Real-Time Water Quality Deployment Report

Lower Churchill River Network

May 24/June 6 to
July 6/14, 2023

Newfoundland Labrador

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

Contents

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Real Time Water Quality Monitoring

- Staff with the Department of Environment and Climate Change monitor real-time water quality data on a regular basis.
- This deployment report discusses water quality related events occurring at three stations on the Lower Churchill River: Churchill River below Metchin River, Churchill River below Muskrat Falls and Churchill River at English Point.
- Real-time water quality monitoring instruments were deployed at Churchill River below Muskrat Falls and Churchill River at English Point on May 24th. An instrument was deployed at Churchill River below Metchin River on June 6th.
- An instrument was not deployed at Churchill River above Grizzle Rapids due to the presence of an ice wall, which prohibited access to that site.
- The instruments at Churchill River below Muskrat Falls and Churchill River at English Point were removed on July 6th, for a deployment period of 43 days.
- The instrument at Churchill River below Metchin River was removed on July 14th, for a deployment period of 38 days.

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. This procedure is based on the approach used by the United States Geological Survey.
- At deployment and removal, a QA/QC 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 QA/QC instrument at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Instrument Performance Ranking classifications for deployment and removal

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

- It should be noted that the temperature sensor on any instrument is the most important. All other parameters can be broken down into three groups: temperature 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.

- Deployment and removal comparison rankings for the Lower Churchill River stations deployed from May 24/June 6 to July 6/14, 2023 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations May 24/June 6 to July 6/14, 2023

Churchill River Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	June 6, 2023	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	July 14, 2023	Removal	Excellent	Poor	Excellent	Excellent	Excellent
Above Grizzle Rapids	N/A	Deployment	N/A	N/A	N/A	N/A	N/A
	N/A	Removal	N/A	N/A	N/A	N/A	N/A
Below Muskrat Falls	May 24, 2023	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	July 6, 2023	Removal	Excellent	Good	Excellent	Good	Excellent
At English Point	May 24, 2023	Deployment	Excellent	Excellent	Good	Excellent	Good
	July 6, 2023	Removal	Fair	Good	Good	Excellent	Good

- **Churchill River below Metchin River**
  - At deployment, all parameters ranked as either 'excellent' or 'good'.
  - At removal, all parameters ranked as 'excellent', with the exception of pH which was 'poor'. This discrepancy may be attributable to sediment build-up around the sensor, or to a broader sensor failure.
- **Churchill River above Grizzle Rapids**
  - An instrument could not be deployed at this station due to unfavourable site conditions.
- **Churchill River below Muskrat Falls**
  - At deployment, all parameters ranked as either 'excellent' or 'good'.
  - At removal, all parameters again ranked as either 'excellent' or 'good'.
- **Churchill River at English Point**
  - At deployment, all parameters ranked as either 'excellent' or 'good'.
  - At removal, dissolved oxygen was 'excellent', pH, conductivity and turbidity were 'good', and temperature was 'fair'.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring from May 24/June 6 to July 6/14, 2023 on the Lower Churchill River Network.
- With the exception of water quantity data (stage & flow), all data used in the preparation of the graphs and subsequent discussion below adhere to stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

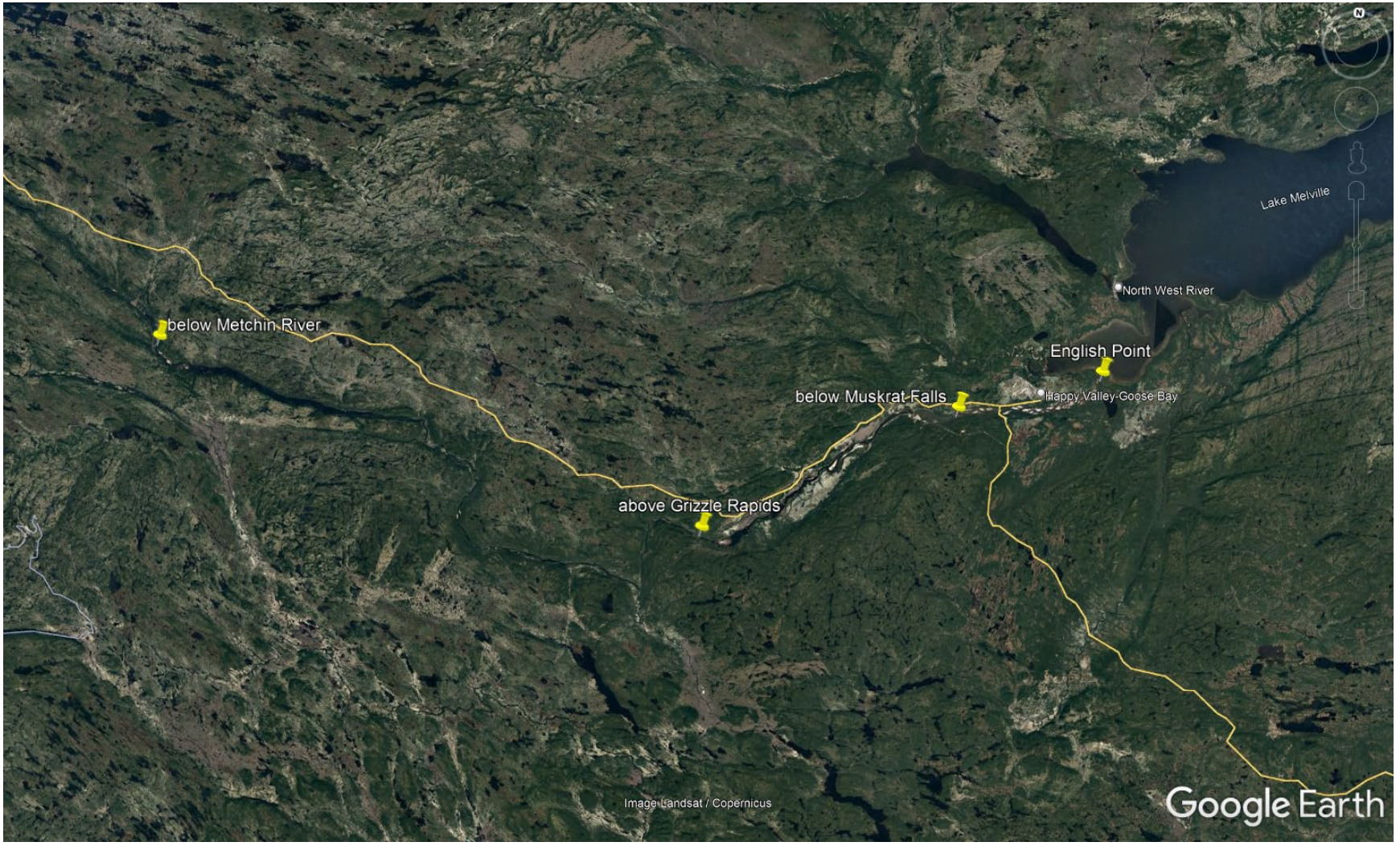

Figure 1: Lower Churchill Network of Real-Time Water Quality Stations

Churchill River below Metchin River

Water Temperature

- Over the deployment period, water temperature ranged from 8.7°C to 20.6°C, with a median value of 14.1°C (Figure 2). Air temperature data was obtained from the Metchin River near TLH Weather Station.
- Water temperature was gradually increasing over the course of deployment, which is to be expected as air temperatures were also increasing through the spring and summer. Water temperature data exhibits a diurnal pattern as expected, and closely correlates with ambient air temperatures.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

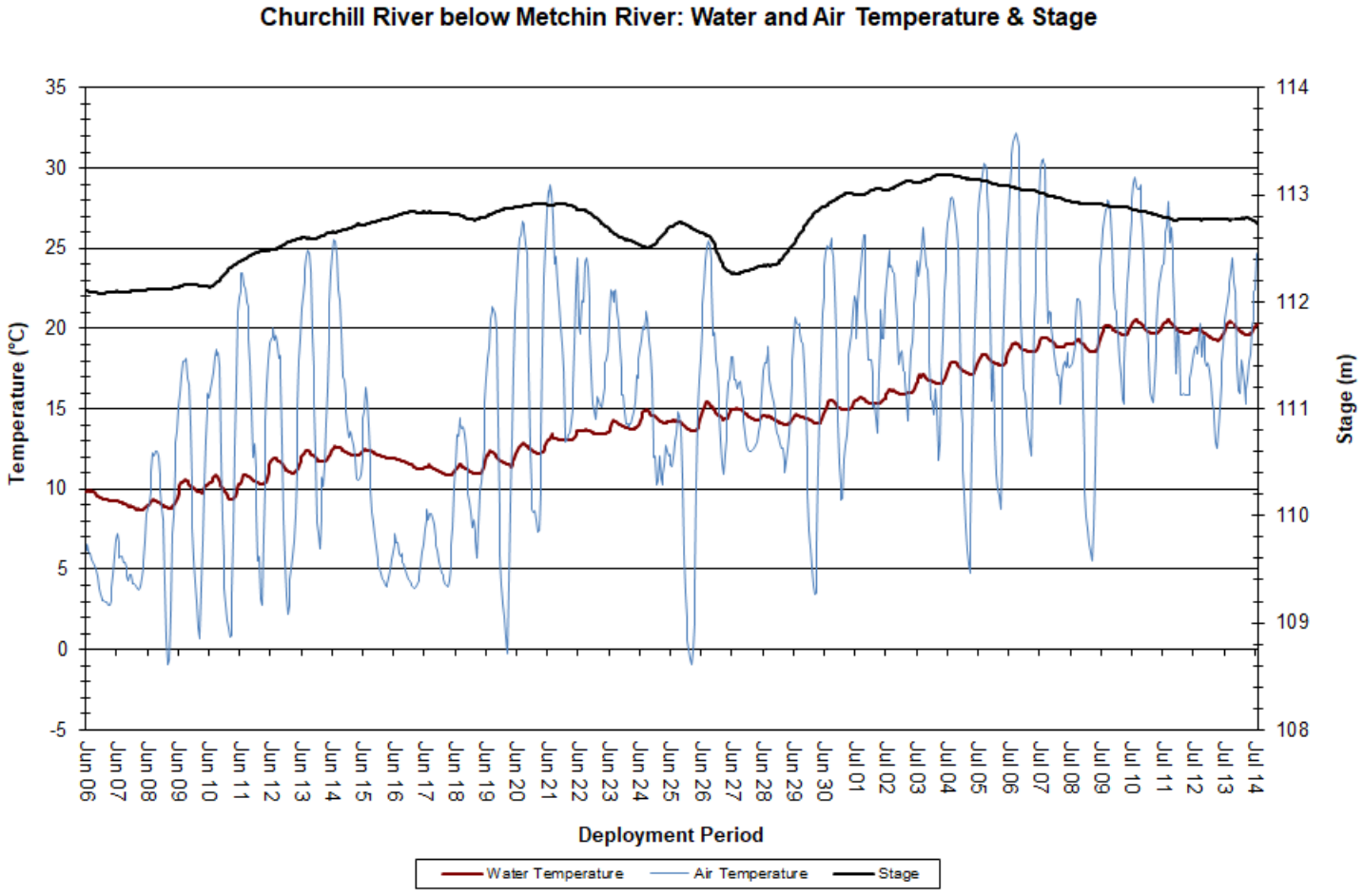

Figure 2: Water and Air Temperature & Stage at Churchill River below Metchin River

pH

- Over the deployment period, pH values ranged from 0 to 6.75 pH units, with a median value of 3.58 (Figure 3).
- pH values were variable across the deployment period. While some fluctuations in pH would be expected, the level of variability observed indicates that there was likely either significant sediment build-up around the instrument or a failure with the pH sensor.
- pH levels were below the CCME's Guidelines for the Protection of Aquatic Life for the duration of deployment.
- Photosynthesis uses up hydrogen molecules; this causes the concentration of hydrogen ions to decrease, which in turn causes pH to increase. For this reason, pH may be higher during daylight hours and during the growing season when photosynthesis is at a maximum. This is typically illustrated by diurnal fluctuations in pH values.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

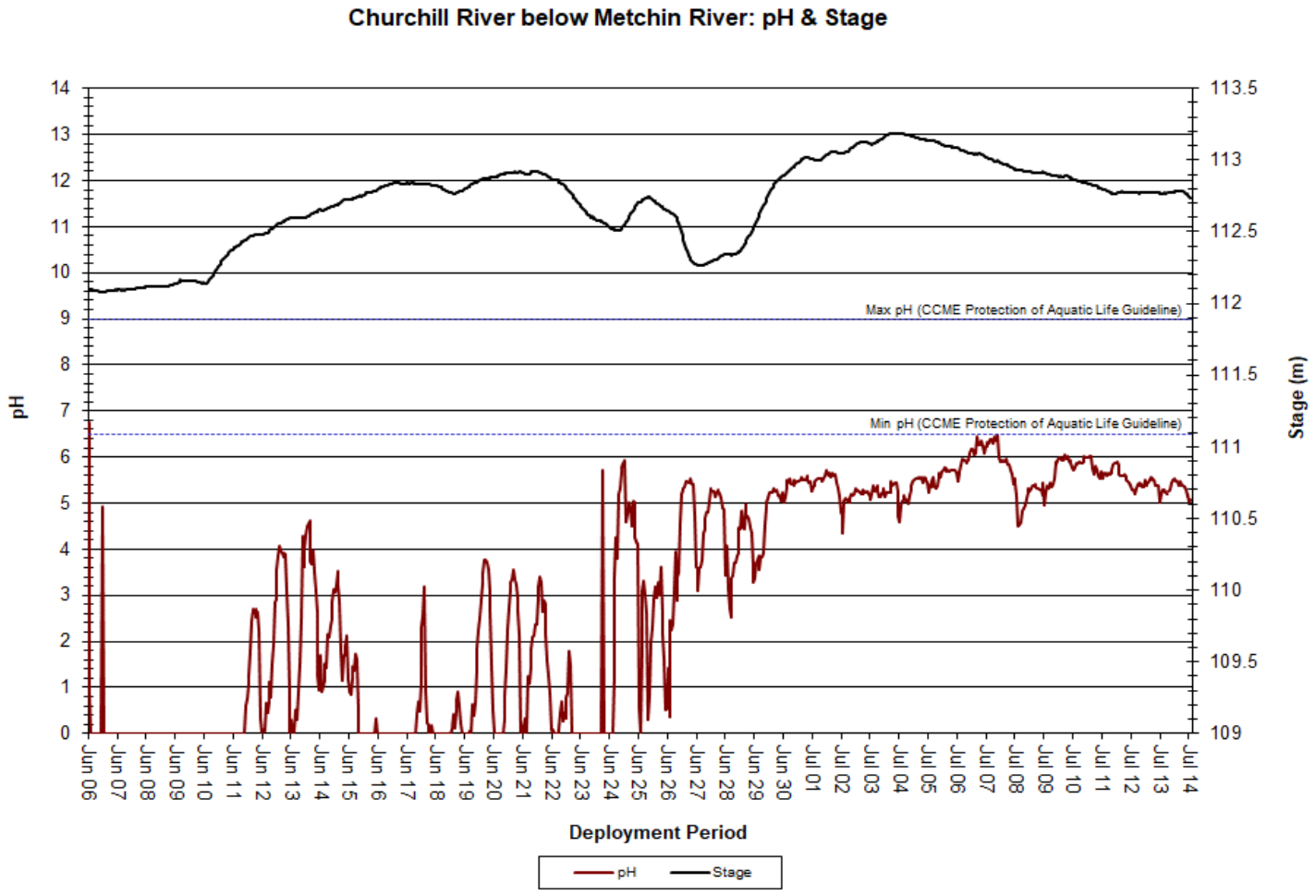

Figure 3: pH & Stage at Churchill River below Metchin River

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 18.6µS/cm to 43.6µS/cm, with a median value of 22.4µS/cm (Figure 4).
- The relationship between conductivity and stage is generally inversed. When stage levels increase, specific conductivity levels decrease as the increased amount of water in the river system dilutes solids that are present. This relationship is somewhat evident in the graph below (Figure 4).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

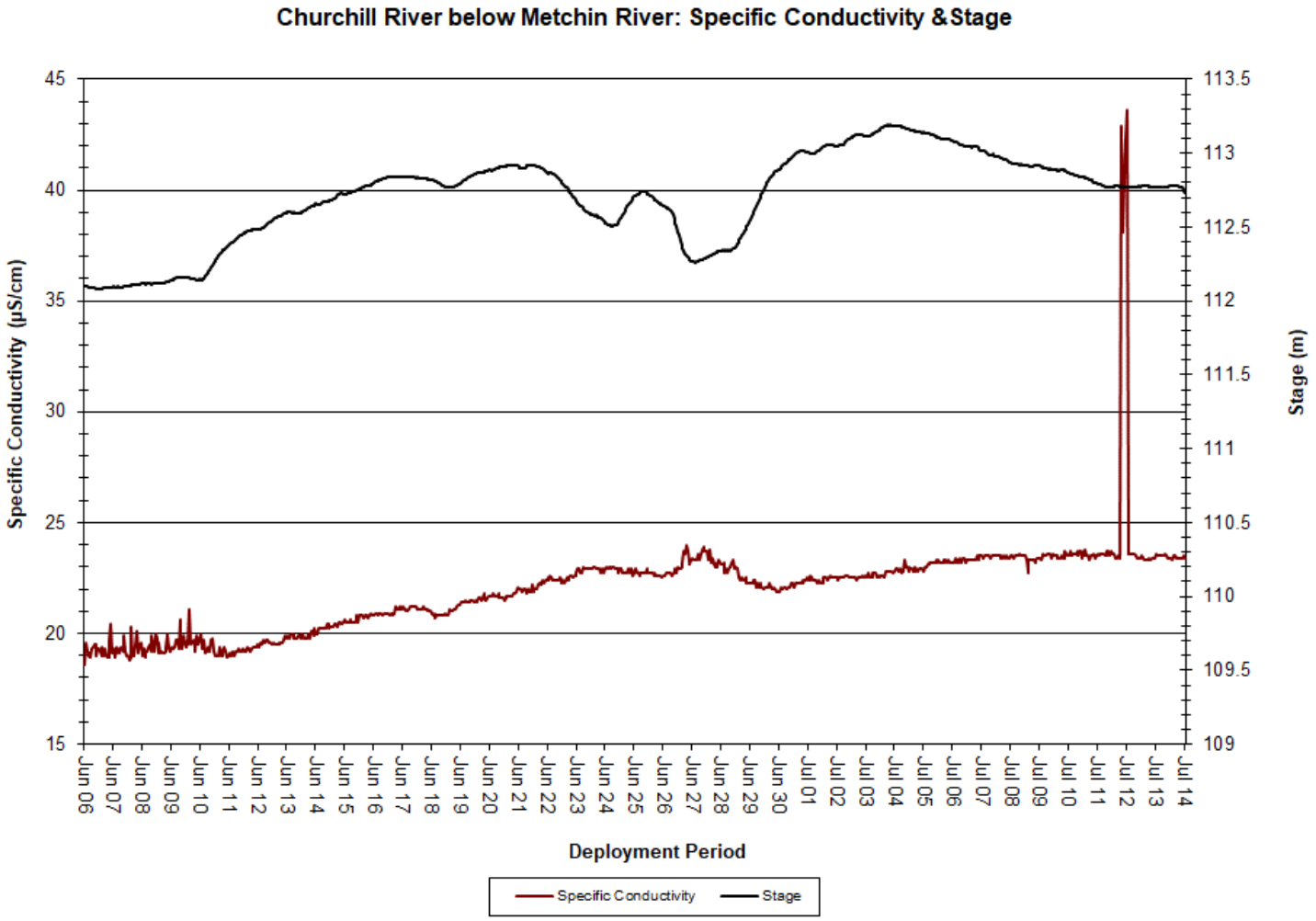

Figure 4: Specific Conductivity & Stage at Churchill River below Metchin River

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 8.93mg/L to 11.36mg/L, with a median value of 10.26mg/L. Saturation of dissolved oxygen ranged from 95.6% to 104.2%, with a median value of 99.5% (Figure 5).
- There is an evident relationship between water temperature and dissolved oxygen. Over the deployment period, dissolved oxygen levels were steadily decreasing, as water temperatures were steadily increasing. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures. Generally, dissolved oxygen levels are higher in a waterbody during cooler temperatures.
- Dissolved oxygen levels were above the CCME's Guideline for the Protection of Early Life Stages until early July, after which they fell below the guideline for the remainder of deployment. Dissolved oxygen levels remained above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment.

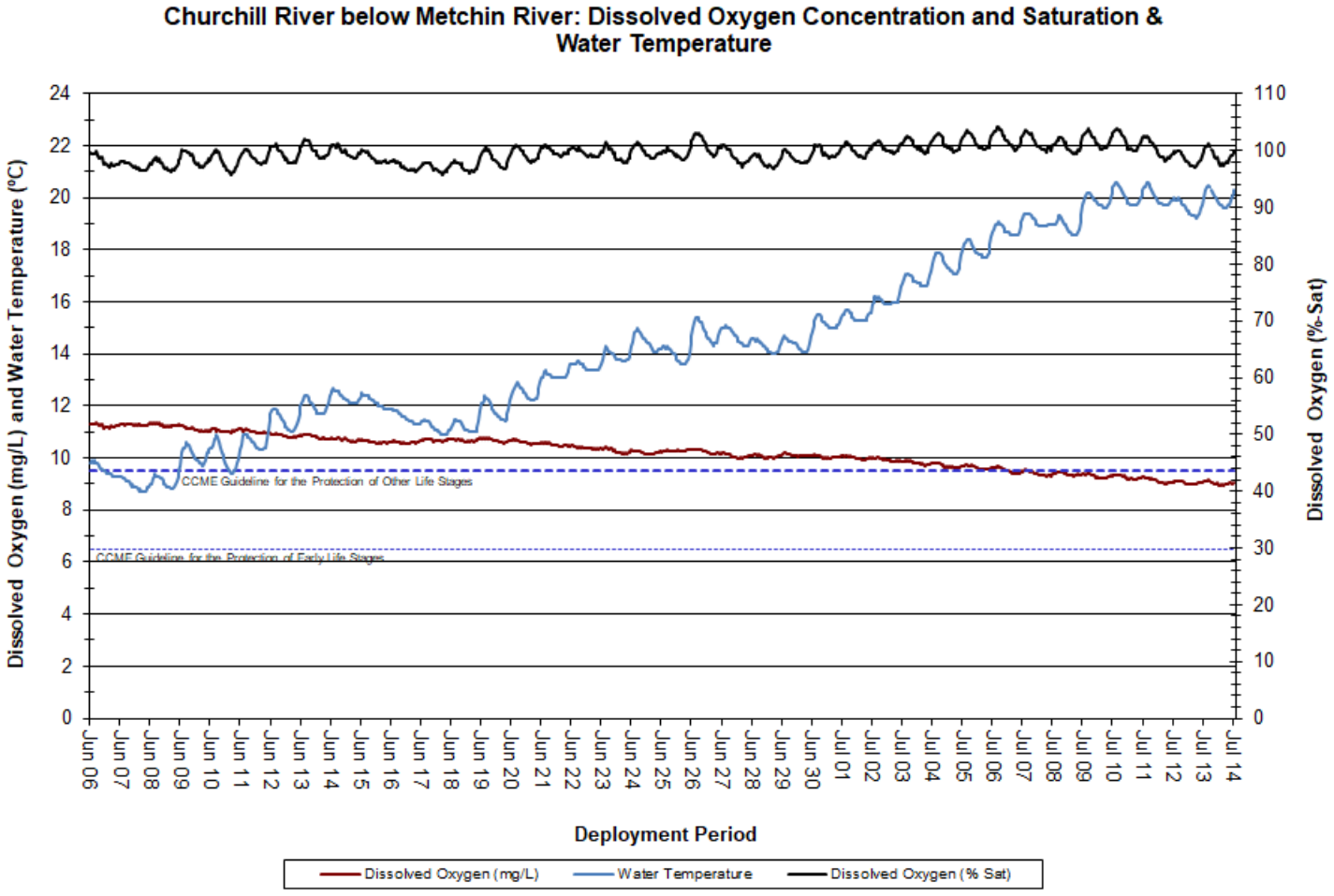

Figure 5: Dissolved Oxygen & Water Temperature at Churchill River below Metchin River

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 4.5NTU, with a median value of 0.0NTU (Figure 6). A median value of 0.0NTU indicates a very low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Some of the turbidity spikes observed throughout the deployment period correlate closely with precipitation events (Figure 6); however, some turbidity events do not coincide with any precipitation. This station is located at a wide and deep section of the Churchill River and therefore turbidity levels are likely less susceptible to precipitation events as compared to other areas.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

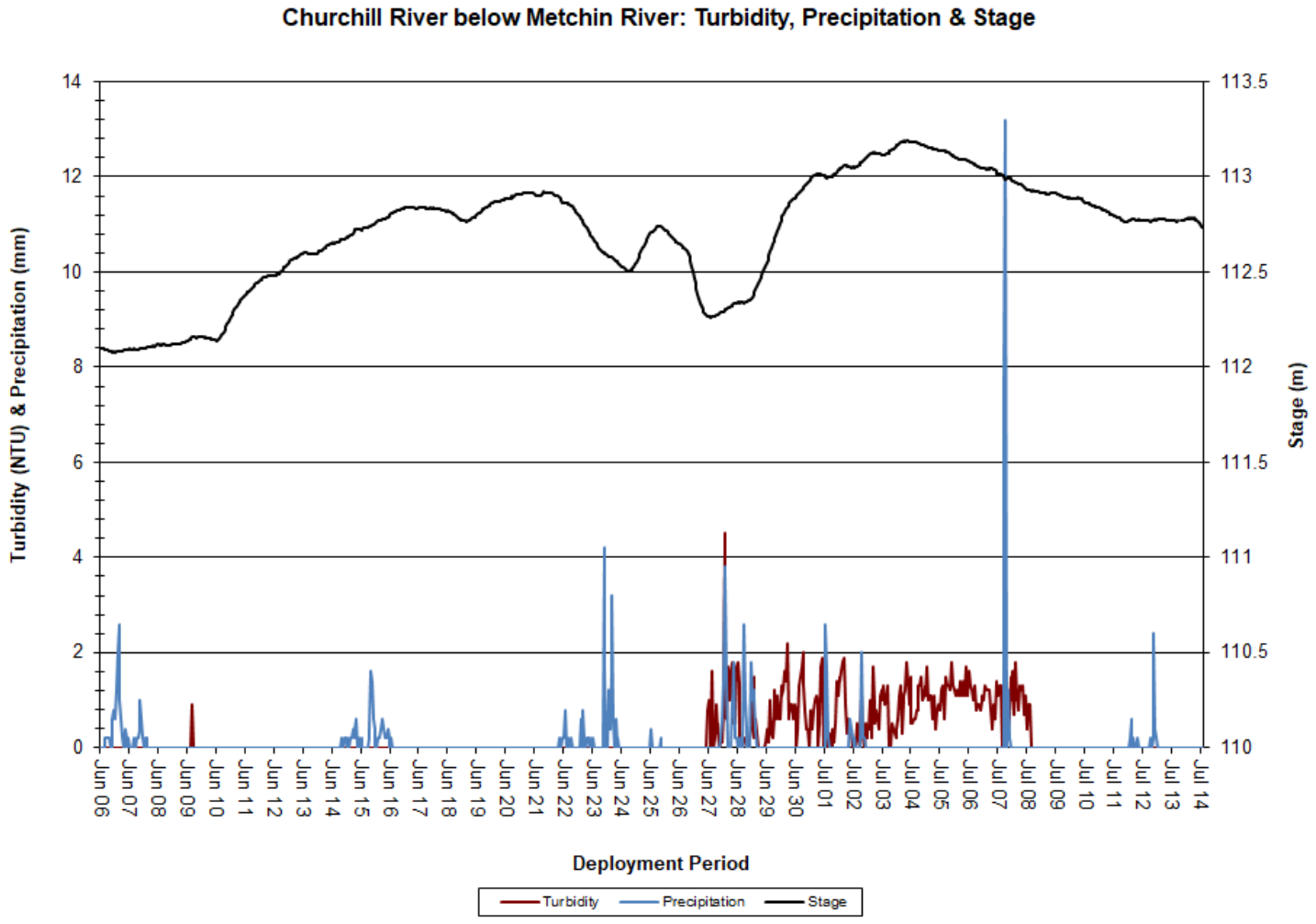

Figure 6: Turbidity, Precipitation & Stage at Churchill River below Metchin River

Stage and Flow

- Over the deployment period, stage levels ranged from 112.079m to 113.189m, with a median value of 112.775m. Flow ranged from 923.413m^3/s to 1317.77m^3/s, with a median value of 1197.652m^3/s (Figure 7). Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Stage and flow were variable but relatively stable over the course of deployment. Precipitation amounts across the same period often correlated with increases in both stage and flow (Figure 8).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

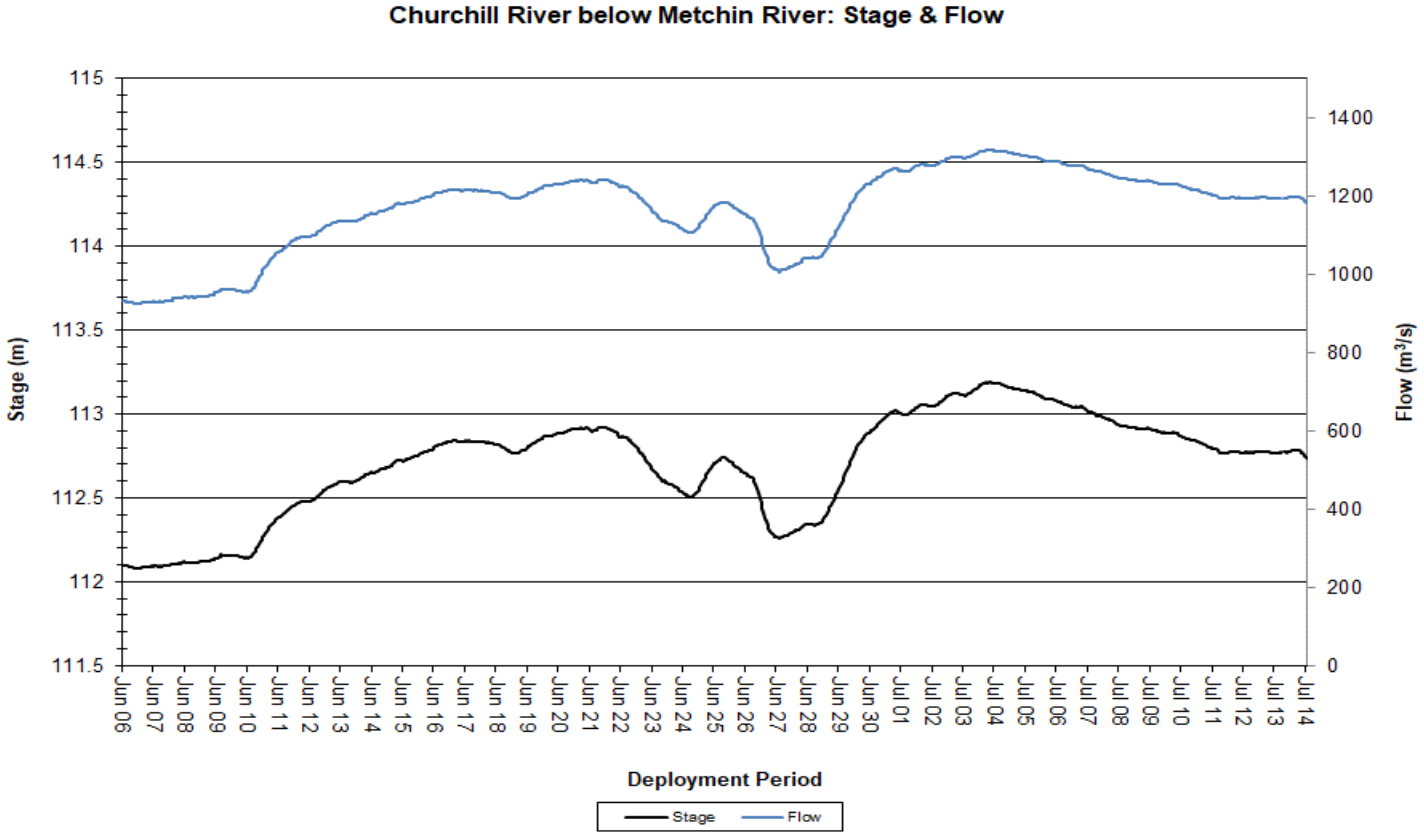

Figure 7: Stage & Flow at Churchill River below Metchin River

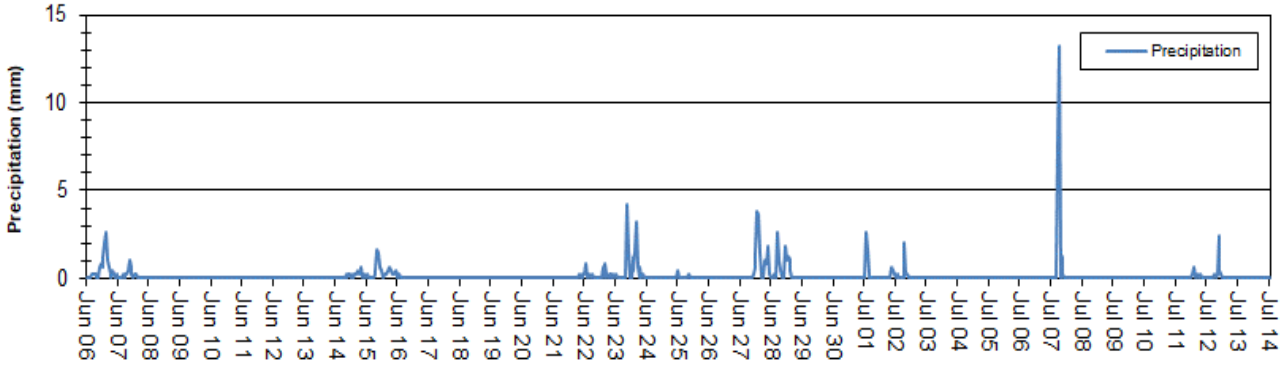

Figure 8: Precipitation at Churchill River below Metchin River

Churchill River below Muskrat Falls

Water Temperature

- Over the deployment period, water temperature ranged from 3.3°C to 15.7°C, with a median value of 7.45°C (Figure 9). Air temperature data was obtained from the Muskrat Falls Weather Station, which experienced some transmission issues toward the end of the deployment period.
- Water temperature steadily increased over the course of the deployment period. This is to be expected as ambient air temperatures also increased over the same period. Water temperatures closely correlate with ambient air temperatures.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

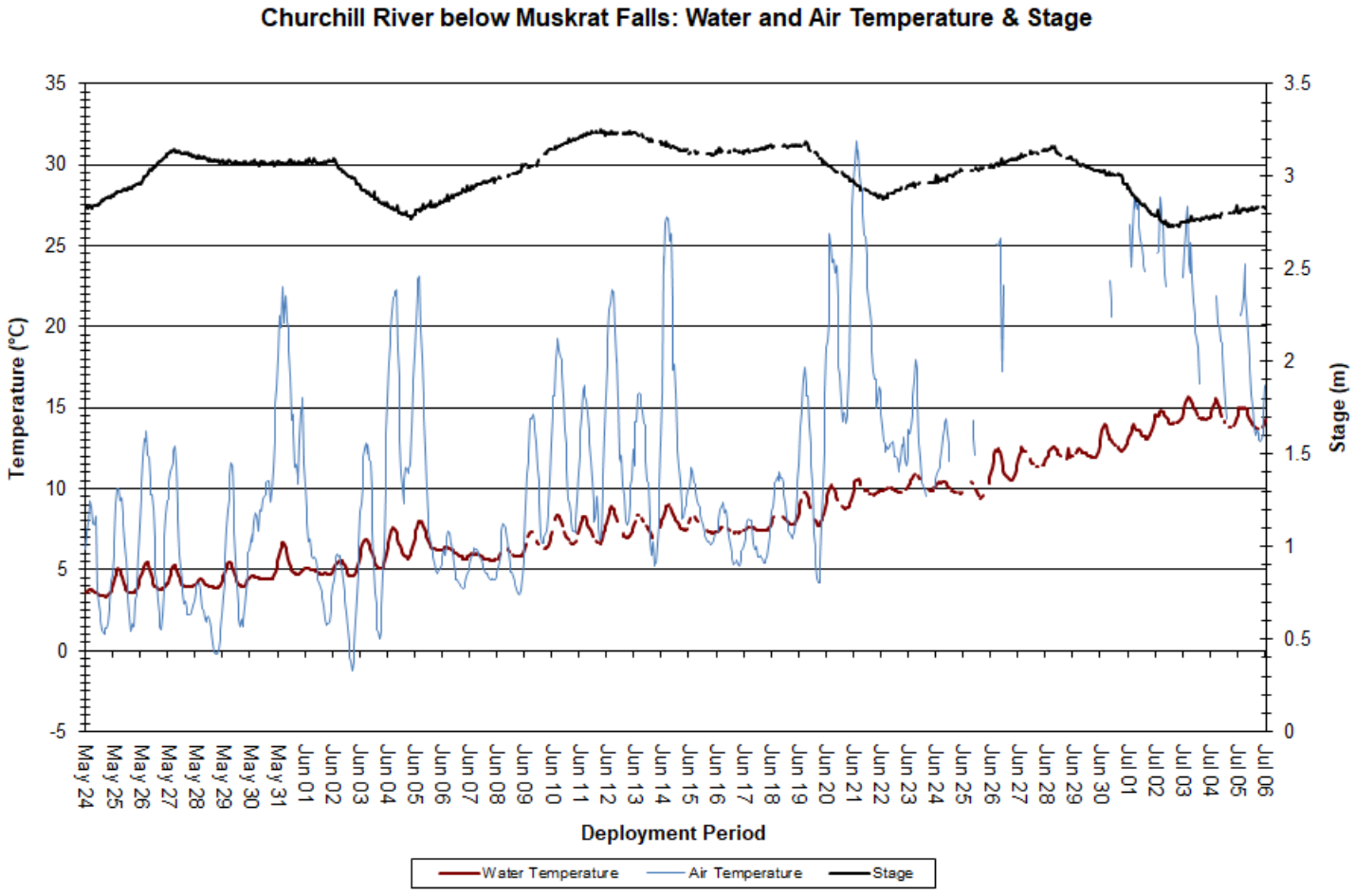

Figure 9: Water and Air Temperature & Stage at Churchill River below Muskrat Falls

pH

- Over the deployment period, pH ranged from 6.24 pH units to 6.70 pH units, with a median value of 6.51 (Figure 10).
- pH values were quite stable over the course of deployment, hovering around the CCME's Minimum Guideline for the Protection of Aquatic Life for the duration of deployment (Figure 10).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

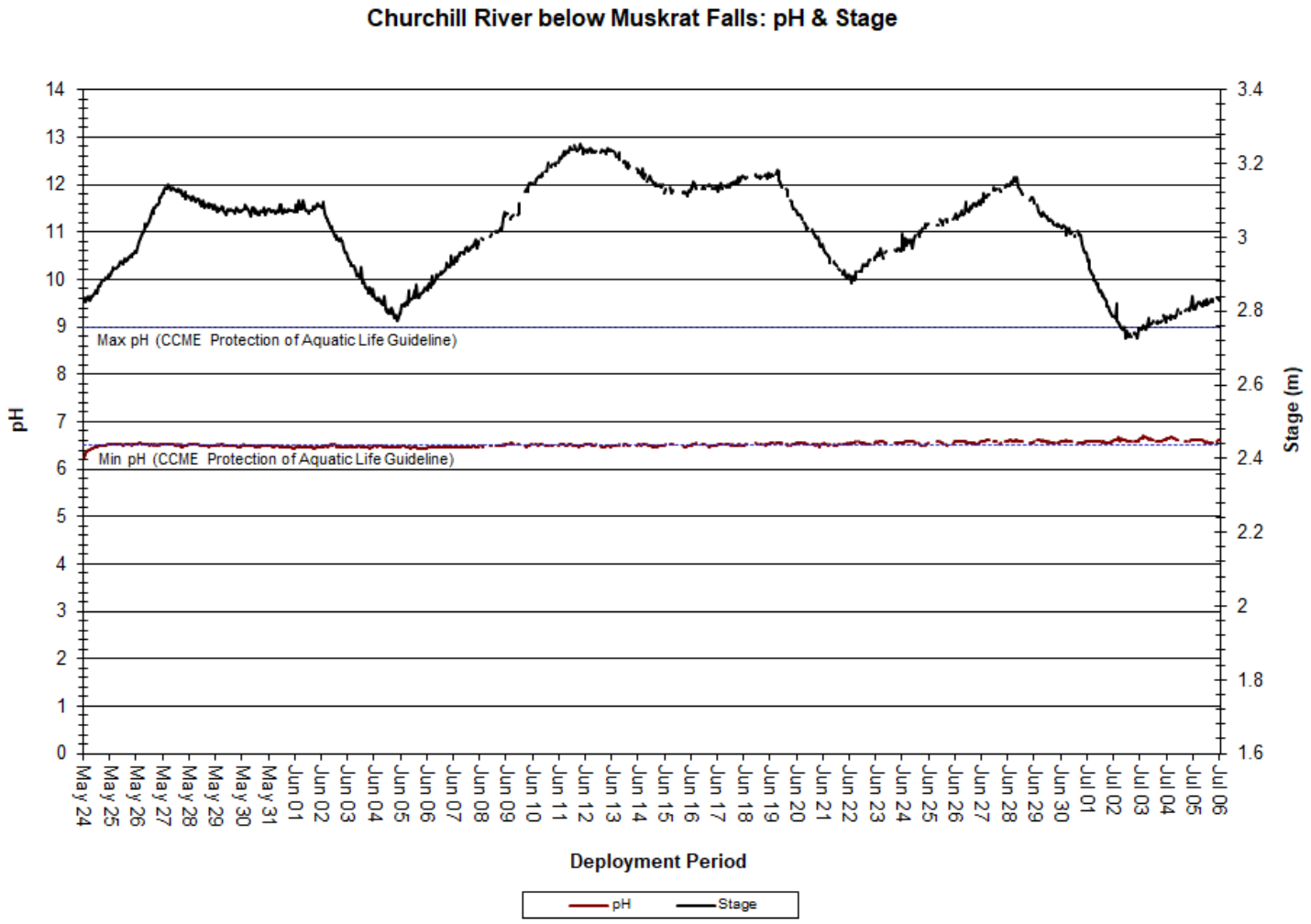

Figure 10: pH & Stage at Churchill River below Muskrat Falls

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 12.2µS/cm to 18.0µS/cm, with a median value of 14.5µS/cm (Figure 11).
- The relationship between conductivity and stage is generally inversed. When stage decreases, specific conductivity increases as the decreased amount of water in the river system concentrates solids that are present, and vice versa. This relationship is only somewhat evident in the graph below, likely because this station is located at a deep and wide section of the Churchill River and other factors in the water column influence conductivity levels (Figure 11).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

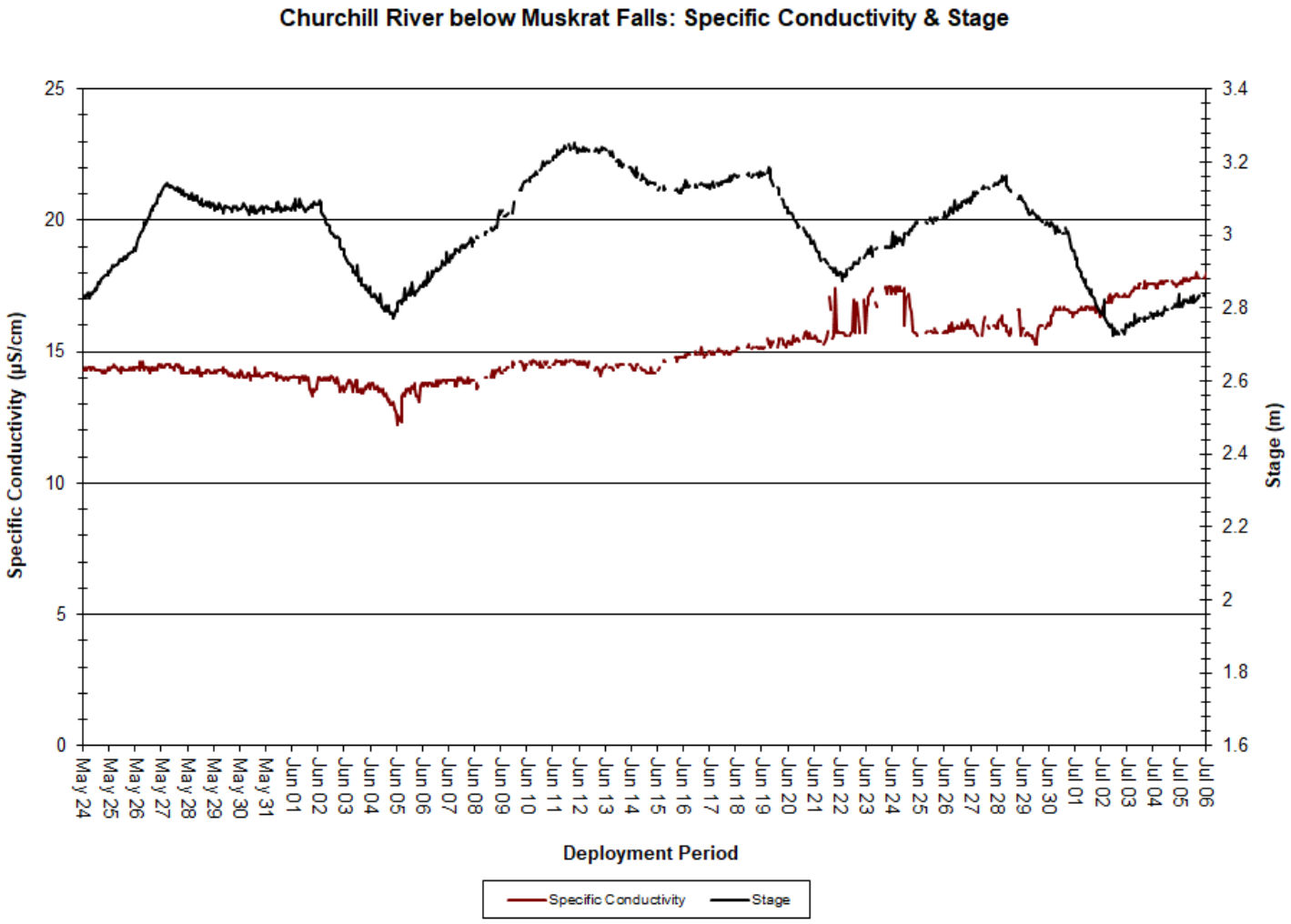

Figure 11: Specific Conductivity & Stage at Churchill River below Muskrat Falls

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 10.06mg/L to 12.96mg/L, with a median value of 11.64mg/L. Saturation of dissolved oxygen ranged from 94.7% to 105.7%, with a median value of 98.5% (Figure 12).
- Dissolved oxygen and water temperature exhibit an inverse relationship: as one parameter increases, the other decreases, and vice versa. Dissolved oxygen levels slowly decreased over the course of deployment. This is to be expected since water temperatures were slowly increasing over the same period. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures.
- Dissolved oxygen levels were above the CCME's Guidelines for the Protection of Early and Other Life Stages for the duration of deployment.

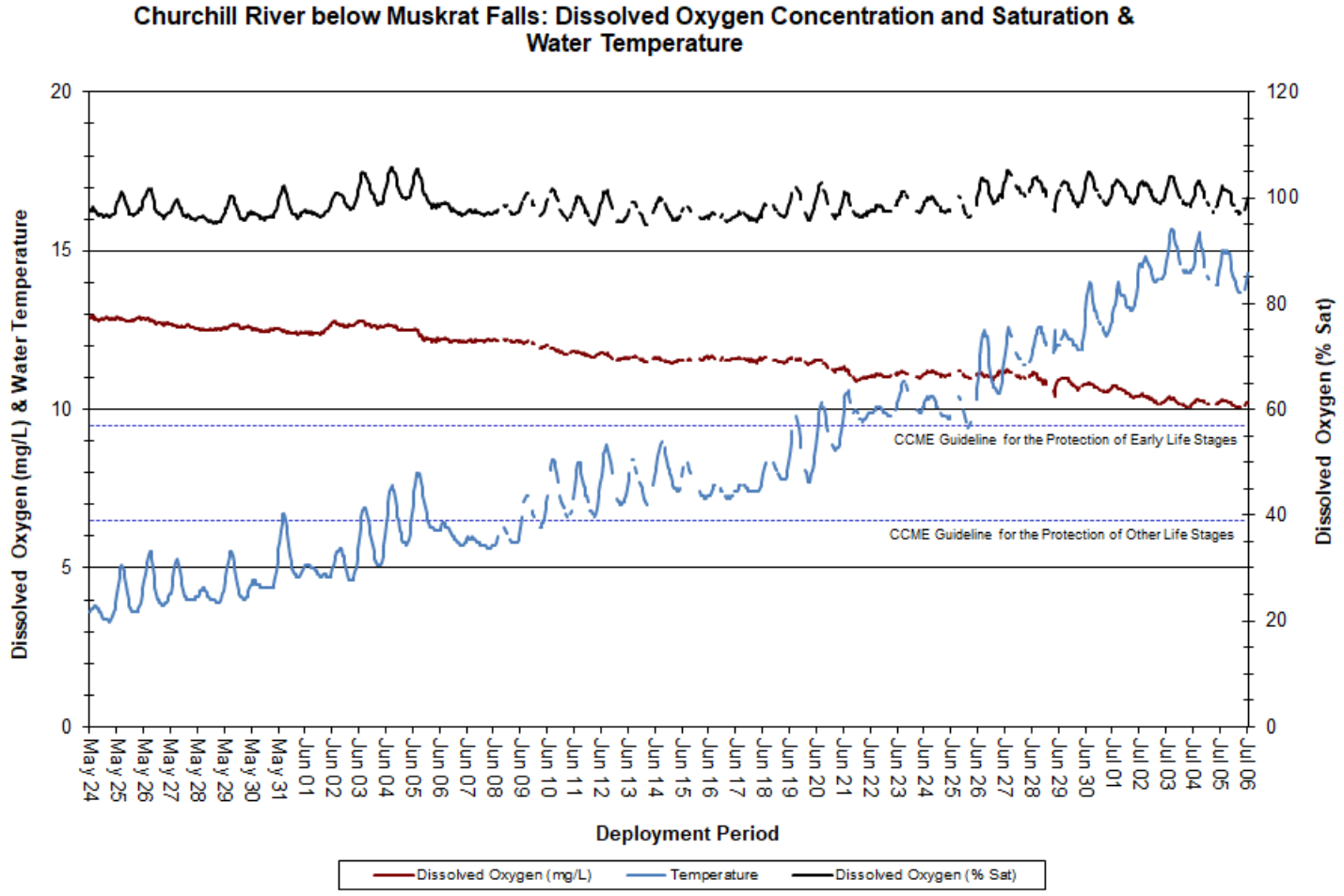

Figure 12: Dissolved Oxygen & Water Temperature at Churchill River below Muskrat Falls

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 43.7NTU, with a median value of 0.5NTU. A median value of 0.5NTU indicates a very low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Muskrat Falls Weather Station, which experienced some transmission issues toward the end of the deployment period.
- There was some correlation between turbidity events and precipitation events across the deployment period (Figure 13).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

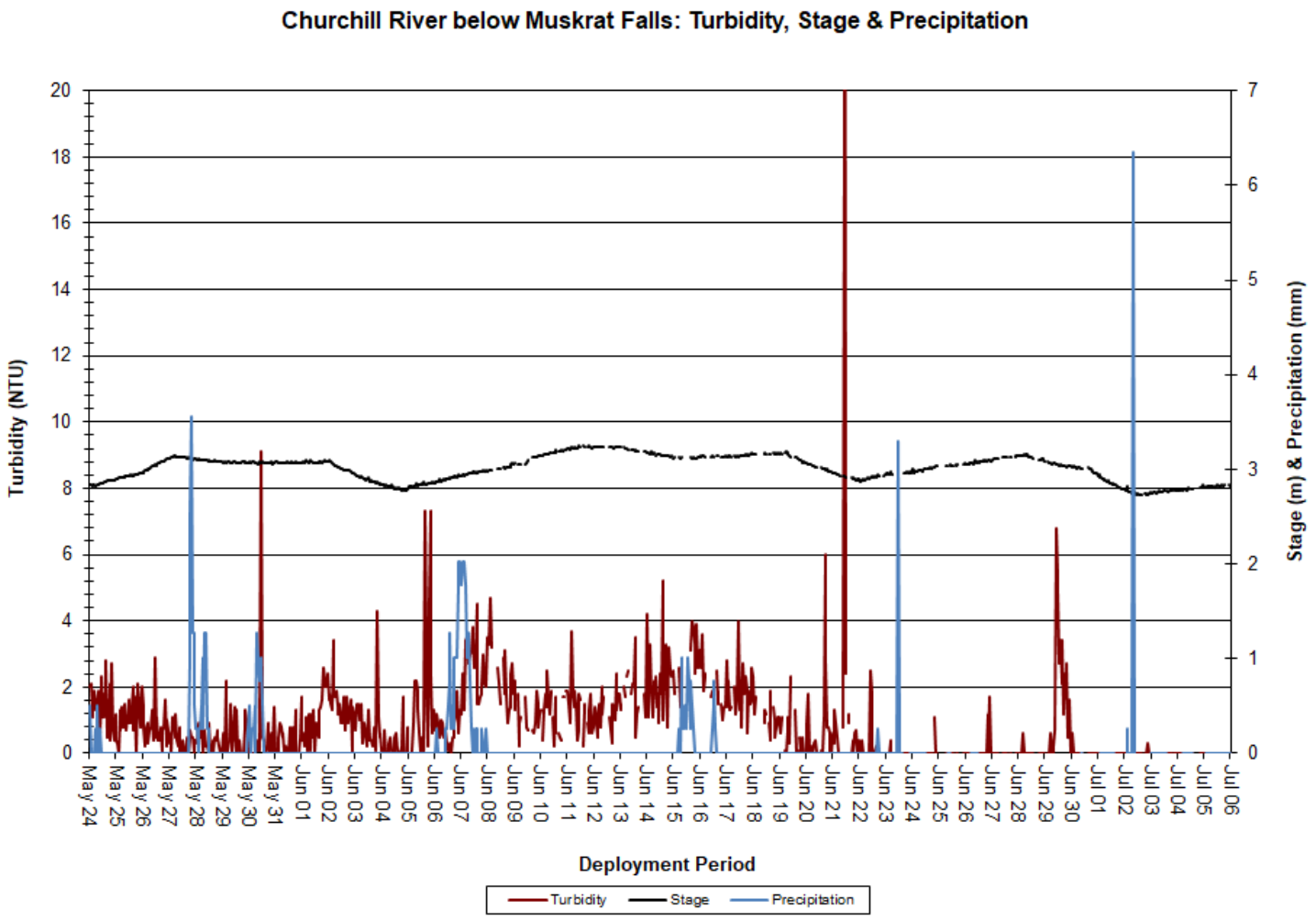

Figure 13: Turbidity, Precipitation & Stage at Churchill River below Muskrat Falls

Stage & Flow

- Over the deployment period, stage ranged from 2.726m to 3.252m, with a median value of 3.046m. Flow ranged from 1714.12m^3/s to 2278.63m^3/s, with a median value of 2054.17m^3/s (Figure 14). Precipitation data was obtained from the Muskrat Falls Weather Station, which experienced some transmission issues toward the end of the deployment period.
- Stage and flow were variable over the course of deployment and correlated somewhat with precipitation events. This is partly related to the fact that this station is located on a very wide section of the Churchill River and therefore not as easily influenced by smaller precipitation events. Stage and flow at this station are also influenced by upstream activities at the Muskrat Falls hydroelectric project.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

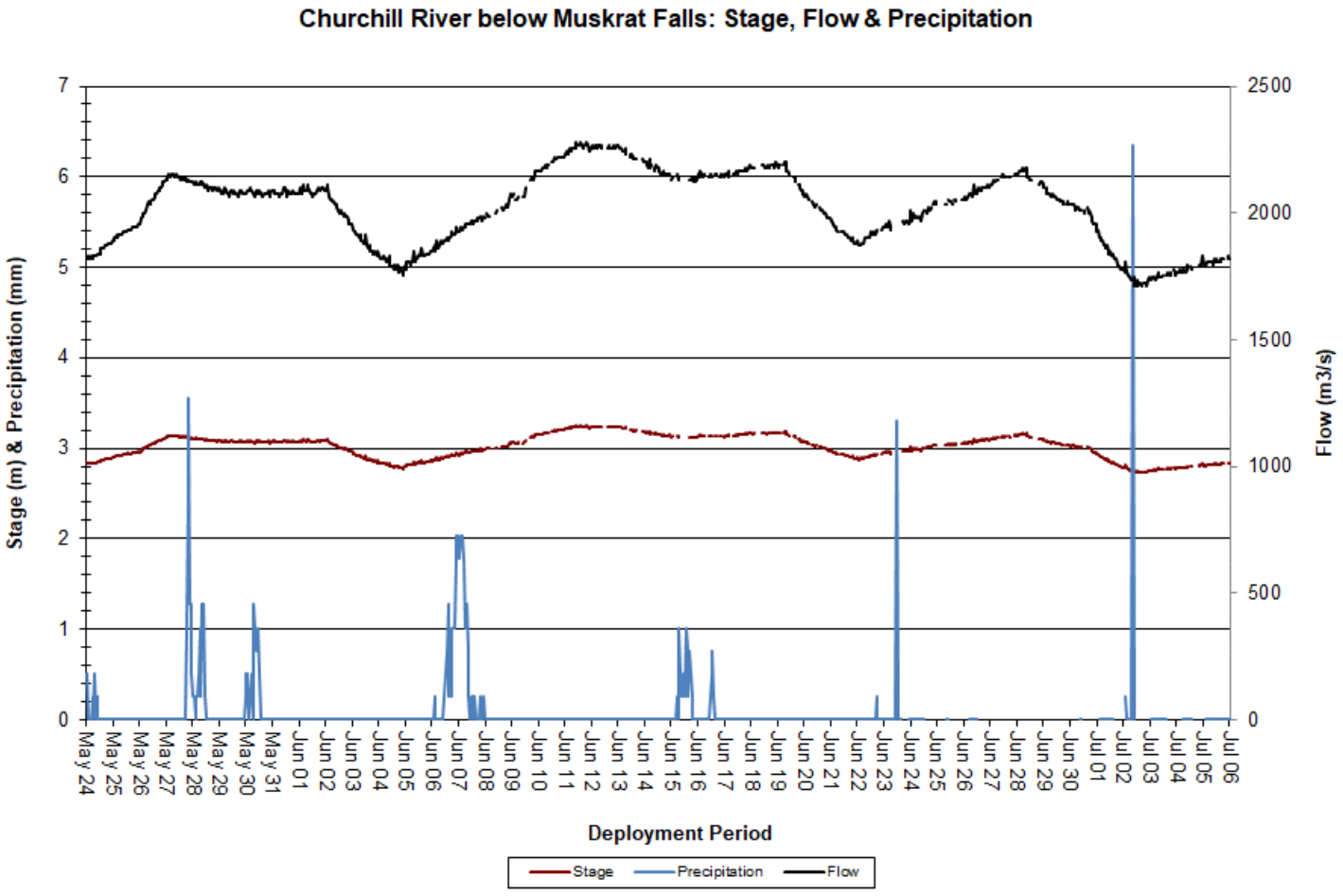

Figure 14: Stage, Flow & Precipitation at Churchill River below Muskrat Falls

Churchill River at English Point

Water Temperature

- Water temperature ranged from 3.5°C to 20.4°C, with a median value of 9.5°C (Figure 15). Air temperature data was obtained from the Muskrat Falls Weather Station, which experienced some transmission issues toward the end of the deployment period.
- Water temperature increased steadily across the deployment period. Water temperatures closely correlated with ambient air temperatures, which followed a similar trend across the same period.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

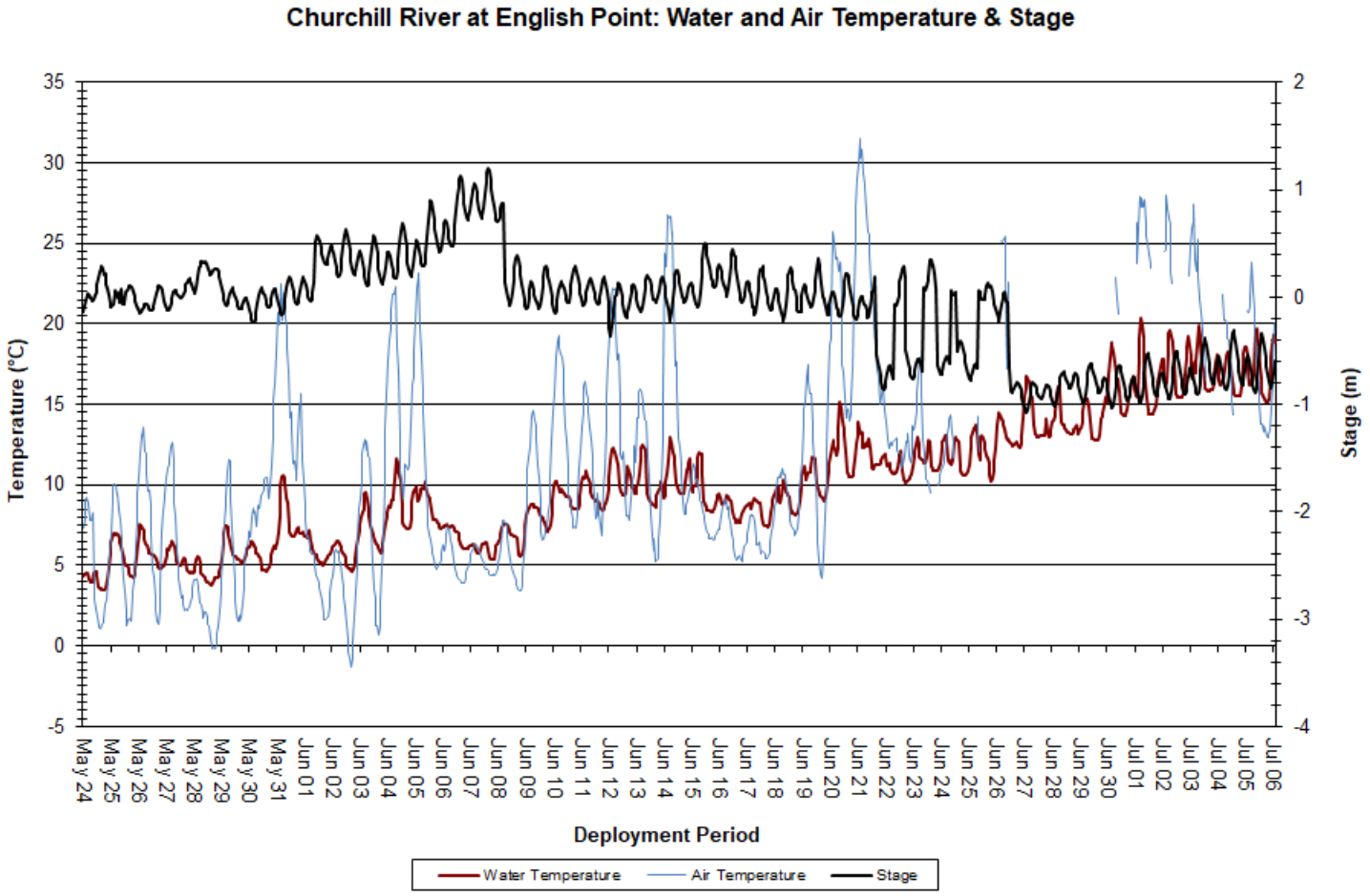

Figure 15: Water and Air Temperature & Stage at Churchill River at English Point

pH

- Over the deployment period, pH ranged from 6.53 pH units to 6.97 pH units, with a median value of 6.74 (Figure 16).
- pH values were consistent across the deployment period and remained within the CCME's Guidelines for the Protection of Aquatic Life for the duration of deployment.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

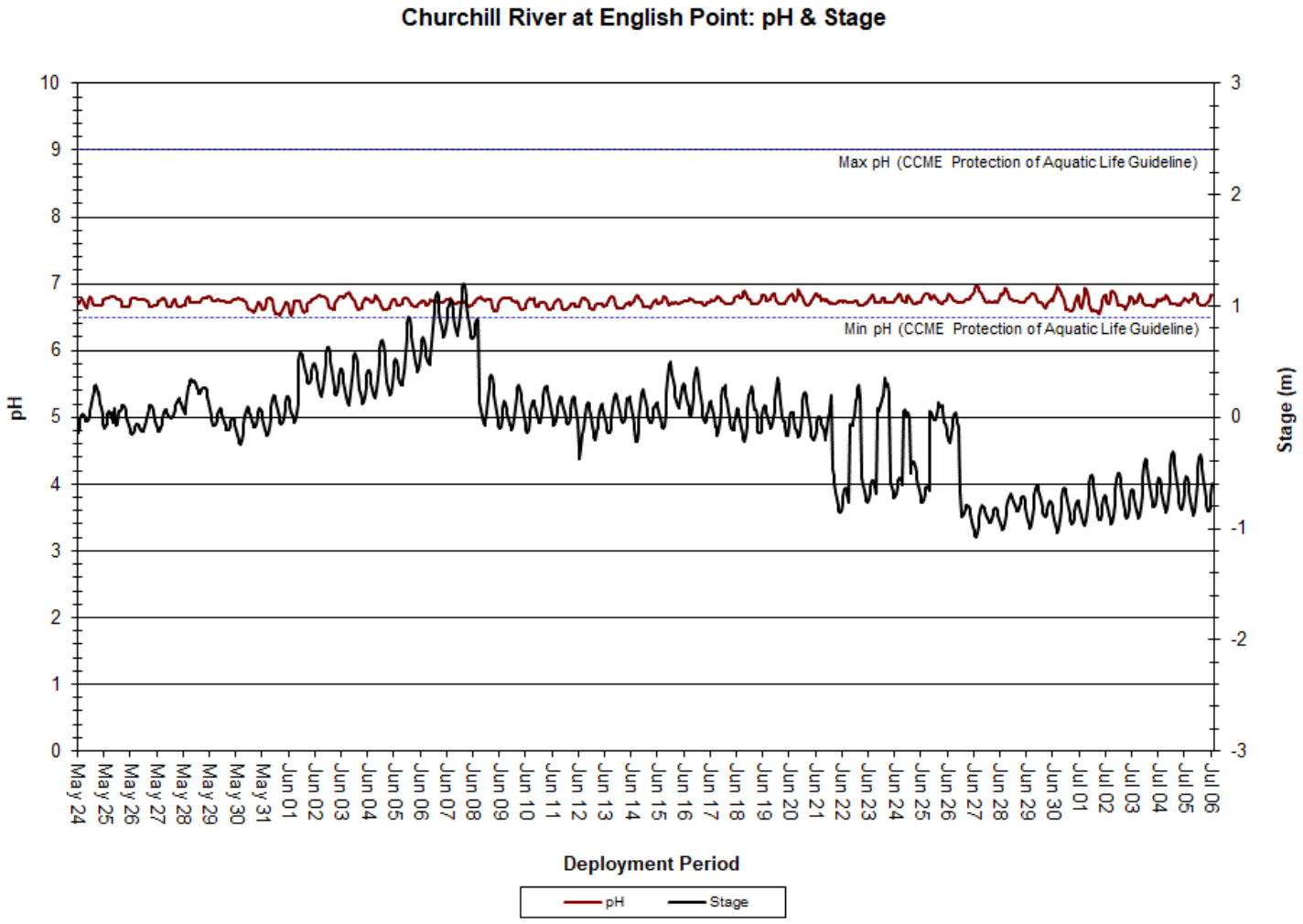

Figure 16: pH & Stage at Churchill River at English Point

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 14.0µS/cm to 54.7µs/cm, with a median value of 27.8µS/cm (Figure 17).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean on Lake Melville. As the tide comes in, specific conductivity increases as dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period (Figure 17).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

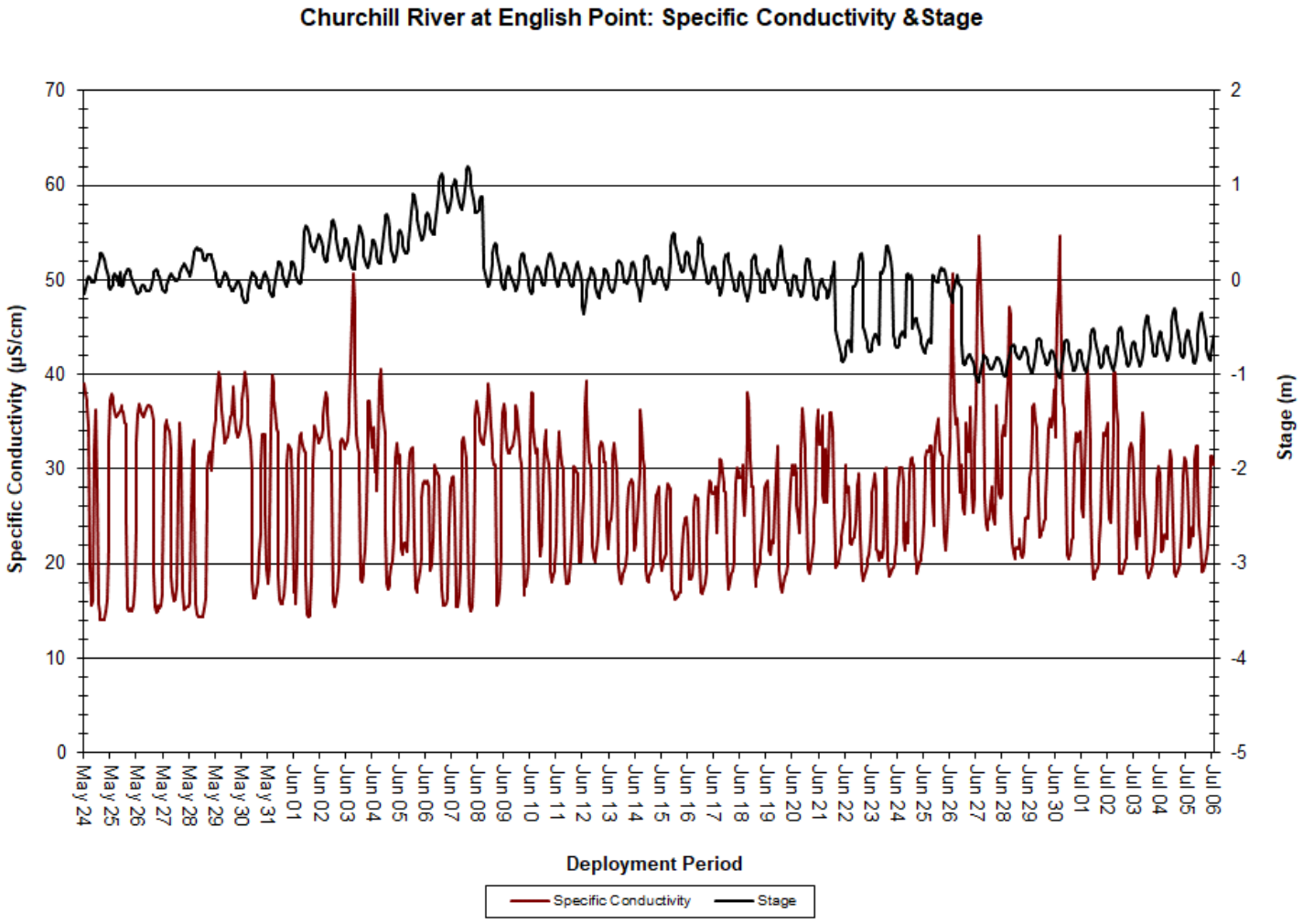

Figure 17: Specific Conductivity & Stage at Churchill River at English Point

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 9.39mg/L to 12.98mg/L, with a median value of 11.34mg/L. Saturation of dissolved oxygen ranged from 92.4% to 113.9% saturation, with a median value of 98.8% (Figure 18).
- There is an evident relationship between water temperature and dissolved oxygen. As water temperatures increased over the deployment period, dissolved oxygen levels decreased. Dissolved oxygen levels also follow a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures. Generally, dissolved oxygen levels are higher in a waterbody during cooler temperatures.
- Dissolved oxygen levels remained above the CCME's Guideline for the Protection of Early Life Stages until the very end of deployment. Dissolved oxygen levels were above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment (Figure 18).

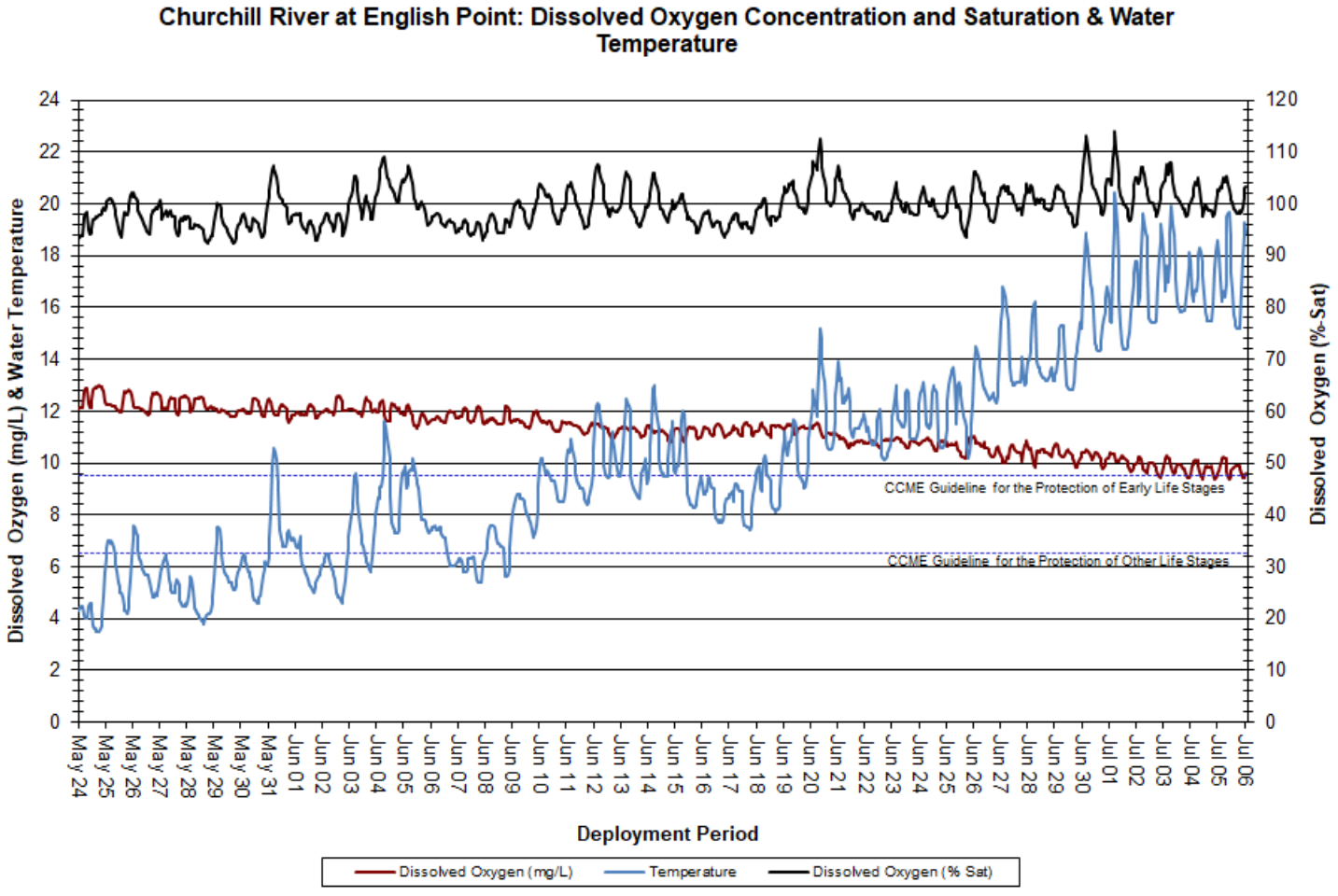

Figure 18: Dissolved Oxygen & Water Temperature at Churchill River at English Point

Turbidity

- Over the deployment period, turbidity ranged from 0 NTU to 155.6 NTU, with a median value of 4.2 NTU (Figure 19). A median value of 4.2 NTU indicates a low level of background turbidity; this is to be expected considering the sandy riverbed and tidal influences present at this station. Precipitation data was obtained from the Muskrat Falls Weather Station, which experienced some transmission issues toward the end of the deployment period.
- Turbidity events generally correlate with precipitation events, as these can increase the presence of suspended material in water. High winds and tidal influences can also contribute to turbidity events at this station by disturbing sediment from the riverbed (Figure 19). Wind speed data was also obtained from the Muskrat Falls Weather Station.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

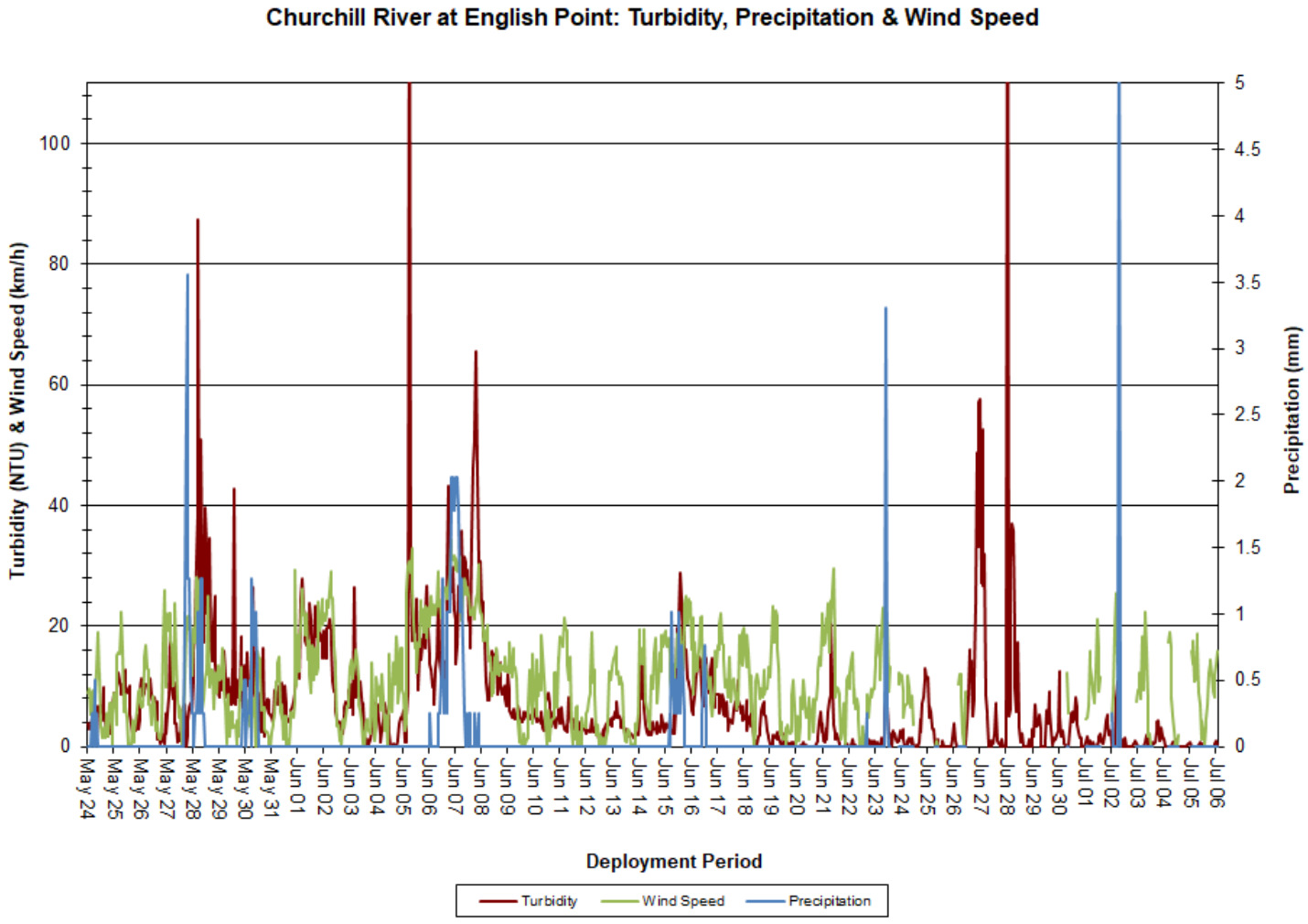

Figure 19: Turbidity, Precipitation & Wind Speed at Churchill River at English Point

Stage

- Over the deployment period, stage ranged from -1.075m to 1.197m, with a median value of -0.009m (Figure 20). Precipitation data was obtained from the Muskrat Falls Weather Station, which experienced some transmission issues toward the end of the deployment period.
- Stage fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. This pattern is consistent over the deployment period. Increases in stage often correlate with precipitation events.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

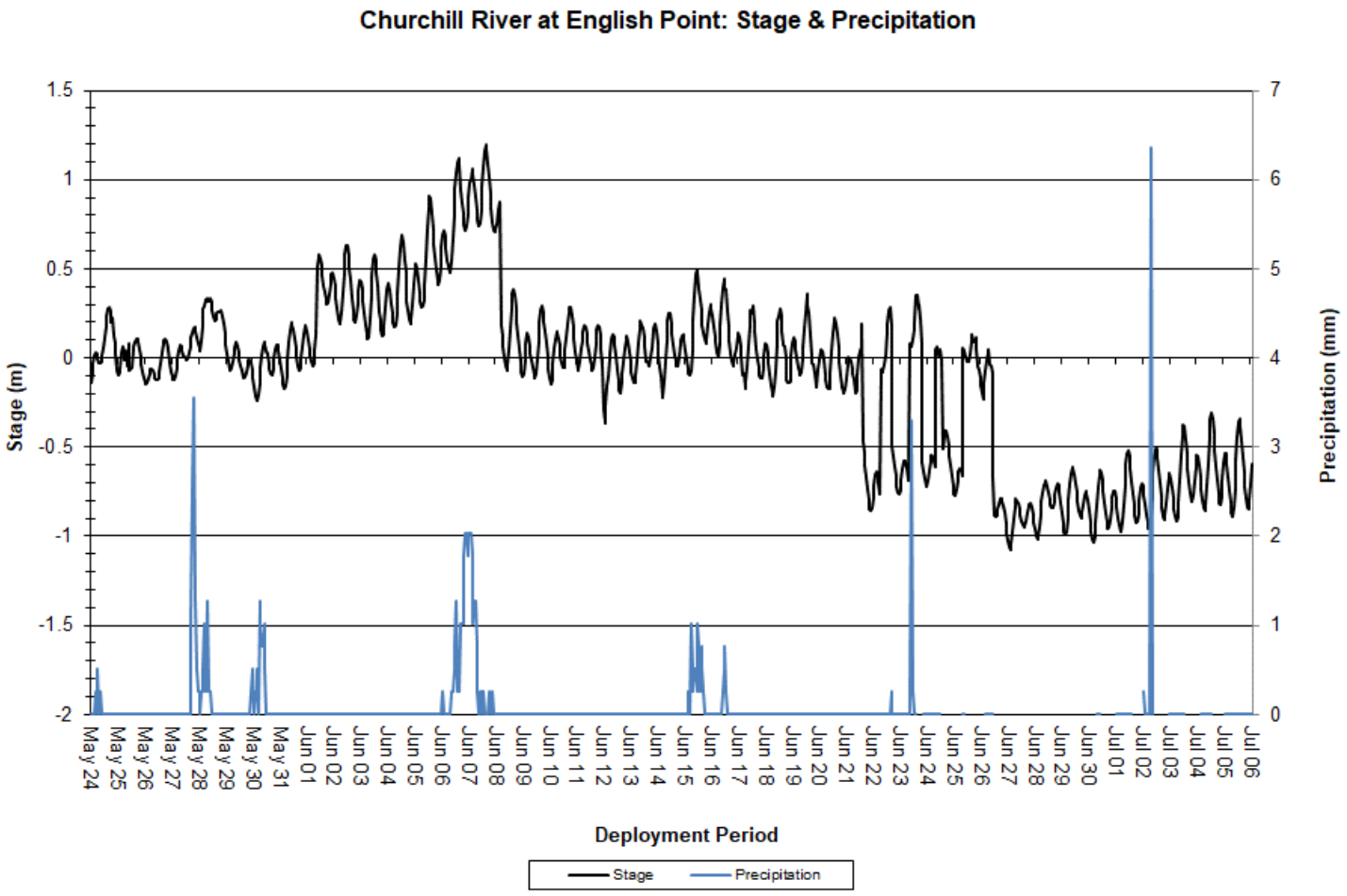

Figure 20: Stage & Precipitation at Churchill River at English Point

Conclusions

- Instruments at three water quality monitoring stations on the Lower Churchill River were deployed from May 24/June 6 through July 6/14, 2023.
- Water temperature increased steadily at all stations over the course of deployment. This is to be expected based on ambient air temperature trends during the same period through June and July.
- pH was relatively stable at Churchill River below Muskrat Falls and Churchill River at English Point, staying within the CCME's Guidelines for the Protection of Aquatic Life at English Point and hovering around the Minimum Guideline below Muskrat Falls. pH levels at Churchill River below Metchin River were likely inaccurate for much of the deployment period.
- Specific conductivity generally increased over the course of deployment at all stations. Since English Point is influenced by tides in Lake Melville, specific conductivity values at the Churchill River at English Point station had a much wider range, which is comparable to other deployments at this location.
- Dissolved oxygen levels slowly decreased over the course of deployment at all stations as water temperatures increased through the summer. Dissolved oxygen levels are generally higher in water at cooler temperatures. Dissolved oxygen levels were above the CCME's Guideline for the Protection of Early Life Stages for the majority of deployment at all stations. Dissolved oxygen levels were above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment at all stations.
- Turbidity events occurred at all stations and were generally related to precipitation, wind or tidal events. Turbidity values returned to background levels following each observed event.

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APPENDIX A

Water Parameter Description

Water Parameter Description

Dissolved Oxygen - The amount of Dissolved Oxygen (DO) (mg/l or % saturation) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (USGS, 2017).

Flow - Flow (m3/s) is a measure of how quickly a volume of water is displaced in streams, rivers, and other channels.

pH - pH is a measure of the relative amount of free hydrogen and hydroxyl ions in water. pH is an important indicator of chemically changing water, and determines the solubility and biological availability of nutrients and heavy metals in the water (USGS, 2017).

Specific conductivity - Specific conductivity (µs/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25°C. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Fondriest Environmental Inc, 2016).

Stage - Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature - Essential to the measurement of most water quality parameters, temperature (°C) controls most aquatic processes. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth. In turn, water temperature has an influence on the metabolic rates and biological activity of aquatic organisms (Fondriest Environmental Inc, 2016b).

Total Dissolved Solids - Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Swenson and Baldwin, 1965).

Turbidity - Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Swenson and Baldwin 1965).

APPENDIX B

Grab Sample Results

Bureau Veritas Job #: C3H0137
Report Date: 2023/06/28

NL Department of Environment, Climate Change and Municipalities
Site Location: LABRADOR
Your P.O. #: 220028978-9
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
WBS581 CR BELOW MR								
Sampling Date 2023/06/06 12:40								
Matrix W								
Sample # 2023-6303-00-SI-SP								
Registration # SA-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	9.0	1.0	mg/L	N/A	2023/06/23		8722303
Nitrate (N)	-	ND	0.050	mg/L	N/A	2023/06/21		8722227
Total dissolved solids (calc., EC)	-	12	1.0	mg/L	N/A	2023/06/16		8722338
Inorganics								
Conductivity	-	22	1.0	uS/cm	N/A	2023/06/15	NGI	8727590
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2023/06/19	LKH	8732150
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/06/19	LKH	8732150
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2023/06/19	LKH	8732150
Total Alkalinity (Total as CaCO3)	-	7.4	2.0	mg/L	N/A	2023/06/15	NGI	8727593
Colour	-	24	5.0	TCU	N/A	2023/06/20	TGO	8737879
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/06/15	NGI	8727594
Total Kjeldahl Nitrogen (TKN)	-	0.14	0.10	mg/L	2023/06/22	2023/06/23	RTY	8746431
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2023/06/21	TGO	8737875
Nitrite (N)	-	ND	0.010	mg/L	N/A	2023/06/20	TGO	8736712
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2023/06/22	TGO	8745758
Dissolved Organic Carbon (C)	-	4.2	0.50	mg/L	N/A	2023/06/15	CPP	8729203
Total Organic Carbon (C)	-	4.1	0.50	mg/L	N/A	2023/06/15	CPP	8729190
pH	-	7.14		pH	N/A	2023/06/15	NGI	8727592
Total Phosphorus	-	0.011	0.004	mg/L	2023/06/22	2023/06/23	SPC	8746738
Total Suspended Solids	-	2.2	1.0	mg/L	2023/06/13	2023/06/15	RMK	8721816
Turbidity	-	0.64	0.10	NTU	N/A	2023/06/21	NGI	8737994
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/06/19	2023/06/20	SGK	8736613
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.048	0.0050	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Barium (Ba)	-	0.0078	0.0010	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Boron (B)	-	ND	0.050	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Calcium (Ca)	-	2.3	0.10	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Copper (Cu)	-	0.00051	0.00050	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Iron (Fe)	-	0.12	0.050	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Magnesium (Mg)	-	0.77	0.10	mg/L	2023/06/23	2023/06/23	BCZ	8747400

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Bureau Veritas Job #: C3H0137
Report Date: 2023/06/28

NL Department of Environment, Climate Change and Municipalities
Site Location: LABRADOR
Your P.O. #: 220028978-9
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
WBS581 CR BELOW MR								
Sampling Date 2023/06/06 12:40								
Matrix W								
Sample # 2023-6303-00-SI-SP								
Registration # SA-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.011	0.0020	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Potassium (K)	-	0.30	0.10	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Sodium (Na)	-	0.59	0.10	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Strontium (Sr)	-	0.012	0.0020	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Uranium (U)	-	ND	0.00010	mg/L	2023/06/23	2023/06/23	BCZ	8747400
Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/06/23	2023/06/23	BCZ	8747400

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Bureau Veritas Job #: C3F3406
Report Date: 2023/06/13

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-9
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
VYF338 CR BELOW MF								
Sampling Date 2023/05/24 11:30								
Matrix W								
Sample # 2023-6300-00-SI-SP								
Registration # SA-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	7.4	1.0	mg/L	N/A	2023/06/12		8692406
Nitrate (N)	-	0.052	0.050	mg/L	N/A	2023/06/12		8692408
Total dissolved solids (calc., EC)	-	10	1.0	mg/L	N/A	2023/06/07		8692515
Inorganics								
Conductivity	-	19	1.0	uS/cm	N/A	2023/06/06	NGI	8706178
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2023/06/05	LKH	8701537
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/06/05	LKH	8701537
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2023/06/05	LKH	8701537
Total Alkalinity (Total as CaCO3)	-	7.9	2.0	mg/L	N/A	2023/06/06	NGI	8706199
Colour	-	36	5.0	TCU	N/A	2023/06/09	TGO	8713236
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/06/06	NGI	8706204
Total Kjeldahl Nitrogen (TKN)	-	0.12	0.10	mg/L	2023/06/08	2023/06/08	RTY	8711893
Nitrate + Nitrite (N)	-	0.052	0.050	mg/L	N/A	2023/06/09	TGO	8713234
Nitrite (N)	-	ND	0.010	mg/L	N/A	2023/06/09	TGO	8712887
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2023/06/09	TGO	8712036
Dissolved Organic Carbon (C)	-	5.0	0.50	mg/L	N/A	2023/06/12	CPP	8716200
Total Organic Carbon (C)	-	5.2	0.50	mg/L	N/A	2023/06/12	CPP	8716171
pH	-	7.01		pH	N/A	2023/06/06	NGI	8706179
Total Phosphorus	-	0.010	0.004	mg/L	2023/06/08	2023/06/09	SPC	8713490
Dup.Total Phosphorus	-	0.010	0.004	mg/L	2023/06/08	2023/06/09	SPC	8713490
Total Suspended Solids	-	4.2	1.0	mg/L	2023/06/01	2023/06/05	RMK	8698185
Turbidity	-	5.1	0.10	NTU	N/A	2023/06/13	NGI	8721922
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/06/08	2023/06/12	SGK	8712653
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.22	0.0050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Aluminum (Al)	-	0.22	0.0050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Arsenic (As)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Barium (Ba)	-	0.0079	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Barium (Ba)	-	0.0077	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Boron (B)	-	ND	0.050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Boron (B)	-	ND	0.050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Cadmium (Cd)	-	0.000011	0.000010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Cadmium (Cd)	-	0.000010	0.000010	mg/L	2023/06/09	2023/06/10	BCZ	8715639

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Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
VYF338 CR BELOW MF Sampling Date 2023/05/24 11:30 Matrix W Sample # 2023-6300-00-SI-SP Registration # SA-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Calcium (Ca)	-	1.9	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Calcium (Ca)	-	1.9	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Copper (Cu)	-	0.00071	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Copper (Cu)	-	0.00069	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Iron (Fe)	-	0.32	0.050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Iron (Fe)	-	0.31	0.050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Lead (Pb)	-	ND	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Magnesium (Mg)	-	0.66	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Magnesium (Mg)	-	0.67	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Manganese (Mn)	-	0.010	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Manganese (Mn)	-	0.011	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Phosphorus (P)	-	ND	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Potassium (K)	-	0.32	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Potassium (K)	-	0.32	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Selenium (Se)	-	ND	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Sodium (Na)	-	0.57	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Sodium (Na)	-	0.58	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Strontium (Sr)	-	0.010	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Strontium (Sr)	-	0.010	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Uranium (U)	-	ND	0.00010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Uranium (U)	-	ND	0.00010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Dup.Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/06/09	2023/06/10	BCZ	8715639

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Bureau Veritas Job #: C3F3406
Report Date: 2023/06/13

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-9
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
VYF339 CR @ EP								
Sampling Date 2023/05/24 12:25								
Matrix W								
Sample # 2023-6301-00-SI-SP								
Registration # SA-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	13	1.0	mg/L	N/A	2023/06/12		8692406
Nitrate (N)	-	ND	0.050	mg/L	N/A	2023/06/12		8692408
Total dissolved solids (calc., EC)	-	26	1.0	mg/L	N/A	2023/06/07		8692515
Inorganics								
Conductivity	-	47	1.0	uS/cm	N/A	2023/06/06	NGI	8706178
Chloride (Cl-)	-	6.1	1.0	mg/L	N/A	2023/06/05	LKH	8701537
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/06/05	LKH	8701537
Sulphate (SO4)	-	2.0	1.0	mg/L	N/A	2023/06/05	LKH	8701537
Total Alkalinity (Total as CaCO3)	-	9.1	2.0	mg/L	N/A	2023/06/06	NGI	8706199
Colour	-	58	25	TCU	N/A	2023/06/09	TGO	8713236
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/06/06	NGI	8706204
Total Kjeldahl Nitrogen (TKN)	-	0.13	0.10	mg/L	2023/06/08	2023/06/08	RTY	8711893
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2023/06/09	TGO	8713234
Nitrite (N)	-	ND	0.010	mg/L	N/A	2023/06/09	TGO	8712887
Nitrogen (Ammonia Nitrogen)	-	0.053	0.050	mg/L	N/A	2023/06/09	TGO	8712036
Dissolved Organic Carbon (C)	-	6.6	0.50	mg/L	N/A	2023/06/12	CPP	8719967
Total Organic Carbon (C)	-	6.6	0.50	mg/L	N/A	2023/06/12	CPP	8716171
pH	-	7.04		pH	N/A	2023/06/06	NGI	8706179
Total Phosphorus	-	0.064	0.004	mg/L	2023/06/08	2023/06/09	SPC	8713490
Total Suspended Solids	-	7.6	1.0	mg/L	2023/06/01	2023/06/05	RMK	8698185
Turbidity	-	12	0.10	NTU	N/A	2023/06/13	NGI	8721922
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/06/08	2023/06/12	SGK	8712653
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.70	0.0050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Barium (Ba)	-	0.016	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Boron (B)	-	ND	0.050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Calcium (Ca)	-	2.5	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Chromium (Cr)	-	0.0015	0.0010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Copper (Cu)	-	0.0014	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Iron (Fe)	-	1.2	0.050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Magnesium (Mg)	-	1.5	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Manganese (Mn)	-	0.046	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639

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Bureau Veritas Job #: C3F3406
Report Date: 2023/06/13

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-9
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
VYF339 CR @ EP Sampling Date 2023/05/24 12:25 Matrix W Sample # 2023-6301-00-SI-SP Registration # SA-0000 **ELEMENTS BY ICP/MS (WATER)** **Metals**								
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Potassium (K)	-	0.78	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Sodium (Na)	-	4.6	0.10	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Strontium (Sr)	-	0.020	0.0020	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Uranium (U)	-	ND	0.00010	mg/L	2023/06/09	2023/06/10	BCZ	8715639
Total Zinc (Zn)	-	ND	0.0050	mg/L	2023/06/09	2023/06/10	BCZ	8715639

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