Real-Time Water Quality Deployment Report

Lower Churchill River Network

August 23 to
September 21, 2010

Newfoundland Labrador

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

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General

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This monthly deployment period illustrates and discusses water quality related events from August 23 to September 21, 2010; a period of 29 days.
- On August 22, 2010, real-time water quality monitoring instruments were deployed at all four Lower Churchill River Stations.

Maintenance and Calibration of Instrument

- 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 QA/QC Sonde is temporarily deployed along side the Field Sonde. 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 Sonde and QAQC Sonde at deployment, a qualitative statement is made on the data quality (Table 1).
  - ► At the end of a deployment period, readings are taken in the water body from the Field Sonde before and after a thorough cleaning in order to assess the degree of biofouling. During calibration in the laboratory, an assessment of calibration drift is made and the two error values are combined to give Total Error (T_e). If T_e exceeds a predetermined data correction criterion, a correction based on T_e is applied to the dataset using linear interpolation.

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (oC)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde 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 sonde the entire sonde 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 Churchill River stations deployed between August 22 and September 21, 2010 are summarized in Table 2.

Table 2: Comparison rankings for Churchill River stations, August 22 – September 21, 2010

Station Churchill River	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Muskrat Falls	Aug 22, 2010	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Sep 21, 2010	Removal	Good	Good	Excellent	Excellent	Poor
Above Muskrat Falls	Aug 22, 2010	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Sep 21, 2010	Removal	Excellent	Good	Excellent	Excellent	Poor
Below Grizzle Rapids	Aug 22, 2010	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Sep 21, 2010	Removal	Excellent	Fair	Excellent	Excellent	Excellent
Below Metchin River	Aug 22, 2010	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Sep 21, 2010	Removal	Good	Fair	Excellent	Excellent	Excellent

- The turbidity sensor on the instrument deployed at stations above and below Muskrat Falls ranked "poor" at removal. This may have been in part caused by the placement of the QAQC sonde in the water adjacent to the field sonde. Weather conditions were unfavourable at the time and also could have affected the ability to obtain a stable turbidity reading.
- A transmission error at the station below Grizzle Rapids prevented data from being transmitted in real time between July 12 and September 21. The instruments internal log file was recovered to provide data for this period.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from August 23 to September 21 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. Where appropriate, corrected data for water quality parameters are indicated.

Churchill River below Muskrat Falls

- Water temperature ranged from 12.3 to 19.30^{o}C during this deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period.. This trend is expected due to the decreasing ambient air temperatures in the fall season (Appendix 1). Water temperature fluctuates diurnally.

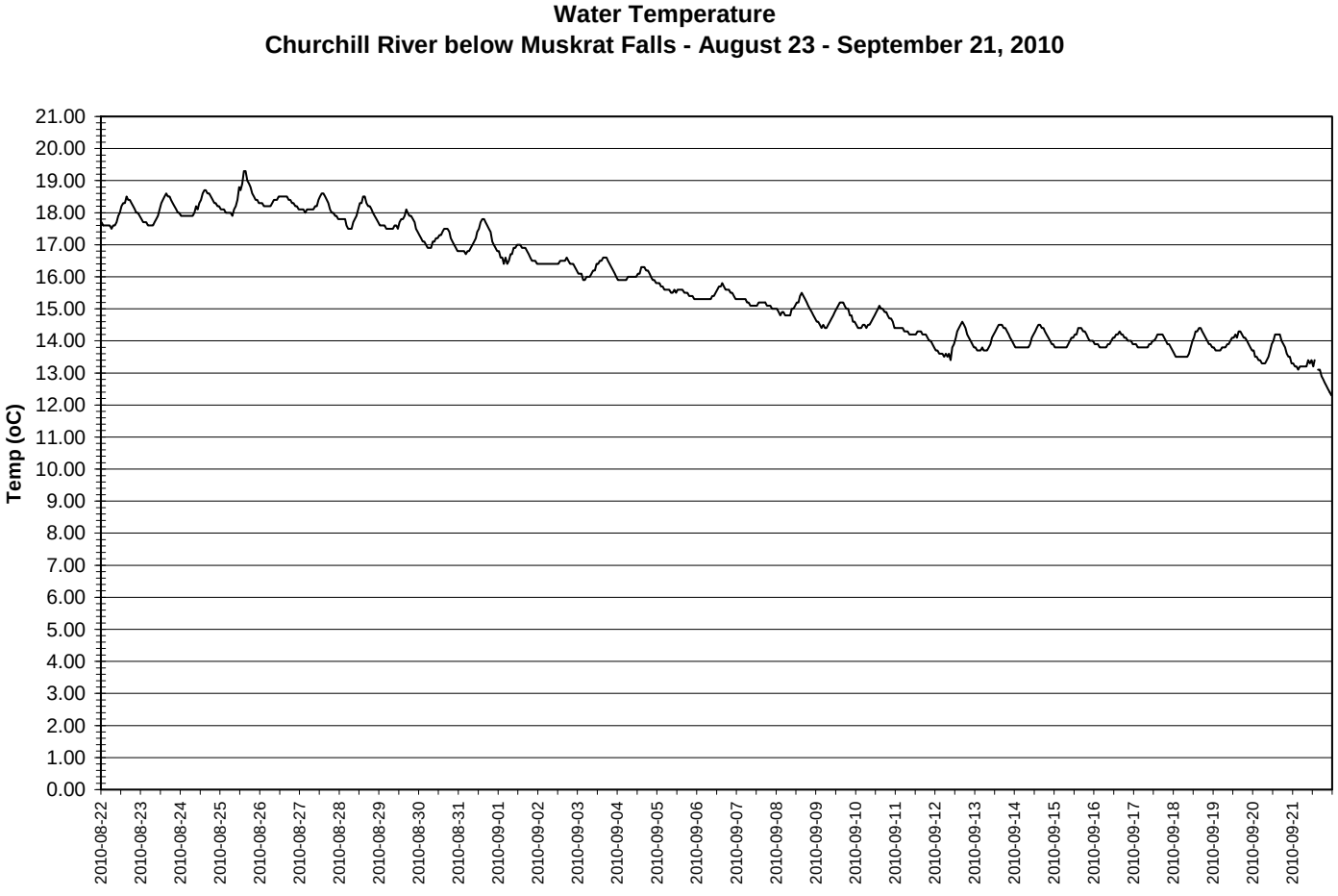

Figure 1: Water temperature at Churchill River below Muskrat Falls

- pH ranges between 6.98 and 7.37 pH units and are consistent throughout the deployment period (Figure 2).
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 2).

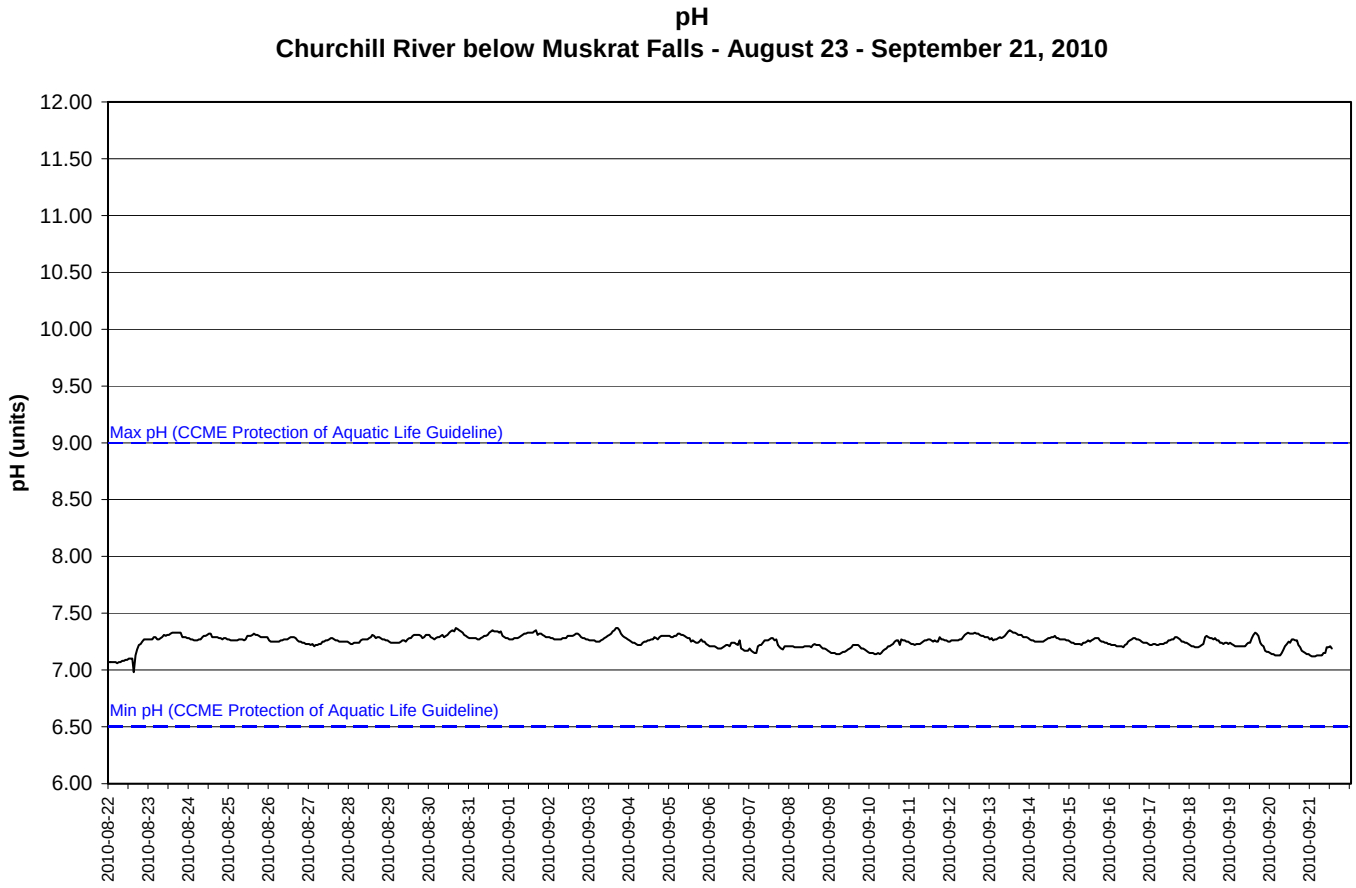

Figure 2: pH at Churchill River below Muskrat Falls

- Specific conductivity ranges from 18.2 to 23.0µS/cm during the deployment period (Figure 3). Specific conductance generally increases throughout the deployment period.
- Stage is included in Figure 3 to illustrate the inverse relationship between conductivity and water level. Stage generally remains stable throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 3).

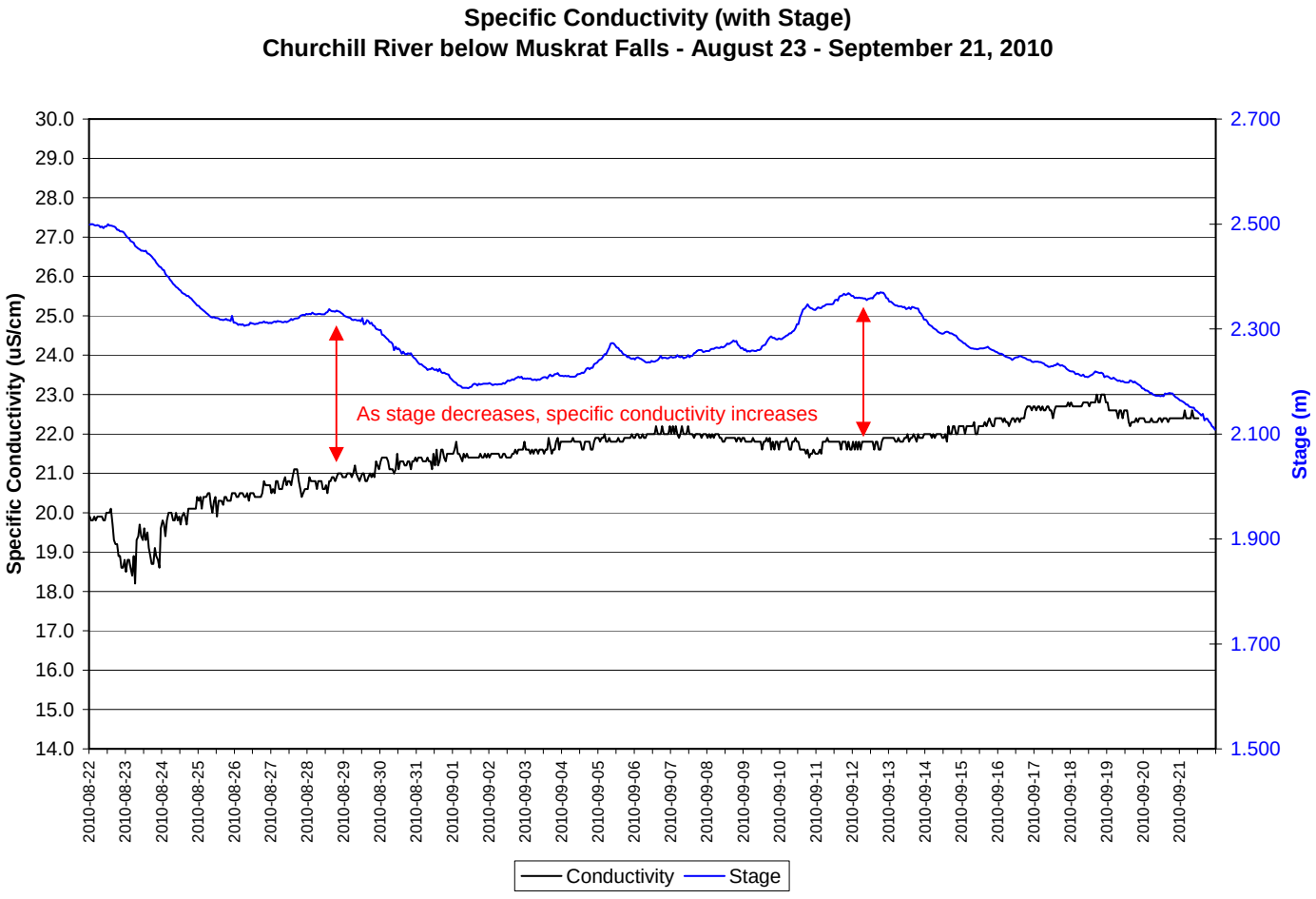

Figure 3: Specific conductivity at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen ranged from 100.0 to 114.2% and a range of 9.85 to 11.19mg/l was found in the concentration of dissolved oxygen with a median value of 10.47 mg/l (Figure 4).
- All values were above both the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l and the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in green on Figure 4
- Dissolved oxygen content increases slightly throughout the deployment period. This trend is expected given the decreasing air and water temperatures (Figure 1 & Appendix 1).

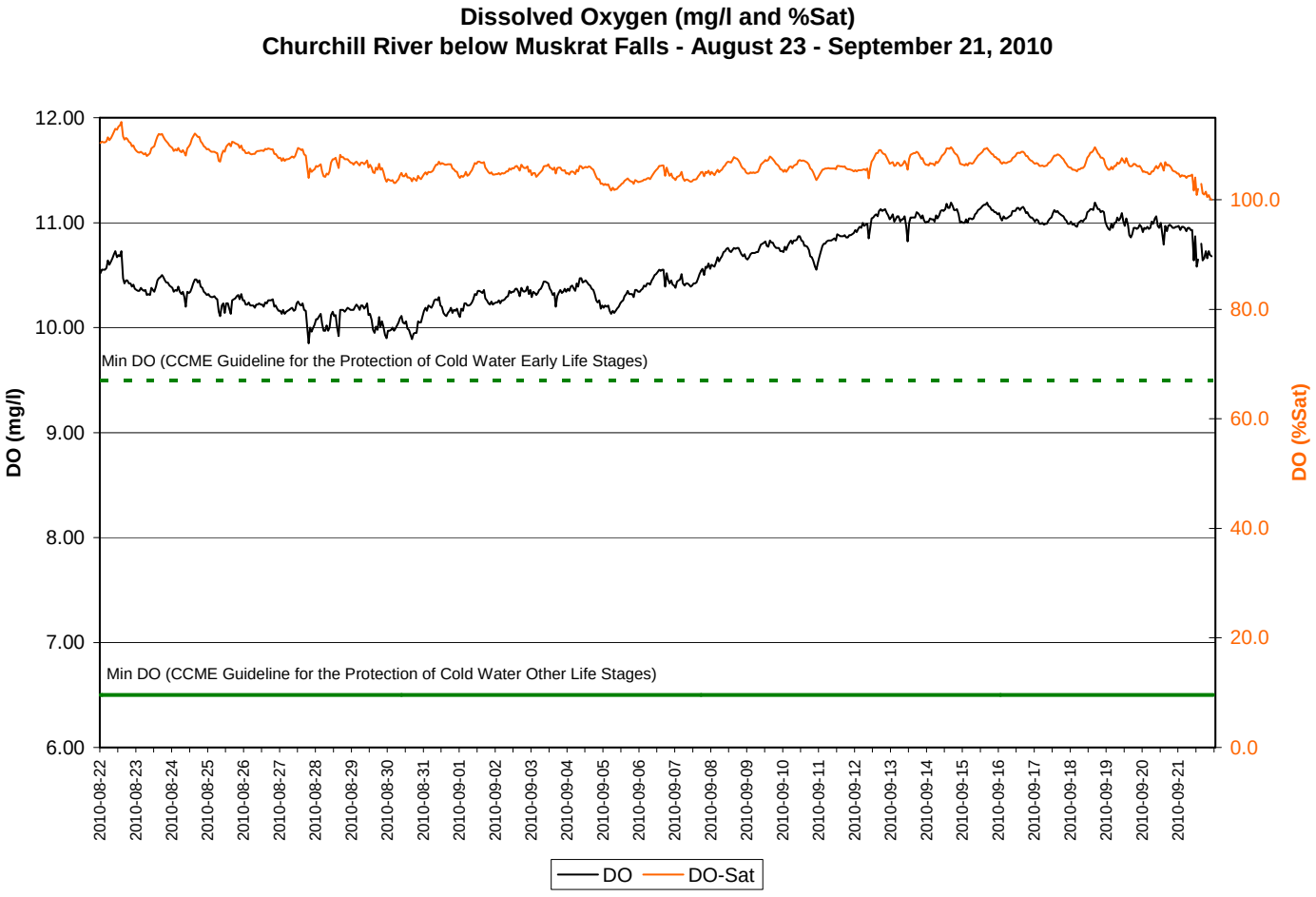

Figure 4: Dissolved oxygen at Churchill River below Muskrat Falls

- A range of 1.4 to 88.4 NTU was recorded for turbidity for this deployment period (Figure 5). A median value of 6.0 NTU indicates there is a consistent natural background turbidity value at this station.
- One significant event (to 88.4NTU) was recorded on August 30-31. This event (turbidity values >20NTU) last for over 8 hours and corresponds with winds gusts >30km/hr recorded at Goose Bay for a period of four days (Aug 28-31).

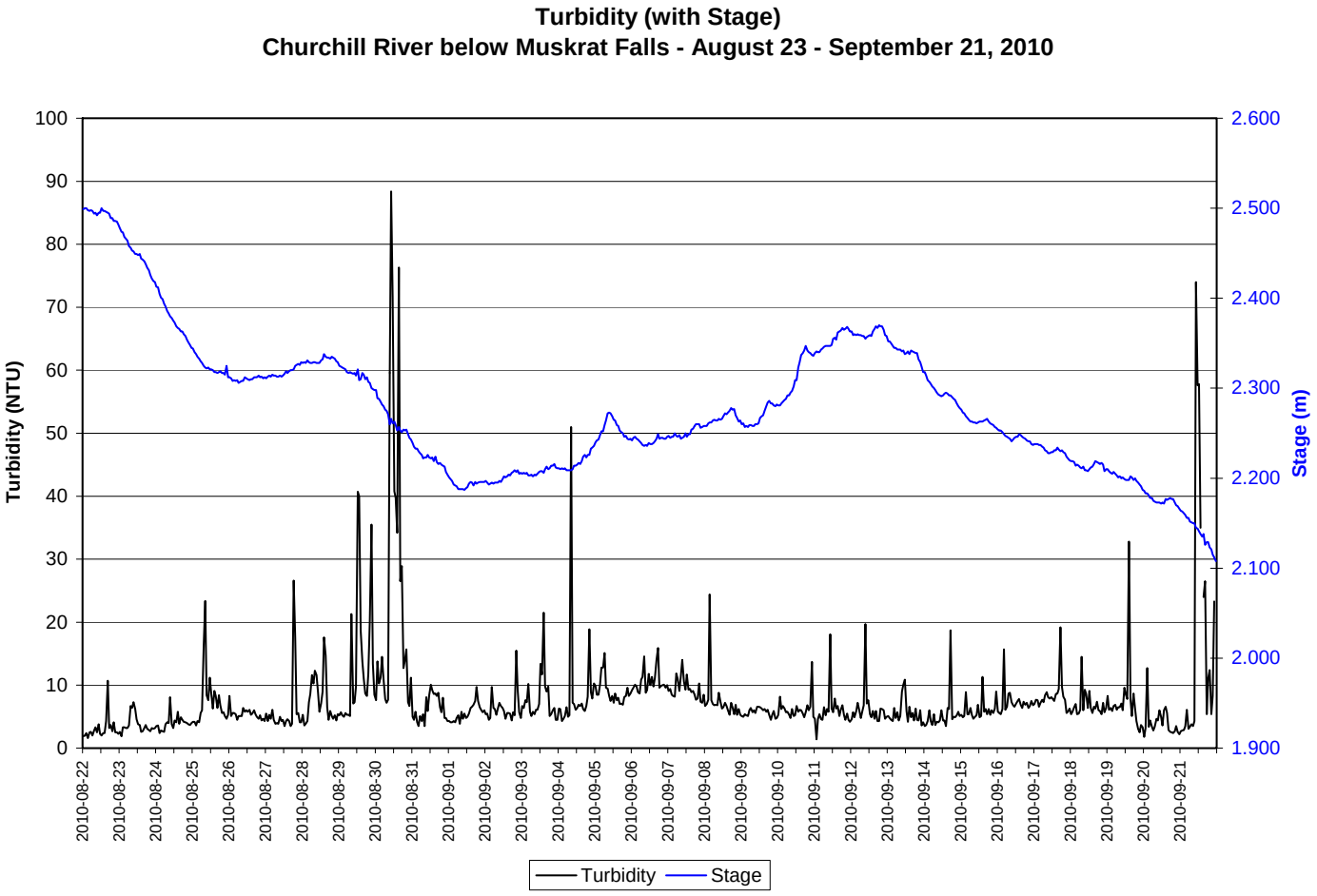

Figure 5: Turbidity at Churchill River below Muskrat Falls

Churchill River above Muskrat Falls

- Water temperature ranges from 11.91 to 19.16^{o}C during this deployment period (Figure 6).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the decreasing ambient air temperature in the fall (Appendix 1). Water temperature fluctuates diurnally.

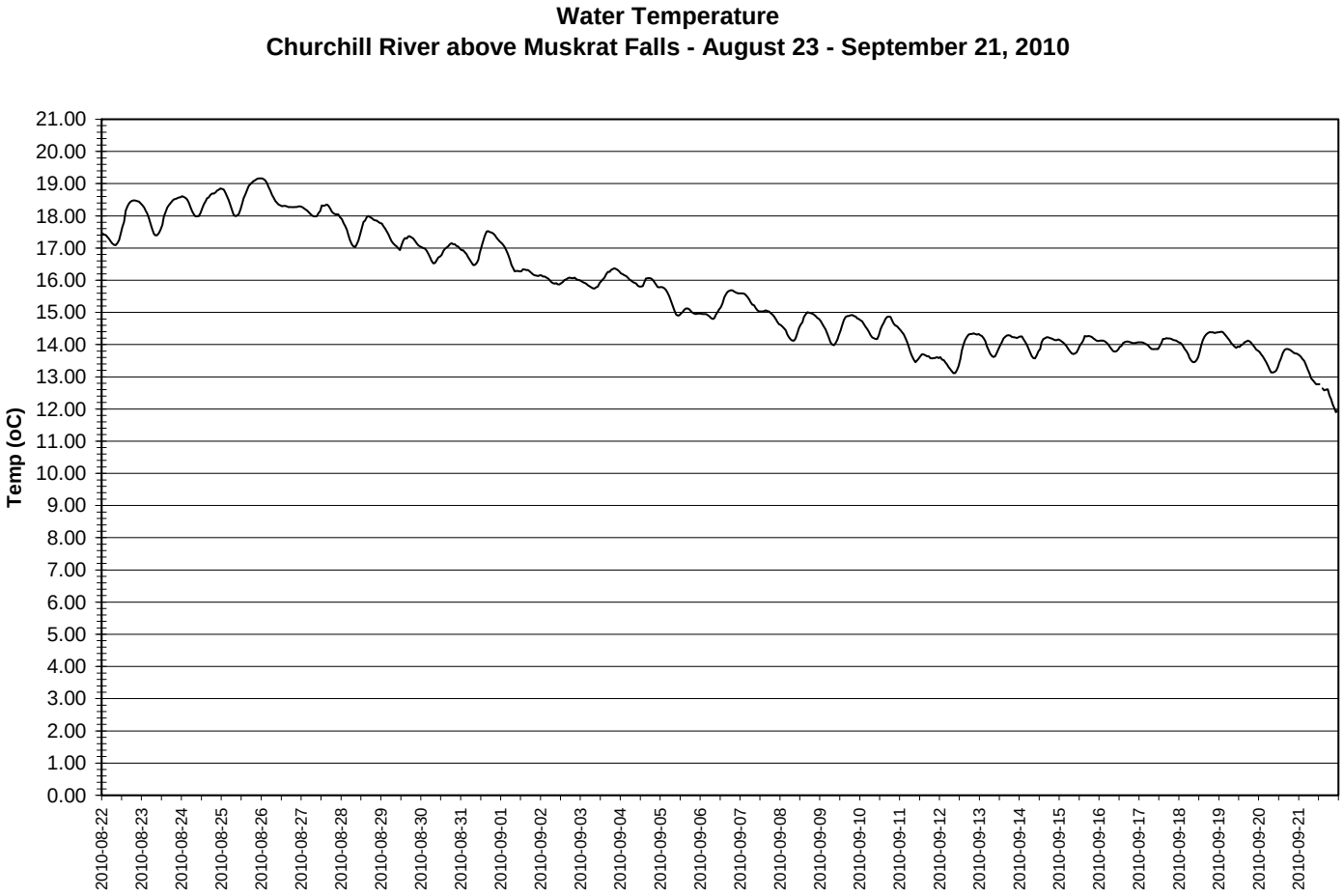

Figure 6: Water temperature at Churchill River above Muskrat Falls

- pH ranges between 7.14 and 7.43 pH units (Figure 7). pH values are consistent throughout the deployment period.
- All values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 7).

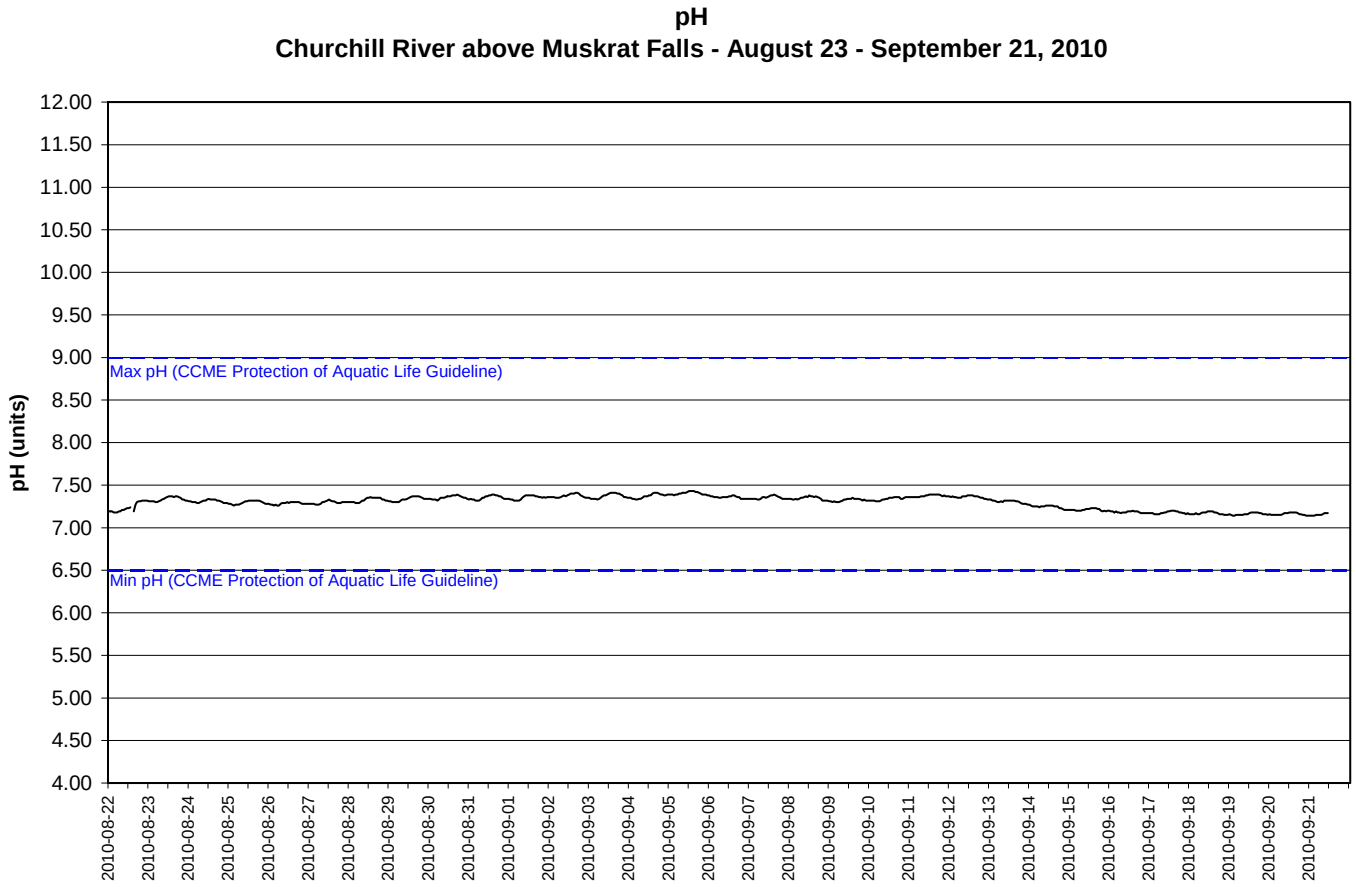

Figure 7: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges between 20.0 and 23.4µS/cm during the deployment period (Figure 8).
- Specific conductivity is variable throughout the deployment period with several increases and decreases. One noticeable increase occurs on August 28 and follows two days of rain in the area. The second noticeable increase occurs on September 7 and also corresponds with several days of precipitation in the area. Both events are indicated on the Figure 8 by red arrows.

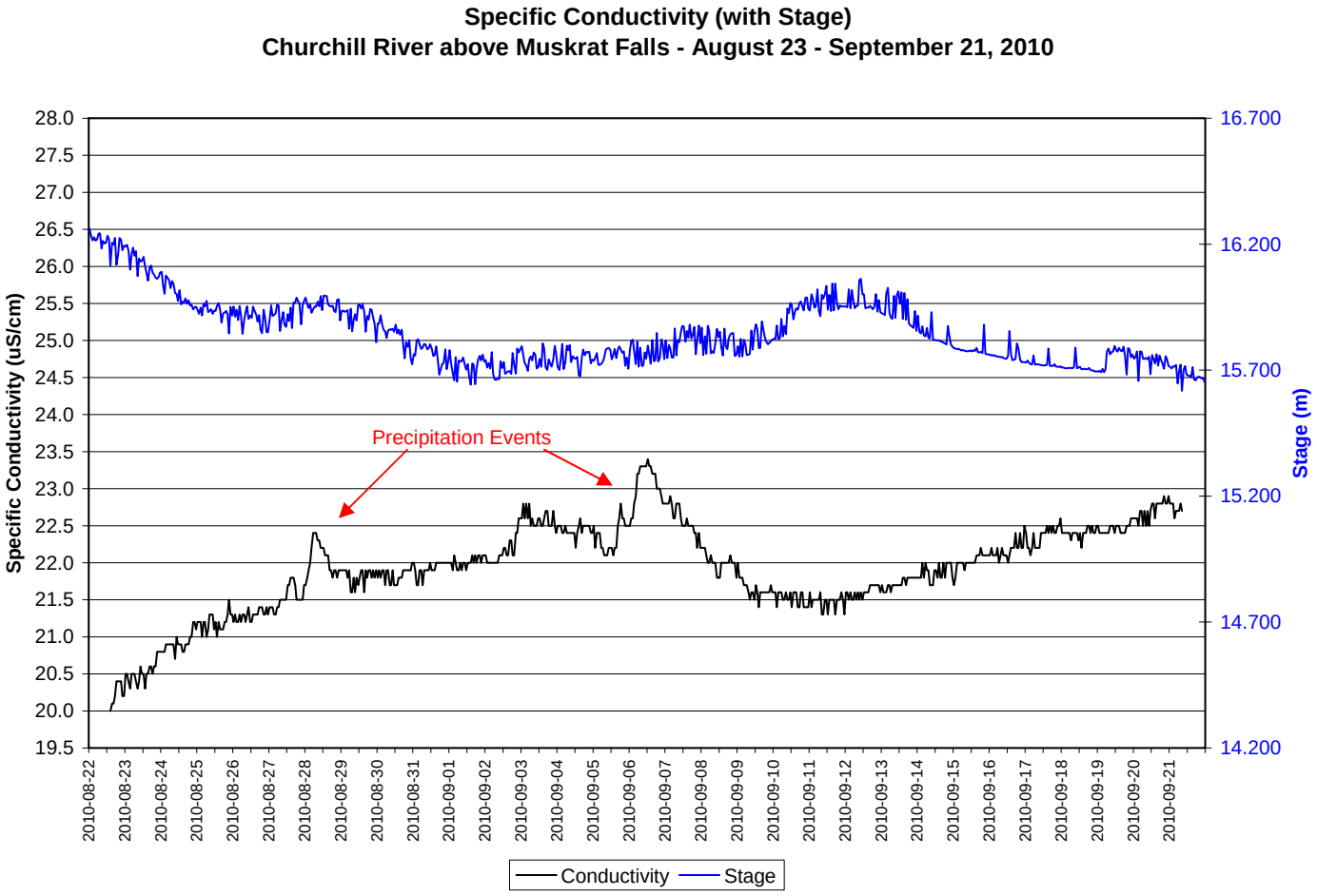

Figure 8: Specific conductivity at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 93.3 to 100.6% and a range of 9.03 to 10.29 mg/l was found in the concentration of dissolved oxygen with a median value of 9.52 mg/l (Figure 9).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. From August 22 to September 7, most values for dissolved oxygen were below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. After September 7, dissolved oxygen content increases above the minimum guideline of 9.5mg/L. The guidelines are indicated in green on Figure 9.
- Dissolved Oxygen content is increasing throughout the deployment period and is remains low for the first half of the deployment. This trend is expected given the warm water temperatures during the first half of the deployment period (Figure 6). As water temperatures cool, dissolved oxygen content increases.

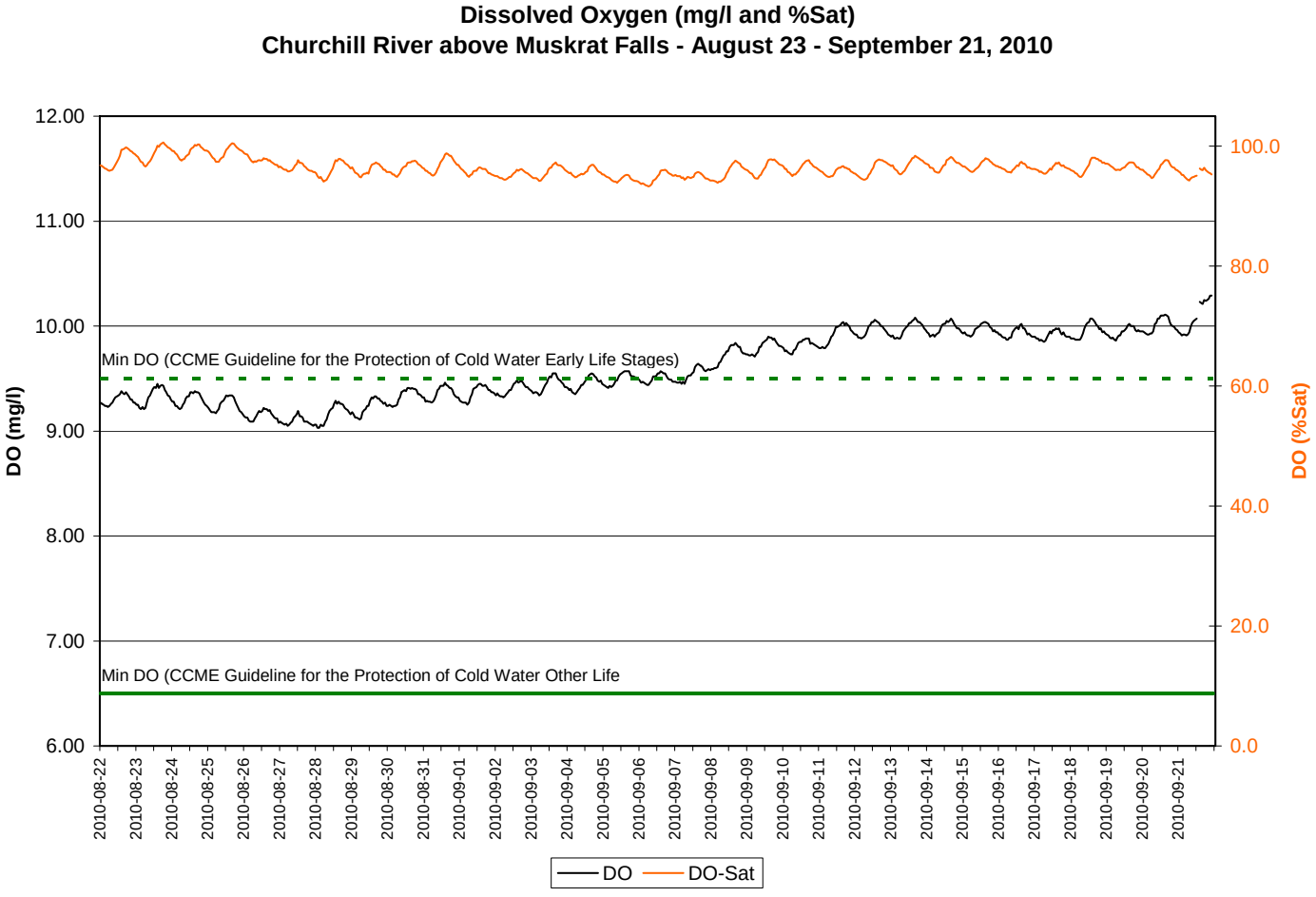

Figure 9: Dissolved oxygen at Churchill River above Muskrat Falls

- A range of 2.0 to 68.0 NTU was recorded for turbidity for this deployment period (Figure 10). A median value of 5.0 NTU indicates there is a consistent natural background turbidity value at this station.
- A rainfall event lasting 2 days near the end of August likely caused a turbidity spike to 68.0NTU on August 30 (indicated in red on Figure 10). Similarly, from September 5-7, increased turbidity values also correspond with a three day precipitation event recorded at Goose Bay (Appendix 1).
- It is unknown what caused an increase in turbidity around September 11 as there is no corresponding weather event recorded in Goose Bay. There is however a clear increase in stage, suggesting that the increase in water level, and turbidity, could have come from upstream. Precipitation data for Churchill Falls is not available for this time period (indicated in green on Figure 10).

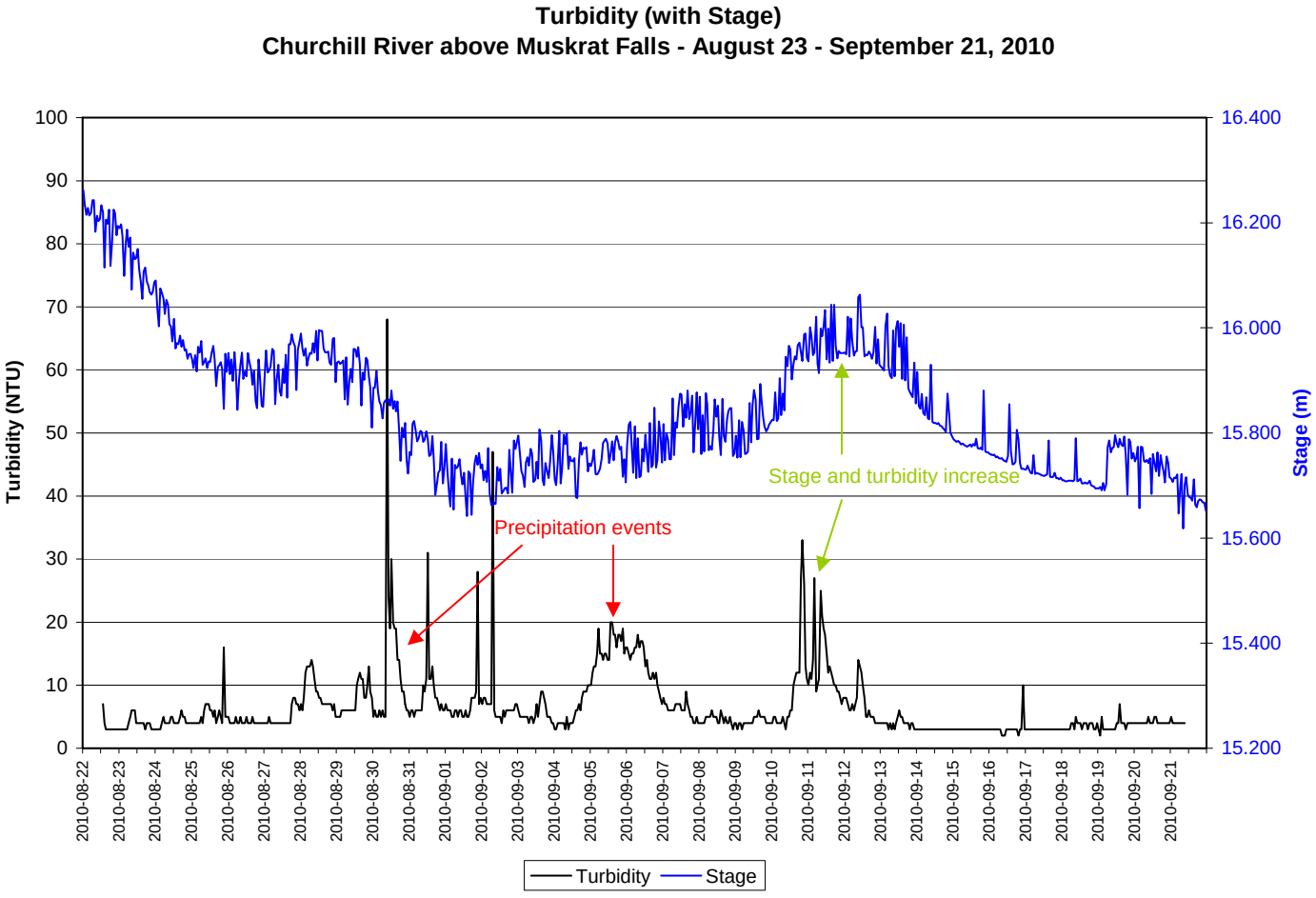

Figure 10: Turbidity at Churchill River above Muskrat Falls

Churchill River below Grizzle Rapids

- A transmission error occurred on July 12 and the instruments internal log file was recovered to provide information for this period. Stage and flow data is not available for this time.
- Water temperature ranges from 11.72 to 19.60^{o}C during this deployment period (Figure 11).
- Water temperature is decreasing throughout the deployment period (Figure 11). This trend is expected given the decreasing ambient air temperatures (Appendix 1). Water temperature fluctuates diurnally.

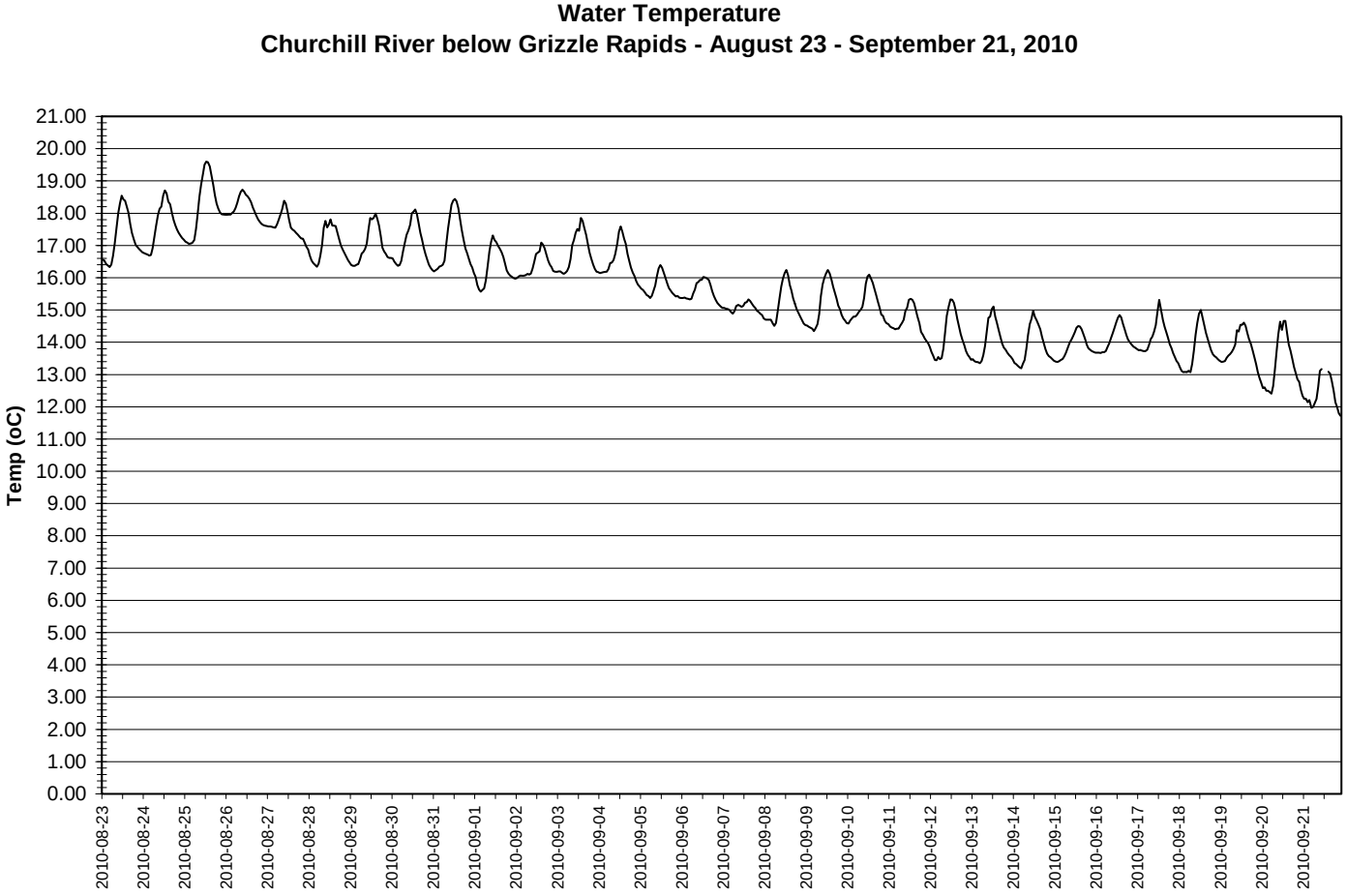

Figure 11: Water temperature at Churchill River below Grizzle Rapids

- pH ranges between 7.13 and 7.49 pH units (Figure 12). pH values are consistent throughout the deployment period.
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 12).

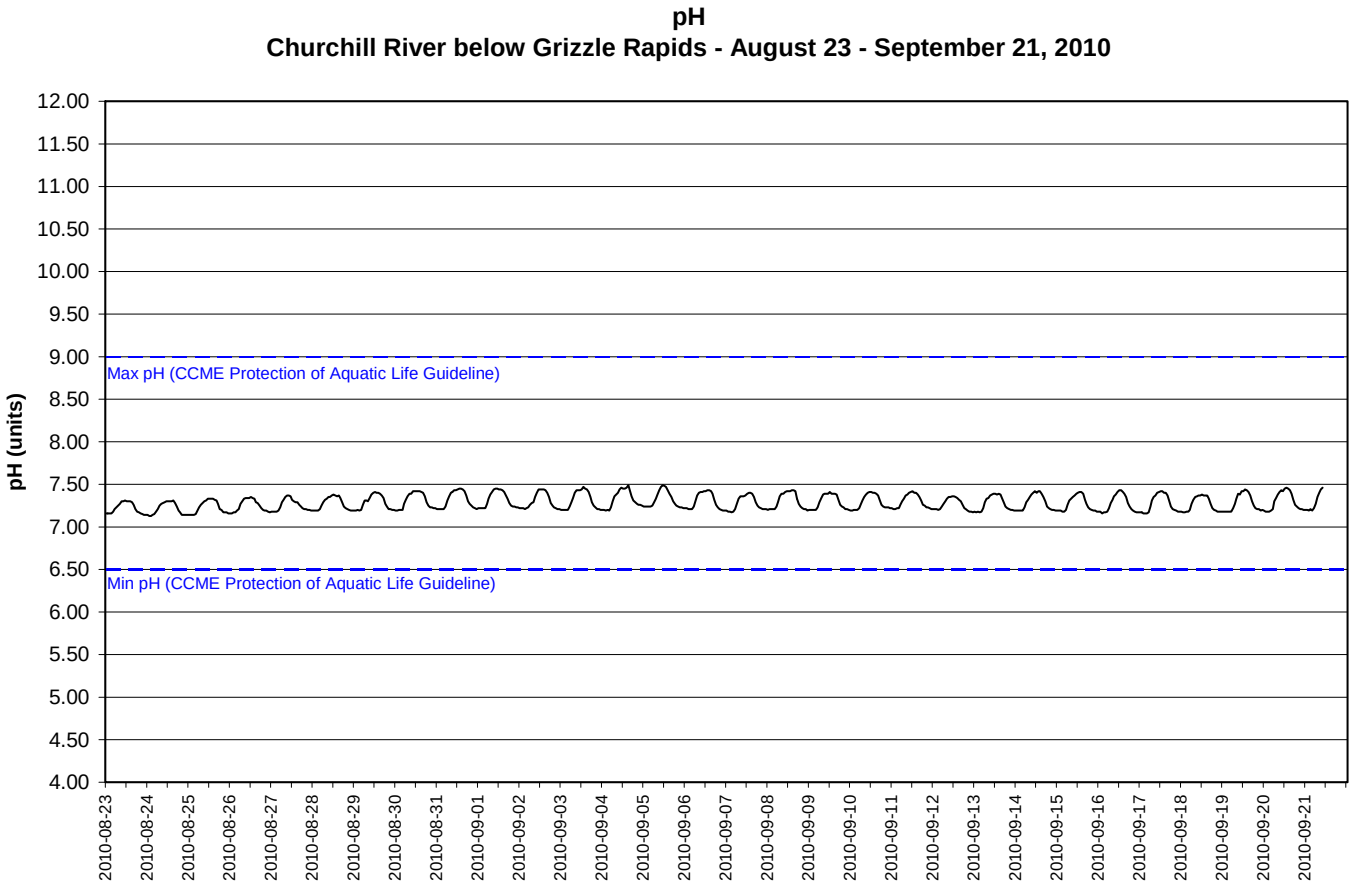

Figure 12: pH at Churchill River below Grizzle Rapids

- Data recovered from the instruments internal log file after July 12 only measures conductivity to 0 decimal places.
- Specific conductivity ranges between 19.0 and 22.0µS/cm during the deployment period (Figure 13). Specific conductance generally increases throughout the deployment period.

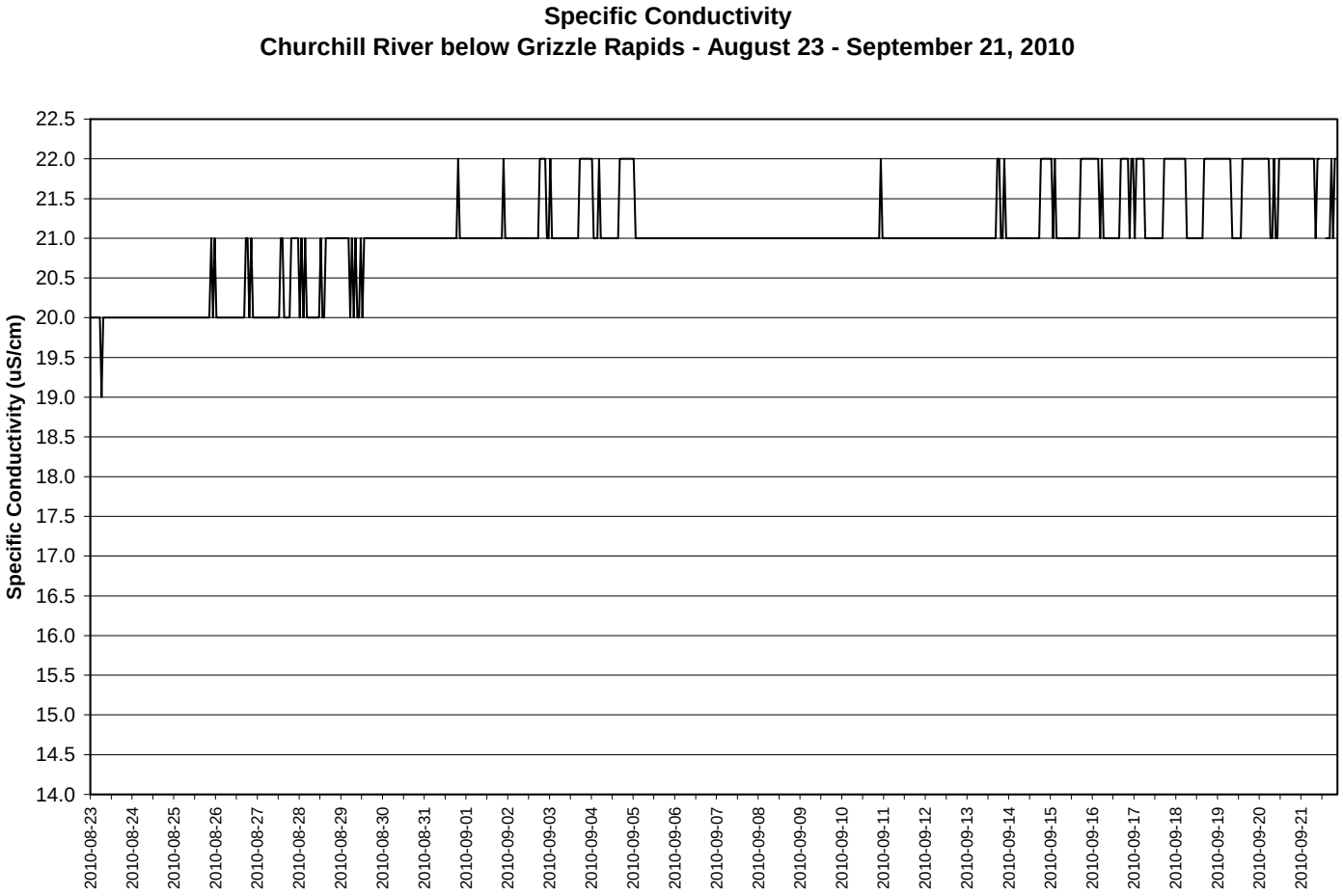

Figure 13: Specific conductivity at Churchill River below Grizzle Rapids

- The saturation of dissolved oxygen ranged from 91.4 to 100.1% and a range of 8.89 to 10.32 mg/l was found in the concentration of dissolved oxygen with a median value of 9.48 mg/l (Figure 14).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. From August 22 to September 7, all values were below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. After September 7, dissolved oxygen content increases to above the minimum guideline of 9.5mg/L. The guidelines are indicated in green on Figure 14.
- Dissolved oxygen content is increasing throughout the deployment period and remains low for the first half of the deployment. This trend is expected given the warm water temperatures during the first half of the deployment period (Figure 11). As water temperatures cool, dissolved oxygen content increases.

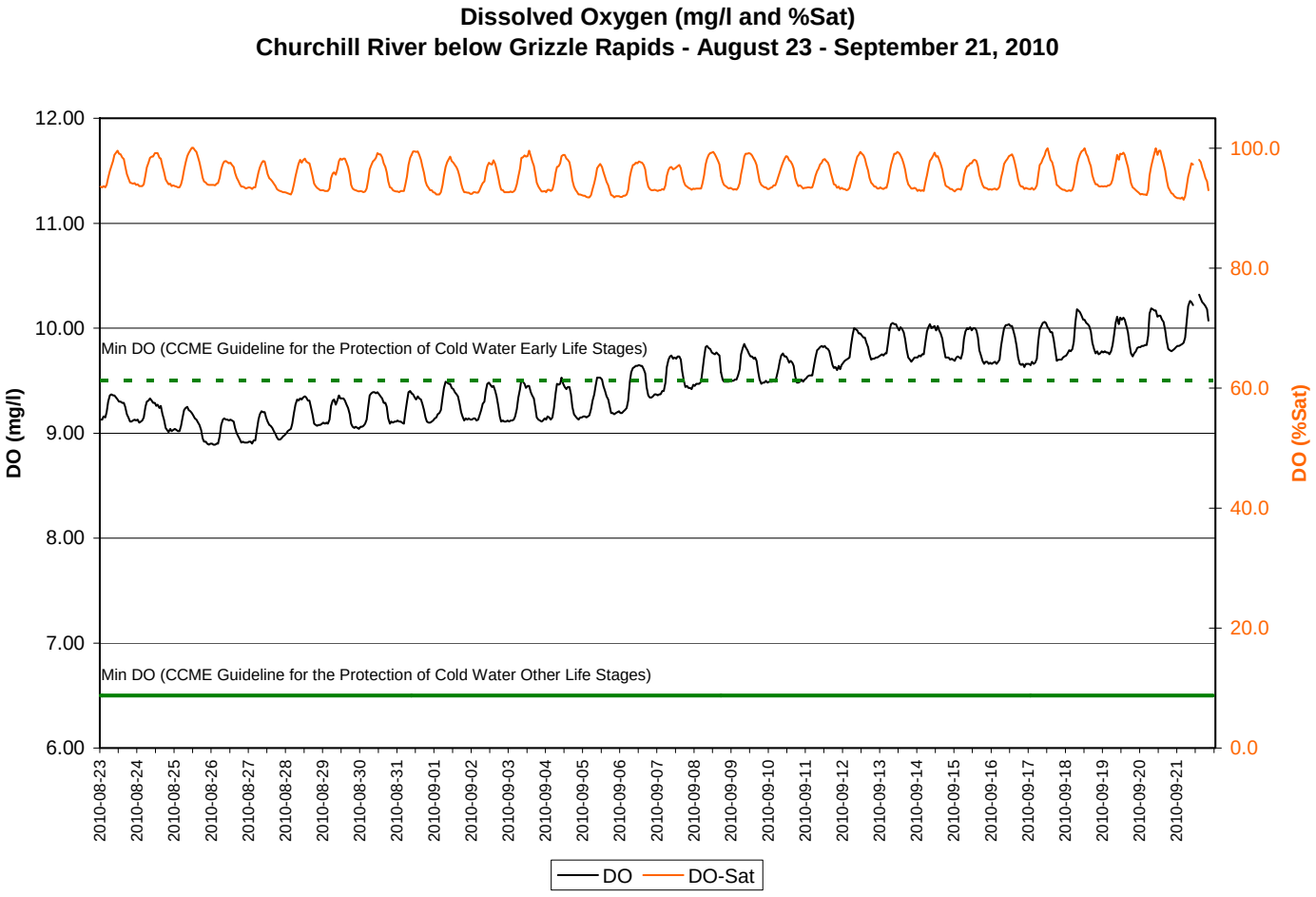

Figure 14: Dissolved oxygen at Churchill River below Grizzle Rapids

- Turbidity remains at 0.0NTU for the entire deployment period. This site is naturally clear with very few turbidity events.

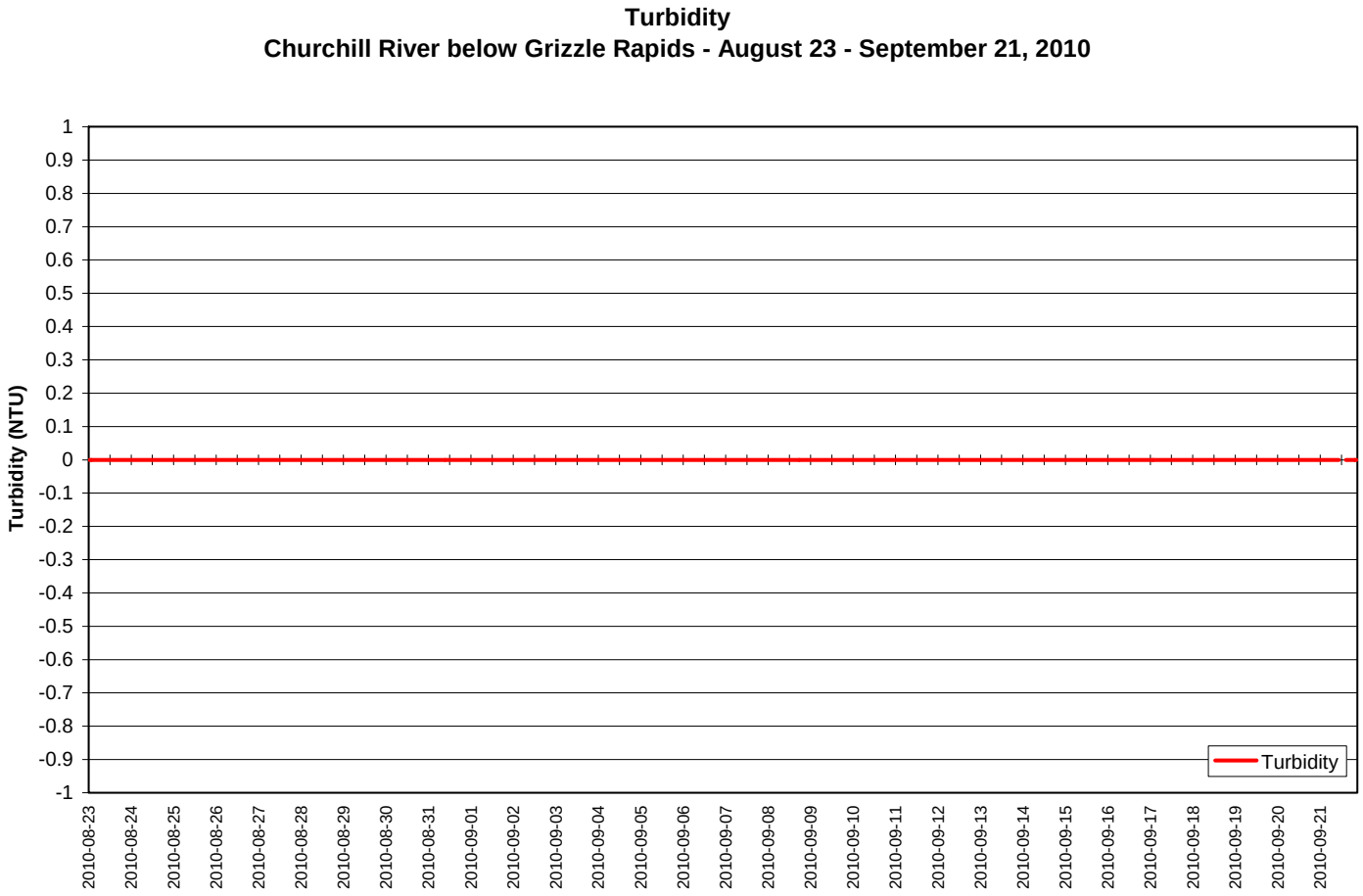

Figure 15: Turbidity at Churchill River below Grizzle Rapids

Churchill River below Metchin River

- Water temperature ranges from 11.40 to 18.30^{o}C during this deployment period (Figure 16).
- Water temperature is decreasing throughout the mid-summer deployment period. This trend is expected given decreasing ambient air temperatures (Appendix 1). Water temperature fluctuates diurnally.

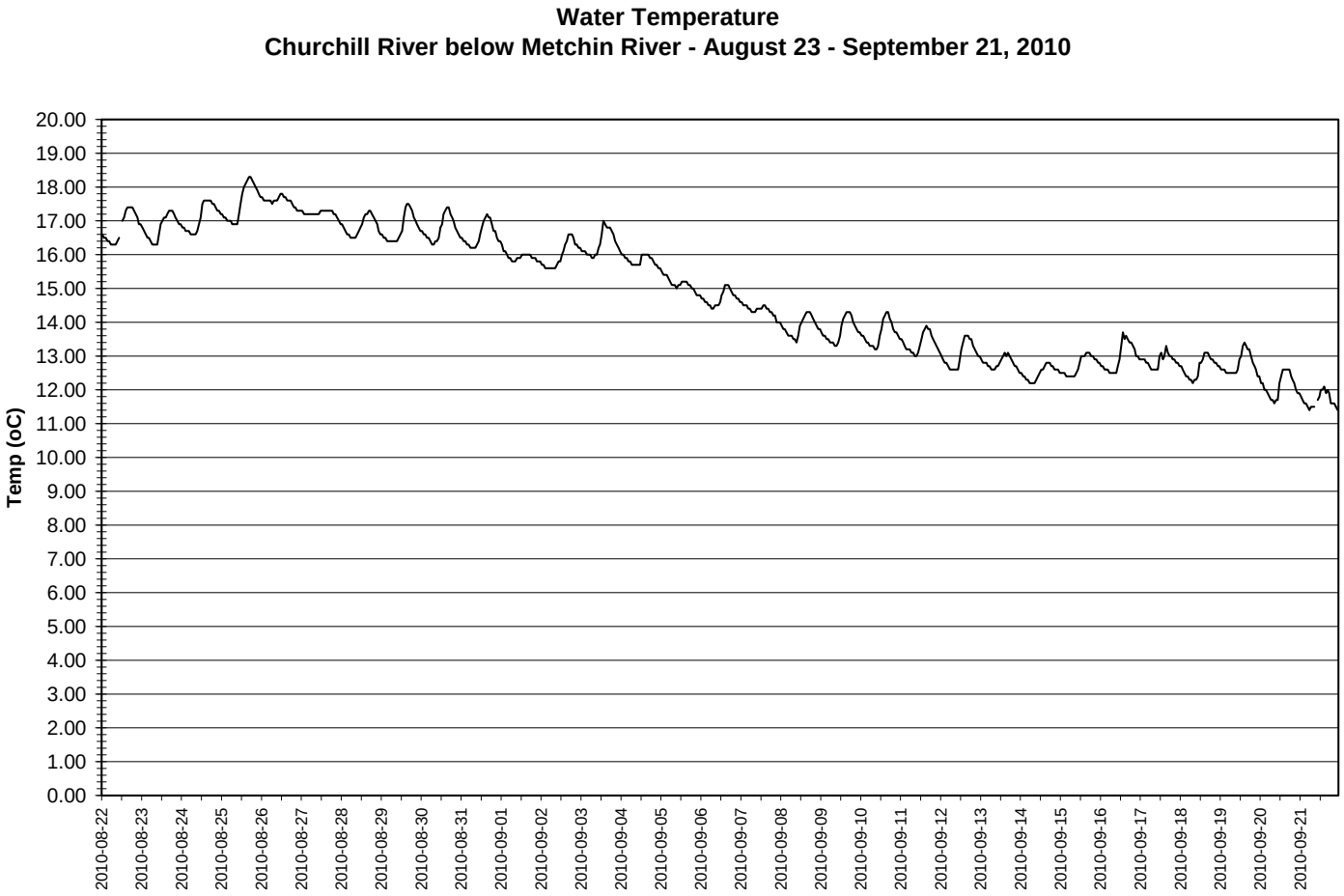

Figure 16: Water temperature at Churchill River below Metchin River

- pH ranges between 7.15 and 7.47 pH units (Figure 17). pH values are consistent throughout the deployment period.
- All values during the deployment are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

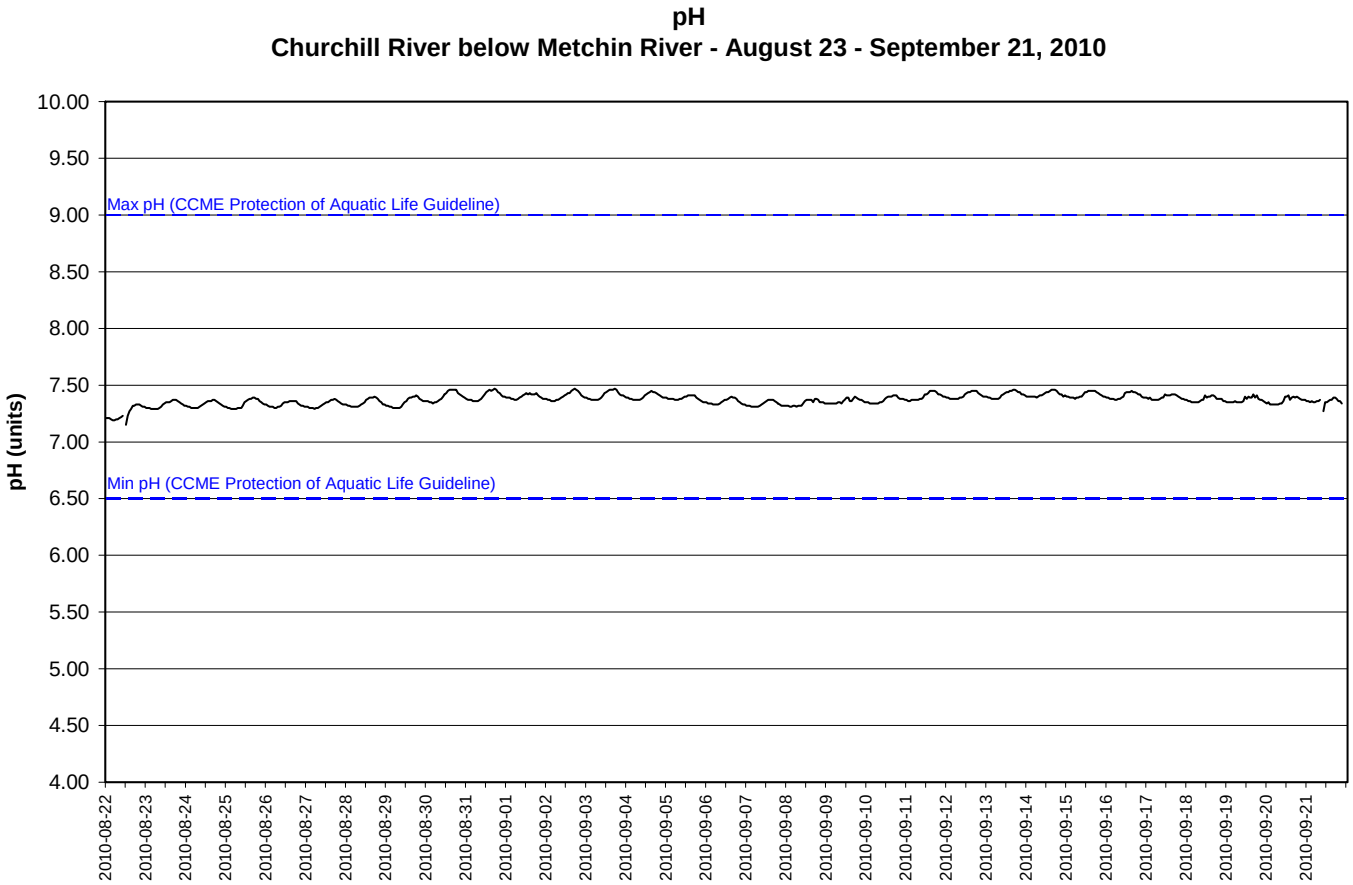

Figure 17: pH at Churchill River below Metchin River

- Specific conductivity ranged from 21.9 to 35.5µS/cm during the deployment period (Figure 18). Specific conductance fluctuates slightly throughout the deployment period.
- Variability in specific conductance most often can be related back to weather events. The nearest weather station to the site below Metchin River is located in Churchill Falls. However, for much of the time between May and November 2010, precipitation data is missing from the dataset. Generally, as stage increases, conductivity decreases. This trend is indicated by the red arrows on Figure 18.
- On September 16, there is a significant spike in conductivity at this site. Values peak to 35.5µS/cm for a period of three hours. The cause of this increase is unknown.

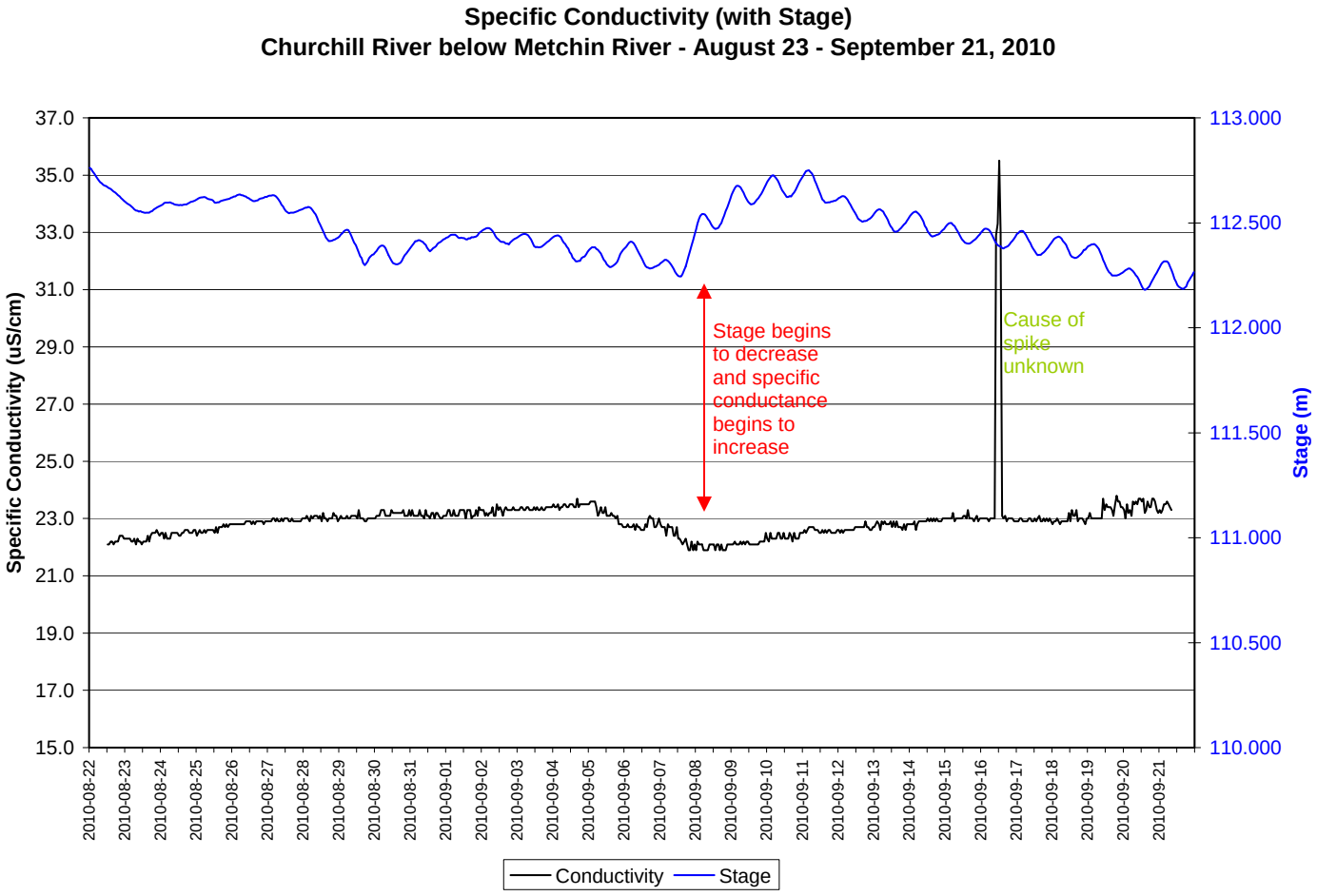

Figure 18: Specific conductivity at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 91.3 to 99.2% and a range of 9.06 to 10.20mg/l was found in the concentration of dissolved oxygen with a median value of 9.41mg/l (Figure 19).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. From August 22 to September 7, all values were below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. After September 7, dissolved oxygen content increases to above the minimum guideline of 9.5mg/L. The guidelines are indicated in green on Figure 19.
- Dissolved oxygen content is increasing throughout the deployment period and remains low for the first half of the deployment. This trend is expected given the warm water temperatures during the first half of the deployment period (Figure 16). As water temperatures cool, dissolved oxygen content increases.

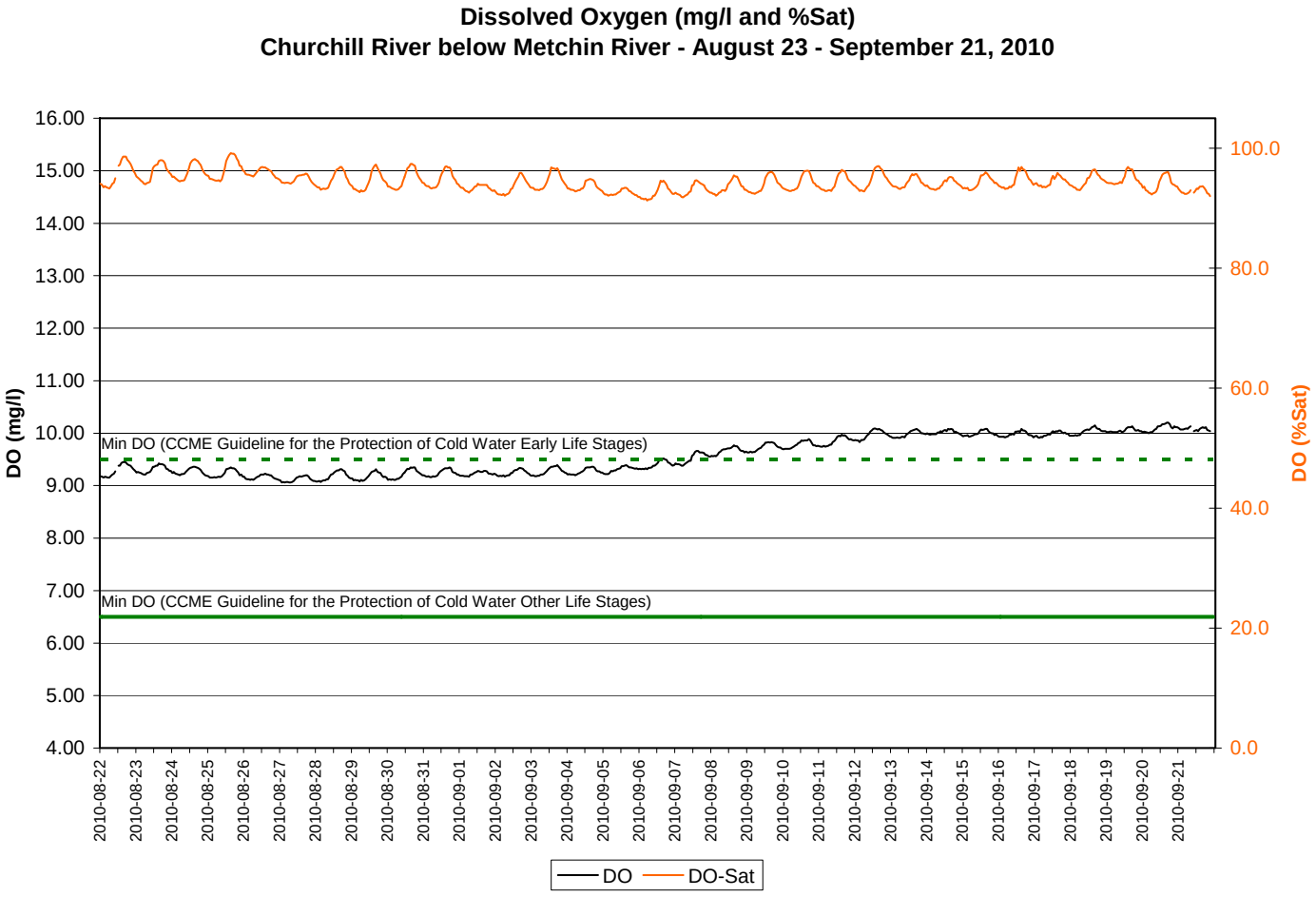

Figure 19: Dissolved oxygen at Churchill River below Metchin River

- A range of 0.0 to 6.9 NTU was recorded for turbidity for this deployment period (Figure 20). A median value of 0.0 NTU indicates this site is naturally clear with out significant background turbidity values.
- Turbidity values remain at or near 0.0NTU for the entire deployment period. Spikes are of minimal magnitude (<7NTU).

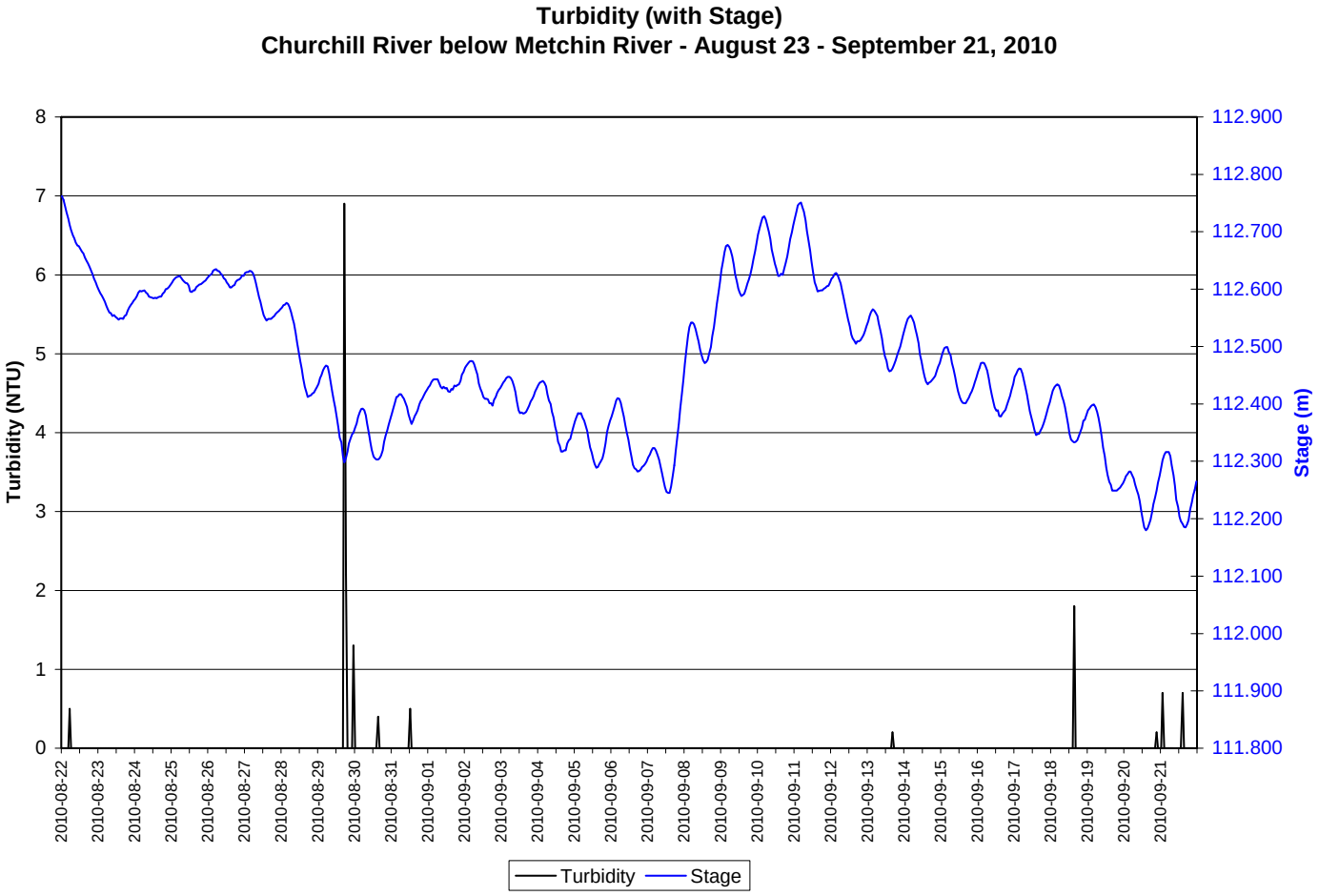

Figure 20: Turbidity at Churchill River below Metchin River

Conclusions

- Instruments at water quality monitoring stations on the Lower Churchill River were deployed at all four stations between August 23 and September 21.
- No significant water quality events were captured during this time. In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations.
- All values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH. Dissolved oxygen content was below the CCME Guideline for the Protection of Aquatic Life at Early Life Stages for the first half of the deployment period for stations above Muskrat Falls, below Grizzle Rapids and below Metchin River.
- A transmission error at the station below Grizzle Rapids prevented data from being transmitted in real time between July 12 and September 21. The instruments internal log file was recovered to provide data for this period.

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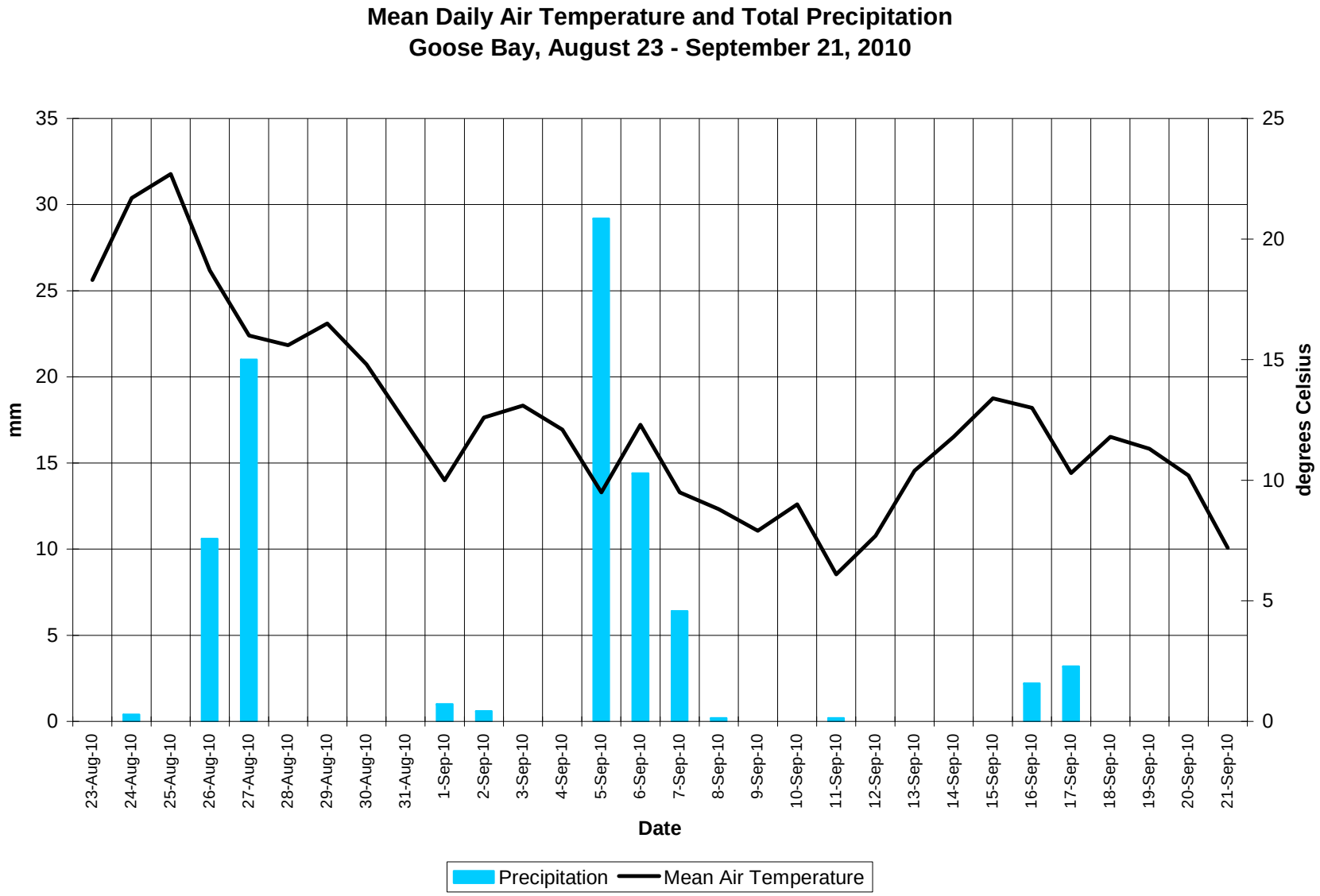
Appendix 1


Mean Daily Air Temperature and Total Precipitation
Goose Bay, August 23 - September 21, 2010
mm
degrees Celsius
Date
Precipitation
Mean Air Temperature
0
5
10
15
20
25
30
35
23-Aug-10
24-Aug-10
25-Aug-10
26-Aug-10
27-Aug-10
28-Aug-10
29-Aug-10
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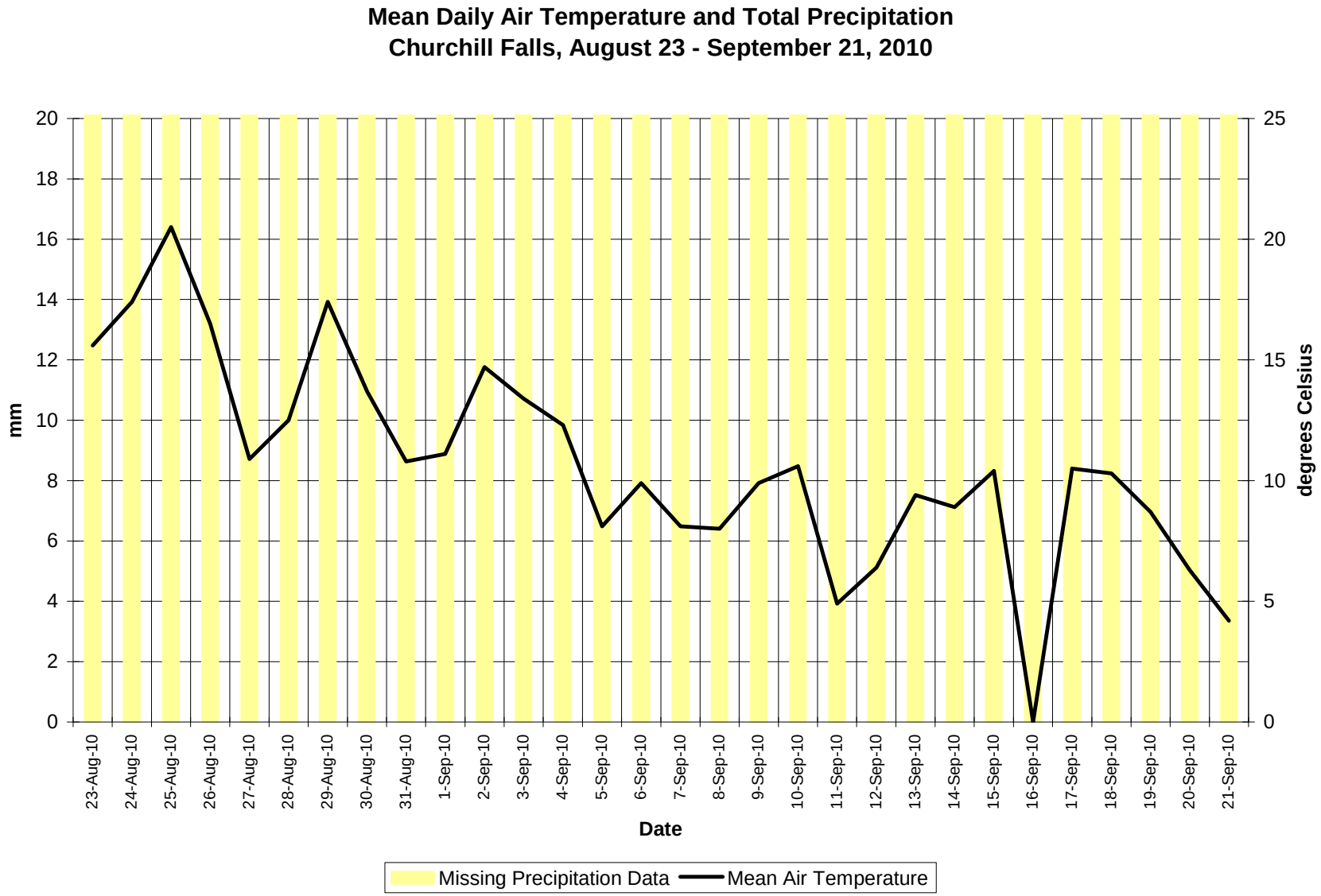
Mean Daily Air Temperature and Total Precipitation
Churchill Falls, August 23 - September 21, 2010
mm
degrees Celsius
Date
Missing Precipitation Data
Mean Air Temperature