Real-Time Water Quality Deployment Report

Lower Churchill River Network

May 29 to
June 25, 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 May 29, 2014, real-time water quality monitoring instruments were deployed at three of the Lower Churchill River Stations (below Metchin River, above Muskrat Falls, and at English Point) for a period of 26 days. Instruments were removed on June 25, 2014. Instruments were not deployed during this period at below Grizzle rapids or below Muskrat Falls due to an ice wall and a damaged helicopter pad, respectively, creating site accessibility issues.

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 May 29 to June 25, 2014 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, May 29 to June 25, 2014

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45707)	May 29, 2014	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	June 25, 2014	Removal	n/a*	n/a*	n/a*	n/a*	n/a*
Below Grizzle Rapids (N/A)	N/A†	Deployment	N/A	N/A	N/A	N/A	N/A
	N/A†	Removal	N/A	N/A	N/A	N/A	N/A
Above Muskrat Falls (47590)	May 29, 2014	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	June 25, 2014	Removal	n/a*	n/a*	n/a*	n/a*	n/a*
Below Muskrat Falls (N/A)	N/A†	Deployment	N/A	N/A	N/A	N/A	N/A
	N/A†	Removal	N/A	N/A	N/A	N/A	N/A
At English Point (45042)	May 29, 2014	Deployment	Excellent	Poor	Excellent	Good	Excellent
	June 25, 2014	Removal	Excellent	Fair	Poor	Excellent	Good

* Comparison ranking unavailable due to field sonde being out of the water and reading incorrectly

† Comparison ranking unavailable due to instrument not deployed/removed

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

  At removal, the sonde was out of the water due to the rapid drop in spring water levels, making rankings impossible.
- At the station below Grizzle Rapids, the sonde could not be deployed on May 29, 2014, due to the presence of an ice wall which made accessibility impossible.

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

  At removal, the sonde was out of the water due to the rapid drop in spring water levels, making rankings impossible.

- At the station below Muskrat Falls, the sonde could not be deployed on May 29, 2014, due to the helicopter landing pad having been damaged during the winter, making this station inaccessible and deployment impossible.

- At the station at English Point, temperature, specific conductivity, dissolved oxygen and turbidity all rank either 'good' or 'excellent' at deployment. pH is ranked as 'poor'. The field sonde value for pH was 7.12, while the QA/QC sonde value was 6.09. The grab sample pH value was 7.18, indicating that the field sonde is accurate and the QA/QC sonde may not have stabilized before the pH value was recorded.

  At removal, temperature, dissolved oxygen and turbidity all rank either 'good' or 'excellent'. Specific conductivity was ranked as 'poor' while pH ranked 'fair'. For specific conductivity, the field sonde value was 40.6 uS/cm and the QA/QC sonde value was 53.9 uS/cm. For pH, the field sonde value was 7.76 and the QA/QC sonde value was 7.12. The QA/QC sonde may not have stabilized when the readings were taken, or the sensors may have experienced minor sensor drift during deployment.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring between May 29 and June 25, 2014 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 levels dropped significantly at this site after deployment, exposing the sonde on June 9th, preventing the collection of accurate water quality data June 9-25th.
- Water temperature ranges from 4.10°C to 10.80°C during the deployment period of May 29 to June 9 (Figure 1).
- Water temperature is increasing throughout the deployment period. This trend is expected due to the warming air temperatures in the spring season (Figure 2).

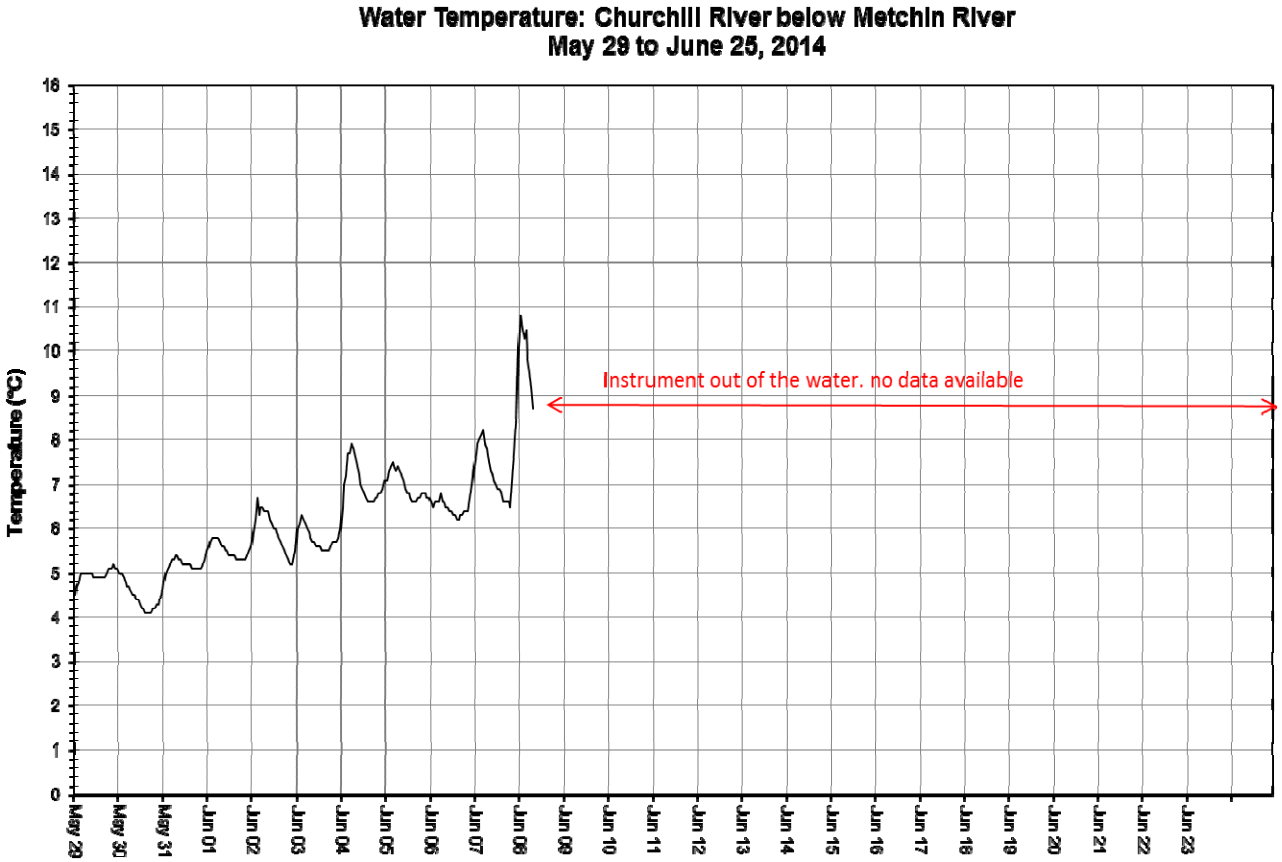


Figure 1: Water temperature at Churchill River below Metchin River

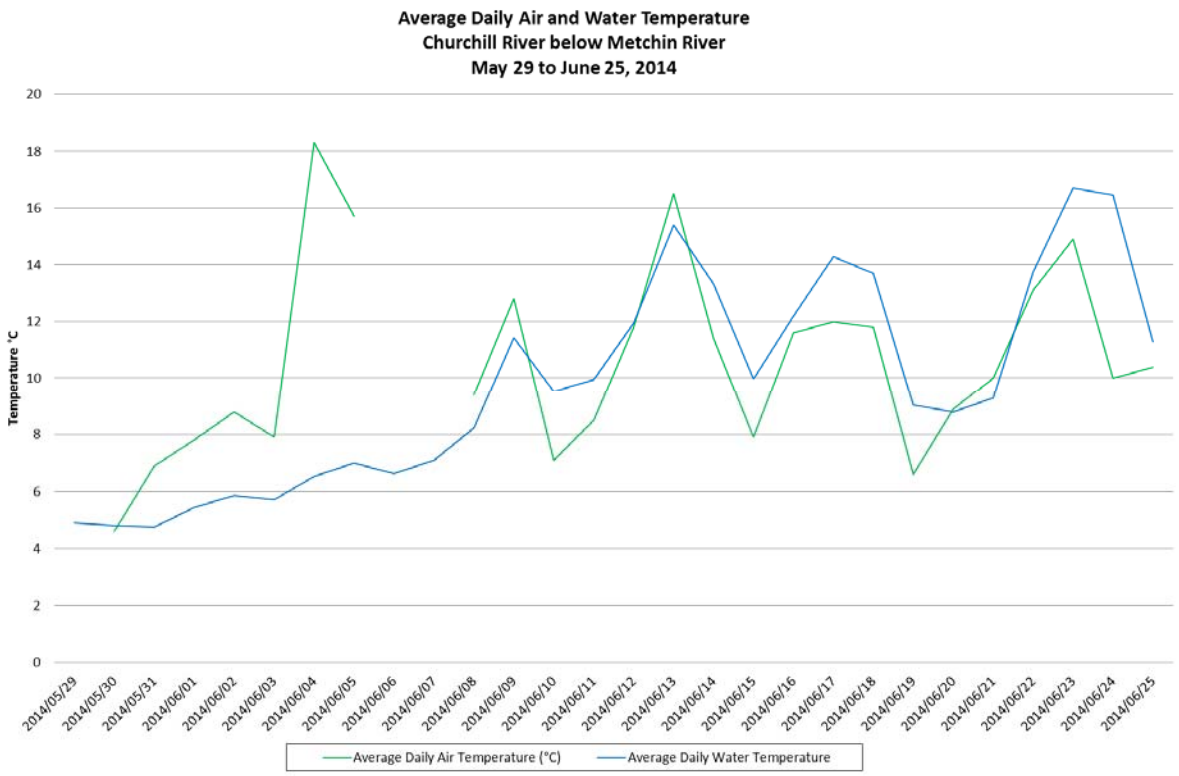


Figure 2: Average daily air and water temperature at Churchill River below Metchin River (weather data recorded at Churchill Falls, NL)

- pH ranges between 6.04 and 6.67 pH units and was stable up until June 9th when the water level dropped and exposed the instrument (Figure 3). The sensor did take 24 hours to stabilize, as evident from the value's slow climb at the start of deployment.
- All values recorded after the sensor stabilized are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

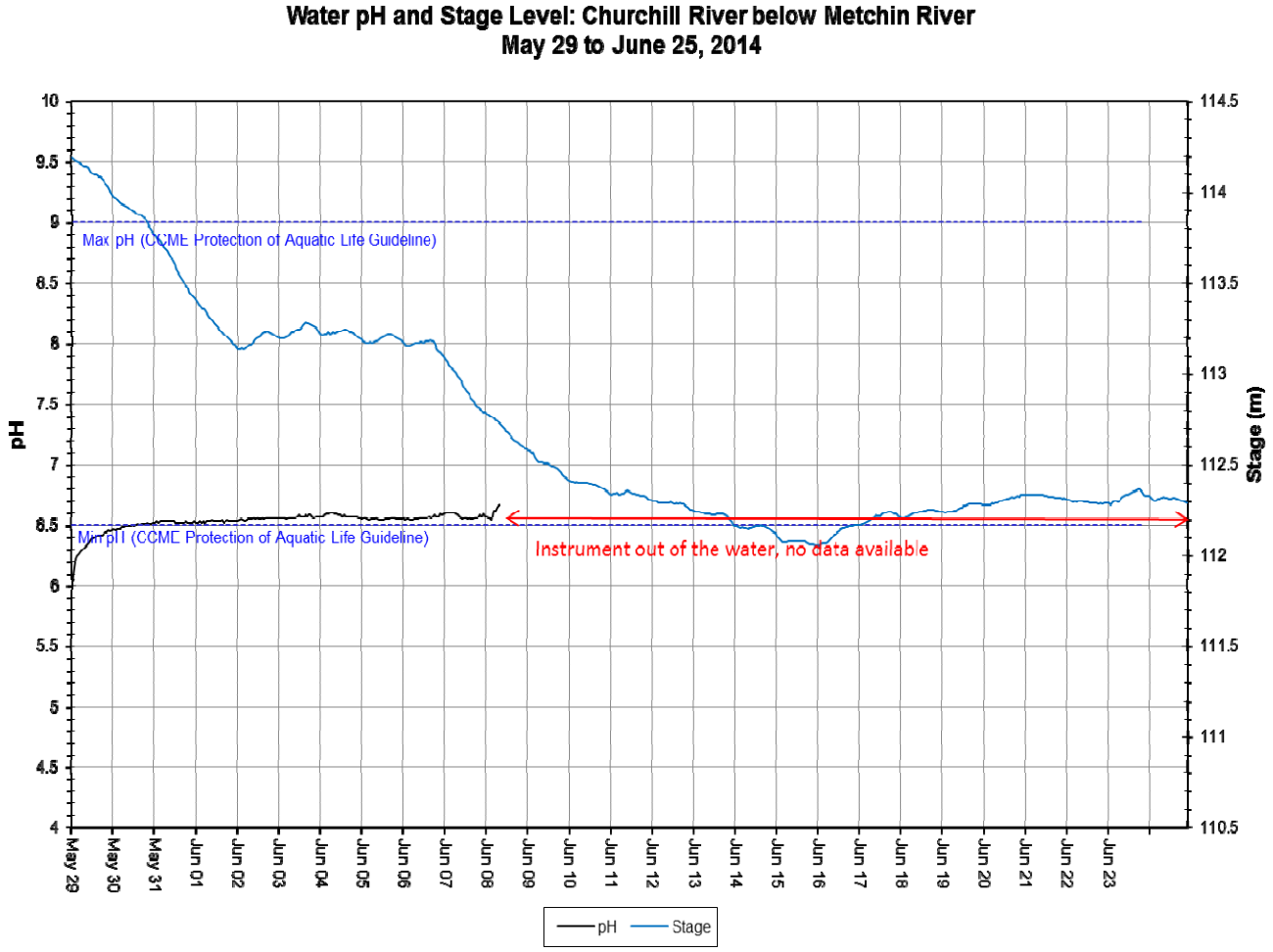


Figure 3: pH and stage level at Churchill River below Metchin River

- Specific conductivity ranges between 14.4µS/cm to 19.3µS/cm during the deployment period, averaging 15.6µS/cm (Figure 4).
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage fluctuates throughout the deployment period. The overall decreasing trend is expected as the spring freshet runs through. 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 visible in the data collected during the deployment period as specific conductivity increases as the stage level begins to decrease.

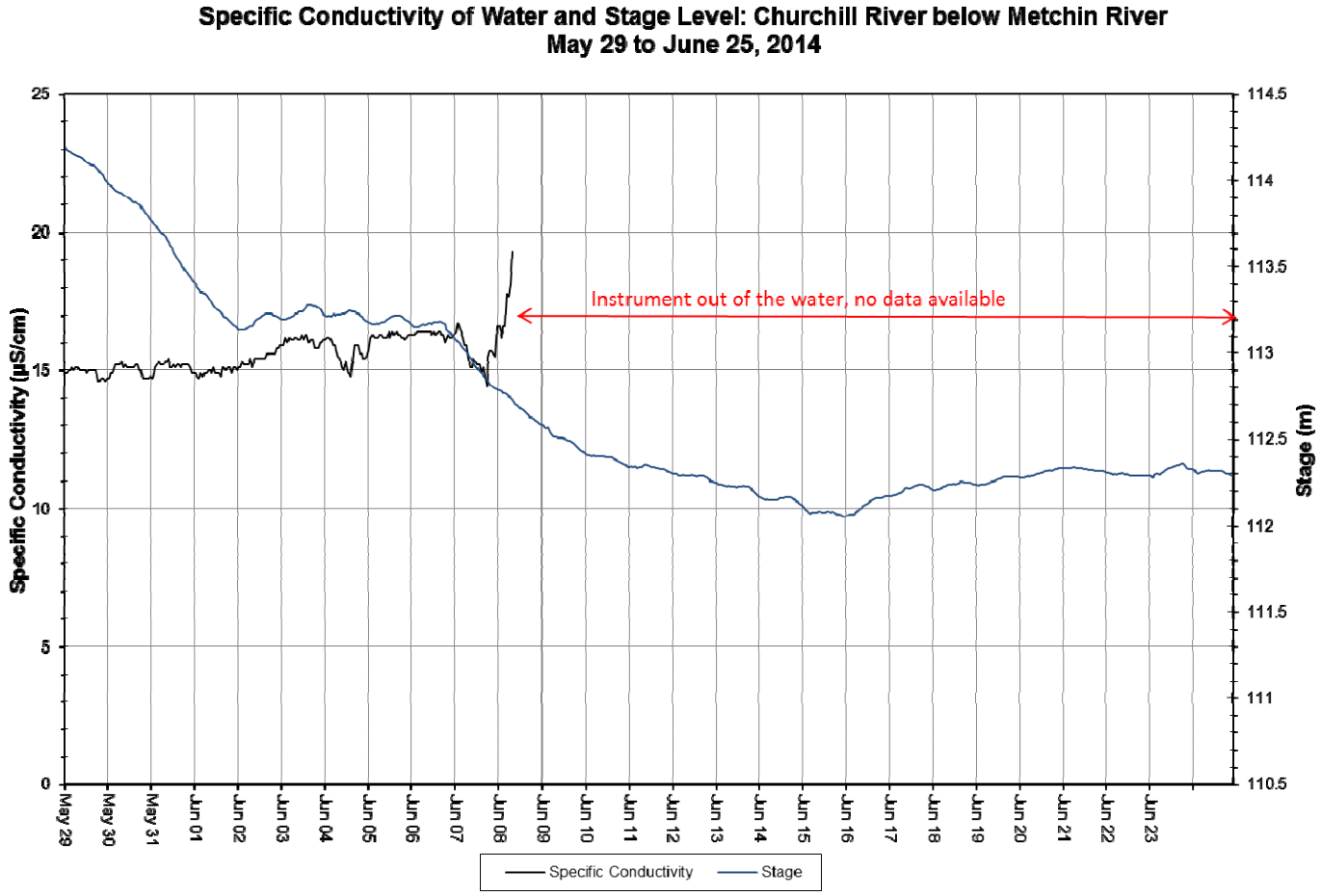


Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- Dissolved oxygen content ranges between 10.84mg/l and 12.21mg/l. The saturation of dissolved oxygen ranges from 91.4% to 98.1% (Figure 5).
- All values are above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 2).

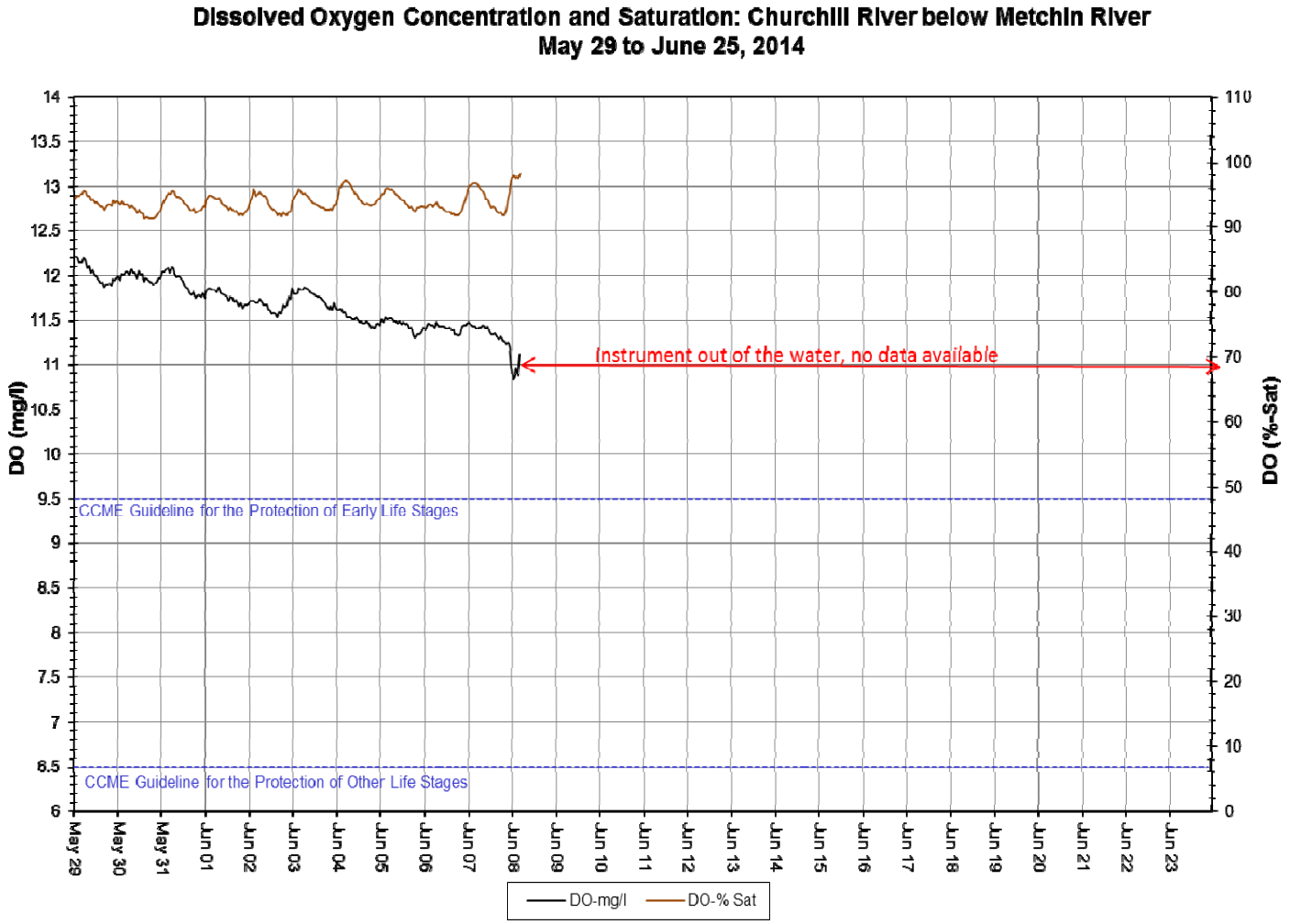


Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- Turbidity generally remains at 0NTU for the majority of the deployment period (Figure 6). A median value of 0NTU indicates there is no natural background turbidity value at this station.
- There are a few instances when turbidity briefly increased to values >0NTU. These events are low in magnitude and not significant.

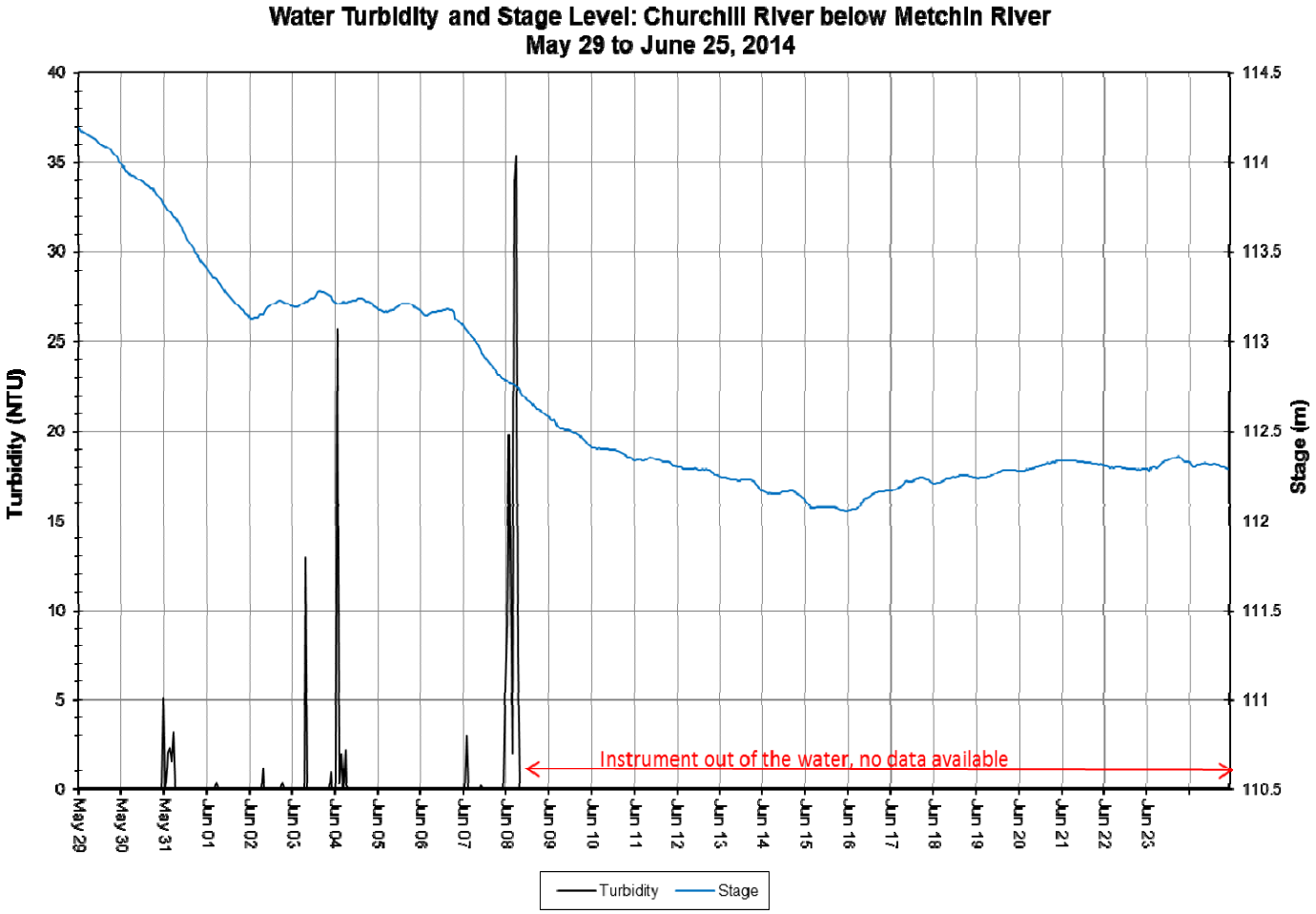


Figure 6: Turbidity and stage level at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is mostly decreasing throughout the deployment period. Precipitation occurs on <50% of the days in the deployment period and amounts are generally low except for a 25.7mm event on June 14-15. Stage ranges between 112.06m and 114.19m.

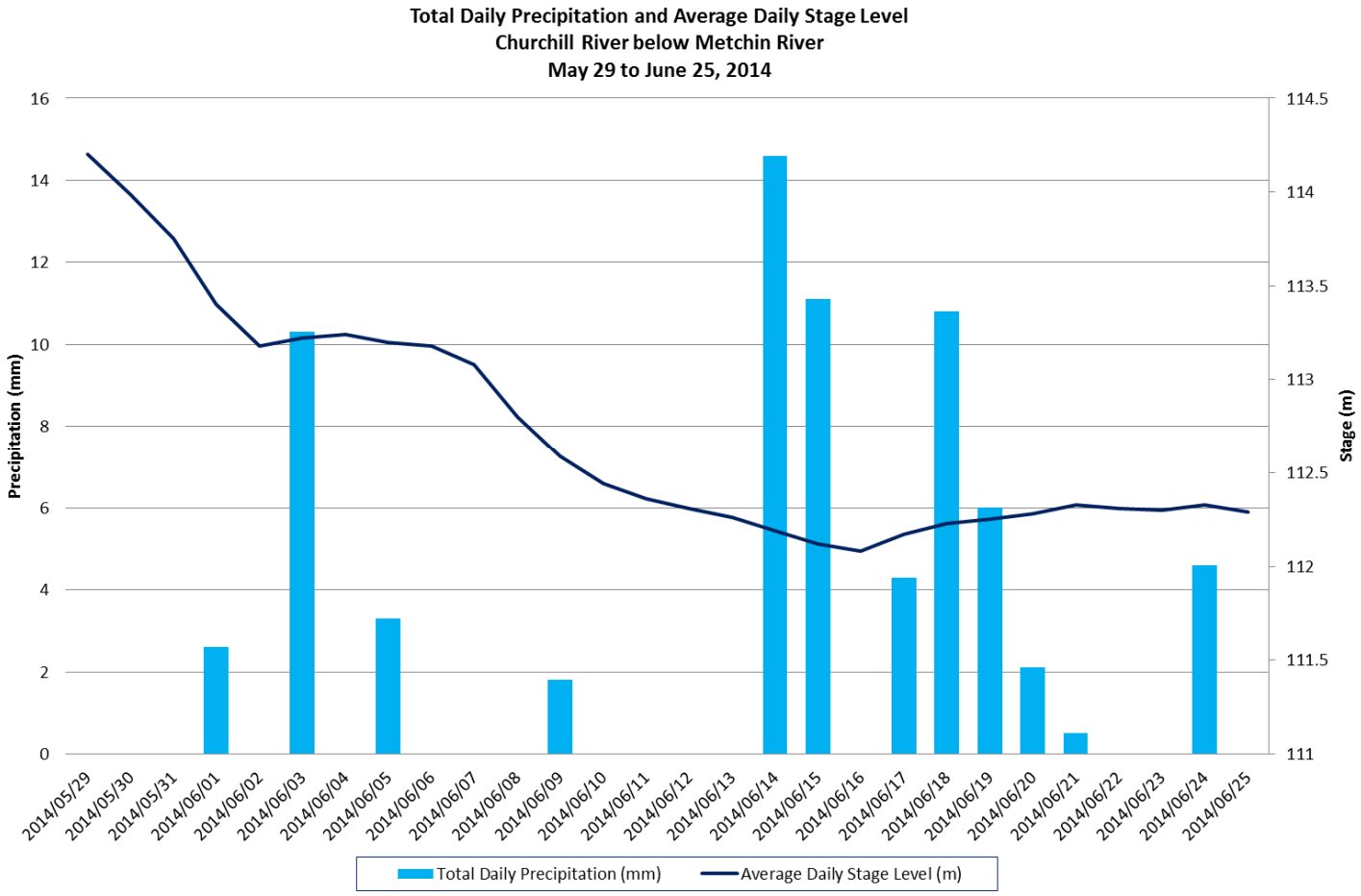


Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- The below Grizzle Rapids station could not be deployed on May 29, 2014 due to the presence of an ice wall which restricted accessibility to the river.
- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 8). Stage is mostly decreasing throughout the deployment period. Precipitation occurs on >50% of the days in the deployment period and amounts are small in magnitude, with the exception of one 25mm event on June 19, 2014. Stage ranges between 33.26m and 34.14m.

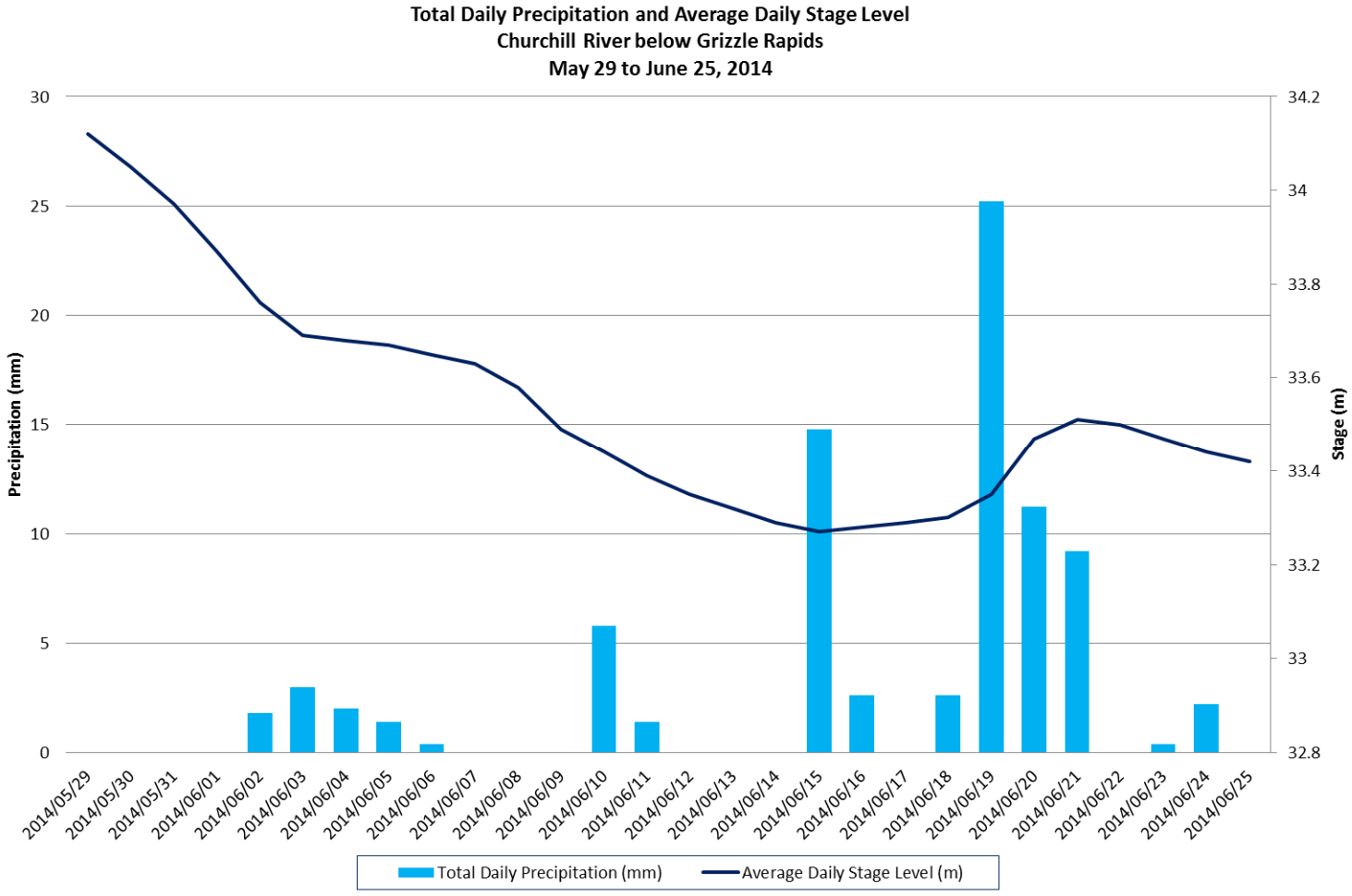


Figure 8: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids

(weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water levels dropped significantly at this site after deployment, exposing the sonde on June 9th. Thus accurate water quality data was not collected June 9-25th, and this data has been removed from the dataset.
- Water temperature ranges from 4.69°C to 8.42°C during the deployment period of May 29-June 9 (Figure 9).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring season (Figure 10).

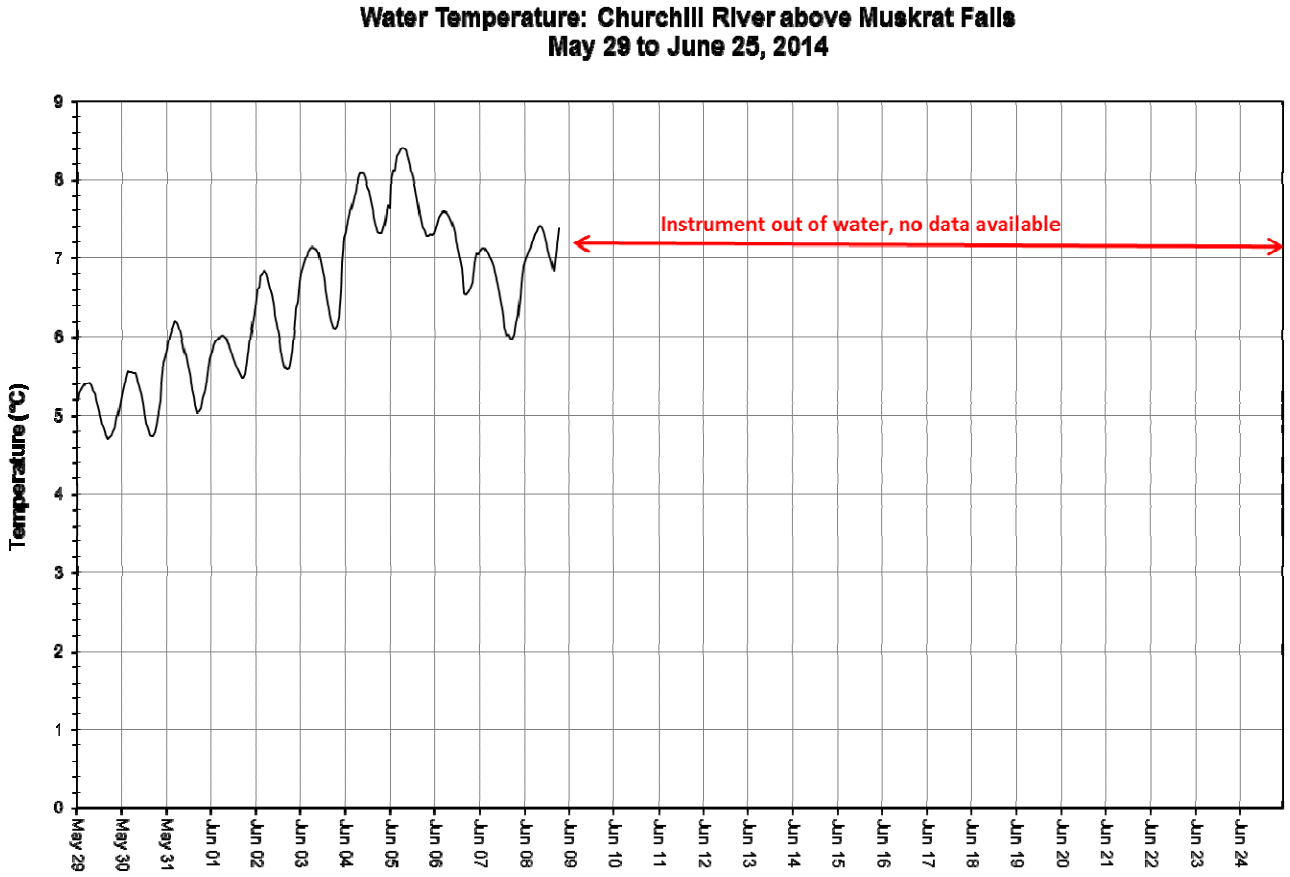


Figure 9: Water temperature at Churchill River above Muskrat Falls

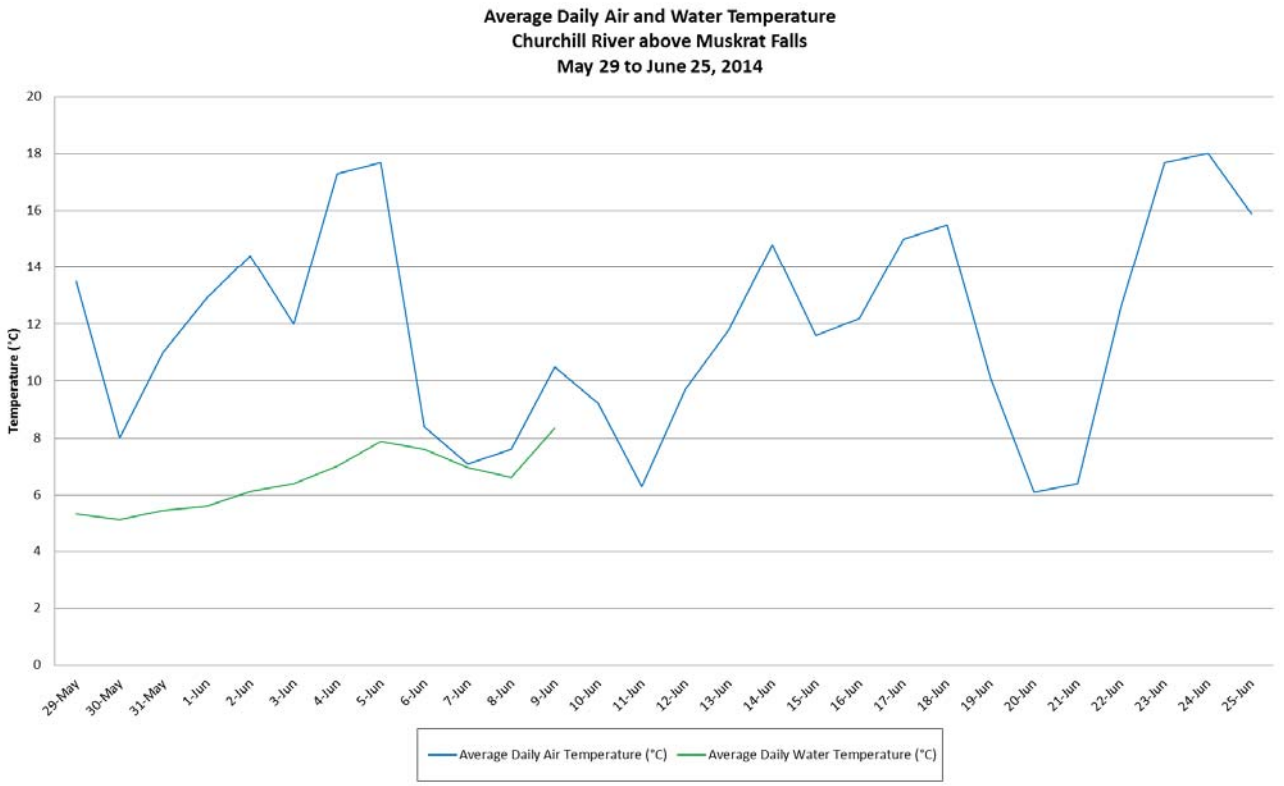


Figure 10: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.57 and 6.88 pH units (Figure 11). pH values are very stable throughout the deployment period despite the changing water levels.
- All pH values recorded are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 11).

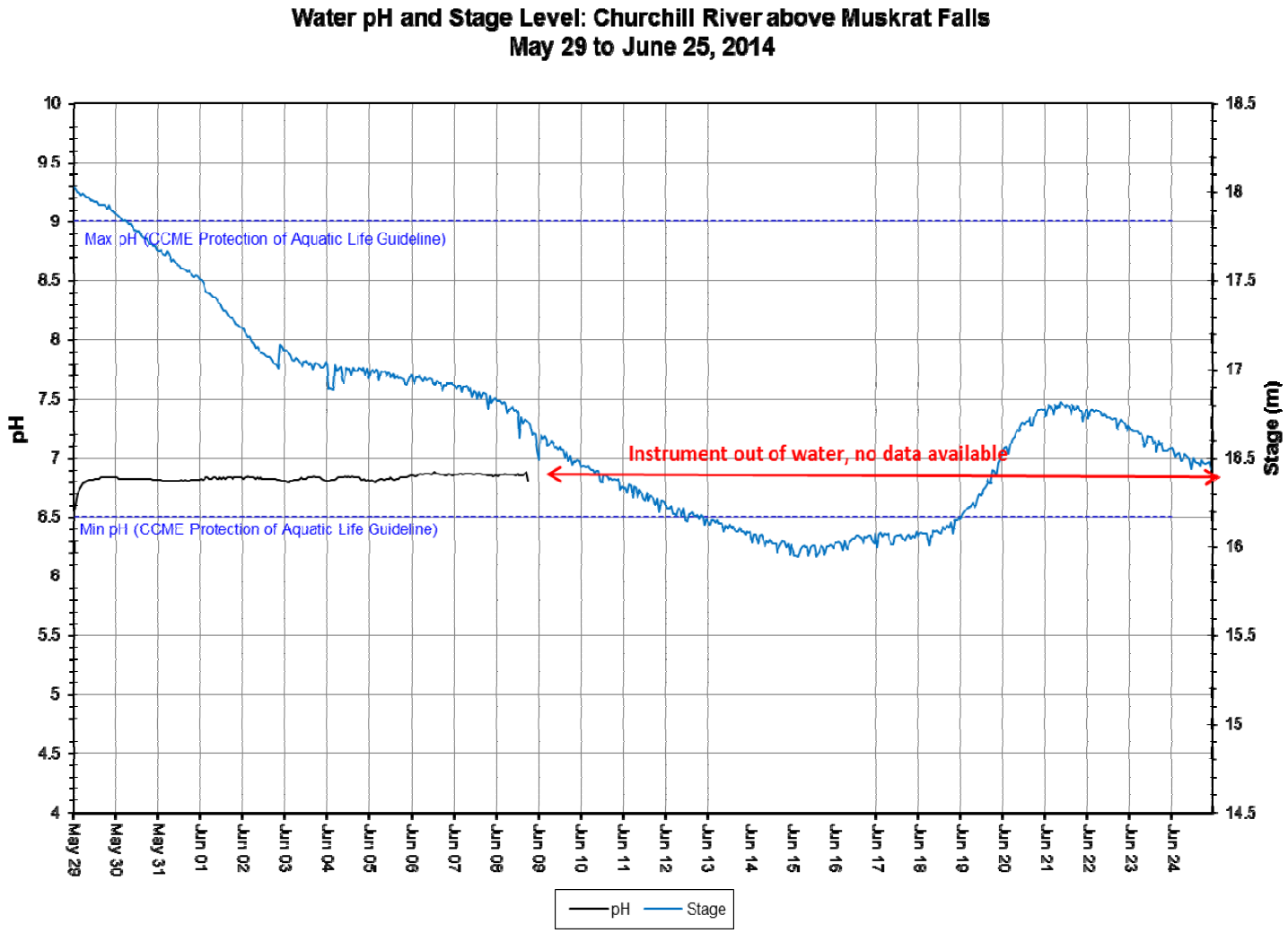


Figure 11: pH and stage at Churchill River above Muskrat Falls

- Specific conductivity ranges from 14.2µS/cm to 15.9µS/cm during the deployment period, averaging 14.9µS/cm. (Figure 12).
- Stage is included in Figure 12 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 clearly visible in the data collected during the deployment period. Specific conductivity is increasing slightly as water levels drop after the spring freshet.

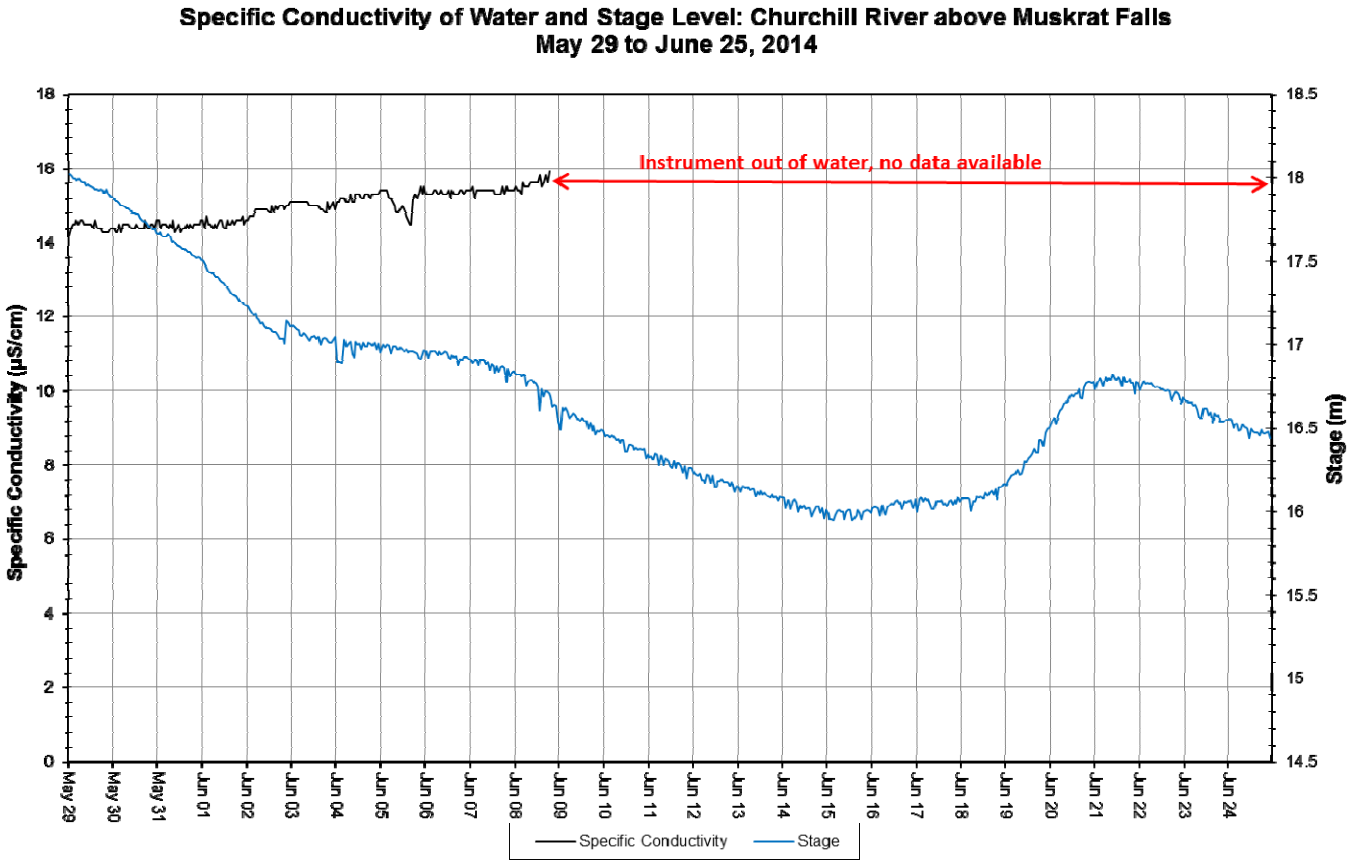


Figure 12: Specific conductivity and stage level at Churchill River above Muskrat Falls

- Dissolved oxygen content ranges between 11.29mg/l and 12.36mg/l. The saturation of dissolved oxygen ranges from 92.8% to 97.9% (Figure 13).
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 13.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 13).

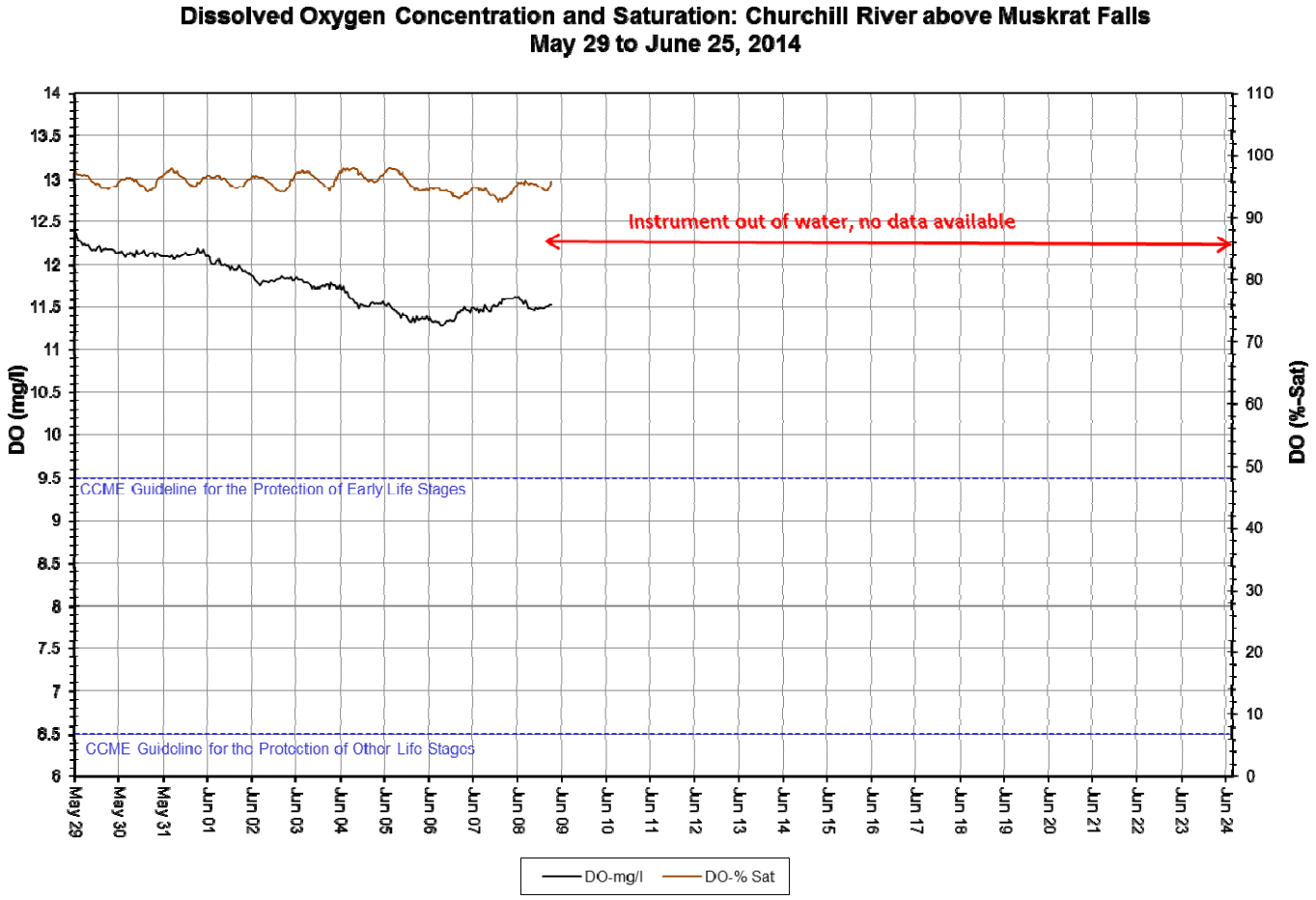


Figure 13: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity ranges between 3.8NTU and 14.3NTU, averaging 7.6 NTU during the first week of the deployment (Figure 14). A median value of 7.7NTU suggests there is consistent natural background turbidity value. This trend is typical at this station.
- Turbidity increases on June 2 and 3 each correspond with precipitation events, and are highlighted on Figure 14.

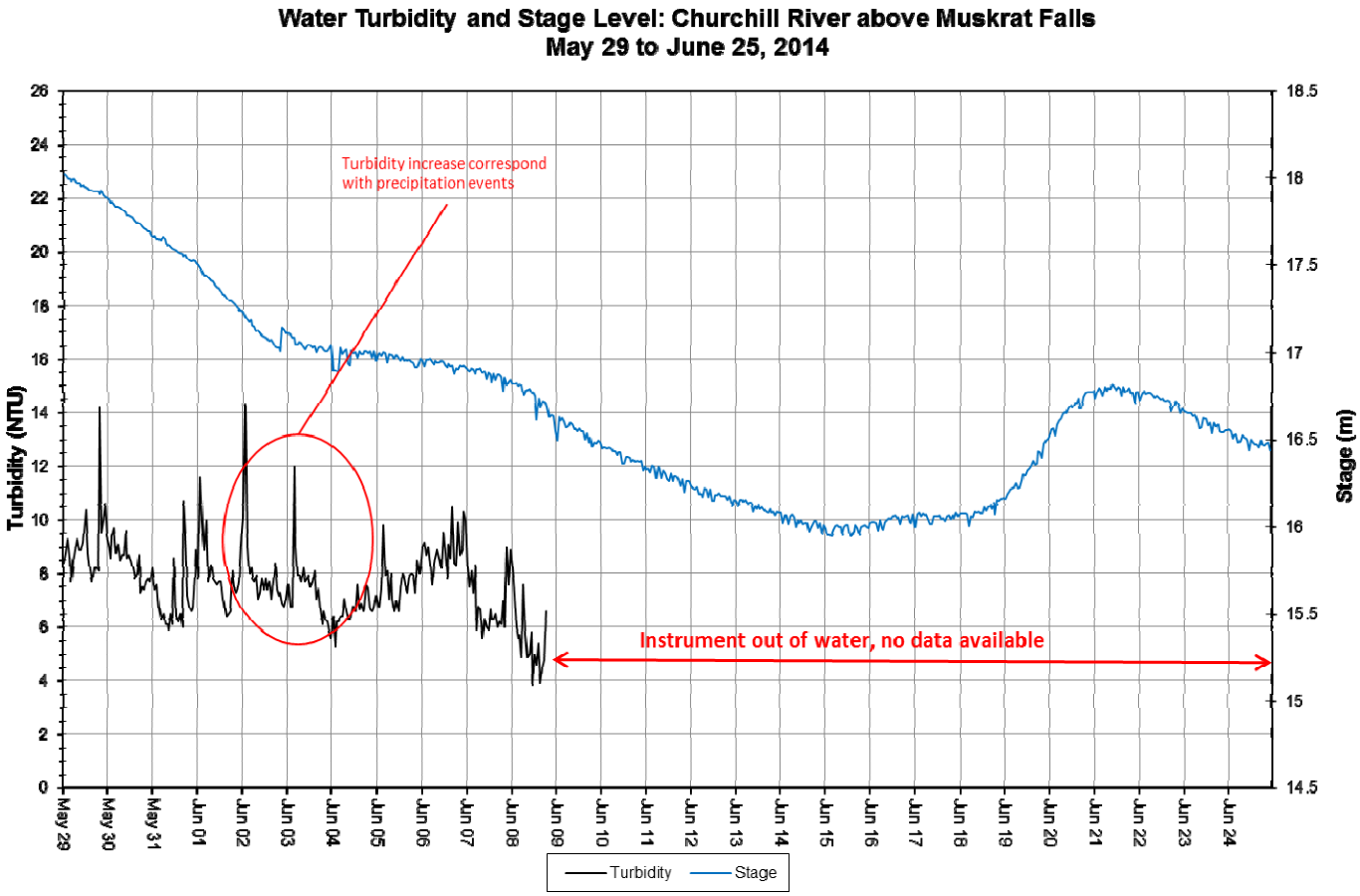


Figure 14: Turbidity and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 15). Stage is mostly decreasing throughout the deployment period. Precipitation occurs on >50% of the days in the deployment period and amounts are moderate in magnitude, with one 25+mm event on June 19th. Stage ranges between 15.95m and 18.02m. Discharge ranges from 1240m^3/s to 2560m^3/s.

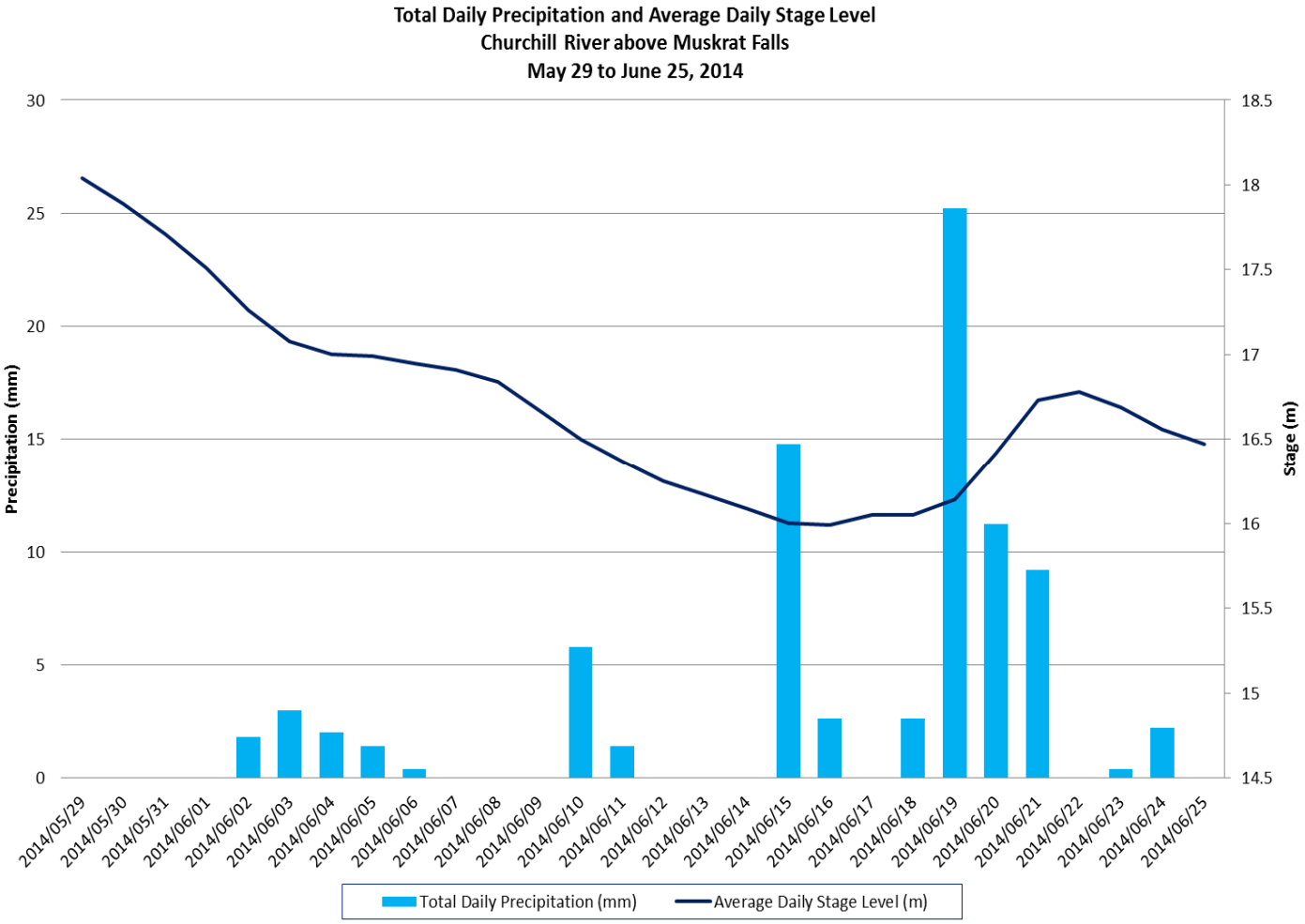


Figure 15: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- The below Muskrat Falls station could not be deployed on May 29, 2014 due to the helicopter landing pad having been damaged during the winter or spring, preventing access to the water quality station at this time.
- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 16). Stage data is unavailable until June 9th as the hydrometric equipment was damaged by ice. From June 9-25, stage is mostly decreasing until June 16, before increasing after this date, due to several precipitation events. Precipitation occurs on >50% of the days in the deployment period and amounts are moderate in magnitude, with the exception of one 25+mm event on June 19th. From June 9-25, daily stage ranges between 2.48m and 2.95m.

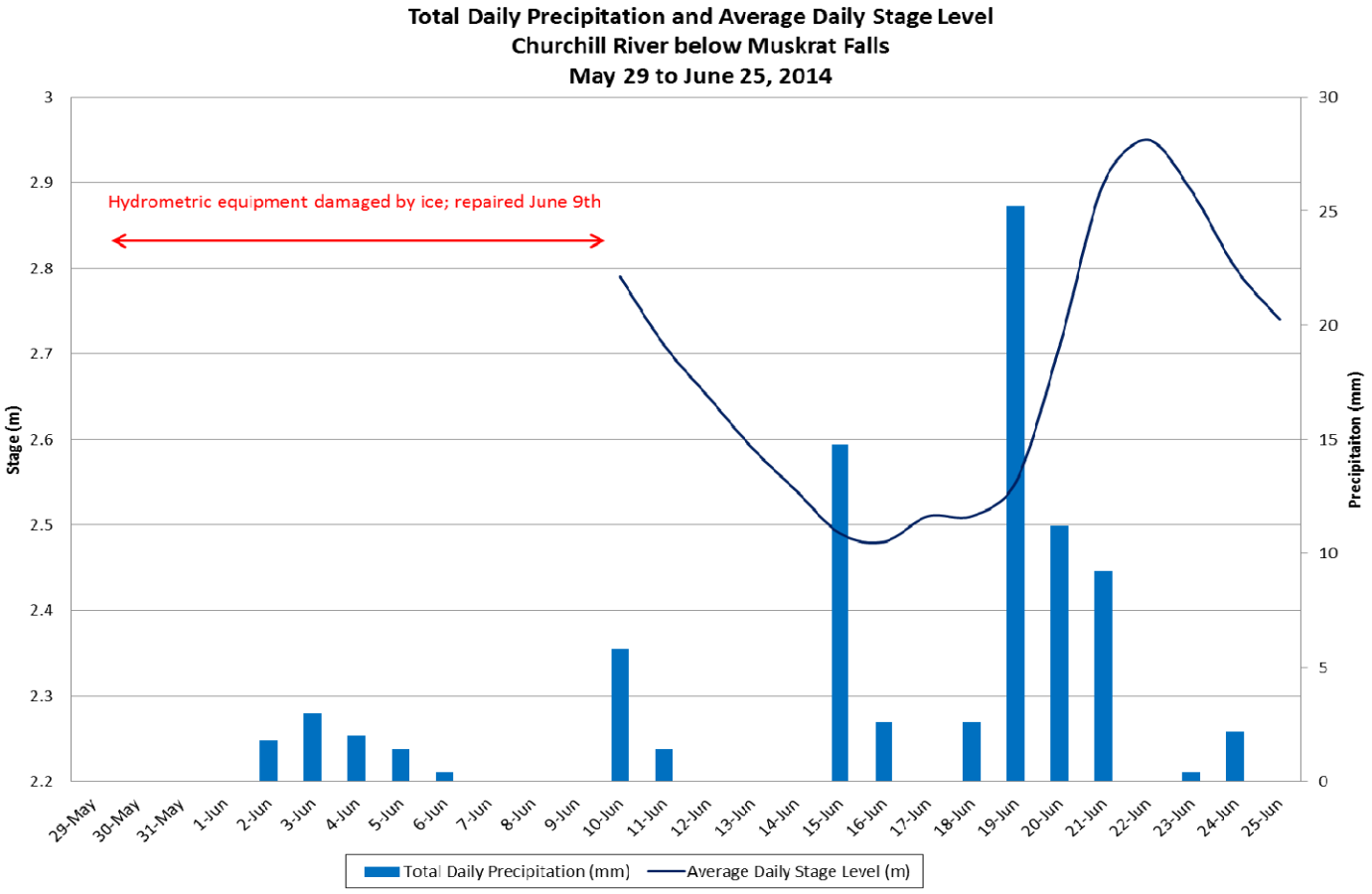


Figure 16: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Churchill River at English Point

- Water temperature ranges from 3.90°C to 14.90°C during the deployment period (Figure 17).
- Water temperature is increasing throughout this period. This trend is expected given the warming ambient air temperatures in the spring season (Figure 18). Water temperature fluctuates diurnally.

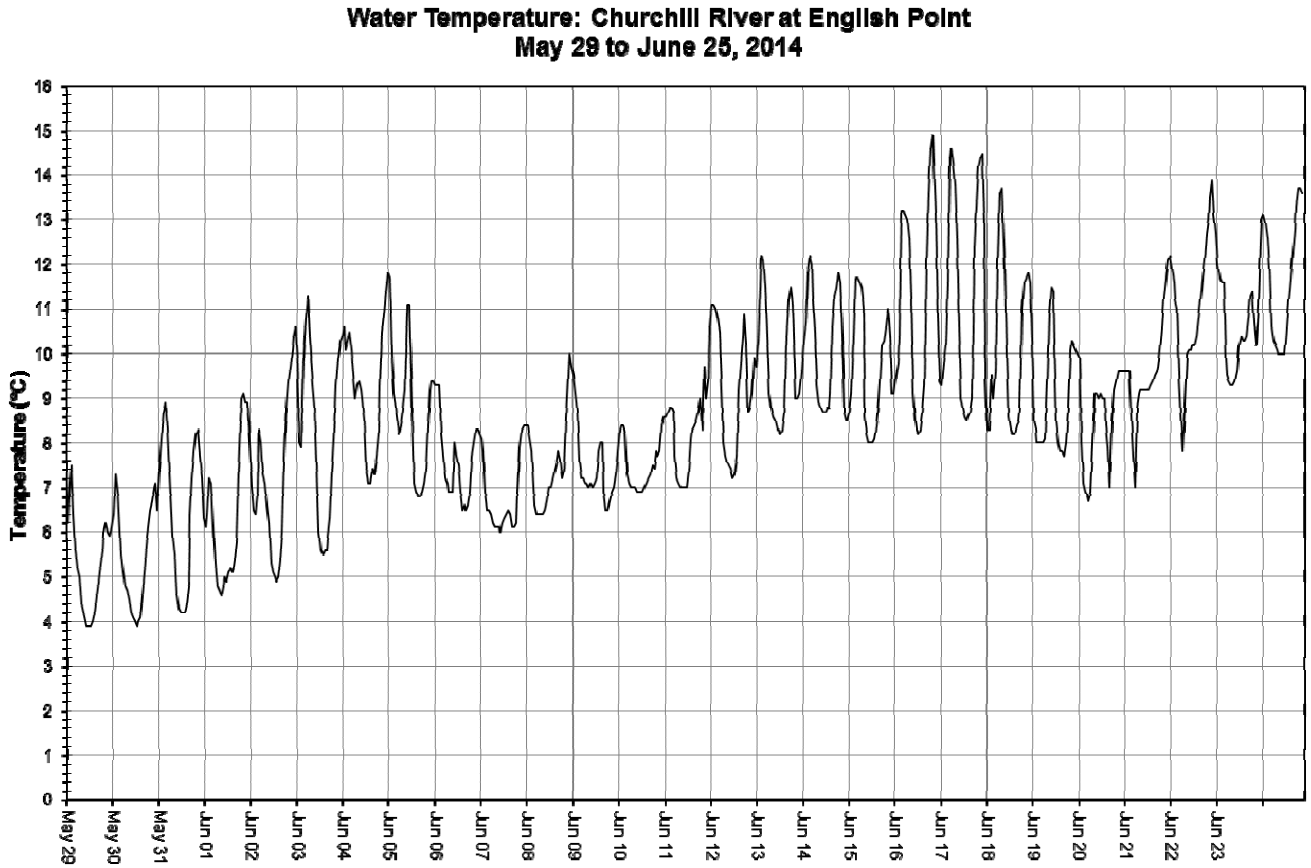


Figure 17: Water temperature at Churchill River at English Point

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

(weather data recorded at Goose Bay)

- pH ranges between 7.24 and 7.93 pH units during the deployment period (Figure 19).
- All values during this period are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 19).

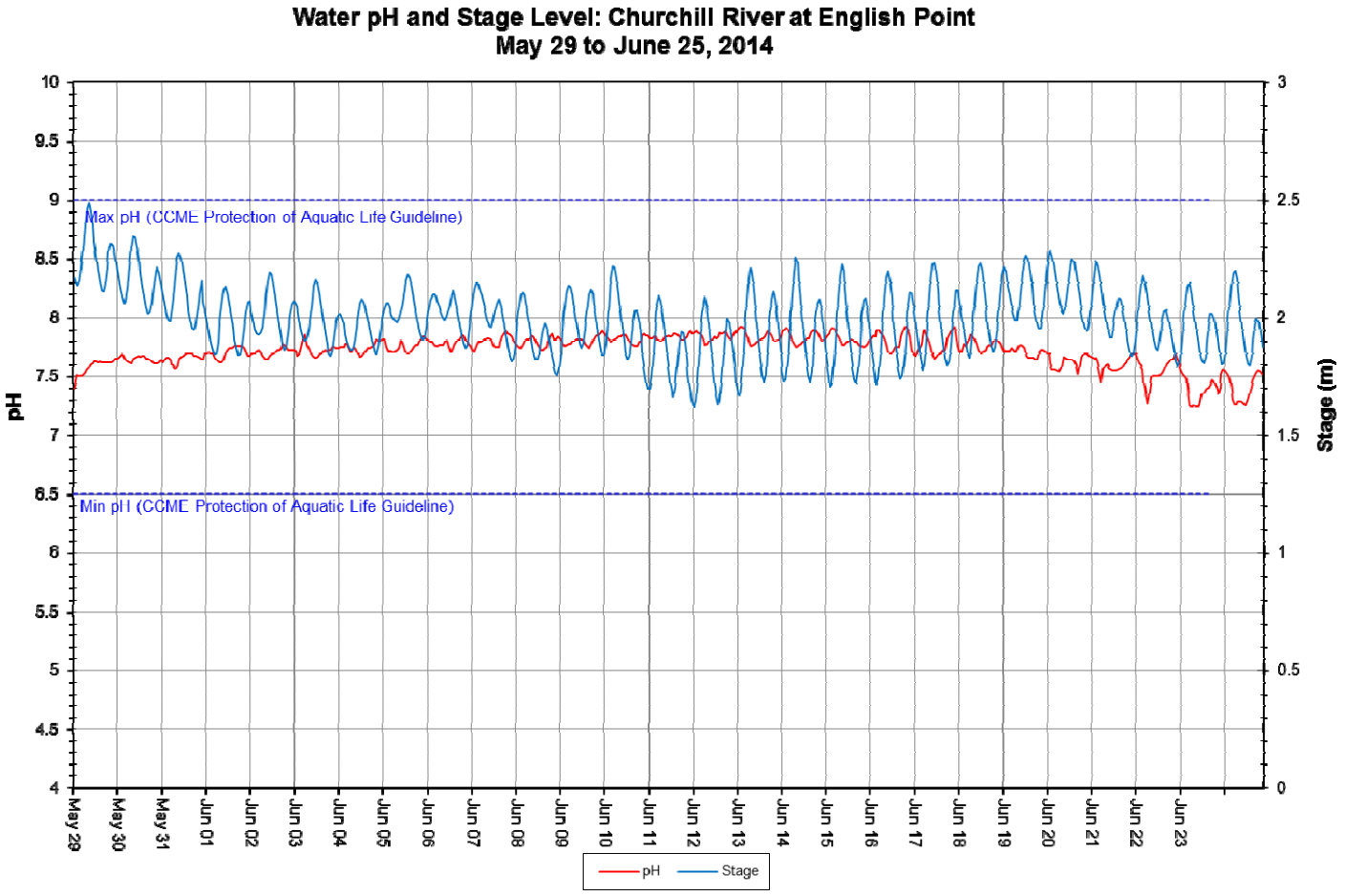


Figure 19: pH and stage level at Churchill River at English Point

- Specific conductance typically ranges between 14.1µS/cm and 46.3µS/cm during the deployment period, averaging 26.4µS/cm (Figure 20).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the specific conductivity increases as the dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period. There is a decrease in specific conductivity during a period of high stage level from June 9-10. This decrease is highlighted in red on Figure 20.

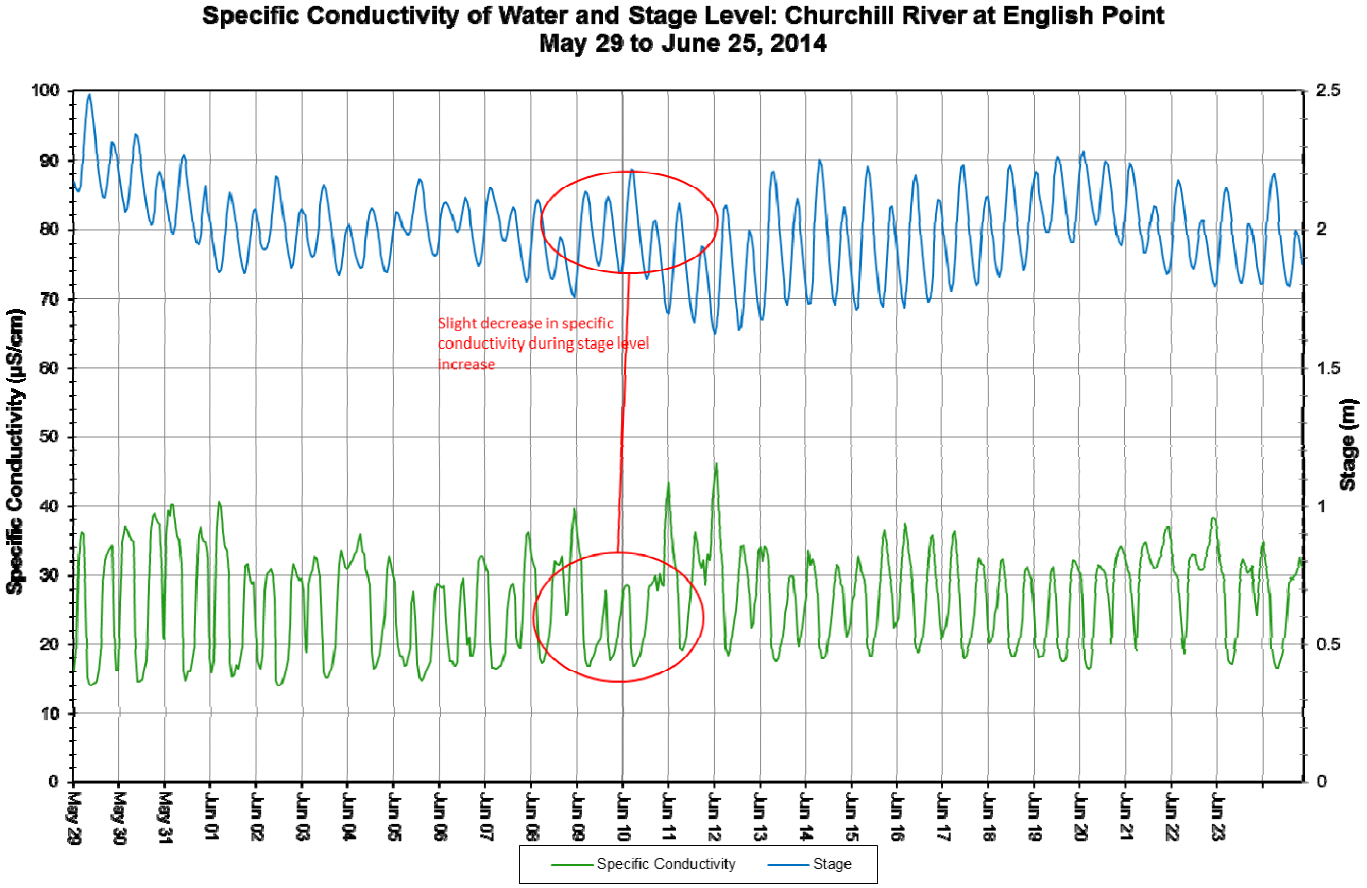


Figure 20: Specific conductivity and stage level at Churchill River at English Point

- Dissolved oxygen content ranges between 10.13mg/l and 13.52mg/l during the deployment. The saturation of dissolved oxygen ranges from 86.9% to 109.5% (Figure 21).
- All values were above both the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stage of 6.5mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 21.
- Dissolved oxygen content is decreasing slightly throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 18).

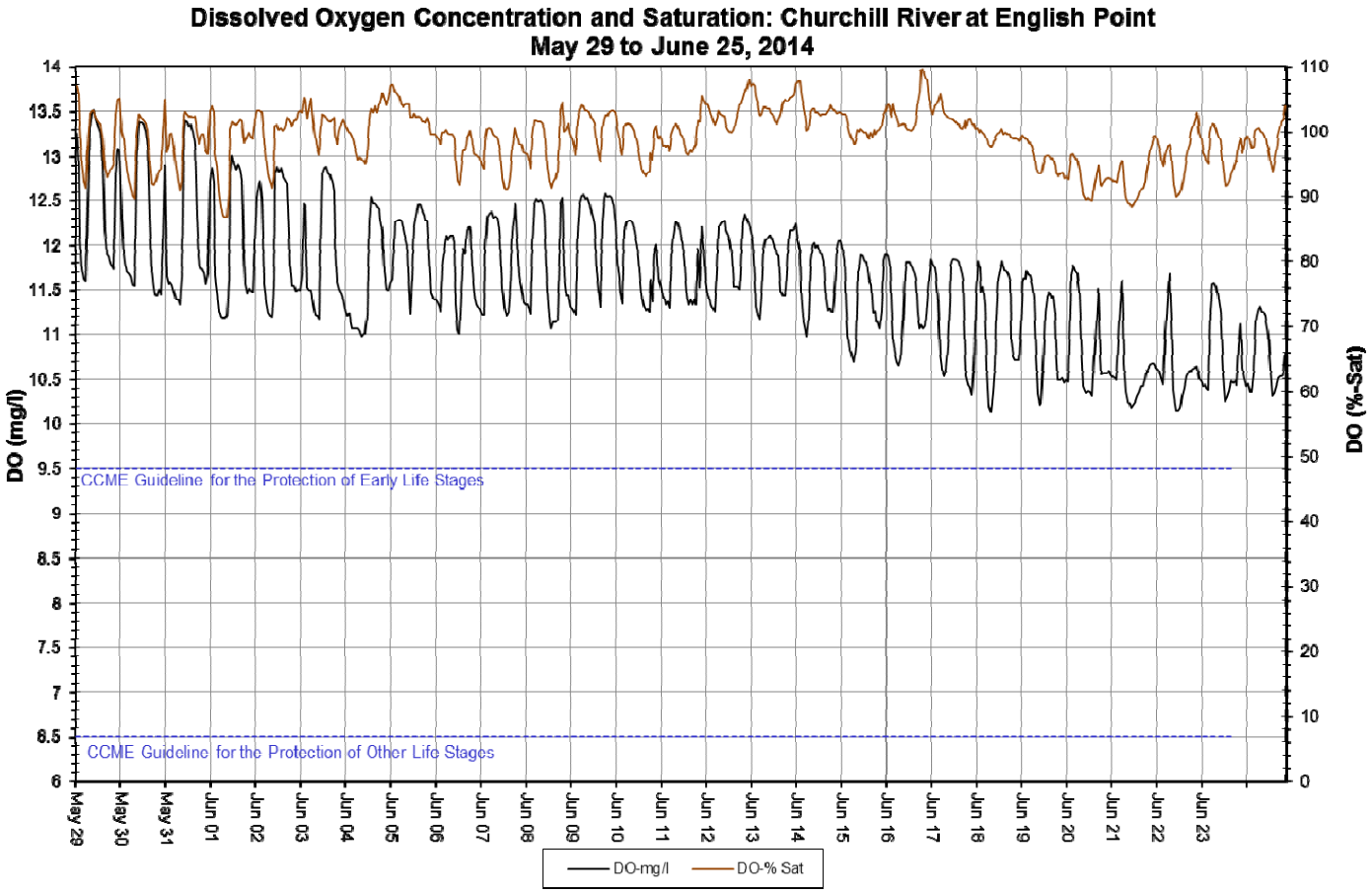


Figure 21: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity ranges from 3.2NTU to 115.1NTU during the deployment (Figure 22).
- A turbidity increase on June 19-20 corresponds with precipitation events recorded in the region. These events are highlighted in red on Figure 22.

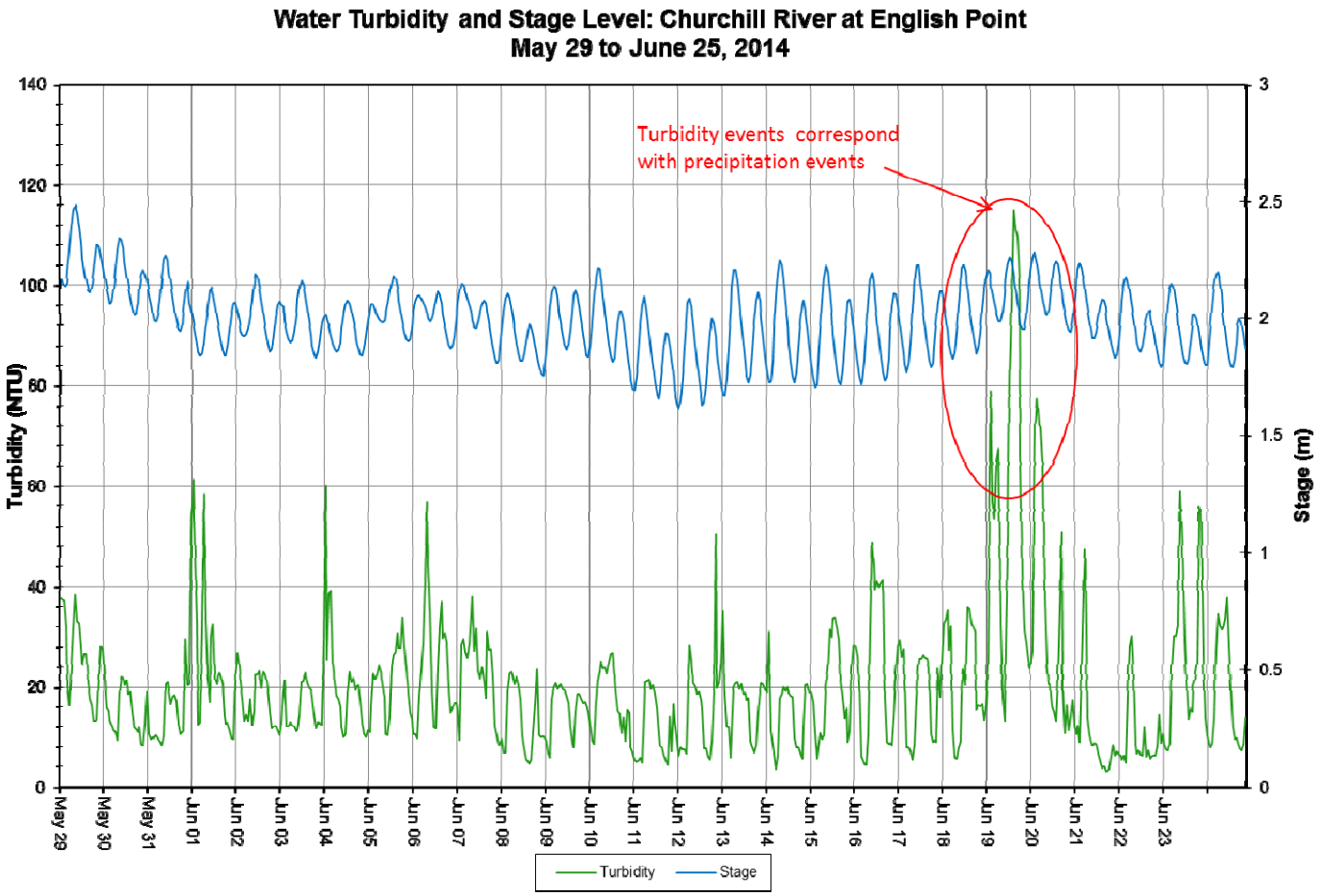


Figure 22: Turbidity and stage level at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 23). Stage is fluctuating throughout the deployment period. Precipitation occurs on >50% of the days in the deployment period and amounts are moderate in magnitude with the exception of one 25+mm event on June 19th. Stage ranges between 1.62m and 2.49m.

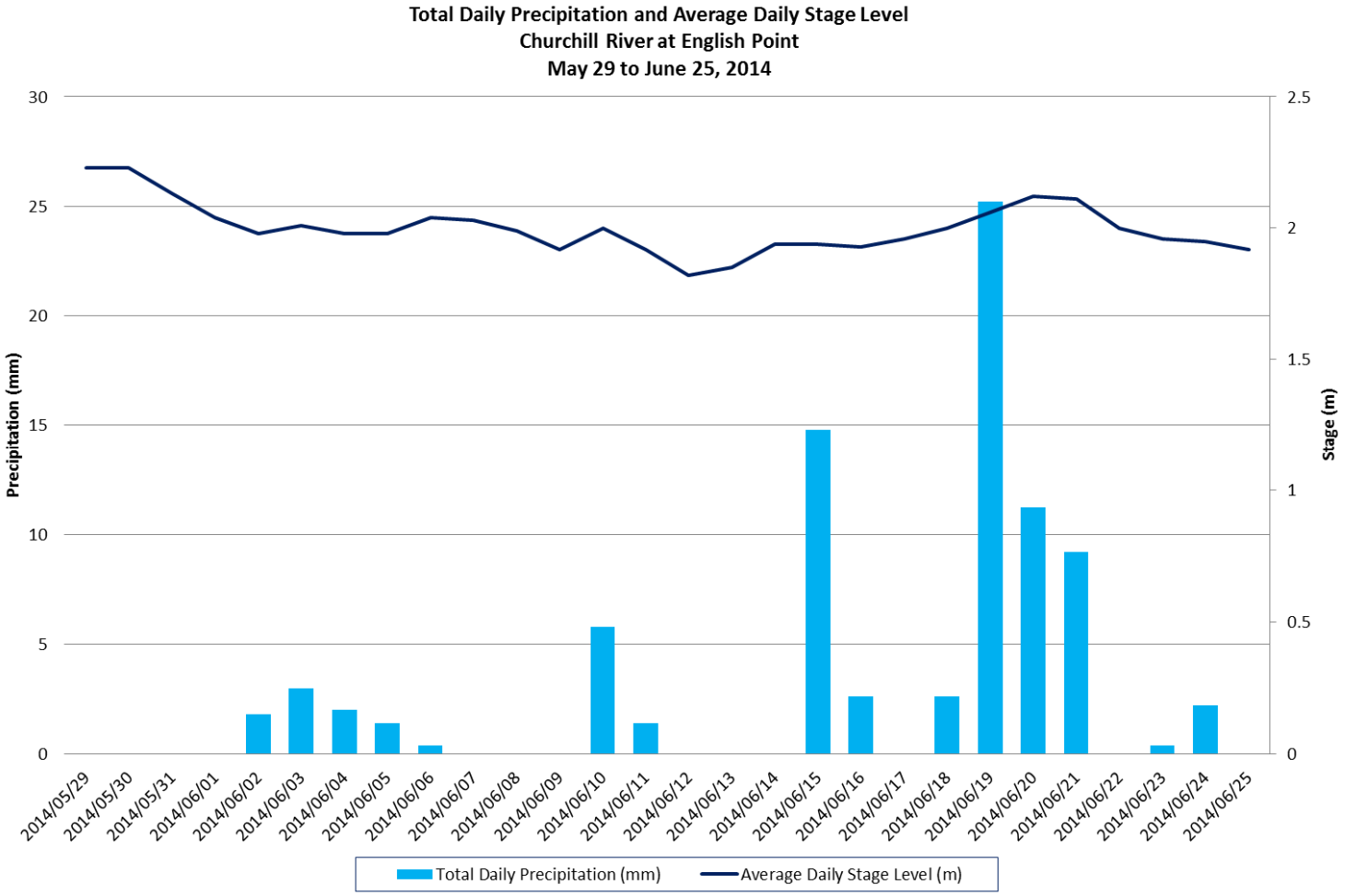
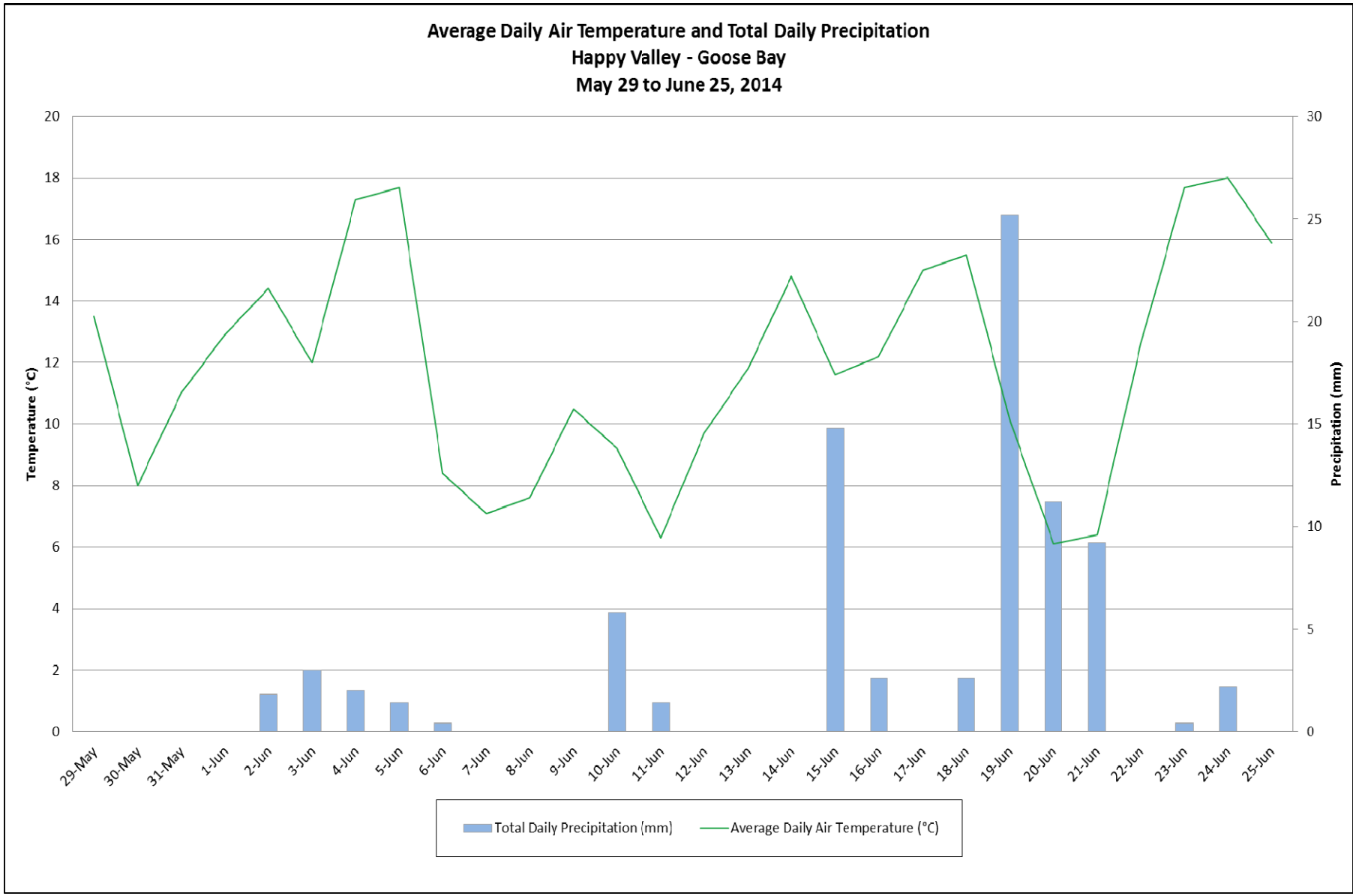


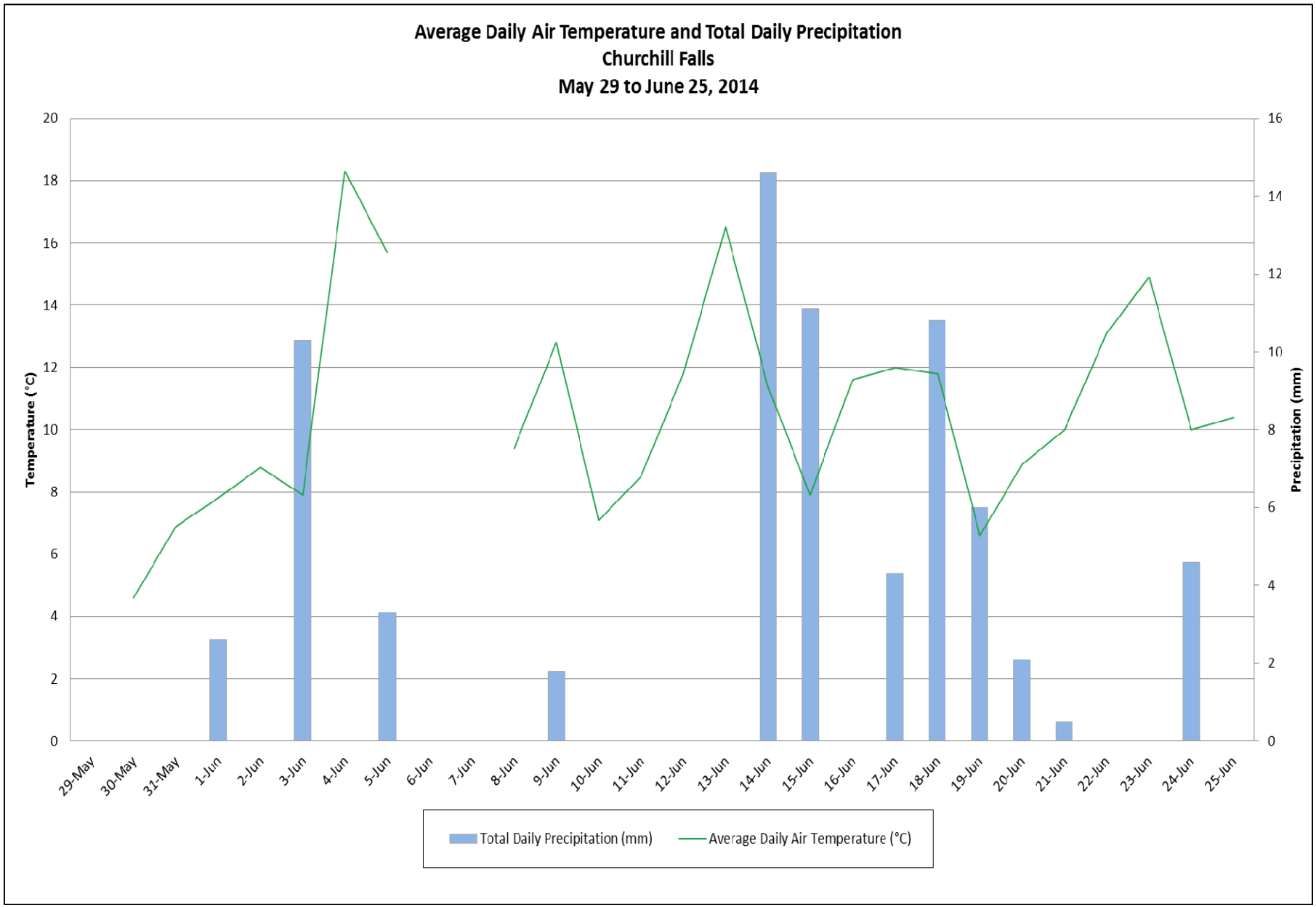
Figure 23: Daily precipitation and average daily stage level at Churchill River at English Point (weather data recorded at Goose Bay)

Conclusions

- Instruments at three water quality monitoring stations on the Lower Churchill River were deployed from May 29 to June 25, 2014. Instruments at two of these stations stopped recording accurate data on June 9th as water levels had dropped significantly, leaving the sondes exposed on the shoreline.
- Stage levels mostly decreased at all stations throughout the deployment period.
- Water temperature was increasing throughout the deployment period due to the warming ambient air temperatures in the region in the spring season. Water temperature typically ranged between 3.9°C and 14.9°C. Comparisons between stations cannot be made as only one station recorded temperature data for the entire deployment period.
- pH is generally neutral and stable at stations along the Lower Churchill River ranging between 6.04 and 7.93 pH units. All pH values at all stations were within the recommended CCME Guidelines for the Protection of Aquatic Life after the water quality sondes stabilized.
- Specific conductivity was relatively stable at all stations regardless of the fluctuating stage levels. While this trend is not normally experienced, for this deployment period, the trend was similar throughout the network with the exception of the station at English Point which is influenced by the tides in Lake Melville. Specific conductivity averaged between 14.2µS/cm and 19.3µS/cm at the stations below Metchin River and above Muskrat Falls. Specific conductivity values at the station at English Point had a higher range of 14.1µS/cm to 46.3µS/cm. However, it should be noted that the data set for below Metchin River and above Muskrat Falls is only for the period May 29-June 9, 2014.
- Dissolved oxygen content was decreasing throughout the deployment period as it is inversely related to water temperature. Values ranged between 10.13mg/l and 13.52mg/l. All values were above both the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages at 6.5mg/l and at Early Life Stages of 9.5mg/l.
- Turbidity data at the station below Metchin River remained mostly at 0NTU throughout the deployment period which is typical of this station. Turbidity values at the stations above Muskrat Falls and at English Point were typical for the stations, reporting background values of 7.6NTU and 20.4NTU, respectively.

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




Average Daily Air Temperature and Total Daily Precipitation
Churchill Falls
May 29 to June 25, 2014
Temperature (°C)
Precipitation (mm)
0
2
4
6
8
10
12
14
16
18
20
0
2
4
6
8
10
12
14
16
29-May
30-May
31-May
1-Jun
2-Jun
3-Jun
4-Jun
5-Jun
6-Jun
7-Jun
8-Jun
9-Jun
10-Jun
11-Jun
12-Jun
13-Jun
14-Jun
15-Jun
16-Jun
17-Jun
18-Jun
19-Jun
20-Jun
21-Jun
22-Jun
23-Jun
24-Jun
25-Jun
Total Daily Precipitation (mm)
Average Daily Air Temperature (°C)