Real-Time Water Quality 2014 Annual Report

Lower Churchill River Network

May 29 to November 5, 2014

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

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Acknowledgements

The Real-Time Water Quality (RTWQ) monitoring network on the Lower Churchill River is successful in tracking emerging water quality issues as well as creating a database of baseline water quality data due to the hard work and diligence of certain individuals. The management and staff of Nalcor work in cooperation with the management and staff of the Department of Environment and Conservation (ENVC) as well as Environment Canada (EC) to ensure the protection of ambient water resources in the Lower Churchill River.

ENVC employees have been integral in ensuring the smooth operation of such a technologically advanced network. In 2014, ENVC Environmental Scientist, Maria Murphy, was responsible for deployment and removal of instruments including cleaning, calibration and maintenance, while ENVC Environmental Scientist Kyla Brake was responsible for the preparation of monthly deployment reports. Ryan Pugh, Leona Hyde, Steven Duffy and Kelly Maher are acknowledged for their efforts during deployment and removal procedures in 2014.

EC staff, with the Water Survey of Canada (Brent Ruth, Perry Pretty, Roger Ellsworth, Dwayne Akerman and Mike Ludwicki) play an essential role in the data logging/communication aspect of the network. These individuals visit the site regularly to ensure the data logging equipment is operating properly and transmitting the data efficiently. Finally, they play the lead role in dealing with hydrological quantity and flow issues.

The managers from each agency (Marion Organ/David Haley – Nalcor; Renee Paterson - ENVC; Howie Wills – EC) are fully committed to improving this network and ensuring it provides meaningful and accurate water quality/quantity data that can be used in the decision-making process. Throughout the summer and fall months in 2014, there was continued communication in the form of small meetings and email correspondence between ENVC and Nalcor. This network is continually successful due to the participation and collaboration of all three agencies.

Abbreviations

EC	Environment Canada
ENVC	Department of Environment and Conservation
CRaboveMF	Station at Churchill River above Muskrat Falls
CRbelowGR	Station at Churchill River below Grizzle Rapids
CRbelowMF	Station at Churchill River below Muskrat Falls
CRbelowMR	Station at Churchill River below Metchin River
CRatEP	Station at Churchill River below English Point
DO	Dissolved Oxygen
NL	Newfoundland and Labrador
QAQC	Quality Assurance and Quality Control
RTWQ	Real-Time Water Quality
SC	Specific Conductivity
WRMD	Water Resources Management Division
%Sat	Percent Saturation

History

- The RTWQ monitoring network on the Lower Churchill River was successfully established by ENVC and EC in cooperation with Nalcor Energy in September 2008.
- The objective of the network is to identify and track emerging water quality or quantity management issues and ensure protection of ambient water resources along the Lower Churchill River. The information being collected will serve as a baseline from which changes throughout the several phases of the Lower Churchill Hydroelectric Generation Project can be monitored.
- The original network, established in 2008, consisted of 4 water quality/quantity monitoring stations along the Lower Churchill River from just below the confluence with Metchin River to just below Muskrat Falls. In addition, there were two water quantity monitoring stations on the Churchill River below the Tailrace and above Grizzle Rapids, which strictly recorded stage level continuously along with hydrometric stations on select tributaries to the Churchill River.
- In 2011, ENVC in cooperation with EC established another water quality/quantity monitoring station at the mouth of the Churchill River (Churchill River at English Point). This station is included in this annual report for comparison purposes.
- Continuous monitoring at the five water quality/quantity monitoring stations in the Lower Churchill River Network recommenced in spring 2014. This annual deployment report illustrates, discusses and summarizes water quality related events from May 29 to November 5, 2014. During this time, six visits were made to each of the five RTWQ sites. Instruments were deployed for 4-5 month-long intervals referred to as deployment periods.
- Issues were encountered at several of the stations during the deployment season. Due to the presence of an ice wall at below Grizzle Rapids and a broken helicopter pad at below Muskrat Falls, these two stations were not installed during the initial site visit in May. The below Muskrat Falls station continued to experience issues throughout the season due to the accumulation of sand around the instrument, which was pulled to prevent damage on August 14.
- During the 2014 deployment year, one water quality/quantity monitoring station (Churchill River below Metchin River) and three water quantity monitoring stations (Churchill River above Churchill Falls Tailrace, East Metchin River below Highway Bridge and Minipi River below Minipi Lake) were ‘mothballed’ or discontinued as per changes to the Memorandum of Agreement between ENVC and Nalcor. An additional water quantity monitoring station (Churchill River Mid Pool) was added to the agreement in 2014.
- Construction at the Muskrat Falls Hydroelectric Generation site began in 2013. In 2014, construction continued on the worksite with progress on the powerhouse and spillway. Site water controls at Muskrat Falls continue to direct run-off flows to one of two discharge points either above or below the lower falls. Significant forestry activity continues, including transmission line and reservoir clearing. Construction is scheduled to continue until 2017.
- The Muskrat Falls construction site weather station was successfully installed in July 2014.

Maintenance and Calibration

- It is recommended that regular maintenance and calibration of the instruments take place on a monthly basis to ensure accurate data collection. This procedure is the responsibility of the ENVC staff and is performed preferably every 30 days.
- Maintenance includes a thorough cleaning of the instrument and replacement of any small sensor parts that are damaged or unsuitable for reuse. Once the instrument is cleaned, ENVC staff carefully calibrates each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity.
- An extended deployment period (>30 days) can result in instrument sensor drift which may result in skewed data. The instrument sensors will still work to capture any water quality event even though the exact data values collected may be inaccurate. Installation and removal dates for each station in the 2014 deployment season are summarized in Table 1.

Table 1: Installation and removal dates for 2014 deployment periods

Installation	Removal	Deployment
May 29	June 25	26 days
June 25	July 22/23	27-28 days
July 22/23	August 12/14	20-21 days
August 12/14	Sept 30/Oct 1	47-49 days
October 1	Nov 5	34 days

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 alongside 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 2).

Table 2: Ranking classifications for deployment and removal

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

- It should be noted that the temperature sensor on any instrument is the most important. All other parameters can be broken down into three groups: temperature dependent, 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.
- Comparison rankings for the Lower Churchill River stations, deployed for five deployment periods from May 29 to November 5, 2014, are summarized in Table 3.

  For additional information and explanations of rankings including "n/a" rankings, please refer to the monthly deployment reports.

Table 3: Comparison rankings for Lower Churchill River stations, May 29 – November 5, 2013

Station	Date	Action	Instrument #	Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	May 29	Deployment	45707	Good	Excellent	Excellent	Excellent	Excellent
	June 25	Removal		Instrument out of the water upon retrieval				
	June 25	Deployment	45701	Excellent	Good	Excellent	Excellent	Excellent
	July 22	Removal		Excellent	Excellent	Excellent	Excellent	Excellent
	July 22	Deployment	45042	Excellent	Good	Excellent	Excellent	Excellent
	Aug 12	Removal		Excellent	Good	Excellent	Excellent	Excellent
	Aug 12	Deployment	45709	Excellent	Good	Excellent	Excellent	Excellent
	Sept 30	Removal		Excellent	Poor	Excellent	Excellent	Excellent
	Sept 30	Deployment	n/a	Station Discontinued September 30, 2014				
	Nov 5	Removal						
Below Grizzle Rapids	May 29	Deployment	n/a	Not deployed due to ice wall limiting access to station				
	June 25	Removal						
	June 25	Deployment	45709	Fair	Good	Excellent	Excellent	Excellent
	July 22	Removal		Good	Excellent	Excellent	Excellent	Excellent
	July 22	Deployment	47384	Excellent	Good	Excellent	Excellent	Excellent
	Aug 12	Removal		Good	Good	Excellent	Excellent	Excellent
	Aug 12	Deployment	45699	Good	Excellent	Excellent	Excellent	Excellent
	Oct 1	Removal		Excellent	Excellent	Excellent	Good	Excellent
	Oct 1	Deployment	45701	Fair	Good	Excellent	Fair	Excellent
	Nov 5	Removal		Excellent	Poor	Good	Excellent	Excellent
Above Muskrat Falls	May 29	Deployment	47590	Good	Excellent	Excellent	Excellent	Excellent
	June 25	Removal		Instrument out of the water upon retrieval				
	June 25	Deployment	45708	Excellent	Excellent	Excellent	Excellent	Good
	July 23	Removal		Excellent	Poor	Excellent	Excellent	Excellent
	July 23	Deployment	45700	Excellent	Excellent	Excellent	Excellent	Good
	Aug 14	Removal		Excellent	Excellent	Excellent	Poor	Poor
	Aug 14	Deployment	45708	Excellent	Excellent	Excellent	n/a	Good
	Oct 1	Removal		Good	Good	Excellent	Good	Poor
	Oct 1	Deployment	45700	Good	Good	Excellent	Good	Excellent
	Nov 5	Removal		Fair	Excellent	Excellent	Excellent	Excellent
Below Muskrat Falls	May 29	Deployment	n/a	Station inaccessible due to broken helicopter landing pad				
	June 25	Removal						
	June 25	Deployment	47500	Excellent	Excellent	Excellent	Excellent	Good
	July 23	Removal		Instrument buried in sand				
	July 23	Deployment	47590	Excellent	Poor	Excellent	Excellent	Good
	Aug 14	Removal		Instrument buried in sand				
	Aug 14	Deployment	n/a	Instrument not deployed due to issues with excessive sand at the station				
	Oct 1	Removal						
	Oct 1	Deployment	n/a	Instrument not deployed due to issues with excessive sand at the station				
	Nov 5	Removal						
At English Point	May 29	Deployment	45042	Excellent	Poor	Excellent	Good	Excellent
	June 25	Removal		Excellent	Fair	Poor	Excellent	Good
	June 25	Deployment	45699	Excellent	Excellent	Excellent	Excellent	Fair
	July 23	Removal		Excellent	Poor	Excellent	Excellent	Good
	July 23	Deployment	45701	Good	Fair	Excellent	Good	Good
	Aug 14	Removal		Excellent	Good	Excellent	Good	Poor

	Aug 14	Deployment	45042	Excellent	Good	Excellent	Excellent	Good
	Oct 1	Removal		Good	Excellent	Excellent	Good	Good
	Oct 1	Deployment	47384	Excellent	Fair	Excellent	Excellent	Poor
	Nov 5	Removal		Good	Good	Excellent	Excellent	Good

Data Interpretation and Review

- The following graphs and discussion illustrate significant water quality-related trends from May 29 to November 5 in the Lower Churchill River Network. In this summary of the deployment periods for 2014, general patterns will be discussed. More detailed analysis and discussion of specific events can be found in the monthly deployment reports.
- 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.
- For a general comparison, 2012 and 2013 data has been included in the following graphs to show differences in trends in water quality on the Lower Churchill River over the past 3 years.
- Summary statistics are calculated using the entire data set. This means that the number of values used to calculate the median, min and max vary from year to year depending on the length of the deployment season. The 2014 deployments season was 156 days long while the 2013 and 2012 seasons used for comparison purposes in this report are 169 and 131 days each, respectively.

Churchill River below Metchin River

- Water temperature ranges from 4.1°C to 20.4°C during the 2014 deployment season, with a median value of 16.1°C (Figure 1).
- Water temperatures appear slightly warmer in 2014, especially in the spring and summer seasons when compared to data collected in previous years. Water temperatures cooled very rapidly in September before the station was 'mothballed' on September 30.

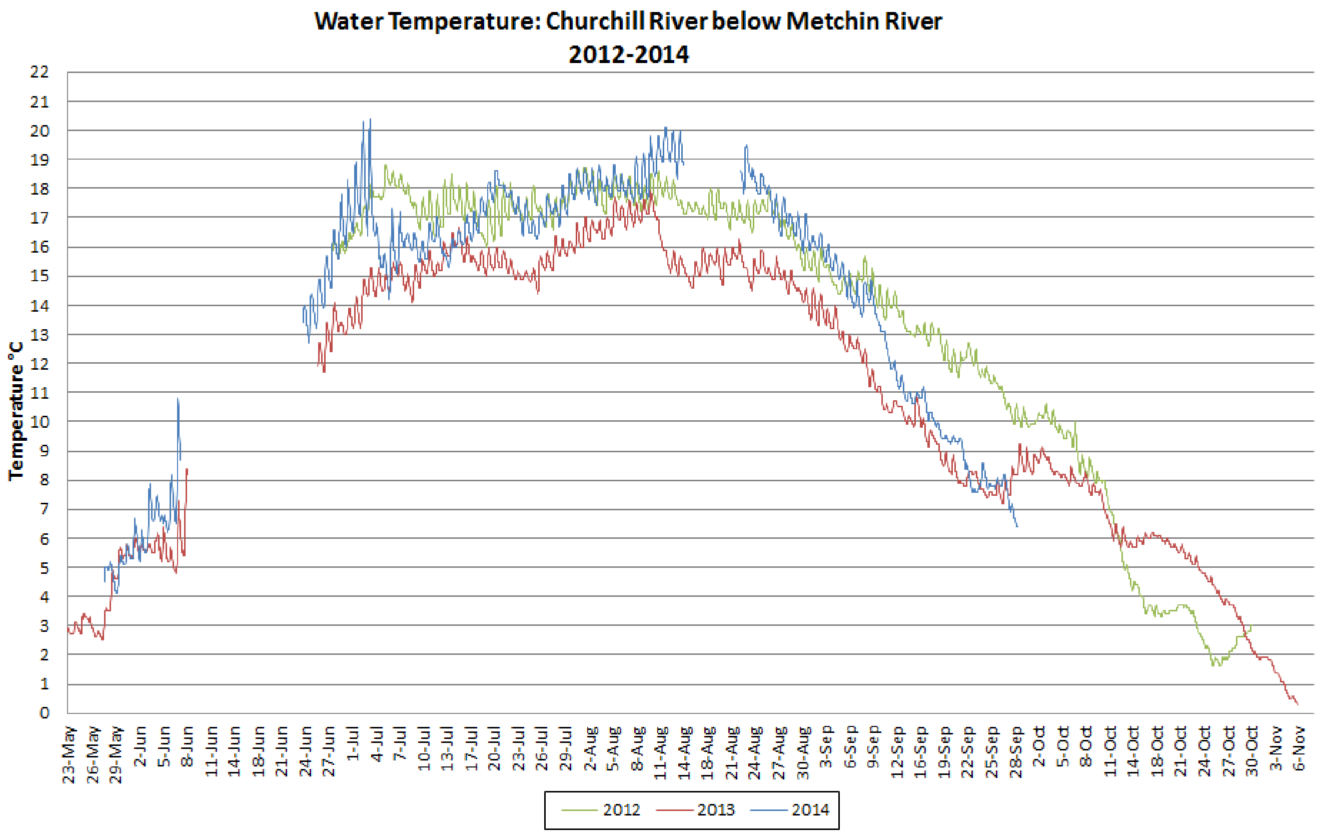

Figure 1: Water temperature at Churchill River below Metchin River

Temperature	2014	2013	2012
Median	16.1	11.7	16.0
Max	20.4	17.9	18.8
Min	4.1	0.3	1.6

- Water temperature values show a typical seasonal trend (Figure 2). Water and air temperatures are increasing throughout the spring and early summer with water temperatures peaking in mid August. Average air and water temperatures decrease throughout the late summer and into fall.

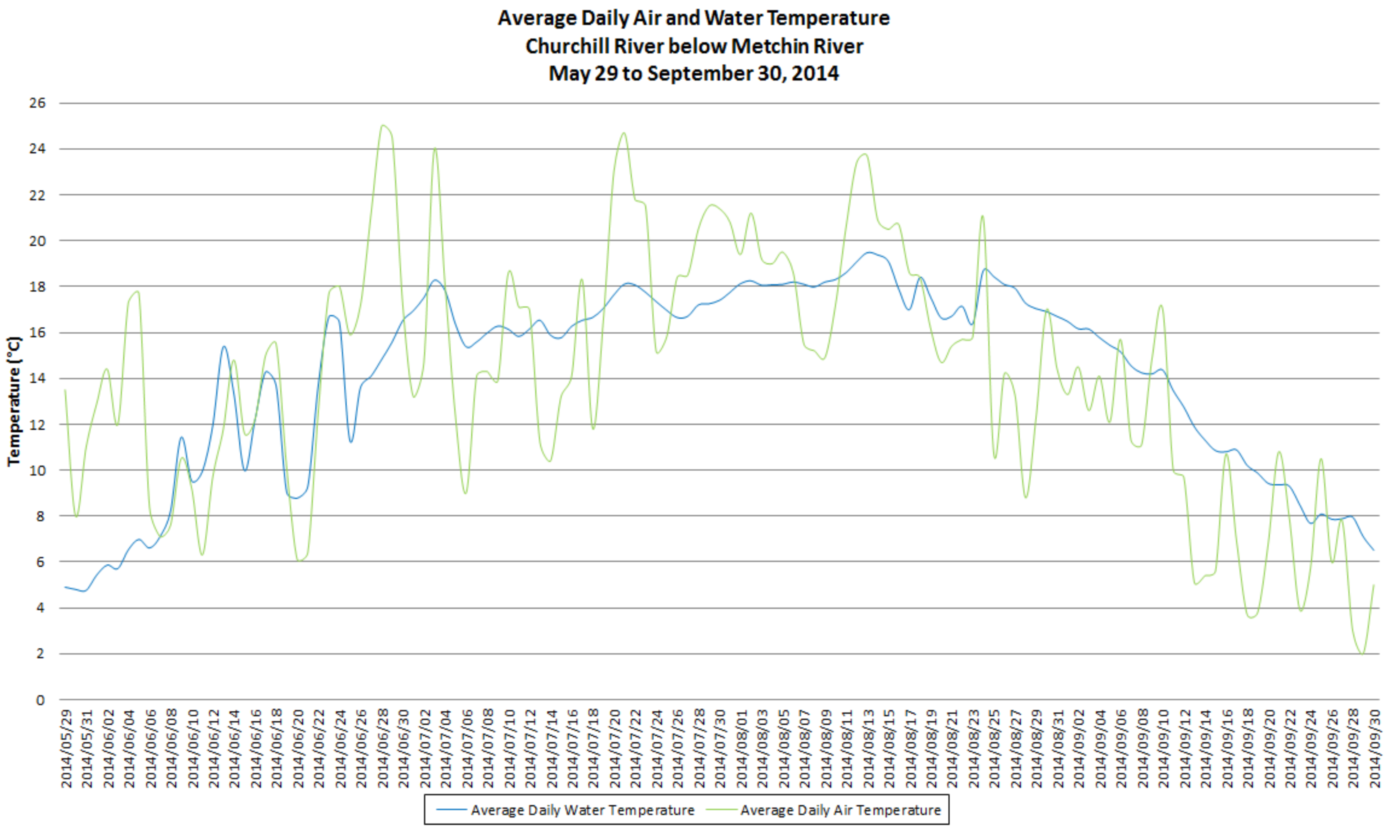

Figure 2: Average daily air and water temperatures at Churchill River below Metchin River (weather data recorded at Happy Valley – Goose Bay due to extensive missing data from Churchill Falls station in 2014)

- pH ranges between 6.04 and 7.30 pH units during the 2014 deployment season, with a median value of 7.04 pH units (Figure 3).
- pH values are relatively consistent throughout the deployment period. There are increased pH fluctuations from August to September.
- All values during the 2014 deployment season are within the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units), with the exception of values recorded during a slow sensor acclimation period after initial deployment. The guidelines are indicated in red on Figure 3.
- pH values appear to be slightly lower in the 2014 season when compared to data from 2012 and 2013.

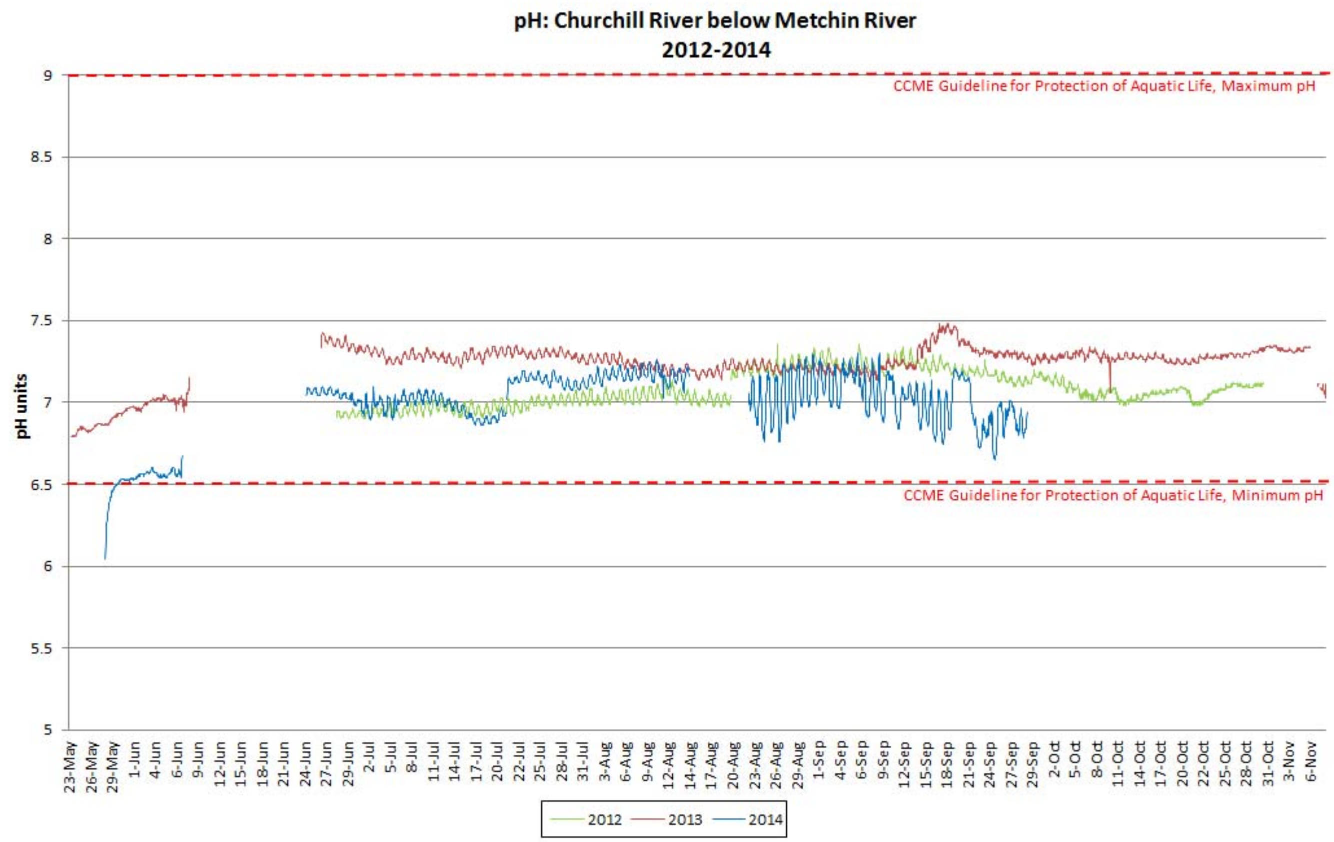

Figure 3: pH at Churchill River below Metchin River

pH (units)	2014	2013	2012
Median	7.04	7.27	7.06
Max	7.30	7.48	7.36
Min	6.04	6.79	6.90

- Specific conductivity ranges from 14.4µS/cm to 32.9µS/cm during the 2014 deployment season, with a median value of 19µS/cm (Figure 4).
- Specific conductance increases gradually throughout the spring and early summer before levelling off in August and then decreasing steadily through September.
- Increases and decreases in specific conductivity are most times clearly related to fluctuations in stage. As stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases. Inversely, when stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column.
- Specific conductivity values are slightly lower than in 2012 and 2013, but follow the same trend as the previously collected data.

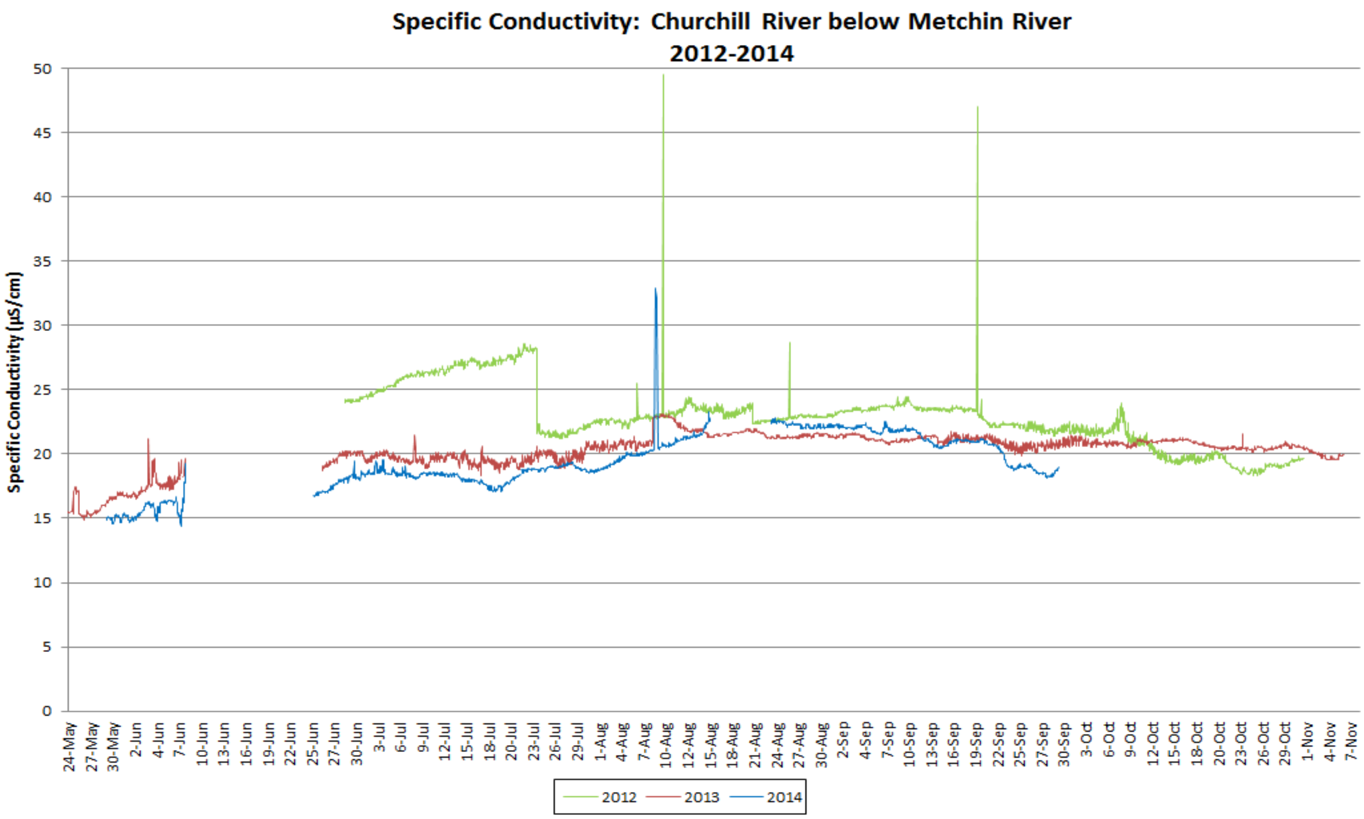

Figure 4: Specific conductivity at Churchill River below Metchin River

Specific Conductivity (µS/cm)	2014	2013	2012
Median	19.0	20.6	22.8
Max	32.9	23.1	49.5
Min	14.4	14.9	18.3

- Throughout the 2014 deployment season, dissolved oxygen ranges from 8.71mg/l to 12.21mg/l, with a median value of 9.37mg/l, while percent saturation ranges from 90.5% to 104.6%, with a median value of 94.7% (Figure 5).
- Dissolved oxygen content shows a typical seasonal fluctuation in 2014. Dissolved oxygen content fluctuates regularly on a daily basis. Percent saturation remains stable throughout the entire deployment season, fluctuating on a daily basis.
- All values were above the minimum CCME Guideline for the Protection of Aquatic Life at Other Life Stages (6.5 mg/l). Between July and early September during the warmest part of the deployment season, dissolved oxygen content is at or just below the minimum CCME Guideline for the Protection of Aquatic life at Early Life Stages (9.5mg/l). In September as air and water temperatures cool, the dissolved oxygen content increases above 9.5mg/l. The guidelines are indicated in red on Figure 5.
- Dissolved oxygen and percent saturation values are similar to values collected in 2012 and 2013 (Figure 5). The 2014 data is lower than previous years during late July to late August, corresponding to warmer than normal water temperatures during this time period.

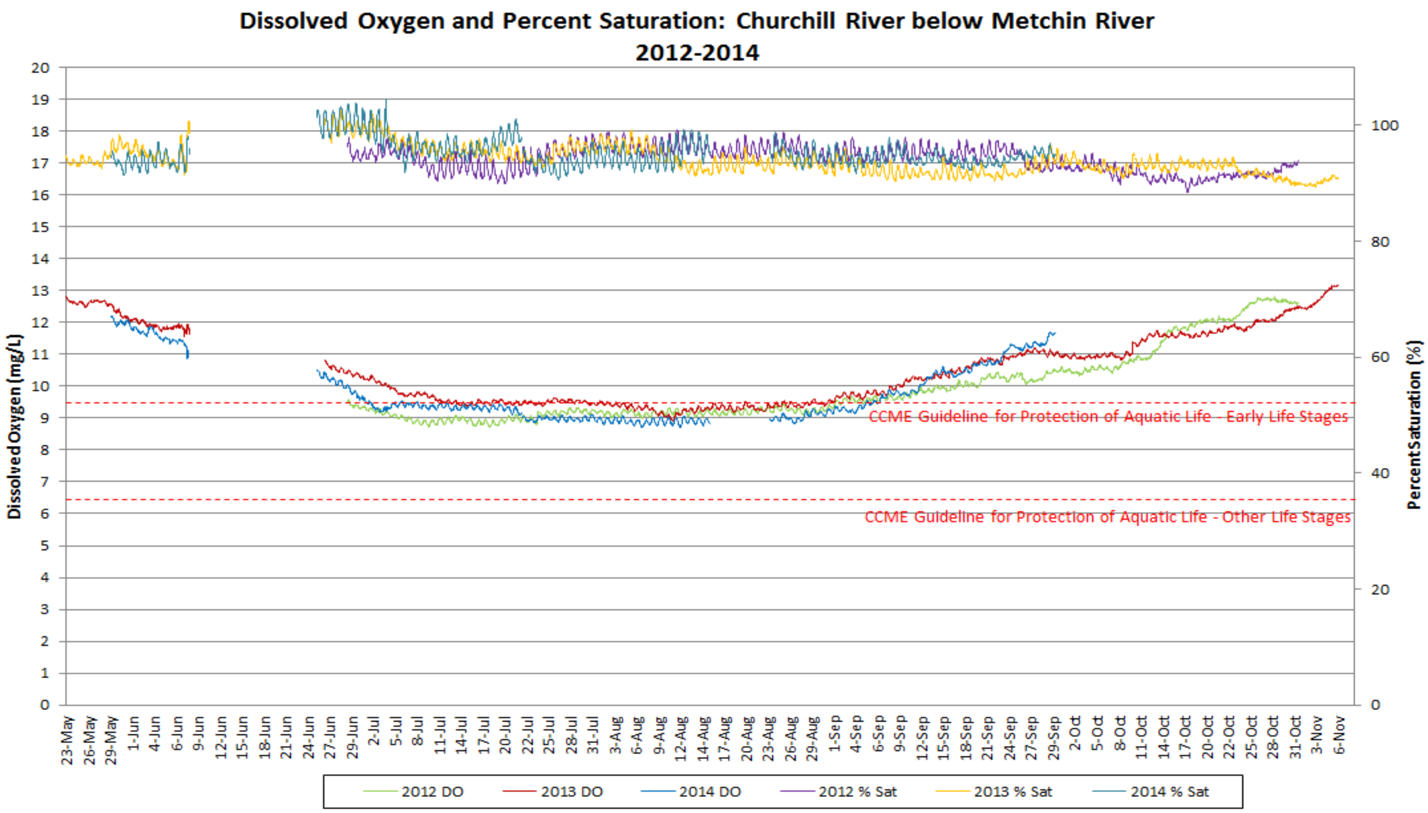

Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

Dissolved Oxygen (mg/L)	2014	2013	2012		Percent Saturation (%)	2014	2013	2012
Median	9.37	10.28	9.38		**Median**	94.7	93.6	94.5
Max	12.21	13.17	12.8		**Max**	104.6	102.7	99.3
Min	8.71	8.88	8.72		**Min**	90.5	89.3	88.4

- Turbidity generally remains at 0NTU for the majority of the deployment season (Figure 6). A median value of 0NTU from 2012-14 indicates there is no natural background turbidity at this station.
- There are a couple of instances where turbidity increases (to as high as 35.4NTU) for very short periods of time (1-3 hours). These are not considered water quality events as they are isolated and infrequent occurrences. In the beginning of June there are a number of turbidity spikes that occur as the water levels were decreasing rapidly. This decrease in stage left the instrument exposed to air on the river's edge from June 8 – 25.
- When 2014 values are compared to 2012 and 2013 values for the same time period, a similar trend is observed with background levels at 0NTU. Numerous short lived increases occurred throughout the season.

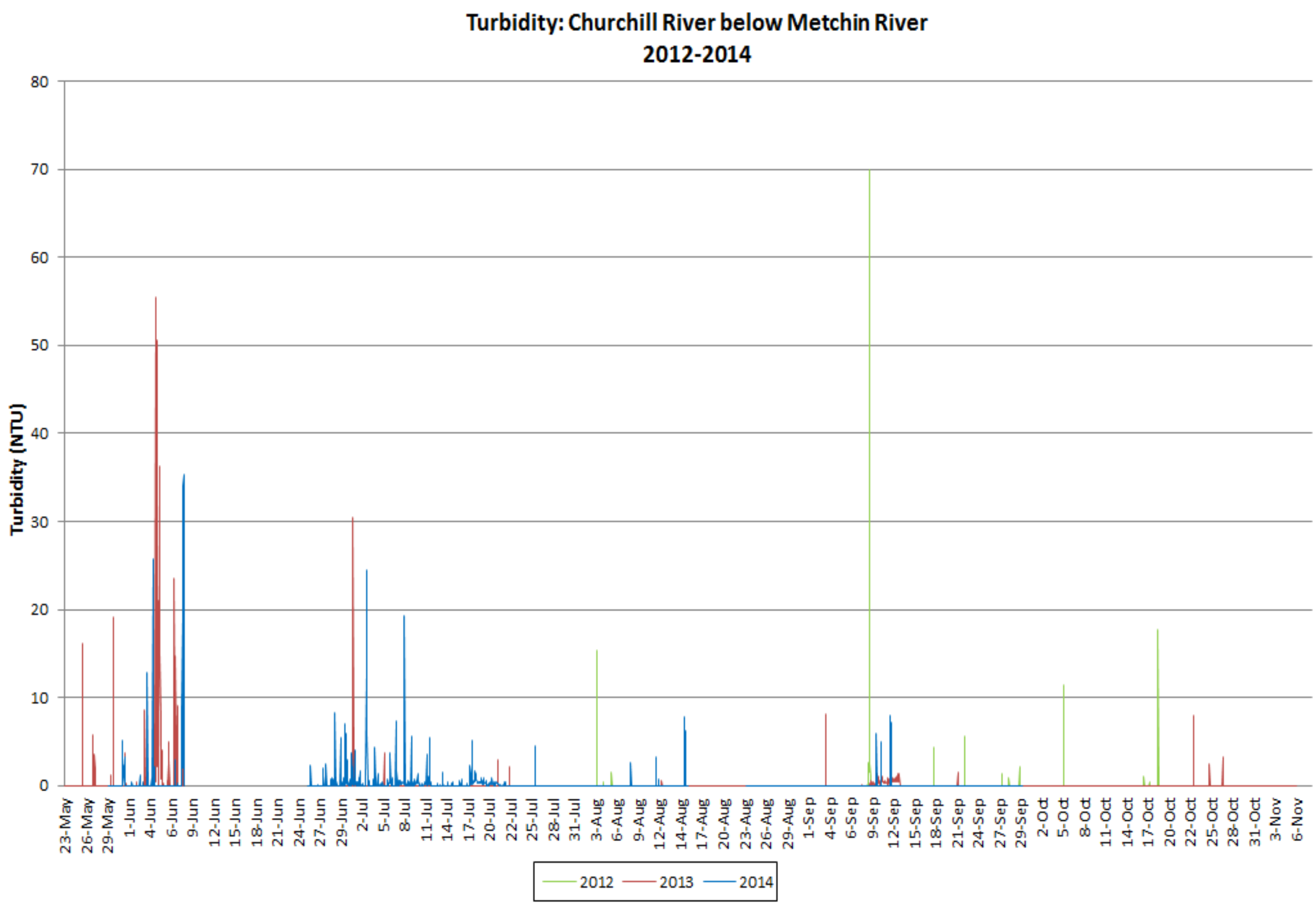

Figure 6: Turbidity at Churchill River below Metchin River

Turbidity (NTU)	2014	2013	2012
Median	0	0	0
Max	35.4	55.5	69.9
Min	0	0	0

- Stage levels in 2014 decreased rapidly in the spring before leveling off in the summer months, reaching a seasonal low mid-August, before increasing into the fall months (Figure 7).
- Stage levels from 2012-2014 are graphed below to show how stage levels vary throughout the season and from year to year. The seasonal low of 2014 was reached in mid-August and was lower than levels reached in 2012 or 2013. Stage ranges between 1.53m and 2.76m each year.

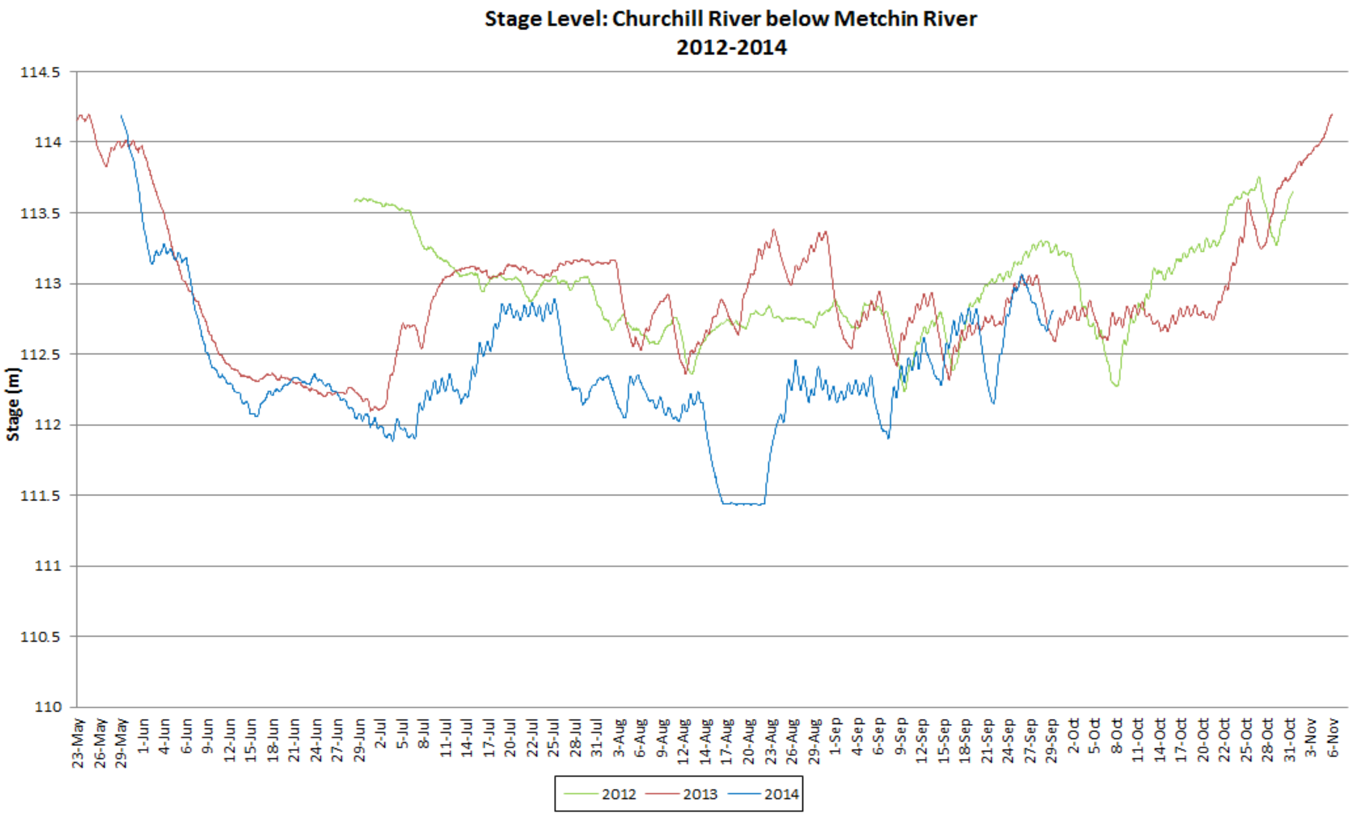

Figure 7: Stage level at Churchill River below Metchin River

Stage (m)	2014	2013	2012
Median	112.283	112.832	112.932
Max	114.192	114.197	113.758
Min	111.430	112.093	112.232
Range	2.762	2.104	1.526

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 8).
- Stage is decreasing rapidly in the first month of the deployment season. Stage increases in July before dropping to the season's minimum in August, then increases steadily into the fall season.
- Precipitation events are frequent and range from low to high in magnitude.

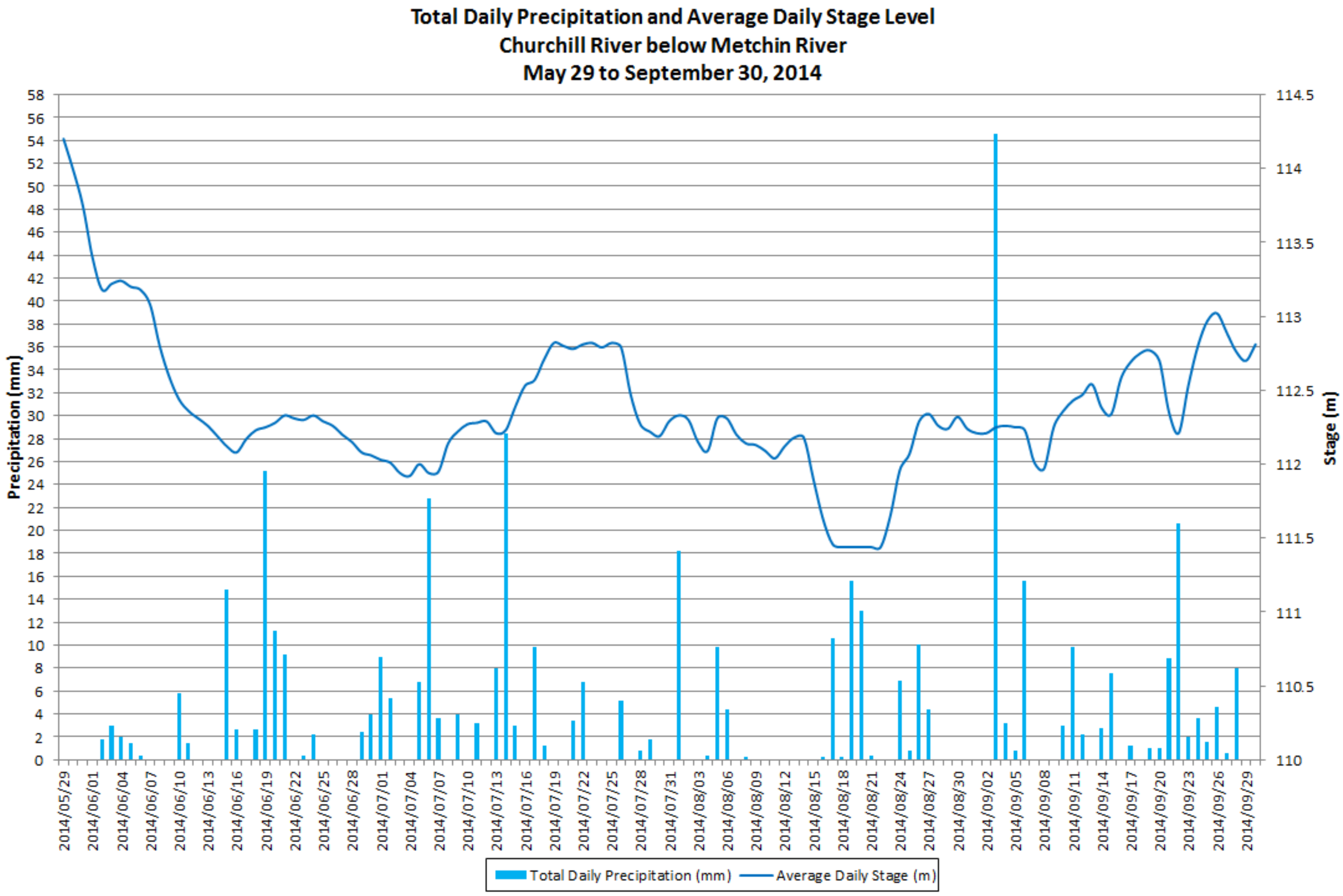

Figure 8: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Happy Valley – Goose Bay due to extensive missing data from Churchill Falls station in 2014)

Churchill River below Grizzle Rapids

- Water temperature ranges from 3.8°C to 21.9°C during the 2014 deployment season, with a median value of 14.7°C (Figure 9).
- Water temperatures during spring and summer were warmer in 2014 than in 2013, but were on par with 2012 temperatures. Temperature trends into the fall months are similar for all three years.

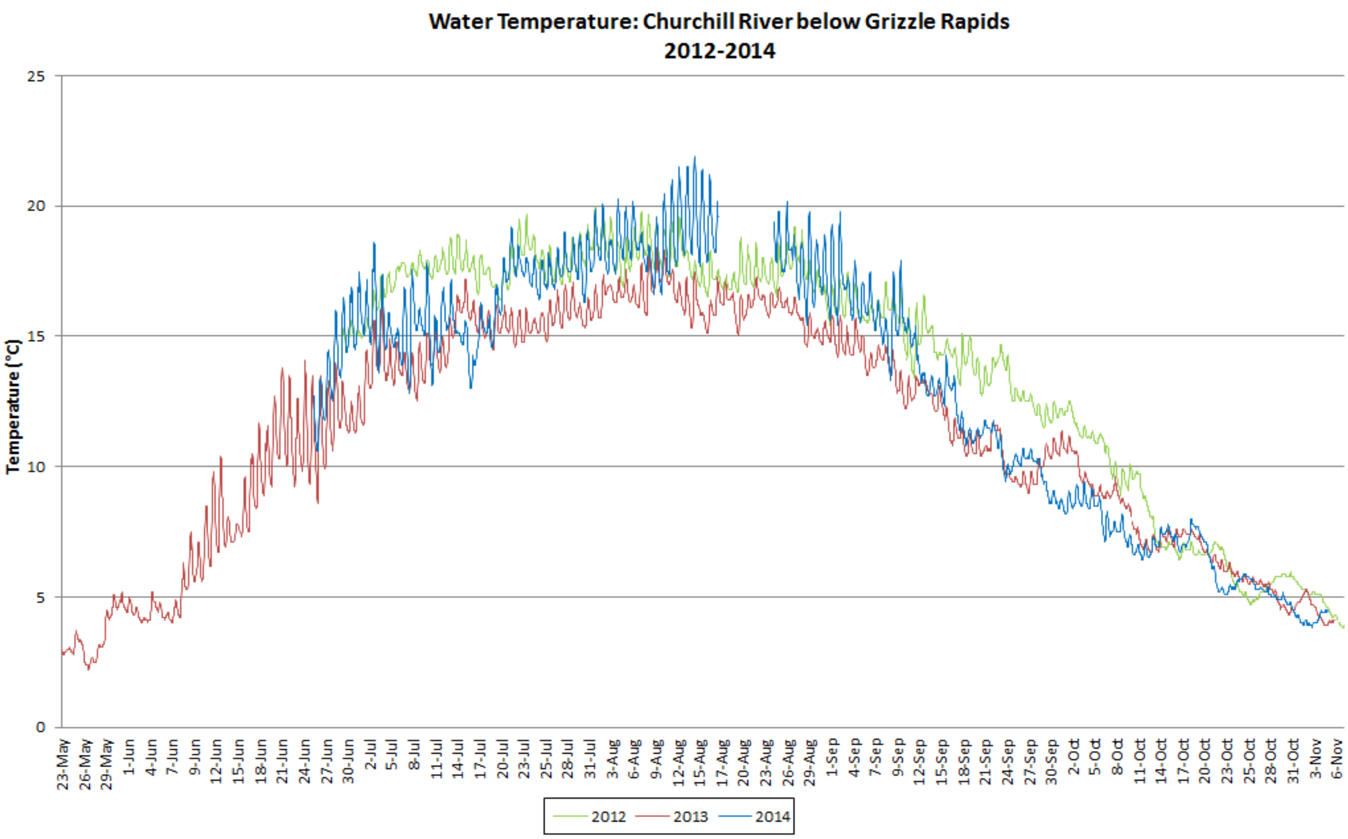

Figure 9: Water temperature at Churchill River below Grizzle Rapids

Temperature	2014	2013	2012
Median	14.7	11.6	15.9
Max	21.9	18.4	20.0
Min	3.8	2.2	3.8

- Water temperature values show a typical seasonal trend (Figure 10). Water and air temperatures are increasing throughout the spring and summer with water temperatures peaking in August before steadily decreasing into the fall months.

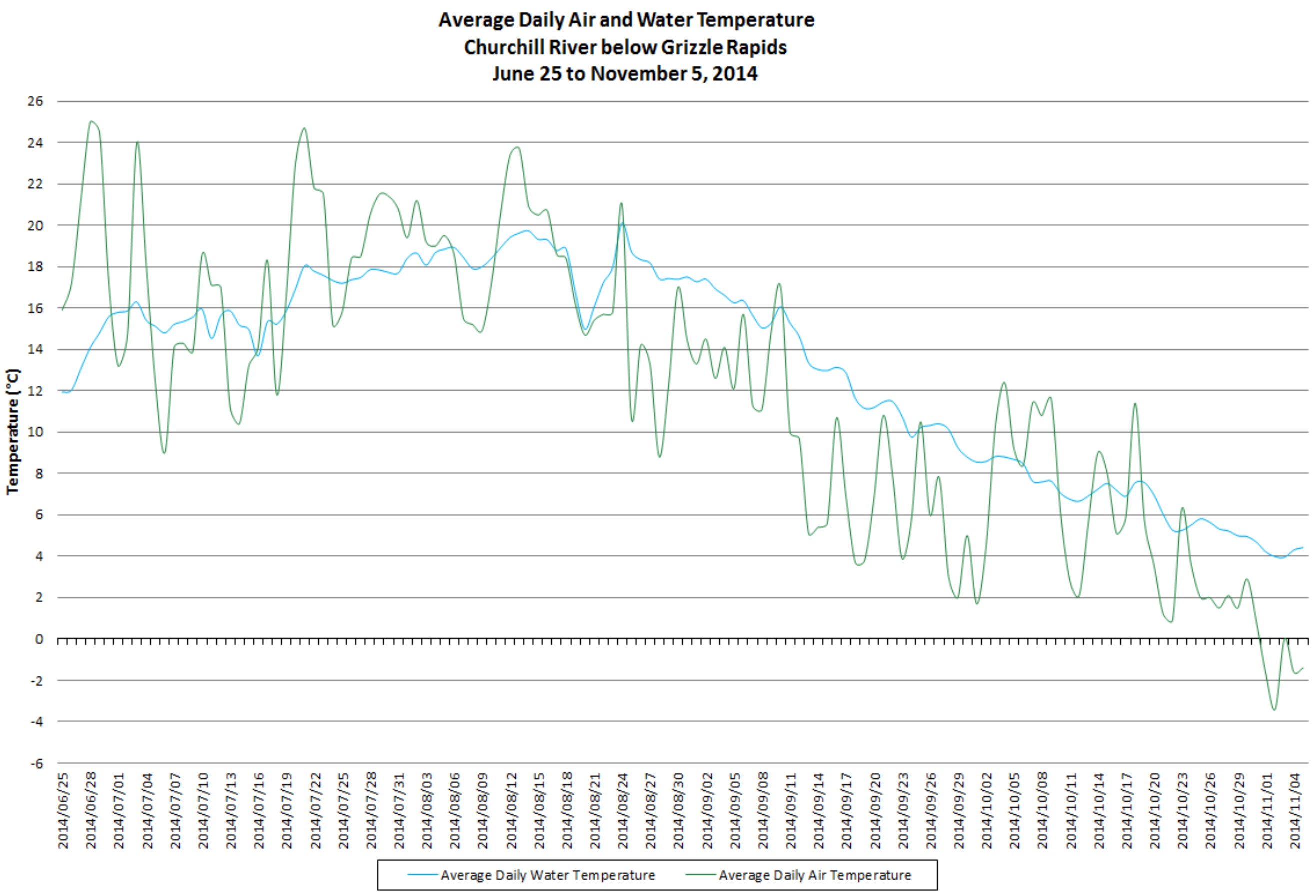

Figure 10: Average daily air and water temperatures at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

- pH ranges between 6.52 and 7.50 pH units during the 2014 deployment season, with a median value of 7.09 pH units (Figure 11).
- pH values are consistent throughout the deployment season with a clear diurnal fluctuation. A drop in pH values during the last week of September is lower than expected and is likely from a sensor issue.
- All values during the 2014 deployment season are within the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). The guidelines are indicated in red on Figure 11.
- pH values in 2014 are very similar to data collected in 2012 and 2013.

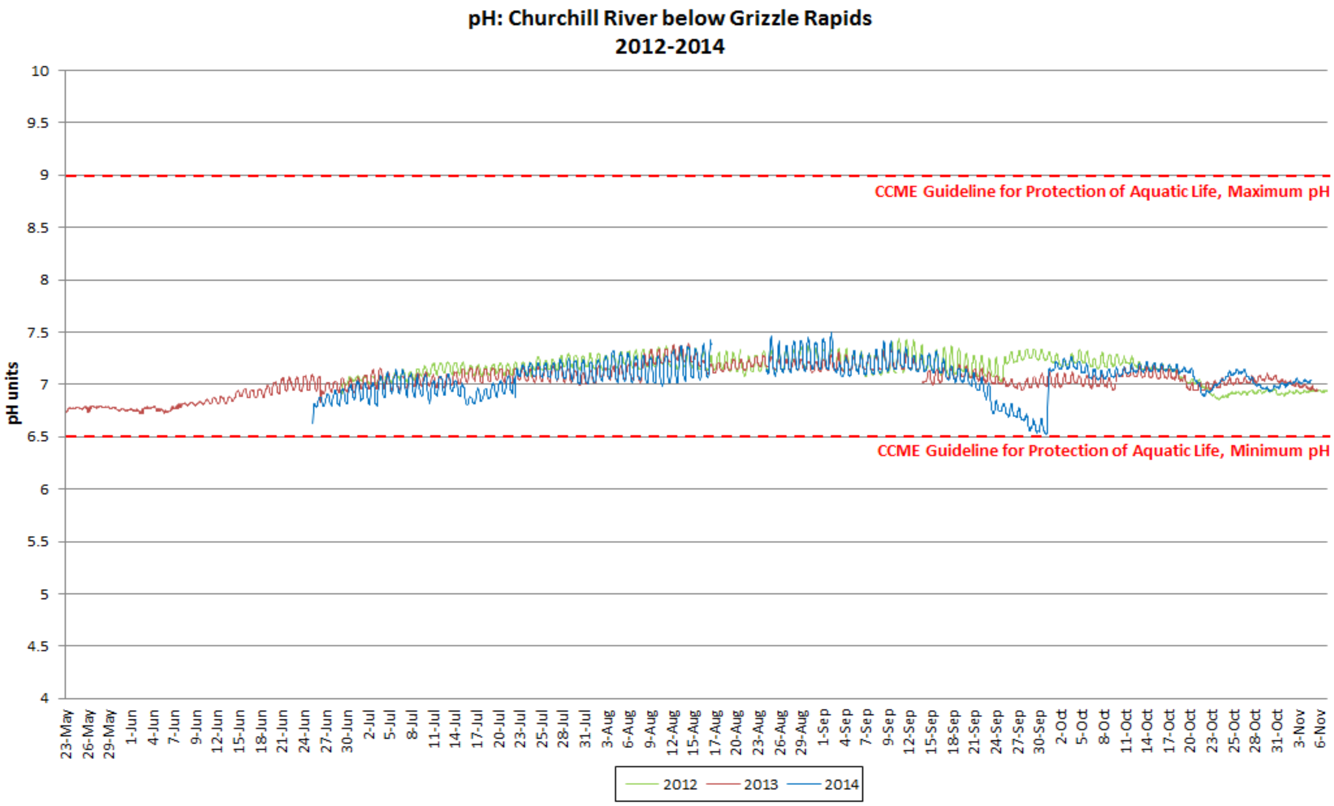

Figure 11: pH at Churchill River below Grizzle Rapids

pH (units)	2014	2013	2012
Median	7.09	7.05	7.17
Max	7.50	7.39	7.44
Min	6.52	6.72	6.85

- Specific conductivity ranges from 14.4µS/cm to 21.9µS/cm during the 2014 deployment season, with a median value of 18.0µS/cm (Figure 12).
- Specific conductivity is increasing in the spring and early summer, peaking in late August. Specific conductivity then begins to decrease slowly throughout the remainder of the deployment season into the fall months.
- Increases and decreases in specific conductivity are most times clearly related to fluctuations in stage. As stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases. Inversely, when stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column.
- Specific conductivity trends in 2012 and 2013 are somewhat similar, increasing throughout the summer when stage is typically decreasing and decreasing again in the fall season when stage typically increases. The majority of 2014 values are slightly lower than the previous two years, reaching lower median and maximum values.

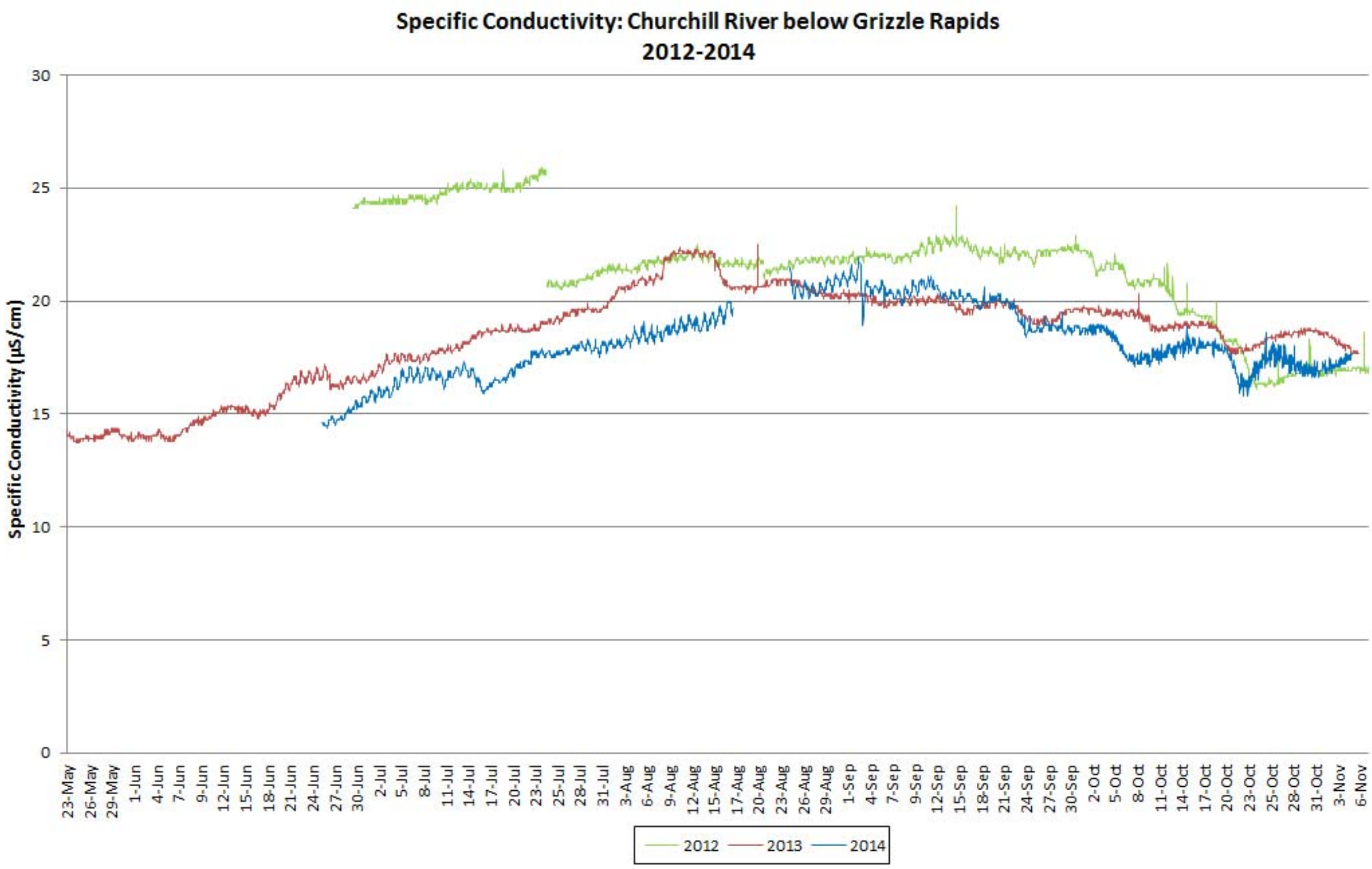

Figure 12: Specific conductivity at Churchill River below Grizzle Rapids

Specific Conductivity (µS/cm)	2014	2013	2012
Median	18.0	18.9	21.8
Max	21.9	22.5	25.9
Min	14.4	13.7	16.1

- During the 2014 deployment season, dissolved oxygen ranges from 8.70mg/l and 12.11mg/l, with a median value of 9.92mg/l, while percent saturation ranges from 89.4% to 105.9%, with a median value of 95.8% (Figure 13).
- Dissolved oxygen content shows a typical seasonal fluctuation in 2014. Dissolved oxygen content fluctuates regularly on a daily basis but is notably lower than in the previous two years. Percent saturation is generally consistent throughout the deployment season.
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5 mg/l). During late July to early September, dissolved oxygen values hovered around the minimum CCME Guideline for the Protection of Aquatic life at Early Life Stages (9.5mg/l), coinciding with warm temperatures recorded at this time which decrease the amount of oxygen the water can hold. As air and water temperatures cool into the fall, the dissolved oxygen content increases above 9.5mg/l. The guidelines are indicated in red on Figure 13.
- Dissolved oxygen and percent saturation values are comparable to the data collected in 2012 and 2013.

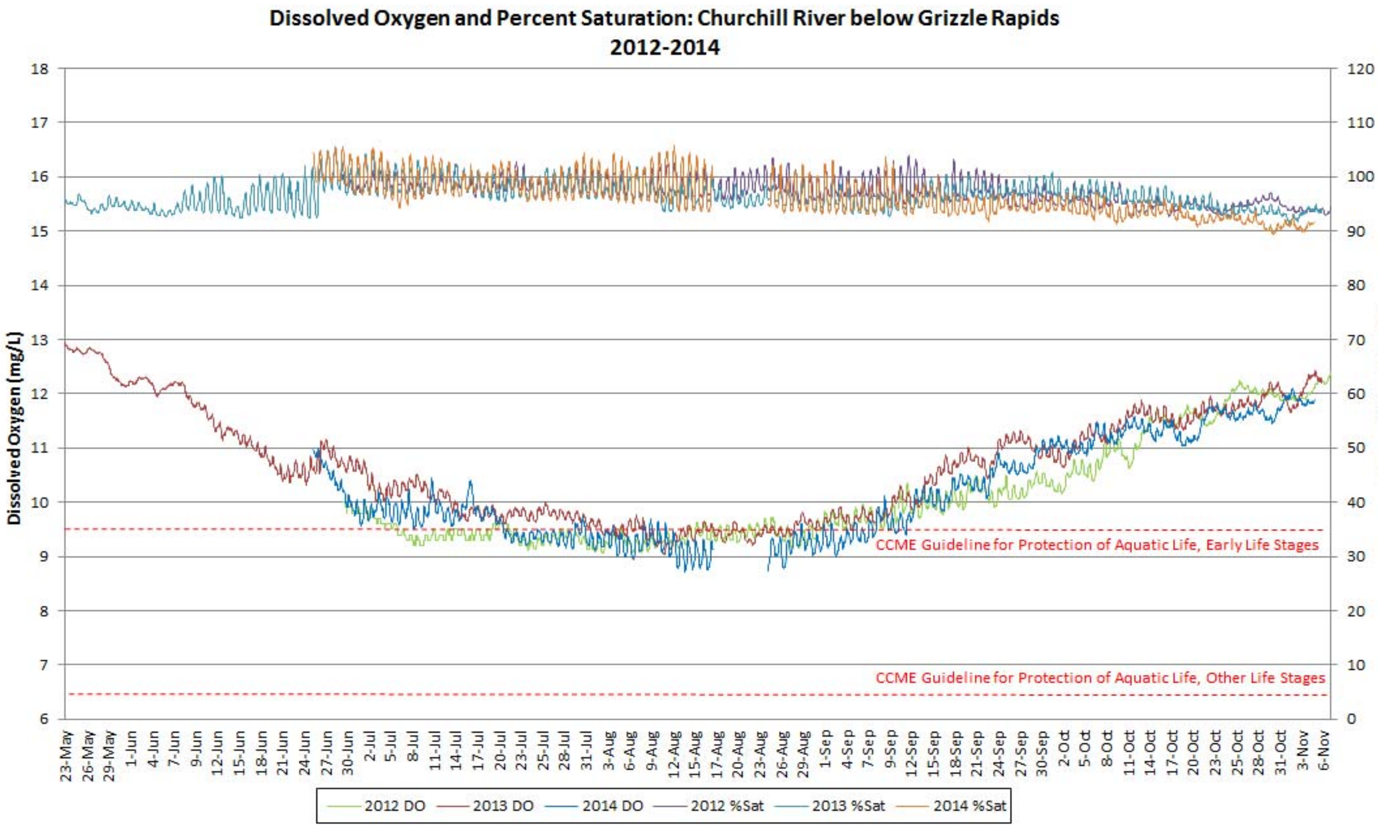

Figure 13: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

Dissolved Oxygen (mg/L)	2014	2013	2012		Percent Saturation	2014	2013	2012
Median	9.92	10.63	9.72		Median	95.8	96.3	97.2
Max	12.11	12.95	12.41		Max	105.9	105.2	103.9
Min	8.70	9.04	9.06		Min	89.4	91.4	92.6

- Turbidity generally remains at 0NTU for the majority of the 2014 deployment season (Figure 14). A median value of 0 NTU from 2012 to 2014 indicates there is no natural background turbidity value at this station.
- There are a couple of instances where turbidity increases minimally in 2014 to as high as 161.2NTU for very short periods of time (1-5 hours). These are not considered water quality events as they are isolated and infrequent occurrences, likely caused by debris interfering with the turbidity sensor.
- Similar trends have been identified in the 2012 and 2013 datasets for this station.

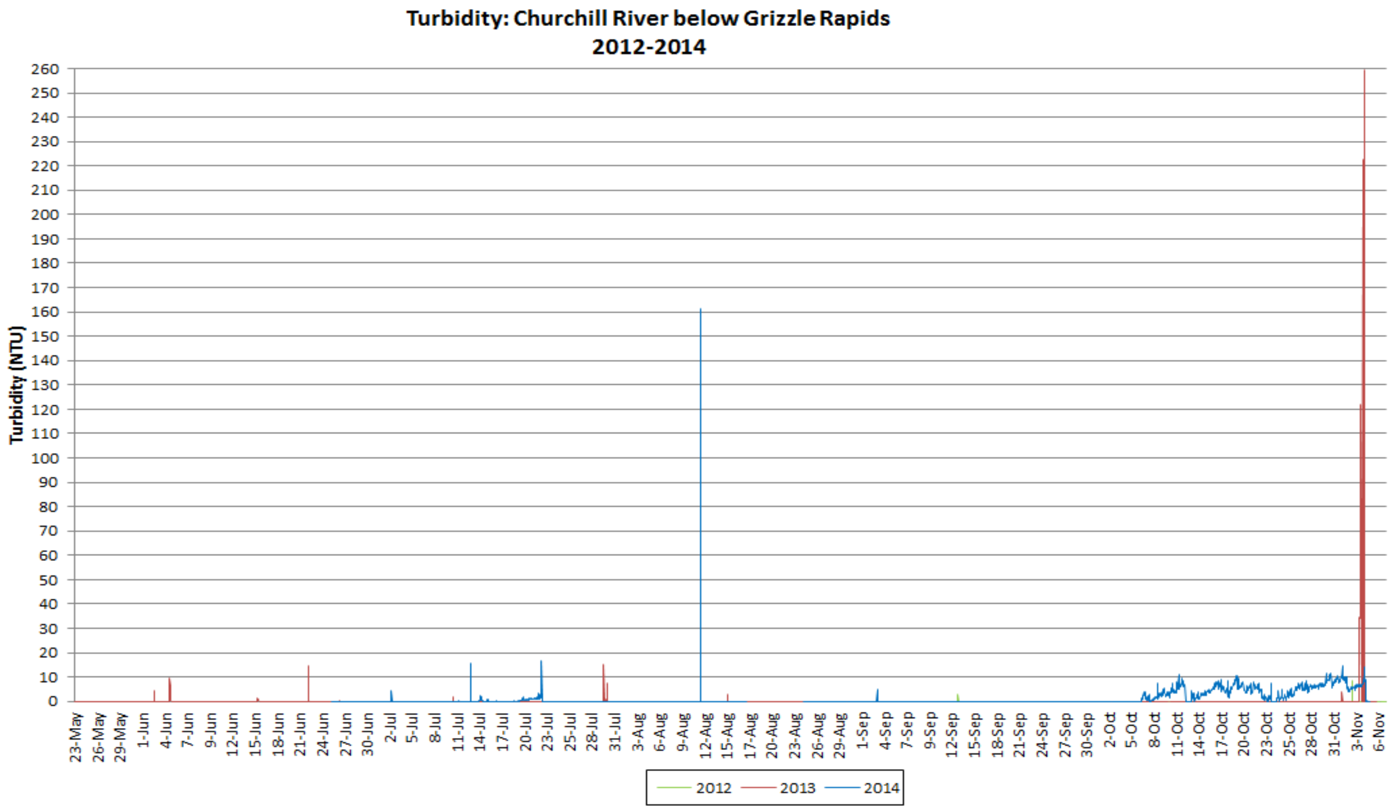

Figure 14: Turbidity at Churchill River below Grizzle Rapids

Turbidity (NTU)	2014	2013	2012
Median	0	0	0
Max	161.2	259.4	8.3
Min	0	0	0

- Stage levels in 2014 decreased after the spring freshet, before rising again slightly due to precipitation events in July and dropping to a seasonal low in mid-August (Figure 15). Stage levels rose steadily into the fall months.
- Stage levels from 2012-2014 are graphed below to show how stage levels vary throughout the season and from year to year. The seasonal low of 2014 was reached in mid-August and was significantly lower than levels reached during the 2012 and 2013 seasons. Stage ranges between 0.74m and 1.02m each year.

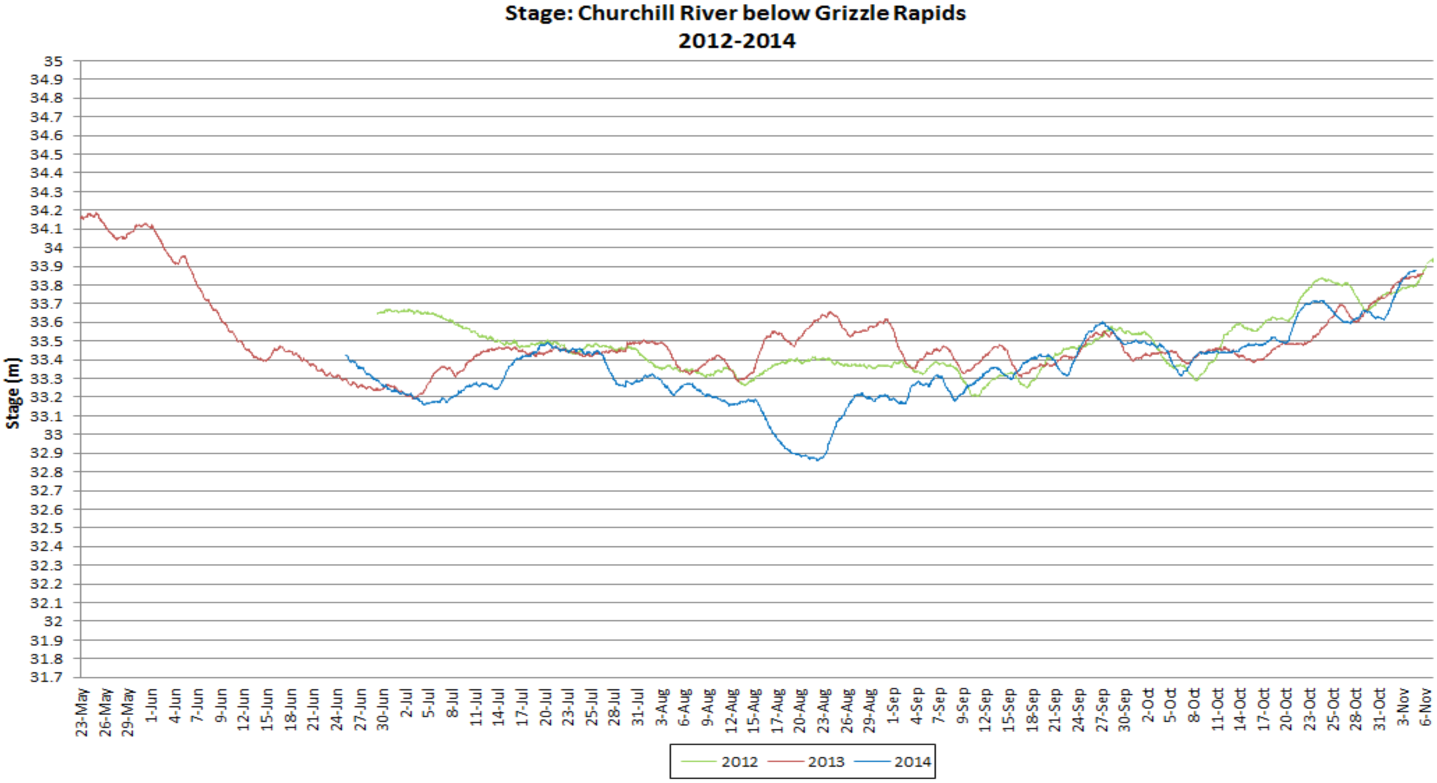

Figure 15: Stage level at Churchill River below Grizzle Rapids

Stage (m)	2014	2013	2012
Median	33.327	33.448	33.461
Max	33.878	34.189	33.941
Min	32.860	33.190	33.201
Range	1.018	0.999	0.740

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 16).
- Stage is decreasing in the first week of the deployment season, as expected after the spring freshet. Stage increases in early to late July, before decreasing to a seasonal low in mid-August. Numerous precipitation events cause stage levels to increases steadily into fall. Water levels at this station do not fluctuate as greatly when compared to other stations in the network.
- Precipitation events are frequent and range from low to high in magnitude.

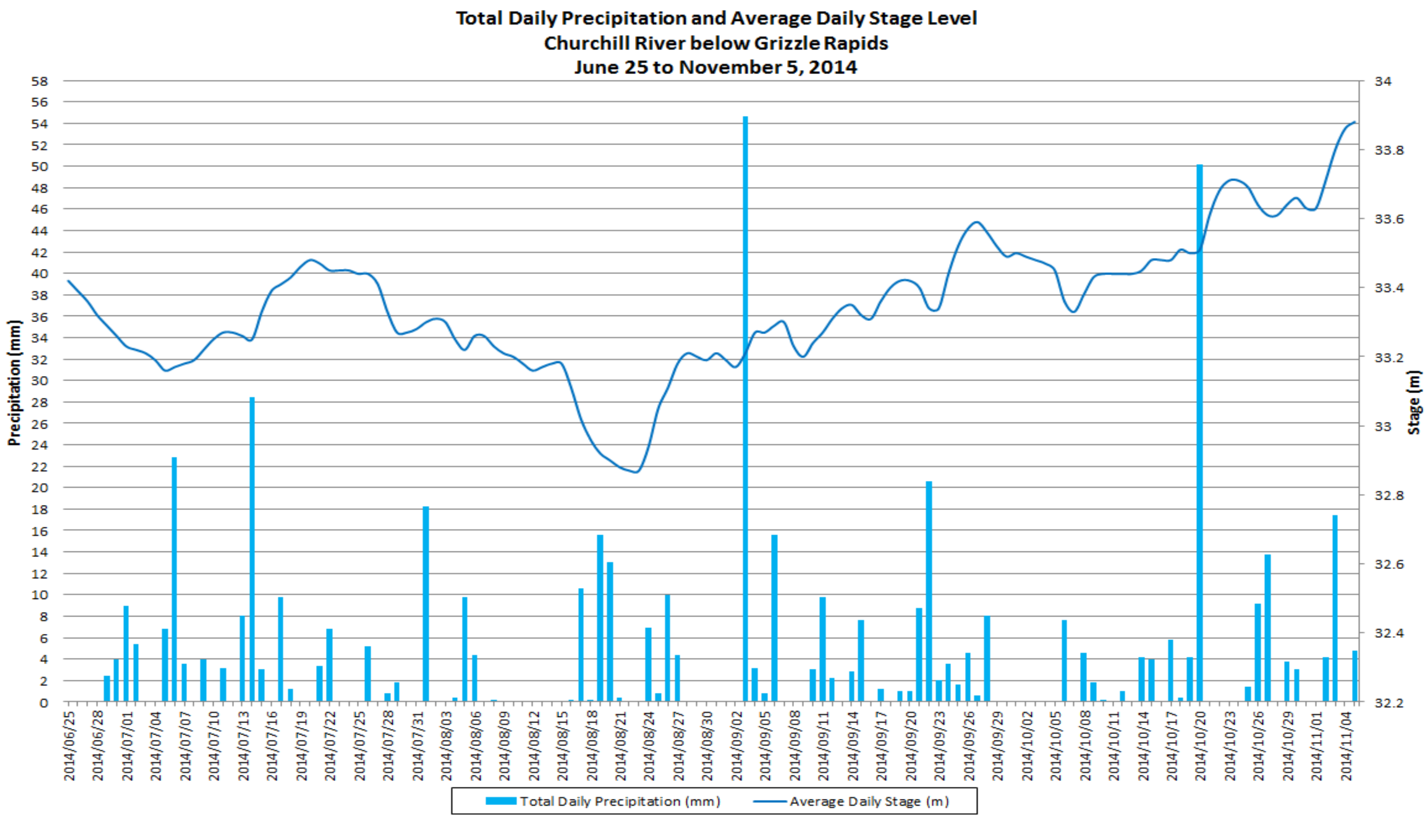

Figure 16: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- Water temperature ranges from 1.81°C to 20.68°C during the 2014 deployment season, with a median value of 14.31°C (Figure 17).
- Water temperatures appear slightly warmer at times in 2014, especially in the spring and summer seasons when compared to data collected in 2012 and 2013. Temperature in the fall months is on par to the previous years.

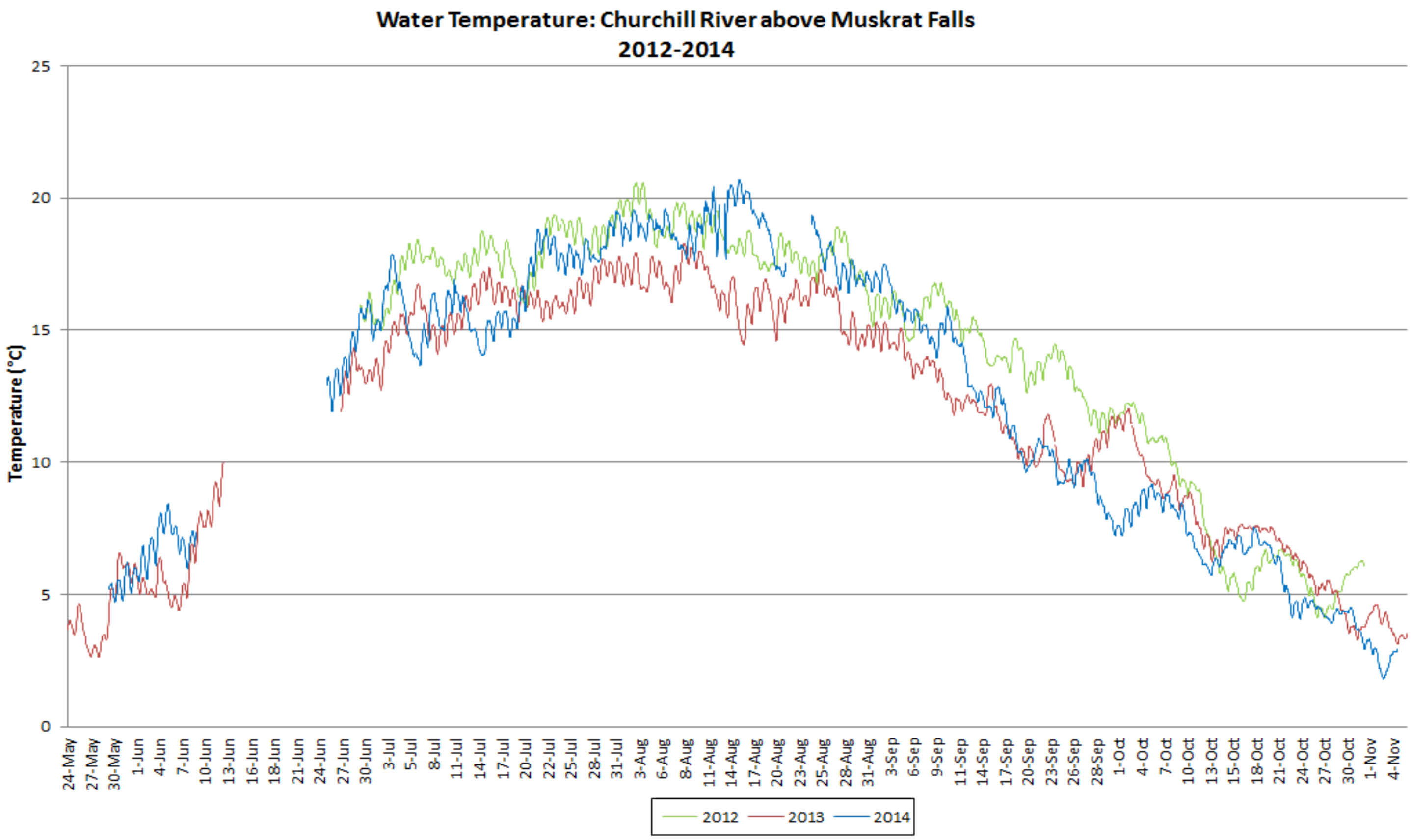

Figure 17: Water temperature at Churchill River above Muskrat Falls

Temperature	2014	2013	2012
Median	14.31	12.5	16.2
Max	20.68	18.3	20.6
Min	1.81	2.6	4.1

- Water temperature values show a typical seasonal trend (Figure 18). Water and air temperatures are increasing throughout the spring and early summer with water temperatures peaking in mid-August. Average air and water temperatures decrease throughout the late summer and into fall.

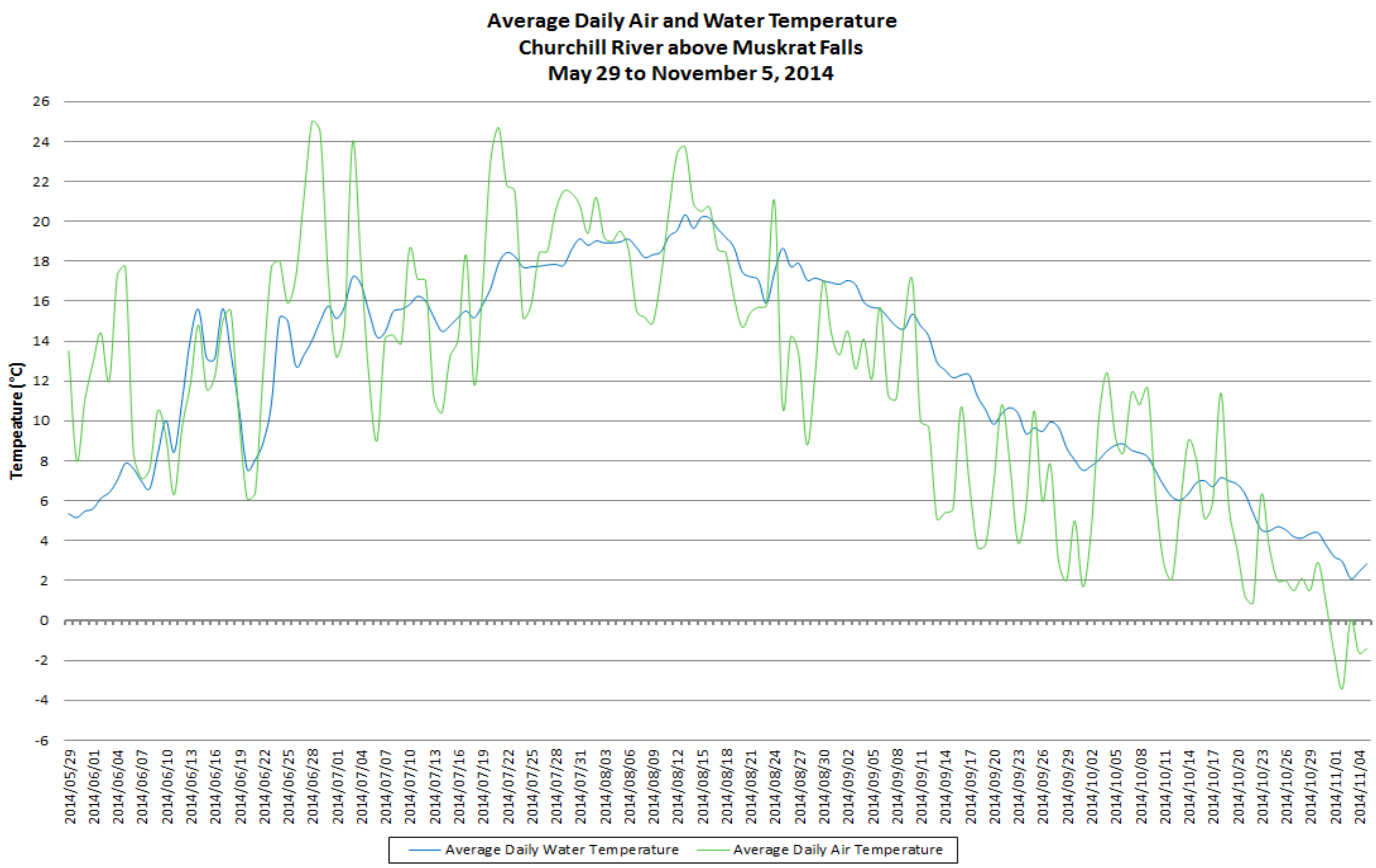

Figure 18: Average daily air and water temperatures at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.51 and 7.35 pH units during the 2014 deployment season, with a median value of 7.09 pH units (Figure 19).
- pH values increased throughout the spring and early summer before leveling off in August. Values then decrease slightly into the fall months. A sudden drop in pH July 14-22 is notable in the data, and corresponds with a rapid rise in stage levels at this time and this is related to precipitation events.
- All values during the 2014 deployment season are within the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units), though the dip in pH mid-July comes close to the minimum pH guideline.
- pH values are comparable to data collected in years previous.

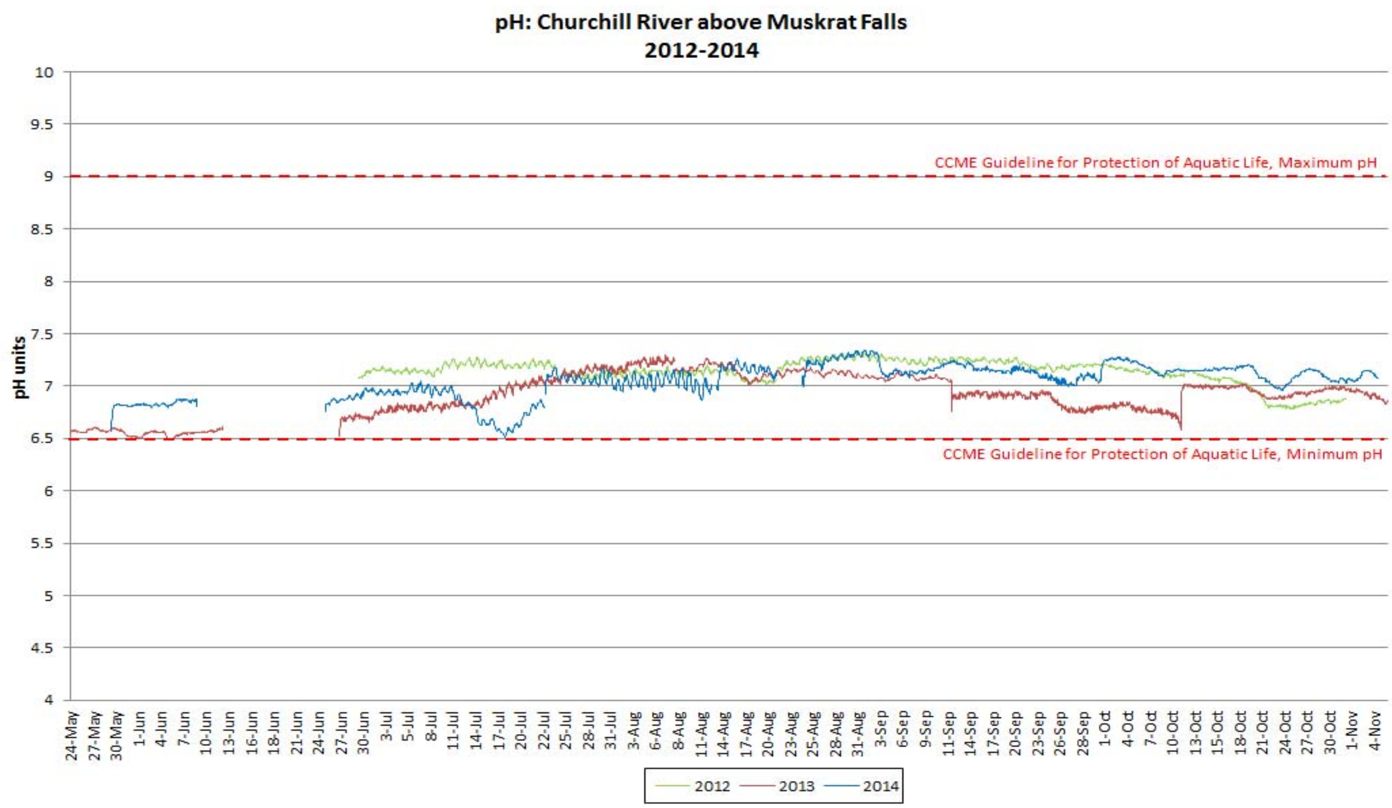

Figure 19: pH at Churchill River above Muskrat Falls

pH (units)	2014	2013	2012
Median	7.09	6.94	7.16
Max	7.35	7.30	7.33
Min	6.51	6.48	6.78

- Specific conductivity ranges from 14.2µS/cm to 23.4µS/cm during the 2014 deployment season, with a median value of 18.3µS/cm (Figure 20).
- Specific conductivity is increasing throughout the spring and most of the summer before gradually decreasing again from late August into the fall months. Generally, specific conductivity does not vary greatly in the Lower Churchill River.
- Increases and decreases in specific conductivity are most times clearly related to fluctuations in stage. As stage decreases, specific conductivity usually increases as the concentration of dissolved solids increases. Inversely, when stage increases, specific conductivity generally decreases due to the dilution of dissolved solids in the water column.
- Data collected in 2012-2013 is similar in trend and value, but 2014 values are slightly lower than the previous two years, with the lowest median value of the three years of the data.

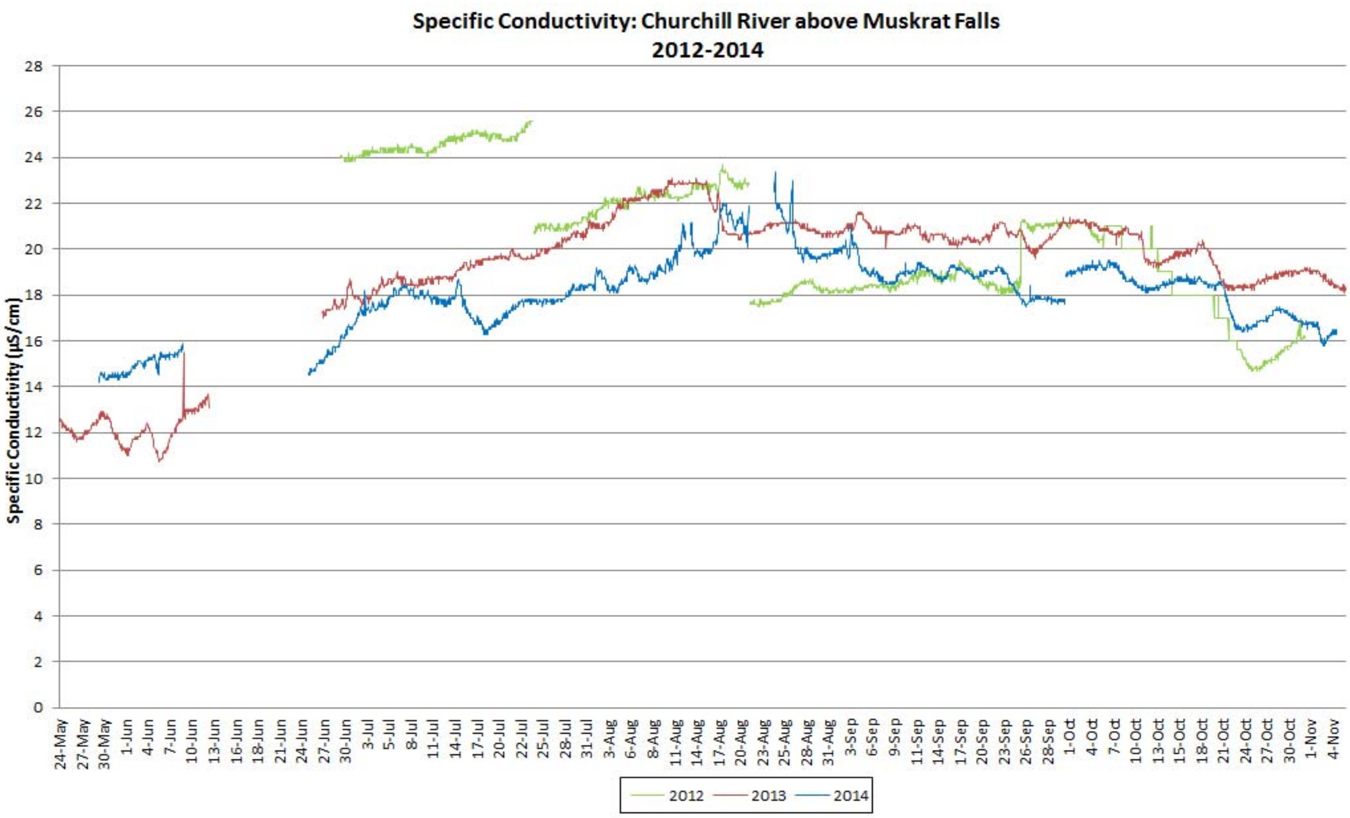

Figure 20: Specific conductivity at Churchill River above Muskrat Falls

Specific Conductivity (µS/cm)	2014	2013	2012
Median	18.3	20.1	20.9
Max	23.4	23.1	25.6
Min	14.2	10.7	14.7

- Throughout the 2014 deployment season, dissolved oxygen ranges from 8.73mg/l to 12.9mg/l, with a median value of 9.75mg/L, while percent saturation ranges from 90.8% to 101.6%, with a median value of 95.5% (Figure 21).
- Dissolved oxygen content shows a typical seasonal fluctuation in 2014 and is similar to data collected in previous years. Dissolved oxygen content fluctuates regularly on a daily basis but is notably lower during the summer (July-August) in 2014 than in the previous two years. This corresponds to warmer temperatures during this time period in 2014, which decreases the amount of oxygen present in the water. Percent saturation is consistent throughout the season.
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5 mg/l). For the months of July and August, dissolved oxygen values hovered around the minimum CCME Guideline for the Protection of Aquatic life at Early Life Stages (9.5mg/l). In early September as air and water temperatures cool, the dissolved oxygen content increases above 9.5mg/l. The guidelines are indicated in red on Figure 21.
- Dissolved oxygen and percent saturation values are similar to data collected in 2012 and 2013.

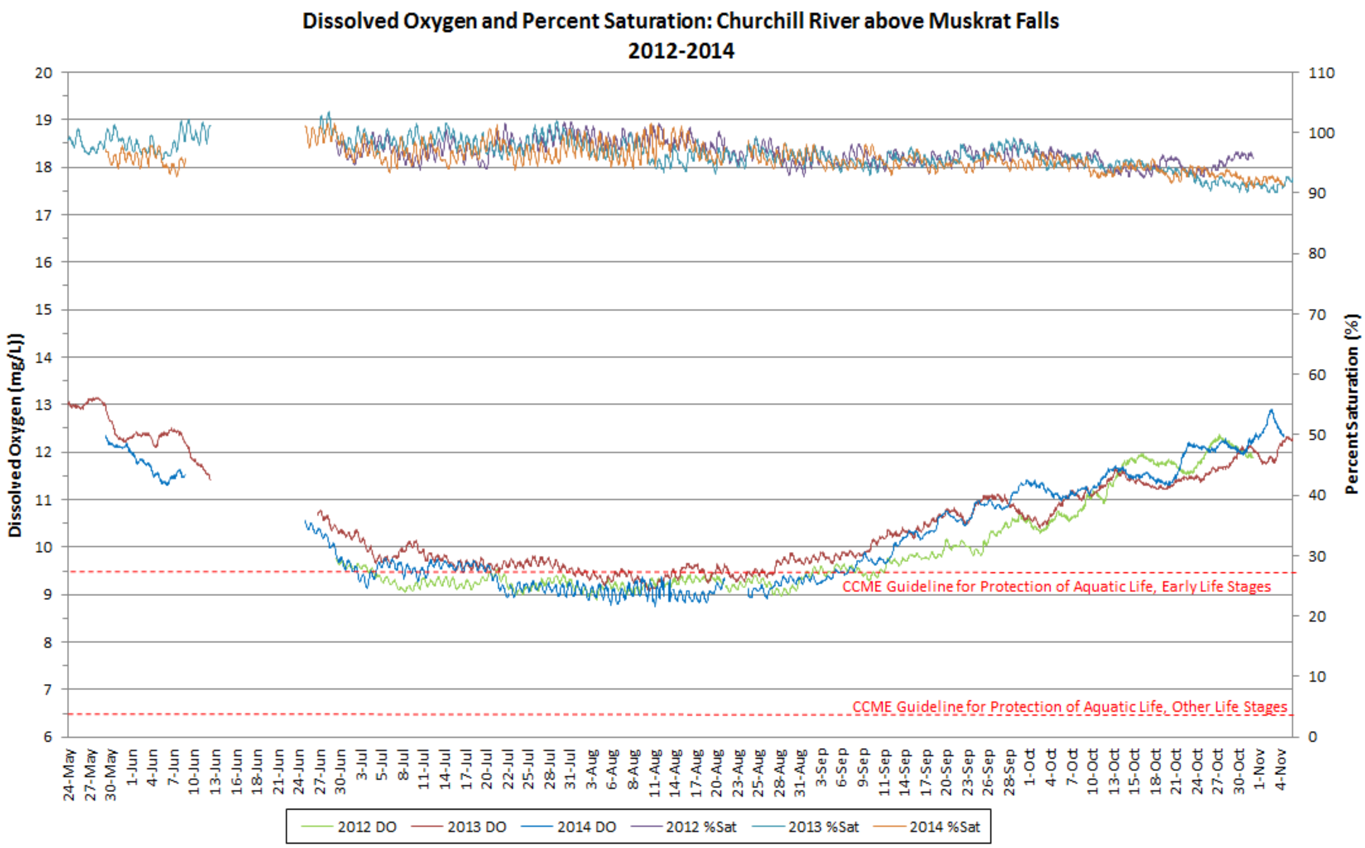

Figure 21: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

Dissolved Oxygen (mg/L)	2014	2013	2012		Percent Saturation	2014	2013	2012
Median	9.75	10.30	9.47		Median	95.5	96.6	96.5
Max	12.9	13.16	12.38		Max	101.6	103.4	101.8
Min	8.73	9.06	8.87		Min	90.8	90.0	92.4

- The majority of turbidity values (95%) were <58.1NTU during the 2014 deployment season (Figure 22 a & b). A median value of 9.0NTU indicates there is a consistent natural background turbidity value at this station. Turbidity values from 2012 to 2014 are depicted in Figures 22 a & b.
- Figure 22a shows data on a scale up to 260NTU. On a number of occasions in 2014, turbidity increased above median background levels for short periods of time throughout the deployment season, to as high as 258.7NTU. 2014 values are notably higher than those from the previous two years, particularly in late August, coinciding with the period of lowest stage levels during the year. Mixing sediment due to low water levels may have contributed to high values during this time.
- Figure 22b shows data at a smaller scale, focusing on the regular consistent background levels, below 60NTU. In the 2014 season, the median value was calculated to be 9NTU and the 95th percentile value was 58.1NTU. When data from all years is combined (2012 to 2014), the median value decreases to 4.0NTU and the 95th percentile is 38.3NTU. In 2014, there appears to be more fluctuating values, though data from all years is similar and comparable in trend.

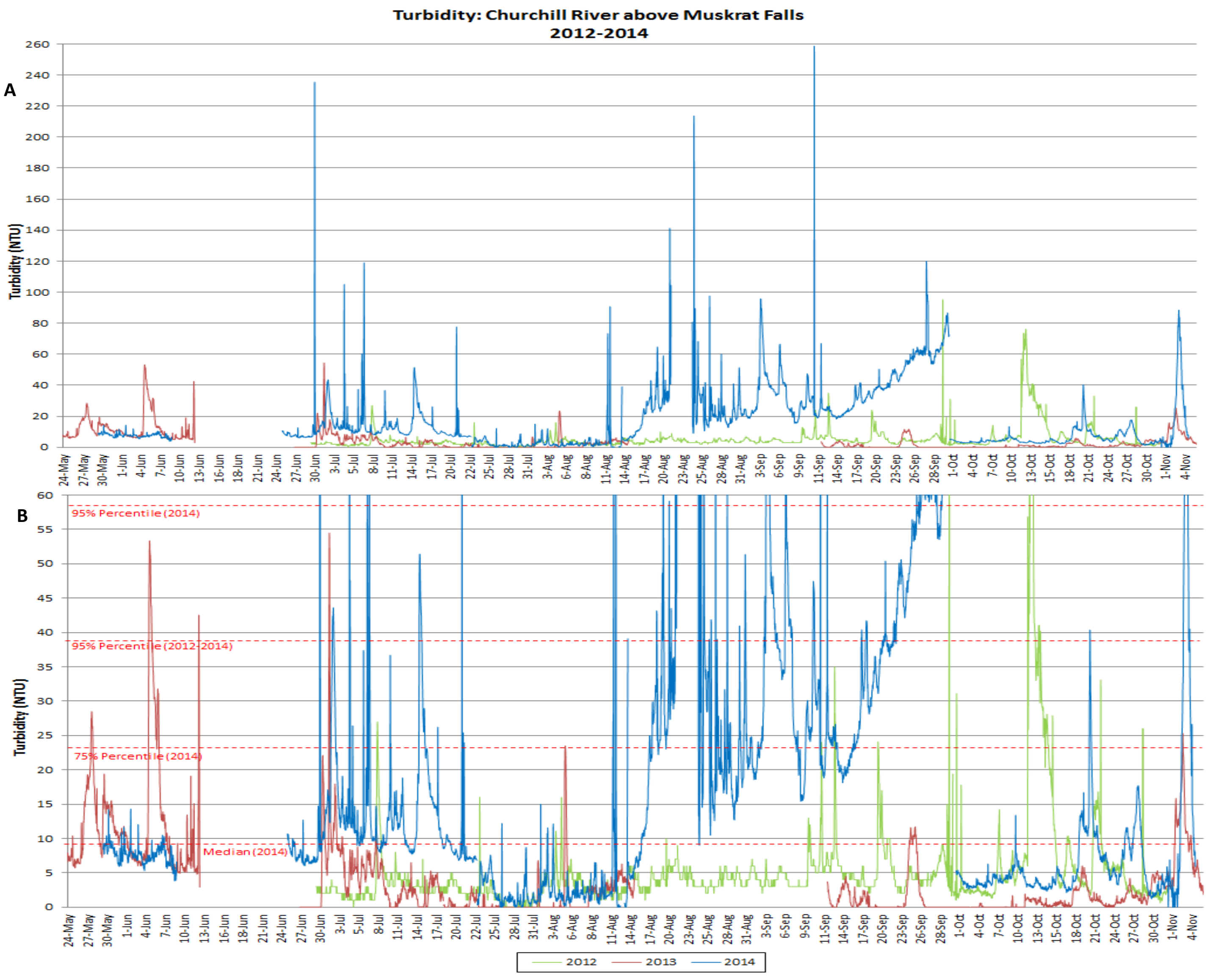

Figure 22a (top): Turbidity to 260NTU at Churchill River above Muskrat Falls
Figure 22b (bottom): Turbidity to 60NTU at Churchill River above Muskrat Falls

Turbidity (NTU)	2014	2013	2012	2012-14
Median	9.0	1.3	3.0	4.0
Max	258.7	54.3	95.3	258.7
Min	0	0	0	0
95%	58.1	14.6	13.9	38.3
75%	23.4	5.2	5.0	8.9

- Stage levels in 2014 decrease in the spring and summer months reaching a seasonal low in late August before increasing again into the fall months (Figure 23).
- Stage levels from 2012-2014 are graphed below to show how stage levels vary throughout the season and from year to year. The 2014 seasonal low was reached much earlier in the season than in 2012 and later than 2013. Stage ranges between 1.75m and 3.34m each year.

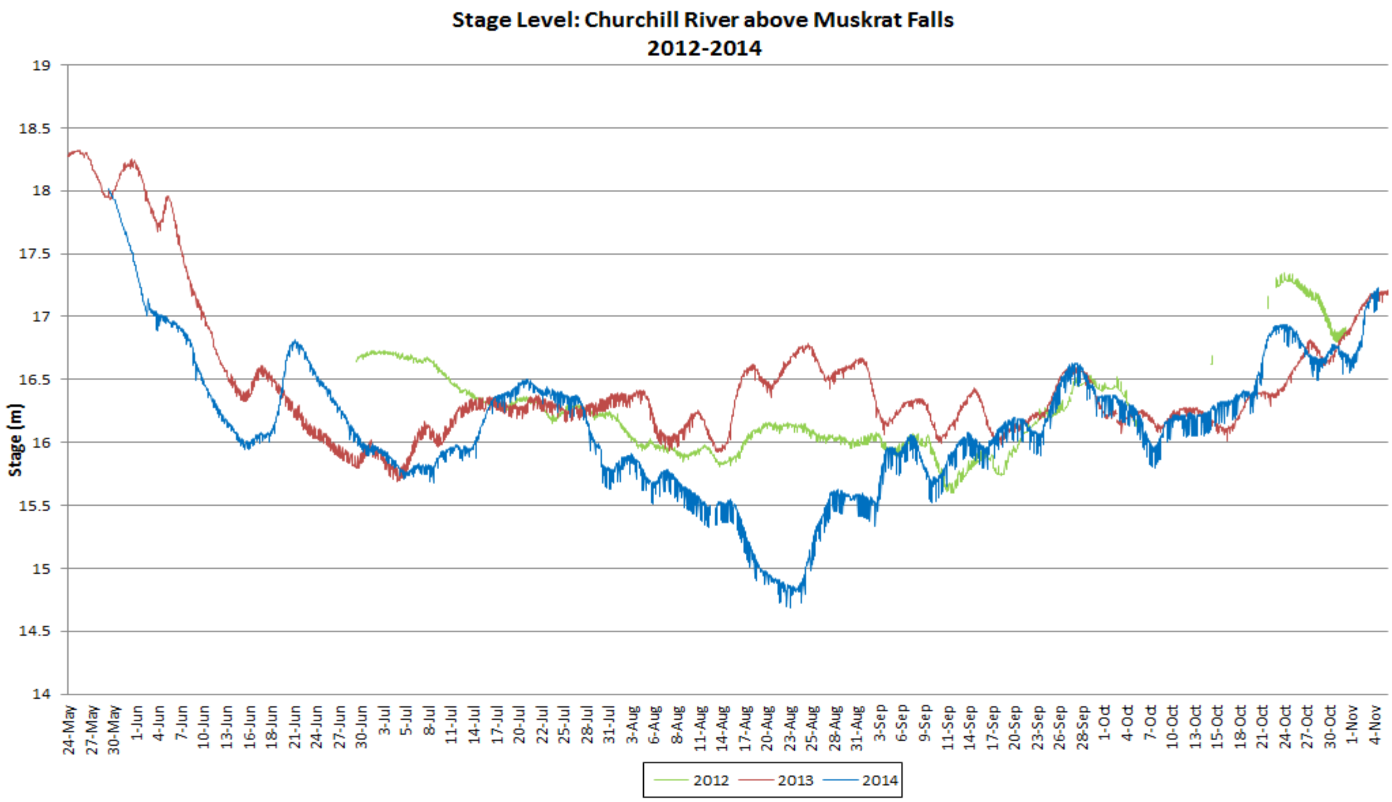

Figure 23: Daily stage level at Churchill River above Muskrat Falls

Stage (m)	2014	2013	2012
Median	16.119	16.314	16.177
Max	18.021	18.323	17.348
Min	14.685	15.690	15.599
Range	3.336	2.633	1.749

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 24).
- Stage is generally decreasing in the first half of the deployment season, reaching a low in mid-August before increasing steadily into the fall months.
- Precipitation events are frequent and range from low to high in magnitude.

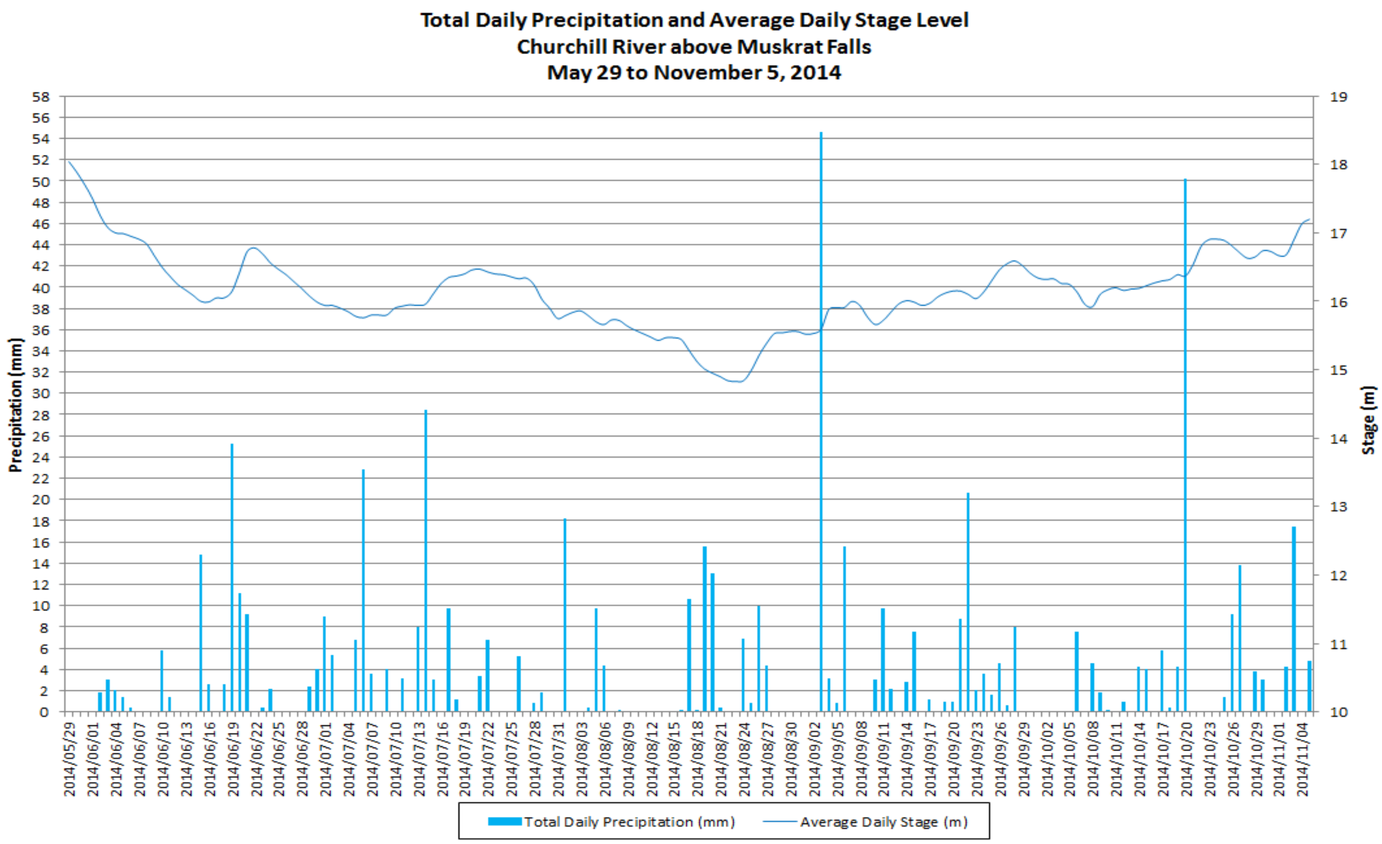

Figure 24: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- During the initial site visit on May 29, the below Muskrat Falls station could not be deployed as the helicopter landing pad had been damaged by ice, preventing access to the site.

- Subsequent deployment trips were able to avail of the shifting sand which had created a 'beach area', allowing the helicopter to land at the water's edge. The instrument was initially deployed on June 25, and was buried in sand by June 29, leading to issues with data reliability and the potential for instrument damage. The instrument was switched out on July 8, but again buried in sand 2 days later. A third attempt at deployment on July 23 resulted in a buried sonde within 12 hours. The decision was made to remove the instrument August 14 until sand conditions improved to prevent damage to the instrument.
- The shifting sand prevented reliable data from being collected at the below Muskrat Falls station for the 2014 season. If conditions do not improve before deployment in spring 2015, ENVC will investigate new methods for deployment at this site.
- The photos below show the extent of the sand that accumulated at the below Muskrat Falls station in 2014, with a photo of the site in 2013 for comparison (Figure 25).

Figure 25: Churchill River below Muskrat Falls: (a) 2013 ; (b) June 2014 ; (c)-(d) August 2014;
(e) October 2014; (f) November 2014

- Stage levels from 2012-2014 are graphed below to show how stage levels vary throughout the season and from year to year (Figure 26). The seasonal low was reached later in the season in 2014 when compared to 2012 and 2013. Stage ranges between 0.98m and 2.24m each year.

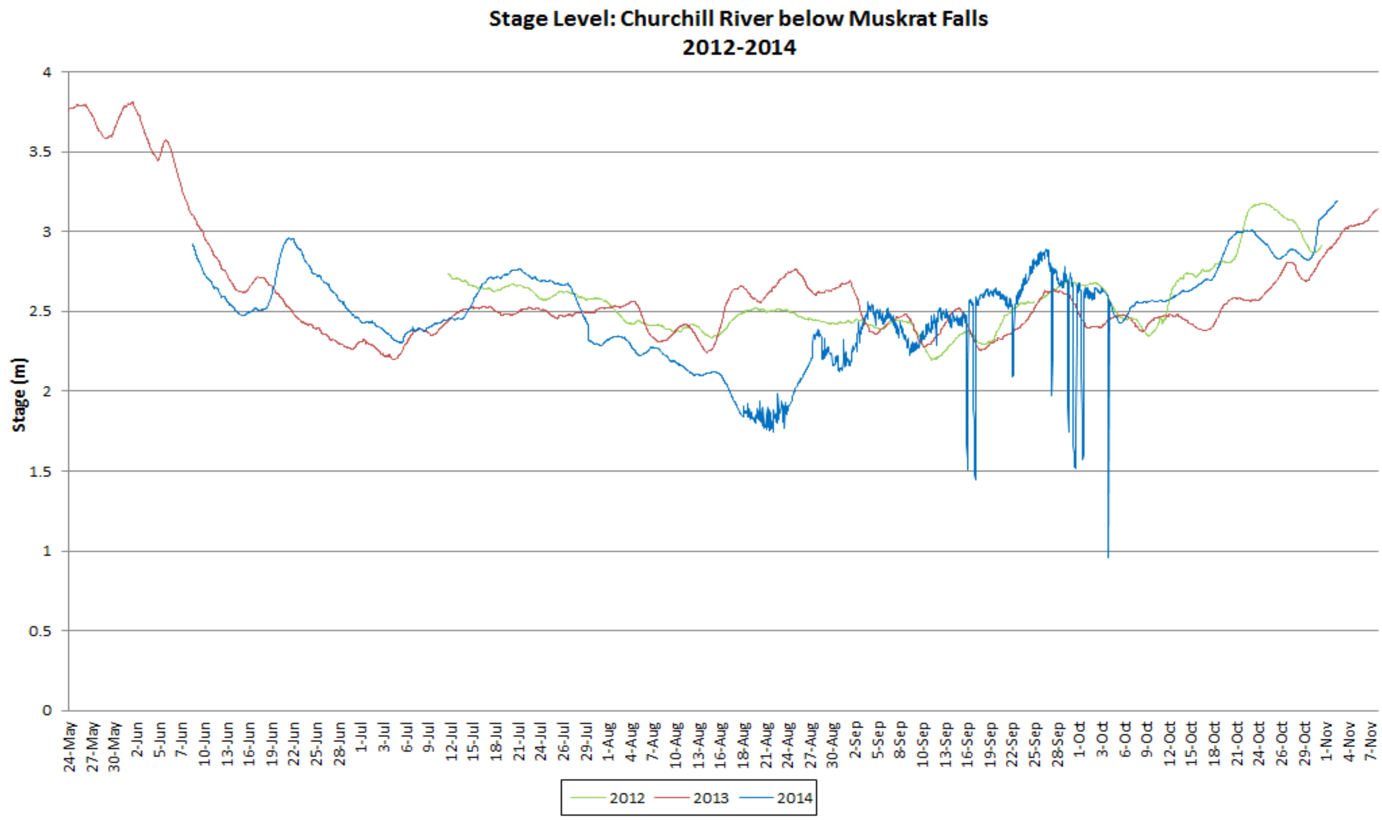

Figure 26: Stage level at Churchill River below Muskrat Falls

Stage (m)	2014	2013	2012
Median	2.518	2.510	2.510
Max	3.193	3.809	3.177
Min	0.955	2.198	2.193
Range	2.238	1.611	0.984

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 27).
- Stage is generally decreasing June-August, with increases occurring after precipitation events. Stage reaches a low in late August before gradually increasing into the fall months. Fluctuations in stage levels are associated with precipitation events.
- Precipitation events are frequent and range from low to high in magnitude.

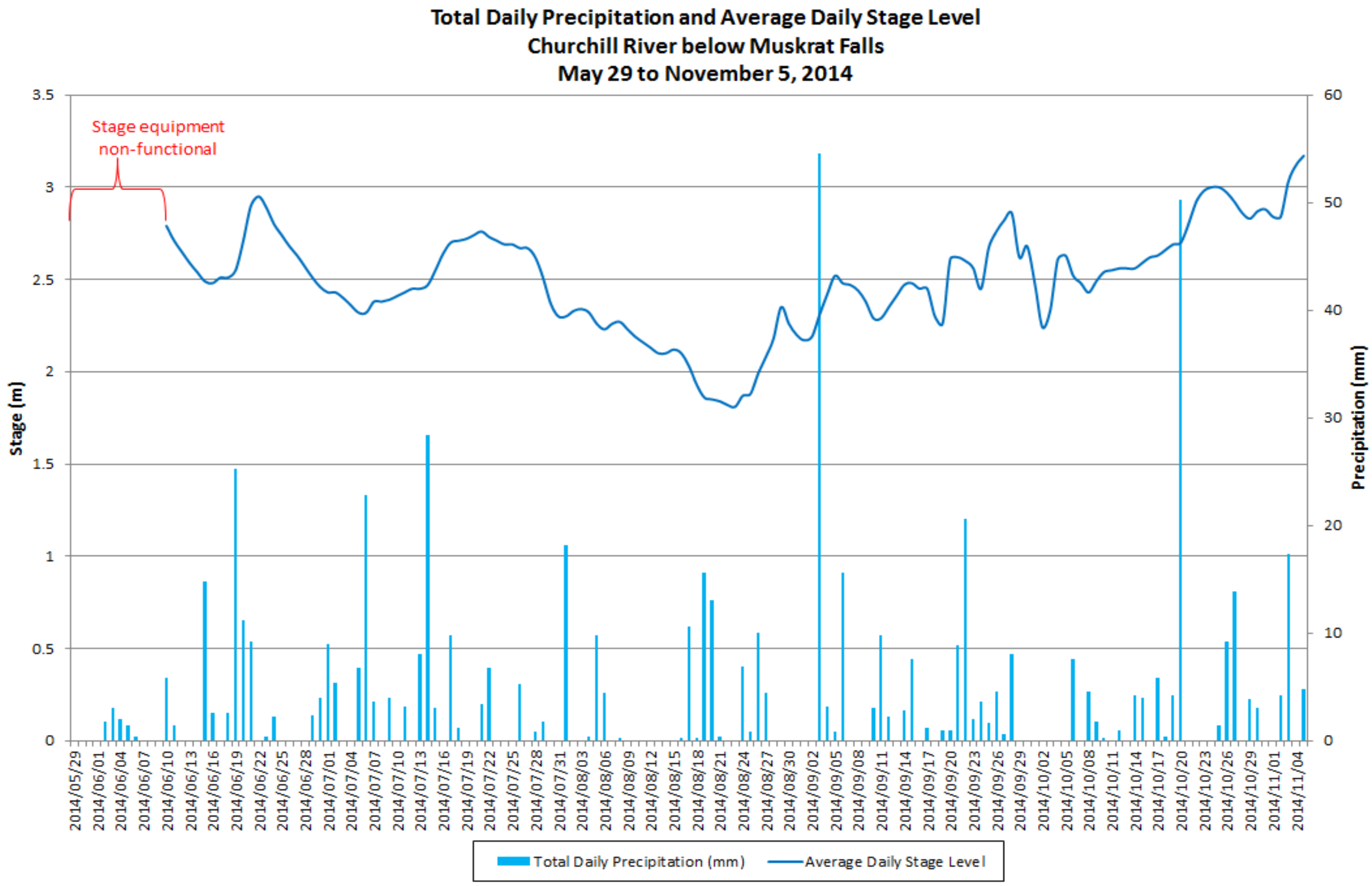

Figure 27: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Churchill River at English Point

- Water temperature ranges from 2.3°C to 22.6°C during the 2014 deployment season, with a median value of 12.6°C (Figure 28).
- There are greater daily fluctuations at this station due to the influence of the tides in the Atlantic Ocean and Lake Melville.
- Water temperatures are slightly cooler when compared to 2012 data but are on par with 2013 values.

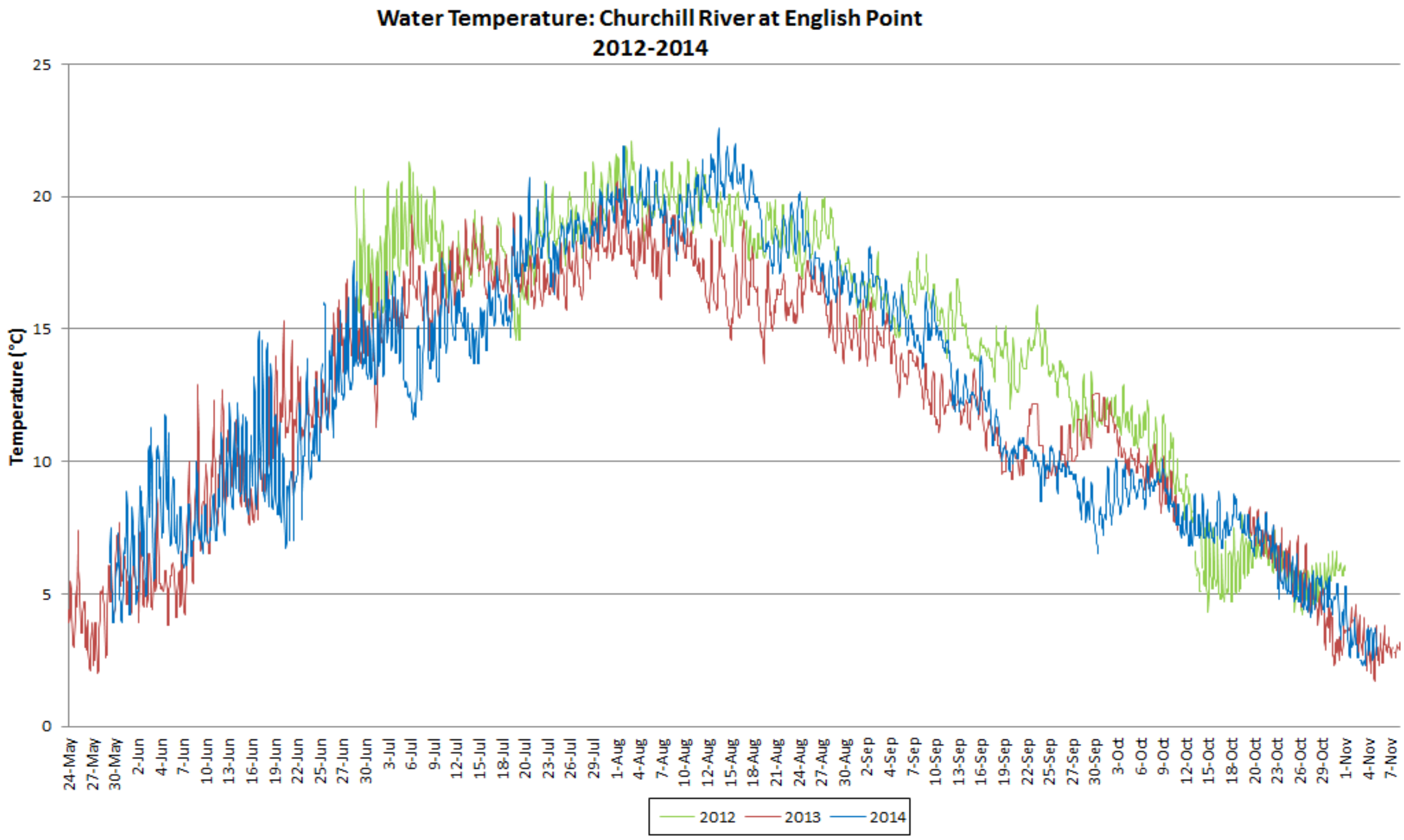

Figure 28: Water temperature at Churchill River at English Point

Temperature	2014	2013	2012
Median	12.6	12.4	16.5
Max	22.6	20.6	22.1
Min	2.3	1.7	4.2

- Water temperature values show a typical seasonal trend (Figure 29). Water and air temperatures are increasing throughout the spring and early summer with water temperatures peaking in mid-August. Average air and water temperatures decrease throughout the late summer and fall.

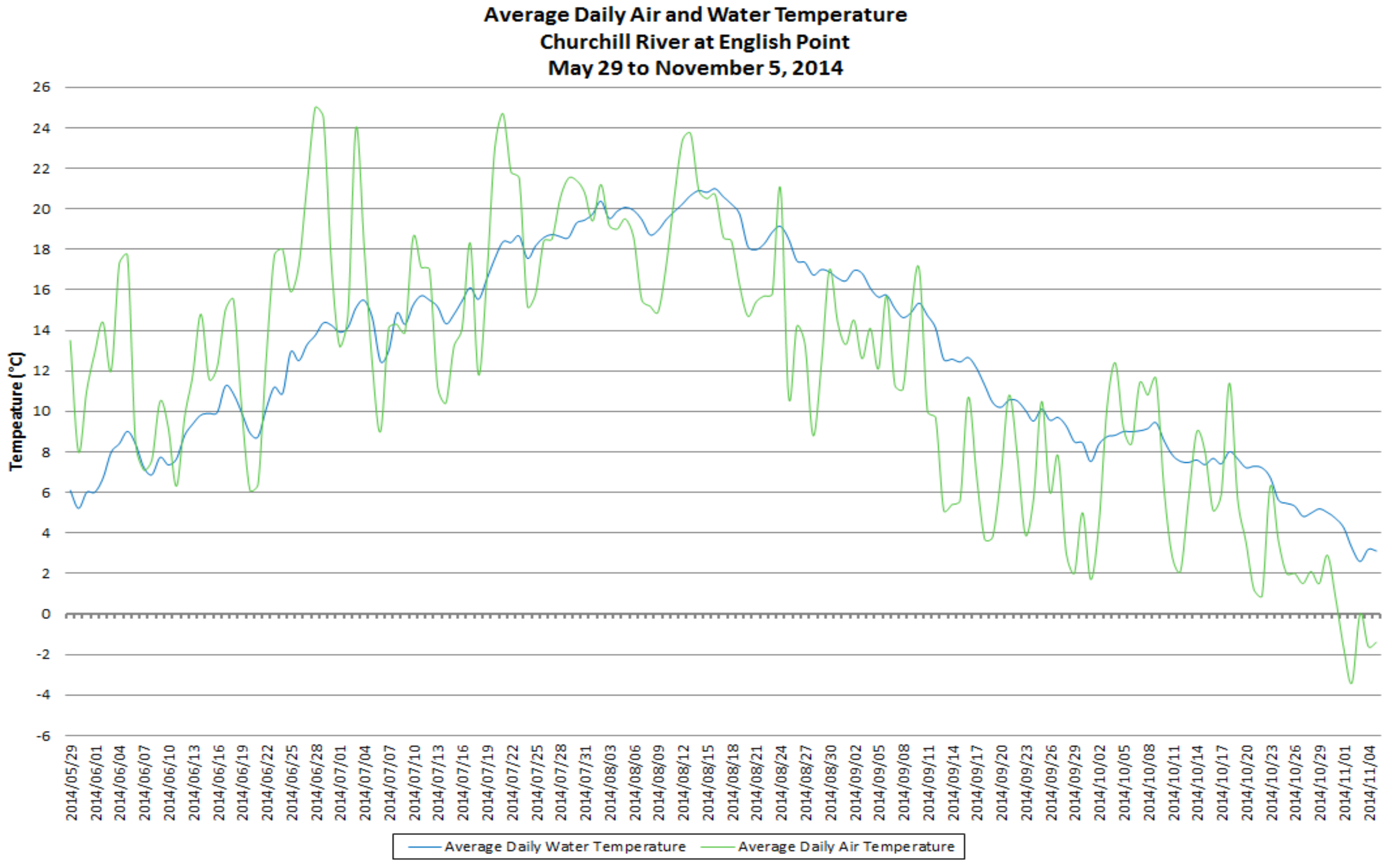

Figure 29: Average daily air and water temperatures at Churchill River at English Point (weather data recorded at Goose Bay)

- pH ranges between 5.92 and 7.93 pH units during the 2014 deployment season, with a median value of 7.04 pH units (Figure 30).
- pH values at English Point fluctuate with the addition of freshwater to the system from precipitation. Drops in pH during 2014 are correlated to large precipitation events, adding acidic freshwater to the system. The data fluctuates around pH 7 throughout the deployment season. The low precipitation period of July-August recorded relatively stable pH values.
- Most pH values during the 2014 deployment season are within the CCME Guidelines for the Protection of Aquatic Life (>6.5 and <9.0 pH units). pH values drop below this guideline for a short period of time in July after several large precipitation events, and again after a large precipitation event on October 20. Guidelines are indicated in red on Figure 30.
- pH trends and values are similar for data collected in previous years.

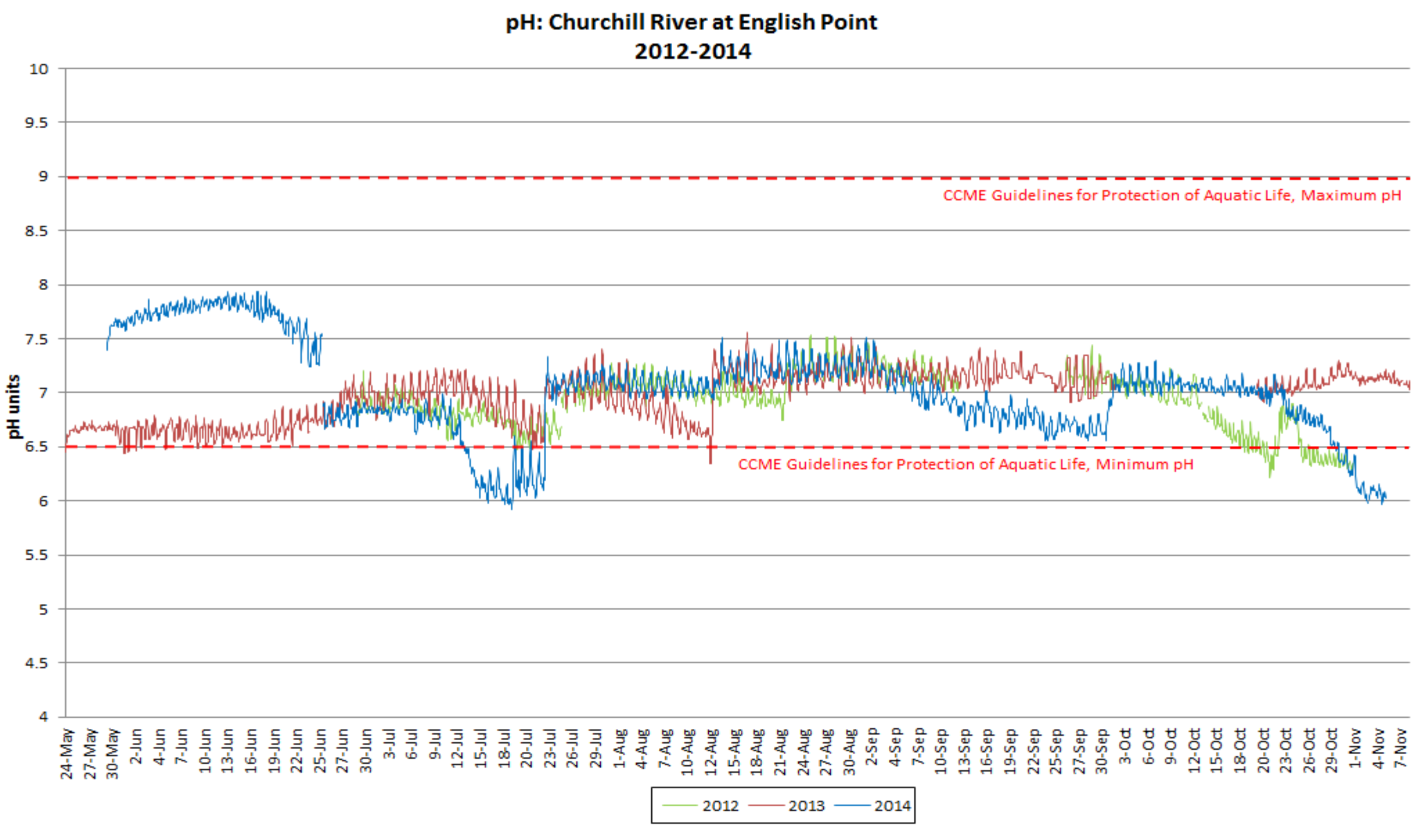

Figure 30: pH at Churchill River at English Point

pH (units)	2014	2013	2012
Median	7.04	7.03	6.97
Max	7.93	7.56	7.53
Min	5.92	6.34	6.21

- Specific conductance ranges between 14.1µS/cm and 69.7µS/cm, with a median value of 30.6µS/cm during the 2014 deployment season (Figure 31).
- Specific conductance is highly variable at this station, fluctuating significantly each day. The consistent fluctuations at this location are 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.
- Trends and values from 2012 and 2013 are similar for the same time period.

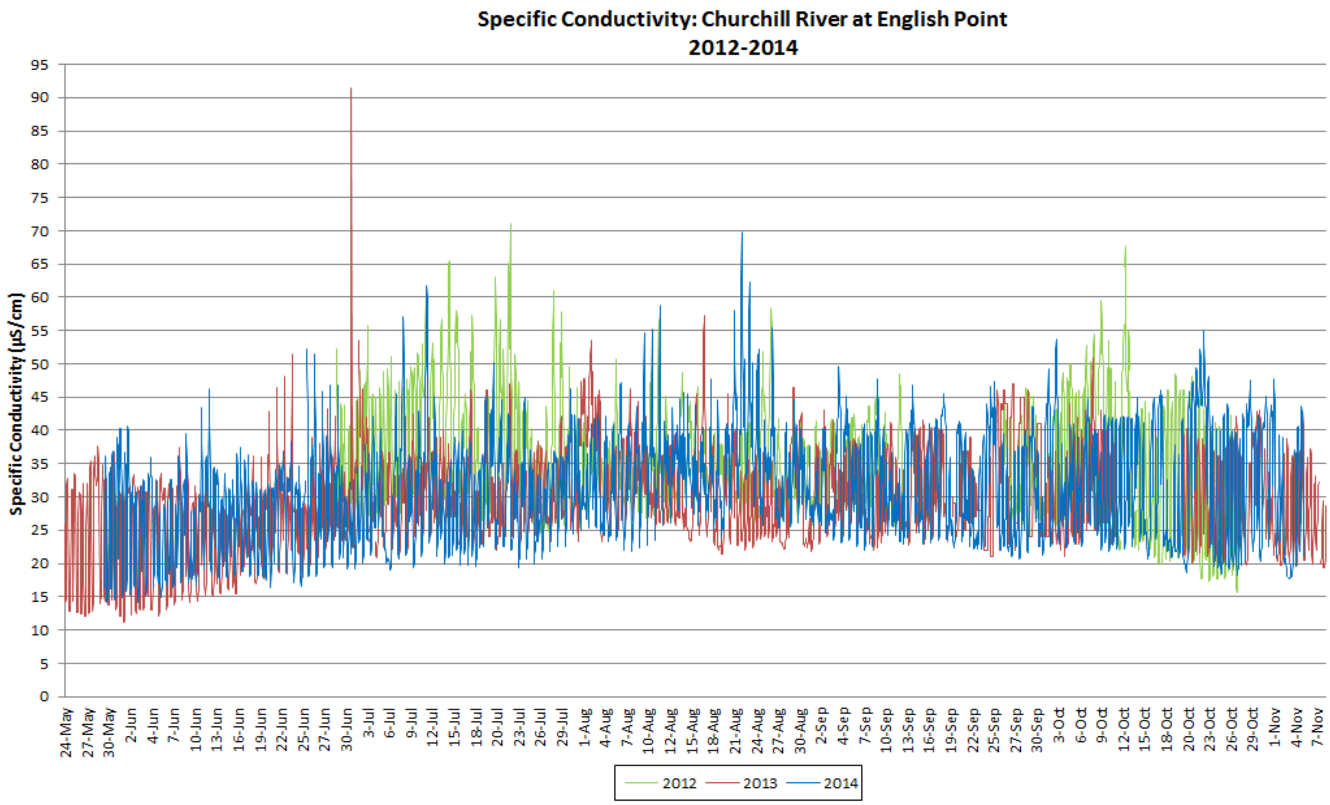

Figure 31: Specific Conductivity at Churchill River at English Point

Specific Conductivity (µS/cm)	2014	2013	2012
Median	30.6	29	34.2
Max	69.7	91.4	71.1
Min	14.1	11.2	15.6

- Throughout the 2014 deployment season, dissolved oxygen ranges from 8.72mg/l and 13.83mg/l, with a median value of 10.34mg/l, while percent saturation ranges from 85.4% to 114.5%, with a median value of 99.6% (Figure 32).
- Dissolved oxygen content shows a typical seasonal fluctuation in 2014. Dissolved oxygen content fluctuates considerably on a regular daily basis. Percent saturation is generally consistent throughout the deployment season.
- All values were above the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages (6.5 mg/l). Between late-July and early September, dissolved oxygen content fluctuated above and below the minimum CCME Guideline for the Protection of Aquatic life at Early Life Stages (9.5mg/l). In September, as air and water temperatures cool, the dissolved oxygen content increases above 9.5mg/l. The guidelines are indicated in red on Figure 32.
- Dissolved oxygen and percent saturation values were very similar to the data collected in 2012 and 2013.

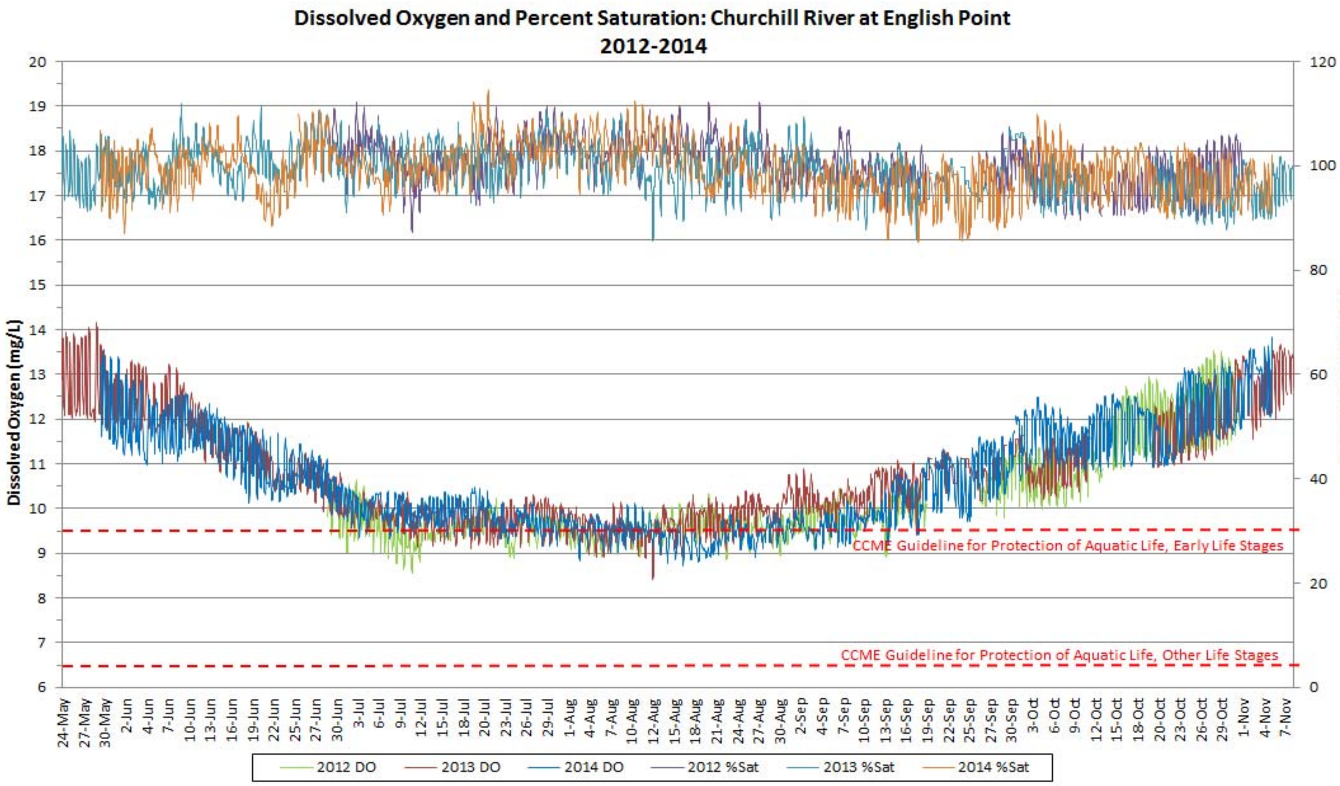

Figure 32: Dissolved oxygen and percent saturation at Churchill River at English Point

Dissolved Oxygen (mg/L)	2014	2013	2012		Percent Saturation	2014	2013	2012
Median	10.34	10.55	9.84		Median	99.6	99.4	100.8
Max	13.83	14.17	13.52		Max	114.5	111.9	112.3
Min	8.72	8.42	8.56		Min	85.4	85.5	87.1

- The majority of turbidity values (95%) were <58.9NTU during the 2014 deployment season (Figure 33 a & b). A median value of 16.1NTU indicates there is a consistent natural background turbidity value at this station. Turbidity values from 2012 to 2014 are depicted in Figures 33 a & b.
- Figure 33a shows data on a scale up to 500NTU. On a number of occasions in 2014, turbidity increased above median background levels for short periods of time throughout the deployment season, to as high as 147NTU. Many of these values fluctuate rapidly as they are influenced by tidal wave action.
- Figure 33b shows data at a smaller scale, focusing on the regular consistent background levels, below 100NTU. In the 2014 season, the median value was calculated to be 16.1NTU and the 95th percentile value was 58.9NTU. When data from 2012 to 2014 is combined, the median value decreases to 9.9NTU and the 95th percentile is 50NTU. Turbidity values are notably higher in 2014 when compared to 2012 and 2013 data, with higher fluctuation ranges.

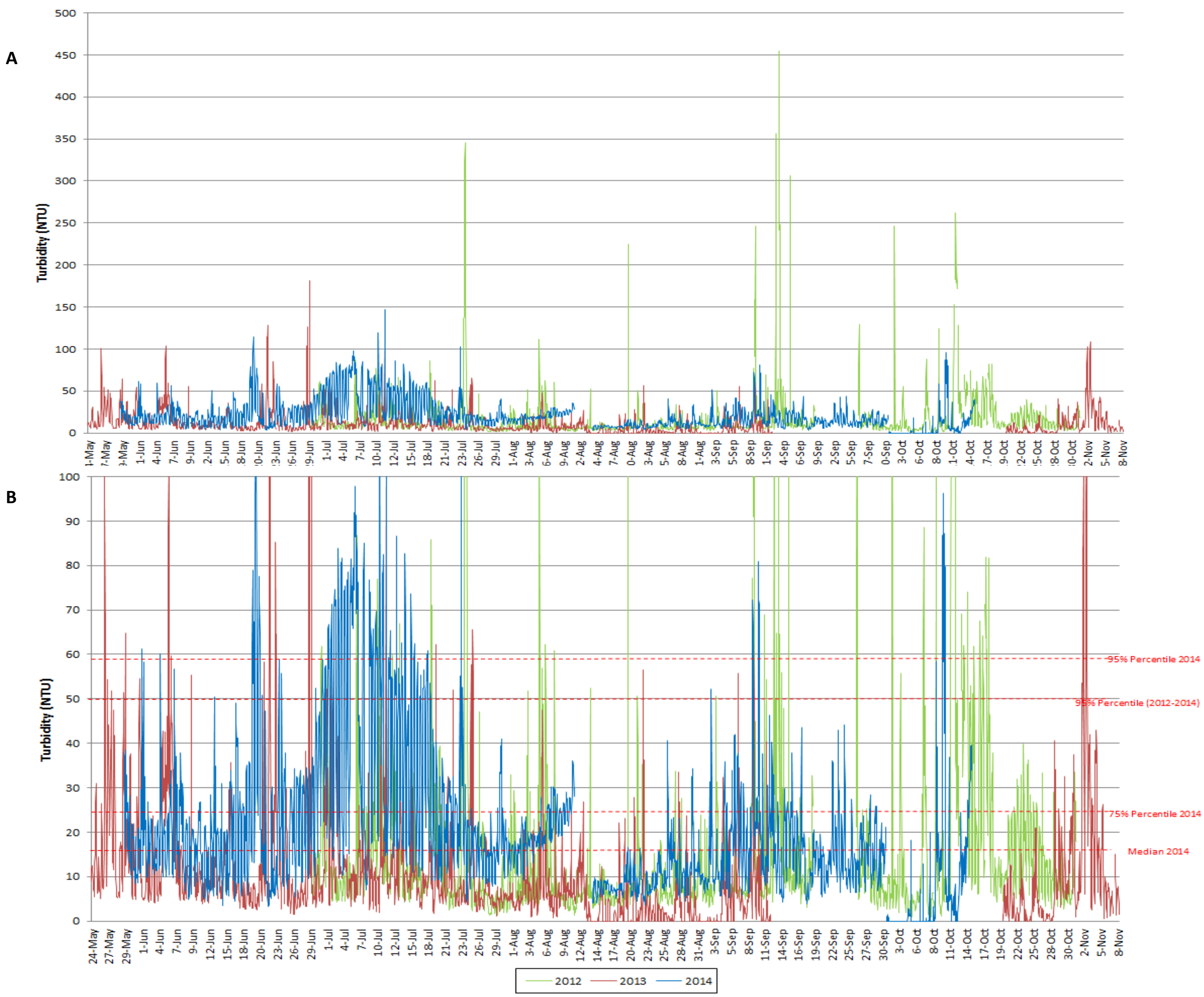

Figure 33 (a) (top): Turbidity to 500NTU at Churchill River at English Point
Figure 33 (b) (bottom): Turbidity to 100NTU at Churchill River at English Point

Turbidity (NTU)	2014	2013	2012	2012-2014
Median	16.1	6.8	8.4	9.9
Max	147	181.3	455.0	455
Min	0.0	0.0	0.9	0.0
95%	58.9	34.6	49.0	50
75%	24.7	12.6	15.3	19

- Stage levels in 2014 are very consistent and do not fluctuate greatly on a seasonal level (Figure 34). Instead, stage values fluctuate considerably with tidal influences on a daily basis.
- Stage levels from 2012-2014 are graphed below to show how stage levels vary throughout the season and from year to year. Stage levels in previous years were very similar when compared data collected in 2014. Stage ranges between 0.93m and 1.27m each year.

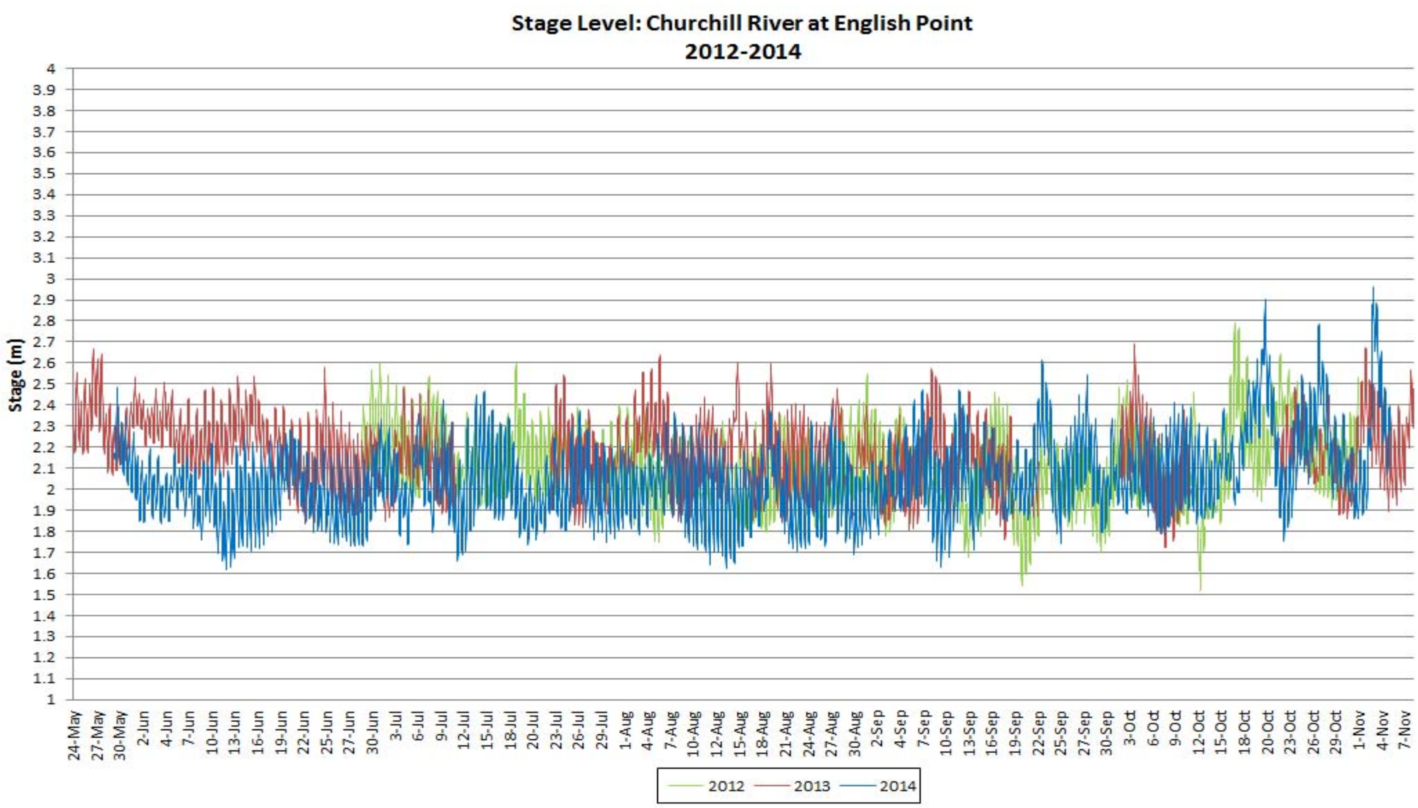

Figure 34: Stage level at Churchill River at English Point

Stage (m)	2014	2013	2012
Median	2.035	2.175	2.093
Max	2.962	2.693	2.790
Min	1.619	1.724	1.519
Range	0.927	0.969	1.271

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 35).
- Stage is consistent throughout the deployment season. This trend is very different from all other network stations due to its location at the mouth of the Lower Churchill River and the tidal influences affecting water level.

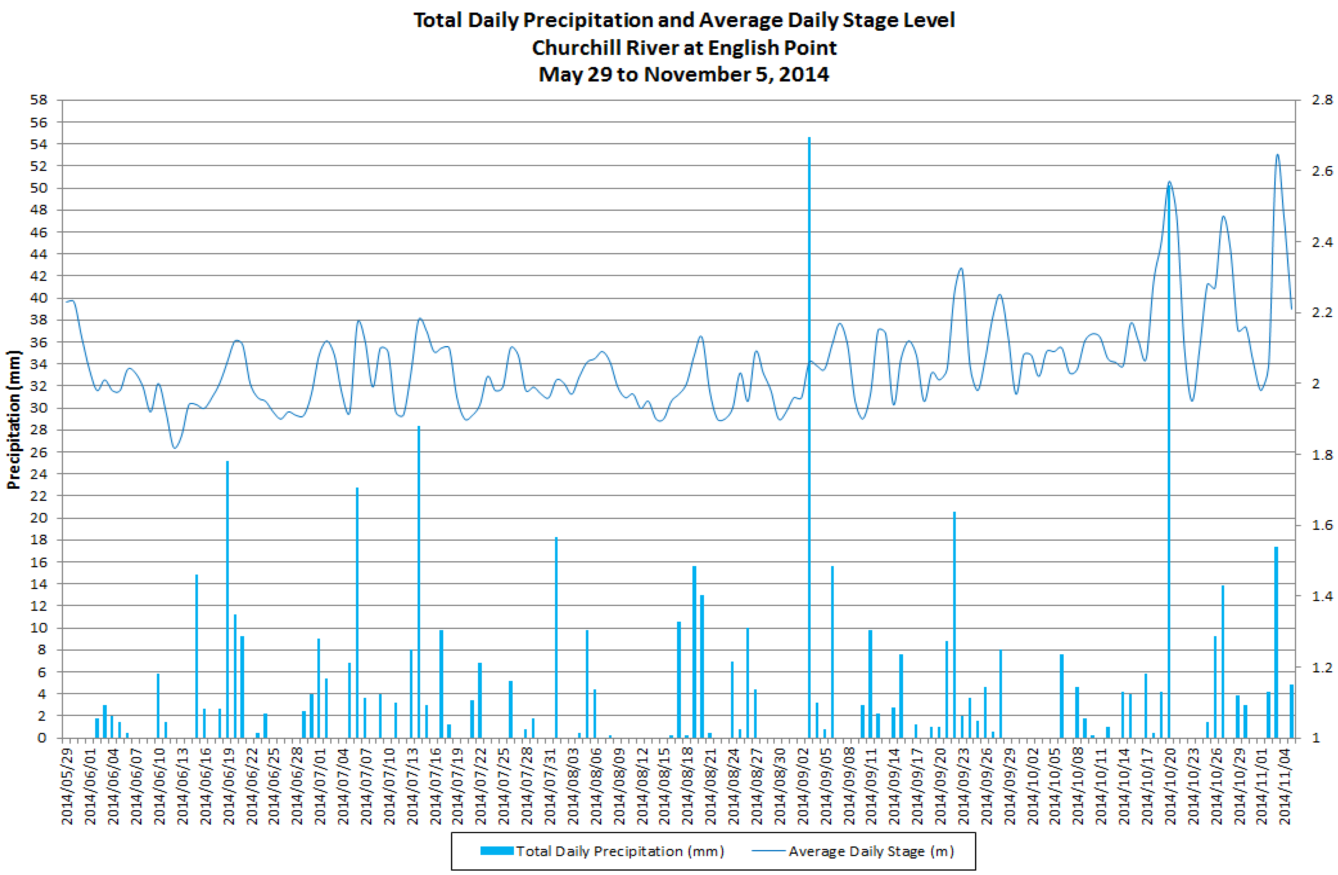

Figure 35: Daily precipitation and average daily stage level at Churchill River at English Point (weather data recorded at Goose Bay)

Station Comparison

- Water temperature at each of the four stations monitored shows a similar trend throughout the 2014 deployment season (Figure 36).
- Water temperature is generally warmest at Churchill River below Metchin, while English Point has the greatest diurnal fluctuations. In the spring and early summer, English Point recorded the highest and lowest temperatures daily. Into the summer, the coolest water temperatures were recorded at below Grizzle Rapids, while the warmest were recorded at English Point. As water temperatures began to cool mid-August into November, Churchill River below Metchin River had the lowest water temperatures when compared to other stations in the network.

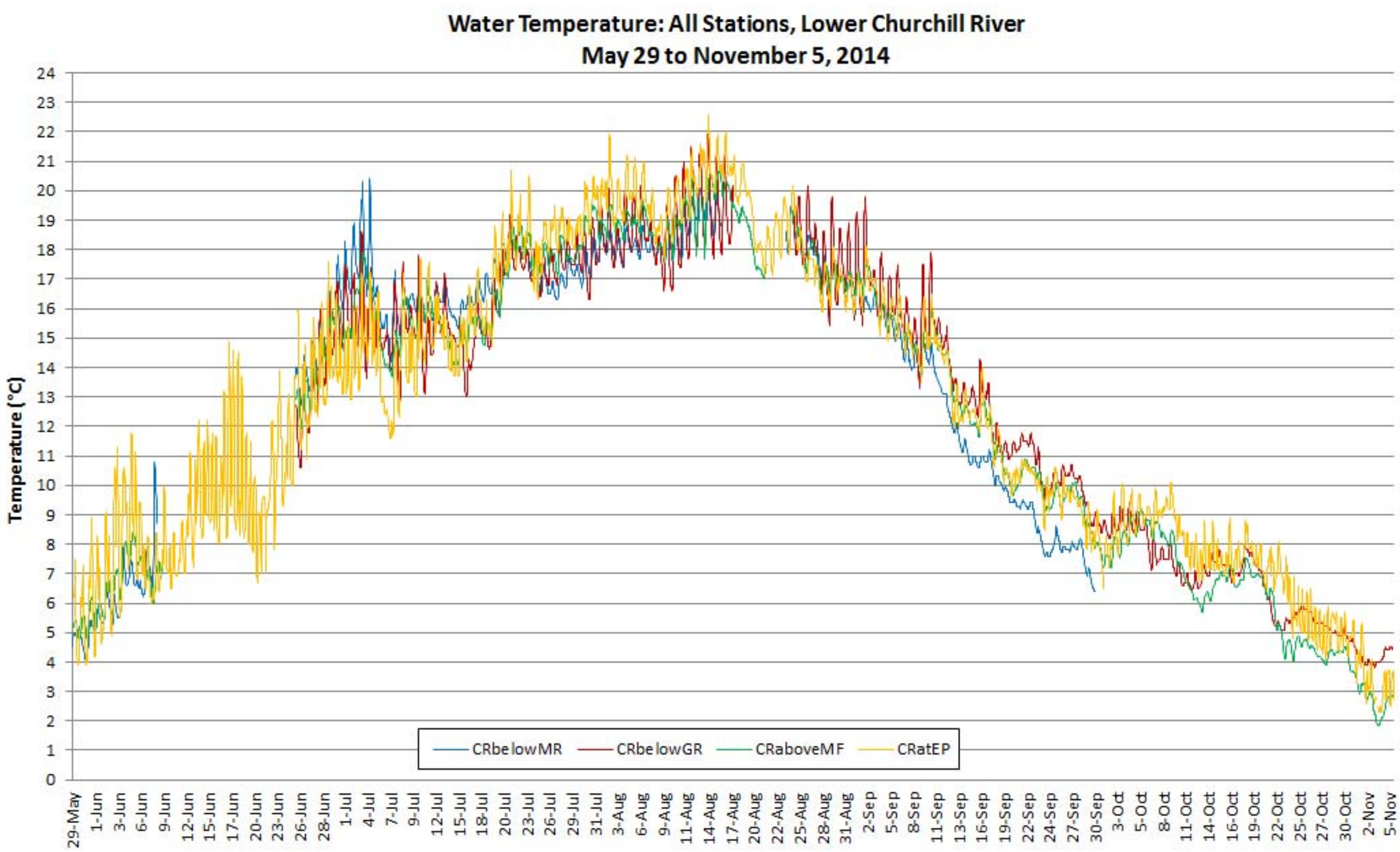

Figure 36: Temperature at all stations in 2014, Lower Churchill River

Temperature	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Median	16.1	14.7	14.31	12.6
Max	20.4	21.9	20.68	22.6
Min	4.1	3.8	1.81	2.3

- Water temperatures at all four stations display clear seasonal trends in response to changes in air temperatures throughout the deployment season (Figure 37).
- Average Daily water temperatures peak at all stations in mid-August.

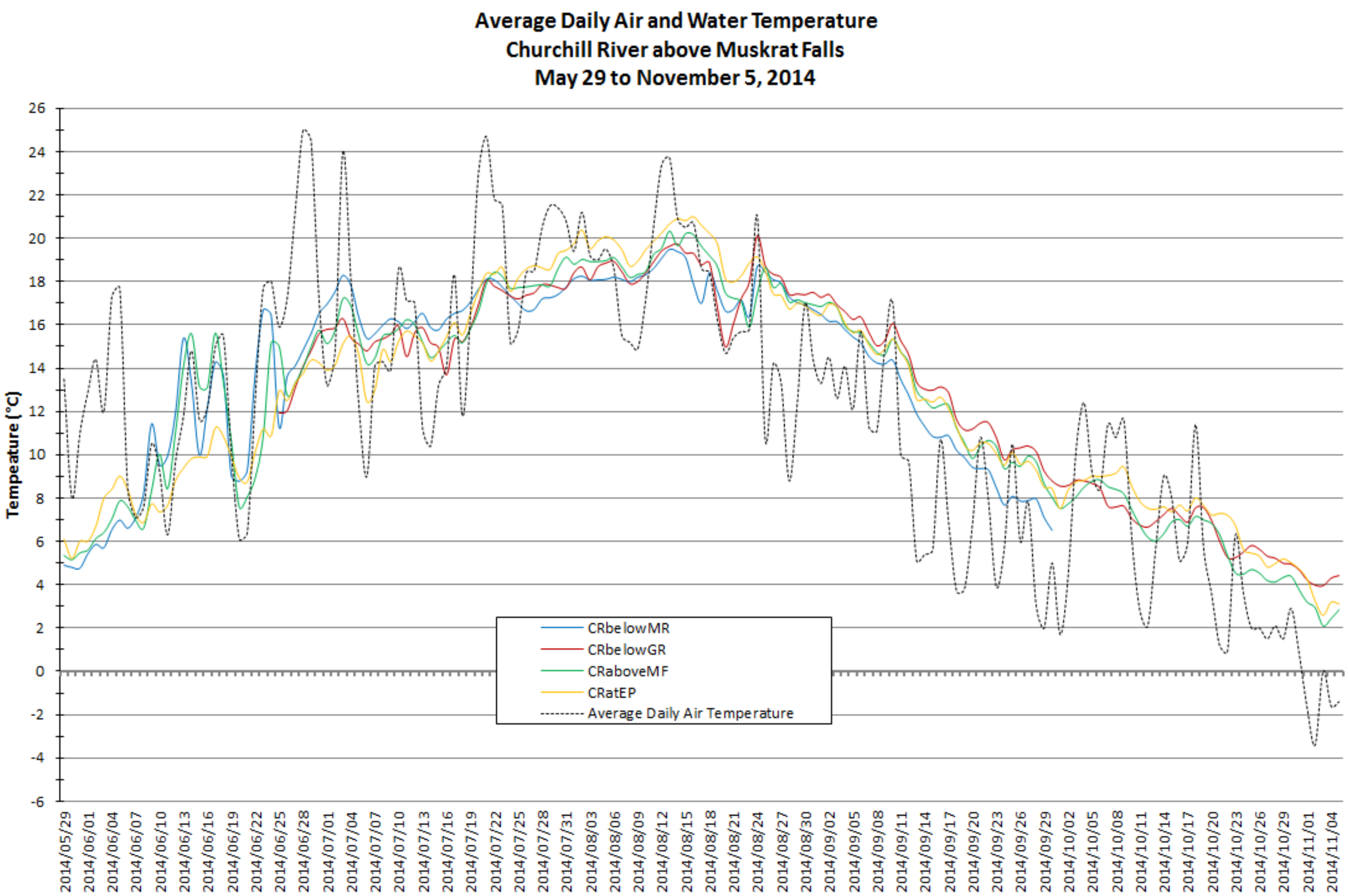

Figure 37: Average daily air and water temperatures at all stations in 2014, Lower Churchill River

- pH values are similar at the four monitoring sites throughout the 2014 deployment season (Figure 38).
- The median values for below Metchin River and at English Point were the same at 7.04, while median values for below Grizzle Rapids and above Muskrat Falls were identical at 7.09. Values at the station at English Point are the most variable day to day throughout the deployment season due to the position of the station at the mouth of the Lower Churchill River and the tidal impact on the station water level and water quality. The effects of increased precipitation into a system are most pronounced at English Point.

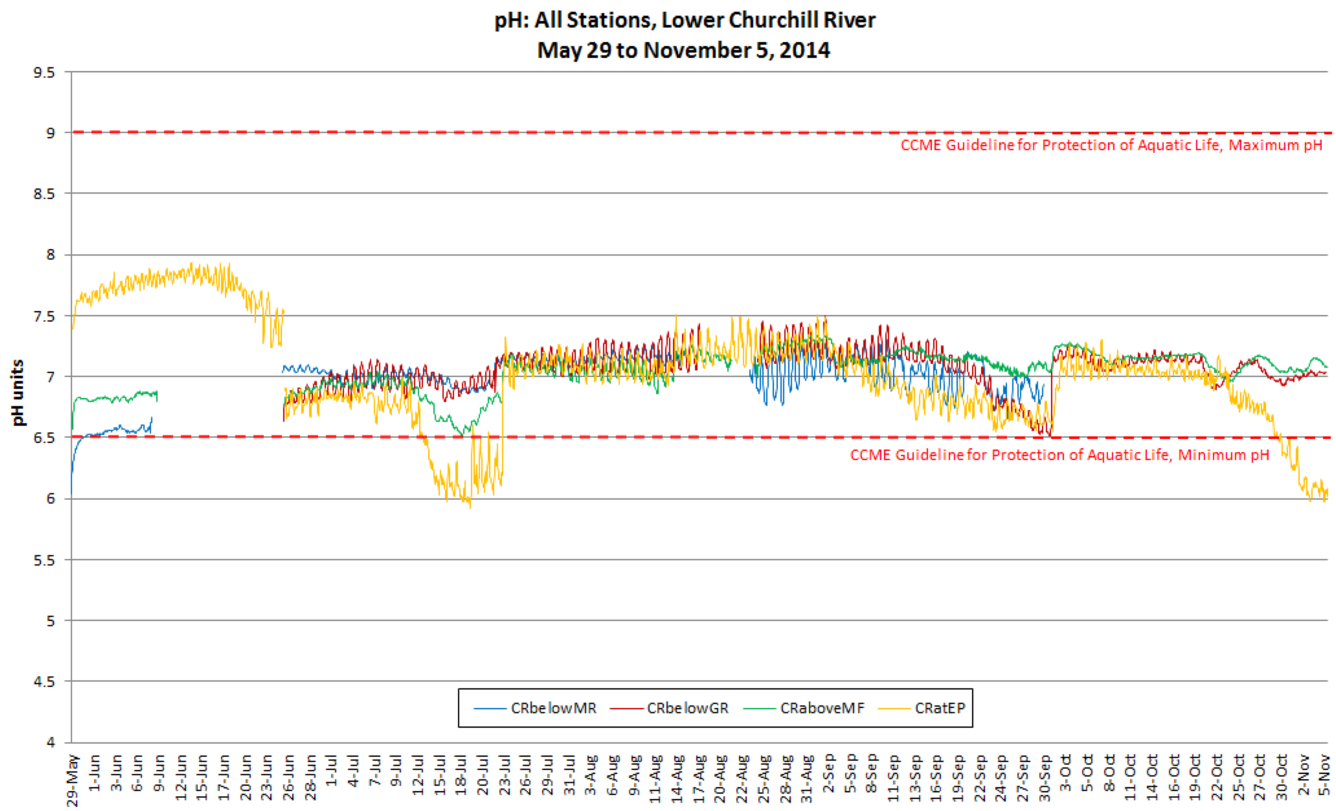

Figure 38: pH at all stations in 2014, Lower Churchill River

pH (units)	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Median	7.04	7.09	7.09	7.04
Max	7.30	7.50	7.35	7.93
Min	6.04	6.52	6.51	5.92

- Specific conductivity trends are similar along the Lower Churchill River except at English Point (Figure 39).
- Specific conductivity is generally very stable on the Lower Churchill River (above English Point), fluctuating only a few micro Siemens during a deployment period.
- Seasonal trends are notable at these stations and show specific conductivity increasing from the time of deployment in May to mid-August. Specific conductivity then decreases into the fall.
- At the station at English Point, specific conductance is highly variable, fluctuating significantly each day 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.

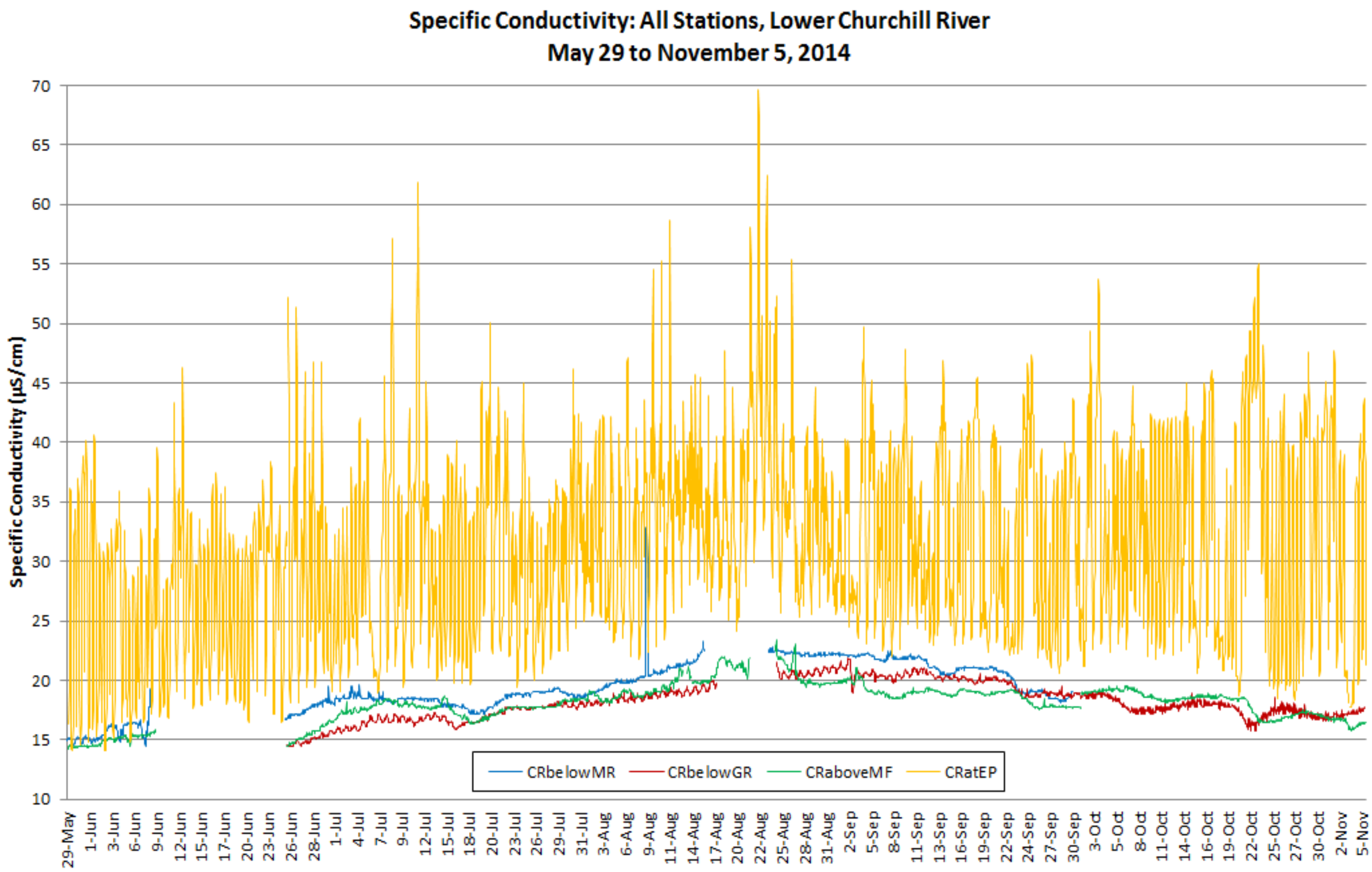

Figure 39: Specific conductivity at all stations in 2014, Lower Churchill River

Specific Conductivity (µS/cm)	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Median	19	18	18.3	30.6
Max	32.9	21.9	23.4	69.7
Min	14.4	14.4	14.2	14.1

- Dissolved oxygen content and percent saturation values are very similar throughout the network with median values from 9.37mg/l (below Metchin River) to 10.34mg/l (at English Point) and 94.7% (below Metchin River) to 99.6% (at English Point) (Figure 40).
- Dissolved oxygen content shows a very clear inverse relationship to water temperature and has a distinct seasonal trend decreasing in the spring and early summer, and increasing in the late summer and fall.
- Generally, dissolved oxygen content at the below Muskrat Falls station is higher than all other stations throughout the deployment season due to its location downstream from Muskrat Falls. However, as data was not available for this station for 2014 due to issues with sand, English Point consistently recorded the highest dissolved oxygen levels throughout the season compared to the other deployed stations. All stations recorded values below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value at 9.5 mg/l during the summer months. Guidelines are indicated in red on Figure 40.

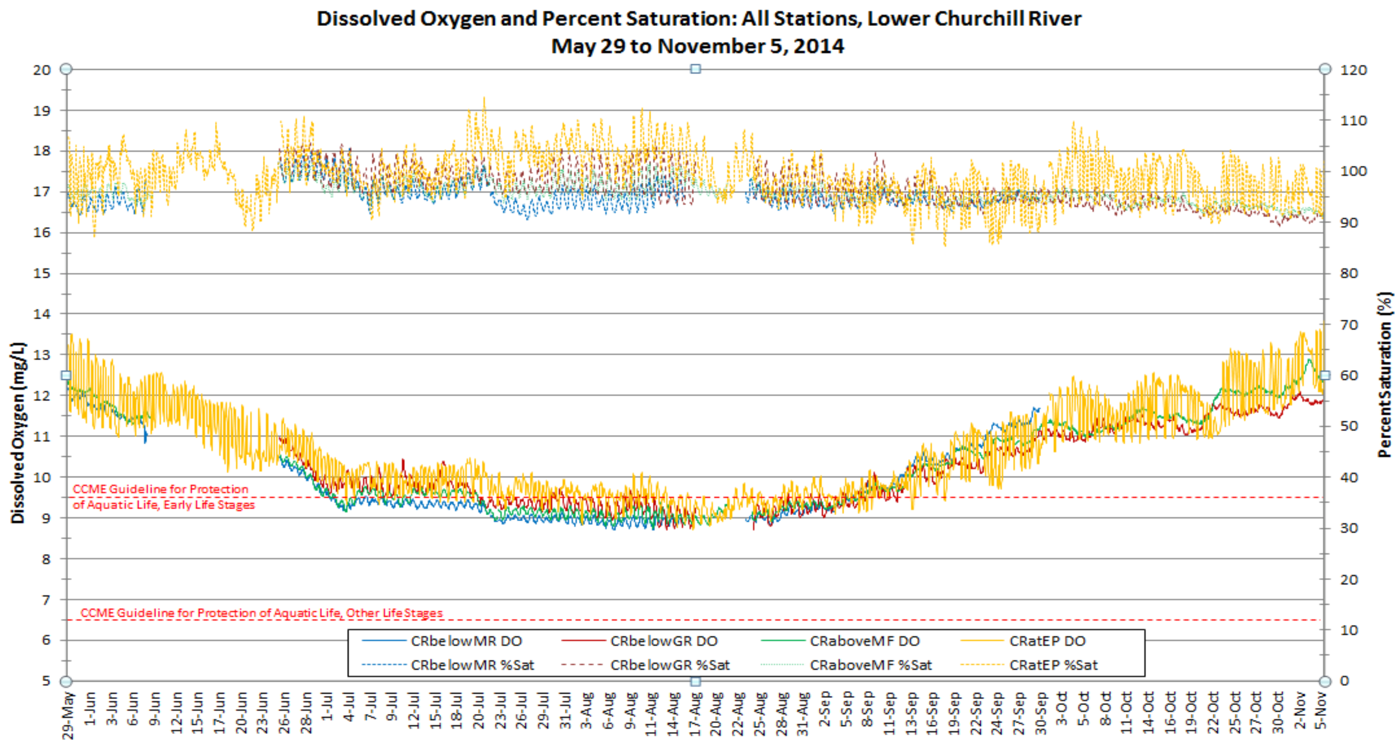

Figure 40: Dissolved oxygen and percent saturation at all stations in 2014, Lower Churchill River

	Dissolved Oxygen (mg/l)			
	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Median	9.37	9.92	9.75	10.34
Max	12.21	12.11	12.90	13.83
Min	8.71	8.70	8.73	8.72
	Percent Saturation (%)			
	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Median	94.7	95.8	95.5	99.6
Max	104.6	105.9	101.6	114.5
Min	90.5	89.4	90.8	85.4

- Turbidity values at stations below Grizzle Rapids and below Metchin River are generally 0NTU with minimal, short lived turbidity events (Figure 41). In the lower reaches of the Lower Churchill River, the stations above Muskrat Falls and at English Point have consistent natural background turbidity values.
- Background turbidity values are 9NTU and 16.1NTU for the stations above Muskrat Falls and at English Point, respectively.

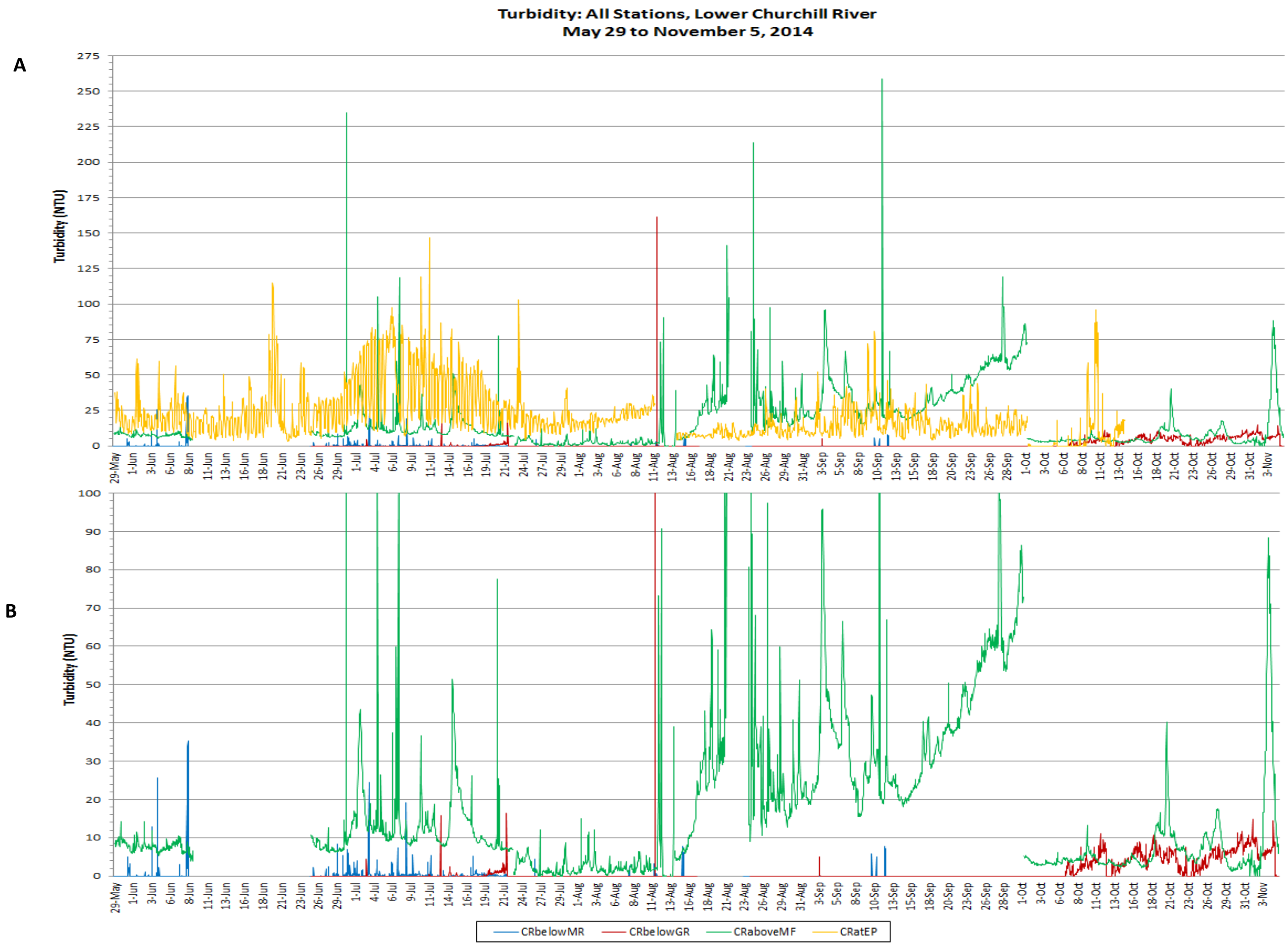

Figure 41a: Turbidity to 275NTU at all stations in 2014; Figure 41b: Turbidity to 100NTU in 2014 (English Point data removed)

Turbidity (NTU)	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Median	0	0	9	16.1
Max	468	161.2	258.7	147
Min	0	0	0	0
95 %	0.6	6.9	58.1	58.9
75 %	0	0	23.4	24.7

- Stage levels are similar across the network throughout the 2014 deployment season (Figure 42). Stage is generally decreasing at all stations from May into August. Stage levels reach a seasonal low at all stations above English Point in late-August before gradually increasing into the fall months. Stage level at English Point reaches a seasonal low in mid-June, is relatively stable during the summer months, and increases into the fall months.
- Stage ranges between 1.02m and 3.34m depending on the station. Most increases and decreases captured are noticeable at all stations in the network. The stage level at English Point is greatly affected by the tidal influence of the Atlantic Ocean and varies widely on a daily basis compared to the other stations in the network.

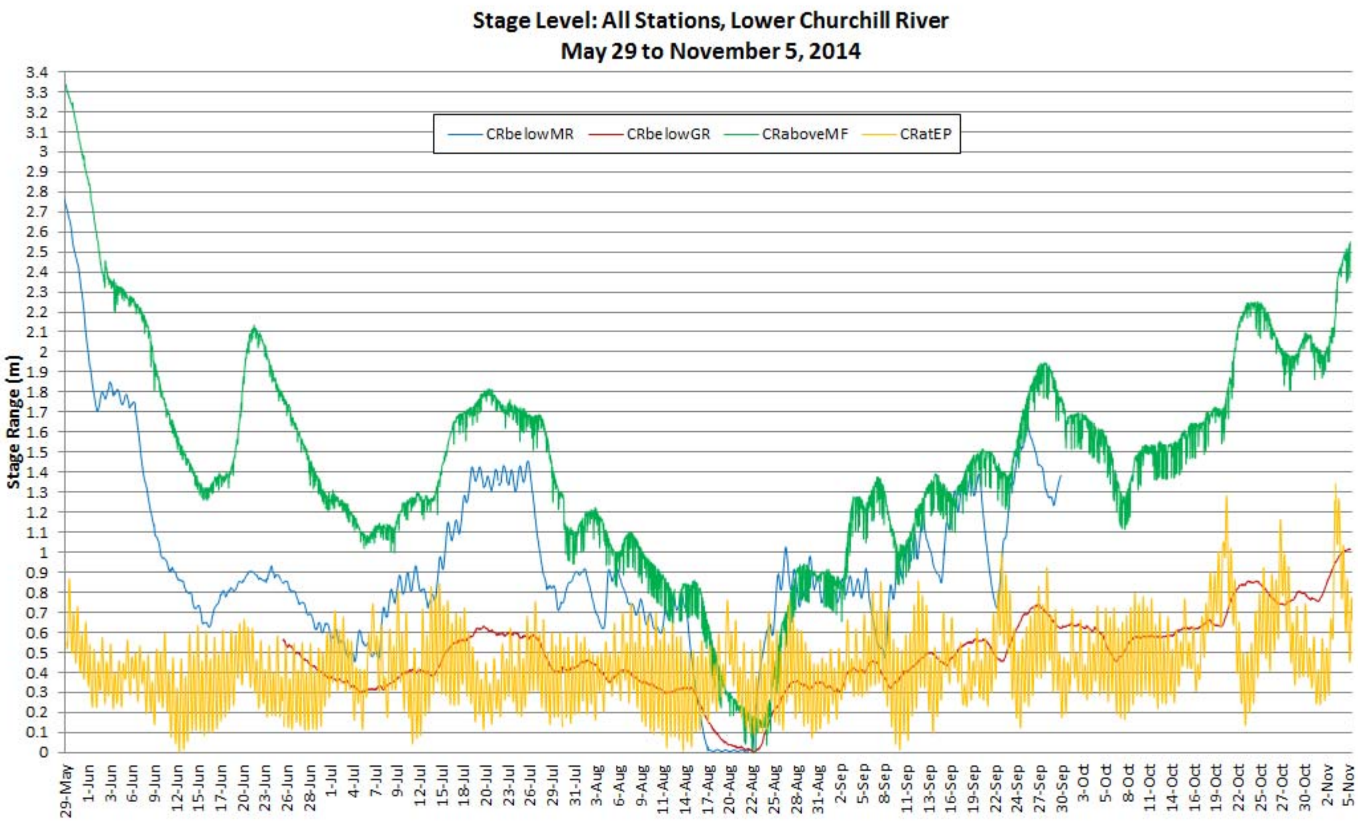

Figure 42: Stage levels at all stations in 2014, Lower Churchill River

	CRbelowMR	CRbelowGR	CRaboveMF	CRatEP
Stage Range (m)	2.762	1.018	3.336	1.343

Conclusions

- Water quality monitoring instruments were successfully deployed on the Lower Churchill River at stations below Metchin River, above Muskrat Falls and at English Point from May 29 to November 5. The below Grizzle Rapids station was not deployed until June 25 due to the presence of an ice wall blocking accessibility to the site in May. The below Muskrat Falls station was deployed from June 25 to August 14, however, the station was unable to provide reliable data due to interference from sand accumulation at the site. The below Metchin River station was removed on September 30 when the station was mothballed from usage.
- In most cases, weather related events explain the fluctuations in water levels. In 2014, the three deployed original stations continue to perform well at capturing water quality baseline data along different reaches of the river. The English Point station provides a last measurement of water quality in the lower Churchill River before entering Lake Melville. This station is affected by tidal influences from the Atlantic Ocean.
- Regular visits on a near 30 day deployment schedule have been adhered to for the most part. This has provided good quality data with limited drift. The effects of bio fouling rarely impact the instruments due to the cold pristine nature of the river and the regular maintenance each month.
- The instruments performed well for much of the deployment season with limited disruptions to data collection.
    - Rapid water level decreases left instruments exposed to air at the river's edge at the stations below Metchin River and above Muskrat Falls from June 8-25, and again for short periods of time August 16-24 at below Metchin River, below Grizzle Rapids and above Muskrat Falls stations. Data for these time periods has been removed from the data set. Turbidity data has been removed for some stations due to data inaccuracies resulting from the instrument being in very shallow water before running dry.
    - Turbidity data was compromised during two different deployments at English Point. Turbidity data for August 11-14 and October 15 -November 2 was removed from the dataset.
    - Finally, transmission errors were infrequent across the network during 2014.
- Data collected in 2014 is comparable with datasets from previous years in 2012 and 2013. Water quality parameters do not tend to vary significantly. Stage appears to be one of the greatest variables from year to year.
- Water temperatures were seasonal at all stations in the network peaking at seasonal highs in early July at below Metchin River and mid-August at all other stations in the network. Water temperatures had median values between 12.6°C (at English Point) and 16.1°C (below Metchin River).
- All values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH except for a short period of time at the station below Metchin River immediately following the initial deployment in May, and at English Point during July and October. Median pH values were 7.04 at below Metchin and at English Point, and 7.09 at below Grizzle Rapids and above Muskrat Falls.
- During the warm summer months of early July to early September, dissolved oxygen at all stations fell below the minimum CCME Guideline for the Protection of Aquatic Life during early life stages (9.5mg/L). All values at all stations remained above the minimum CCME Guideline for the Protection of Aquatic Life during other life stages (6.5mg/L) throughout the deployment period. Median values for dissolved oxygen and percent saturation ranged between 9.37mg/l (94.7%) (below Metchin River) and 10.34 (99.6%) (at English Point).
- Background turbidity values at the stations below Metchin River and below Grizzle Rapids were 0NTU and turbidity events were short lived and insignificant. At stations above Muskrat Falls and at English Point, median turbidity values were 9.0NTU and 16.1NTU respectively. Turbidity events were frequent, most often corresponding with precipitation events and visible at each of these two stations.

Path Forward

In order for this agreement to be successful, it is essential to continually evaluate and move forward. The 2014 deployment season was successful in providing water quality data for the Lower Churchill Project at four of the five stations. The following is a list of planned activities to be carried out in the upcoming year. The list also includes some multi-year activities planned in the previous year that are still in progress.

- ENVC staff will deploy RTWQ instruments in spring 2015 when ice conditions allow and perform regular site visits throughout the 2015 deployment season for calibration and maintenance of the instruments.
- EC staff will perform regular site visits to ensure water quantity instrumentation is correctly calibrated and providing accurate measurements.
- Nalcor will continue to be informed of data trends and any significant water quality events in the form of a monthly deployment report when the deployment season begins. Nalcor will also receive an annual report summarizing the events of the deployment season.
- Nalcor will continue to receive batch datasets of all RTWQ data. Raw data will be provided if requested.
- Open communication lines will continue to be maintained between ENVC, EC and Nalcor employees involved with the agreement in order to respond to emerging issues on a proactive basis.
- ENVC staff will assess the Churchill River below Muskrat Falls station in spring 2015 to determine whether or not a different mode of deployment will be necessary to deal with the sand accumulation issues of 2014. If necessary, the station may need to be relocated.
- ENVC will continuously update the TSS-Turbidity model for the stations above and below Muskrat Falls as new grab sample data becomes available. The model will then be tested and validated in consultation with Nalcor or their consultants as necessary.
- Research into the use of remote sensing (using satellite imagery) to predict/map water quality parameters (i.e. turbidity and TSS) will continue in 2015. Satellite imagery will be acquired by WRMD to further this area of research.
- The Lake Melville station remains a water quantity station. RTWQ monitoring was stopped in 2012 following continual damage to the deployed instrument. Six grab samples were taken during the 2014 season and results have been made available to Nalcor. ENVC has purchased a NexSens BC-450 data buoy to deploy at this site in spring 2015.

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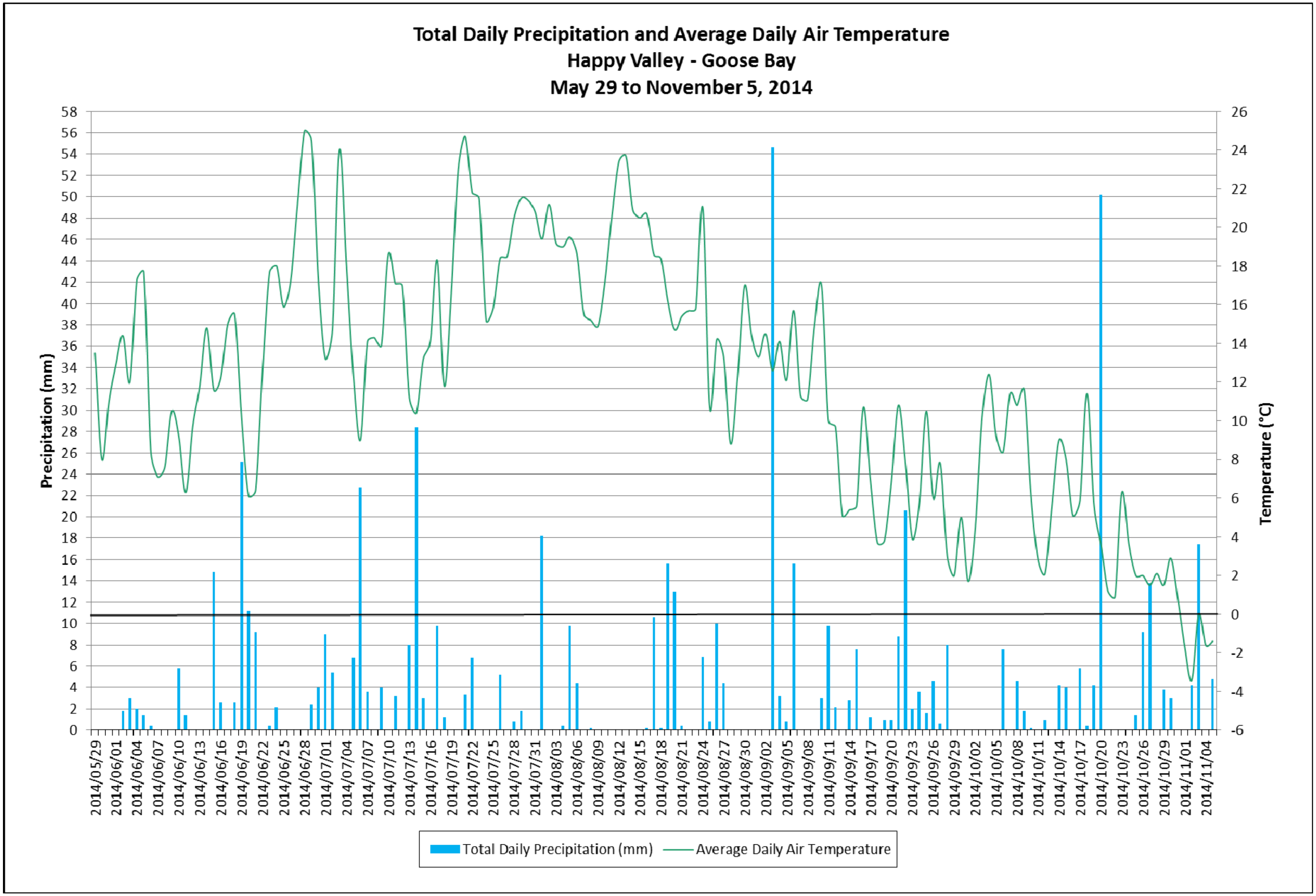
Appendix 1


Total Daily Precipitation and Average Daily Air Temperature
Happy Valley - Goose Bay
May 29 to November 5, 2014
Precipitation (mm)
Temperature (°C)
Total Daily Precipitation (mm)
Average Daily Air Temperature