Real-Time Water Quality Deployment Report

Voisey's Bay Network

July 16 to
August 24, 2013

Newfoundland Labrador

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

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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 four stations in the Voisey's Bay Network; Upper Reid Brook, Tributary to Lower Reid Brook, Lower Reid Brook and Camp Pond Brook.
- On July 16, 2013, Vale Environment and Water Resources Management staff deployed real-time water quality monitoring instruments at the four real time stations in the Voisey's Bay network for a period of 39 days. Instruments were removed by Vale Environment staff on August 24.

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 (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 Voisey's Bay Network stations deployed from July 16 to August 24, 2013 are summarized in Table 2.

Table 2: Comparison rankings for Voisey's Bay Network stations, July 16– August 24, 2013

Station Voisey's Bay	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Upper Reid Brook (62884)	Jul 16, 2013	Deployment	Fair	Good	Excellent	Fair	Excellent
	Aug 24, 2013	Removal	Excellent	Marginal	Excellent	n/a*	n/a*
Camp Pond Brook (62885)	Jul 16, 2013	Deployment	Excellent	Poor	Excellent	Excellent	Excellent
	Aug 24, 2013	Removal	Excellent	Good	Excellent	n/a*	n/a*
Tributary to L. Reid B. (62886)	Jul 16, 2013	Deployment	Excellent	Fair	Excellent	Excellent	Excellent
	Aug 24, 2013	Removal	Excellent	Excellent	Excellent	n/a*	n/a*
Lower Reid Brook (62887)	Jul 16, 2013	Deployment	Excellent	Poor	Excellent	Excellent	Excellent
	Aug 24, 2013	Removal	Excellent	Poor	Excellent	n/a*	n/a*

*Dissolved oxygen and turbidity sensor on the MS5 #62829 not functioning properly on August 24, 2013

- At the station at Upper Reid Brook, pH, specific conductivity and turbidity all rank either 'good' or 'excellent' at deployment while temperature and dissolved oxygen rank 'fair'. As these parameters are closely related, it is likely that they are both reading incorrectly due to the same issue. The field instrument read a value of 9.03°C for temperature and 11.69mg/l for dissolved oxygen. The QAQC instrument read a value of 8.51°C for temperature and 12.23mg/l for dissolved oxygen. The difference in the water temperature and dissolved oxygen content may be due to the placement of the instrument in the river adjacent to one another. If the QAQC instrument was just a little bit deeper, the water temperature may actually have been colder.
- At removal, temperature and specific conductivity rank 'excellent' while pH ranks 'marginal'. For pH, the field instrument read a value of 7.40 and the QAQC instrument read a value of 6.58. This is likely due to insufficient time in allowing the QAQC instrument to stabilize. Dissolved oxygen and turbidity are not ranked.
- At the station on Camp Pond Brook, temperature, specific conductivity, dissolved oxygen and turbidity rank 'excellent' at deployment while pH rank 'poor'. For pH, the field instrument read a value of 6.07 for pH while the QAQC instrument read a value of 7.13. This is likely due to insufficient time in allowing the field instrument to stabilize. At the time of the first data transmission, the field instrument records a value of 6.82 which when compared to the QAQC instrument value of 7.13 yields a 'good' ranking.
- At removal, temperature, pH and specific conductivity all rank either 'good' or excellent'. Dissolved oxygen and turbidity are not ranked.
- At the station on the Tributary to Lower Reid Brook, temperature, specific conductivity, dissolved oxygen and turbidity all rank 'excellent' at deployment while pH rank 'fair'. For pH, the field instrument read a value of 6.52 and the QAQC instrument read a value of 7.06. Similarly to the station at Camp Pond Brook, the QAQC instrument value is lower than expected for this station and may be a result of insufficient time

to stabilize in the environment. At the time of the first reading 1 hour after deployment, the field instrument reported a value of 6.89, which when compared to the QAQC instrument value of 7.06, yields an 'excellent' ranking.

- At removal, temperature, pH, and specific conductivity all rank 'excellent'. Dissolved oxygen and turbidity are not ranked.
- At the station on Lower Reid Brook, temperature, specific conductivity, dissolved oxygen and turbidity rank 'excellent' at deployment while pH rank 'poor'. For pH, the field instrument read a value of 6.02 and the QAQC instrument read a value of 7.25, a difference of 1.23. At the time of the first transmission, the field instrument reads a value of 6.90 which when compared to the QAQC instrument yields a comparison ranking of 'good'.
- At removal, temperature and specific conductivity rank 'excellent' and pH rank 'poor'. For pH, the field instrument read a value of 6.00 while the QAQC instrument read a value of 7.03. This discrepancy may in part be caused by insufficient time in allowing the QAQC instrument to stabilize. Dissolved oxygen and turbidity were not ranked.
- Grab samples were taken at each of the stations at the time of the deployment. The results are attached in Appendix 2.

Data Interpretation

- The following graphs and discussion illustrate significant water quality-related events from July 16 to August 24 in the Voisey's Bay Real Time Water Quality Monitoring 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.

Upper Reid Brook (Outlet from Reid Pond)

- Water temperature ranges from 7.51 ^{o}C to 17.83^{o}C during the deployment period (Figure 1).
- Water temperature is on average increasing throughout the deployment period. This trend is expected given the warm ambient air temperatures in summer seasons (Figure 2). There are a number of larger fluctuations in the water temperature which correspond with cooler weather and rainfalls events.
- Average water temperature is 11.48°C for the deployment period.

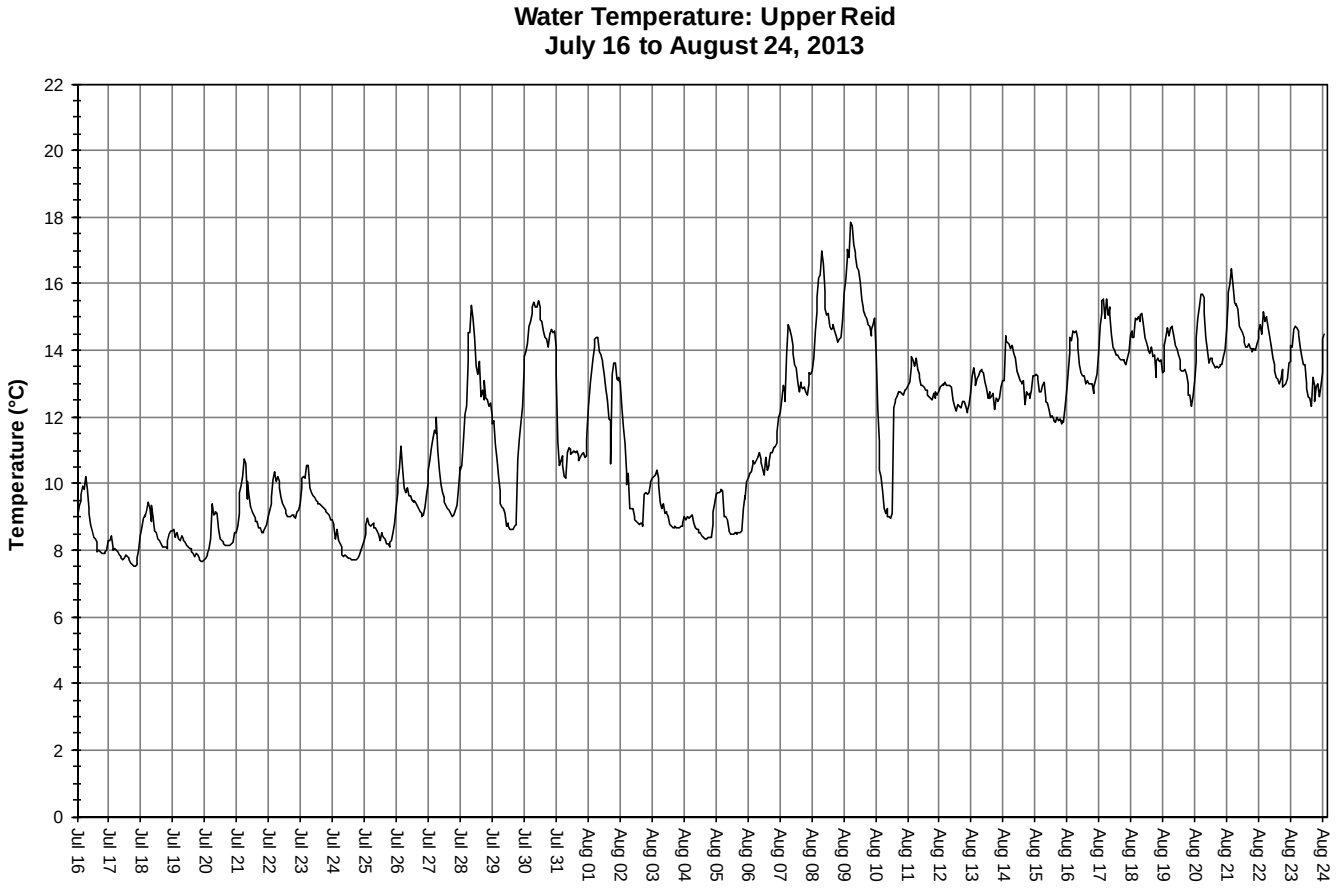


Figure 1: Water temperature at Upper Reid Brook

- Average daily air and water temperature fluctuate throughout the deployment period (Figure 2). Increases and decreases in air temperature are reflected in water temperatures. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

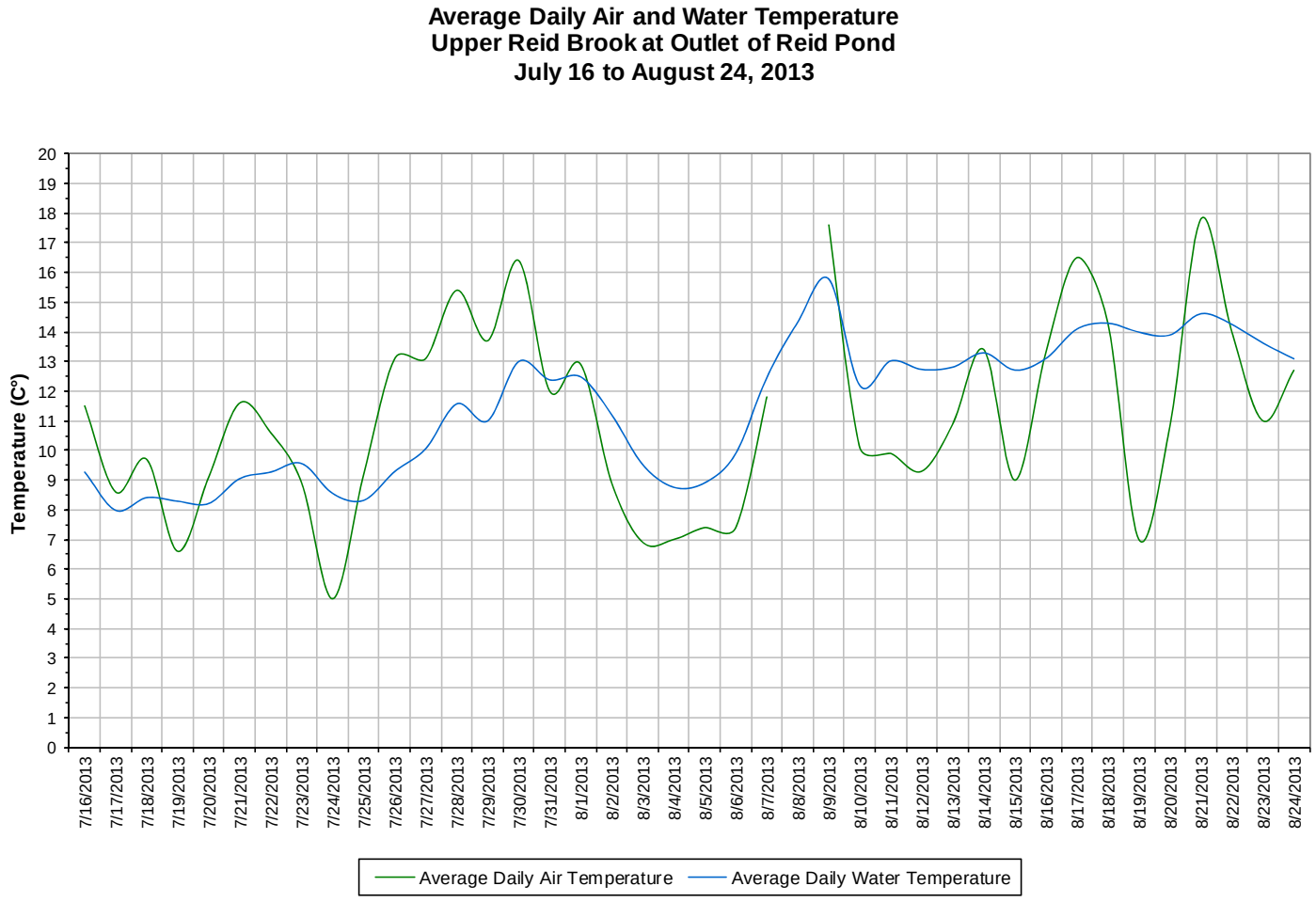


Figure 2: Average daily air and water temperatures at Upper Reid Brook

(weather data recorded at Nain)

- pH ranges between 6.76 and 7.16 pH units (Figure 3) and is increasing slightly throughout the deployment period.
- All values are within the recommended range as suggested by the CCME Guidelines for the Protection of Aquatic Life (> 6.5 and <9.5 pH units). Guidelines are indicated in blue on Figure 3.

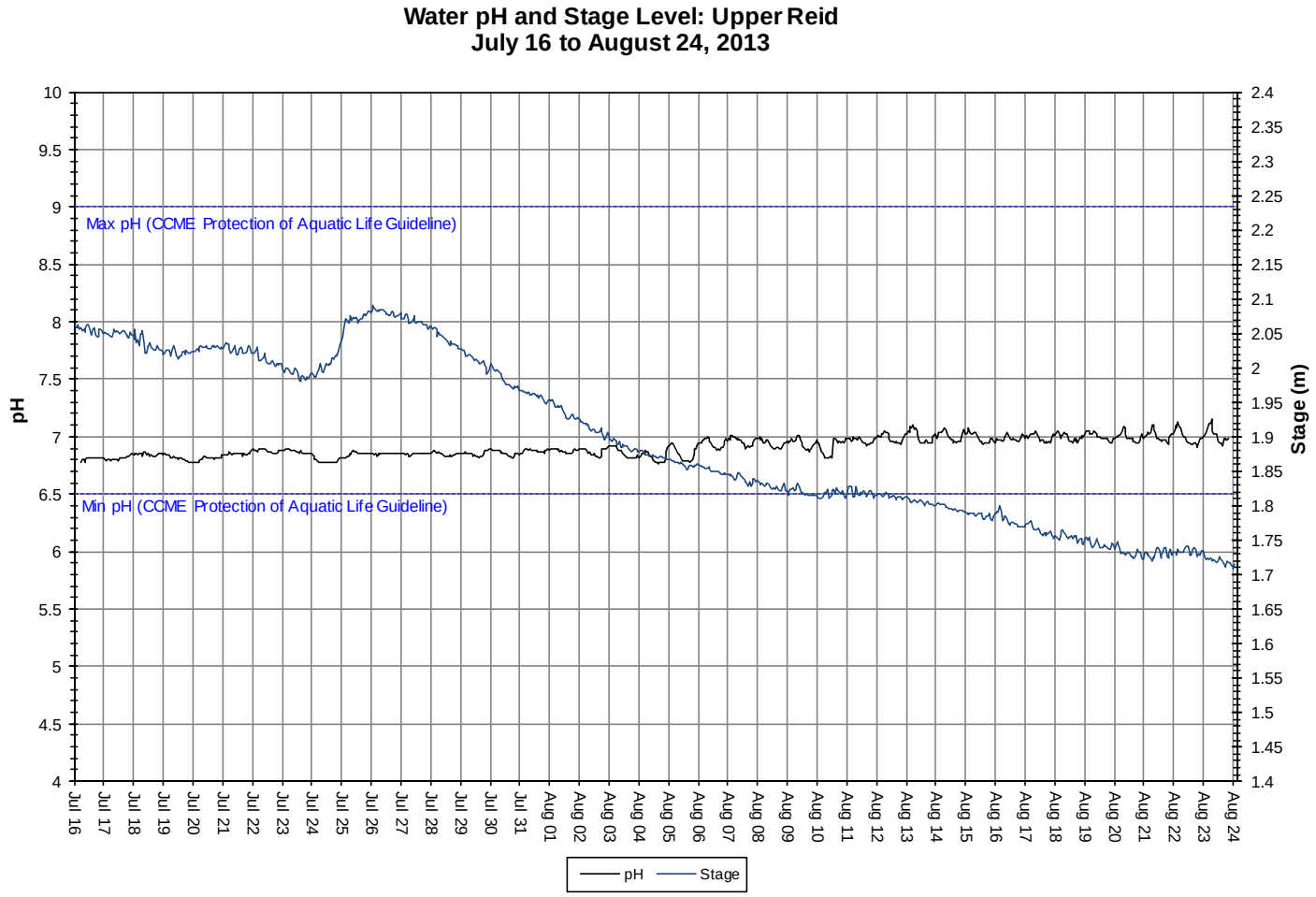


Figure 3: pH and stage level at Upper Reid Brook

- Specific conductivity values range from 9.4µS/cm to 12.1µS/cm during the deployment period (Figure 4).
- Specific conductivity remains very low and stable throughout the deployment period regardless of the decreasing water level. This trend is expected as the flow from this station is directly from a stable lake environment.

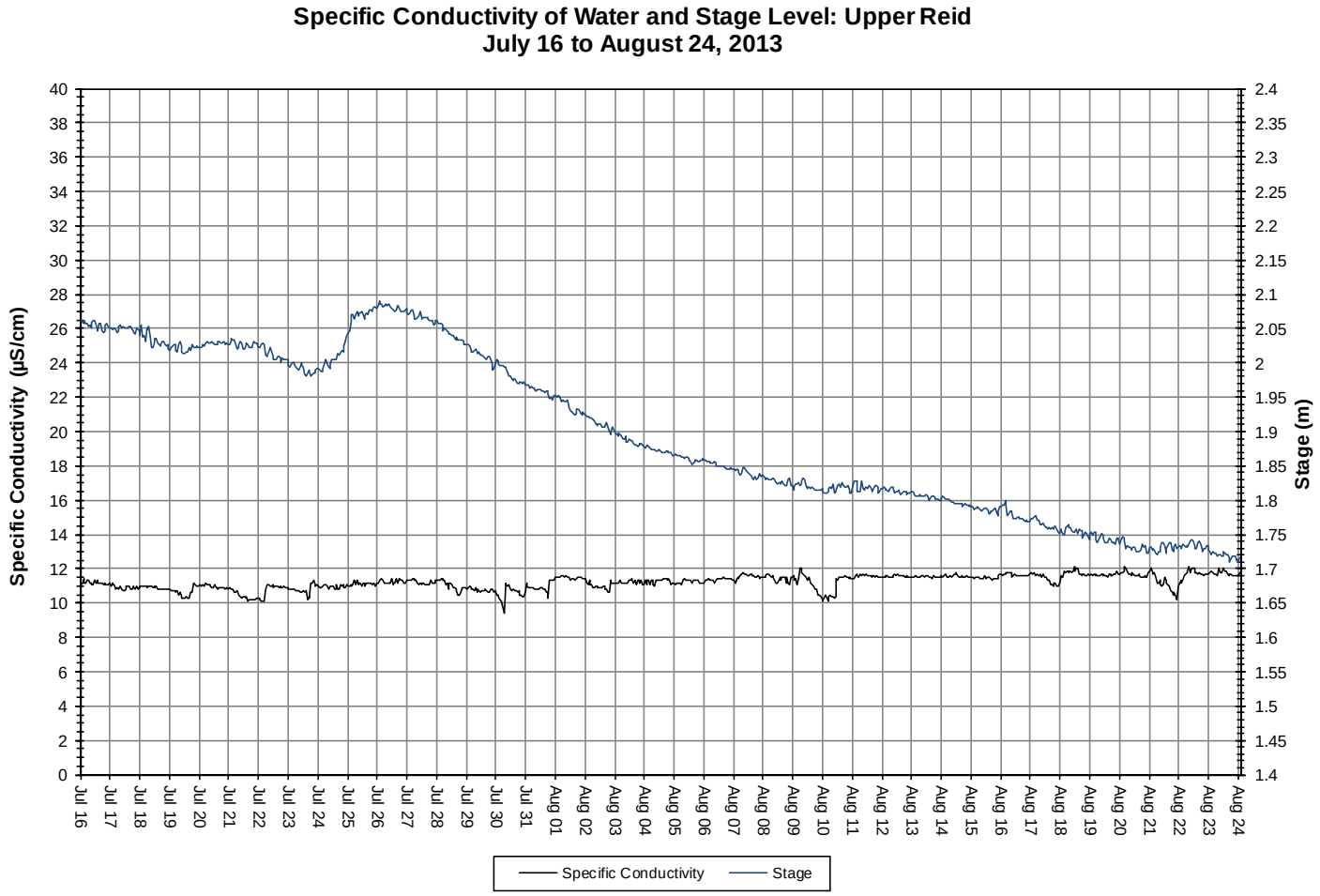


Figure 4: Specific conductivity and stage level at Upper Reid Brook

- Dissolved oxygen content ranges between 9.67mg/l and 11.96mg/l. The saturation of dissolved oxygen ranges from 93.5% to 110.7% (Figure 5).
- Dissolved oxygen content is decreasing throughout the deployment period due to the increasing air and water temperatures (Figure 2). There are a couple of larger fluctuations which correspond with cooler air and water temperatures and rainfall events.
- All values are above both of the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and Early Life Stages (9.5mg/l). The guidelines are indicated in blue on Figure 5. Average dissolved oxygen content is 10.89mg/l.

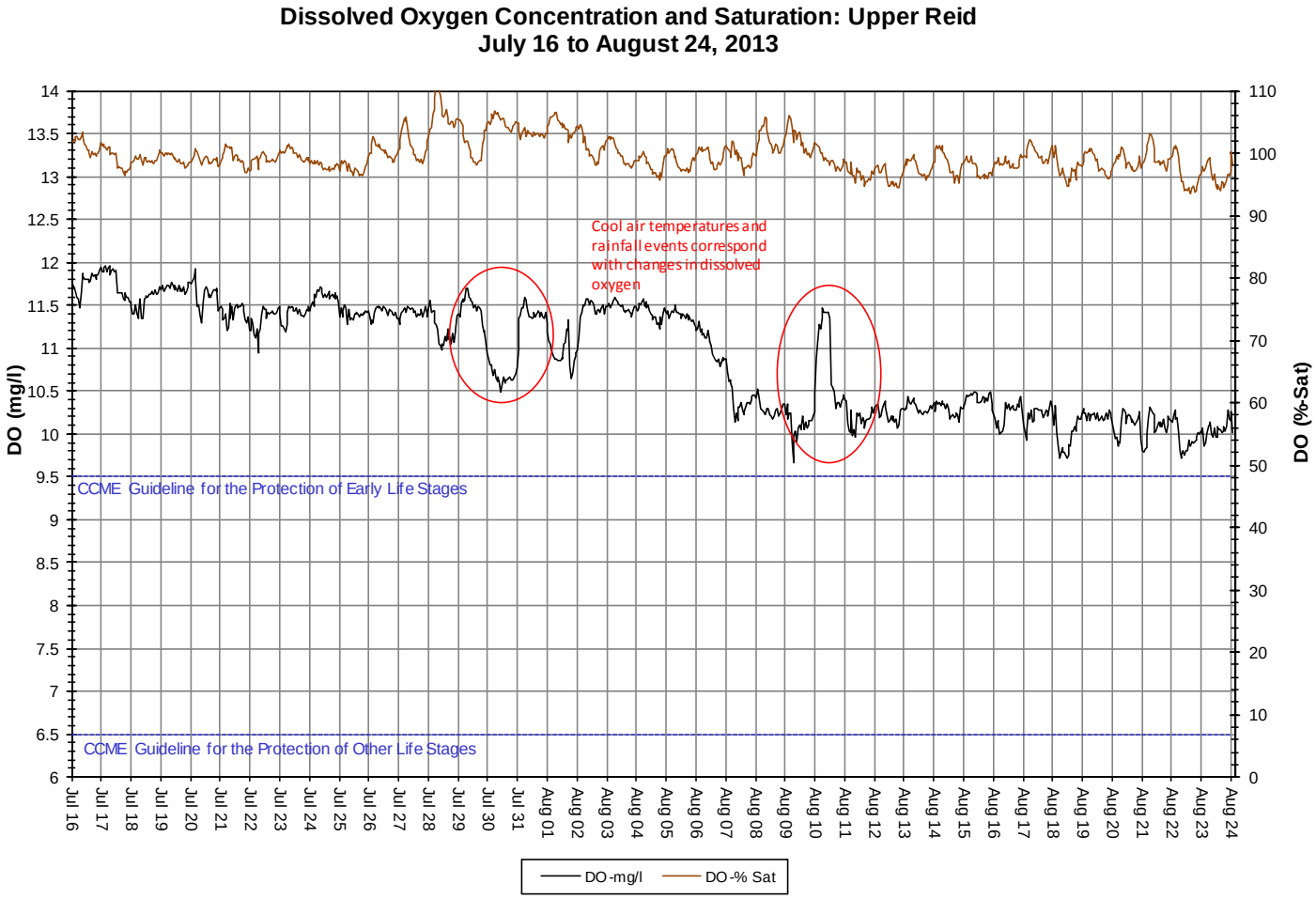


Figure 5: Dissolved oxygen and percent saturation at Upper Reid Brook

- Turbidity at this station remained at 0NTU for the entire deployment period except for two instances when turbidity reached 765NTU and 51NTU, each for a period of 1 hour (Figure 6). This trend is not unusual for this station as the water flowing from the lake is typically very clean, clear and cold.

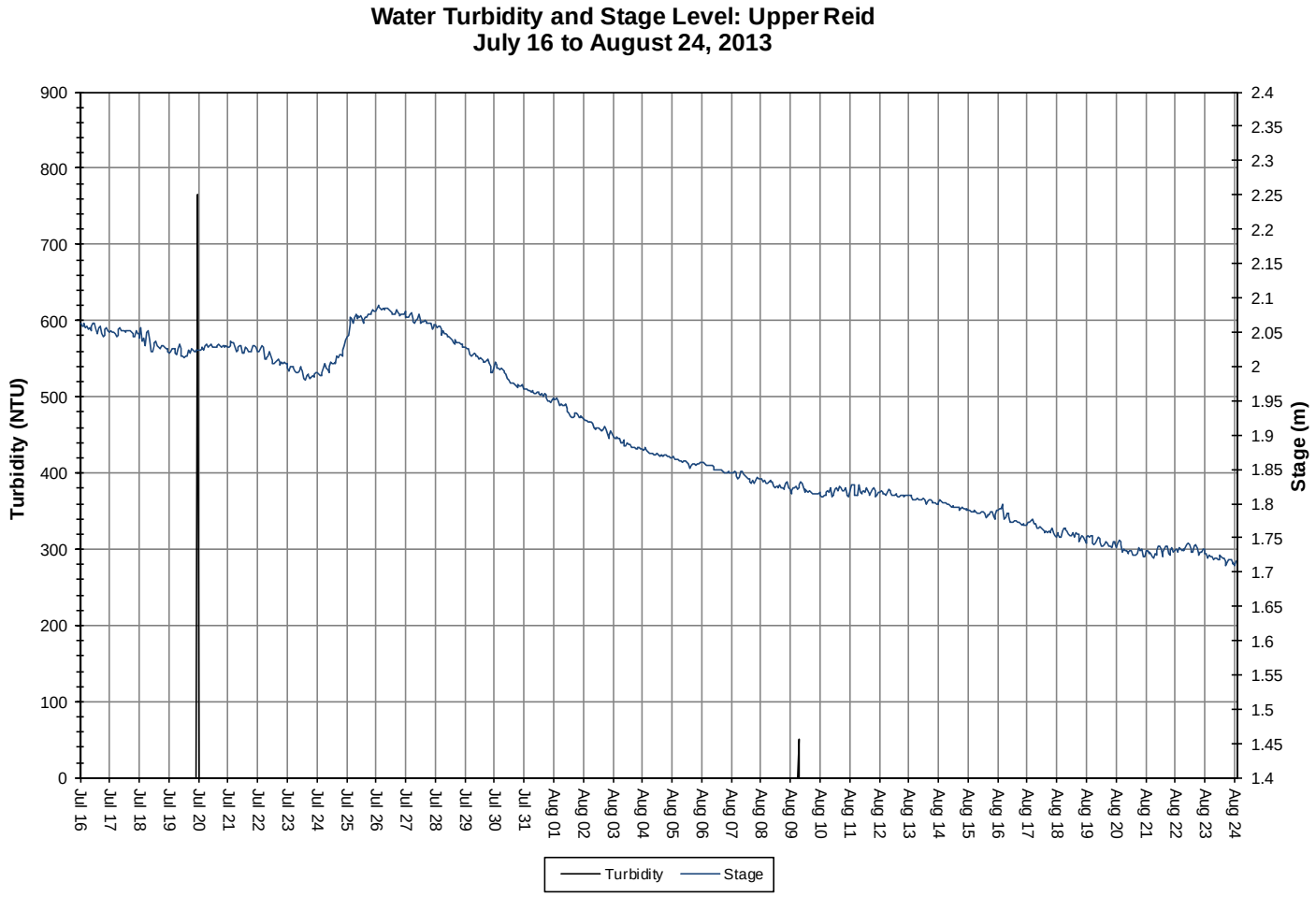


Figure 6: Turbidity at Upper Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is generally decreasing during the deployment period. Stage ranges from 1.71m to 2.09m, a difference of 0.38m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude except for one larger event on July 24 at 23.6mm.

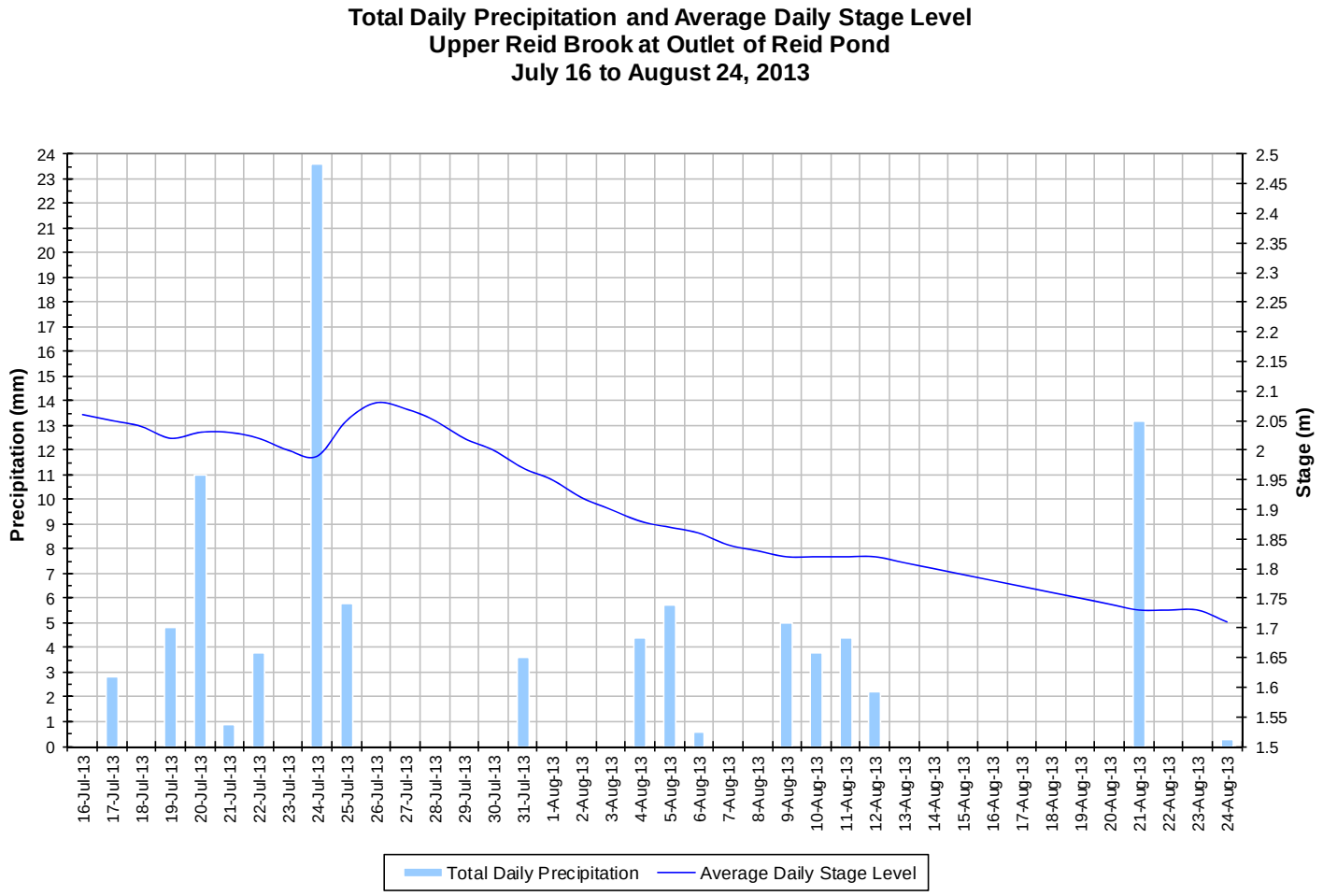


Figure 7: Daily precipitation and average daily stage level at Upper Reid Brook

(weather data recorded at Nain)

Camp Pond Brook

- Water temperature ranges from 10.28 °C to 21.06°C during the deployment period (Figure 8).
- Water temperature is fluctuating throughout the deployment period. Water temperature is at a seasonal high during the deployment period (Figure 8). This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day.
- Average water temperature is 15.24°C for the deployment period.
- This station typically has the highest water temperatures and greatest fluctuations when compared to the other stations in the network.

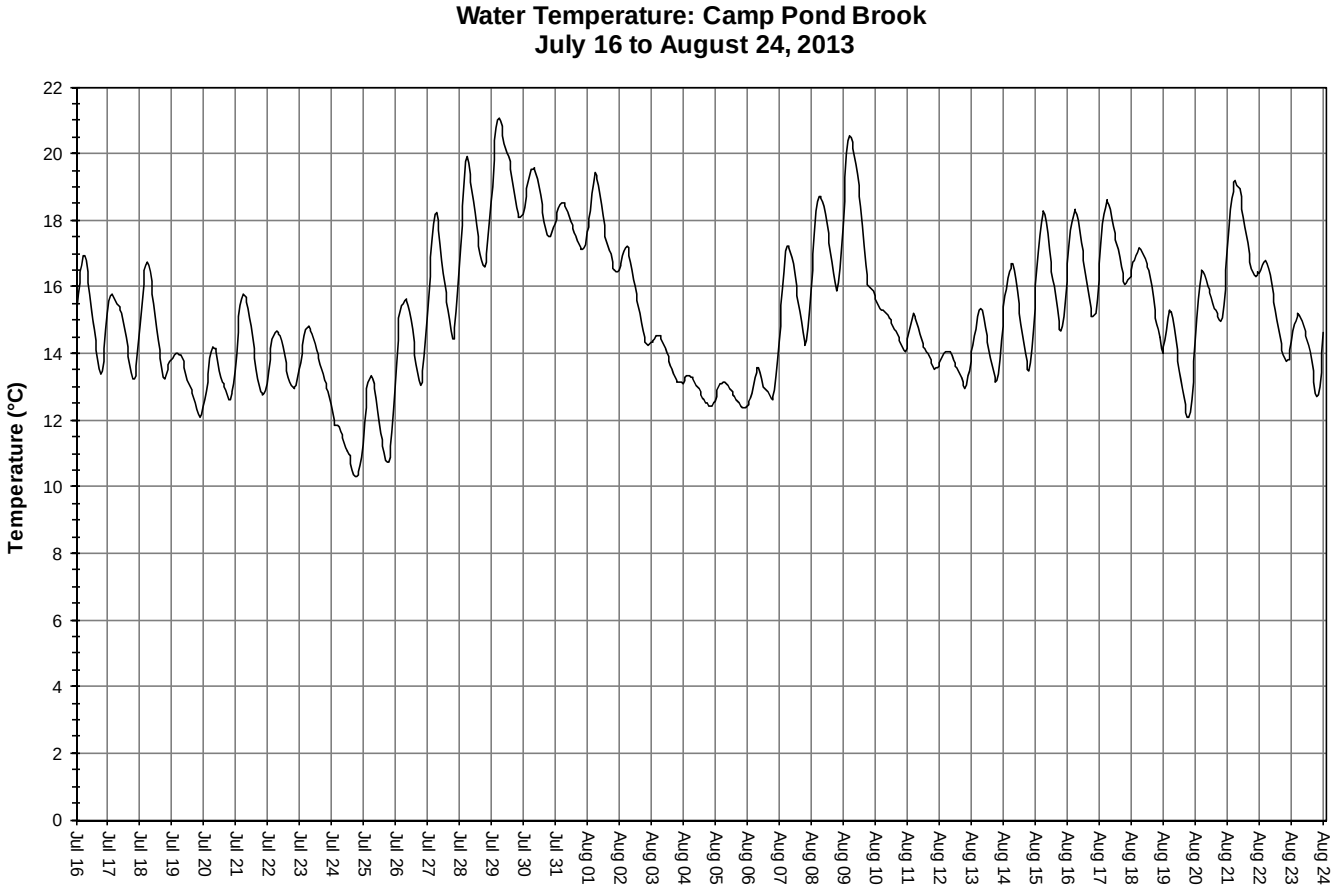


Figure 8: Water temperature at Camp Pond Brook

- Average daily air and water temperatures are fluctuating throughout the deployment period (Figure 9). Fluctuations in average daily air temperatures are reflected by changes in water temperature. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

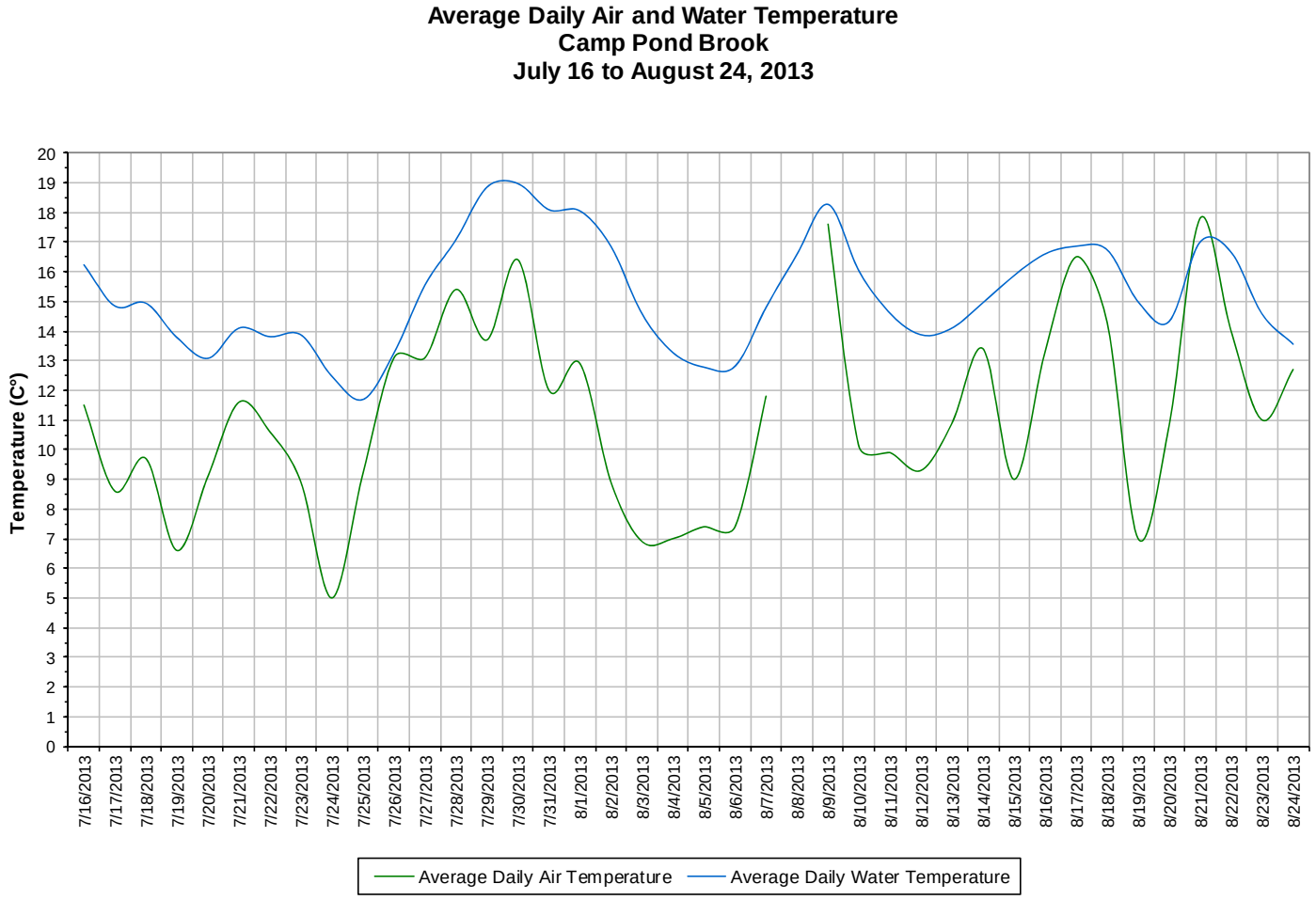


Figure 9: Average daily air and water temperatures at Camp Pond Brook

(weather data recorded at Nain)

- pH ranges between 6.67 and 7.03 pH units (Figure 10).
- pH values are very stable, fluctuating diurnally throughout the deployment period. There is change in the regular pattern of pH values on July 24 and again from Aug 10-11. These irregularities correspond with cooler air temperatures and rainfall events. These events are circled in red on Figure 10.
- All values are within the recommended guidelines for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). Guidelines are indicated in blue on Figure 10.

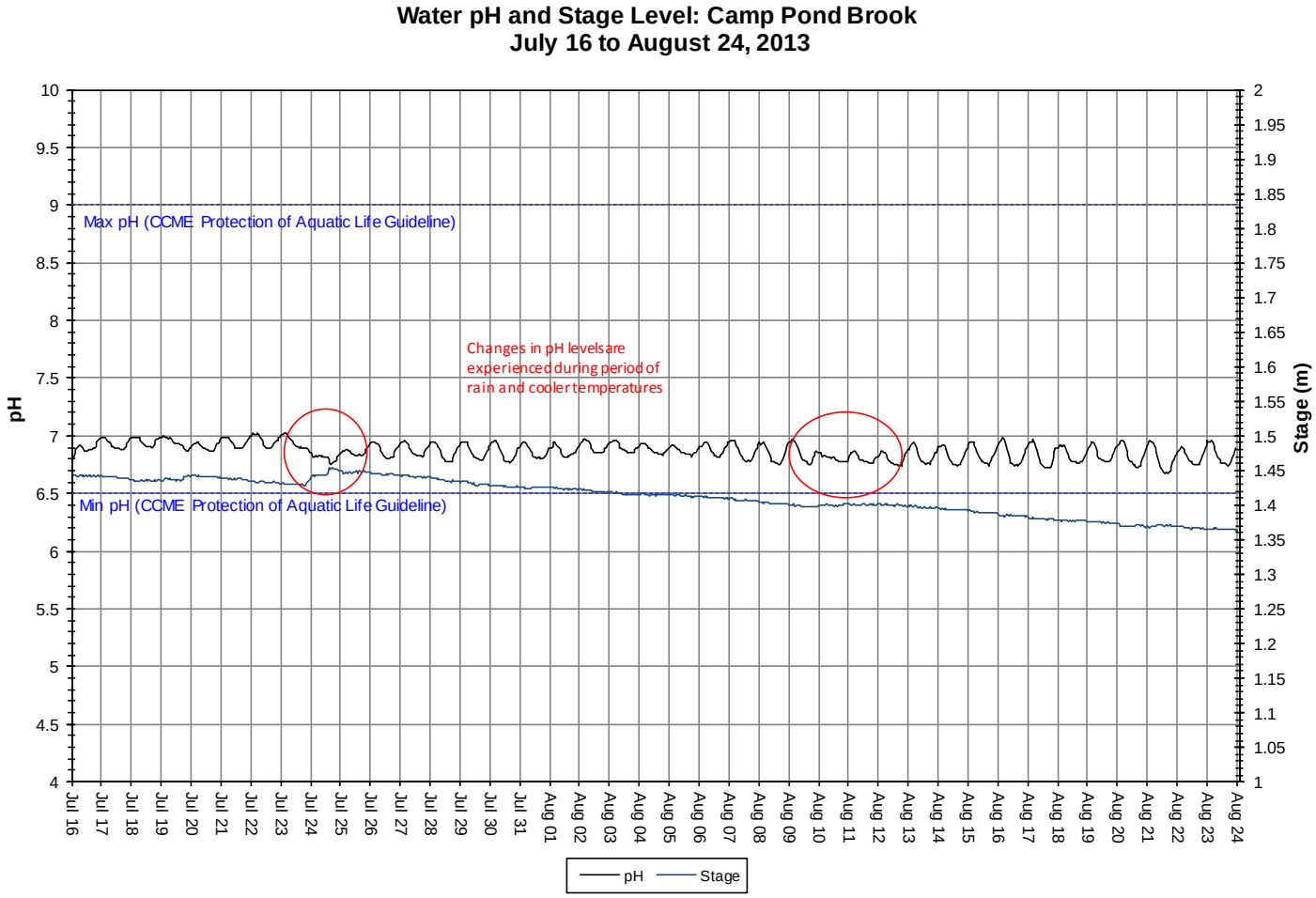


Figure 10: pH and stage level at Camp Pond Brook

- Specific conductivity ranges from 32.2µS/cm to 40.9µS/cm during the deployment period (Figure 11).
- Stage data is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Typically, as stage level decreases, the specific conductivity of the water increases because of the increase in concentration of dissolved solids present in the water column. Inversely, as stage levels increase, specific conductivity generally decreases as the dissolved solids become more diluted in the water column. This trend is not typically experienced at this station. The stage is decreasing consistently throughout the deployment period while the specific conductivity is relatively stable with daily fluctuations. A few more significant fluctuations occur during periods of rain and cooler temperatures. These events are circled in red on Figure 11. Instead of seeing a decrease in specific conductivity when stage levels increase, there is an increase.

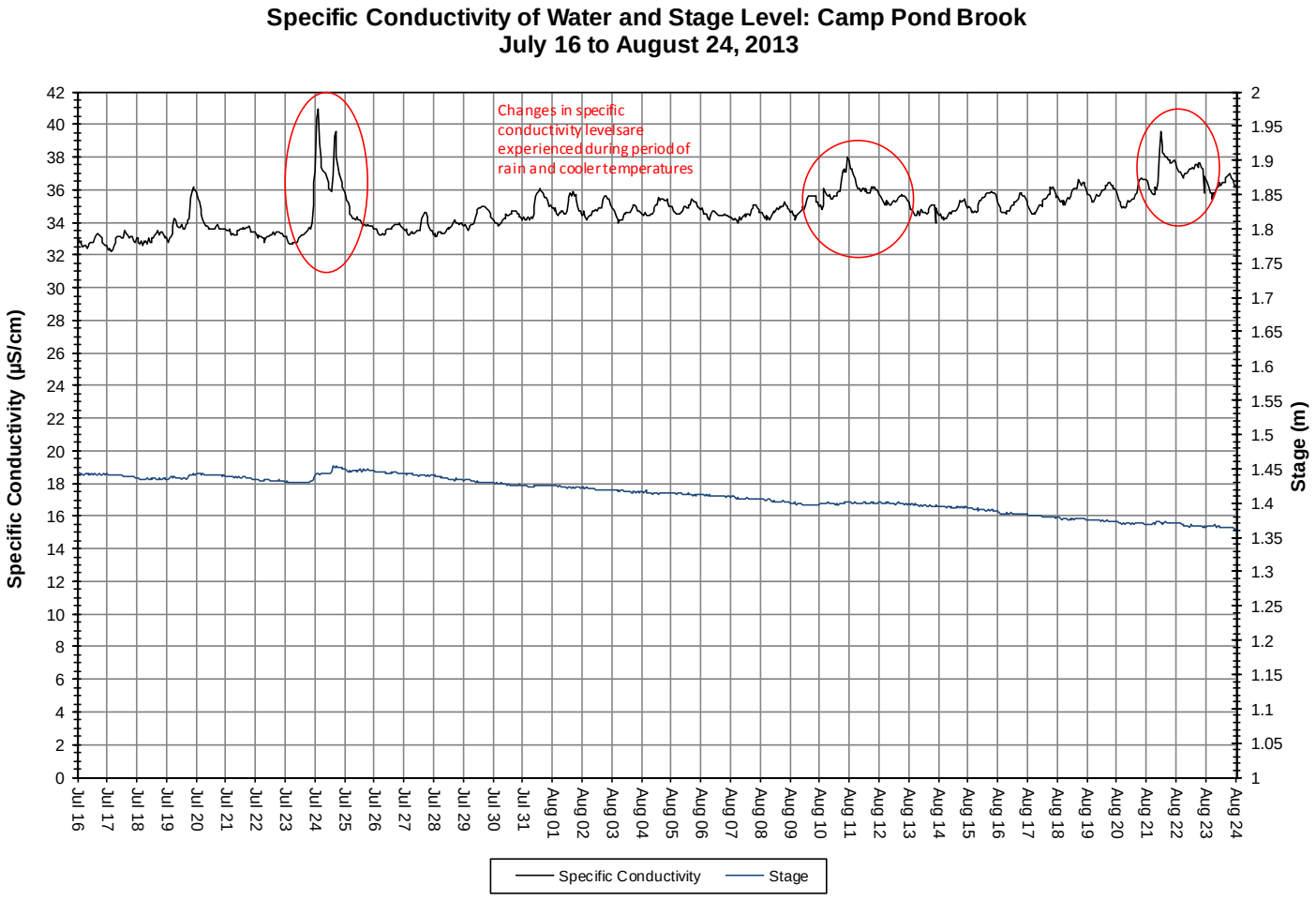


Figure 11: Specific conductivity and stage level at Camp Pond Brook

- Dissolved oxygen content ranges between 8.47mg/l and 10.34mg/l. The saturation of dissolved oxygen ranges from 88.9% to 101.1% (Figure 12).
- Dissolved oxygen content is fluctuating throughout the deployment period. Dissolved oxygen content is generally low at this time of the year as ambient air and water temperatures are at seasonal highs (Figure 9). Larger fluctuations in dissolved oxygen occur during periods of rain and cooler temperatures.
- All values are above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l). Dissolved oxygen content fluctuates above and below minimum CCME Guideline for the Protection of Cold Water Biota at Early Life Stages (9.5mg/l) throughout the deployment period. Average dissolved oxygen content is 9.47mg/l.

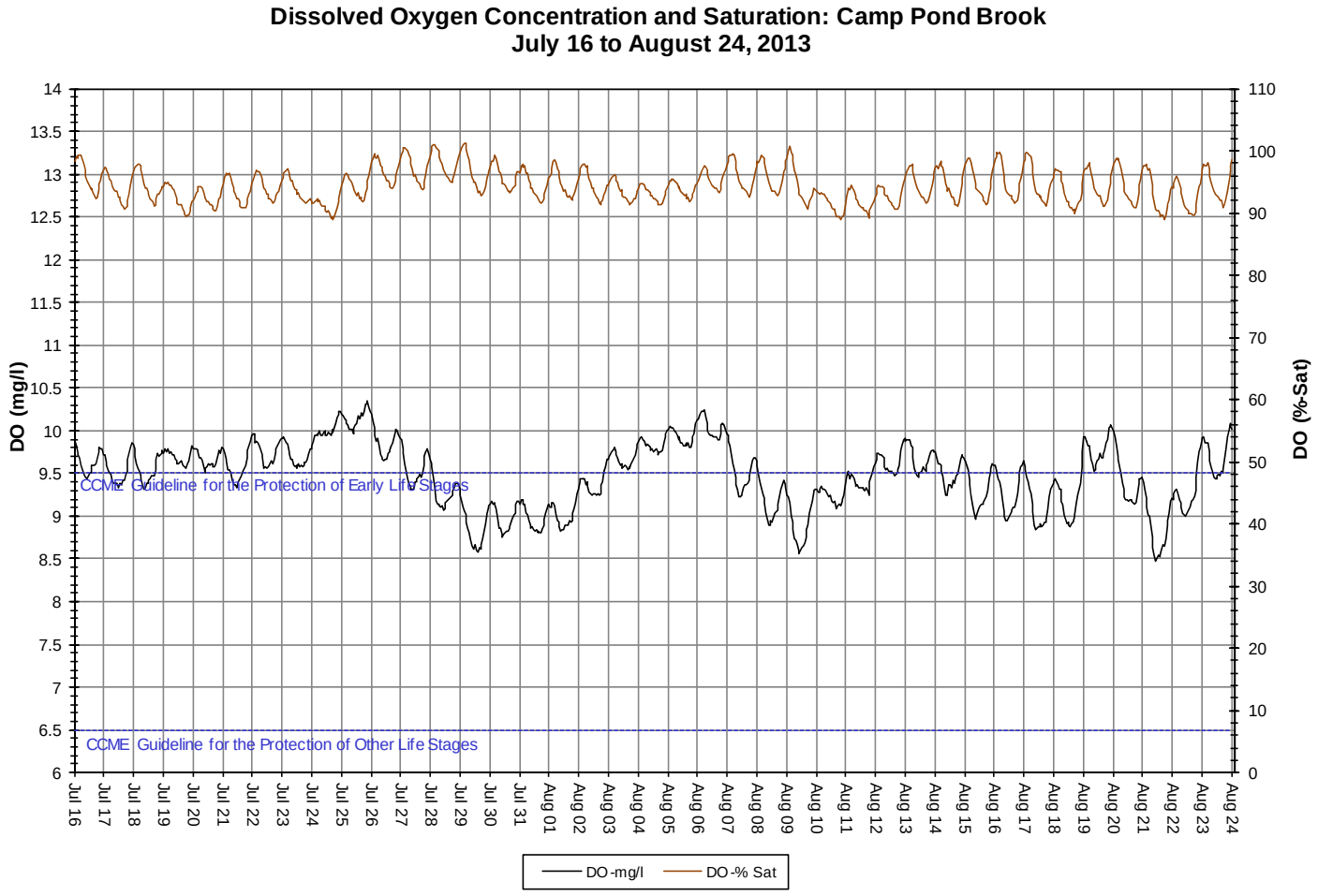


Figure 12: Dissolved oxygen and percent saturation at Camp Pond Brook

- Recorded turbidity values ranges between 0.0NTU to 1001NTU (Figure 13).
- On July 24, following a significant rainfall event, the accuracy of the turbidity sensor appears to have been compromised. This may be due to sediment covering or burying the turbidity sensor. No other sensors appear to be affected during this time. The turbidity data recorded following the July 24 rain event is inaccurate and will be removed from the data set.

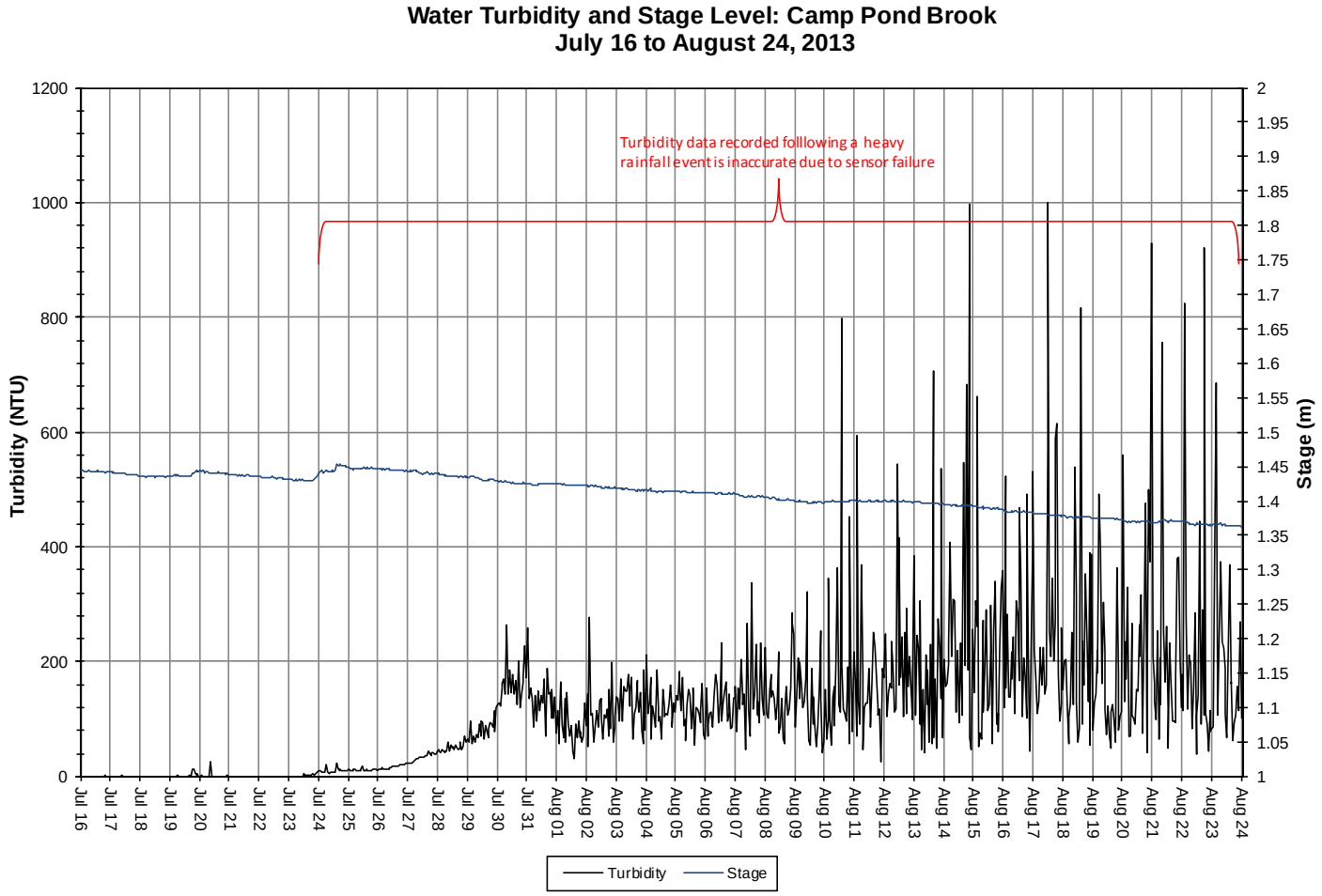


Figure 13: Turbidity and stage level at Camp Pond Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is decreasing slowly and very consistently during the deployment period. Stage level values range from 1.36 to 1.45m, a difference of 0.09m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude except for one larger event on July 24 at 23.6mm.

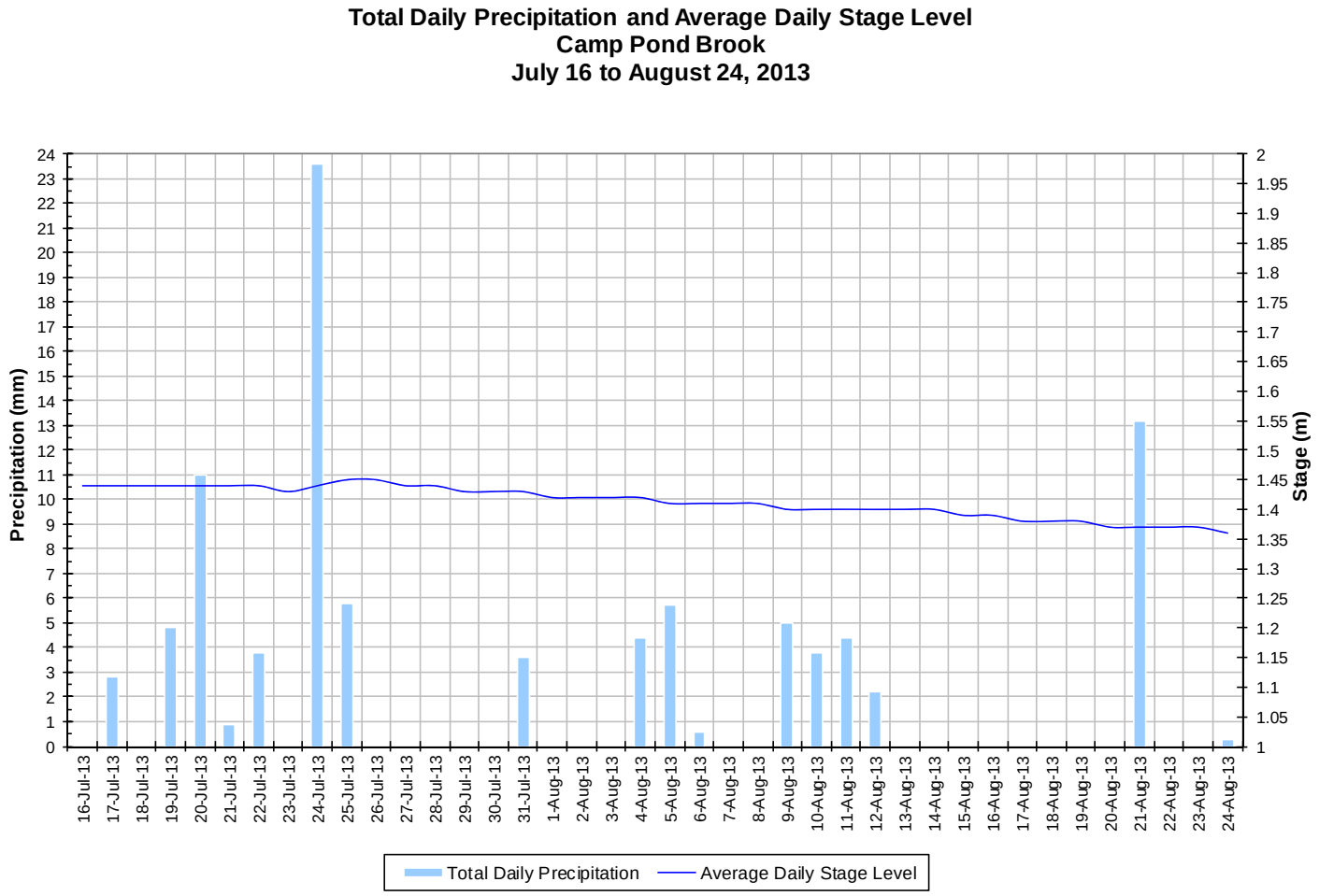


Figure 14: Daily precipitation and average daily stage level at Camp Pond Brook

(weather data recorded at Nain)

Tributary to Lower Reid Brook

- This station experienced data transmission errors from July 9 to July 23. Log file data stored in the instruments internal memory has been used to supplement data transmission for a more complete data set.
- Water temperature ranges from 7.90°C to 16.40°C during the deployment period (Figure 15).
- Water temperature is fluctuating throughout the deployment period. Water temperature is at a seasonal high during the deployment period (Figure 16). This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day.
- Average water temperature is 11.88°C for the deployment period.

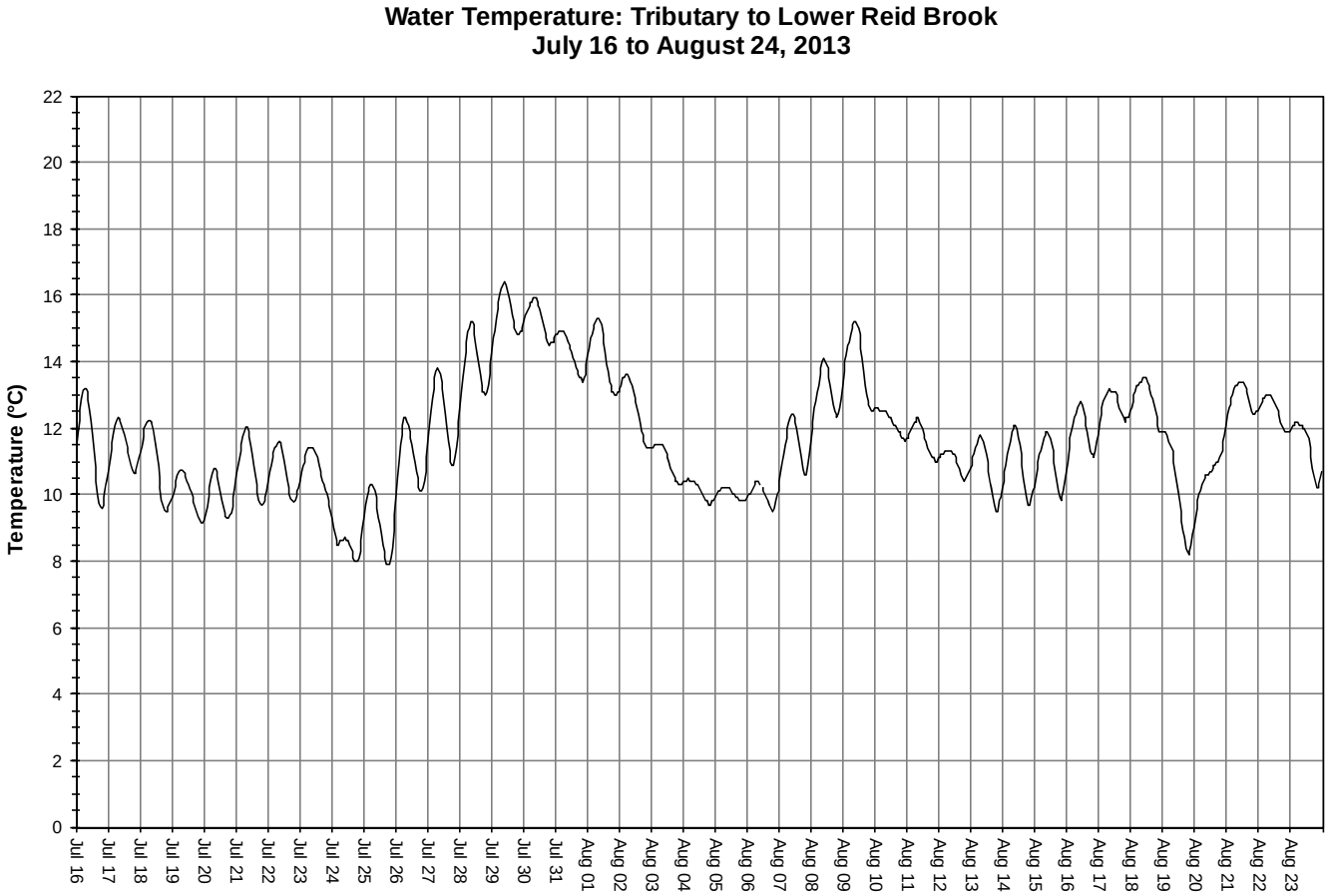


Figure 15: Water temperature at Tributary to Lower Reid Brook

- Average daily air and water temperatures fluctuate throughout the deployment period (Figure 16). Increases and decreases in air temperature are reflected in water temperatures. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

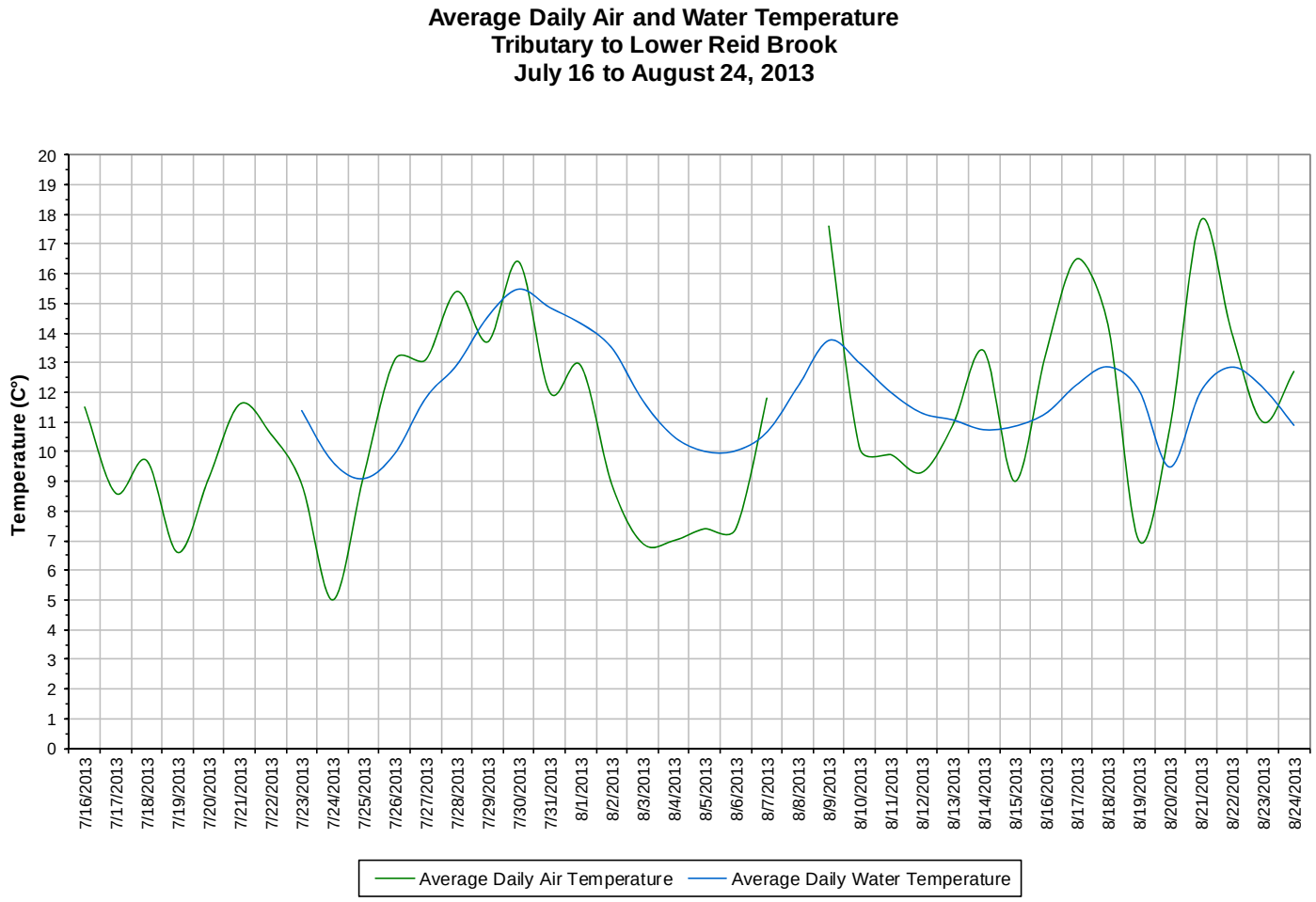


Figure 16: Average daily air and water temperatures at Tributary to Lower Reid Brook (weather data recorded at Nain)

- pH ranges between 6.46 and 7.00 pH units (Figure 17).
- Stage is included on Figure 17 to show the relationship between water level and pH. Stage appears to increase on July 24, corresponding with a heavy rainfall event. pH drops sharply at this time. pH also drops slightly on August 10-11 during periods of rain and cool weather. These events are circled in red on Figure 17.
- Most values are within the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). During the rainfall event and stage increase on July 24, pH drops to just slightly below this guideline. Guidelines are indicated in blue on Figure 17.

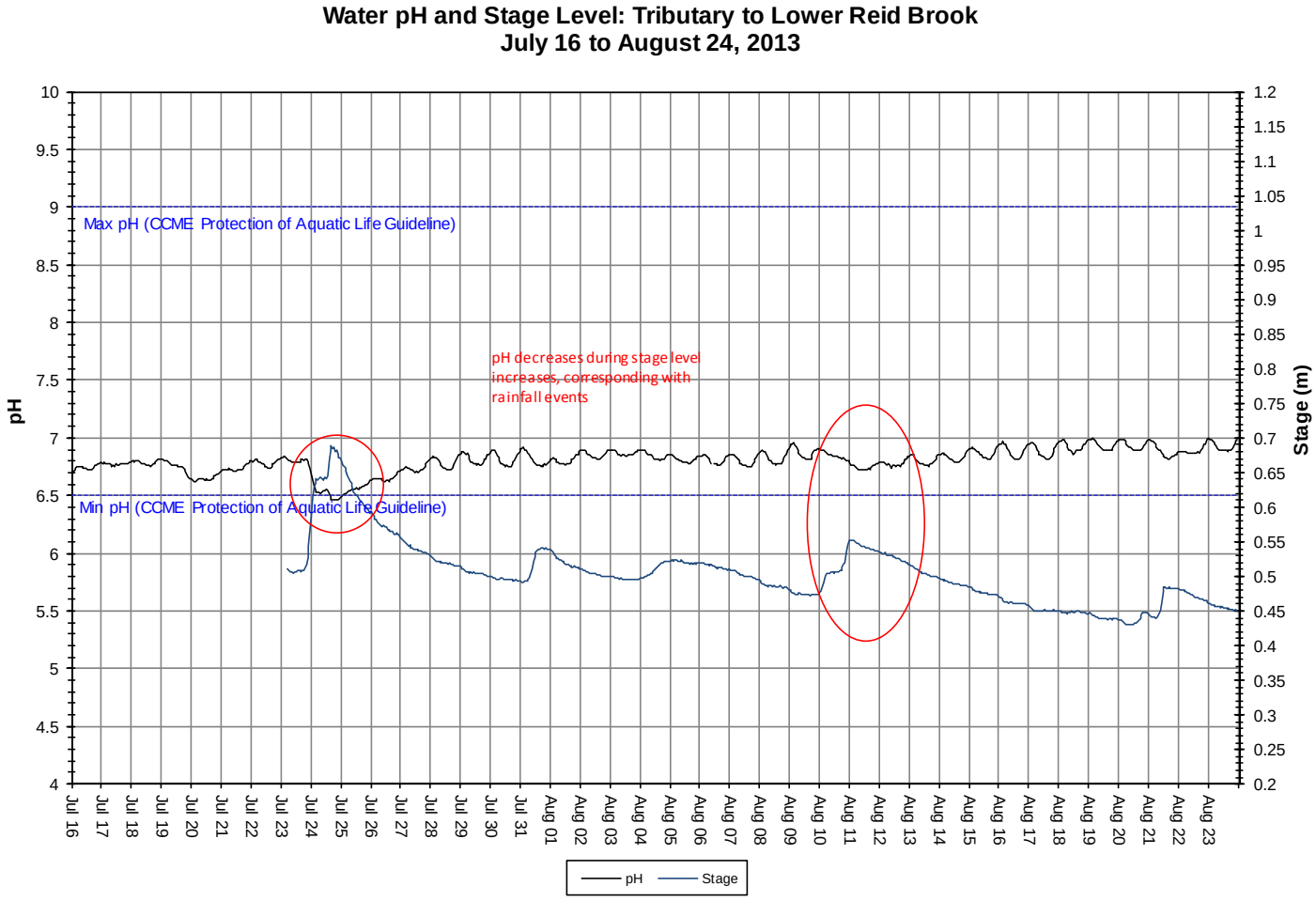


Figure 17: pH and stage level at Tributary to Lower Reid Brook

- Specific conductivity ranges between 22.8µS/cm and 40.2µS/cm and is generally increasing throughout the deployment period (Figure 18).
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Specific conductivity changes with the varying water level. As stage decreases, specific conductivity generally increases due to the increase in concentration of dissolved solids in the water column. Inversely, as stage increases, specific conductivity decreases as the concentration of dissolved solids is diluted.
- This trend is clear with the values collected from this station during the deployment period. This pattern is also clearly apparent at the station nearby on Lower Reid Brook. This trend is highlighted in red on Figure 18.

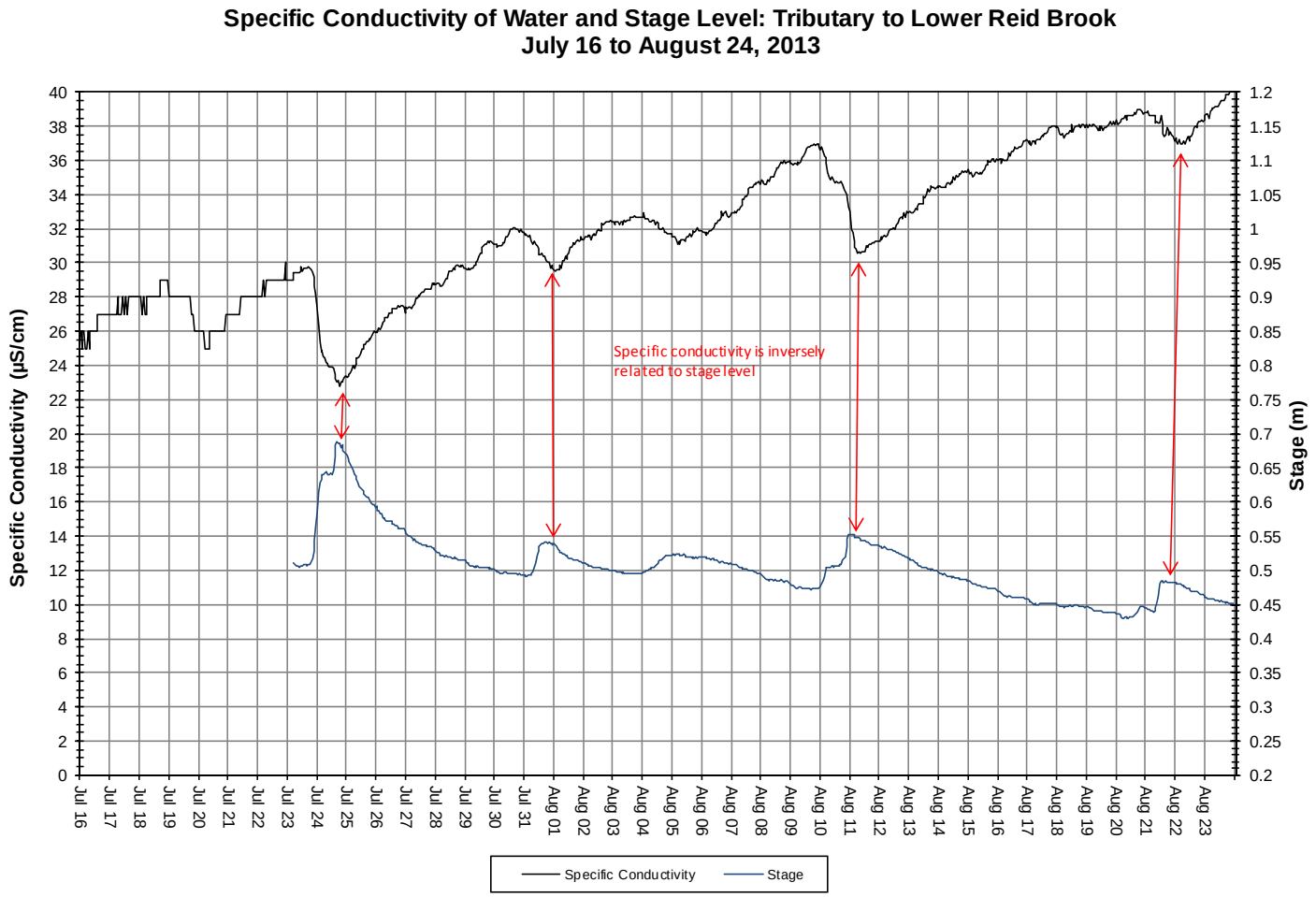


Figure 18: Specific conductivity and stage level at Tributary to Lower Reid Brook

- Dissolved oxygen content ranges between 9.26mg/l and 11.41mg/l. The saturation of dissolved oxygen ranges from 92.6% to 98.2% (Figure 19).
- Dissolved oxygen content is fluctuating throughout the deployment period. Dissolved oxygen content is generally low at this time of the year as ambient air and water temperatures are at seasonal highs (Figure 16). Larger fluctuations in dissolved oxygen occur during periods of rain and cooler temperatures.
- Most values are above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and Early Life Stages (9.5mg/l). During the warmest water temperatures, dissolved oxygen content falls just below the minimum guideline for early life stages. The guidelines are indicated in blue on Figure 19. Average dissolved oxygen value is 10.30mg/l.

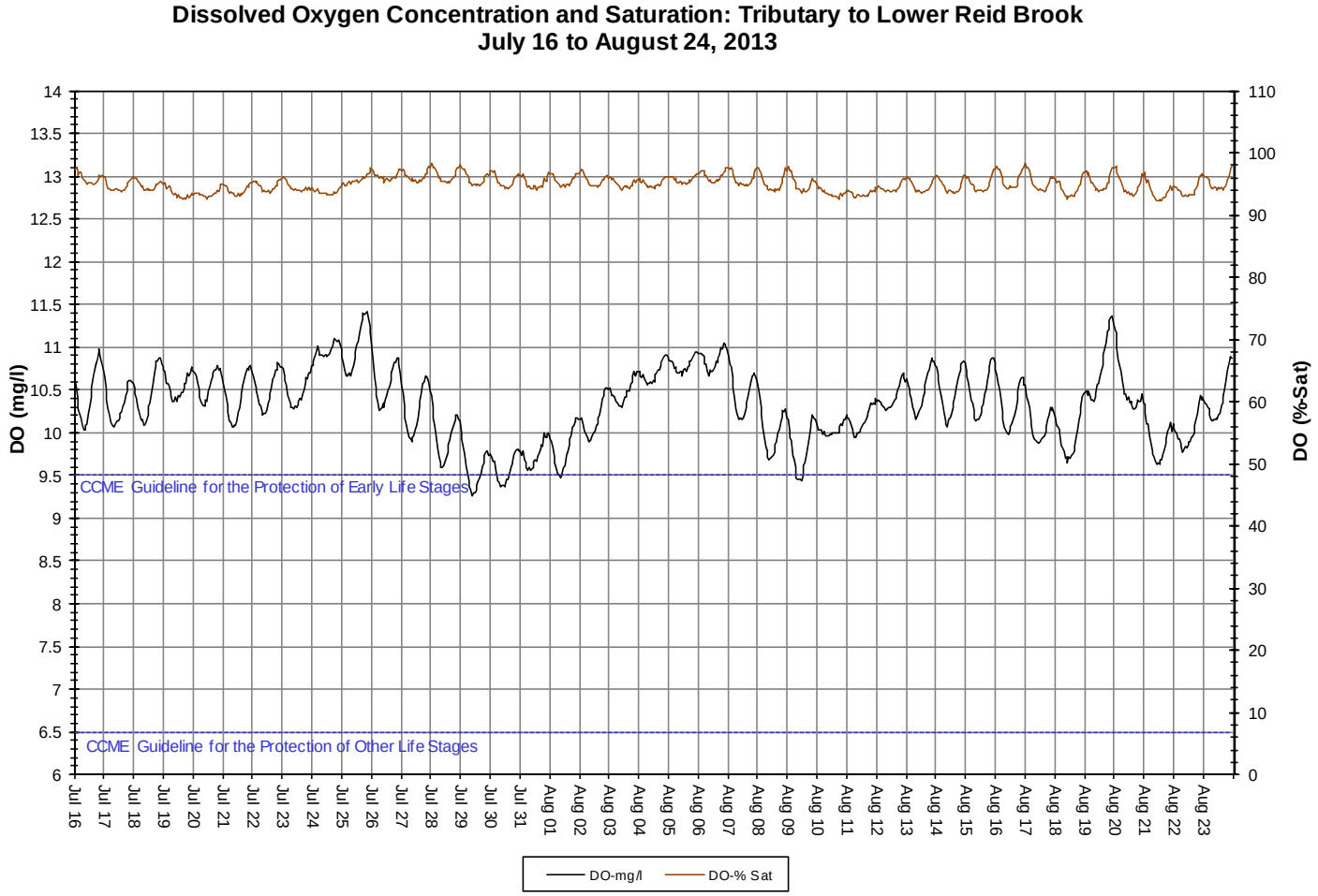


Figure 19: Dissolved oxygen and percent saturation at Tributary to Lower Reid Brook

- Turbidity ranges between 0NTU and 68.6NTU throughout the deployment period (Figure 20). A median value of 0NTU indicates there is no natural background turbidity value for this deployment period.
- Turbidity events at low magnitudes are normal for this station. The first turbidity event occurs following a significant rainfall event in the area on July 24. Turbidity increases last for up to two days before returning to 0NTU. There are a number of low magnitude rain fall events and stage level increases throughout the deployment period which corresponds with some of these increases. These events are indicated in red on Figure 20.

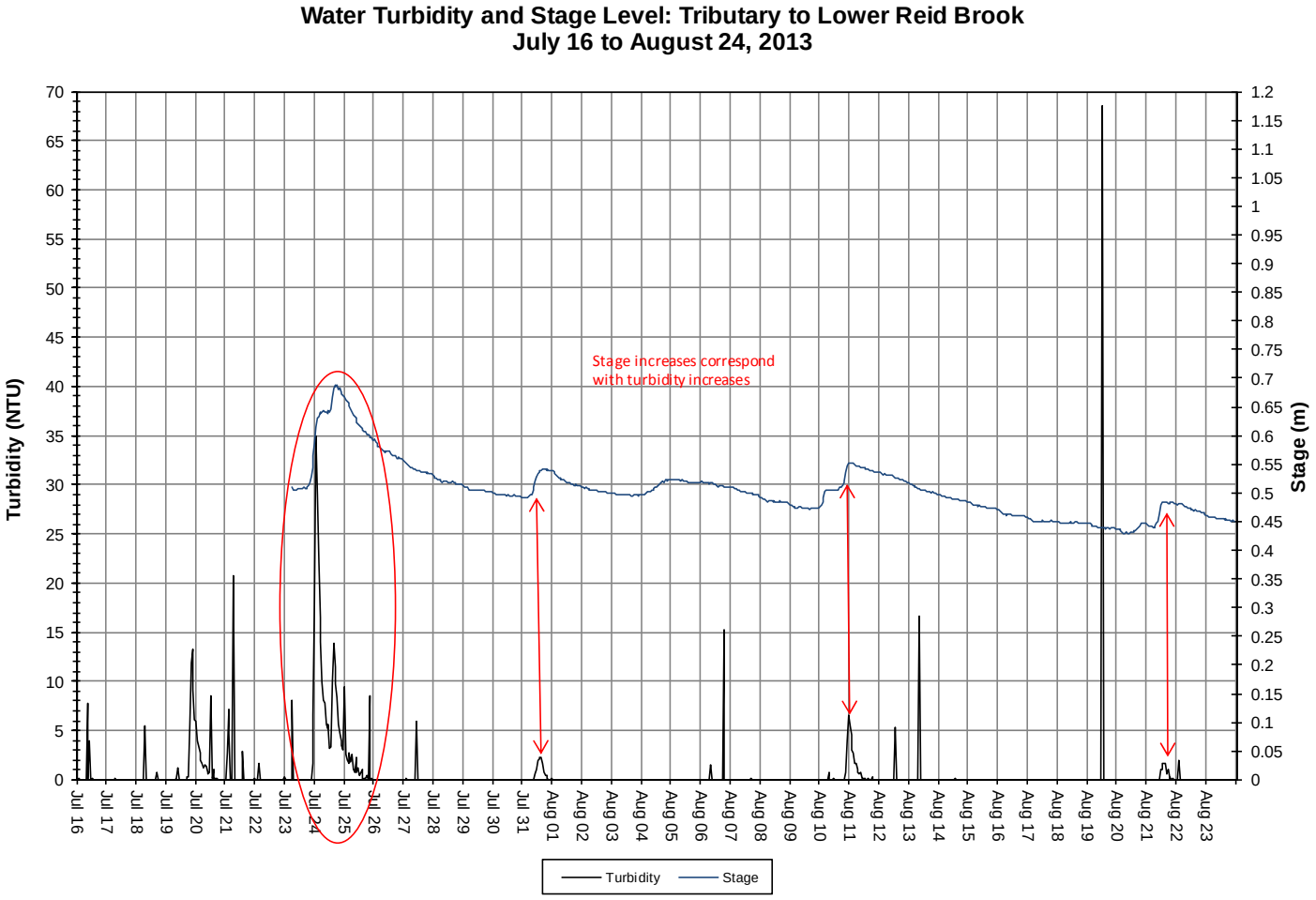


Figure 20: Turbidity and stage level at Tributary to Lower Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 21). Stage is generally decreasing throughout most of the deployment period with a few short increases. Stage ranges from 0.46m to 0.69m, a difference of 0.23m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude except for one larger event on July 24 at 23.6mm.

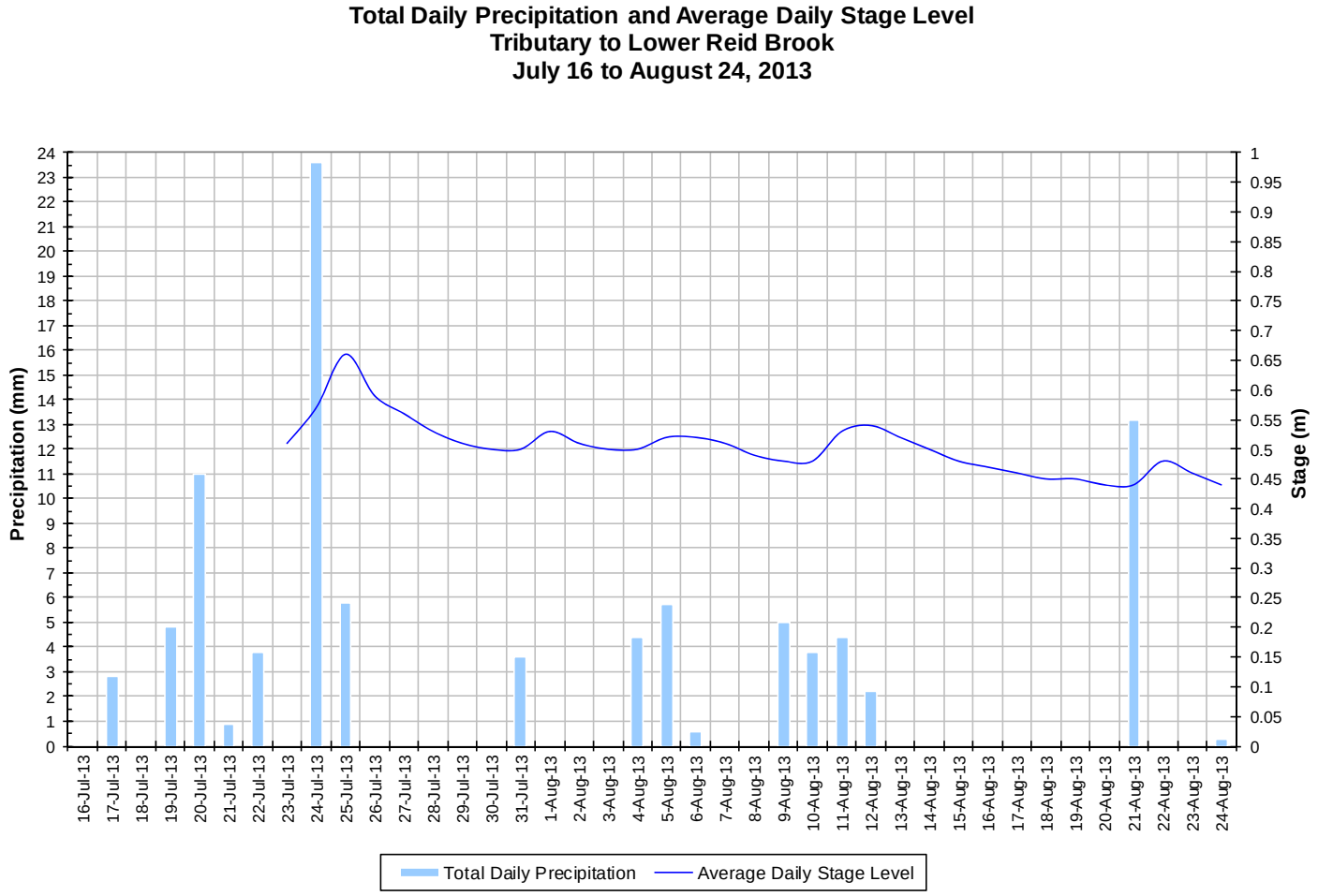


Figure 21: Daily precipitation and average daily stage at Tributary to Lower Reid Brook (weather data recorded at Nain)

Lower Reid Brook

- Data transmissions were intermittent throughout the first nine days of deployment period. Log file data stored in the instruments internal memory has been used to supplement data transmission for a more complete data set.
- Water temperature ranges from 8.05 ^{o}C to 16.68^{o}C during the deployment period (Figure 22).
- Water temperature is fluctuating throughout the deployment period. Water temperature is at a seasonal high during the deployment period (Figure 23). This stream is sensitive to changes in the ambient air temperature and fluctuates considerably depending on the weather and time of day.
- Average water temperature is 12.17°C for the deployment period.

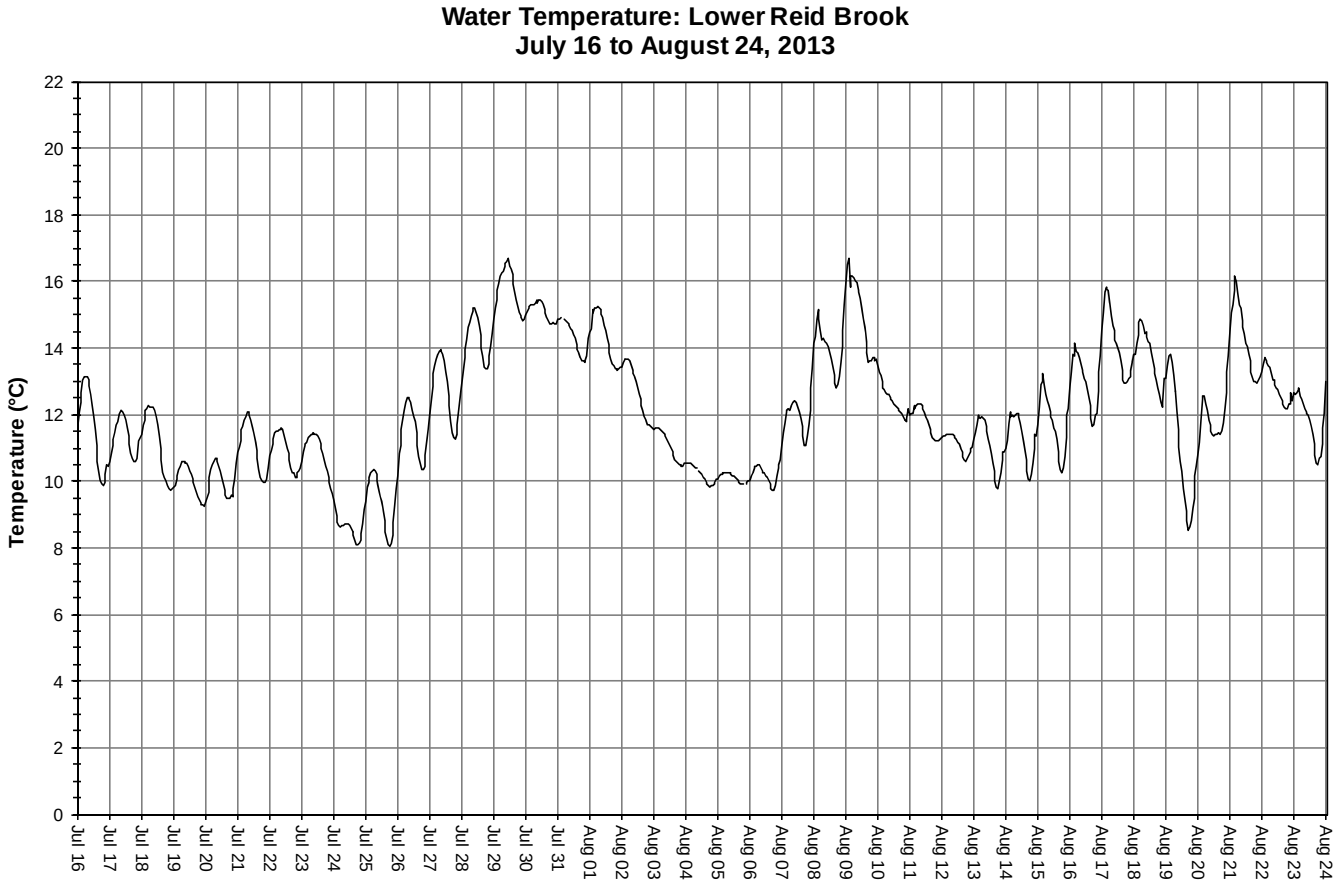


Figure 22: Water temperature at Lower Reid Brook

- Average daily air and water temperatures are fluctuating throughout the deployment period (Figure 23). Increases and decreases in air temperature are reflected in water temperatures. Air temperatures generally increase and decrease faster while water temperatures increase and decrease more slowly over time.

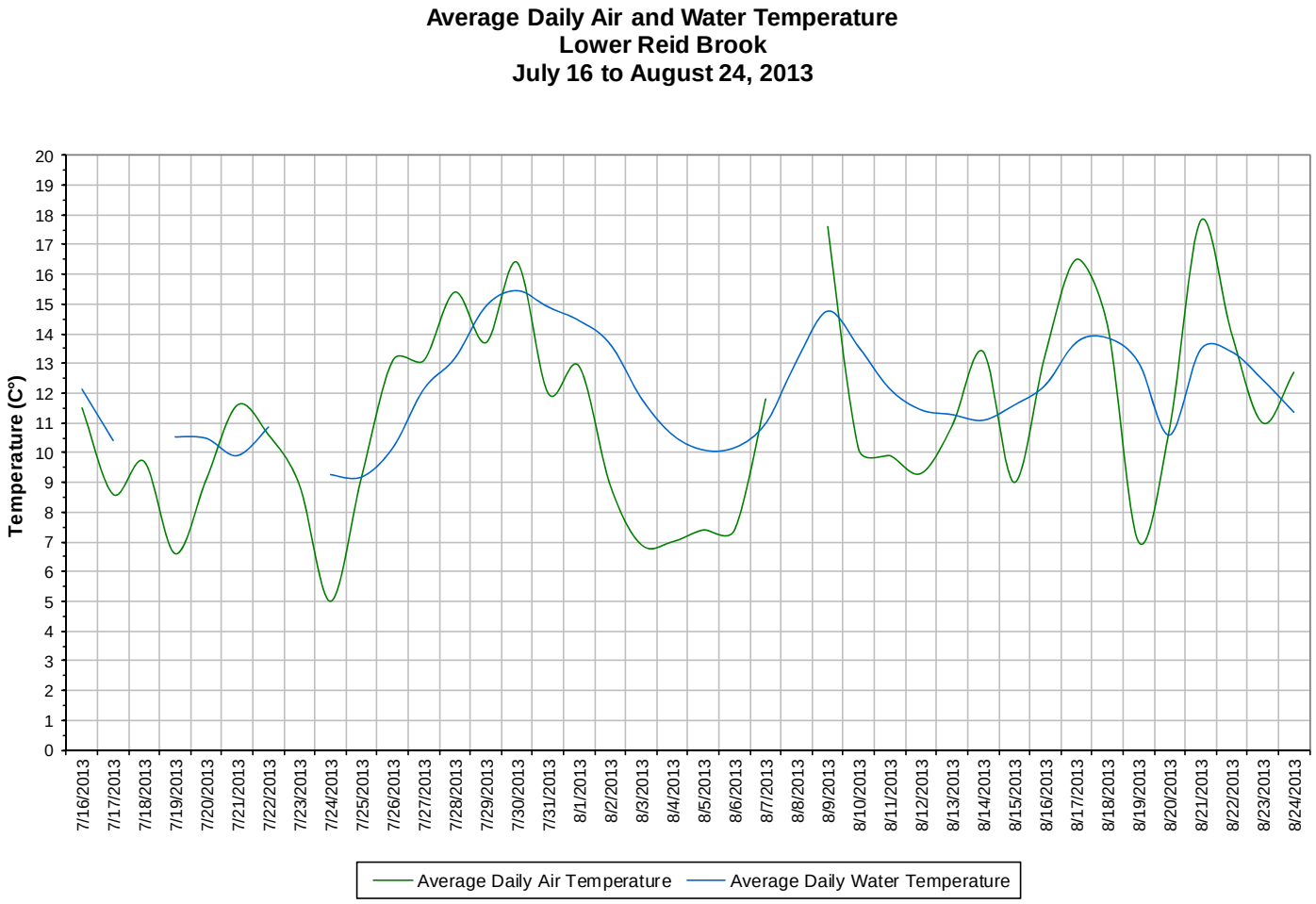


Figure 23: Average daily air and water temperatures at Lower Reid Brook

(weather data recorded at Nain)

- pH ranges between 5.97 and 6.90 pH units (Figure 24).
- pH appears to decrease slowly throughout the entire length of the deployment period. The comparison ranking between the field and QAQC instruments is 'poor' at the time of deployment and also at removal. This decreasing trend is unusual for this station regardless of the consistently decreasing stage level. This data should be considered with caution and will be re-evaluated in the annual report for 2013.
- Given the unusual decreasing trend throughout the deployment period, most values are below the recommended range for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). Guidelines are indicated in blue on Figure 24.

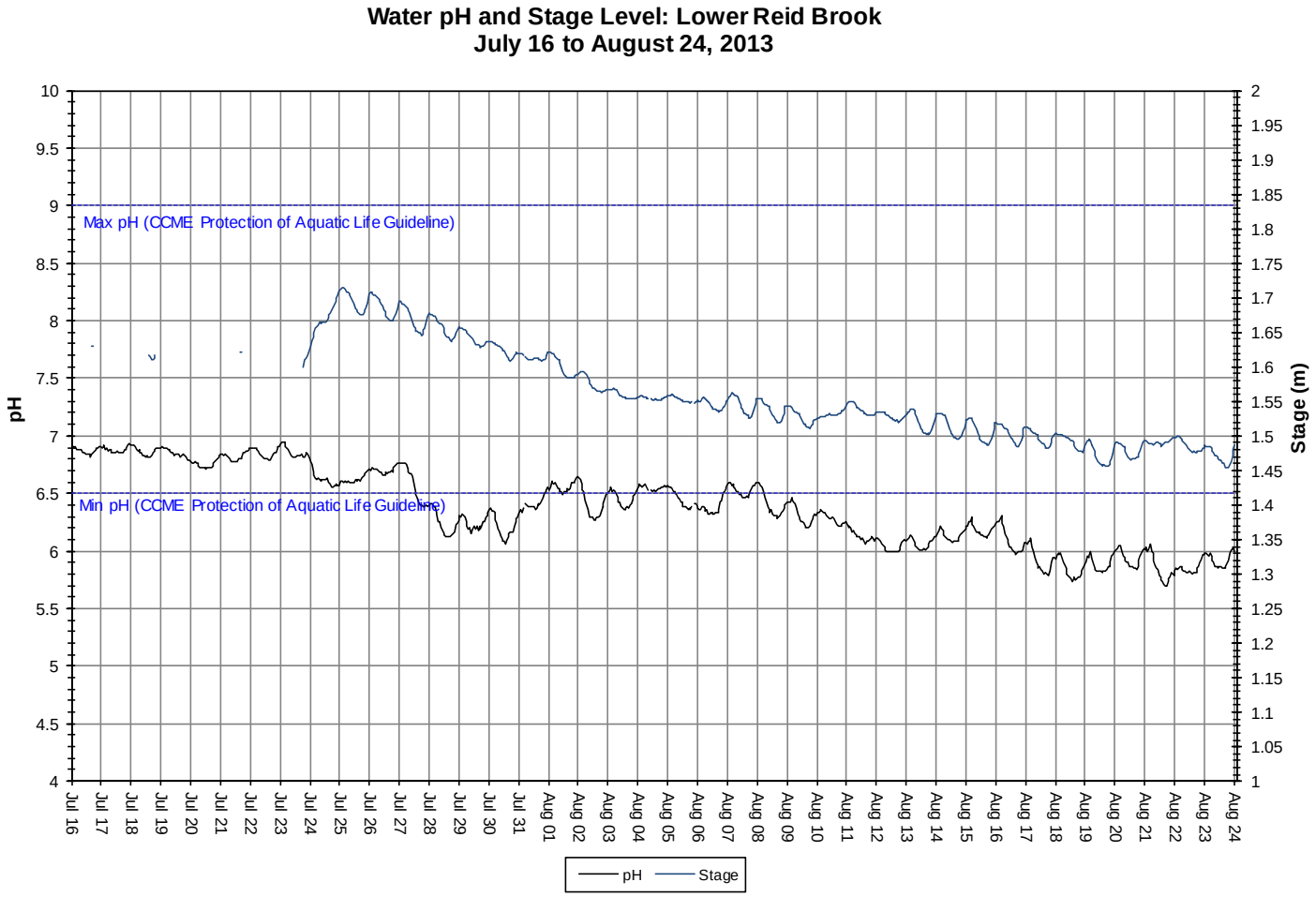


Figure 24: pH and stage level at Lower Reid Brook

- Specific conductivity ranges between 22.8µS/cm and 36.2µS/cm (Figure 25).
- Stage is included in Figure 25 to illustrate the inverse relationship between conductivity and water level. As stage decreases, specific conductivity increases because of the increased concentration of dissolved solids. Inversely, as stage increases, specific conductivity decreases due to the dilution of dissolved solids in the water column.
- This trend is clear with the values collected from this station during the deployment period, regardless of the intermittent stage data. This trend is highlighted in red on Figure 25. This pattern is also clearly apparent at the station nearby on Tributary to Lower Reid Brook (Figure 18).

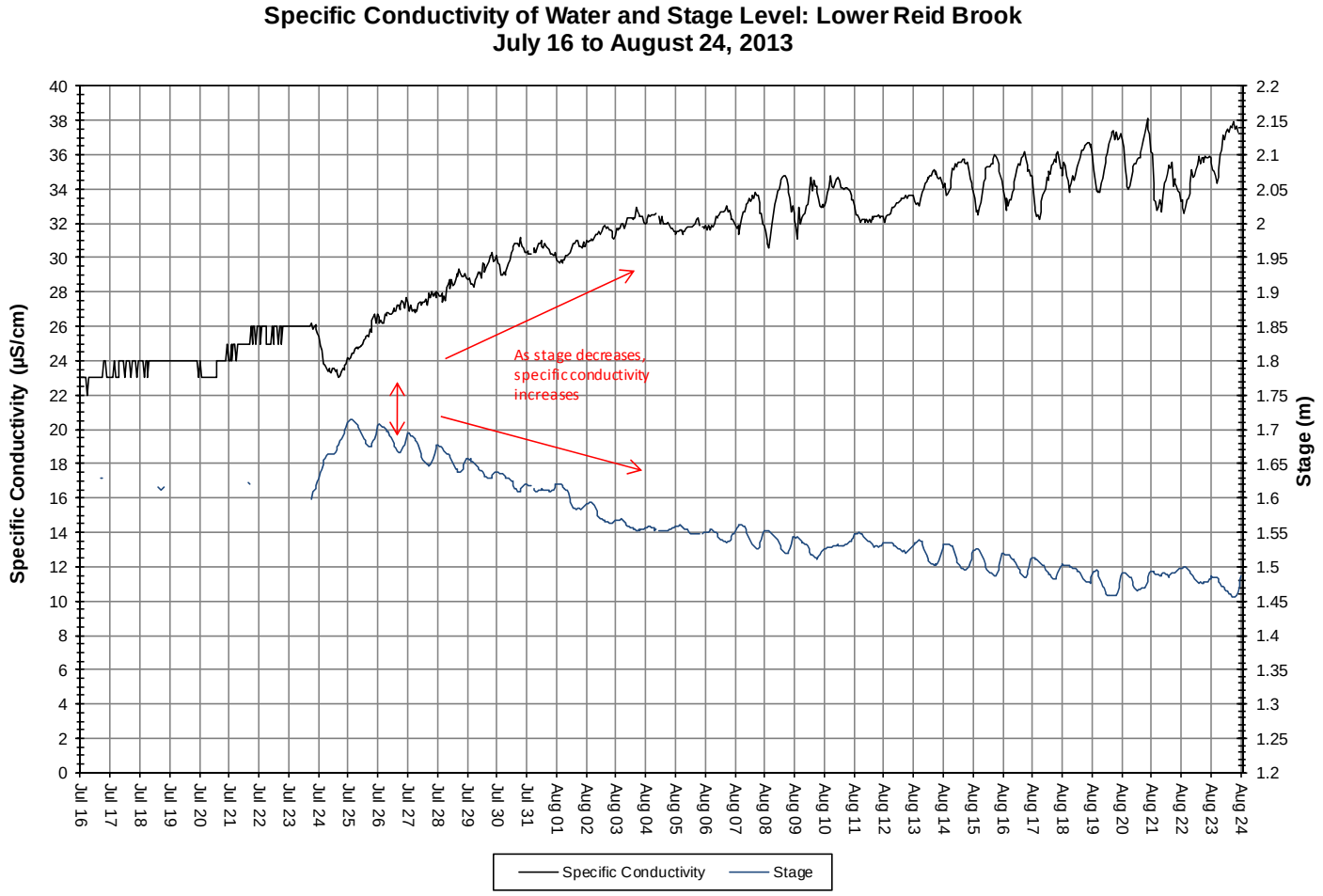


Figure 25: Specific conductivity and stage level at Lower Reid Brook

- Dissolved oxygen content ranges between 9.43mg/l and 10.51mg/l. The saturation of dissolved oxygen ranges from 95.5% to 103.0% (Figure 26).
- Dissolved oxygen content is fluctuating throughout the deployment period. Dissolved oxygen content is generally low at this time of the year as ambient air and water temperatures are at seasonal highs (Figure 23). Larger fluctuations in dissolved oxygen occur during periods of rain and cooler temperatures.
- Most values are above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5mg/l) and Early Life Stages (9.5 mg/l). The guidelines are indicated in blue on Figure 26. Average dissolved oxygen content is 10.50mg/l.

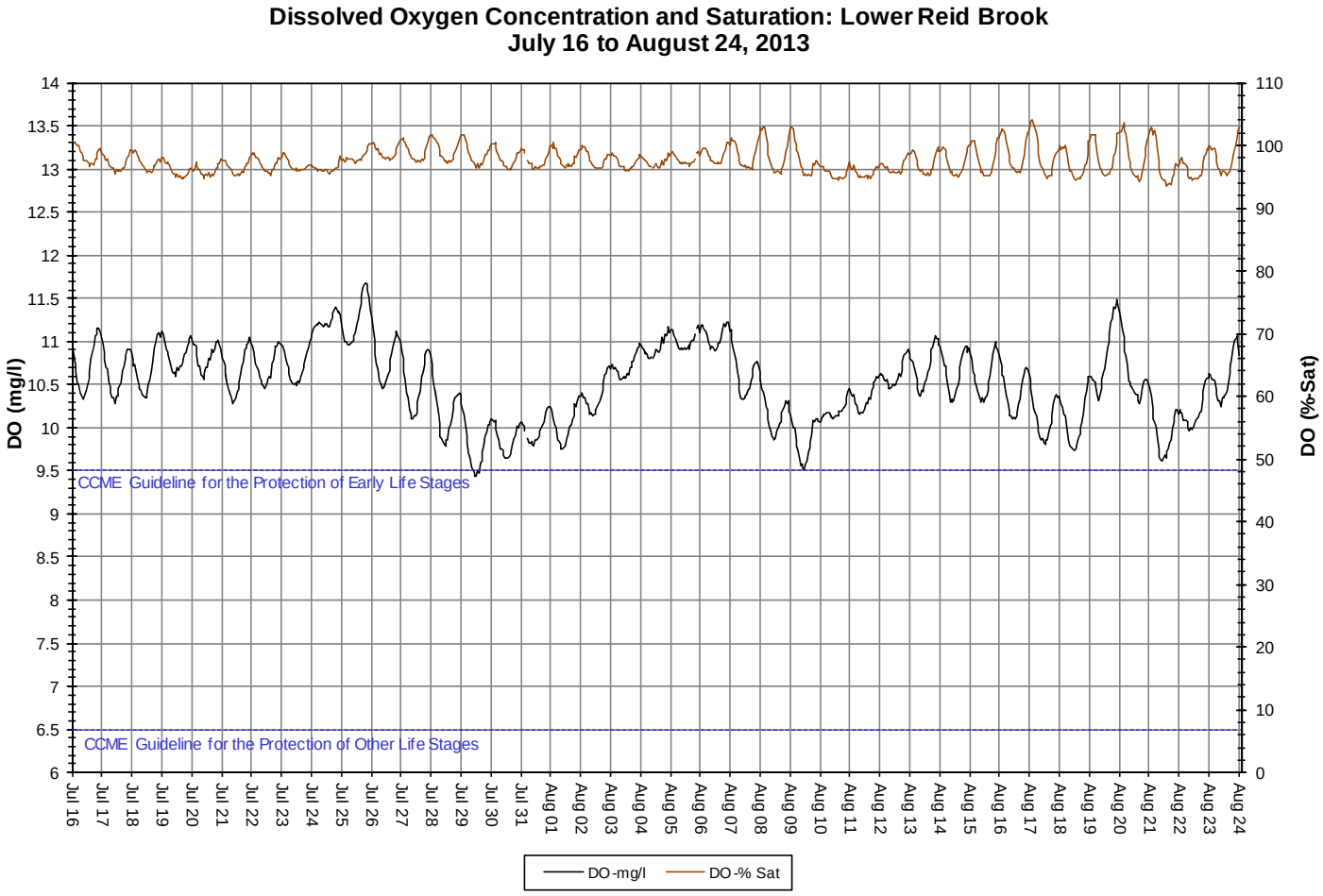


Figure 26: Dissolved oxygen and percent saturation at Lower Reid Brook

- Turbidity ranges between 0NTU and 30.4NTU throughout the deployment period (Figure 27). A median value of 0.0NTU indicates there is no natural background turbidity data for this deployment period.
- Turbidity events at low magnitudes are normal for this station. Events corresponding with rain fall events are circled in Figure 27.

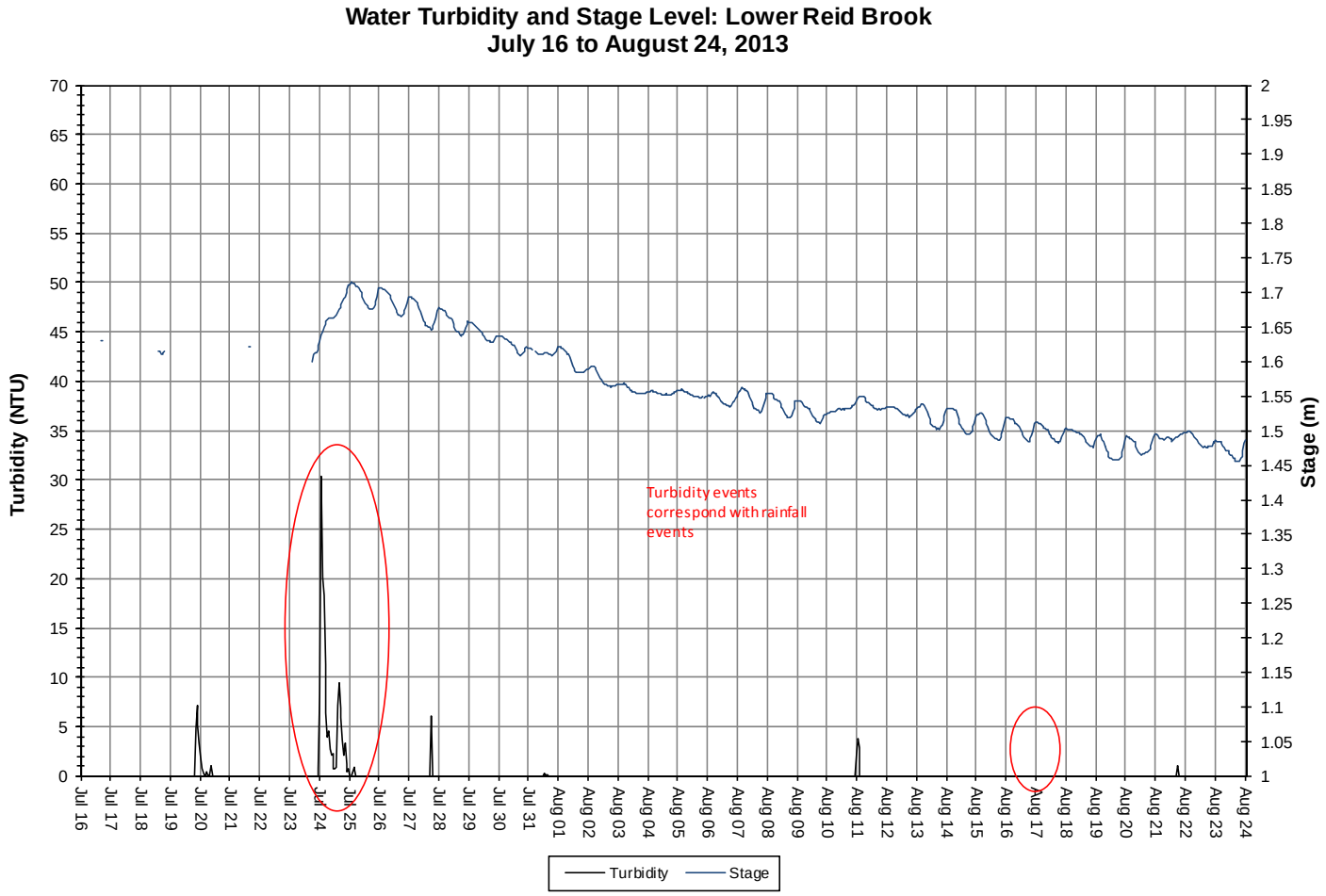


Figure 27: Turbidity and stage level at Lower Reid Brook

- Stage and precipitation are graphed below to show the relationship between rainfall and stage level (Figure 28). Stage is decreasing consistently at this station throughout the deployment period. Stage ranges from 1.49 to 1.79m, a difference of 0.30m.
- Precipitation events occur less than 50% of the time and are generally low in magnitude except for one larger event on July 24 at 23.6mm.

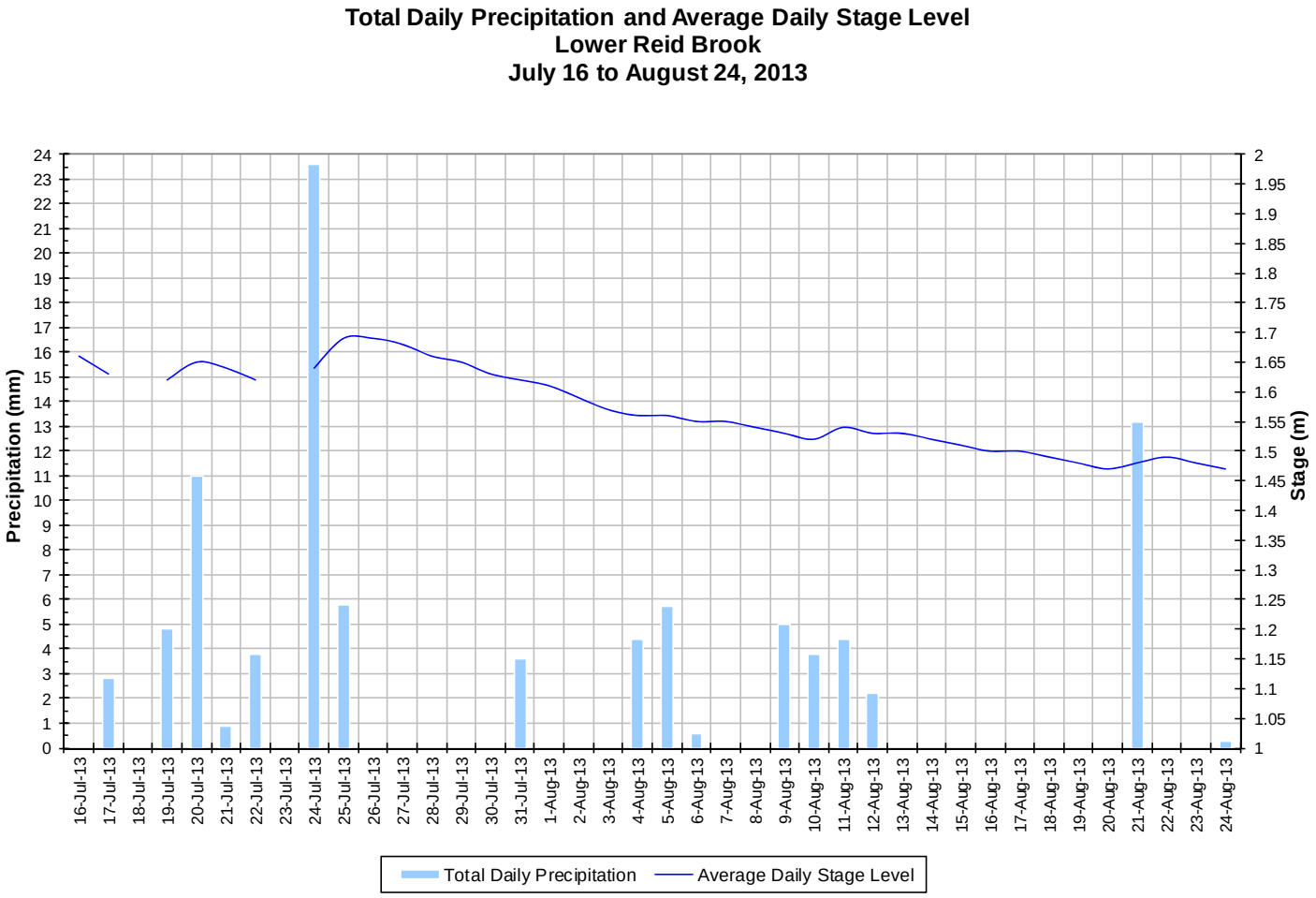


Figure 28: Daily precipitation and average daily stage level at Lower Reid Brook

(weather data recorded at Nain)

Conclusions

- Instruments at water quality monitoring stations in the Voisey's Bay Network were deployed from July 16 to August 24, 2013.

Summary by Station

- At Upper Reid Brook, water temperature increased slightly and dissolved oxygen decreased slightly throughout the deployment period. Specific conductivity was low and very stable which is normal for this station. pH values were neutral and consistent. Turbidity remained mostly at 0NTU. Stage levels decreased consistently throughout the deployment period.
- At Camp Pond Brook, water temperature and dissolved oxygen fluctuated throughout the deployment period. pH was neutral and decreased at times when stage level increased sharply following heavy rainfall events. Specific conductivity increased when stage levels increased and did not portray a typical inverse relationship with stage level. Turbidity data recorded after a heavy rainfall event on July 24 are inaccurate and will be removed from the data set. The sensor was likely buried in sand following the stage increase.
- At Tributary to Lower Reid Brook, log file data was used to supplement transmitted data. Water temperature and dissolved oxygen fluctuated throughout the deployment period. pH values were neutral and stable for the majority of the deployment period except during periods of stage increase which saw temporary decreases in pH. Specific conductivity fluctuated with changes in stage level and remained inversely proportional to water level. Turbidity events were minimal and most often corresponded with precipitation events. Events at this station closely resemble the events captured at the station nearby on Lower Reid Brook.
- At Lower Reid Brook, log file data was used to supplement transmitted data. Water temperature and dissolved oxygen fluctuated throughout the deployment period. pH values decreased consistently throughout the deployment period which is unusual for this station. Data will be subjected to further review in the annual report for 2013. Specific conductivity fluctuated with changes in stage level and remained inversely proportional to water level. Turbidity events were minimal and most often corresponded with precipitation events. Events at this station closely resemble the events captured at the station nearby on Tributary to Lower Reid Brook.

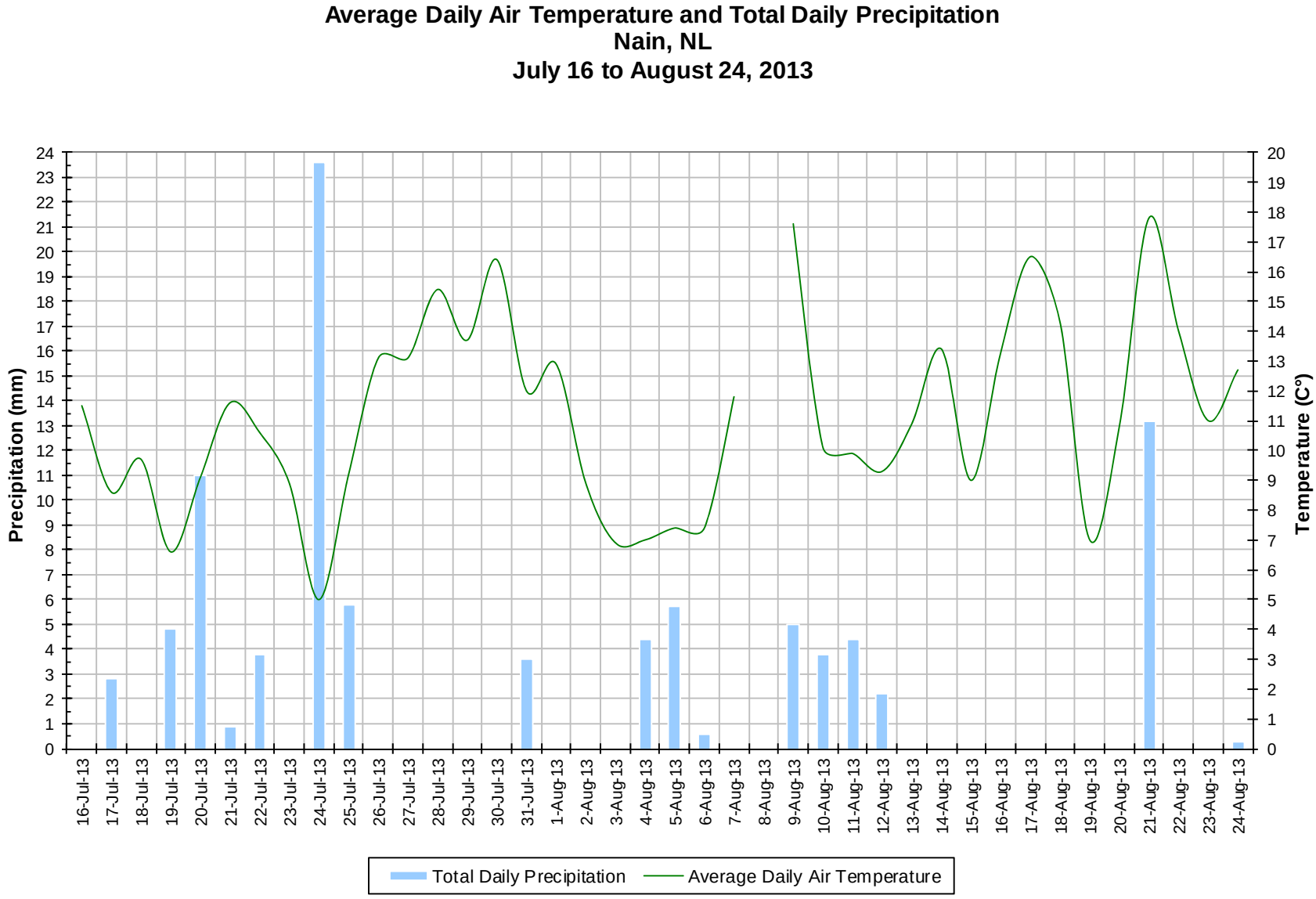
Summary by Parameter

- Temperature averaged between 11.48°C (Upper Reid Brook) and 15.24°C (Camp Pond Brook) at the 4 stations in the Voisey's Bay Network. Water temperature reached seasonal highs at all stations and fluctuated throughout the deployment period depending on the weather conditions. The stations on Camp Pond Brook, Tributary to Lower Redid Brook and Lower Reid Brook are more sensitive to changes in the ambient air temperatures.
- pH values averaged between 6.79 (Tributary to Lower Reid) and 6.80 (Upper Reid Brook) pH units across the network. At Camp Pond Brook and Tributary to Lower Reid Brook, pH values decreased following a sharp increase in stage level on July 24. pH values recorded at Lower Reid Brook are subject to drifting as values appear to decrease consistently throughout the deployment period. With the exception of the

suspect data at Lower Reid Brook, all values recorded at all stations were within or just below the recommended range as stated by the CCME Guideline for the Protection of Aquatic Life.

- At Tributary to Lower Reid Brook, Lower Reid Brook and Camp Pond Brook stations, specific conductivity averaged between 30.9µS/cm (Lower Reid Brook) and 34.8µS/cm (Camp Pond Brook). Values at Upper Reid Brook were considerably lower averaging 11.2µS/cm. These lower values are expected from this pristine station at the outflow from Reid Pond. Values at this station tend not to fluctuate a lot even with changing stage levels. At Tributary to Lower Reid and Lower Reid Brook Stations, specific conductivity displayed a clear inverse relationship with stage level, with values decreasing when stage level increased. At Camp Pond Brook, specific conductivity displayed a positive relationship to stage level however this is typical for this station.
- Dissolved oxygen levels averaged between 9.47mg/l (Camp Pond Brook) and 10.89mg/l (Upper Reid Brook). All values recorded at all stations were above the minimum CCME Guideline for the Protection of Aquatic Life at Other Life Stages (6.5mg/l). Most values were above or just below the minimum CCME Guideline for the Protection of Aquatic Life at Early Life Stages (9.5mg/l). Dissolved oxygen content is typically low during the deployment period due to the seasonably warm air and water temperatures. Dissolved oxygen content at Upper Reid Brook is more stable due to the lake from which the water flows.
- Median turbidity values are 0NTU at stations at Upper Reid Brook, Tributary to Lower Reid Brook and Lower Reid Brook indicating there is generally no background turbidity in these streams. There are no turbidity events at Upper Reid Brook. Turbidity events at the stations on Tributary to lower Reid Brook and Lower Reid Brook are minimal and most often correspond with rainfall events. At Camp Pond Brook, a rainfall event and stage increase on July 24 appears to have compromised the accuracy of the turbidity sensors and all data collected after July 24 is inaccurate.

Appendix 1: Weather Data – Environment Canada Historical Climate Database



Appendix 2: Grab Sample Results: Report of Analysis – Exova Accutest

2013-6320-00-SI-SP, Upper Reid Brook

2013-6321-00-SI-SP, Tributary to Lower Reid Brook

2013-6322-00-SI-SP, Lower Reid Brook

2013-6323-00-SI-SP, Camp Pond Brook

REPORT OF ANALYSIS

Lab Report Number: **1315338**

Cient:	Department of Environment	**COC Number:**	1459
Attention:	Ms. Annette Tobin	**Date Reported:**	2013-07-26
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1044043	WS-S-0000 Upper Ried Brk	2013-6320-00-SI-SP	2013-07-16

Comment:

Holding time for Turbidity analysis was exceeded.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	<5
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	<1
Colour	TCU	2	9
Conductivity	uS/cm	5	14
Dissolved Organic Carbon	mg/L	0.5	2.3
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	2
N-NH3 (Ammonia)	mg/L	0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.73
Sulphate	mg/L	3	<3
Total Dissolved Solids (COND - CALC)	mg/L	1	9
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	2.5
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	0.2
Aluminum	mg/L	0.01	0.05
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	1
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

D. Cameron

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Diana Cameron
Team Leader, Inorganics

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Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1044043	WS-S-0000 Upper Ried Brk	2013-6320-00-SI-SP	2013-07-16	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	<0.03
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.005
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Comment:

Holding time for Turbidity analysis was exceeded.

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL:

Diana Cameron
Team Leader, Inorganics

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1044044	WS-S-0000 Tributary 1	2013-6321-00-SI-SP	2013-07-16

Comment:

Holding time for Turbidity analysis was exceeded.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	8
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	2
Colour	TCU	2	41
Conductivity	uS/cm	5	29
Dissolved Organic Carbon	mg/L	0.5	5.6
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	5
N-NH3 (Ammonia)	mg/L	0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.74
Sulphate	mg/L	3	3
Total Dissolved Solids (COND - CALC)	mg/L	1	19
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	5.7
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	1.4
Aluminum	mg/L	0.01	0.10
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	2
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

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Methods references and/or additional QA/QC information available on request.

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1044044	WS-S-0000 Tributary 1	2013-6321-00-SI-SP	2013-07-16	Copper	mg/L	0.001	0.001
				Iron	mg/L	0.03	0.30
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.013
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Comment:

Holding time for Turbidity analysis was exceeded.

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Methods references and/or additional QA/QC information available on request.

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Team Leader, Inorganics

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1044045	WS-S-0000 Lower Reid Brk	2013-6322-00-SI-SP	2013-07-16

Comment:

Holding time for Turbidity analysis was exceeded.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	7
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	2
Colour	TCU	2	37
Conductivity	uS/cm	5	27
Dissolved Organic Carbon	mg/L	0.5	5.3
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	5
N-NH3 (Ammonia)	mg/L	0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.74
Sulphate	mg/L	3	3
Total Dissolved Solids (COND - CALC)	mg/L	1	18
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	5.4
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	1.3
Aluminum	mg/L	0.01	0.10
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	2
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

D. Cameron

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Methods references and/or additional QA/QC information available on request.

APPROVAL:

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Team Leader, Inorganics

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Attention:	Ms. Annette Tobin	**Date Reported:**	2013-07-26
Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1044045	WS-S-0000 Lower Reid Brk	2013-6322-00-SI-SP	2013-07-16	Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.29
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.013
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	<2

Comment:

Holding time for Turbidity analysis was exceeded.

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Methods references and/or additional QA/QC information available on request.

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Team Leader, Inorganics

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1044046	WS-S-0000 Camp Pond Brk	2013-6323-00-SI-SP	2013-07-16

Comment:

Holding time for Turbidity analysis was exceeded.

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	12
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	2
Colour	TCU	2	20
Conductivity	uS/cm	5	34
Dissolved Organic Carbon	mg/L	0.5	4.0
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	5
N-NH3 (Ammonia)	mg/L	0.02	<0.02
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.77
Sulphate	mg/L	3	5
Total Dissolved Solids (COND - CALC)	mg/L	1	22
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	4.1
Total Phosphorus	mg/L	0.01	<0.01
Turbidity	NTU	0.1	2.3
Aluminum	mg/L	0.01	0.14
Antimony	mg/L	0.0005	<0.0005
Arsenic	mg/L	0.001	<0.001
Barium	mg/L	0.01	<0.01
Boron	mg/L	0.01	<0.01
Calcium	mg/L	1	2
Cadmium	mg/L	0.0001	<0.0001
Chromium	mg/L	0.001	<0.001

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Methods references and/or additional QA/QC information available on request.

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Client Project:	Happy Valley-Goose Bay	**Date Submitted:**	2013-07-19
Purchase Order:	213002094	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1044046	WS-S-0000 Camp Pond Brk	2013-6323-00-SI-SP	2013-07-16	Copper	mg/L	0.001	0.003
				Iron	mg/L	0.03	0.40
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	0.02
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	0.023
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.017
				Uranium	mg/L	0.001	<0.001
				Zinc	mg/L	0.01	<0.01
				Total Suspended Solids	mg/L	2	4

Comment:

Holding time for Turbidity analysis was exceeded.

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Methods references and/or additional QA/QC information available on request.

APPROVAL:

Diana Cameron
Team Leader, Inorganics