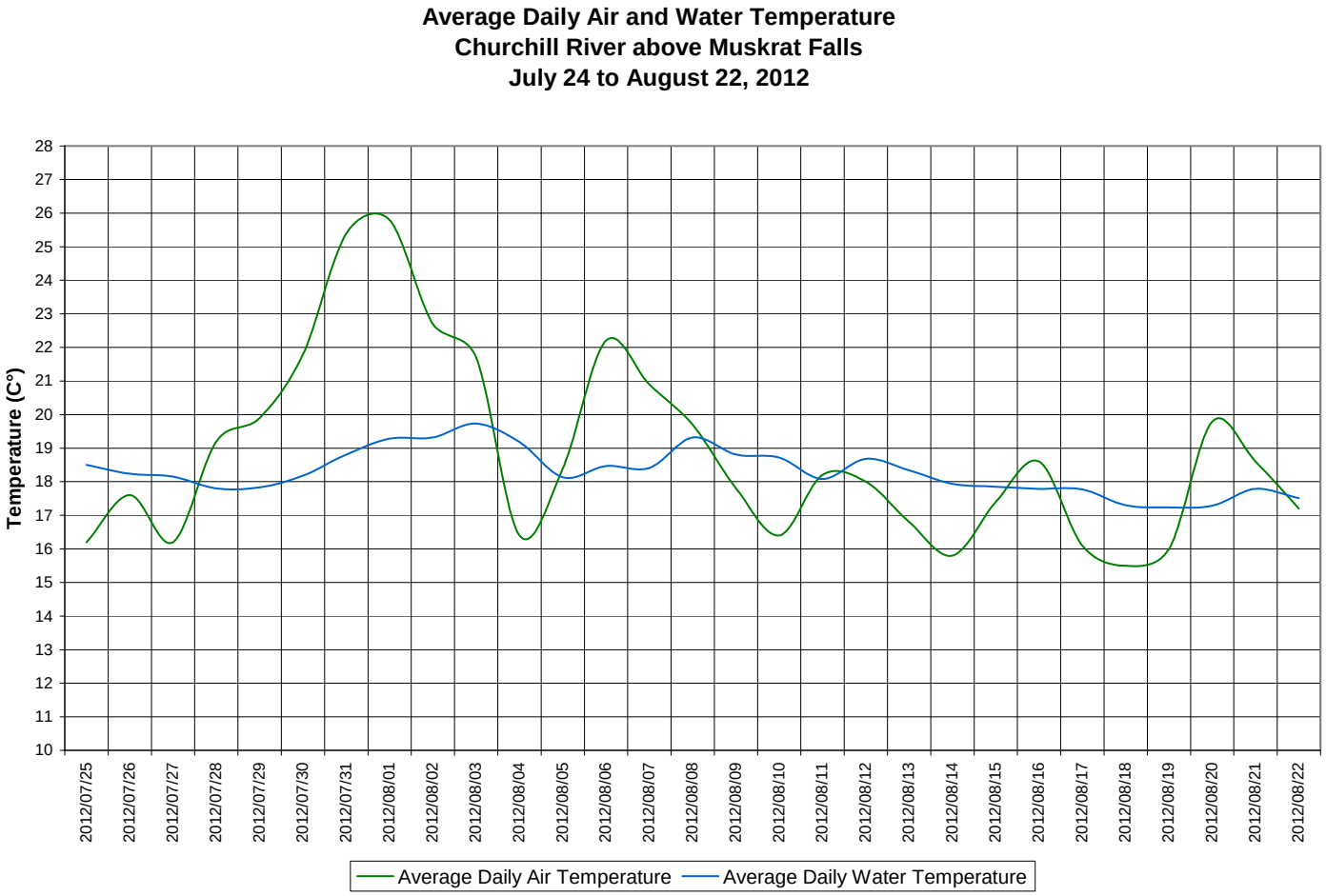

Figure 16: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 7.02 and 7.20 pH units (Figure 17). pH values are very stable throughout the deployment period.
- All pH values recorded are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

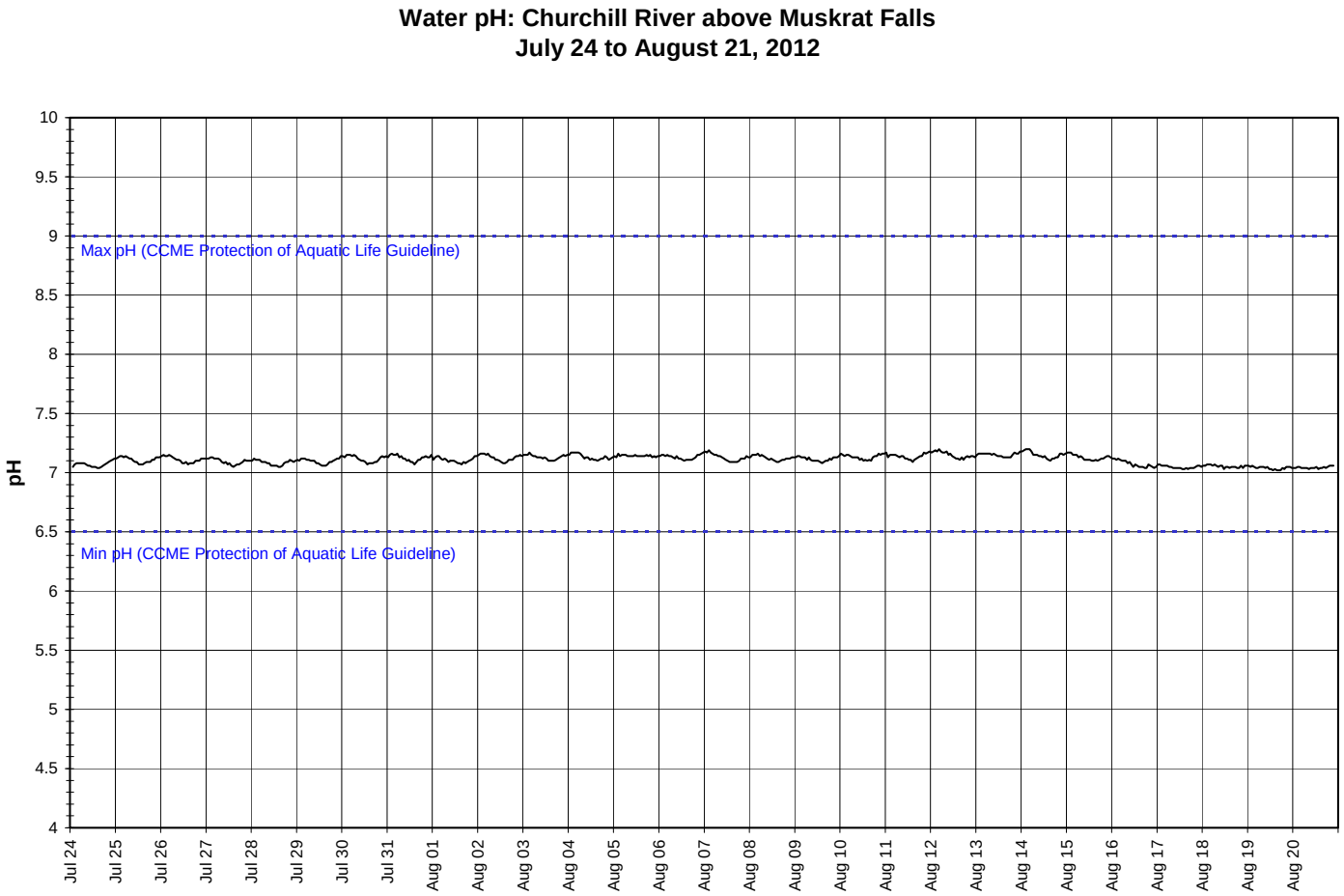

Figure 17: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges from 20.7 to 23.7µS/cm during the deployment period, averaging 22.1µS/cm. (Figure 18).
- Specific conductance is increasing slightly throughout the deployment period.
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is decreasing throughout the majority of the deployment period. As stage decreases, specific conductivity generally increases due to the increased concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

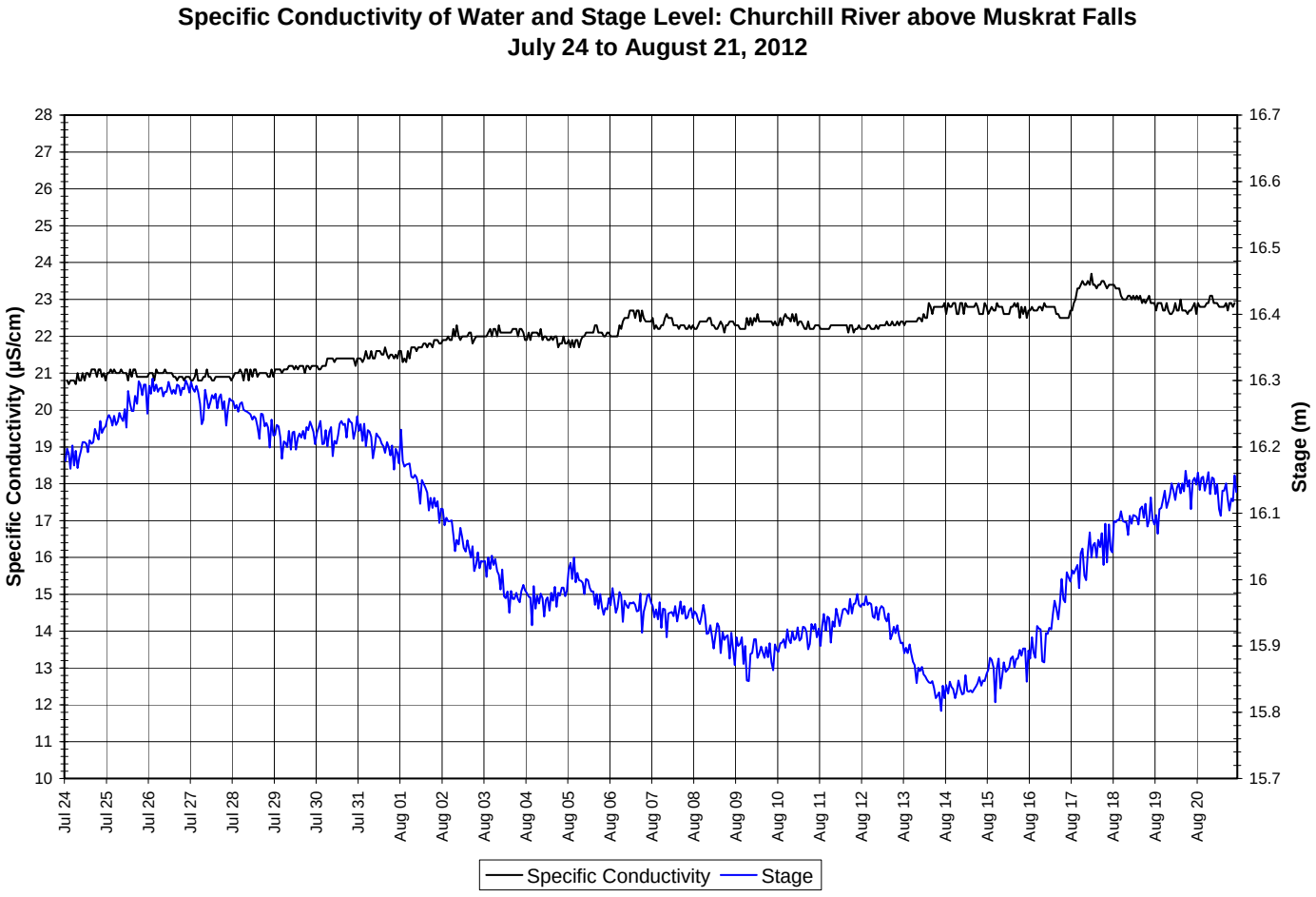

Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 96.1 to 101.8% and a range of 8.87 to 9.743mg/l was found in the concentration of dissolved oxygen with a median value of 9.22mg/l (Figure 19).
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5 mg/l. All values recorded are just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 19.
- Dissolved oxygen content is stable throughout the deployment period. This trend is expected given the consistent air and water temperatures (Figure 16).

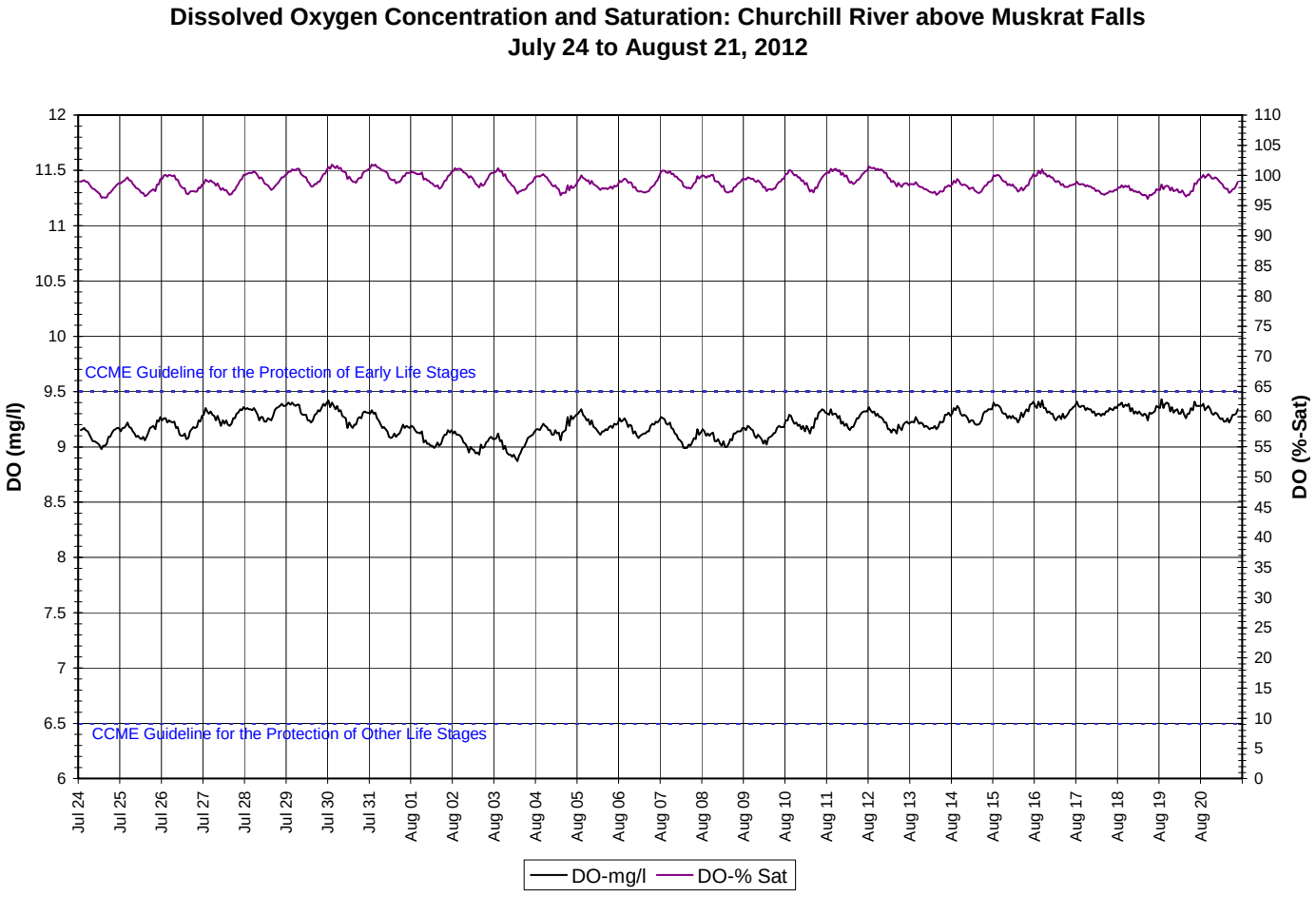

Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity generally ranges between 0.0 and 16.0NTU, averaging 2.8NTU (Figure 20). A median value of 3.0NTU indicates there is a consistent natural background turbidity value at this station.
- There is an increase in turbidity from August 3-5 to as high as 16.0NTU. This increase does not correspond with weather related events recorded in the area. This station typically has a natural background turbidity value.

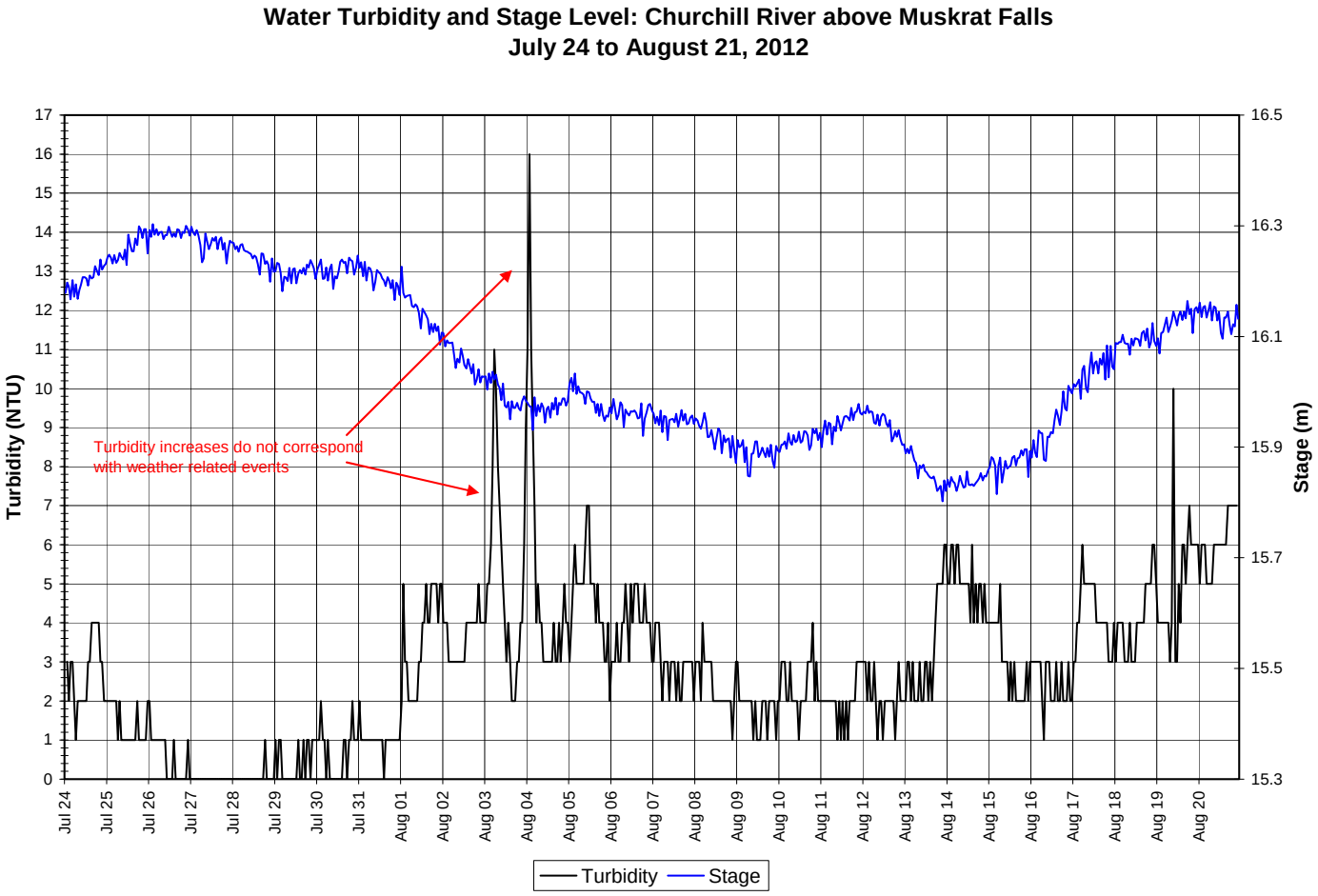

Figure 20: Turbidity at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is generally decreasing throughout the deployment period with some fluctuations and increasing near the end. Precipitation records vary. Stage ranges between 15.80 and 16.30m, a difference of 0.50m.

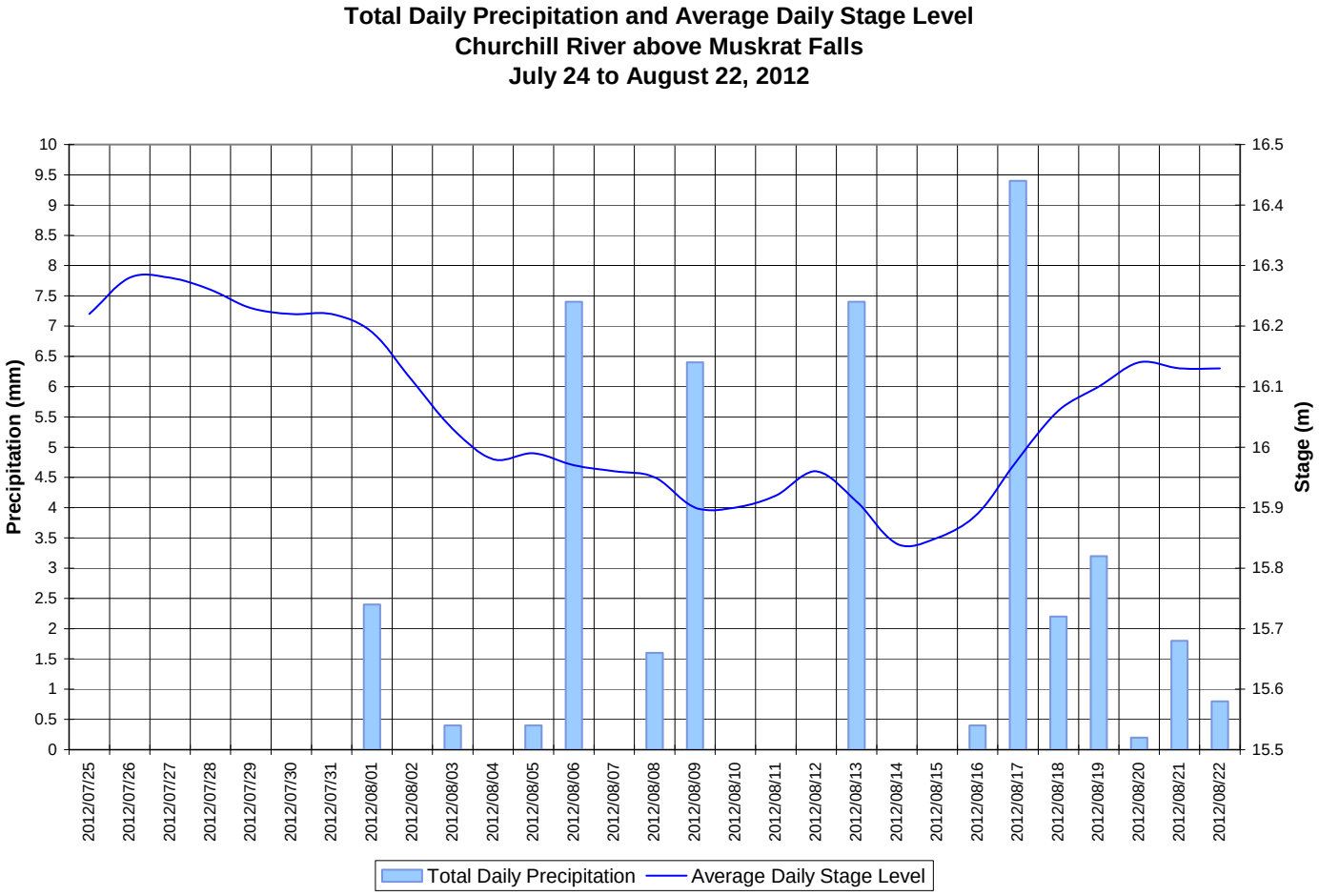

Figure 21: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- Water temperature ranges from 17.50 to 20.60^{o}C during the deployment period (Figure 22).
- Water temperature is generally stable throughout the deployment period. This trend is expected given the consistent warm ambient air temperatures in the summer season (Figure 23). Water temperature fluctuates diurnally.

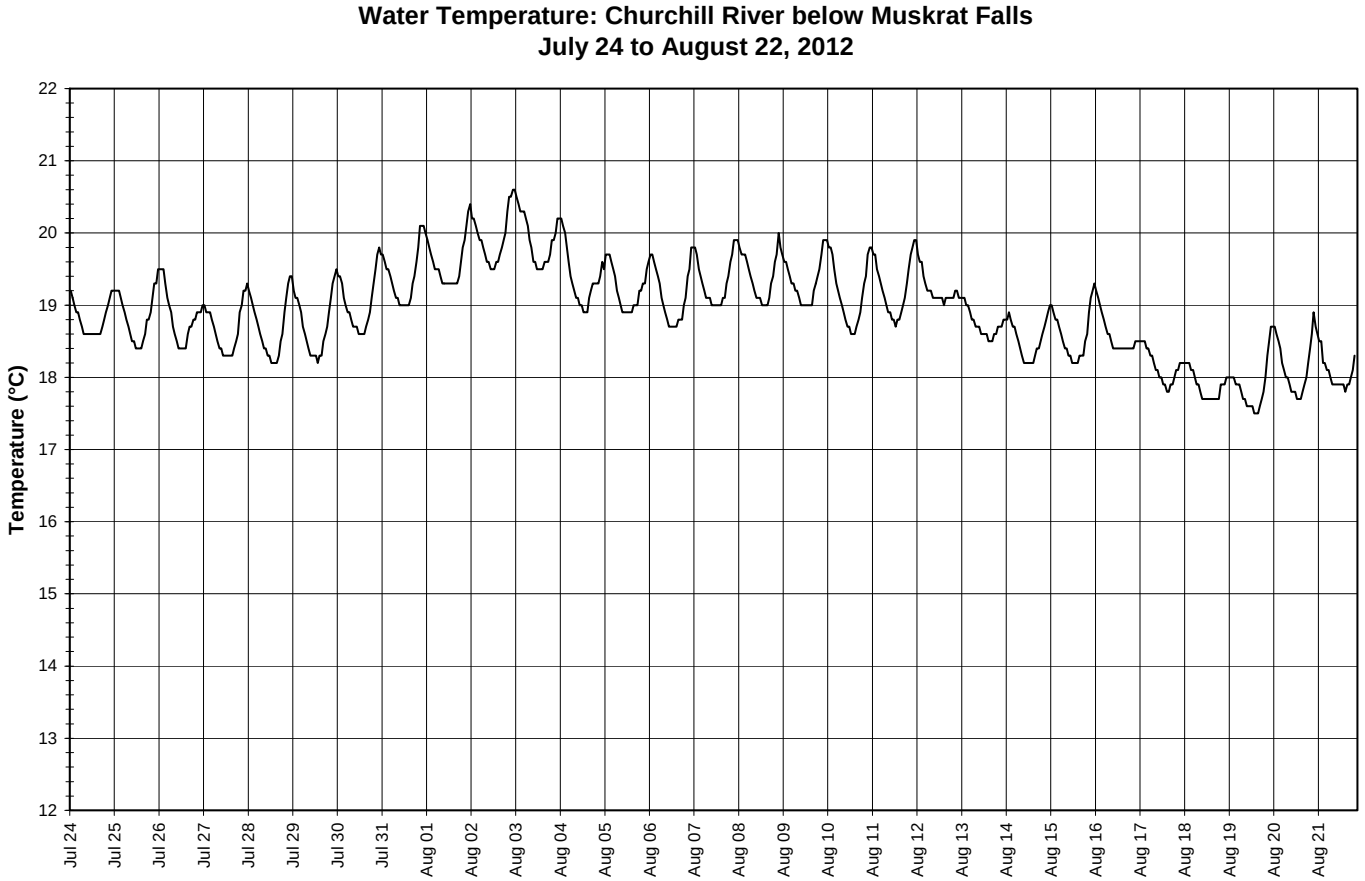

Figure 22: Water temperature at Churchill River below Muskrat Falls

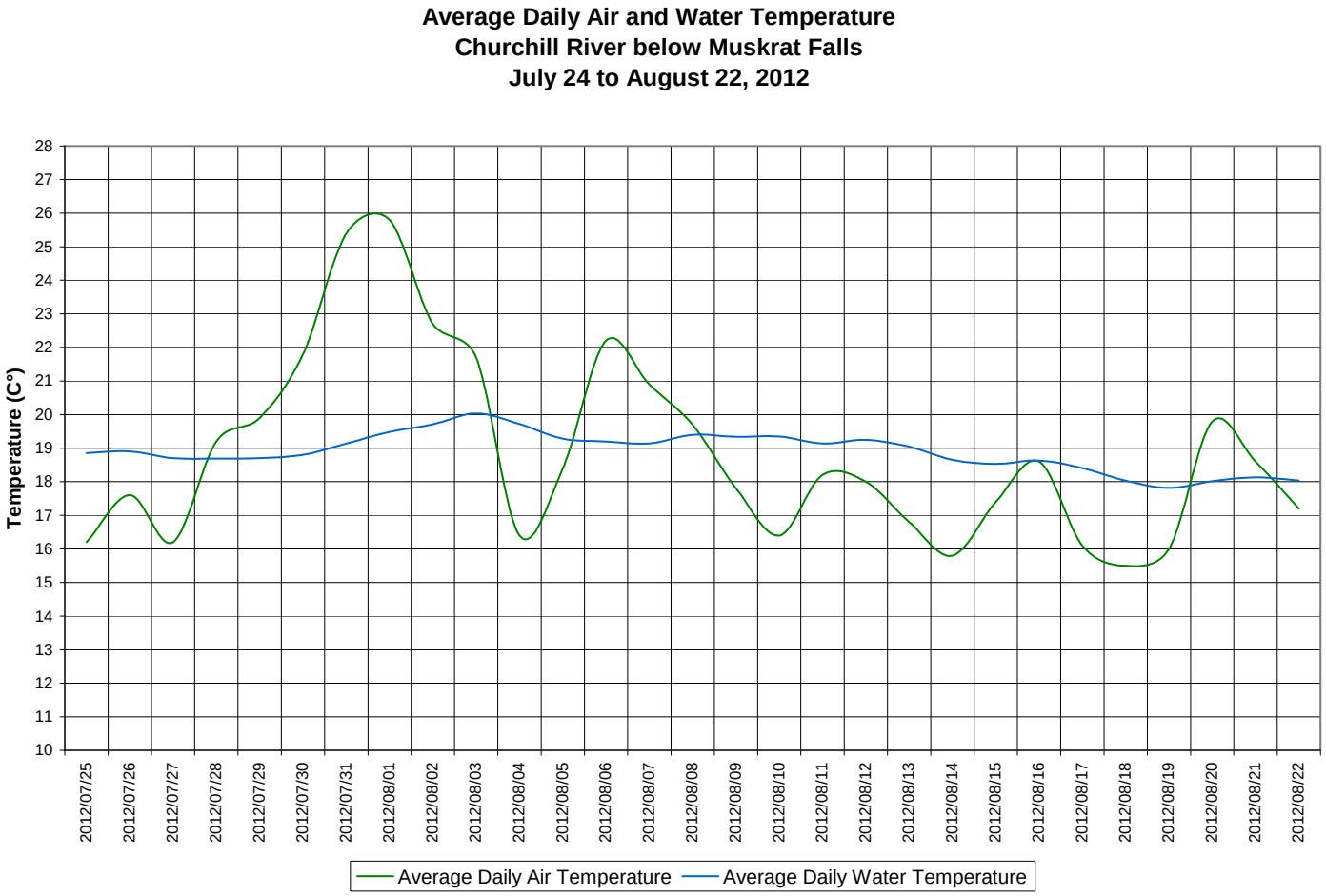

Figure 23: Average daily air and water temperature at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

- pH ranges between 7.04 and 7.28 pH units (Figure 24). pH values 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 24).

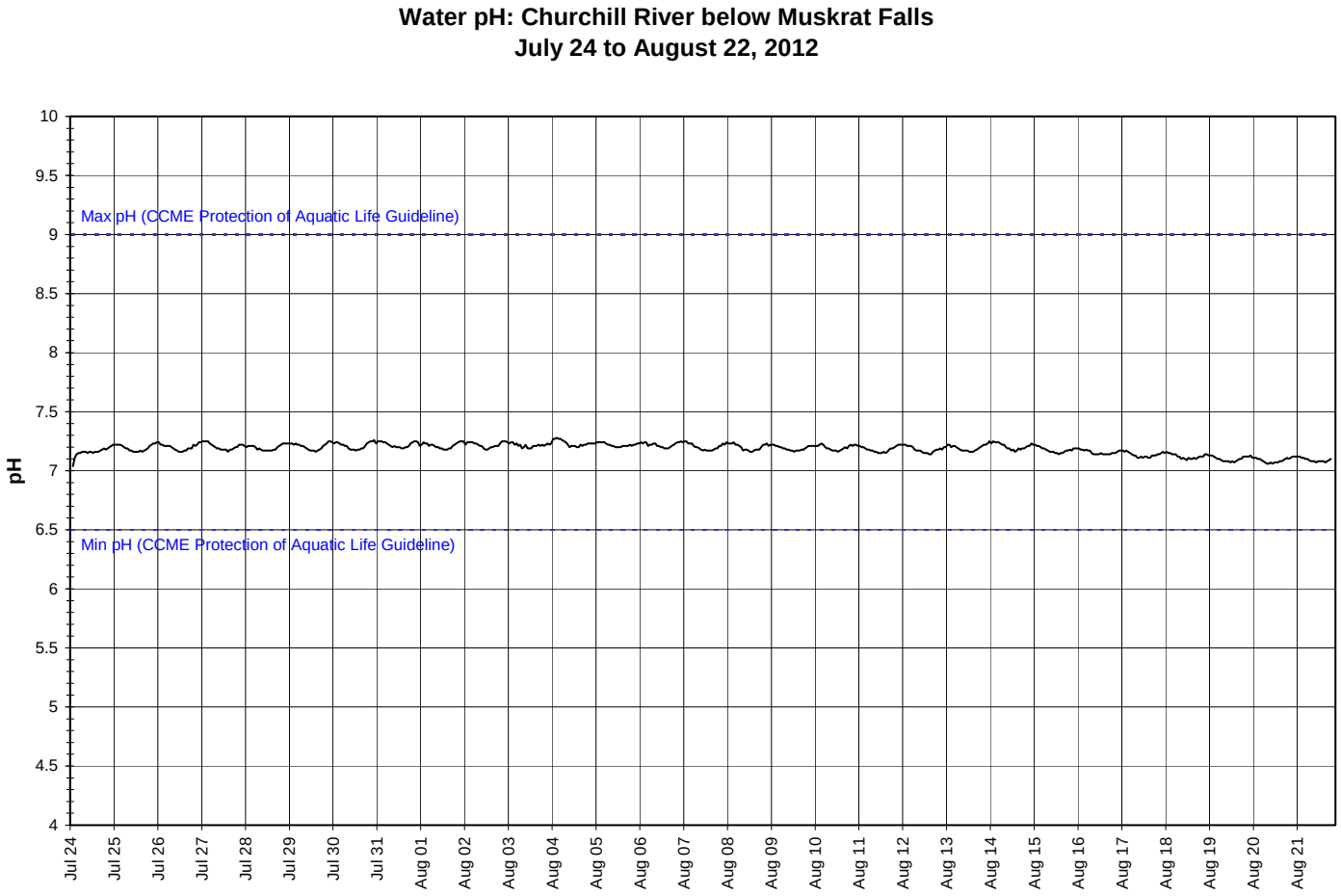

Figure 24: pH at Churchill River below Muskrat Falls

- Specific conductance remained between 15.4 and 24.5µS/cm during the deployment period, averaging 21.8µS/cm (Figure 25).
- Specific conductivity fluctuates considerably during the first week of the deployment period with sharp increases in an hour of ~5uS/cm. Specific conductivity then decreases slowly over a period of 12-24 hours. It is unknown what caused these flucuations.
- After the first week of the deployment period, specific conductivity becomes more stable and generally increases slightly throughout the rest of the month.
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. Stage levels are generally decreasing throughout the majority of the deployment period. As stage decreases, 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.

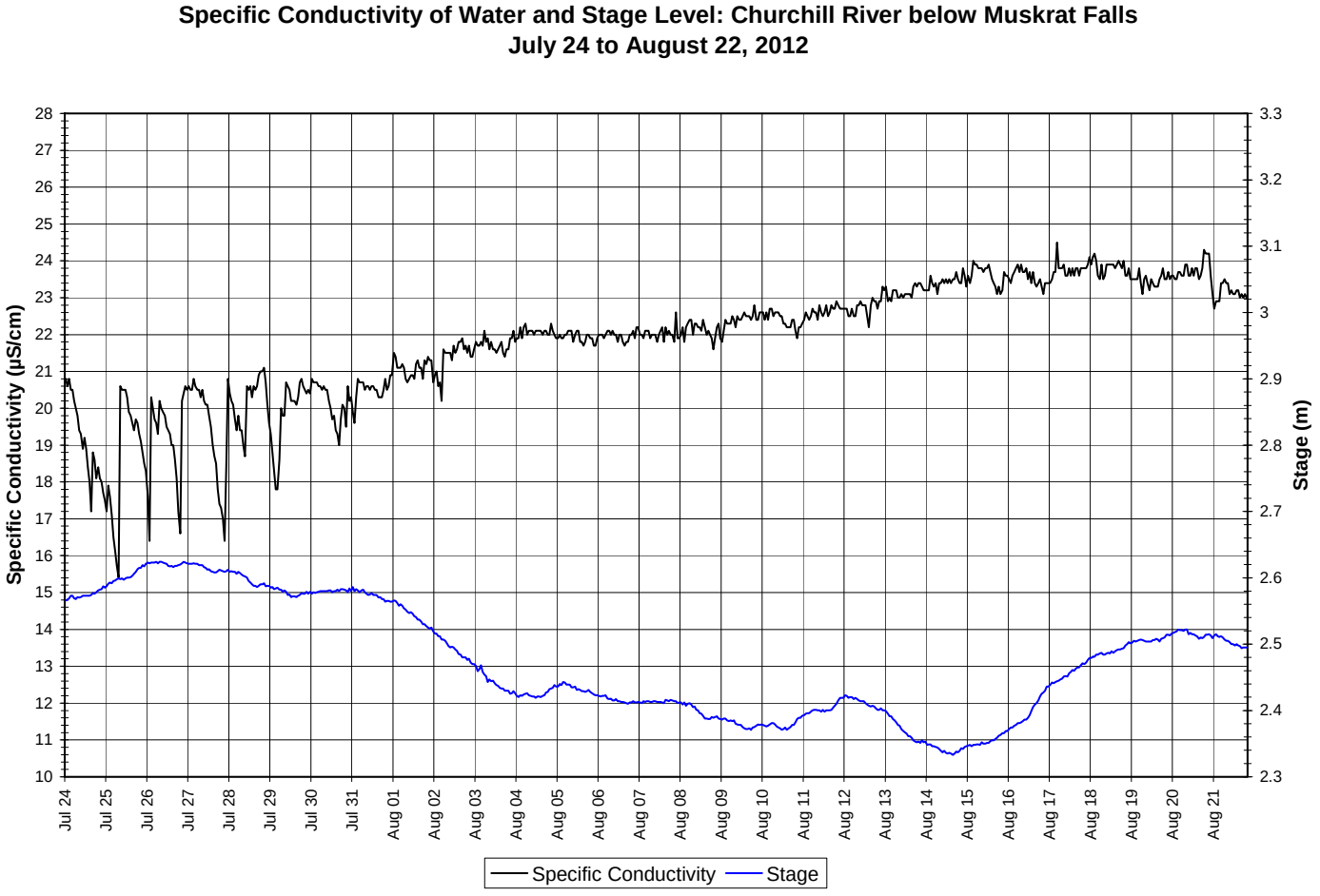

Figure 25: Specific conductivity and stage level at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen ranged from 107.1 to 115.5% and a range of 9.76 to 10.75mg/l was found in the concentration of dissolved oxygen with a median value of 10.35mg/l (Figure 26).
- 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 26.
- Dissolved oxygen content is stable throughout the deployment period. This trend is expected given the consistent warm air and water temperatures (Figure 23). 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.

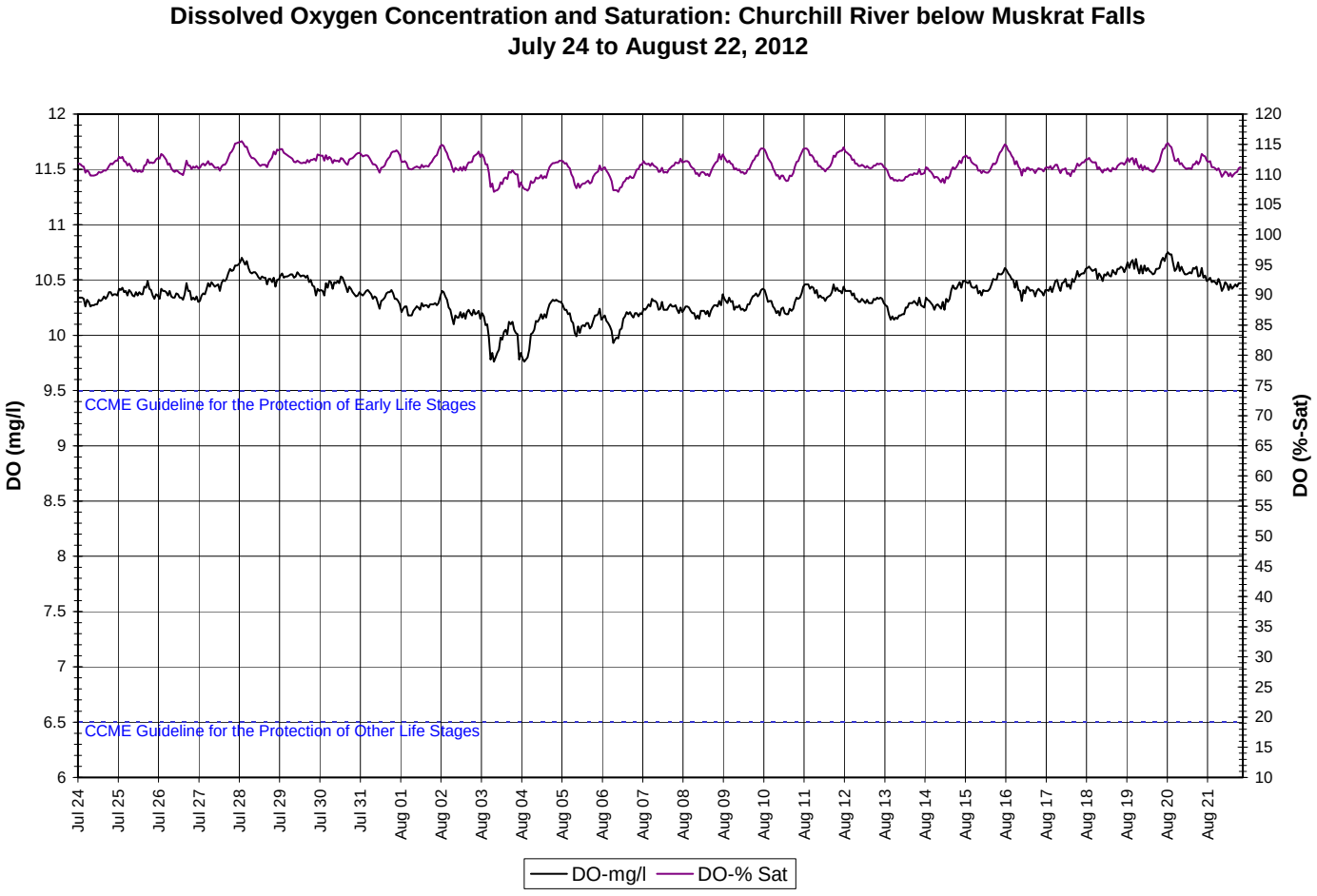

Figure 26: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- Turbidity ranges between 3.2 and 214.3NTU throughout the deployment period (Figure 27). A median value of 6.2NTU indicates there is a consistent natural background turbidity value at this station.
- There are a number of increases in turbidity throughout the deployment period. On August 1, turbidity increases to 47NTU. This increase corresponds with a rainfall event recorded at Goose Bay Airport on the same day. Similarly, turbidity increases on August 6, 13, and 21 also each correspond with rainfall events recorded near the station. Conversely, turbidity increases on July 25, 30, August 2, 3, and 4 do not correspond with weather related events. It is unknown was caused these increases.

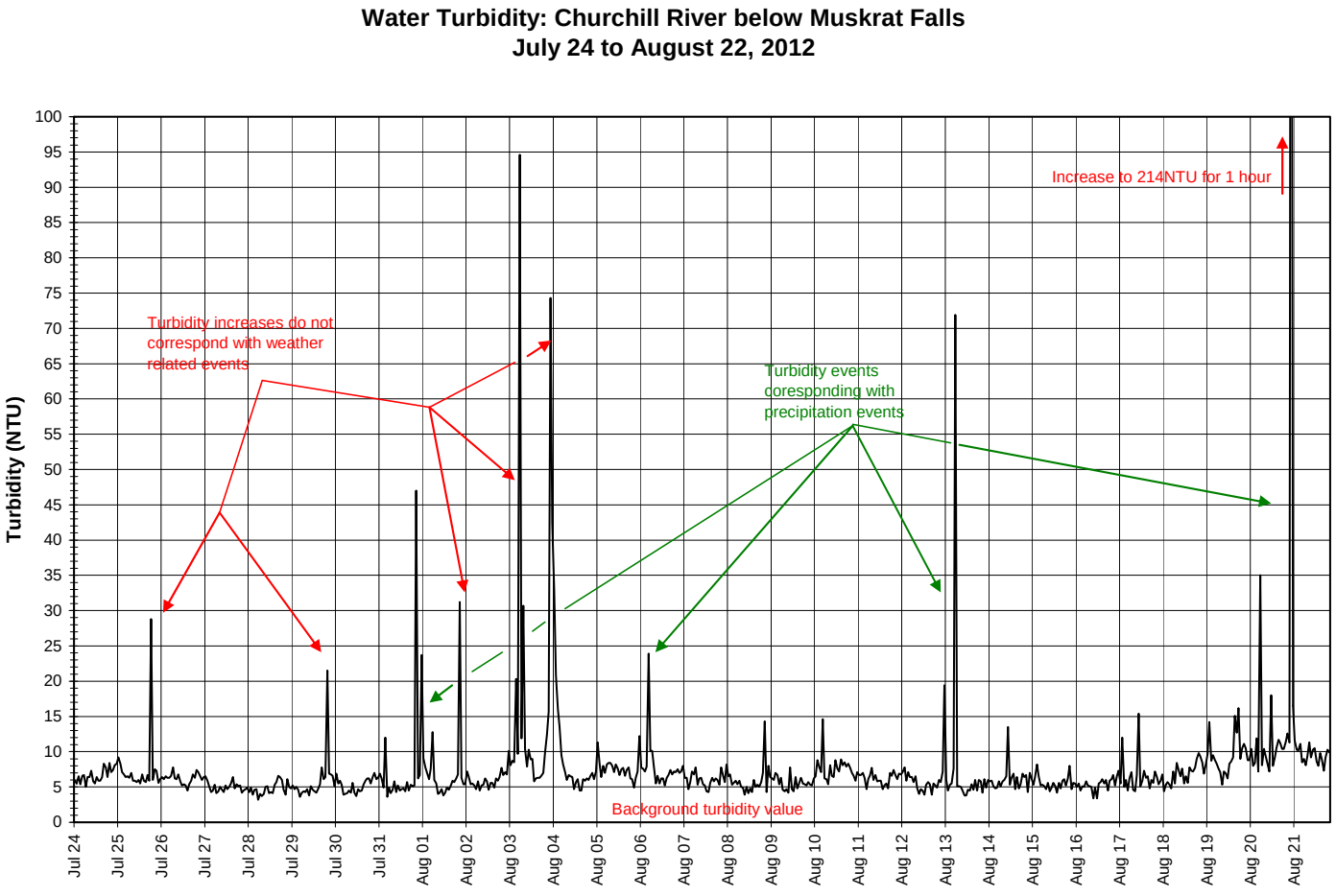

Figure 27: Turbidity at Churchill River below Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 28). Stage is generally decreasing throughout the deployment period with some fluctuations and increasing slightly at the end. Precipitation records vary. Stage ranges between 2.33 and 2.62m, a difference of 0.29m.

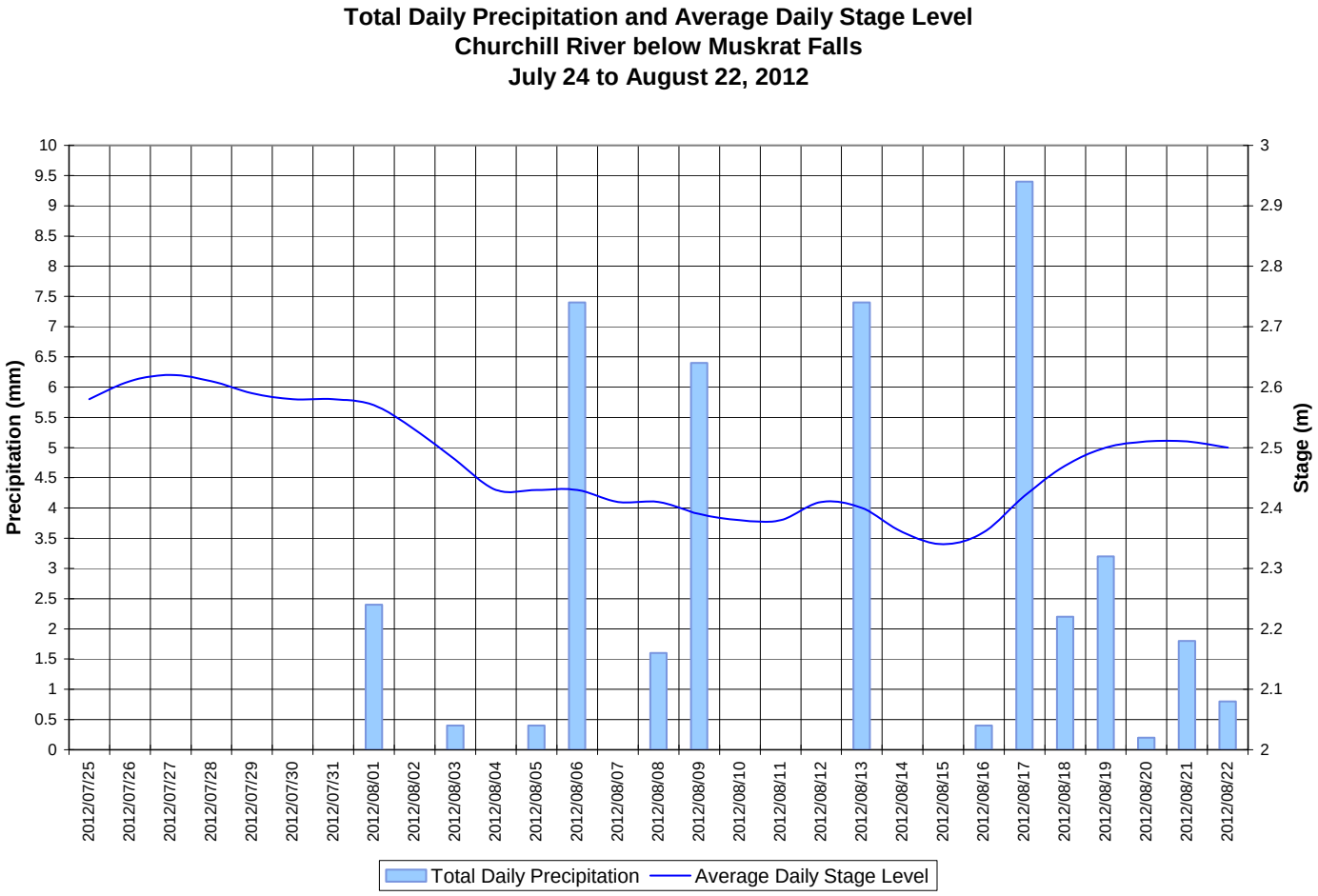

Figure 28: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from July 24 to August 21-22, 2012. In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations.
- Stage levels decreased slightly throughout the deployment period at all stations.
- Water temperature was near seasonal highs and stable at all stations throughout the deployment period due to the consistent warm ambient air temperatures in the region during the summer season. Water temperature typically ranged between 16 and 21°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life and very consistent at all stations. pH is generally very neutral and stable at all stations along the Lower Churchill River ranging between 6.9 and 7.3 pH units.
- Specific conductivity was generally increasing at all stations, typically ranging between 21 and 25µS/cm.
- Dissolved oxygen content was generally low and stable throughout the deployment period. 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. Dissolved oxygen content below Metchin River, below Grizzle Rapids and above Muskrat Falls were all just below the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5mg/l. The station below Muskrat Falls consistently has high dissolved oxygen content due to the location of the Muskrat Falls, 6km upstream and all values remained above this guideline.
- Turbidity values at the stations below Metchin River and below Grizzle Rapids remained mostly at 0NTU throughout the deployment period which is typical of these stations. Background turbidity values between 3.0 and 6.2NTU were found the stations above and below Muskrat Falls, respectively. There are a number of short turbidity increases at both stations as well, which sometimes correspond with weather related events.

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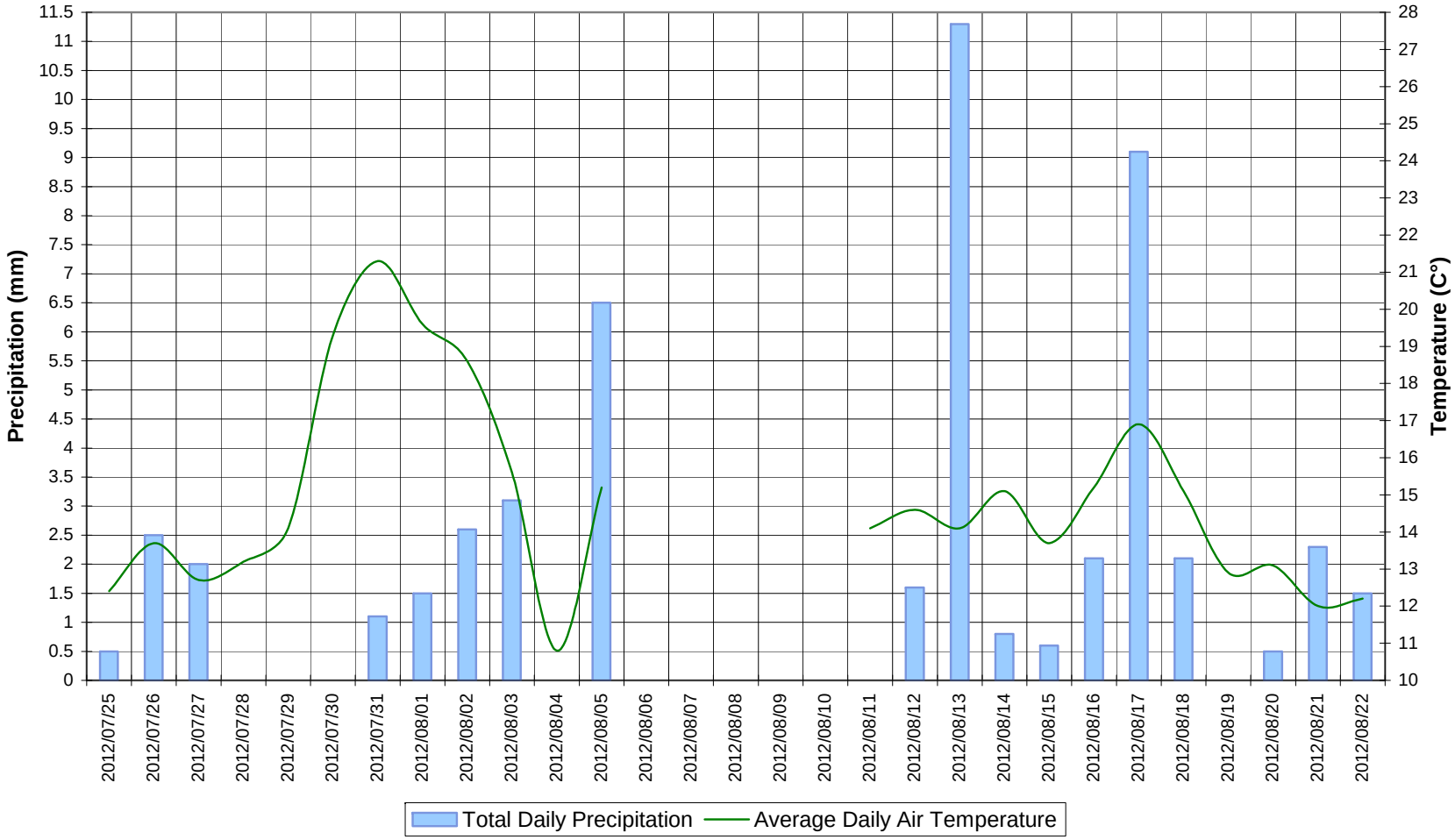
Appendix 1 – Weather Data – Environment Canada Historical Weather and Climate Database

Average Daily Air Temperature and Total Daily Precipitation
Churchill Falls
July 24 to August 22, 2012



Average Daily Air Temperature and Total Daily Precipitation
Happy Valley-Goose Bay
July 24 to August 22, 2012