Real-Time Water Quality Deployment Report

Lower Churchill River Network

May 26 to
June 29, 2011

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 four stations on the Lower Churchill River below Metchin River, below Grizzle Rapids and above and below Muskrat Falls.
- On May 26-27, 2011, real-time water quality monitoring instruments were deployed at three of the four Lower Churchill River Stations for a period of 33-34 days. Instruments were removed on June 29. No instrument was deployed at the station below Grizzle Rapids during this time due to a large ice wall that prohibited safe access to the river.

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 QA/QC 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 (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 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 26/27 to June 29, 2011 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, May 26/27 – June 29, 2011

Station Churchill River	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	May 27, 2011	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Jun 29, 2011	Removal	Good	Excellent	Excellent	Excellent	Fair
Above Muskrat Falls	May 26, 2011	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Jun 29, 2011	Removal	n/a*	n/a*	n/a*	n/a*	n/a*
Below Muskrat Falls	May 27, 2011	Deployment	Fair	Excellent	Excellent	Good	Excellent
	Jun 29, 2011	Removal	n/a*	n/a*	n/a*	n/a*	n/a*

* QAQC comparison readings were not available for removal at station above and below Muskrat Falls. During the deployment period, the water level dropped significantly leaving the instruments exposed on the shoreline.

- At the station below Metchin River, all parameters ranked 'excellent' at deployment. At removal, temperature, pH, specific conductivity and dissolved oxygen all ranked either 'good' or 'excellent'. Turbidity was ranked 'fair'. The field instrument read a value of 0.3NTU while the QAQC instrument read a value of 6NTU. The water level had dropped significantly during the month of June and exposed a mud flat near where the instrument was deployed. During removal, disturbance of the mud flat in the area of the instrument location may have caused the QAQC instrument to read higher than normal turbidity reading resulting in a 'fair' comparison ranking.
- At the station above Muskrat Falls, all parameters ranked either 'good' or 'excellent' at deployment. Between June 14 and June 20 and then again from June 25 until removal on June 29, the instrument was left exposed on the shoreline due to significant decreases in water level. QAQC values were not available at the time of removal due to the exposure and therefore are not ranked.
- At the station below Muskrat Falls, pH, specific conductivity, dissolved oxygen and turbidity all ranked 'good' or 'excellent' at deployment. Temperature was ranked 'fair'. The field instrument read a value of 2.26°C while the QAQC instrument read a value of 2.93°C. This difference may be a result in slightly different locations between the two instruments. Water levels were quite high at the time of deployment as well as turbidity (18NTU) which reduced the visibility required to ensure that the instruments were within close proximity to one another. Both temperature sensors were checked against a lab grade thermometer during calibration and maintenance on the previous day and were both with in the recommended 0.2°C range. Between June 15 and June 18 and then again from June 27 until removal on June 29, the instrument was left exposed on the shoreline due to significant decreases in water level. QAQC values were not available at the time of removal due to the exposure and therefore are not ranked.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from May 26/27 to June 29 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 ranged from 2.1 to 12.8^{o}C during this deployment period (Figure 1).
- Water temperature is increasing throughout the deployment period. This trend is expected due to the increasing ambient air temperatures in the spring and summer seasons (Figure 2). Water temperature fluctuates diurnally.

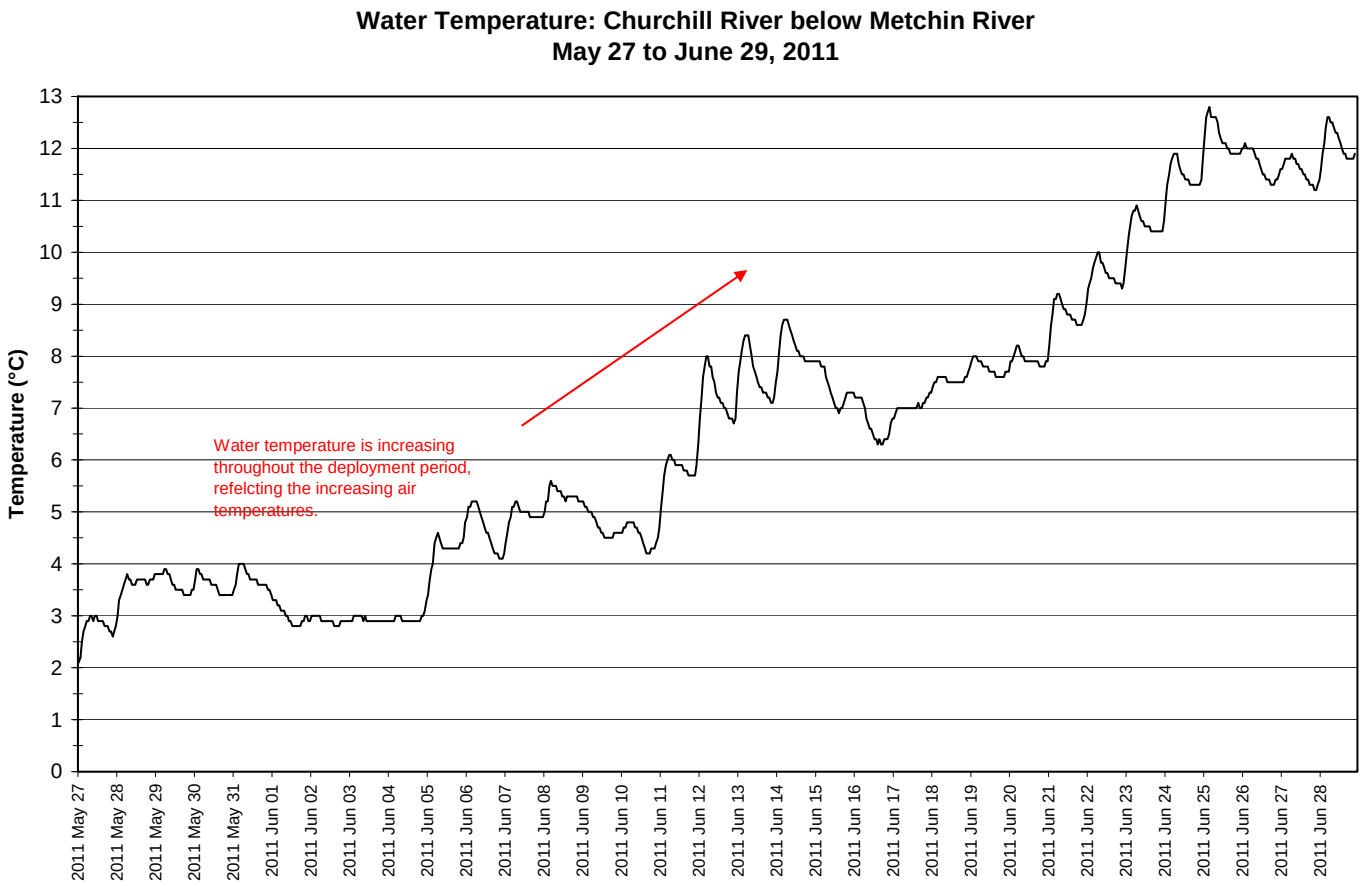

Figure 1: Water temperature at Churchill River below Metchin River

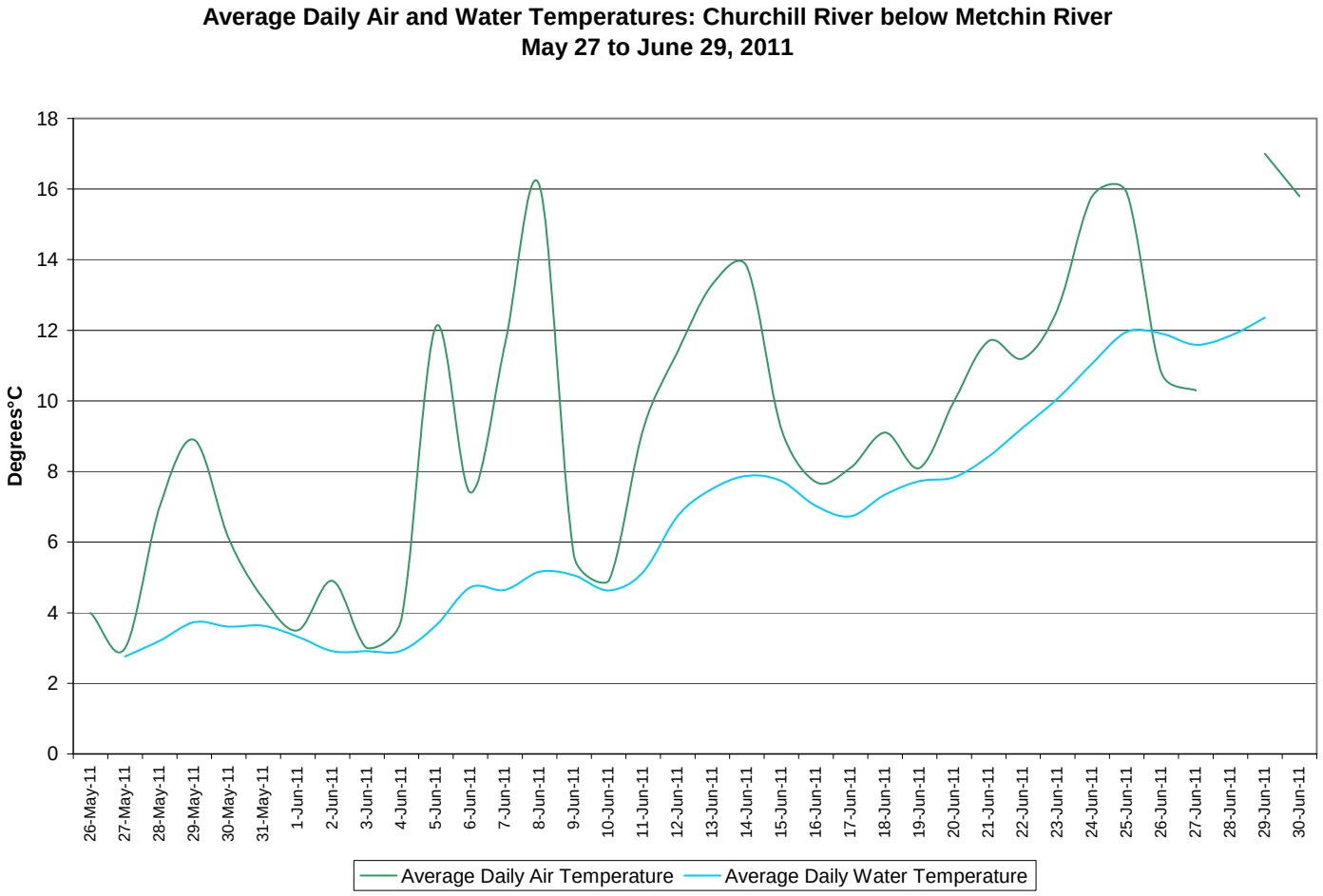

Figure 2: Average daily air and water temperatures at Churchill River below Metchin River (weather data recorded at Churchill Falls)

- pH ranges between 6.39 and 6.75 pH units and increases slightly throughout the deployment period (Figure 3).
- Most values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). At the beginning of the deployment, pH values are just below the minimum guideline.
- There is an increase in pH on May 30 which corresponds with the Environment Canada site visit when the instrument was moved in to deeper water using the boat. Rainfall events recorded at Churchill Falls between June 15 and 21 correspond with a decrease in pH from June 16 to 19.

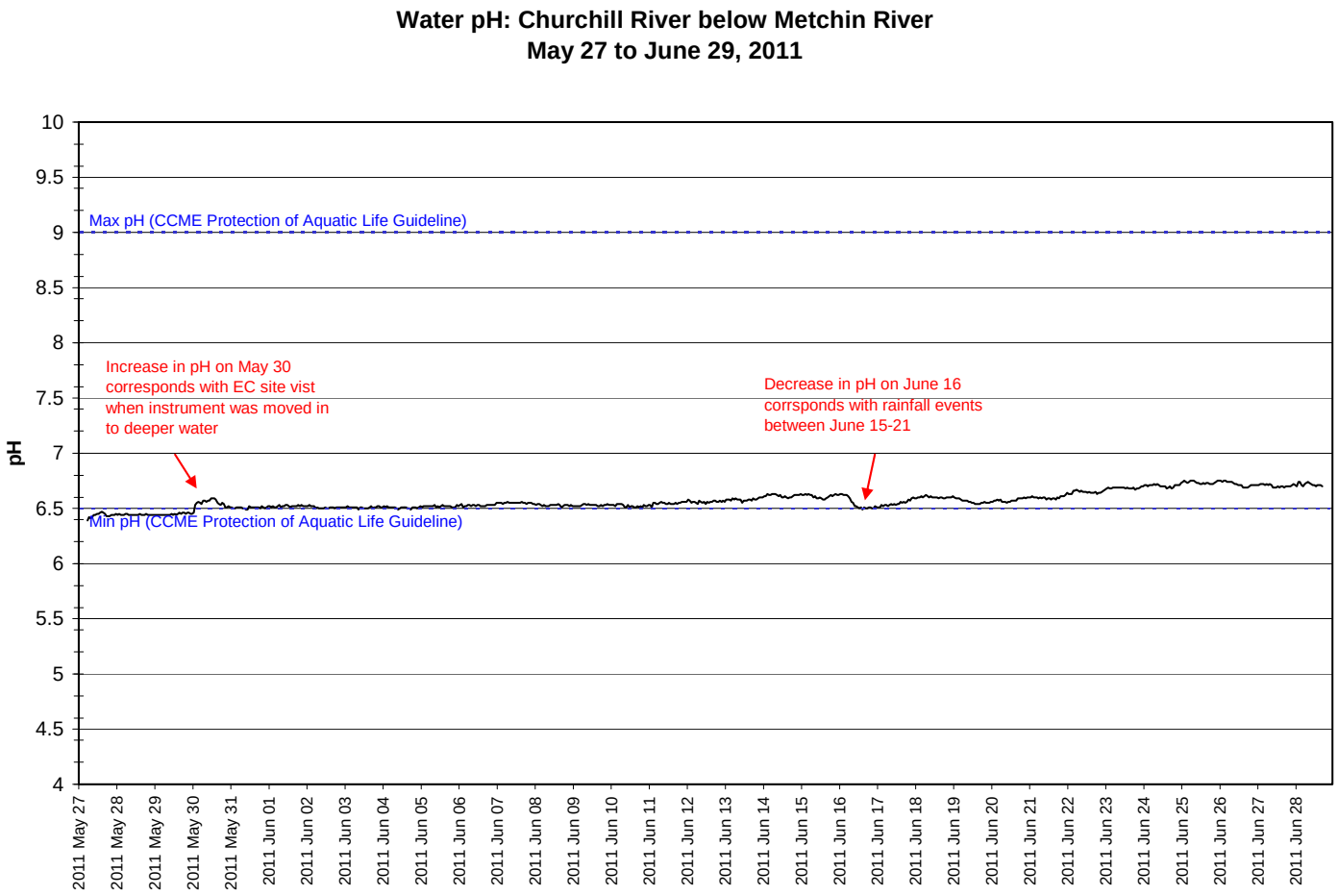

Figure 3: pH at Churchill River below Metchin River

- Specific conductivity ranges from 14.5 to 32.1µS/cm during the deployment period, averaging 17.3µS/cm (Figure 4). Specific conductance generally increases throughout the deployment period.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage generally decreases throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 4). Precipitation input can decrease the specific conductivity of the water body by diluting the concentration of dissolved solids present.
- An increase in specific conductivity for approximately 10 hours on June 13 corresponds with very low stage levels and could be a result from the instrument being in very shallow water or being exposed to surf conditions. An increase on June 15, lasting for 1 hour and then again on June 22 for 3 hours do not correspond with weather related events or relevant fluctuations in water level. The reason for these increases in unknown.

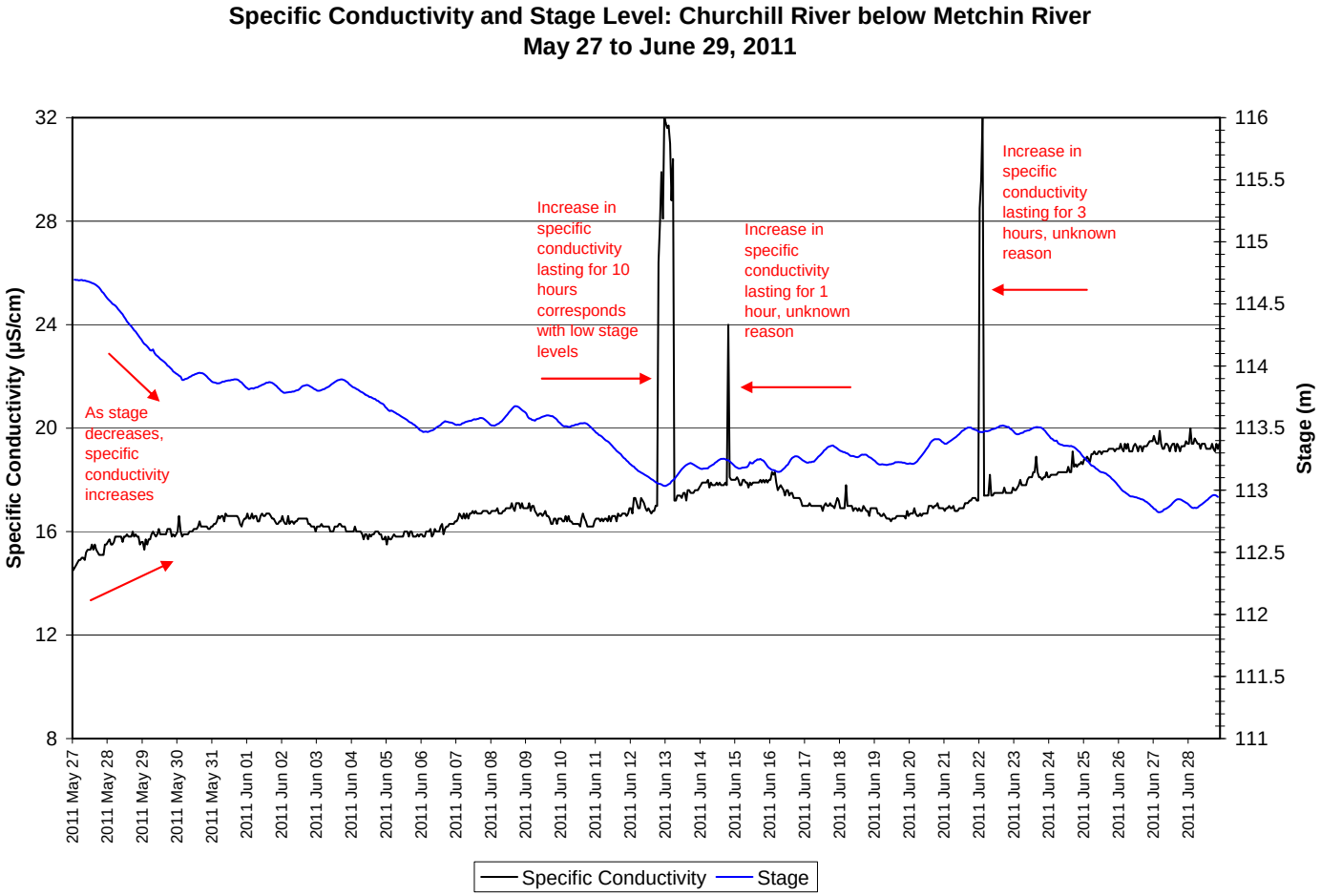

Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- The saturation of dissolved oxygen ranged from 92.3 to 101.1% and a range of 10.22 to 12.99mg/l was found in the concentration of dissolved oxygen with a median value of 11.72 mg/l (Figure 5).
- 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 blue on Figure 5.
- Dissolved oxygen content generally decreases throughout the deployment period. This trend is expected given the increasing air and water temperatures (Figure 2).

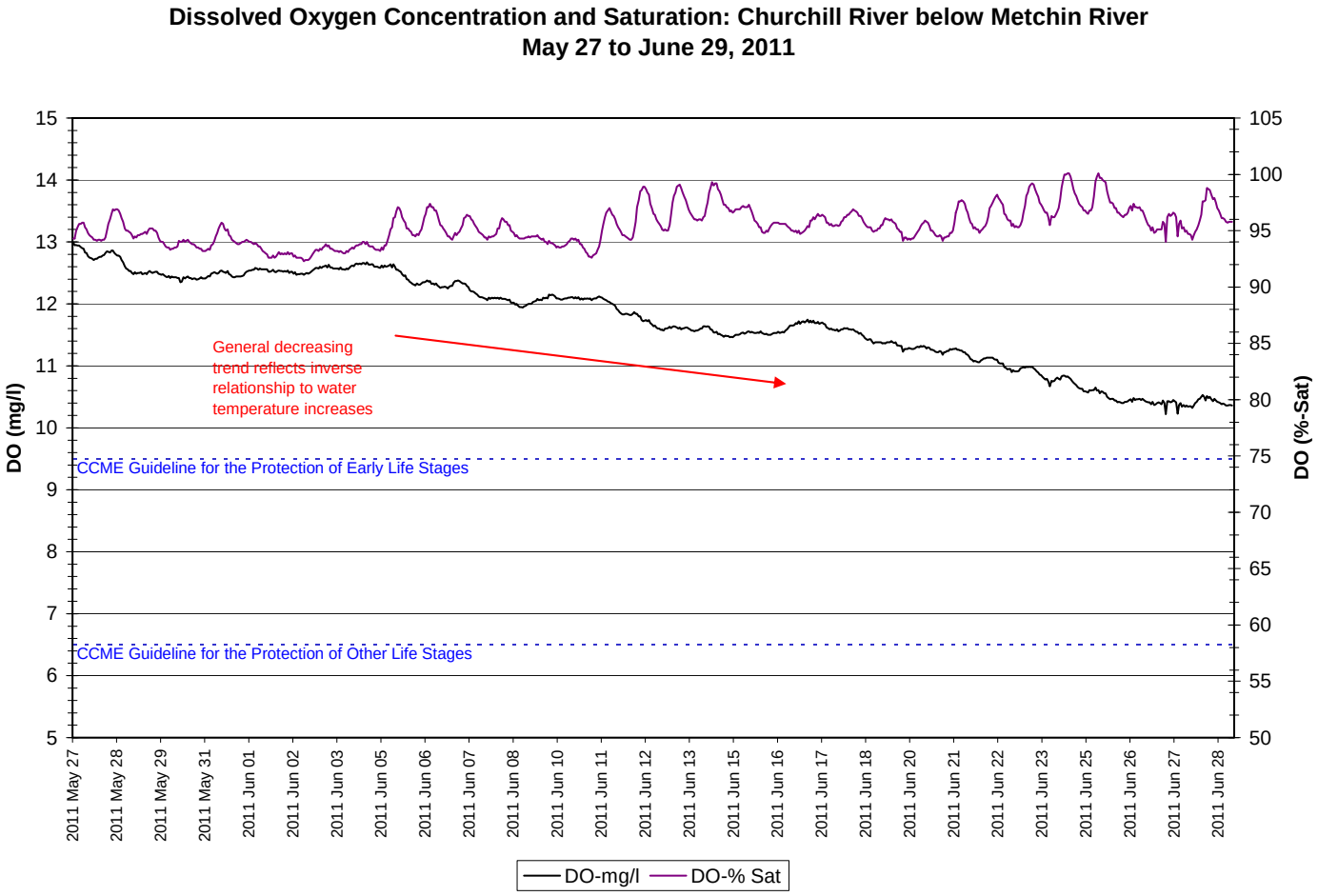

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- A range of 0 to 50.9NTU was recorded for turbidity for this deployment period (Figure 6). A median value of 0 NTU indicates there is generally no natural background turbidity value at this station.
- There are several spikes in turbidity throughout the deployment period however they are sporadic, relatively short lived and of a magnitude <50NTU. Some events last up to 6 hours. One event occurring on May 30 corresponds with the Environment Canada site visit during which the Hydrolab was moved further out in to the river by boat. This disturbance in a muddy reach of the river most likely caused this turbidity event. Turbidity values returned to at or near 0NTU within a few hours.
- It is important to note that at the time of deployment, there was a small ice wall remaining at this site and many ice pans were seen drifting in the river. Throughout the spring season, much of the melt water from the shoreline and in the river most likely caused increased turbidity values.

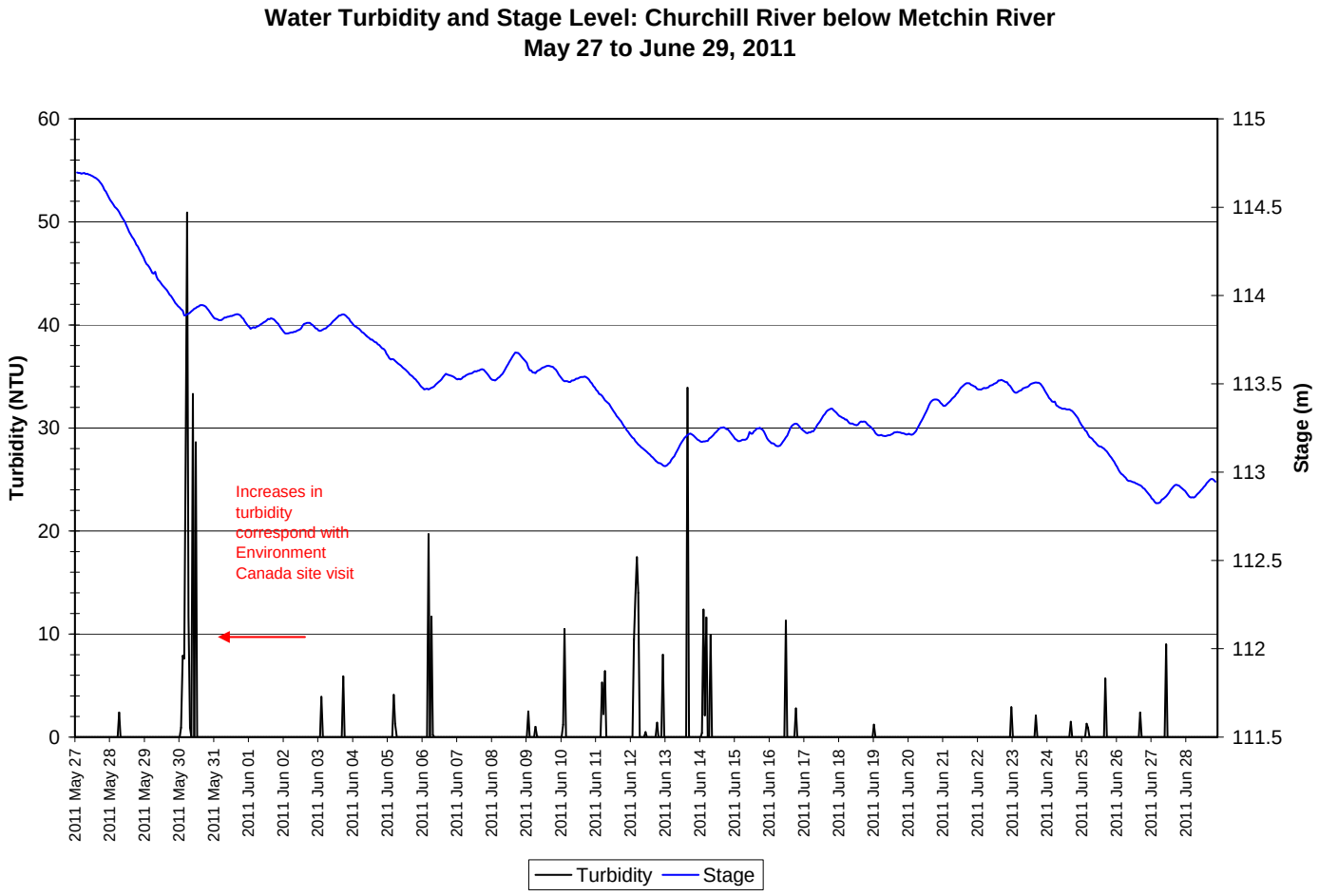

Figure 6: Turbidity and stage level at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is generally decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall events between June 15 and 21, cause the water level in the river to rise in the days following.

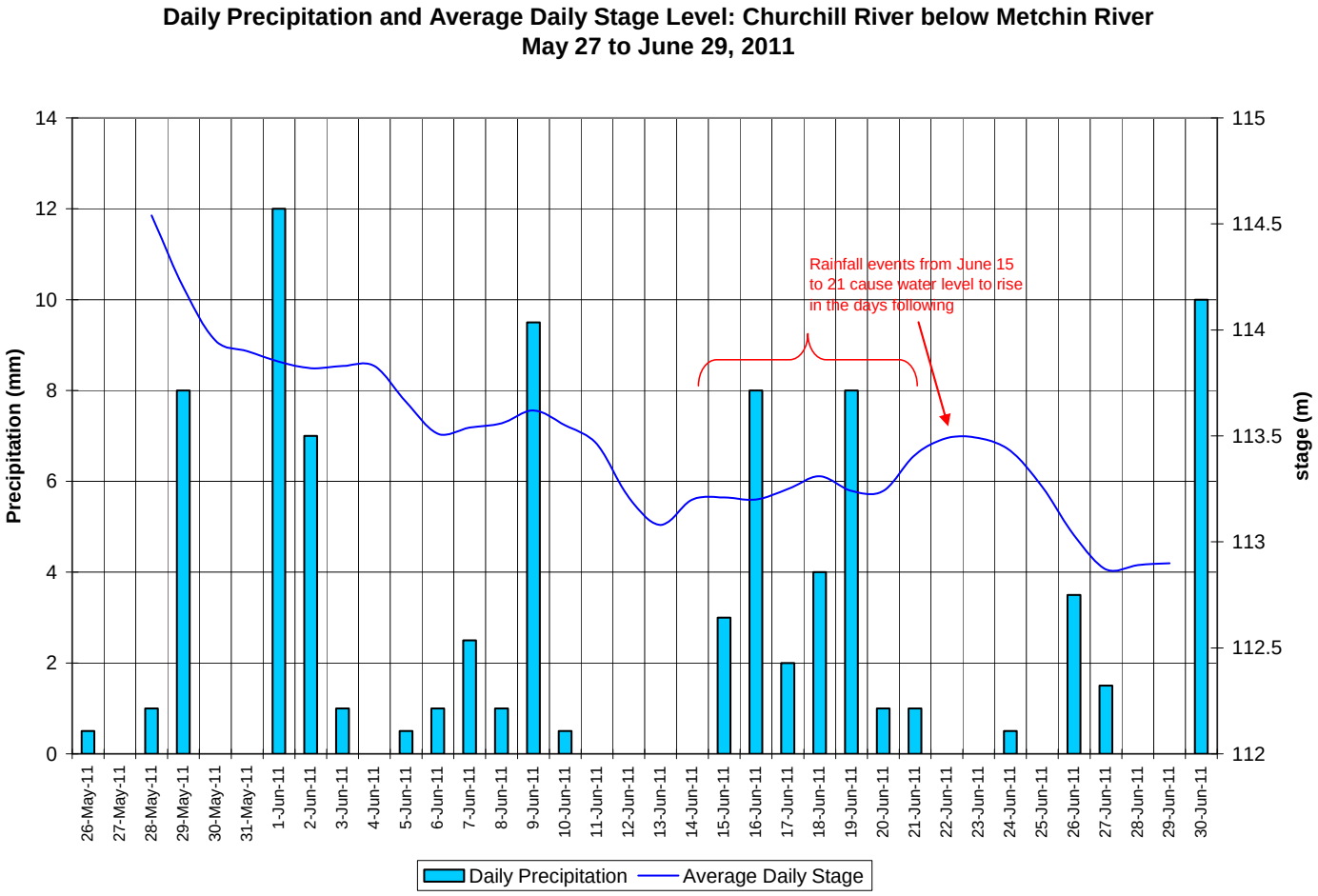

Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- There was no instrument deployed at this station at the end of May 2011 due to a large ice wall remaining on the shoreline which prohibited safe access to the river (Figure 8).

Figure 8: Large ice wall remaining at station below Grizzle Rapids on May 26, 2011 prevented safe access to the river shoreline (above) upstream view, (below) downstream view

Churchill River above Muskrat Falls

- The instrument became exposed to air as water levels dropped between June 14 and 20 and then again from June 25 until removal on June 29. Data collected during the time when the instrument was exposed to air has been removed.

Figure 9: (above) Picture of instrument as found on the river shoreline upon removal on June 29 at station above Muskrat Falls, (below) Picture showing the drop in water level between May 27 and June 29 and the relative location of the exposed instrument

- Water temperature ranges from 2.72 to 8.43°C during this deployment period (Figure 10).
- Water temperature is generally increasing throughout the deployment period. This trend is expected given the increasing ambient air temperature in the spring (Figure 11). Water temperature fluctuates diurnally.

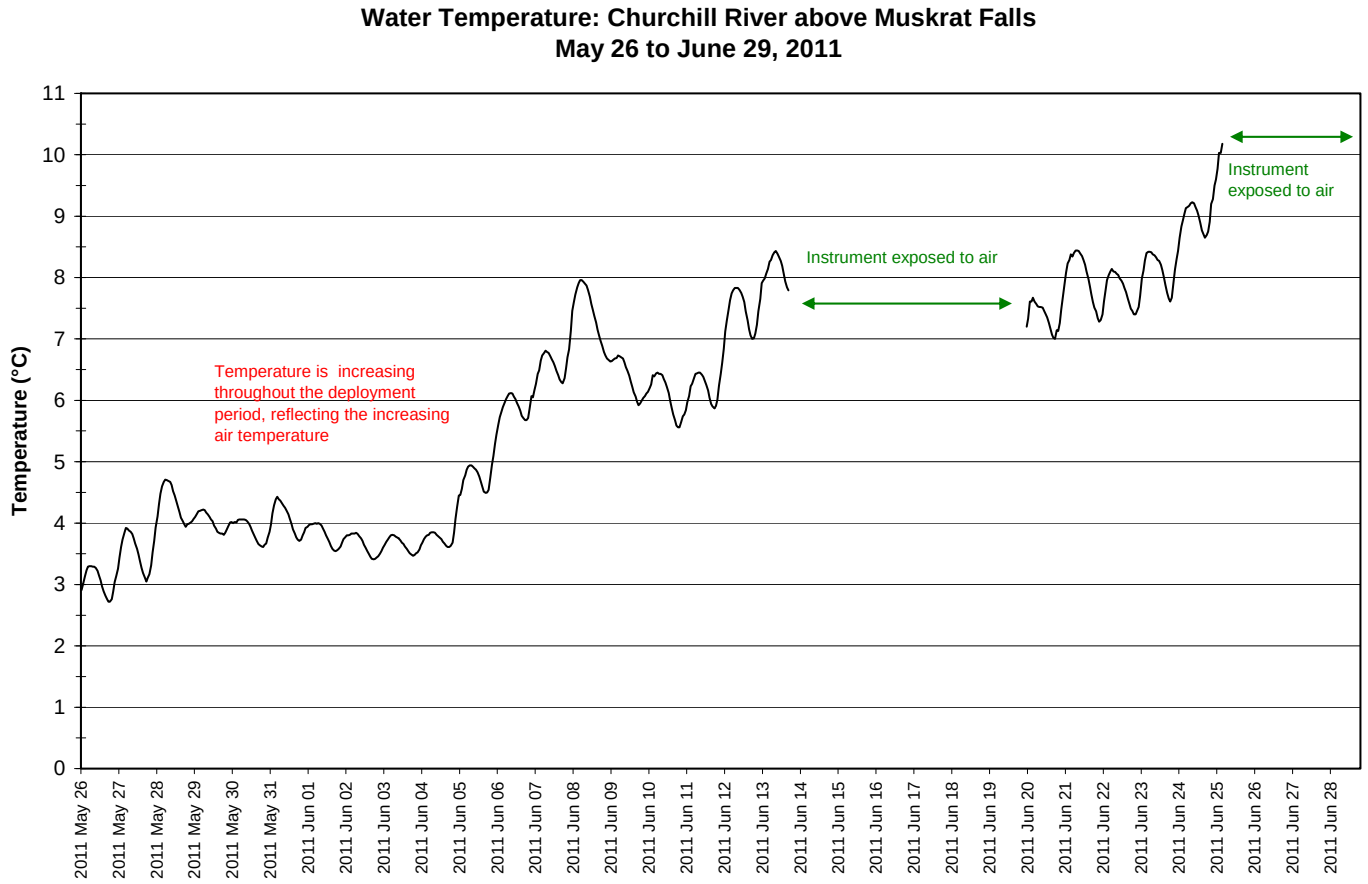

Figure 10: Water temperature at Churchill River above Muskrat Falls

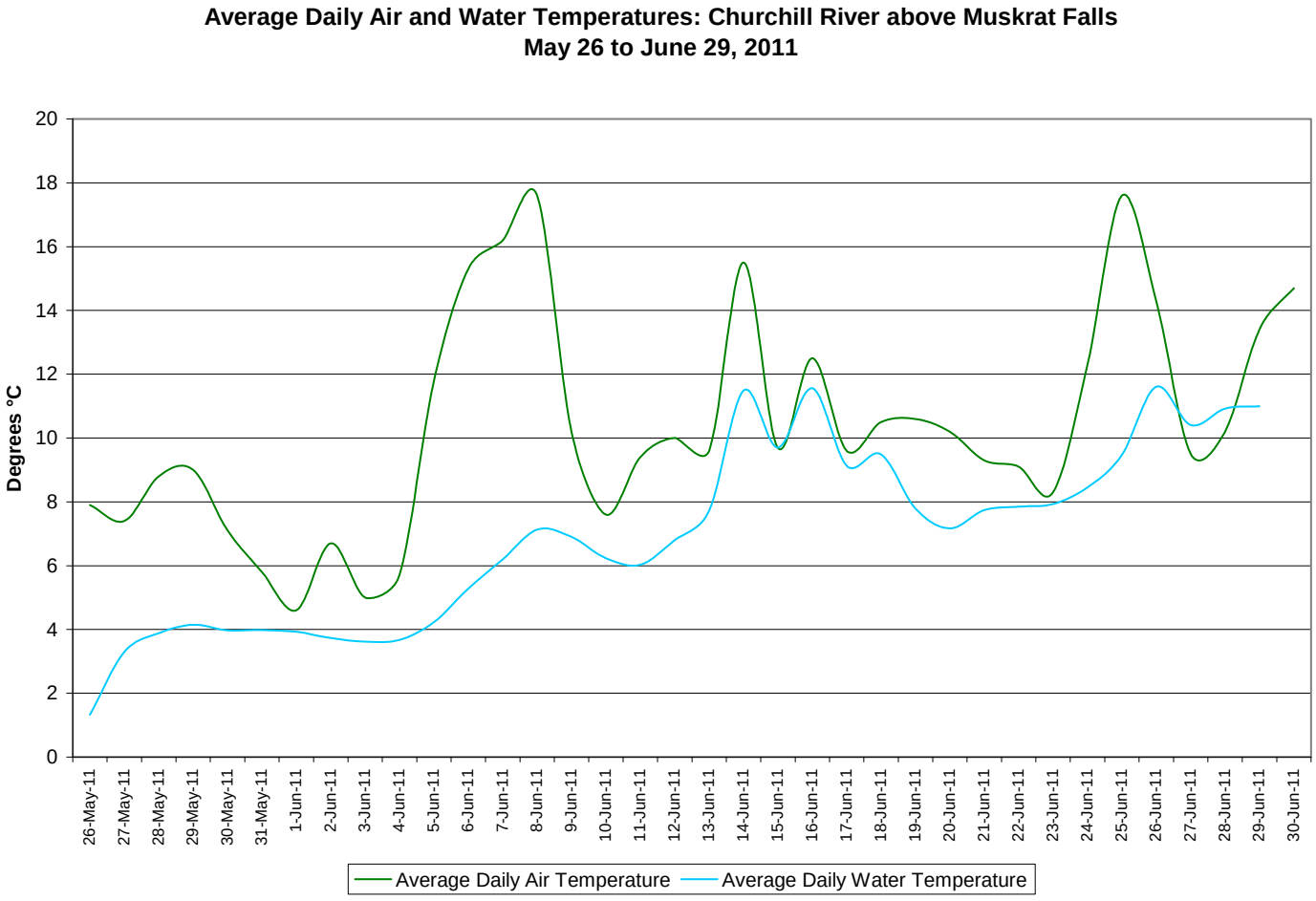

Figure 11: Average daily air and water temperatures at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.40 and 6.62 pH units (Figure 12). pH values are increasing slightly throughout the deployment period.
- Most 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 12). At the beginning of the deployment, pH values are just below or at the minimum guideline.

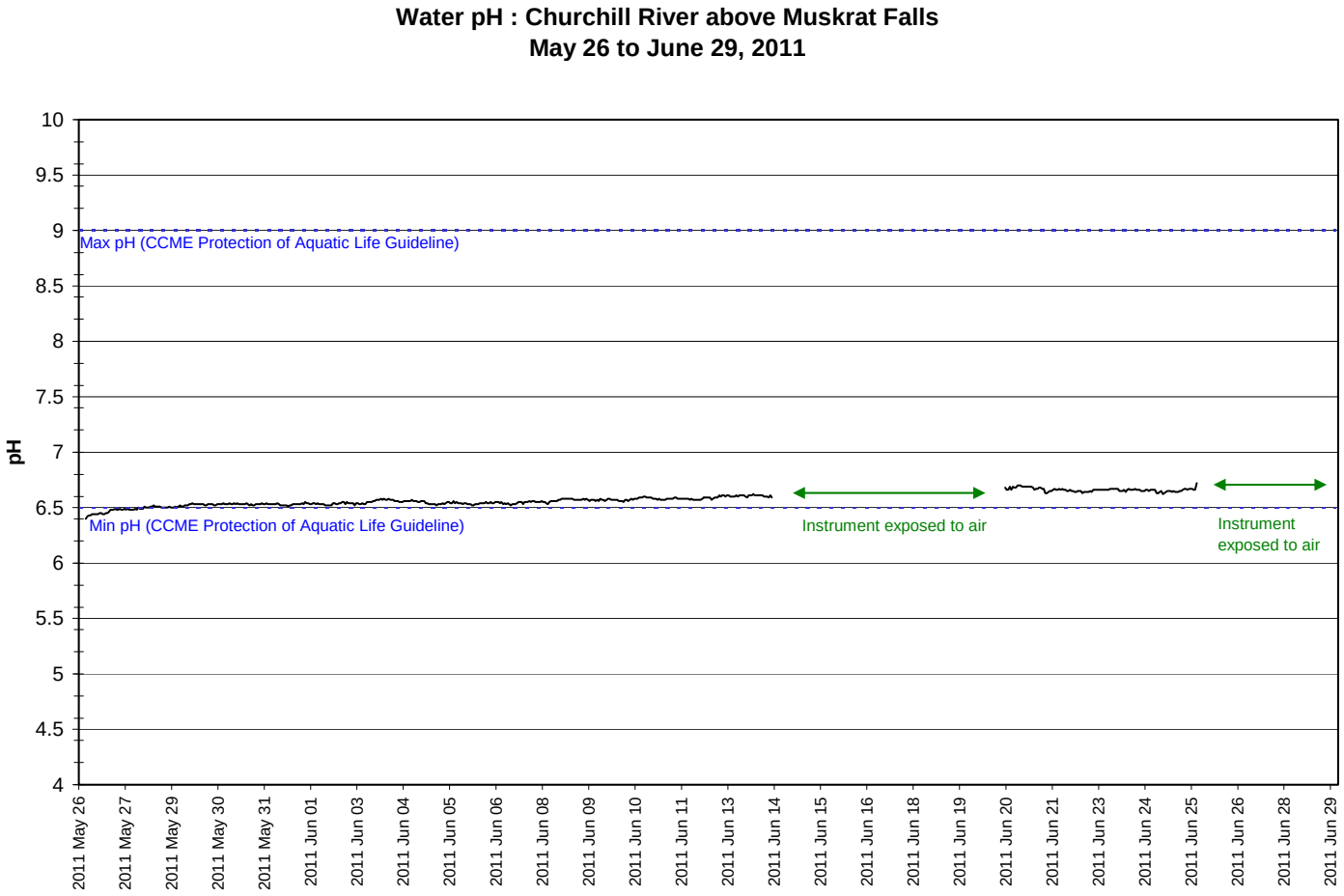

Figure 12: pH at Churchill River above Muskrat Falls

- Specific conductivity ranges between 13.3 and 15.5µS/cm and is generally increasing throughout the deployment period (Figure 13).
- Stage is included in Figure 13 to illustrate the inverse relationship between conductivity and water level. Stage is decreasing significantly throughout the deployment period with slight increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 13). Precipitation input can decrease the specific conductivity of the water by diluting the concentrations of dissolved solids present in the water column.

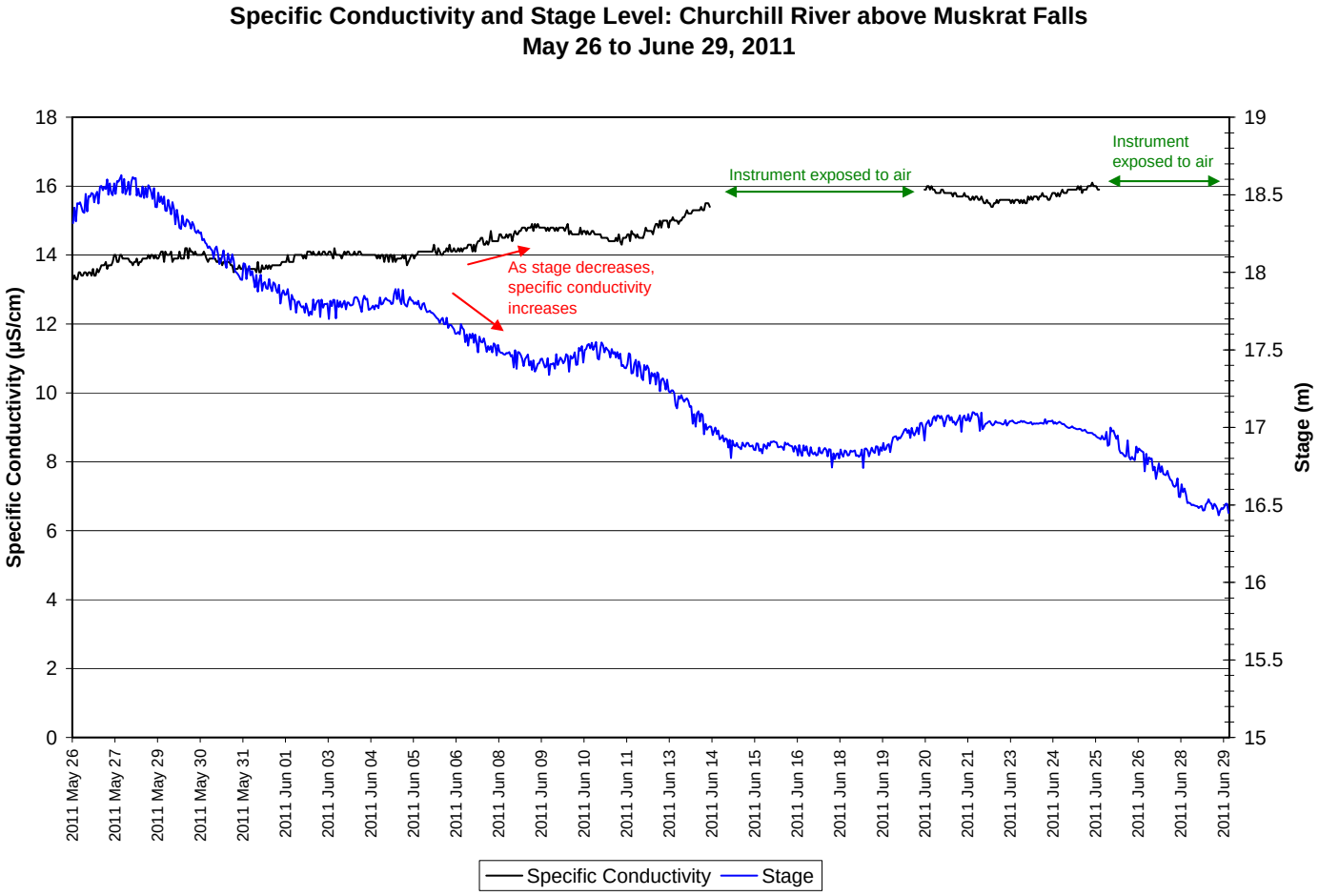

Figure 13: Specific conductivity and stage level at Churchill River above Muskrat Falls

- The saturation of dissolved oxygen ranged from 95.7 to 101.9% and a range of 11.82 to 13.22mg/l was found in the concentration of dissolved oxygen with a median value of 12.73mg/l (Figure 14).
- 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 blue on Figure 14.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the increasing air and water temperatures (Figure 11).

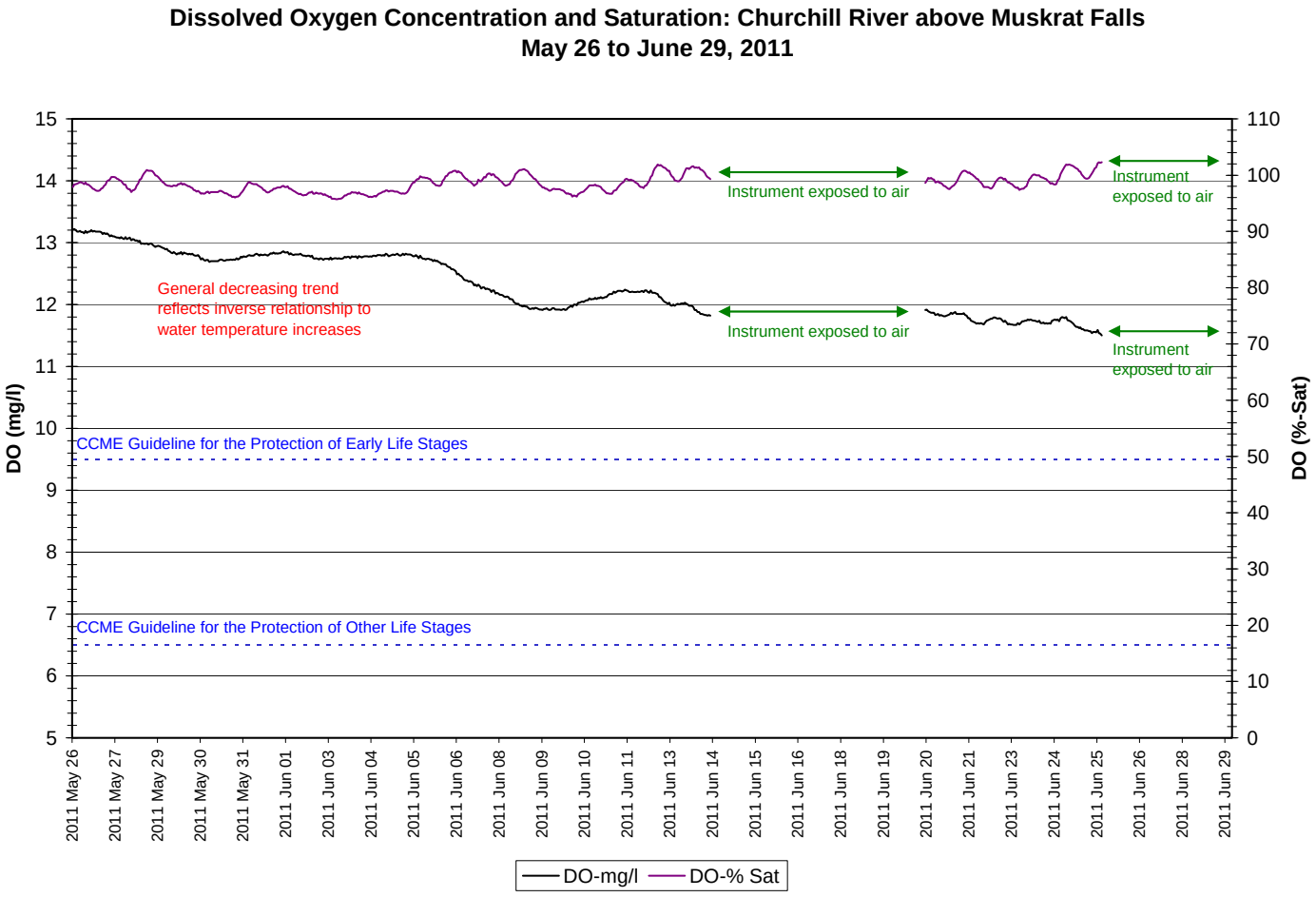

Figure 14: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- A range of 0.0 to 88.0NTU was recorded for turbidity for this deployment period (Figure 15). A median value of 8.0 NTU indicates there is a consistent natural background turbidity value at this station.
- A turbidity event from June 9 to 11 recorded turbidity values up to 33NTU and takes 2 days for turbidity values to return to baseline levels. This event corresponds with warm windy weather and a significant rainfall event. Stage is also affected by this rainfall event with stage levels increasing during the turbidity event. Other turbidity fluctuations during the deployment period are typical for this station.

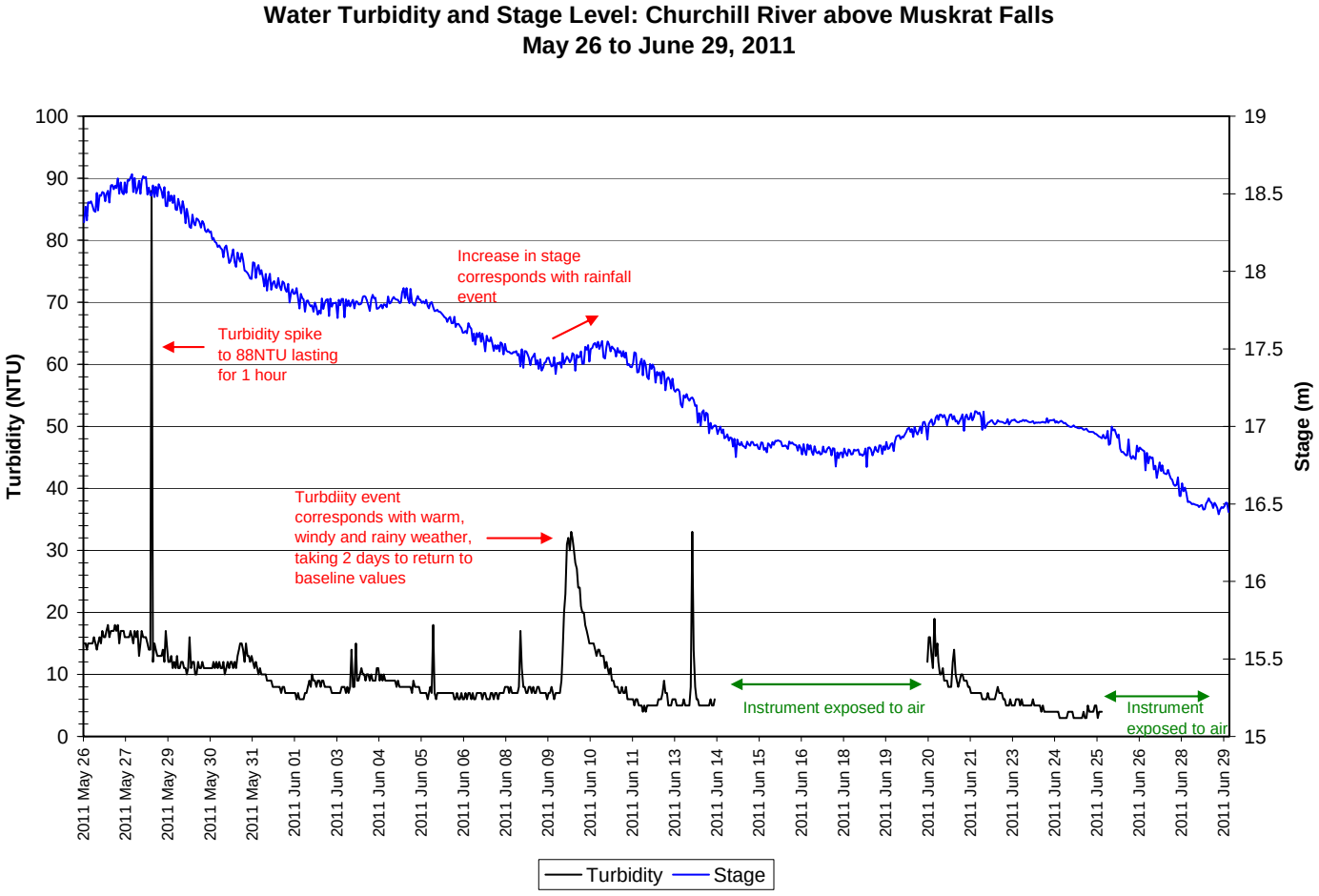

Figure 15: Turbidity and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 16). Stage is generally decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall events on June 9 and from June 17 to 20 cause the water level in the river to rise in the days following.

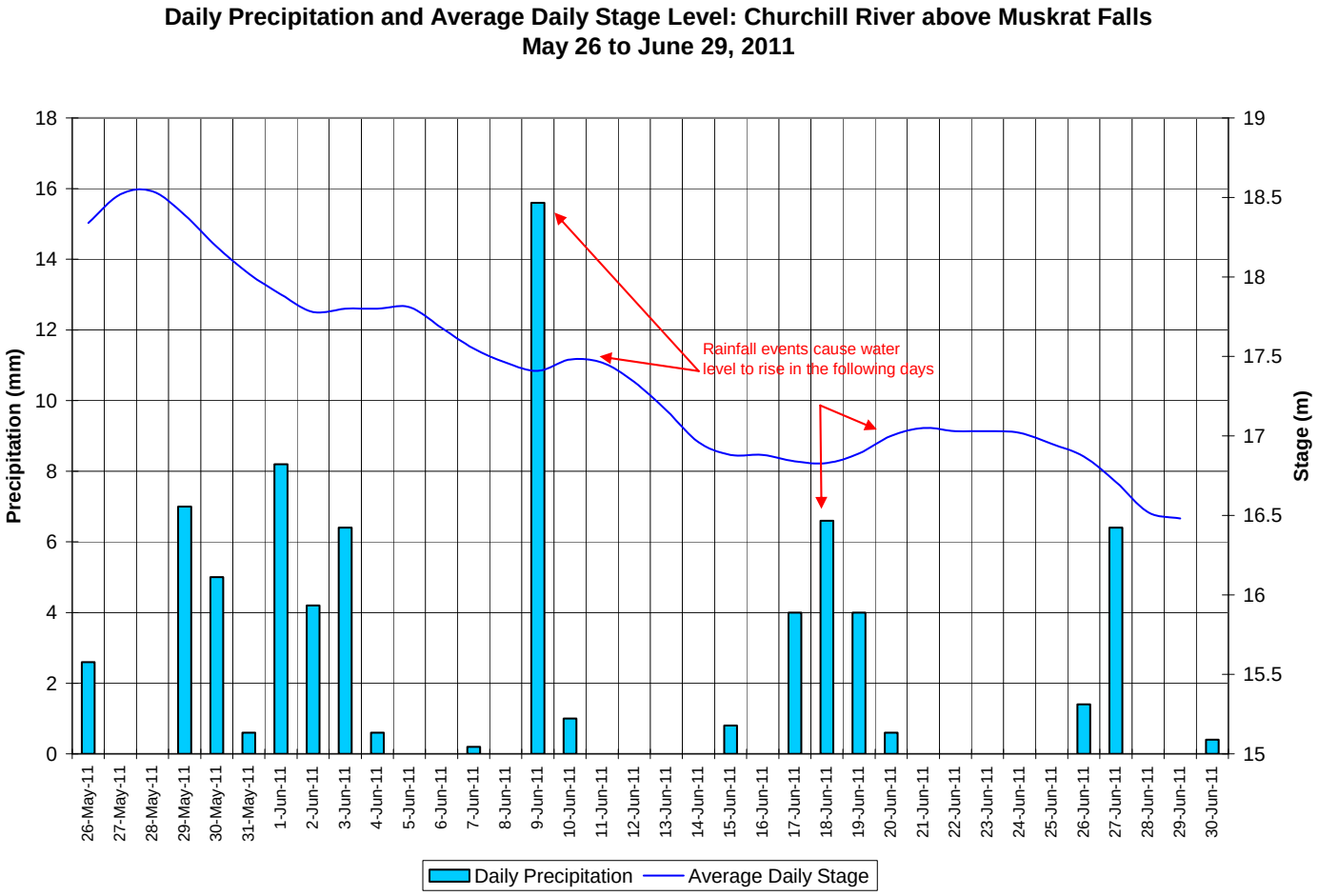

Figure 16: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- The instrument became exposed to air as water levels dropped between June 15 and 18 and then again from June 27 until removal on June 29 (Figure 17). Data collected during the time the instrument was exposed has been removed.

Figure 17: Instrument as found at removal on June 29 exposed on the shoreline at the station below Muskrat Falls

- Water temperature ranges from 1.90 to 8.90°C during this deployment period (Figure 18).
- Water temperature is increasing throughout the deployment period. This trend is expected given increasing ambient air temperatures in the spring and summer seasons (Figure 19). Water temperature fluctuates diurnally.

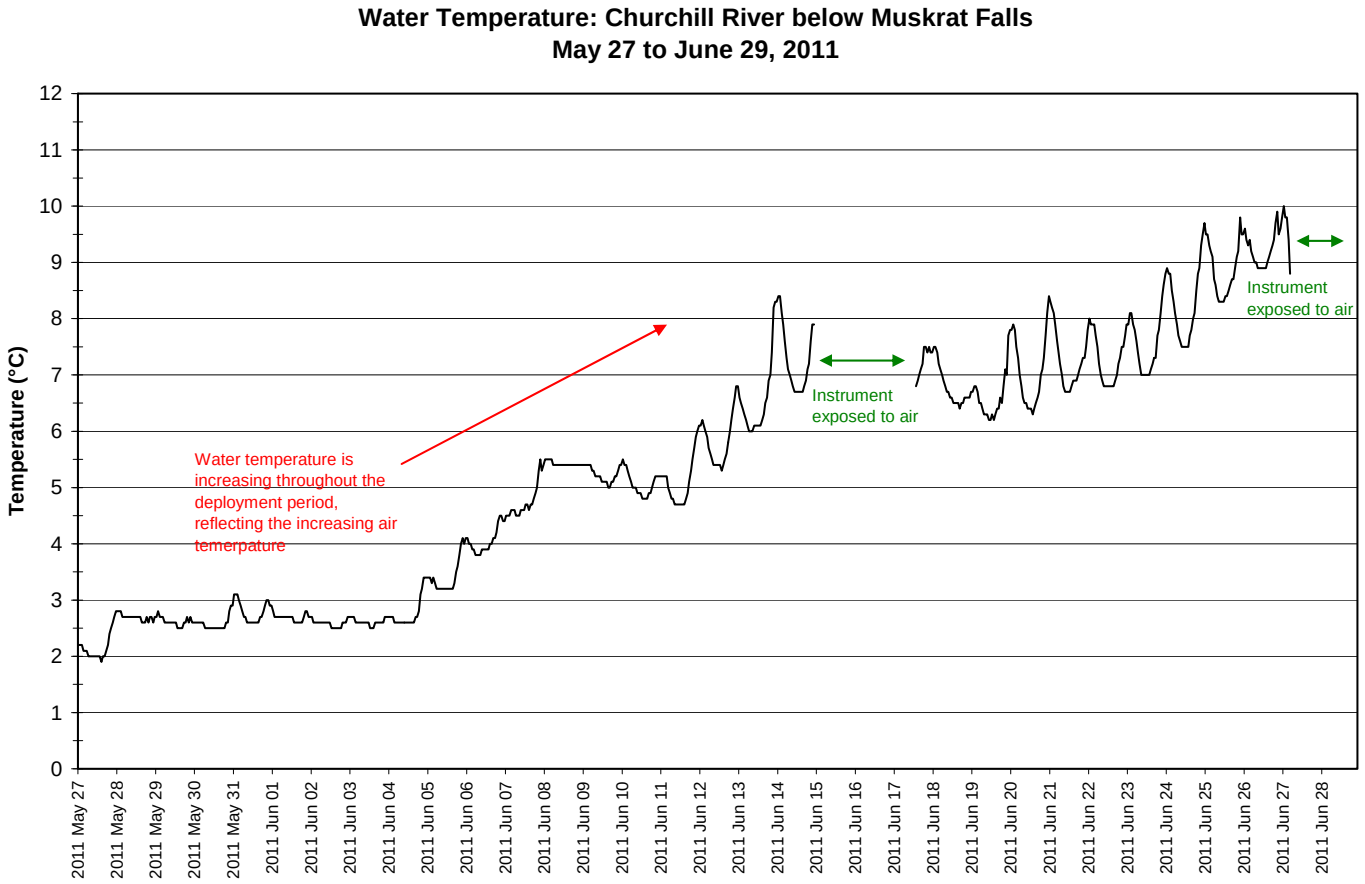

Figure 18: Water temperature at Churchill River below Muskrat Falls

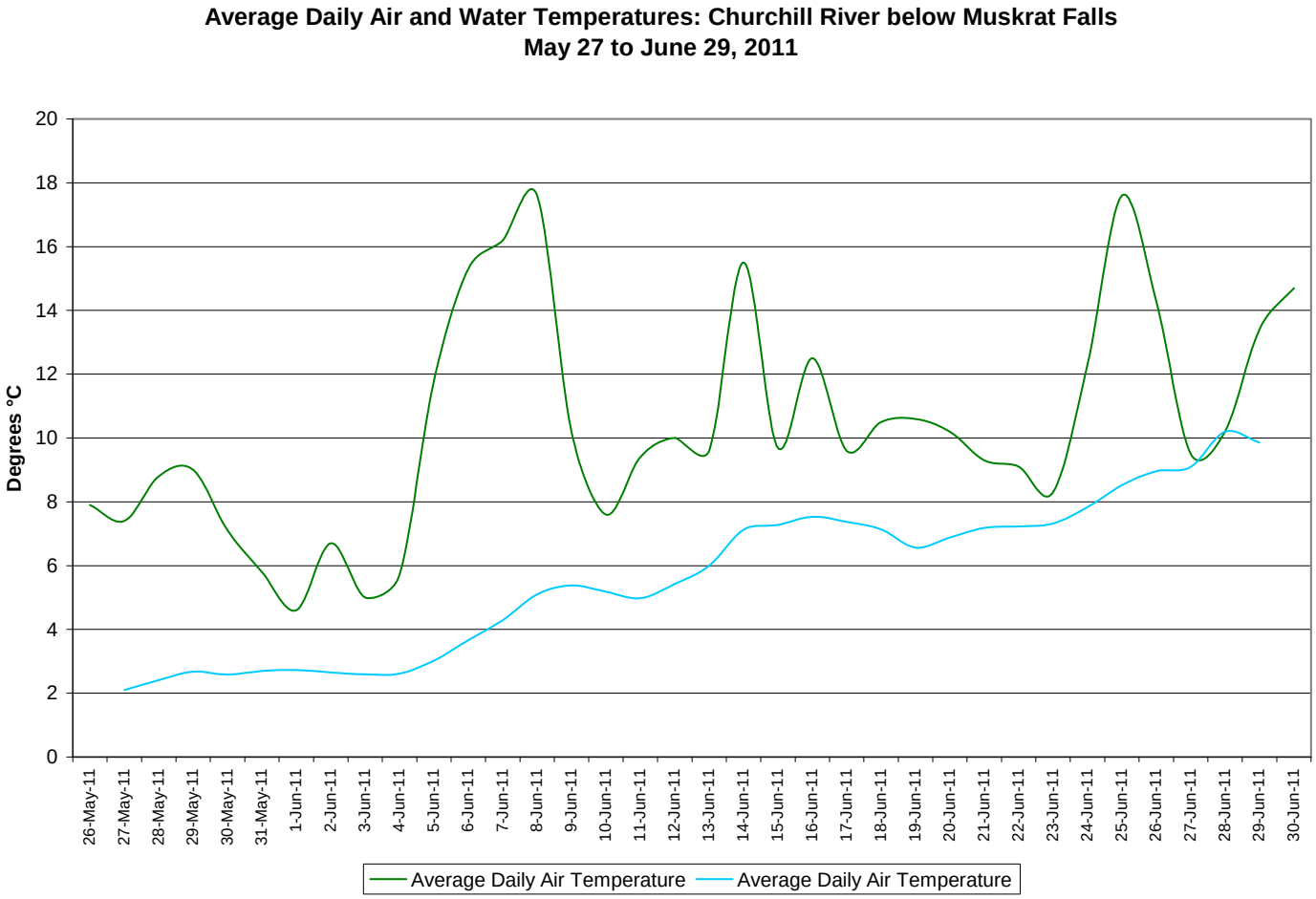

Figure 19: Average daily air and water temperatures at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.59 and 6.87 pH units (Figure 20). pH values fluctuate throughout the deployment period however generally remain consistent.
- 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 20).
- There are several increases and decreases in pH particularly in the first half of the deployment period (indicated by red arrows on Figure 20). These increases and decreases in pH occur during a time of frequent precipitation events recorded daily from May 29 to June 4. Similar fluctuations in specific conductivity are also seen during the same time (Figure 21).

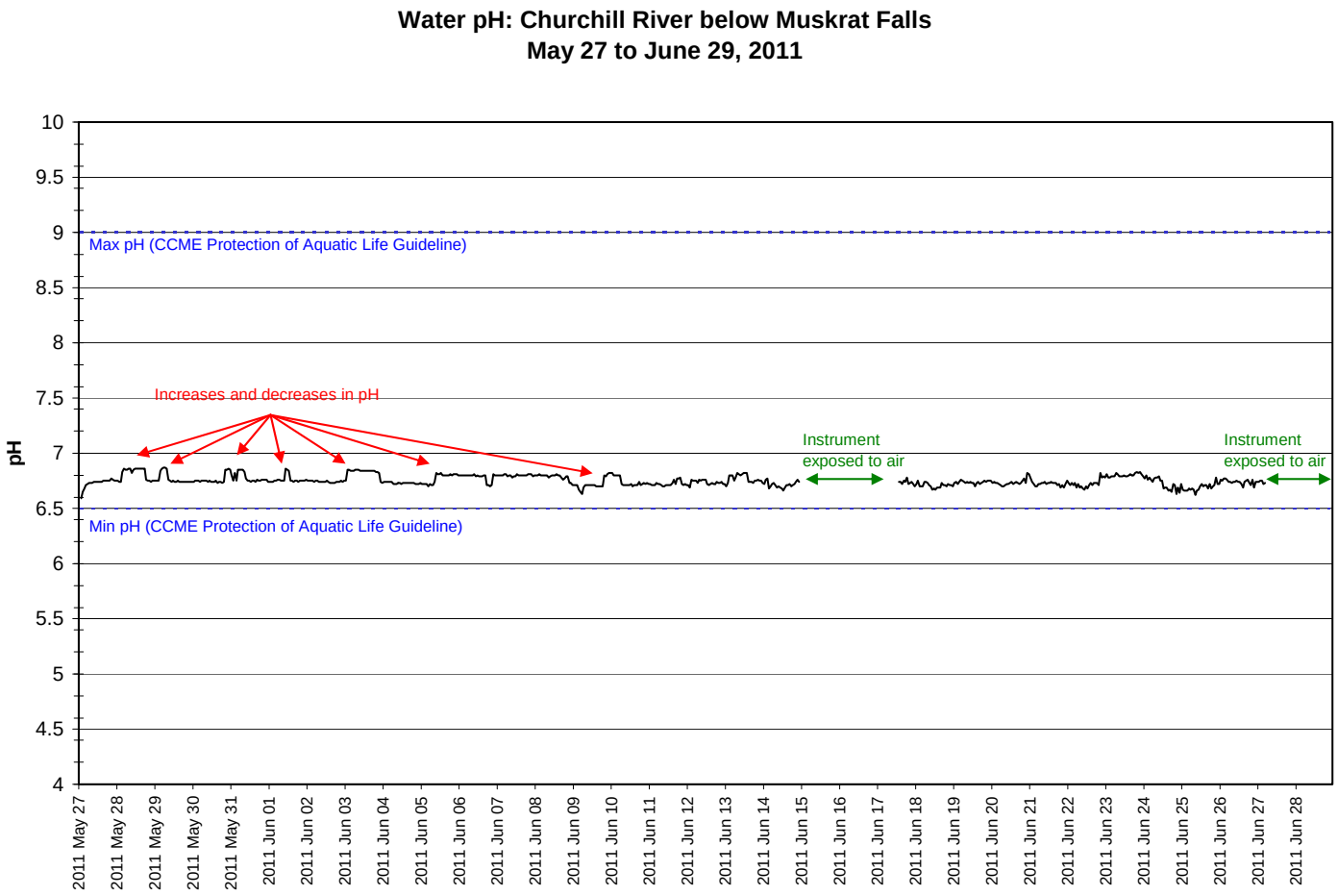

Figure 20: pH at Churchill River below Muskrat Falls

- Specific conductivity ranged from 6.7 to 14.4µS/cm during the deployment period (Figure 21). Specific conductance generally increases throughout the deployment period.
- Stage is included in Figure 21 to illustrate the inverse relationship between conductivity and water level. Stage is decreasing significantly throughout the deployment period with daily increases and decreases. As stage increases, specific conductivity decreases (indicated by red arrows on Figure 21). Precipitation input can decrease the specific conductivity of the water by diluting the concentrations of dissolved solids present in the water column.
- When the instrument was deployed, the water level and flow were quite high. In the first 10 days of the deployment period, the specific conductivity fluctuates considerably. These events correspond with precipitation events as recorded by Environment Canada at Goose Bay Airport (~10km from site).

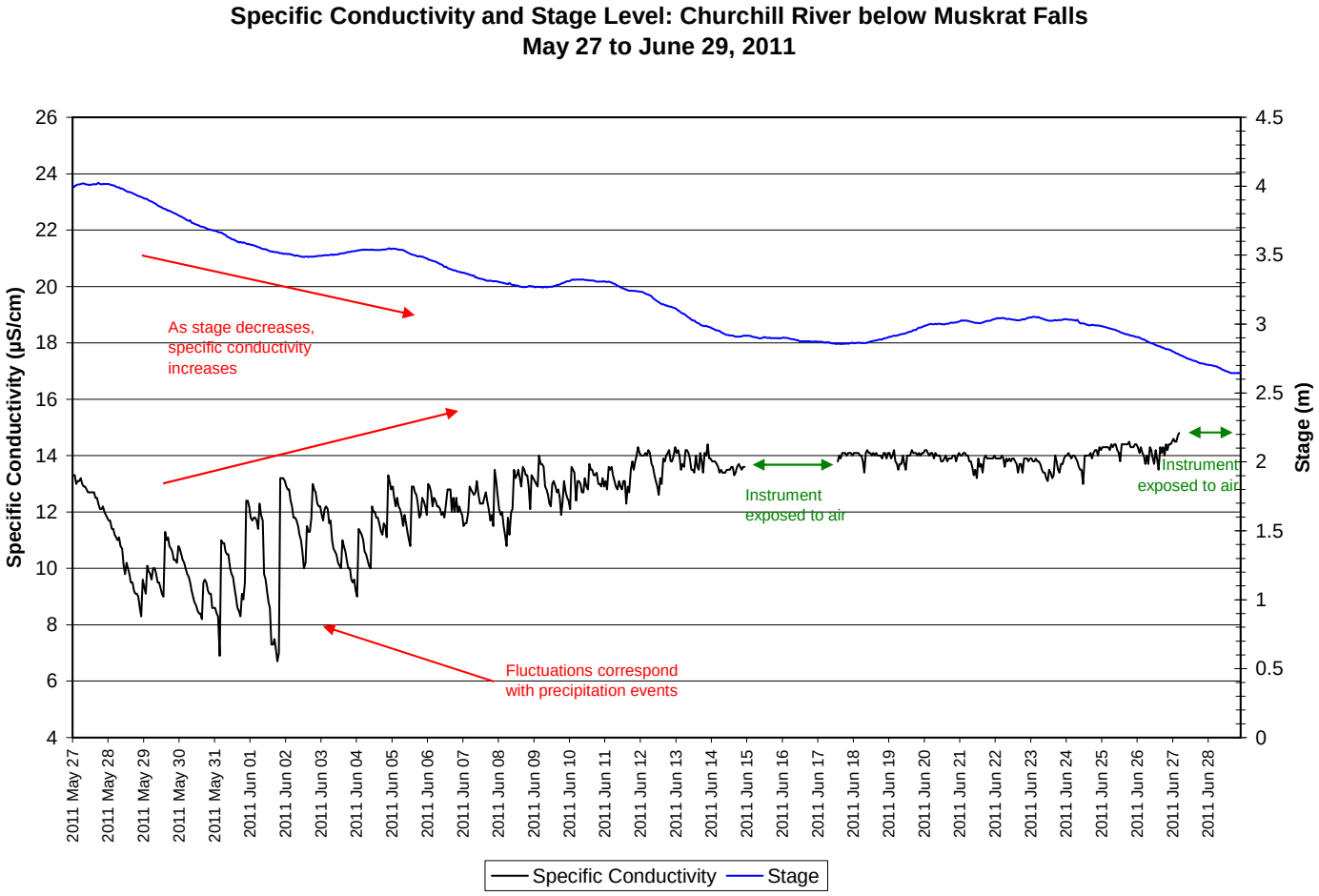

Figure 21: Specific conductivity and stage level at Churchill River below Muskrat Falls

- The saturation of dissolved oxygen generally ranged from 99.7 to 117.9% and a range of 11.83 to 15.39mg/l was found in the concentration of dissolved oxygen (Figure 22). In a couple of instances, DO dropped of significantly for one hour. These outlying values are not included in the range.
- 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 blue on Figure 22.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the increasing air and water temperatures during the deployment period (Figure 22).

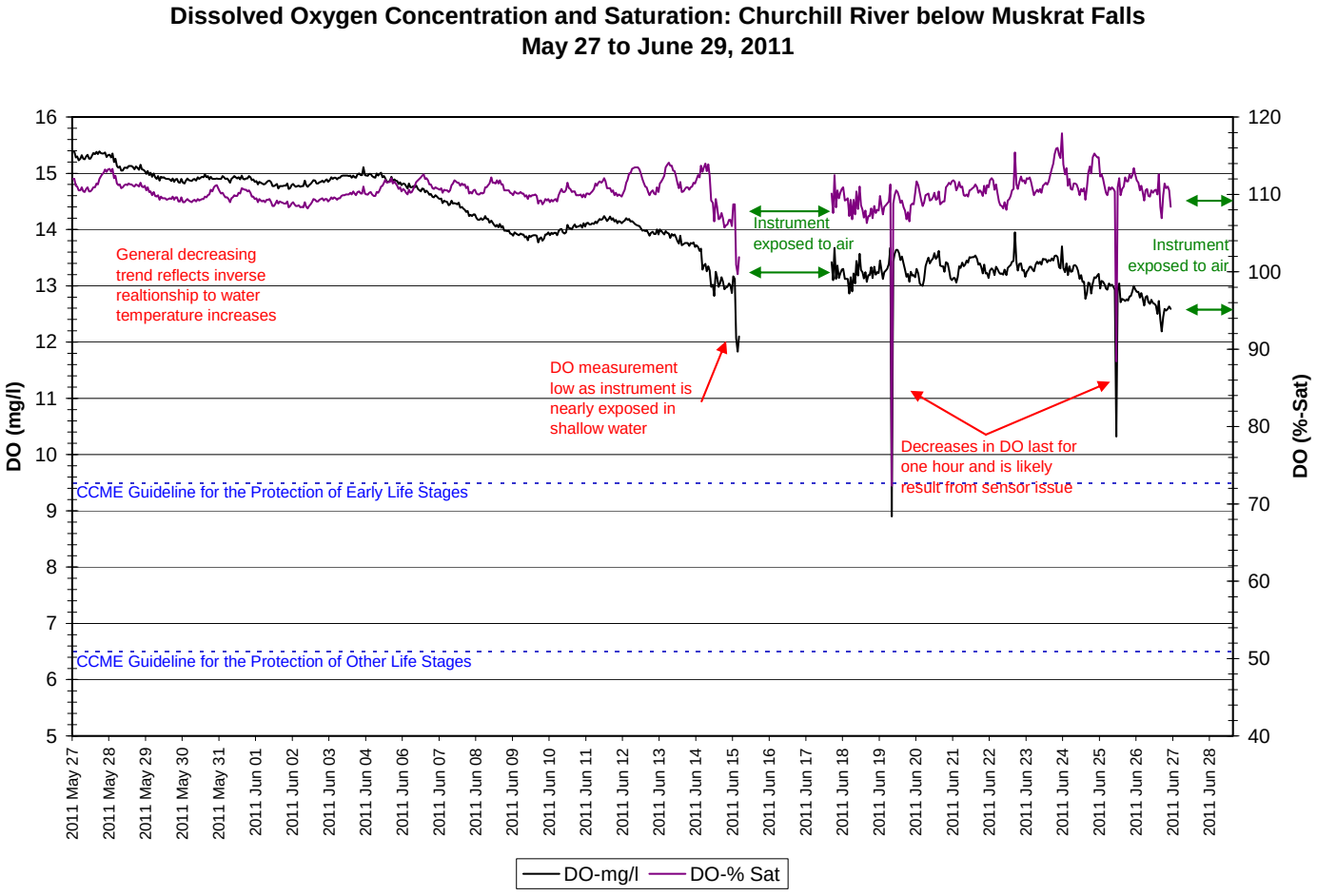

Figure 22: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- A range of 3.0 to 51.0NTU was recorded for turbidity for this deployment period with one instance where turbidity spiked to 181.5NTU (Figure 23). A median value of 10.6 NTU indicates there is a consistent natural background turbidity value at this station. Turbidity generally decreases throughout the deployment period as flows are reduced and spring runoff is reduced.
- The turbidity spike to 181.5NTU corresponds with a rainfall event as recorded by Environment Canada at Goose Bay Airport (Appendix 1).
- Rainy and high flow conditions in the first week of the deployment period are reflected in the increased turbidity values during this time. At deployment, the water color was very cloudy and visibility was poor.

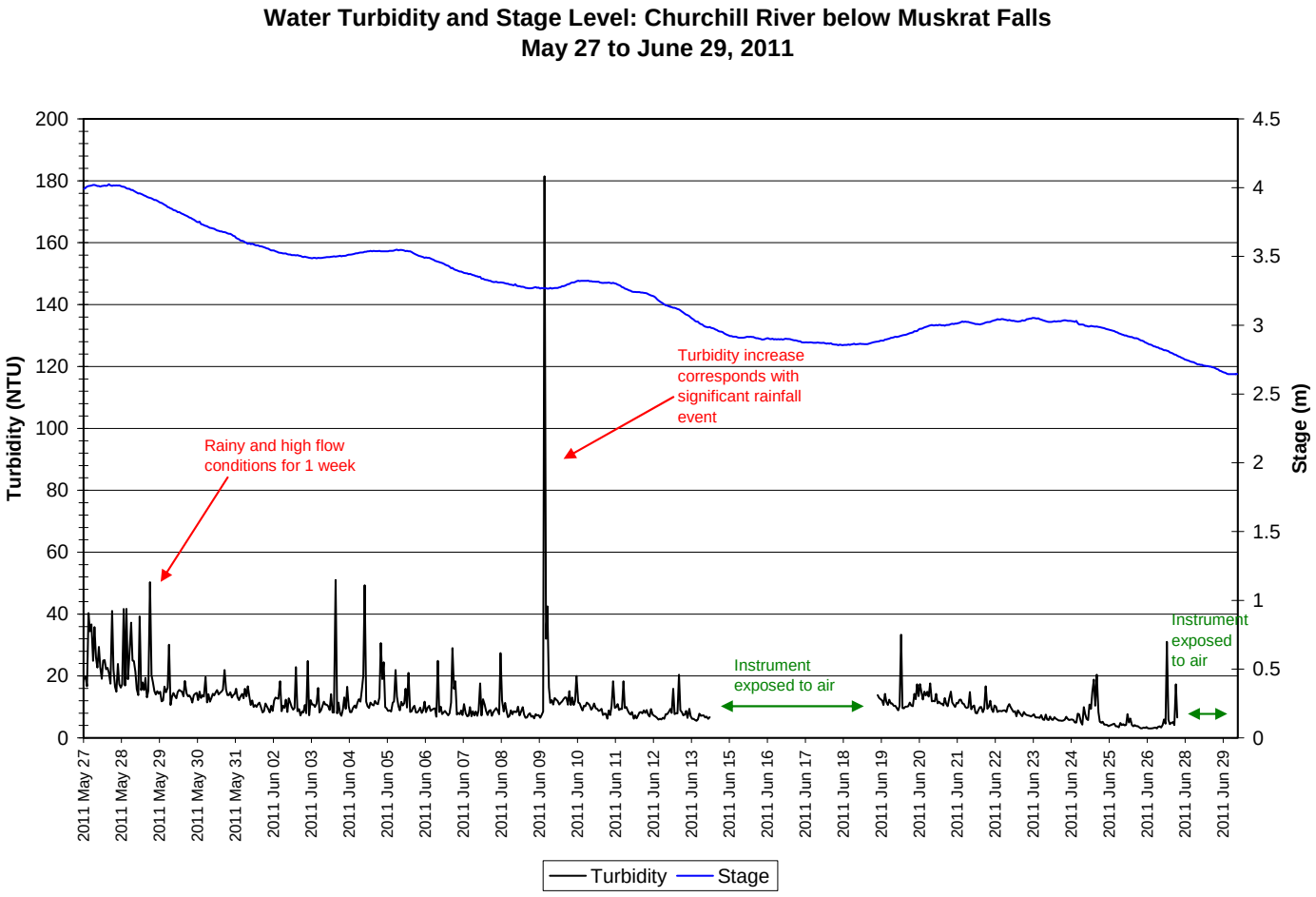

Figure 23: Turbidity and stage level at Churchill River below Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 24). Stage is generally decreasing throughout the deployment period with varying precipitation records.
- In some instances, for example, the rainfall events from June 17 to 20, cause the water level in the river to rise in the days following.

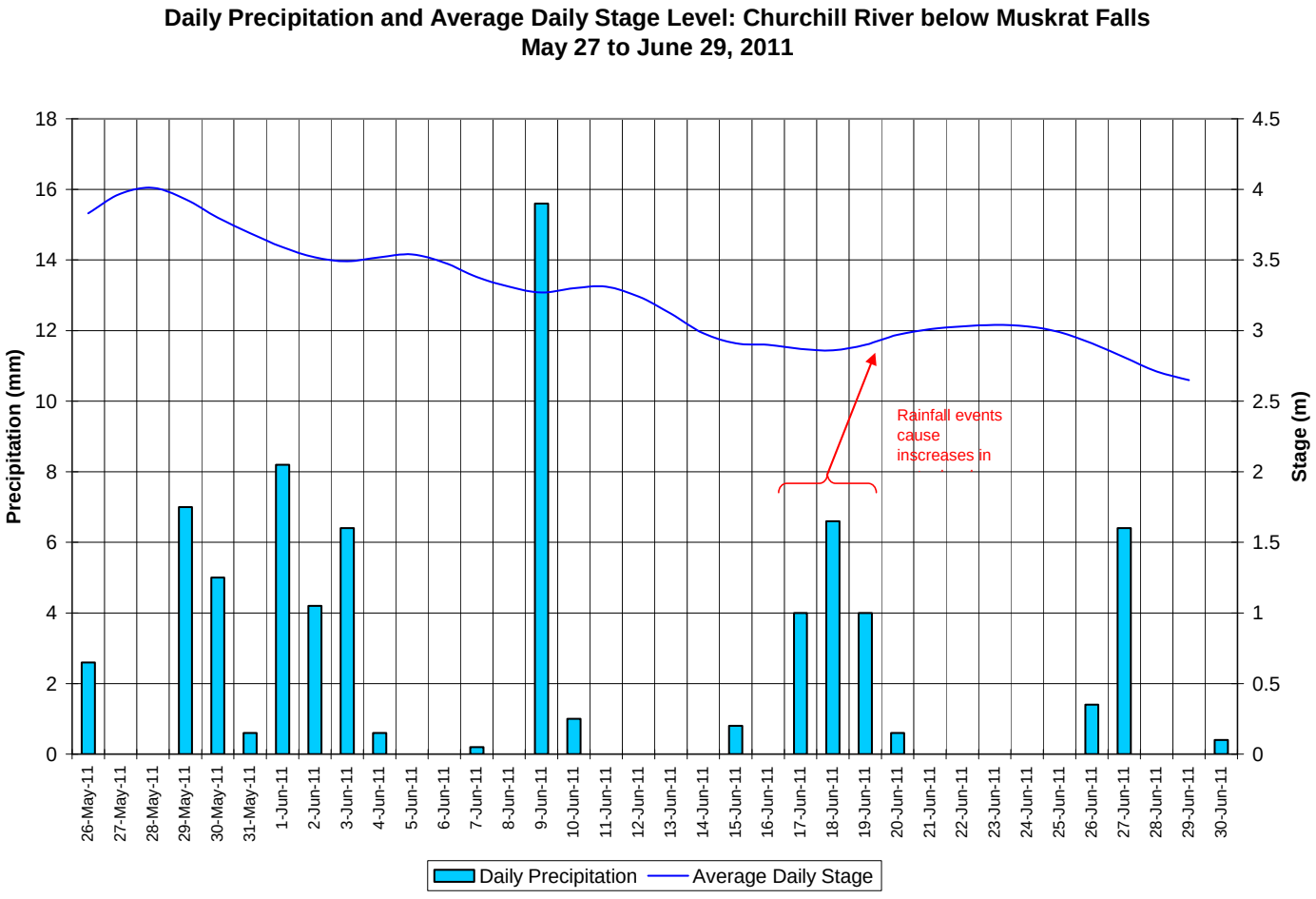

Figure 24: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Conclusions

- Instruments at water quality monitoring stations on the Lower Churchill River were deployed at three of four water quality monitoring stations from May 26/27 to June 29, 2011.
- 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.
- Most values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen. pH values at the beginning of the deployment period at the station below Metchin River were just below the minimum guideline.

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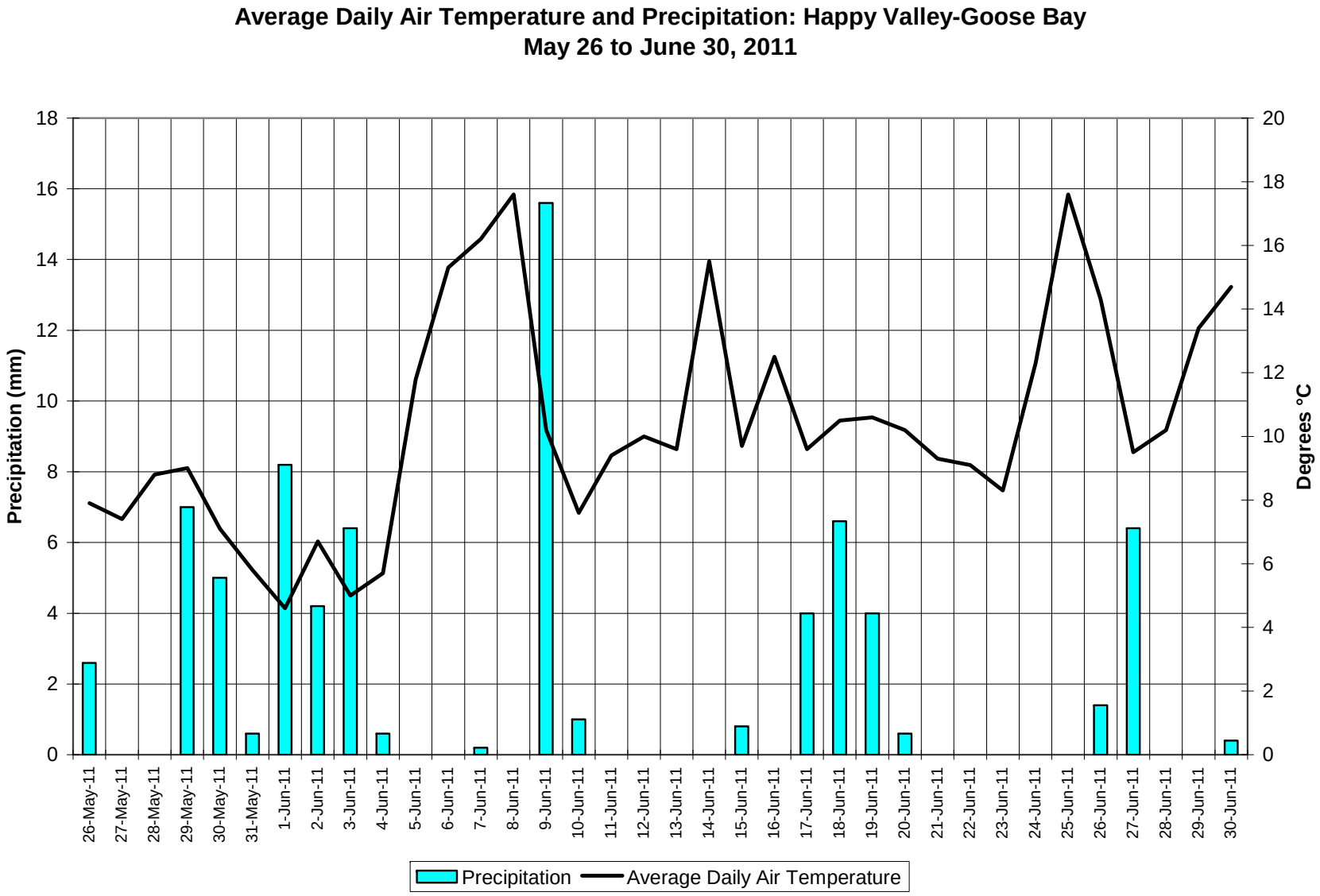
Appendix 1


Average Daily Air Temperature and Precipitation: Happy Valley-Goose Bay
May 26 to June 30, 2011
Precipitation (mm)
Degrees °C
0
2
4
6
8
10
12
14
16
18
20
26-May-11
27-May-11
28-May-11
29-May-11
30-May-11
31-May-11
1-Jun-11
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30-Jun-11
Precipitation
Average Daily Air Temperature

Average Daily Air Temperature and Precipitation: Churchill Falls
May 26 to June 30, 2011