Real-Time Water Quality Deployment Report

Lower Churchill River Network

August 21 to
September 25, 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 August 21-22, 2012, real-time water quality monitoring instruments were deployed at the four Lower Churchill River Stations for a period of 34-35 days. Instruments were removed on September 25.

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 August 21-22 to September 25, 2012 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, August 21-22 – September 25, 2012

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45701)	Aug 21, 2012	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Sep 25, 2012	Removal	Good	Good	Excellent	n/a†	Excellent
Below Grizzle Rapids (45042)	Aug 21, 2012	Deployment	Good	Good	Excellent	Excellent	Excellent
	Sep 25, 2012	Removal	Excellent	Excellent	Excellent	n/a†	Excellent
Above Muskrat Falls (47589)	Aug 21, 2012	Deployment	Excellent	Excellent	Good	Excellent	Good
	Sep 25, 2012	Removal	Excellent	Excellent	Excellent	n/a†	Excellent
Below Muskrat Falls (47590)	Aug 22, 2012	Deployment	Good	Good	Good	n/a‡	Good
	Sep 25, 2012	Removal	Good	Excellent	Good	n/a†	Good

†Comparison ranking unavailable due to dissolved oxygen sensor malfunction on the QAQC instrument 47589 on September 25.

‡Comparison ranking unavailable due to dissolved oxygen malfunction on QAQC instrument 47592 on August 22.

- At the station below Metchin River, all parameters ranked either ‘good’ or ‘excellent’ at deployment. At removal, temperature, pH, specific conductivity and turbidity all ranked either ‘good’ or ‘excellent’. Dissolved oxygen was not ranked due to sensor malfunction on the QAQC instrument s/n 47589.
- At the station below Grizzle Rapids, all parameters ranked either ‘good’ or ‘excellent’ at deployment. At removal, temperature, pH, specific conductivity and turbidity all ranked ‘excellent’. Dissolved oxygen was not ranked due to sensor malfunction on the QAQC instrument s/n 47589.
- At the station above Muskrat Falls, all parameters ranked either ‘good’ or ‘excellent’ at deployment. At removal, temperature, pH, specific conductivity and turbidity all ranked ‘excellent’. Dissolved oxygen was not ranked due to sensor malfunction on the QAQC instrument s/n 47589.
- At the station below Muskrat Falls, temperature, pH, specific conductivity and turbidity all ranked ‘good’ at deployment. Dissolved oxygen was not ranked due to sensor malfunction on the QAQC instrument s/n 47592. At removal, temperature, pH, specific conductivity and turbidity all ranked either ‘good’ or ‘excellent’. Dissolved oxygen was again not ranked due to sensor malfunction on the QAQC instrument s/n 47589.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from August 21-22 to September 25 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 11.50°C to 17.90°C during the deployment period (Figure 1).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the cooling air temperatures late in the summer season (Figure 2). Water temperature fluctuates diurnally.

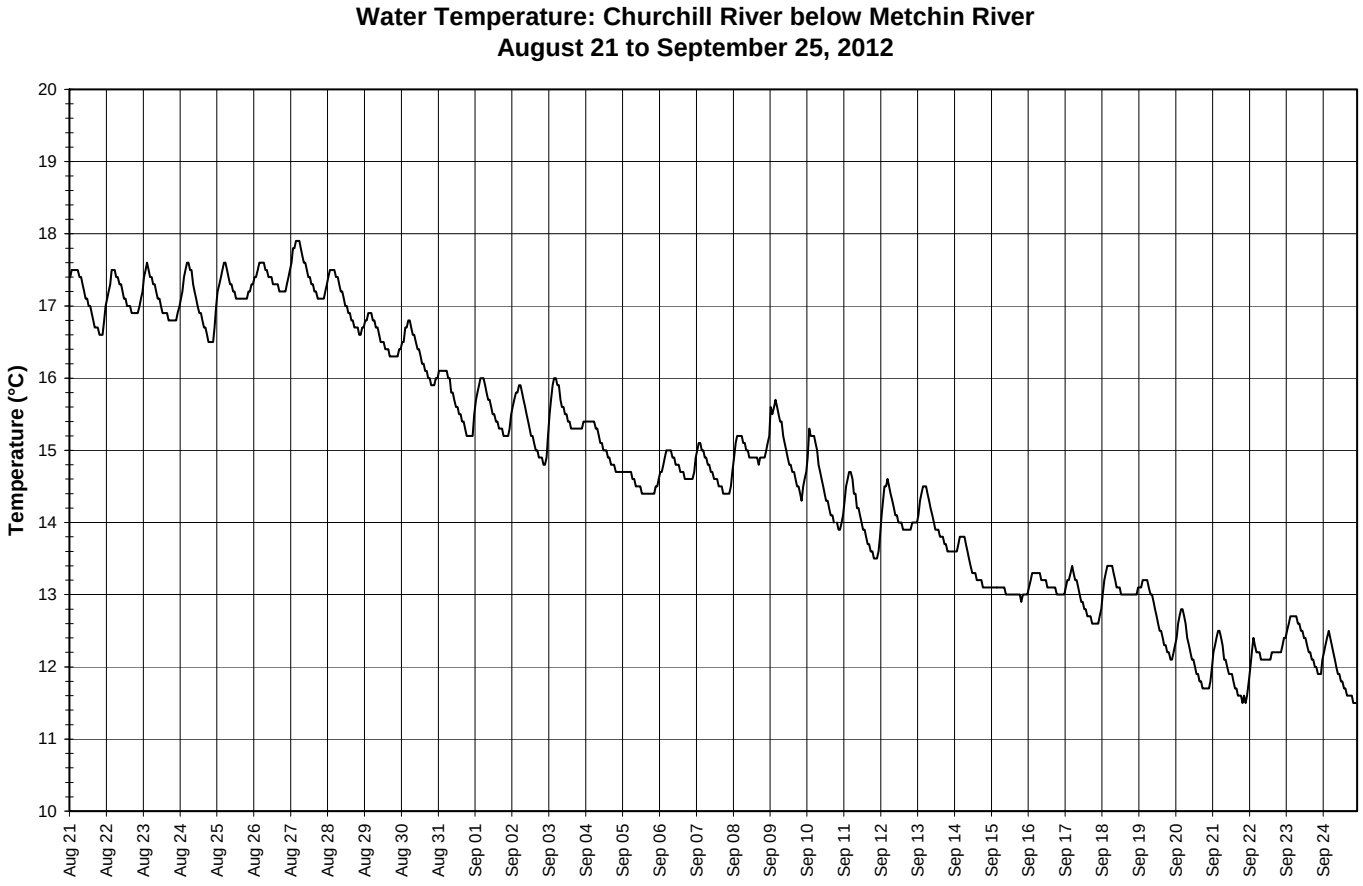

Figure 1: Water temperature at Churchill River below Metchin River

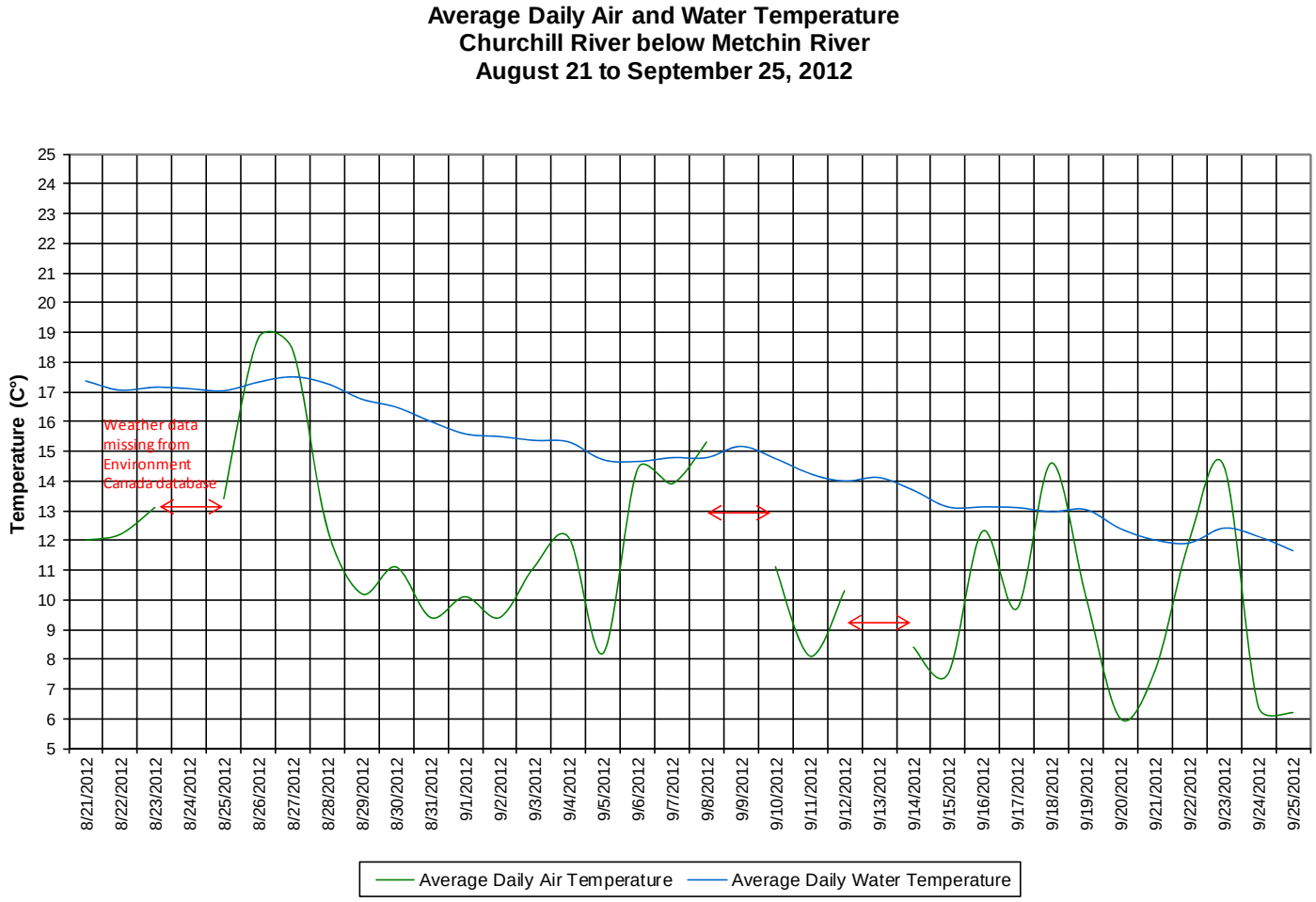

Figure 2: Average daily air and water temperature at Churchill River below Metchin River (weather data recorded at Churchill Falls, NL)

- pH ranges between 7.12 and 7.36 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).
- There is a peak in pH on August 27 to 7.36. This increase corresponds with the warmest water temperatures recorded during the deployment period (Figure 1). No other parameters appear to be affected at this instance.

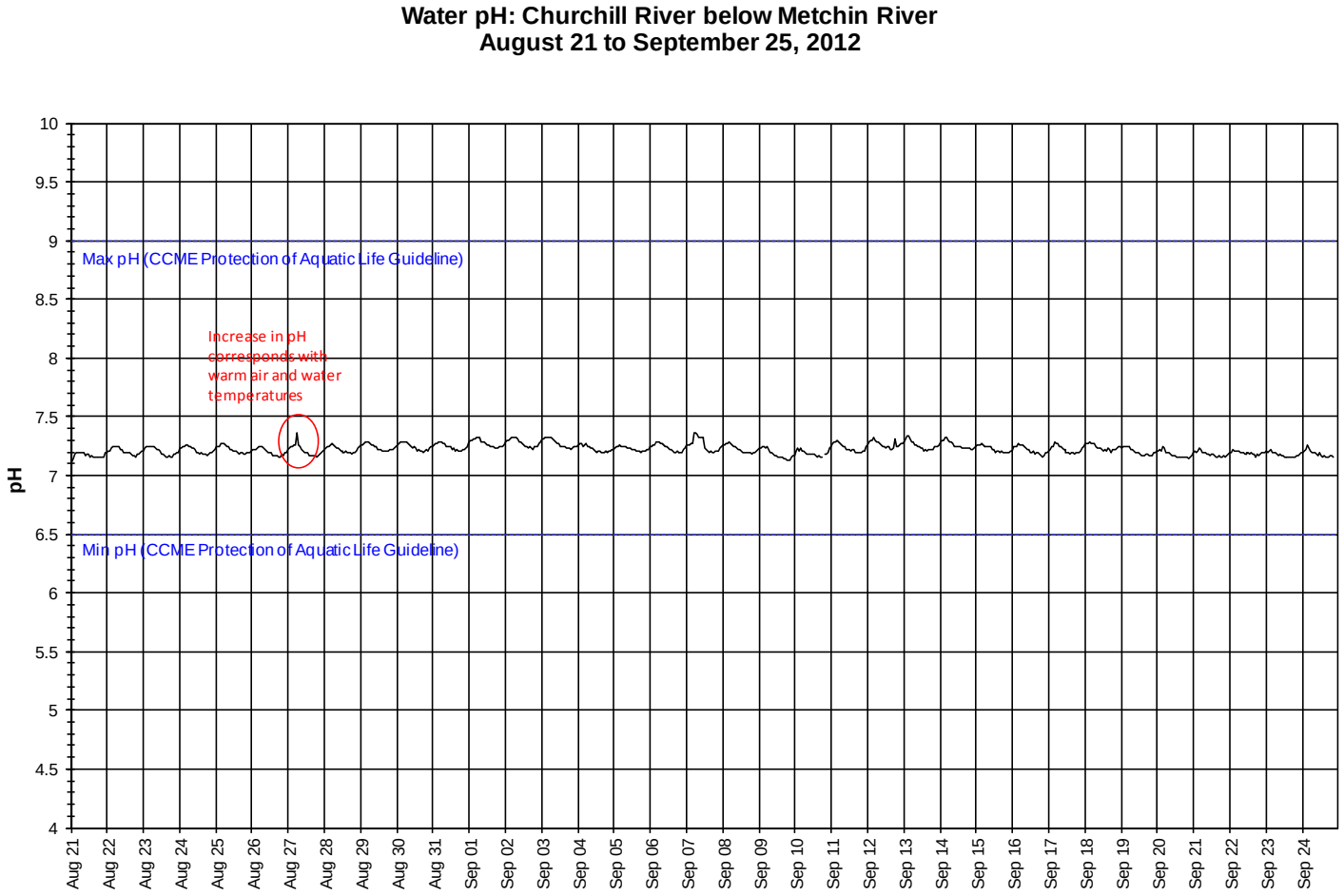

Figure 3: pH at Churchill River below Metchin River

- Specific conductivity generally ranges between 22.0 to 24.5µS/cm during the deployment period, averaging 23.2µS/cm (Figure 4).
- Specific conductivity is increasing slightly in the first three weeks of the deployment period and decreases slightly in the final two weeks. There are 2 instances where specific conductivity increases above this typical range for 1-2 hour periods. Specific conductivity increases to 28.7µS/cm on August 25 and to 47.0µS/cm on September 19. The latter event corresponds with a rainfall event of over 15mm. It is unknown what caused the former event on August 26.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is fluctuating significantly throughout most of 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 necessarily noticeable at this station during this time period as the specific conductivity levels are very stable.

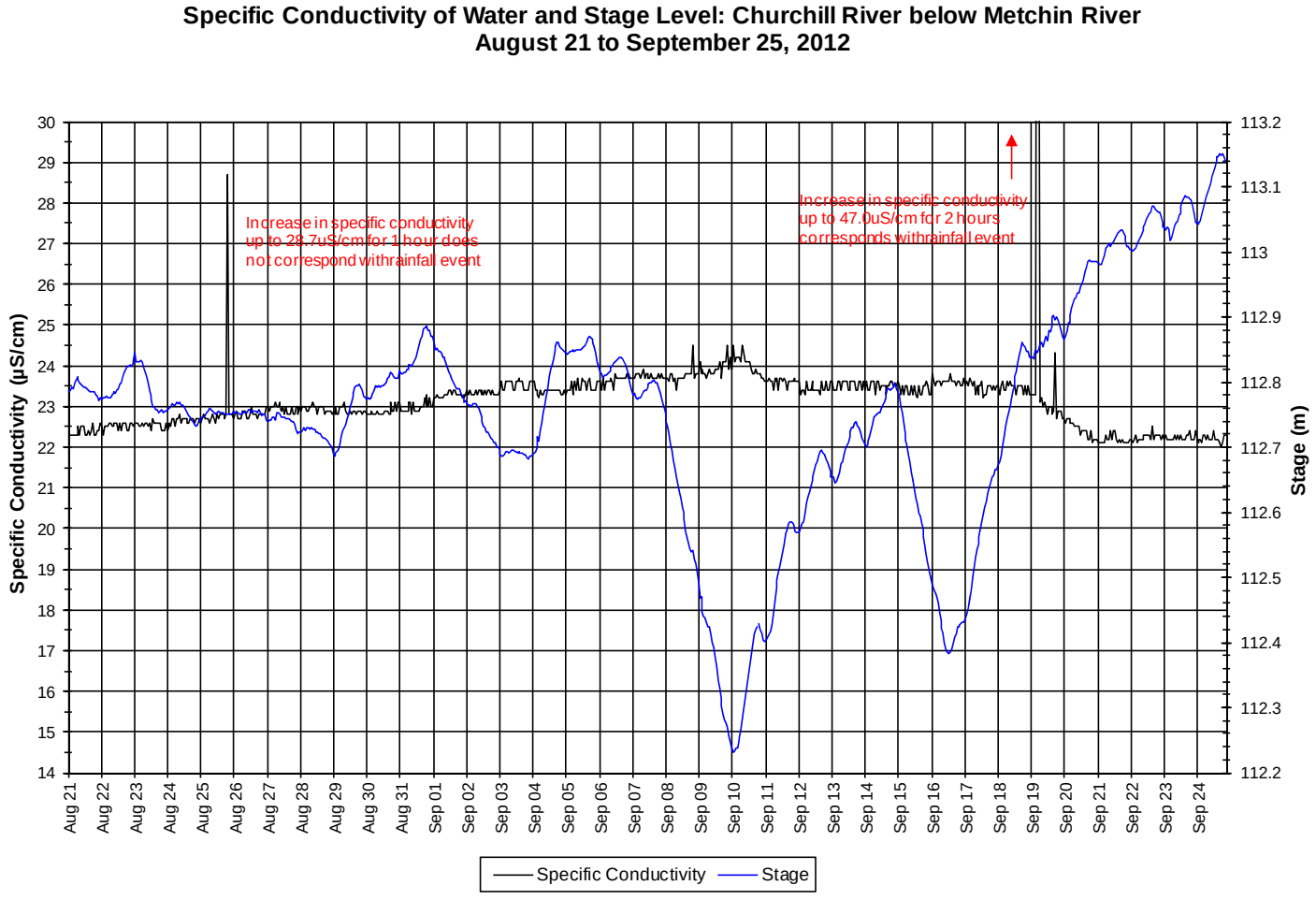

Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- Dissolved oxygen content ranges between 9.10mg/L and 10.44mg/L. The saturation of dissolved oxygen ranges from 92.9 to 98.9% (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. From the beginning of the deployment on August 21 to mid deployment around September 6, values are just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. After September 6, all values remain above this guideline for the remainder of the deployment period. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 2).

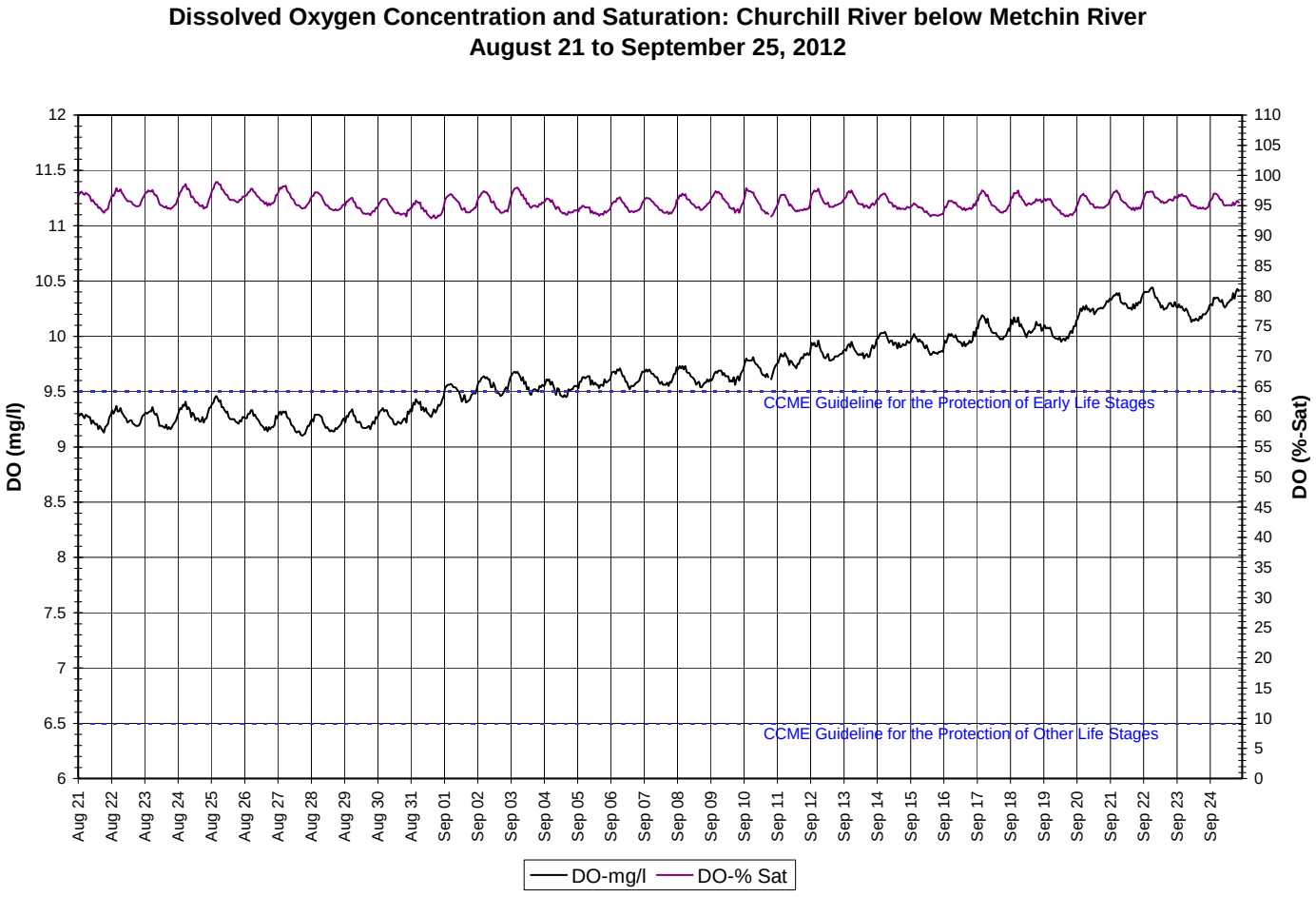

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- 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, lasting for between 1-12 hours. On September 9, turbidity increases up to 69.9NTU. This event lasts for 12 hours and corresponds with a sharp decrease in stage level. On September 17 and 21, turbidity increases each time to around 5NTU for 1-2 hours.

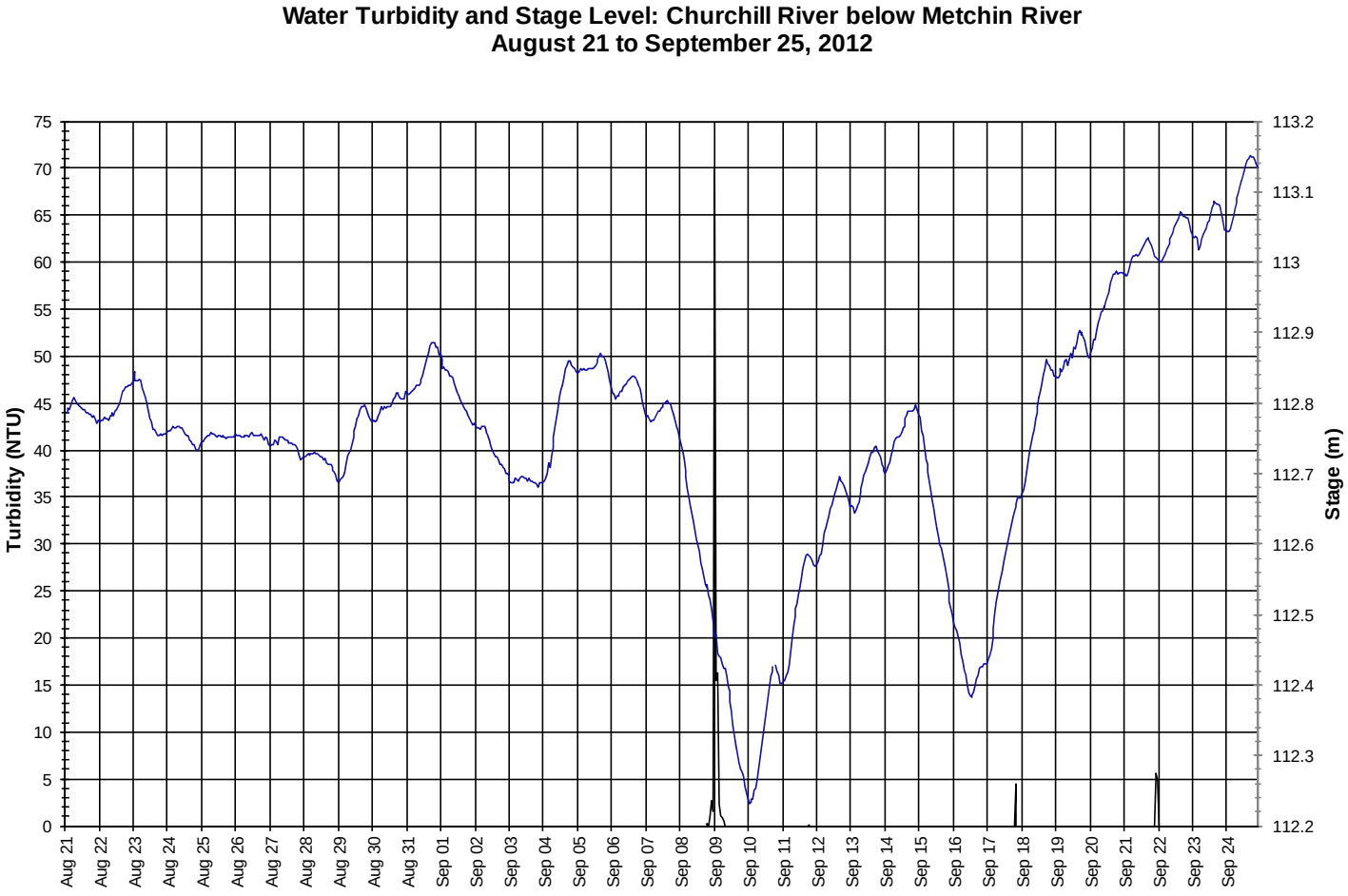

Figure 6: Turbidity and stage level at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is fluctuating throughout the deployment period and increases near the end. Precipitation records vary. Stage ranges between 112.23m and 113.15m, a difference of 0.92m.

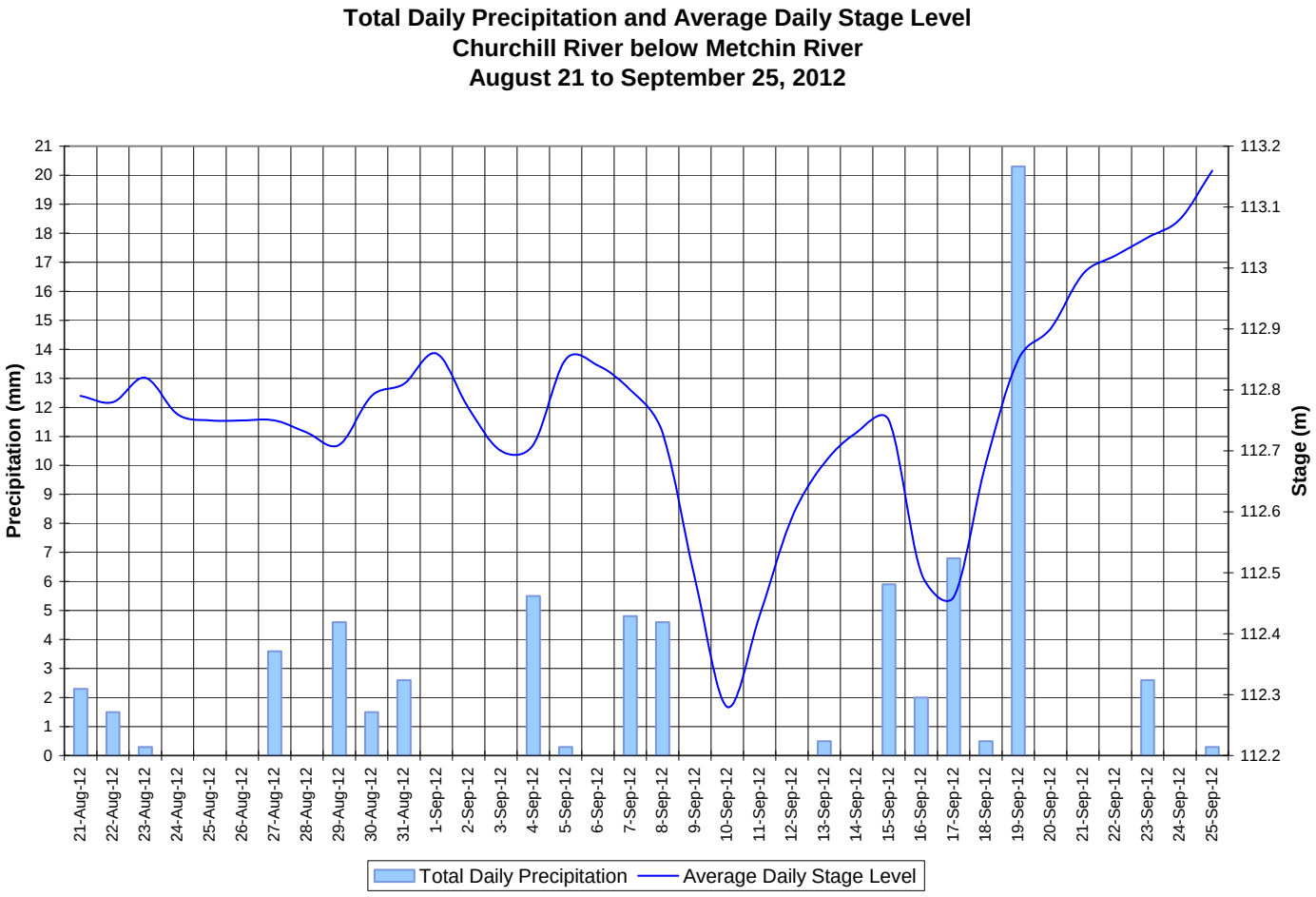

Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- Water temperature ranges from 12.50 to 19.20^{o}C during the deployment period (Figure 8).
- Water temperature is decreasing throughout the deployment period. This trend is expected due to the cooling ambient air temperatures late in the summer season (Figure 9). Water temperature fluctuates diurnally.

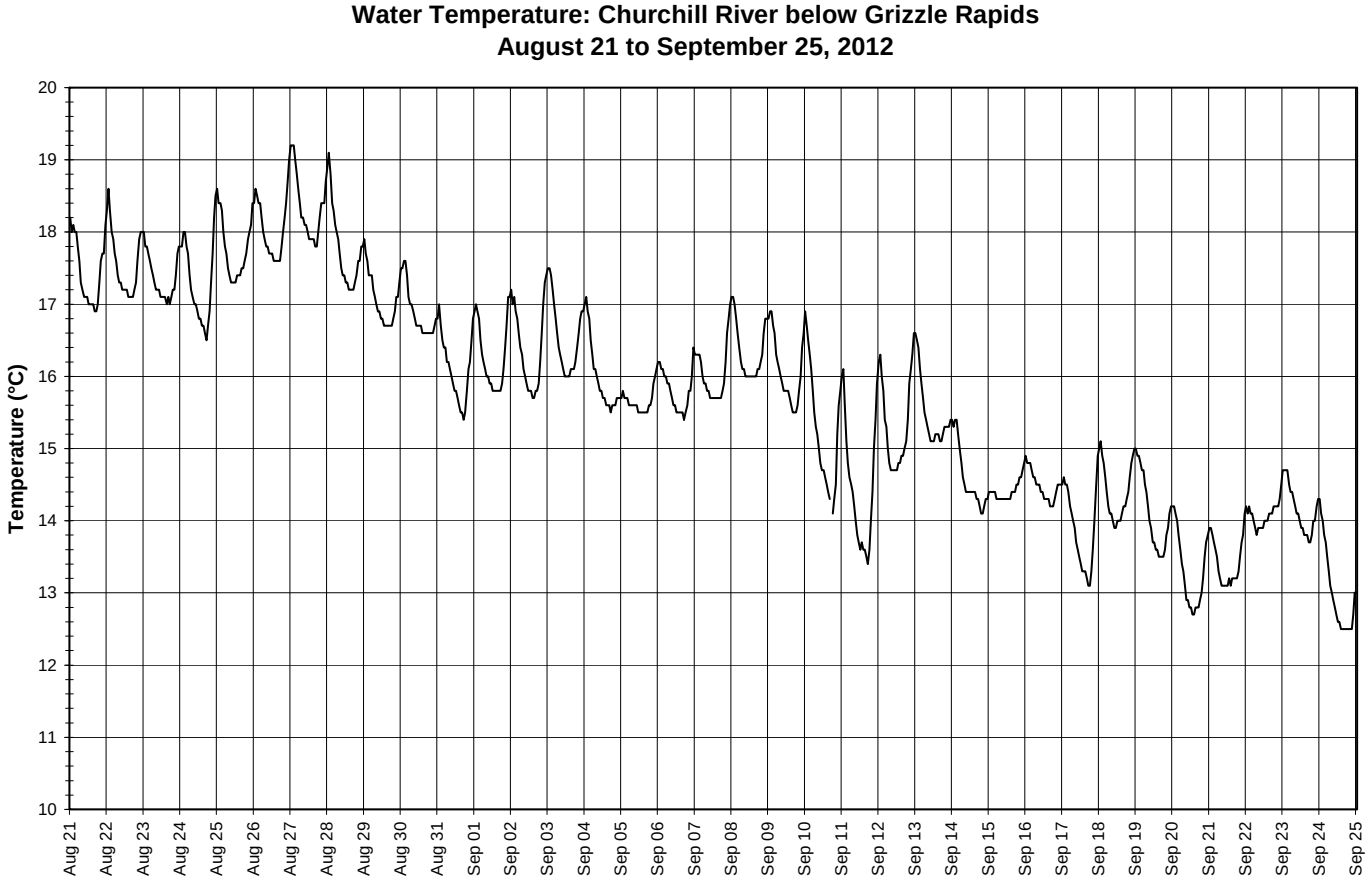

Figure 8: Water temperature at Churchill River below Grizzle Rapids

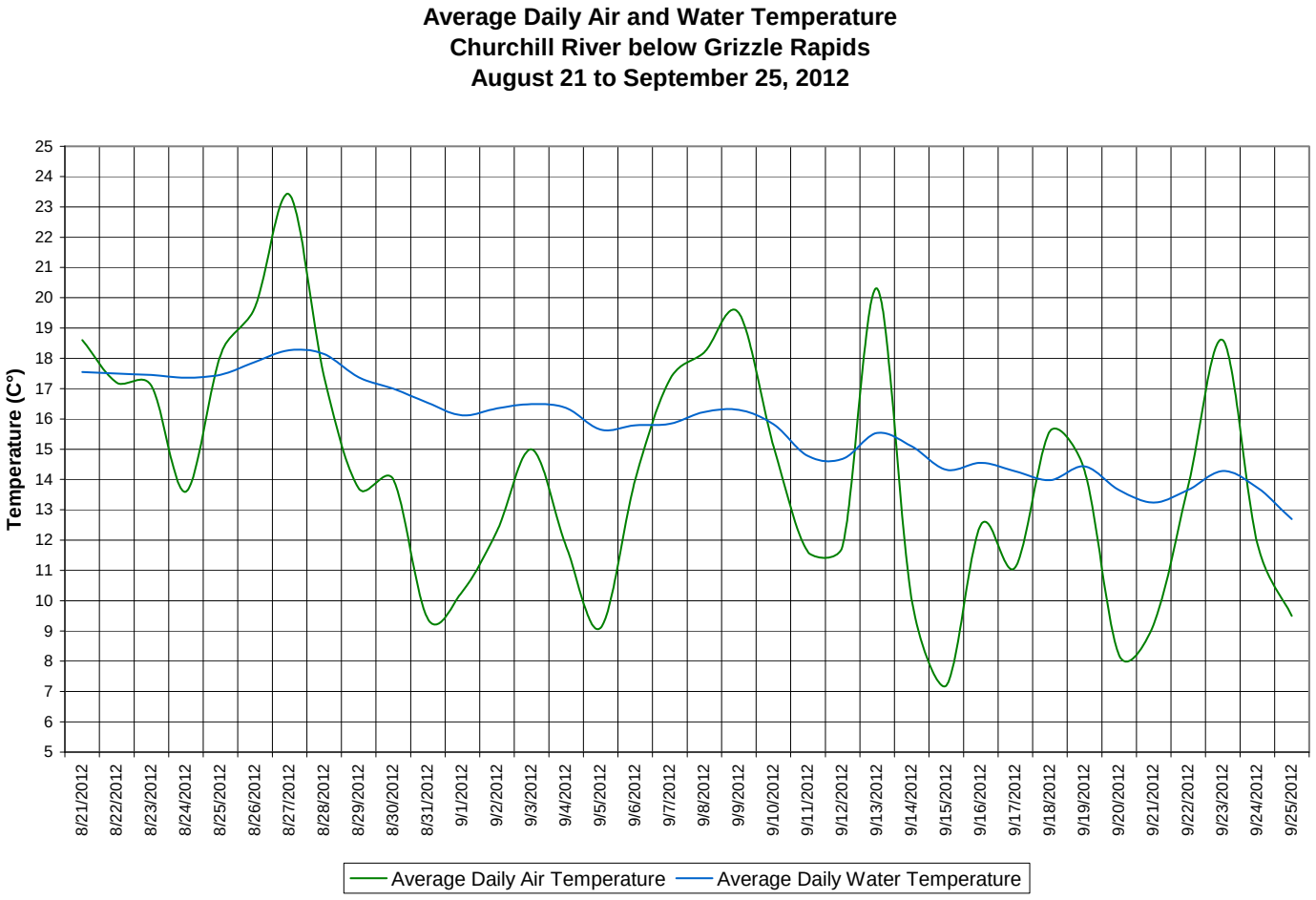

Figure 9: Average daily air and water temperature at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 7.03 and 7.44 pH units and remains very consistent throughout the deployment period, fluctuating diurnally (Figure 10).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10).

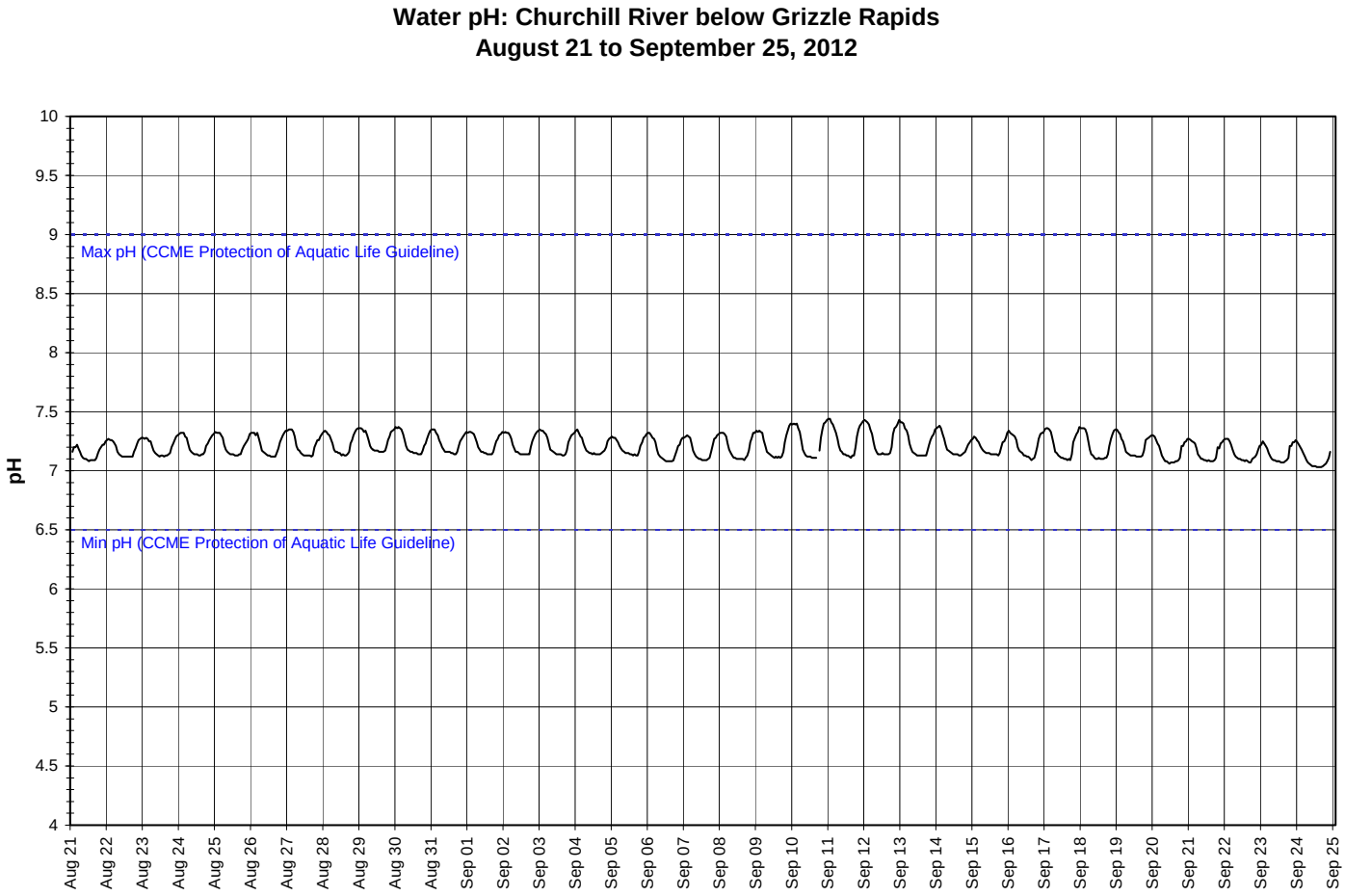

Figure 10: pH at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 21.0 to 24.2µS/cm during the deployment period, averaging 22.0µS/cm (Figure 11).
- Specific conductance is increasing slightly throughout the first three weeks of the deployment period and decreasing in the final two weeks, similar to the trend observed at the station upstream below Metchin River (Figure 4). Specific conductivity generally remains below 23.0µS/cm except for one reading on September 14 to 24.5µS/cm (circled in red on Figure 11). It is unknown what caused this increase.
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Stage is decreasing slightly throughout the deployment period and fluctuates in the latter half. 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 necessarily noticeable at this station during this time period as the specific conductivity levels are very stable.

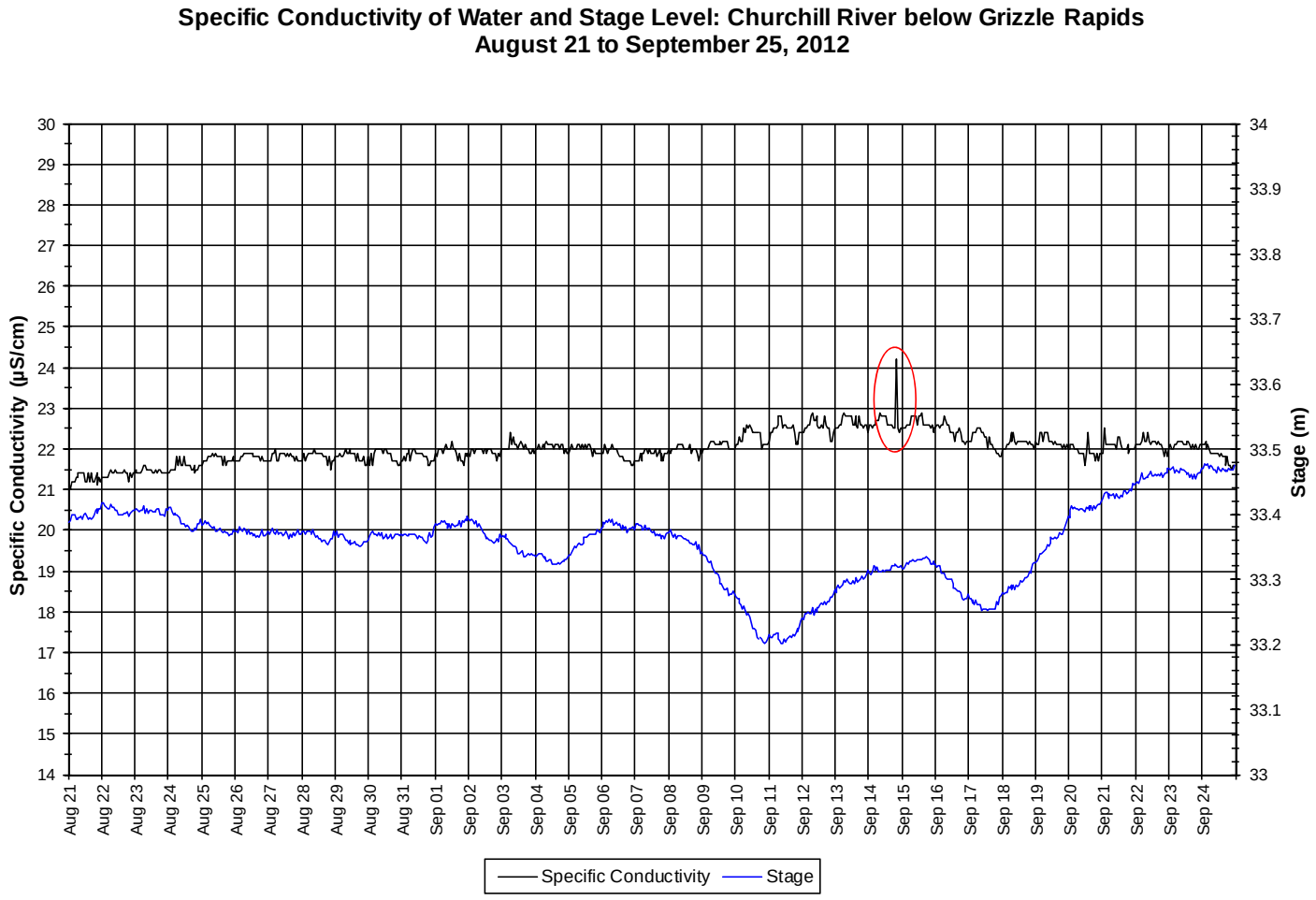

Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- Dissolved oxygen content ranges between 9.15mg/L and 10.50g/L. The saturation of dissolved oxygen ranges from 94.5 to 103.9% (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. From the beginning of the deployment period on August 21 until mid deployment, around September 1, dissolved oxygen values are 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. After September 1, values remain above this guideline. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 9).

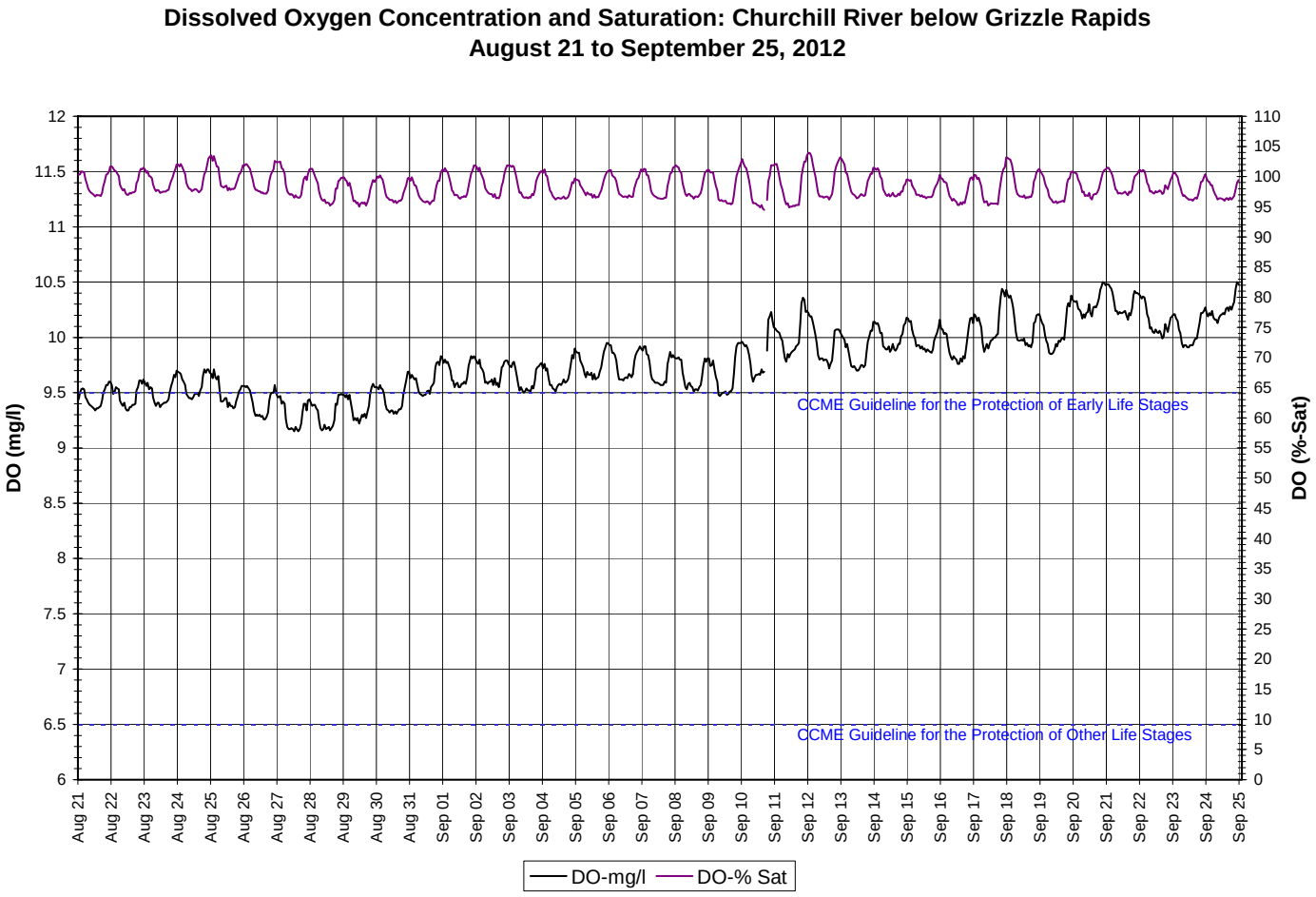

Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values generally remained at 0NTU for the entirety 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. There is one instance where turbidity is recorded at 3NTU for a period of one hour.

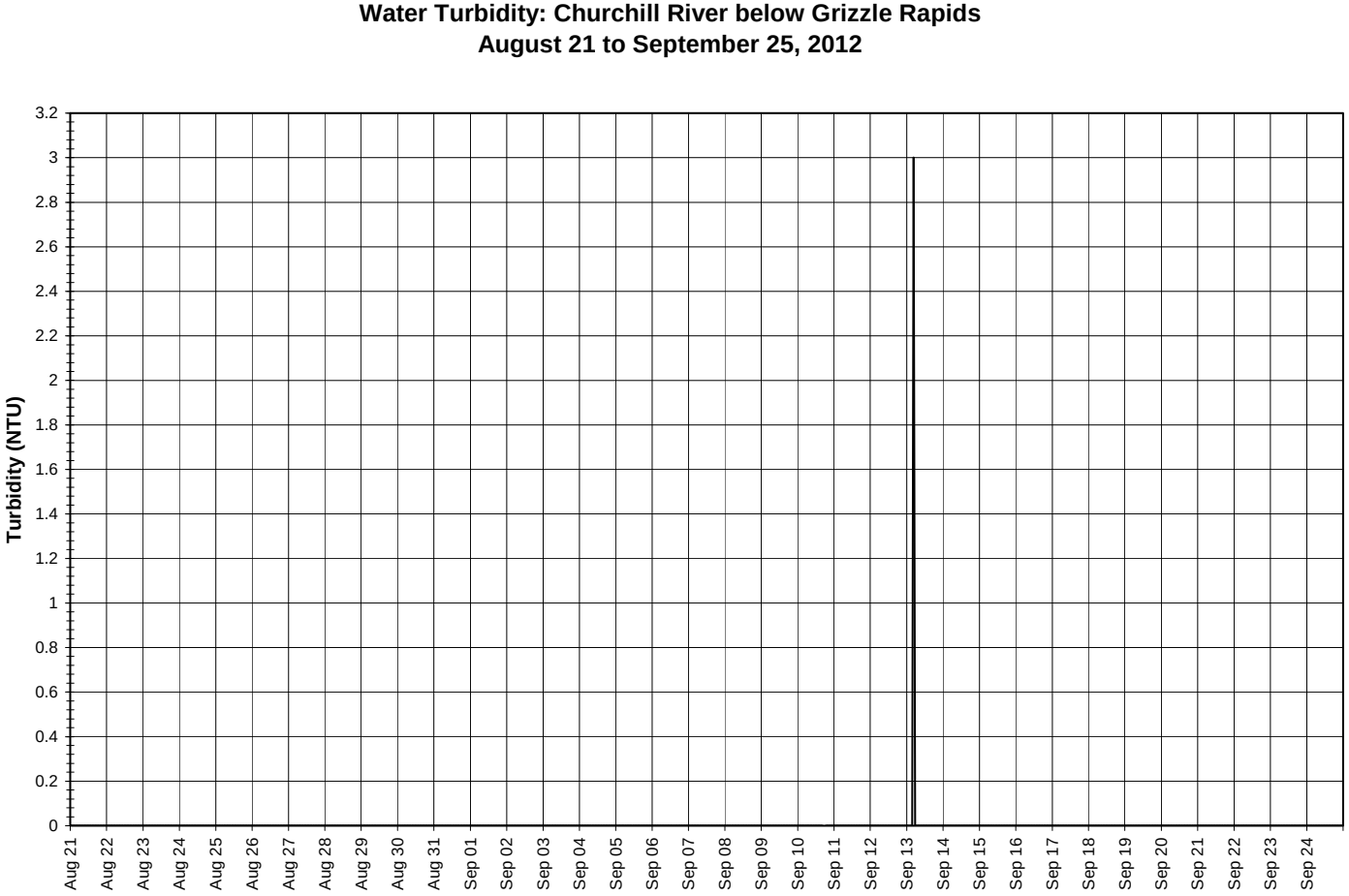

Figure 13: Turbidity at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is fluctuating throughout the deployment period with a slight increase at the end. Precipitation records vary. Stage ranges between 33.20 and 33.48m, a difference of 0.28m.

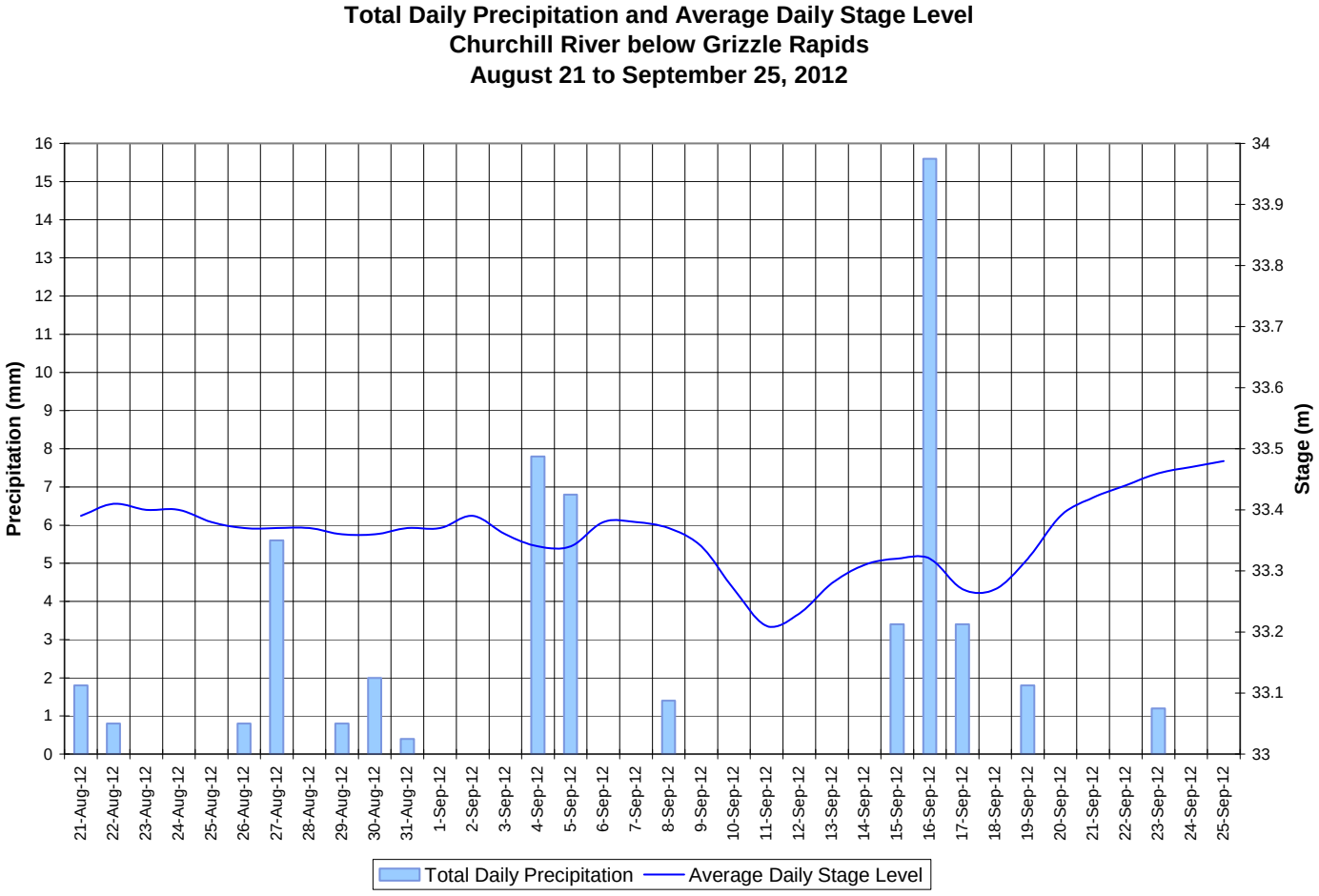

Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids

(weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 12.59 to 18.92^{o}C during the deployment period (Figure 15).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures late in the summer season (Figure 16). Water temperature fluctuates diurnally.

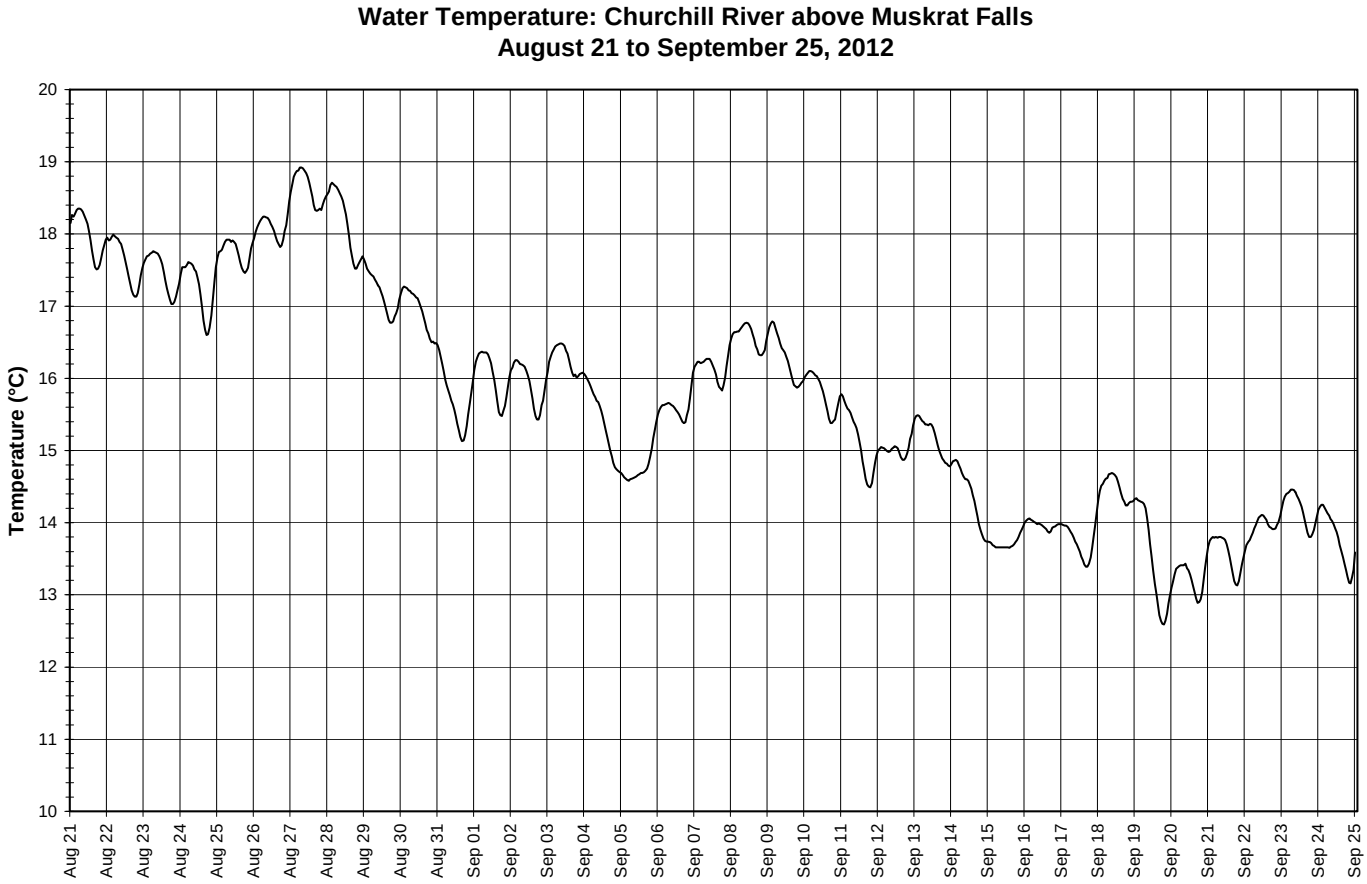

Figure 15: Water temperature at Churchill River above Muskrat Falls

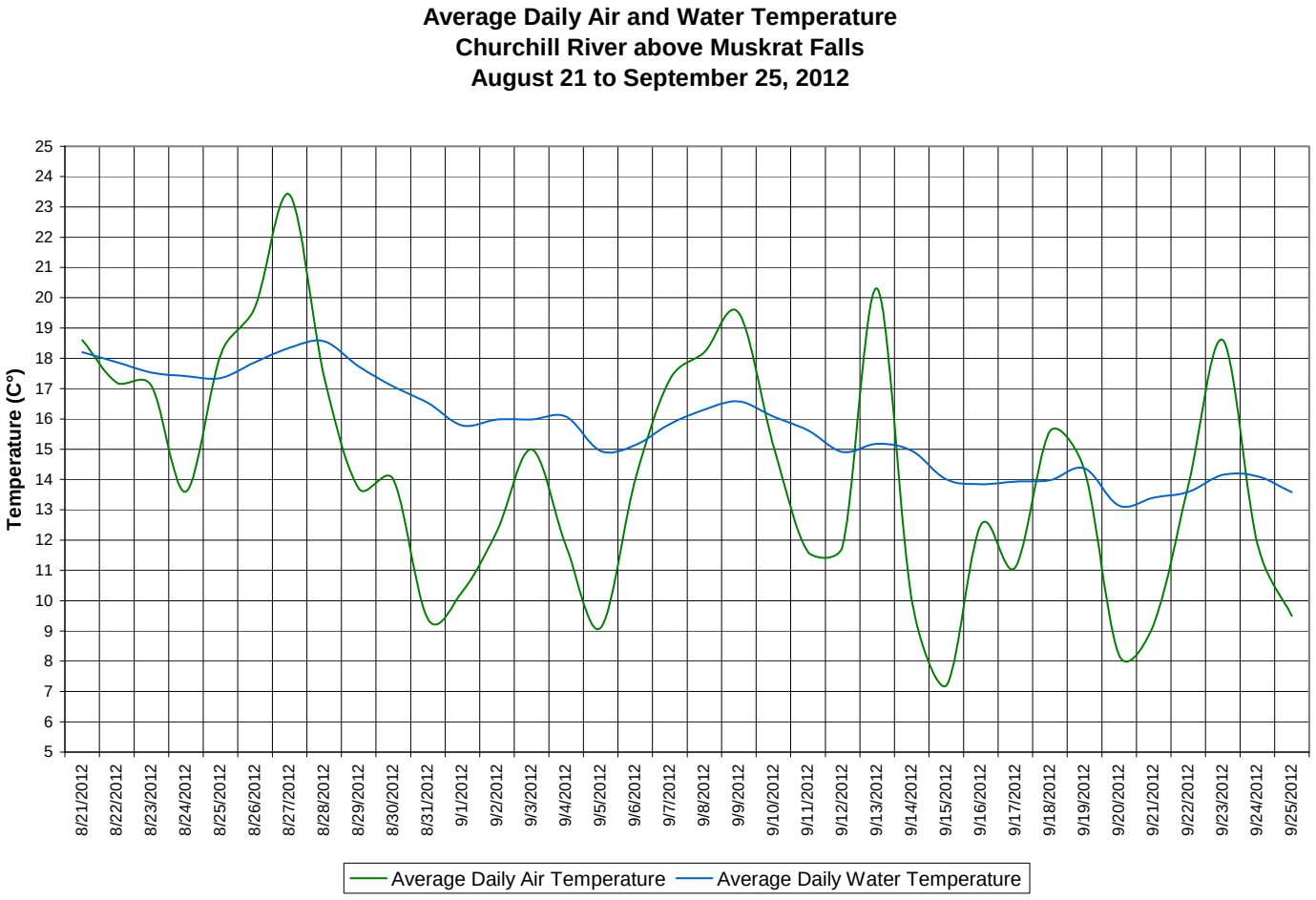

Figure 16: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 7.13 and 7.33 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).

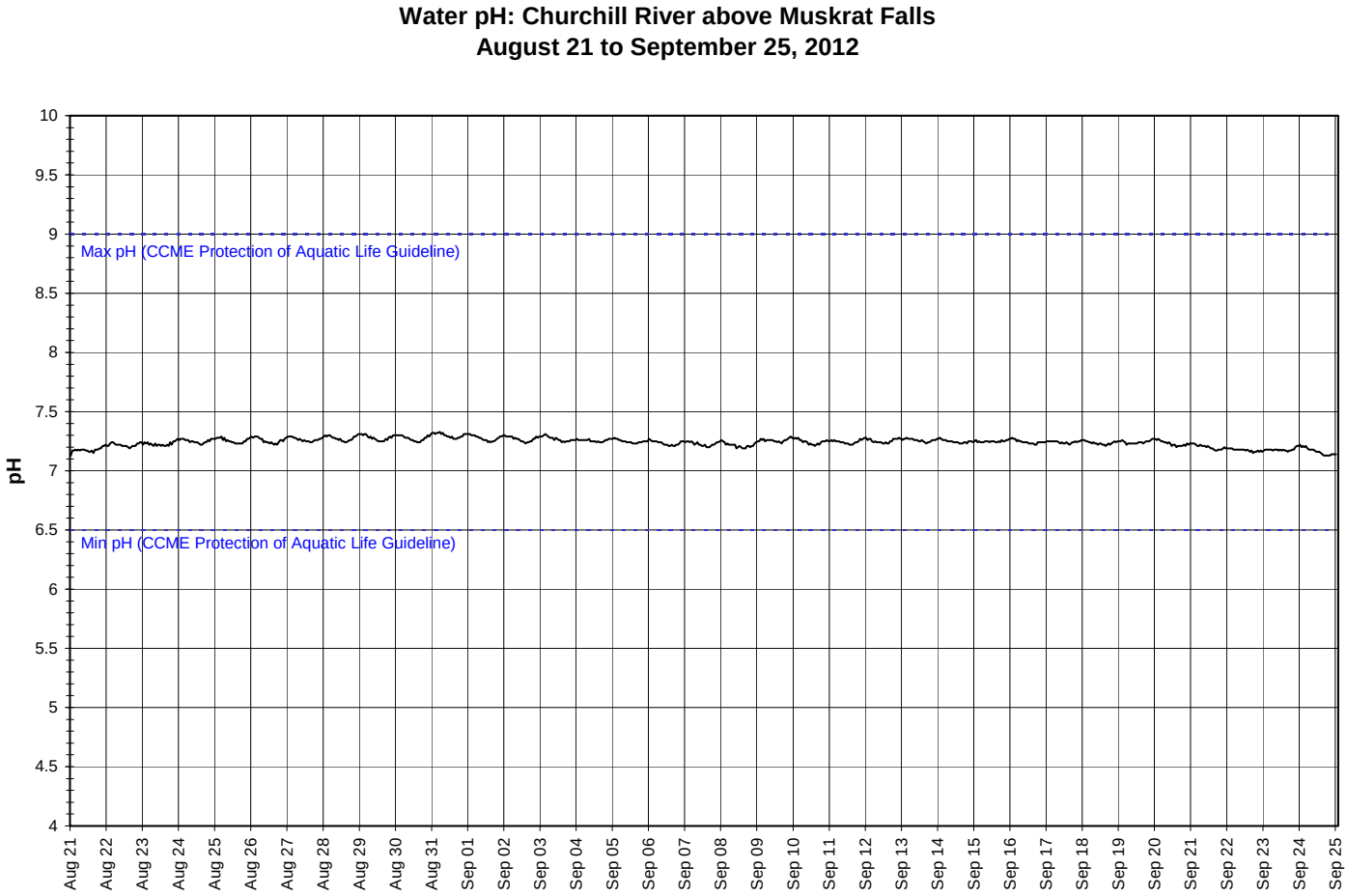

Figure 17: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges from 17.5 to 21.2µS/cm during the deployment period, averaging 18.4µS/cm. (Figure 18).
- Specific conductance is increasing slightly throughout the majority of the deployment period and decreases slightly in the final week.
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is fluctuating throughout the majority of 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 necessarily noticeable at this station during this time period as the specific conductivity levels are very stable.

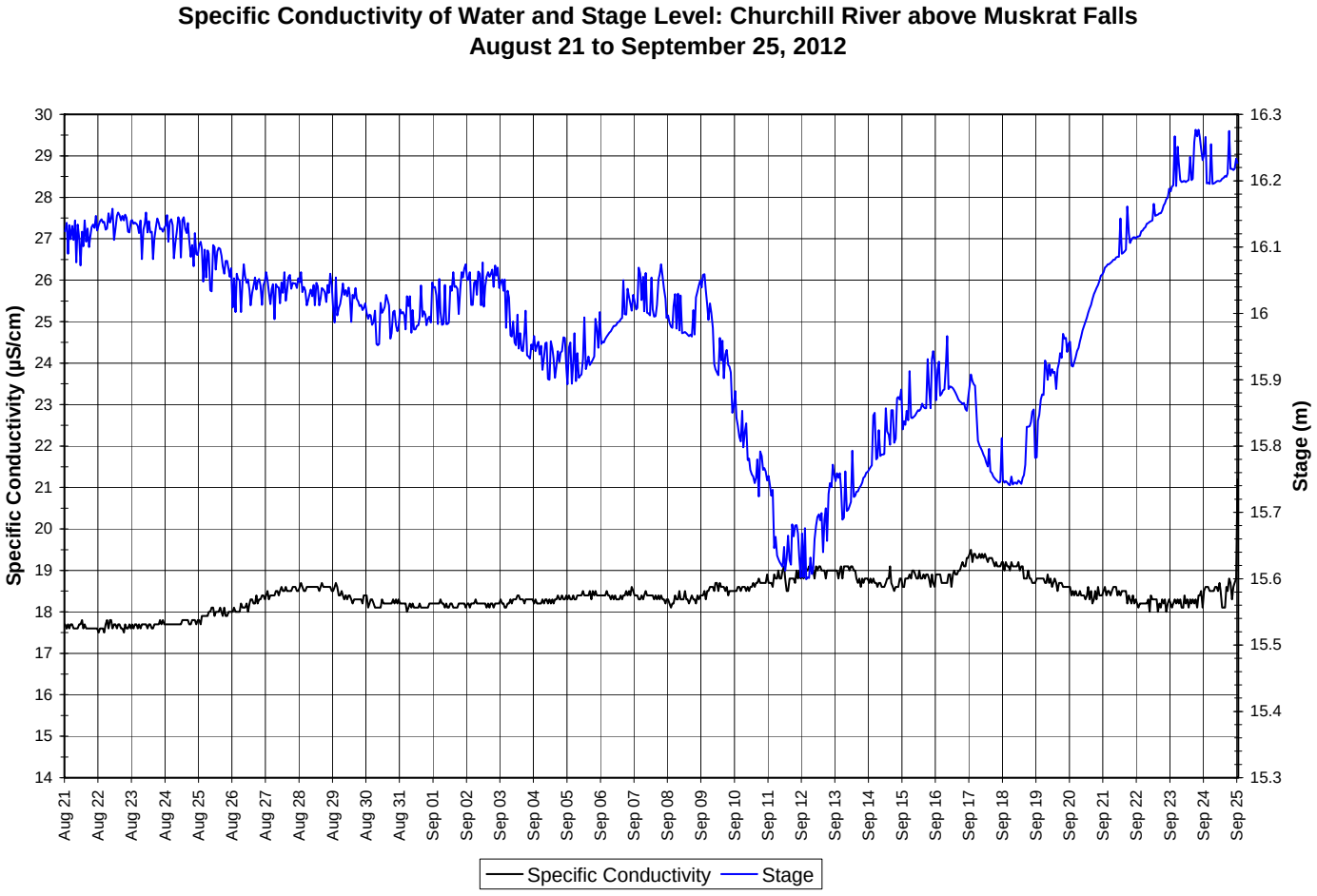

Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls

- Dissolved oxygen content ranges between 8.95mg/L and 10.17g/L. The saturation of dissolved oxygen ranges from 92.8 to 99.1% (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. During the first half of the deployment period, most values are just below the CCME Guideline for the Protection of Cold Water Biota at Early Life Stages of 9.5 mg/l. In the latter half of the deployment period, dissolved oxygen content increases as water temperature decreases. The guidelines are indicated in blue on Figure 19.
- Dissolved oxygen content is increasing throughout the deployment period. This trend is expected given the cooling air and water temperatures (Figure 16).

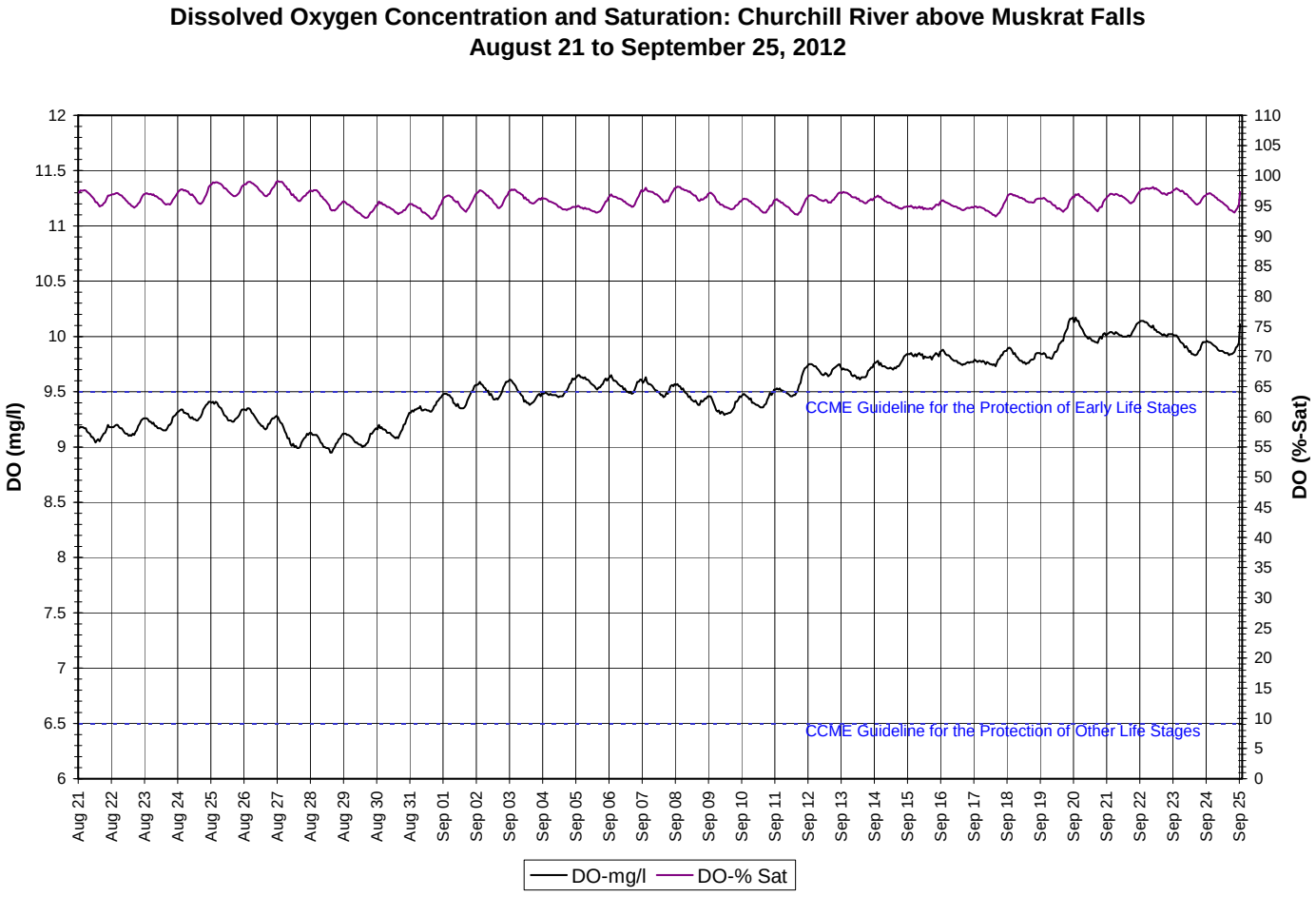

Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity generally ranges between 2.0 and 35.0NTU, averaging 4.9NTU (Figure 20). A median value of 4.0NTU indicates there is a consistent natural background turbidity value. This trend is typical at this station.
- There are several increases in turbidity throughout the deployment period lasting between 1-24 hours. On September 9, 11, and 13, turbidity increases each time however only for a short period of time (<4hours). None of these increases correspond with weather related events recorded in the area at the time however these increases all do correspond with a sharp decrease in stage level.
- On September 19-20, turbidity increases to ~24NTU and remains high for around 20 hours. It is unknown what caused this increase in turbidity.

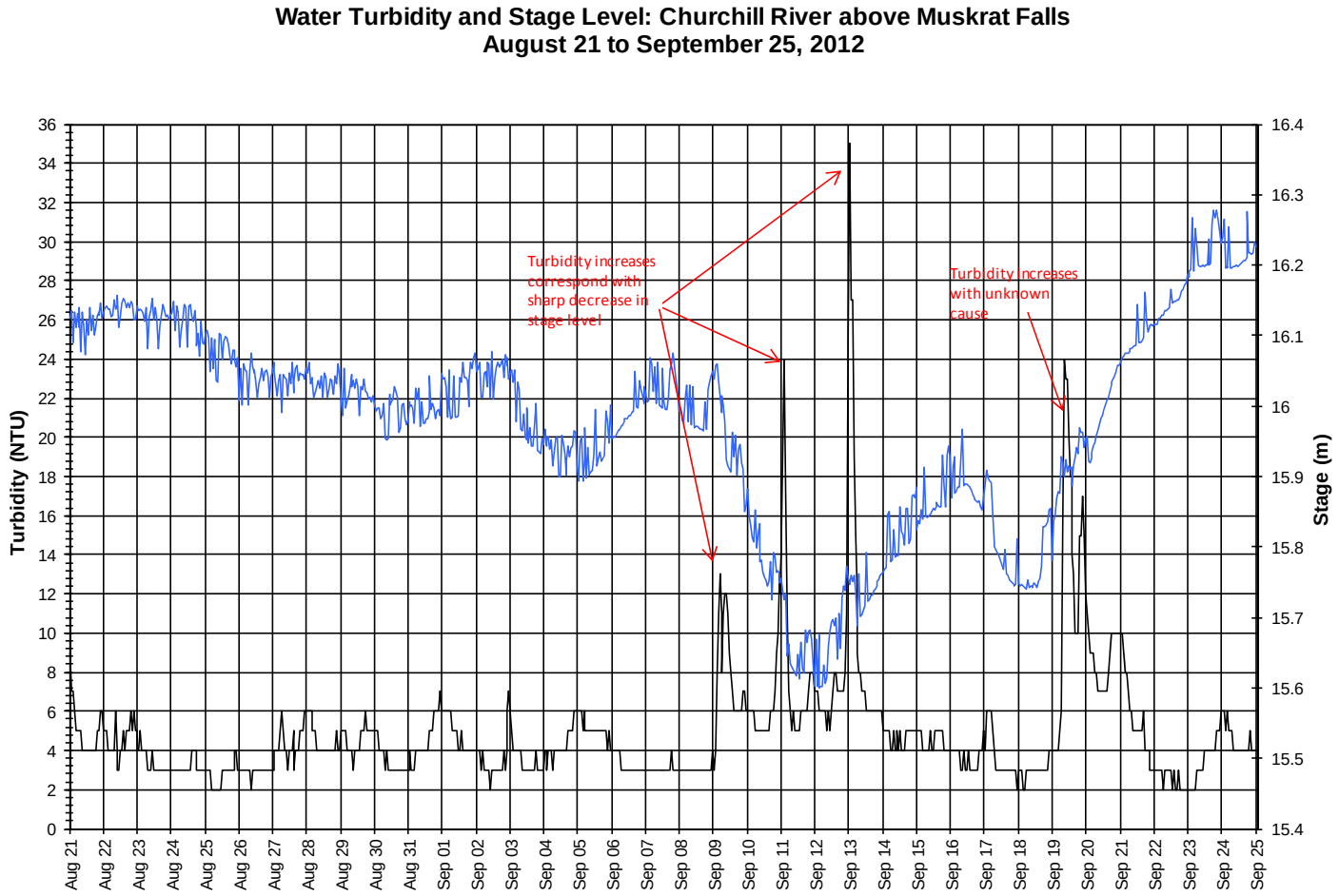

Figure 20: Turbidity and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is generally decreasing throughout the deployment period with some fluctuations and increasing near the end. Precipitation records vary. Stage ranges between 15.60 and 16.28m, a difference of 0.68m.

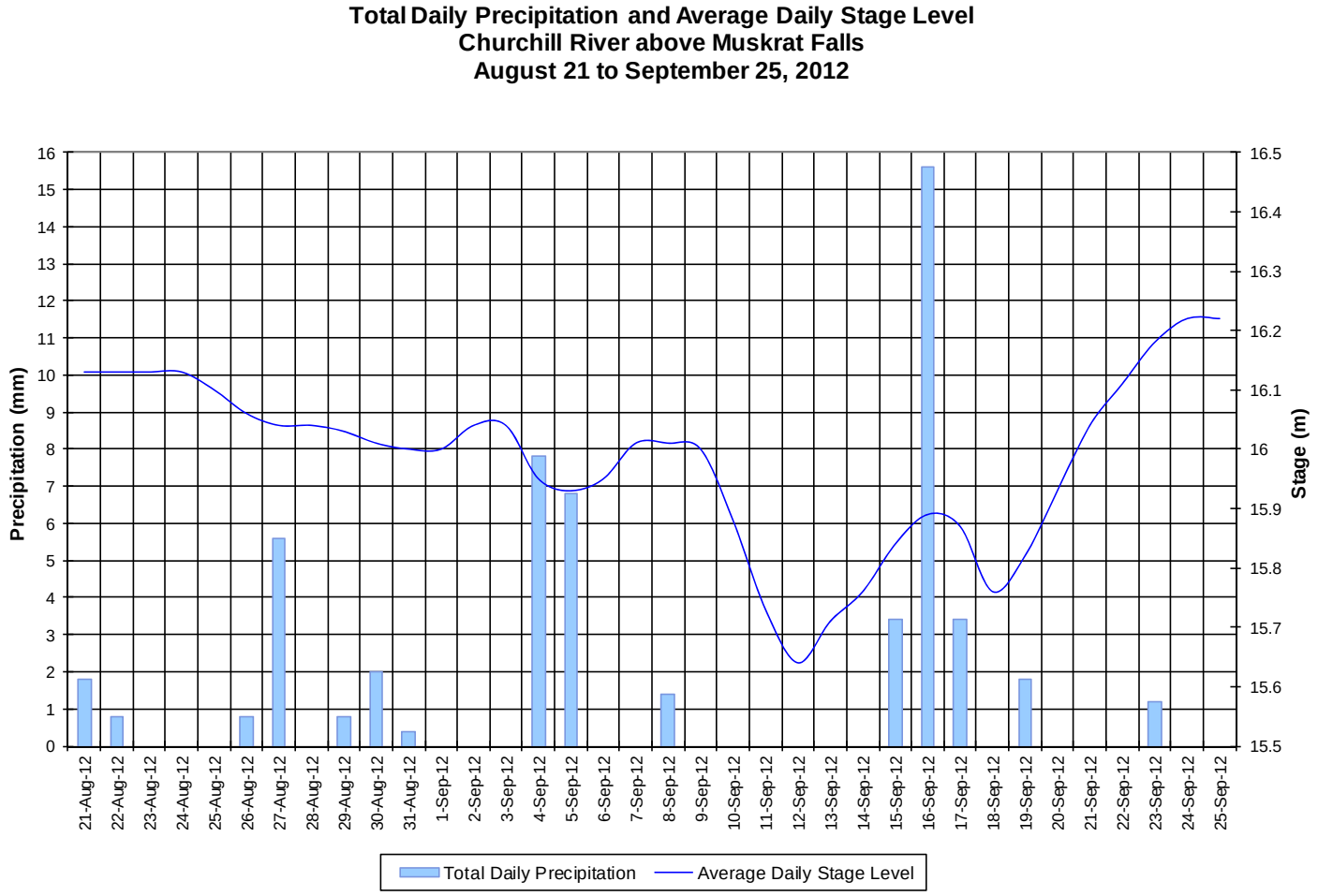

Figure 21: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls

(weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- Water temperature ranges from 13.00 to 18.80^{o}C during the deployment period (Figure 22).
- Water temperature is decreasing throughout the deployment period. This trend is expected given the cooling ambient air temperatures late in the summer season (Figure 23). Water temperature fluctuates diurnally.

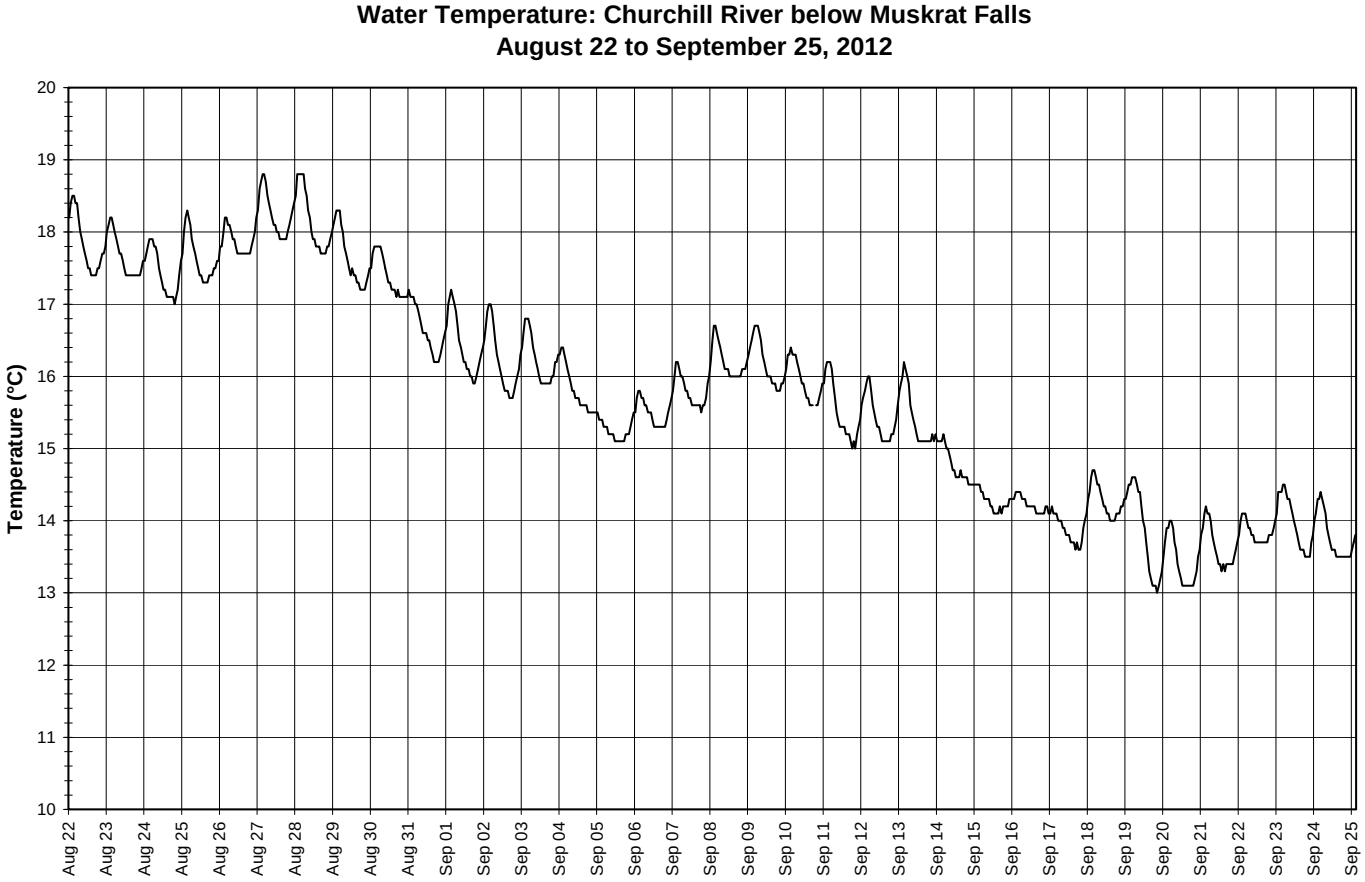

Figure 22: Water temperature at Churchill River below Muskrat Falls

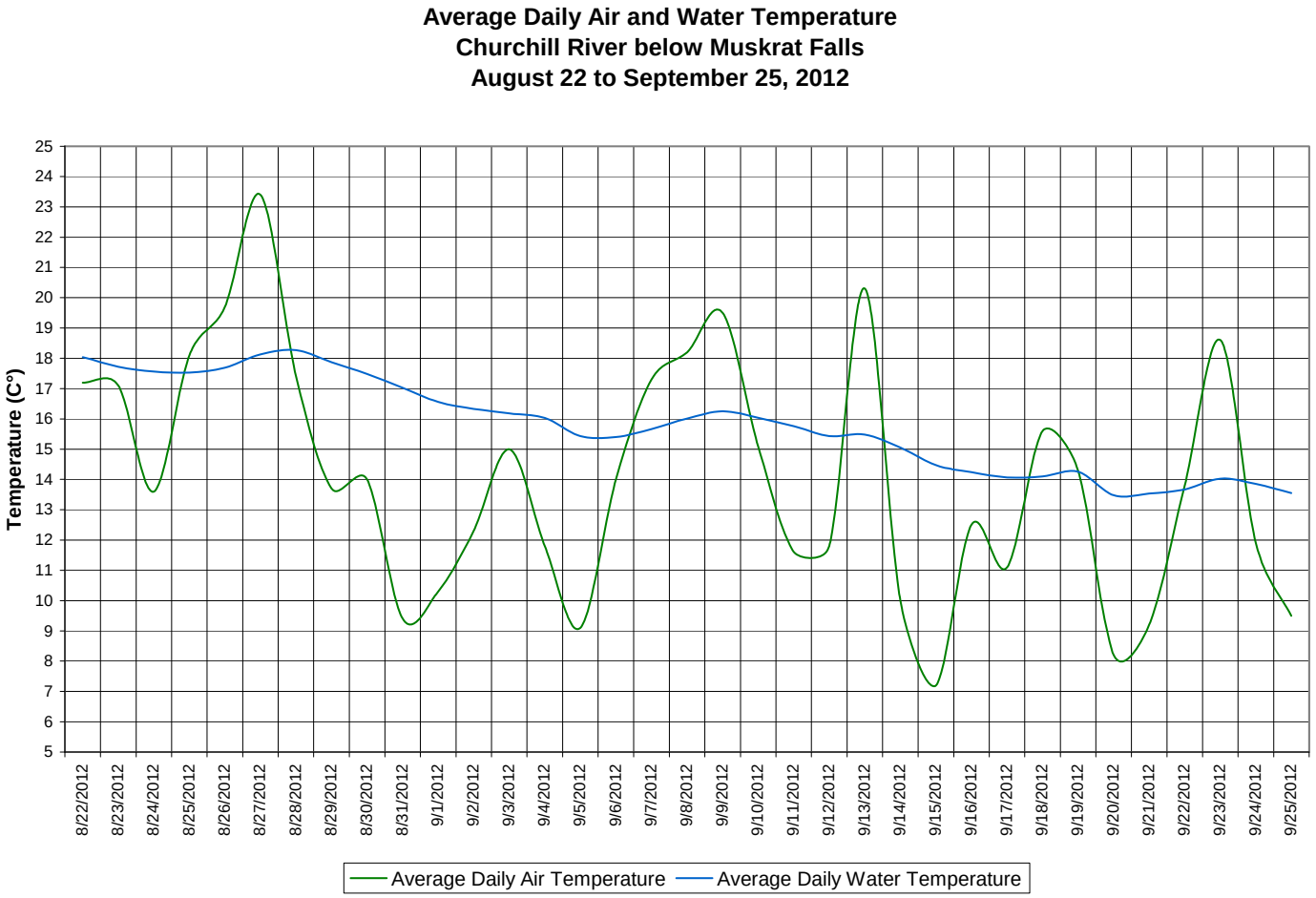

Figure 23: Average daily air and water temperature at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

- pH ranges between 6.99 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).

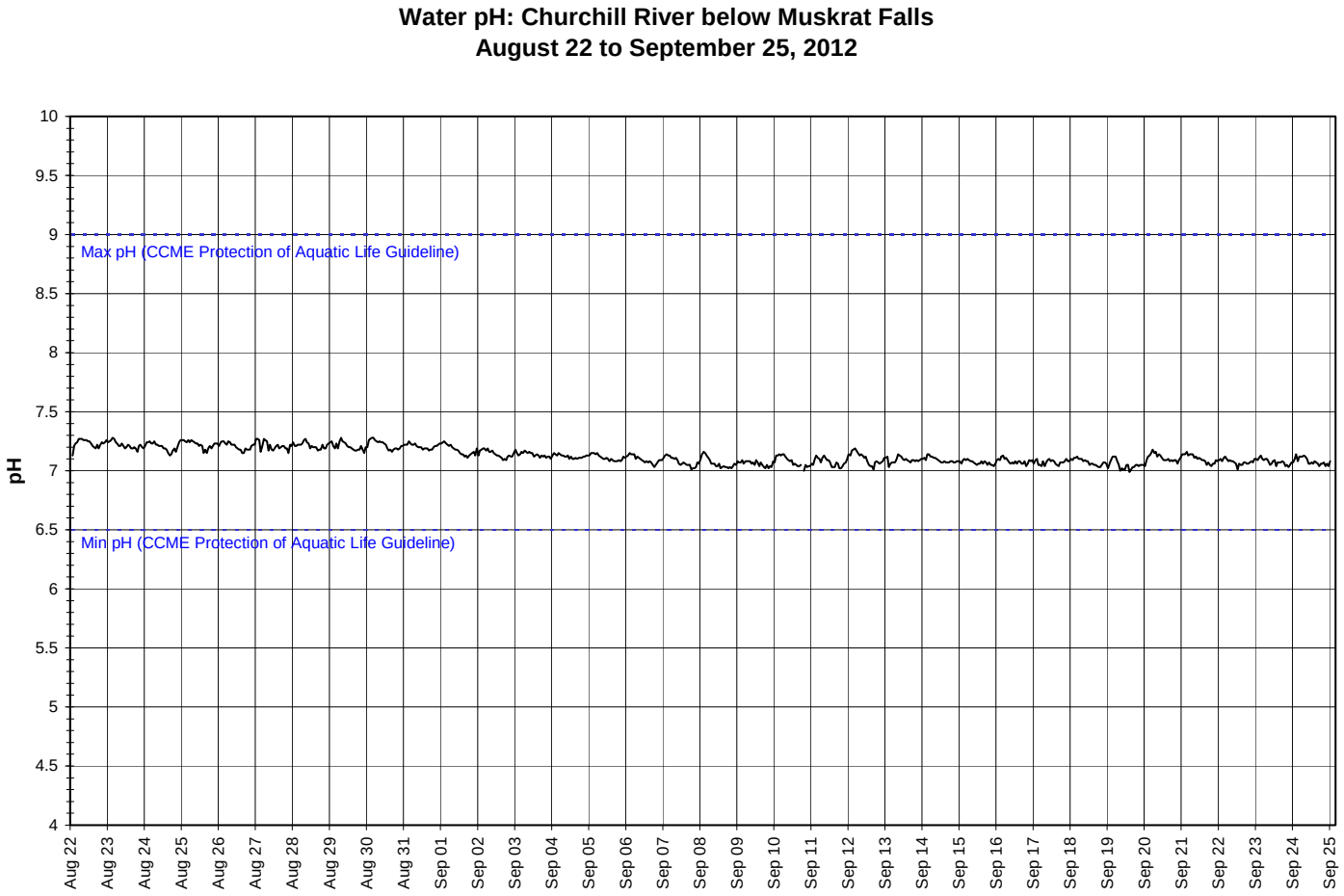

Figure 24: pH at Churchill River below Muskrat Falls

- Specific conductance ranges between 15.9 and 18.3µS/cm during the deployment period, averaging 17.6µS/cm (Figure 25).
- Specific conductivity remains very stable throughout the deployment period before, increasing ever so slightly during the first four weeks of the deployment period and decreasing slightly in the final week.
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. 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 necessarily noticeable at this station during this time period as the specific conductivity levels are very stable.

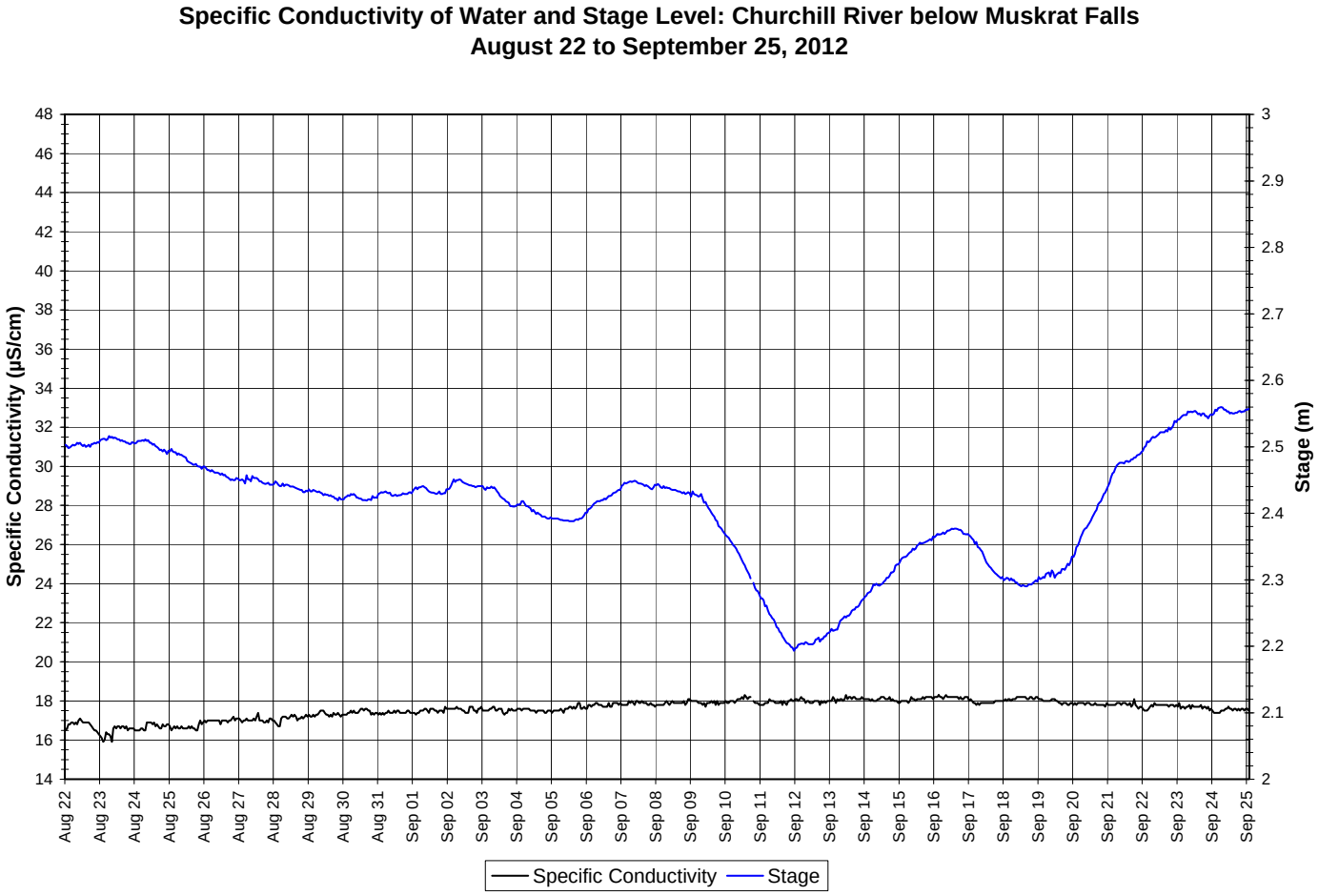

Figure 25: Specific conductivity and stage level at Churchill River below Muskrat Falls

- Dissolved oxygen content ranges between 10.14mg/L and 11.65g/L. The saturation of dissolved oxygen ranges from 103.1 to 113.9% (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 increasing slightly throughout the deployment period. This trend is expected given the cooling 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.

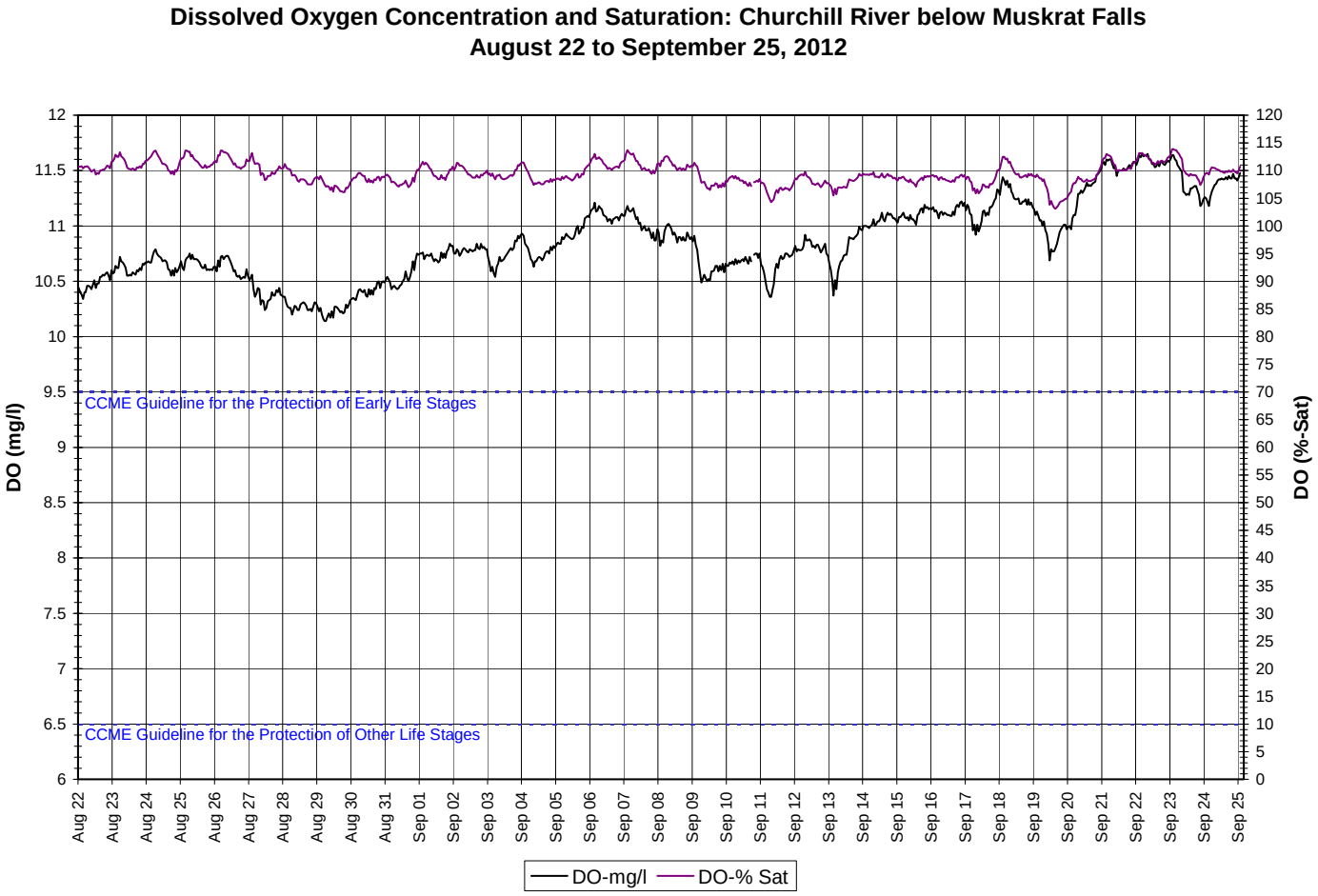

Figure 26: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- Turbidity ranges between 1.9 and 101.7NTU throughout the deployment period (Figure 27). A median value of 5.3NTU indicates there is a consistent natural background turbidity value at this station. This trend is typical at this station.
- There are several increases in turbidity throughout the deployment period lasting between 1-24 hours. On September 10, 11, and 13, turbidity increases each time however only for a short period of time (<4hours). None of these increases correspond with weather related events recorded in the area at the time however these increases all do correspond with a sharp decrease in stage level. This is a similar trend to what was observed at the station just upstream above Muskrat Falls during the same time.
- A turbidity increase on September 17 corresponds with a rainfall event recorded in the area. There is another increase in turbidity from September 19-20, up to ~35TU. It is unknown what caused this increase in turbidity.

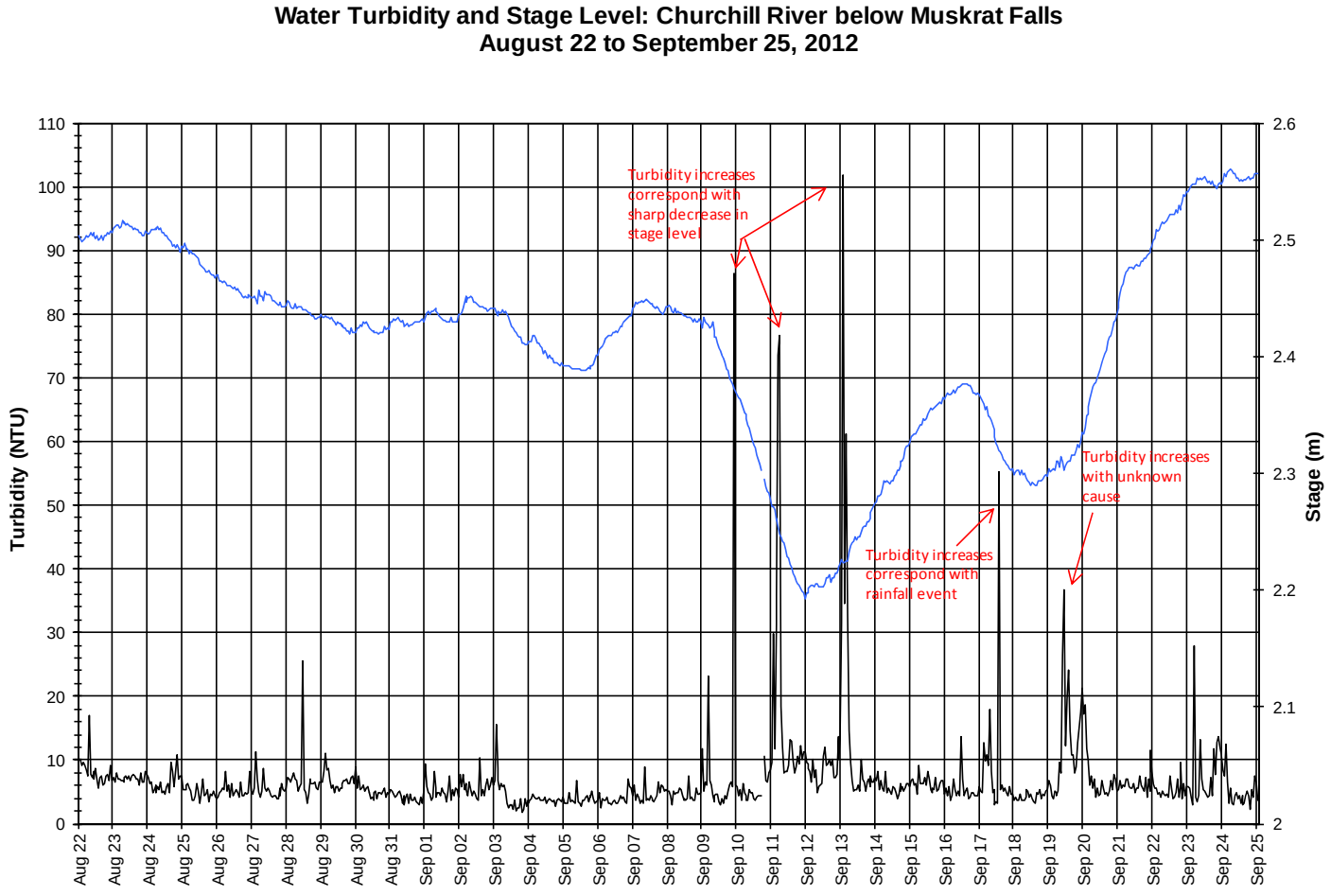

Figure 27: Turbidity and stage level at Churchill River below Muskrat Falls

- 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 2.19 and 2.56m, a difference of 0.37m.

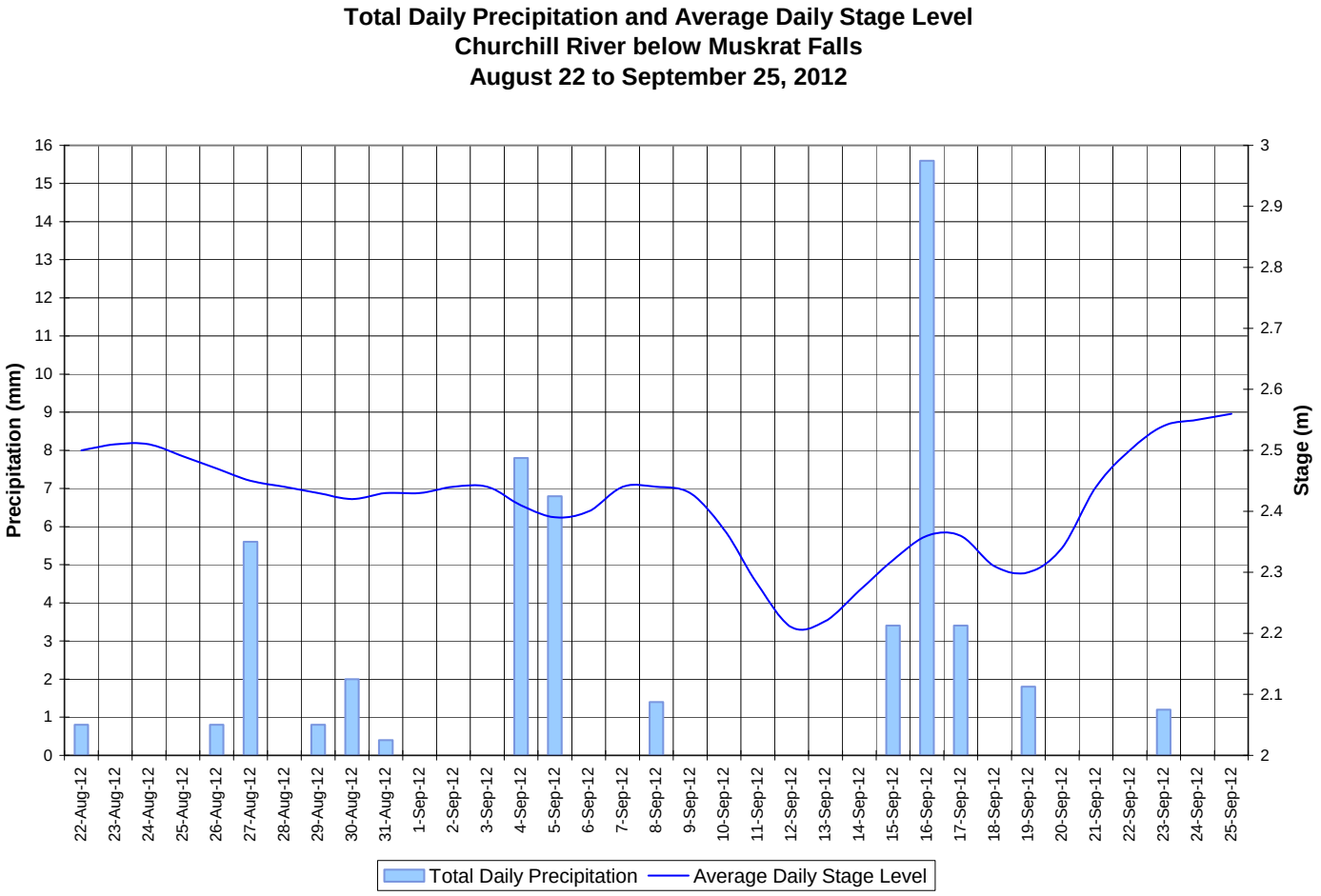

Figure 28: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from August 21-22 to September 25, 2012. In most cases, weather related events or increase/decreases in water level could be used to explain the fluctuations.
- Stage levels were fluctuating slightly at all stations throughout the deployment period, and showed an increasing trend in the final 10 days of the deployment.
- Water temperature was decreasing at all stations throughout the deployment period due to the cooling ambient air temperatures in the region late in the summer season. Water temperature typically ranged between 11 and 19°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 7.4 pH units.
- Specific conductivity was generally stable at all stations regardless of changing stage levels. Specific conductivity typically averaged between 16 and 24µS/cm.
- Dissolved oxygen content was increasing 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 for the first half of the deployment period and increased to above this guideline in the latter half as water and air temperatures decreased. 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 the guideline of 9.5mg/l.
- 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 4.0 and 5.3NTU were found at 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 or rapid decreases in stage level.

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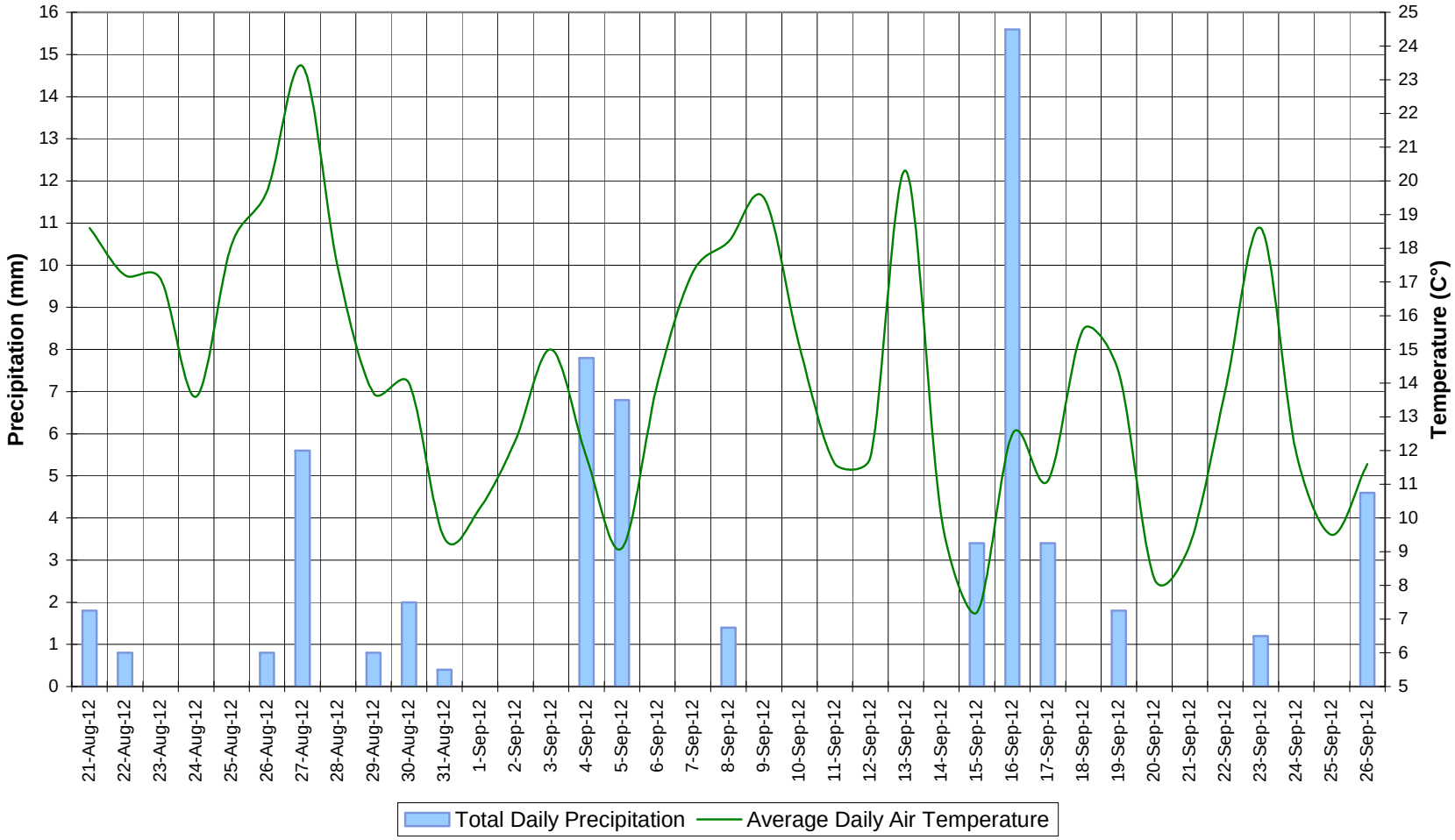
Appendix 1 – Weather Data – Environment Canada Historical Weather and Climate Database

Average Daily Air Temperature and Total Daily Precipitation
Happy Valley-Goose Bay
August 21 to September 26, 2012



Average Daily Air Temperature and Total Daily Precipitation
Churchill Falls
August 21 to September 26, 2012