

Real-Time Water Quality Deployment Report

Lower Churchill River Network

September 28 to
October 26, 2021



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

Contents

Real Time Water Quality Monitoring.....	1
Quality Assurance and Quality Control.....	2
Data Interpretation.....	4
Churchill River below Metchin River.....	6
Churchill River above Grizzle Rapids.....	12
Churchill River below Muskrat Falls.....	18
Churchill River at English Point.....	25
Conclusions.....	31
References.....	32
APPENDIX A - Water Parameter Description.....	33
APPENDIX B - Grab Sample Results.....	35

Prepared by:

Brandon Mesher, B.Sc.

Environmental Scientist

Department of Environment and Climate Change

Water Resources Management Division

brandonmesher@gov.nl.ca

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 four stations on the Lower Churchill River: Churchill River below Metchin River, Churchill River above Grizzle Rapids, Churchill River below Muskrat Falls and Churchill River at English Point.
- A real-time water quality monitoring instrument was deployed at Churchill River at English Point on September 28th. All other instruments at other stations were already deployed from the previous deployment period.
- The instrument at Churchill River below Metchin River was removed from the water on October 12th, earlier than the others. This station is located approximately 200 km from Happy Valley-Goose Bay and is only accessible via helicopter. The decision was made to haul this instrument as this time due to season conditions and helicopter availability. All other stations are significantly closer for efficient retrieval.
- All other instruments in this network were removed on October 26th for a deployment period of 29 days (15 days for Churchill River below Metchin River). This marked the end of the RTWQ monitoring for the 2021 year.

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 adjacent to 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

Parameter	Rank				
	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 September 28 to October 26, 2021 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations September 28 to October 26, 2021

Churchill River Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	September 28, 2021	Deployment	N/A	N/A	N/A	N/A	N/A
	October 12, 2021	Removal	Excellent	Excellent	Excellent	Excellent	Poor
Above Grizzle Rapids	September 28, 2021	Deployment	N/A	N/A	N/A	N/A	N/A
	October 26, 2021	Removal	Good	Good	Excellent	Good	Excellent
Below Muskrat Falls	September 28, 2021	Deployment	N/A	N/A	N/A	N/A	N/A
	October 26, 2021	Removal	Excellent	Good	Excellent	Good	Excellent
At English Point	September 28, 2021	Deployment	Excellent	Fair	Good	Fair	Good
	October 26, 2021	Removal	Good	Excellent	Marginal	Fair	Good
Above Muskrat Falls	Not deployed	Deployment	N/A	N/A	N/A	N/A	N/A
	Not deployed	Removal	N/A	N/A	N/A	N/A	N/A

- Churchill River below Metchin River**

- Comparison rankings are not available for deployment since this instrument was already deployed from the previous report.
- At removal, all parameters were ranked ‘excellent’ with the exception of turbidity which ranked ‘poor’. At the time of removal, the field sonde was covered in fine silt, which had likely fouled the sensor during the long deployment as the QAQC sonde recorded turbidity at 0.0NTU during removal.

- Churchill River above Grizzle Rapids**

- At removal, all parameters ranked as either ‘excellent’ or ‘good’.
- Comparison rankings are not available for deployment since this instrument was already deployed from the previous report.

- Churchill River below Muskrat Falls**

- At removal, all parameters ranked as either ‘excellent’ or ‘good’.

- Comparison rankings are not available for deployment since this instrument was already deployed from the previous report.

- **Churchill River at English Point**

- At deployment, all parameters ranked as either 'excellent', 'good', or 'fair'.
- At removal, all parameters ranked as either 'excellent', 'good', 'fair', or 'marginal'.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring from September 28 to October 26, 2021 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 7.8°C to 11.2°C, with a median value of 8.8°C (Figure 2). Air temperature data was obtained from the Metchin River near TLH Weather Station.
- Despite the early removal of this sonde, water temperature can be seen declining further into the fall season as expected. An episode of mildly warm weather kept the water temperature relatively constant towards the end of this sonde's 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.

Churchill River below Metchin River: Water and Air Temperature & Stage

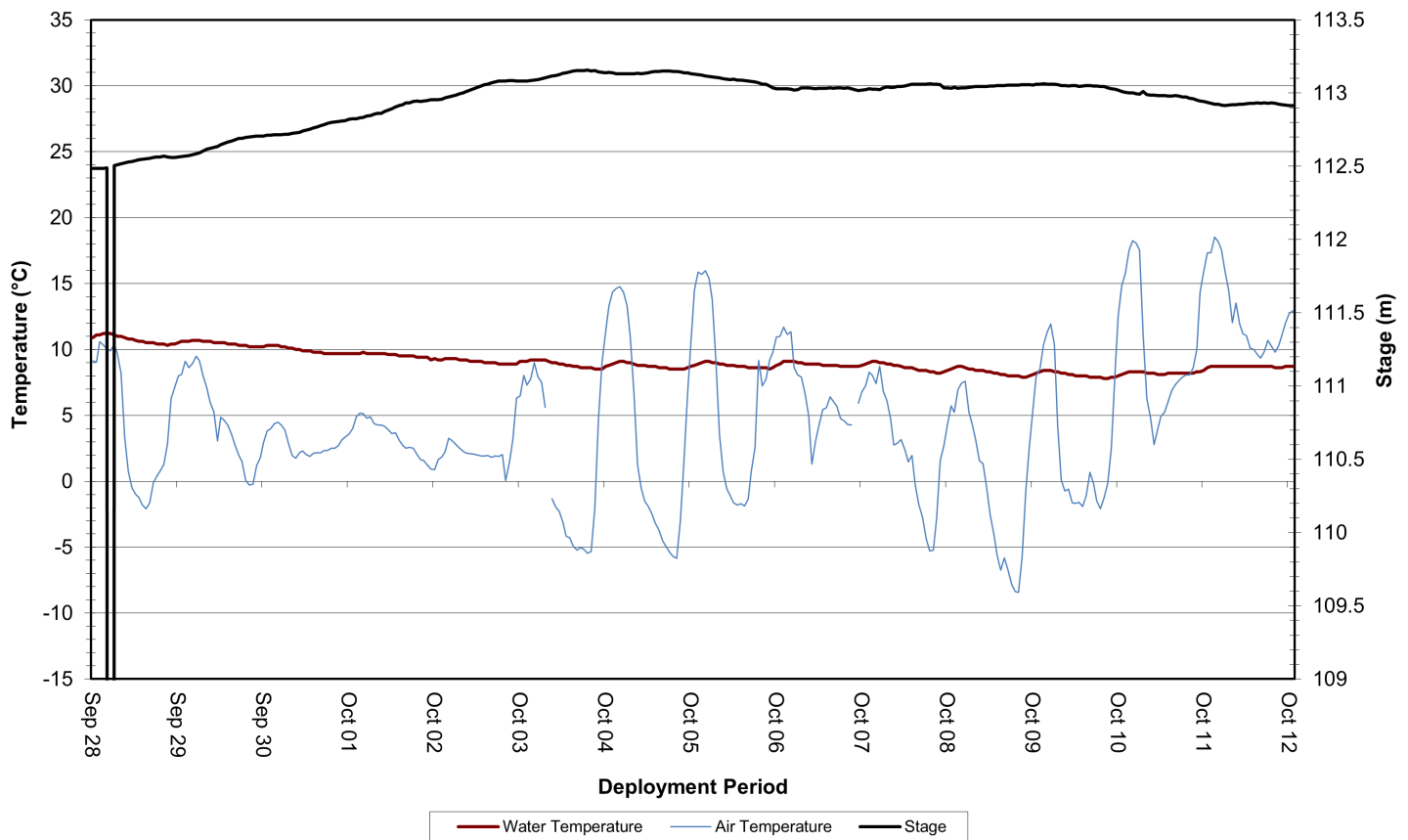


Figure 2: Water and Air Temperature & Stage at Churchill River below Metchin River

pH

- Over the deployment period, pH values ranged from 5.65 to 5.96 pH units, with a median value of 5.76 (Figure 3).
- pH declined slightly over the course of deployment. Given the less hours of daylight at this time of the year, there is less available time for photosynthetic organisms to perform photosynthesis, thus lessening the impact of carbon fixation. Since CO₂ (carbon dioxide) directly impacts pH, the increased accumulation of CO₂ decreased the overall pH at this station. 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 illustrated by the diurnal fluctuations in pH values (Figure 3).
- pH remained outside of the threshold for the Protection of Aquatic Life. This occurrence may be the result of higher stage levels, sensor drift, or a combination of the two.
- 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.

Churchill River below Metchin River: pH & Stage

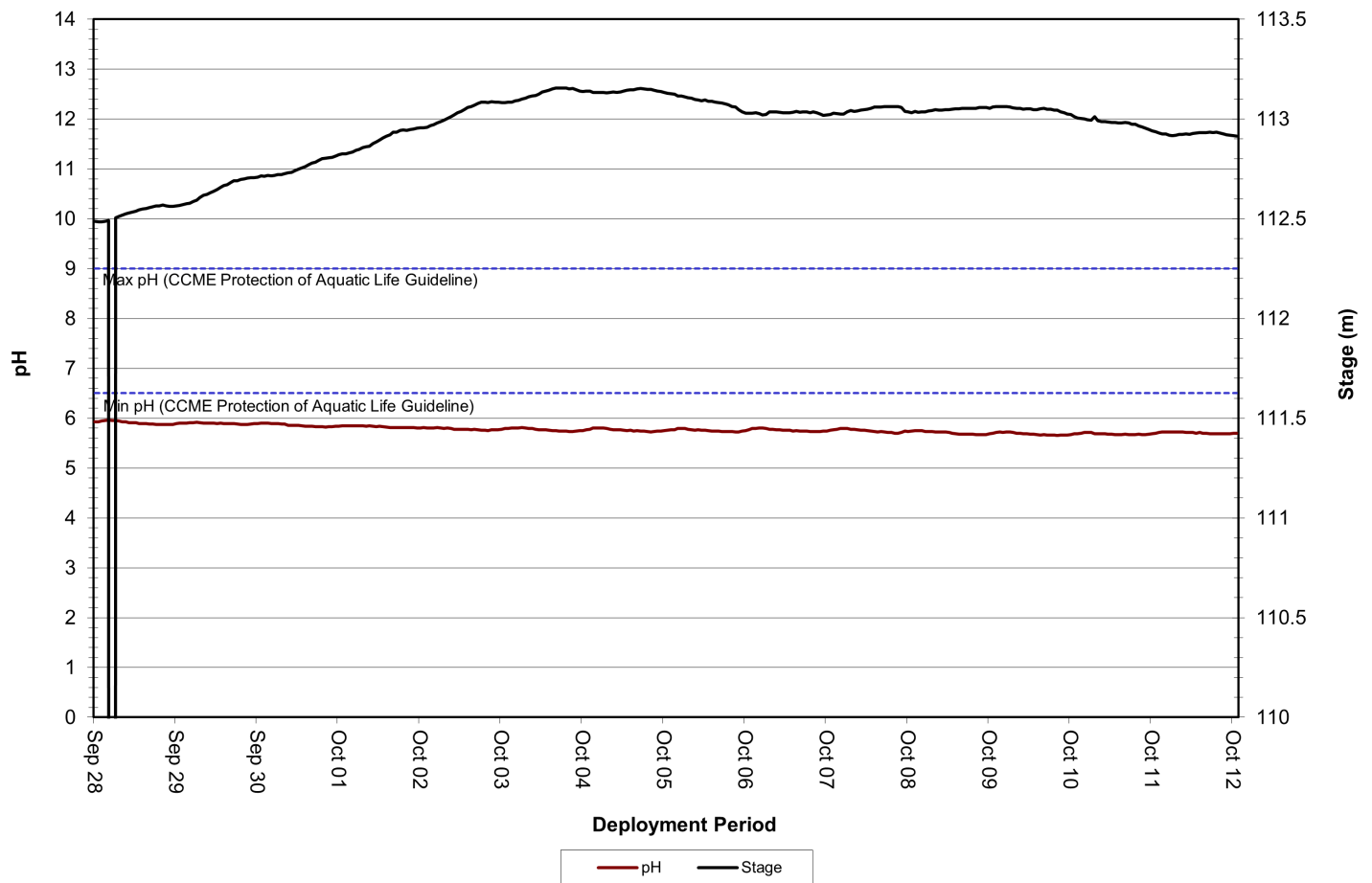


Figure 3: pH & Stage at Churchill River below Metchin River

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 17.9 $\mu\text{S}/\text{cm}$ to 18.9 $\mu\text{S}/\text{cm}$, with a median value of 18.3 $\mu\text{S}/\text{cm}$ (Figure 4).
- Conductivity was inversely related to the stage and decreased with precipitation events as the added water into the system decreased the concentration of solutes in the water, lowering the conductivity.
- 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.

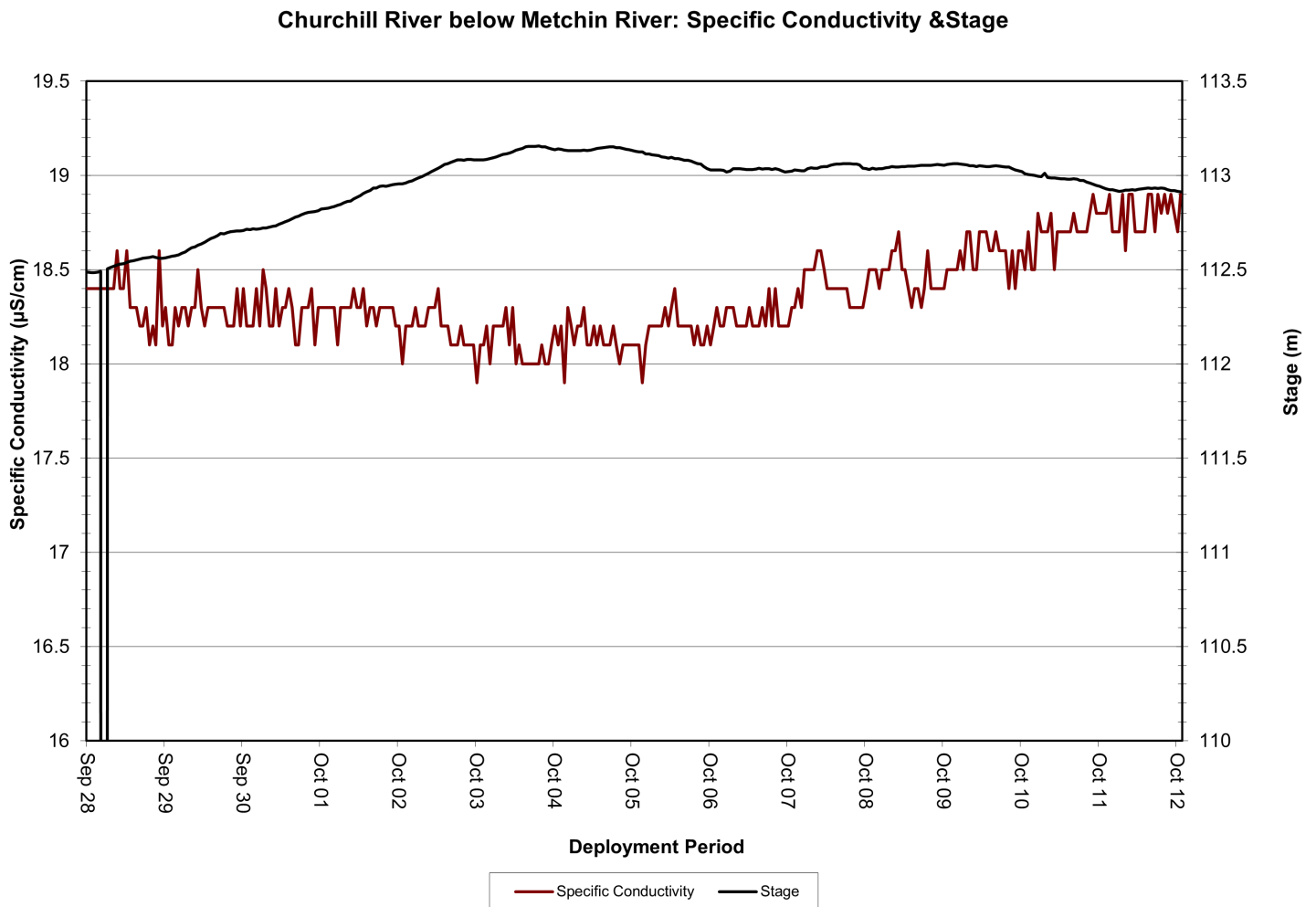


Figure 4: Specific Conductivity & Stage at Churchill River below Metchin River

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 10.29 mg/L to 11.15 mg/L, with a median value of 10.84 mg/L. Saturation of dissolved oxygen ranged from 92.2% to 95.8%, with a median value of 93.7% (Figure 5).
- Dissolved oxygen remained relatively stable throughout the deployment, increasing as the fall season progressed with decreasing water temperatures. This is normal as dissolved oxygen is inversely proportionate to water temperature.
- Dissolved oxygen levels were above the acceptable minimums for the Protection of Early Life Stages and Other Life Stages for the entire deployment period.

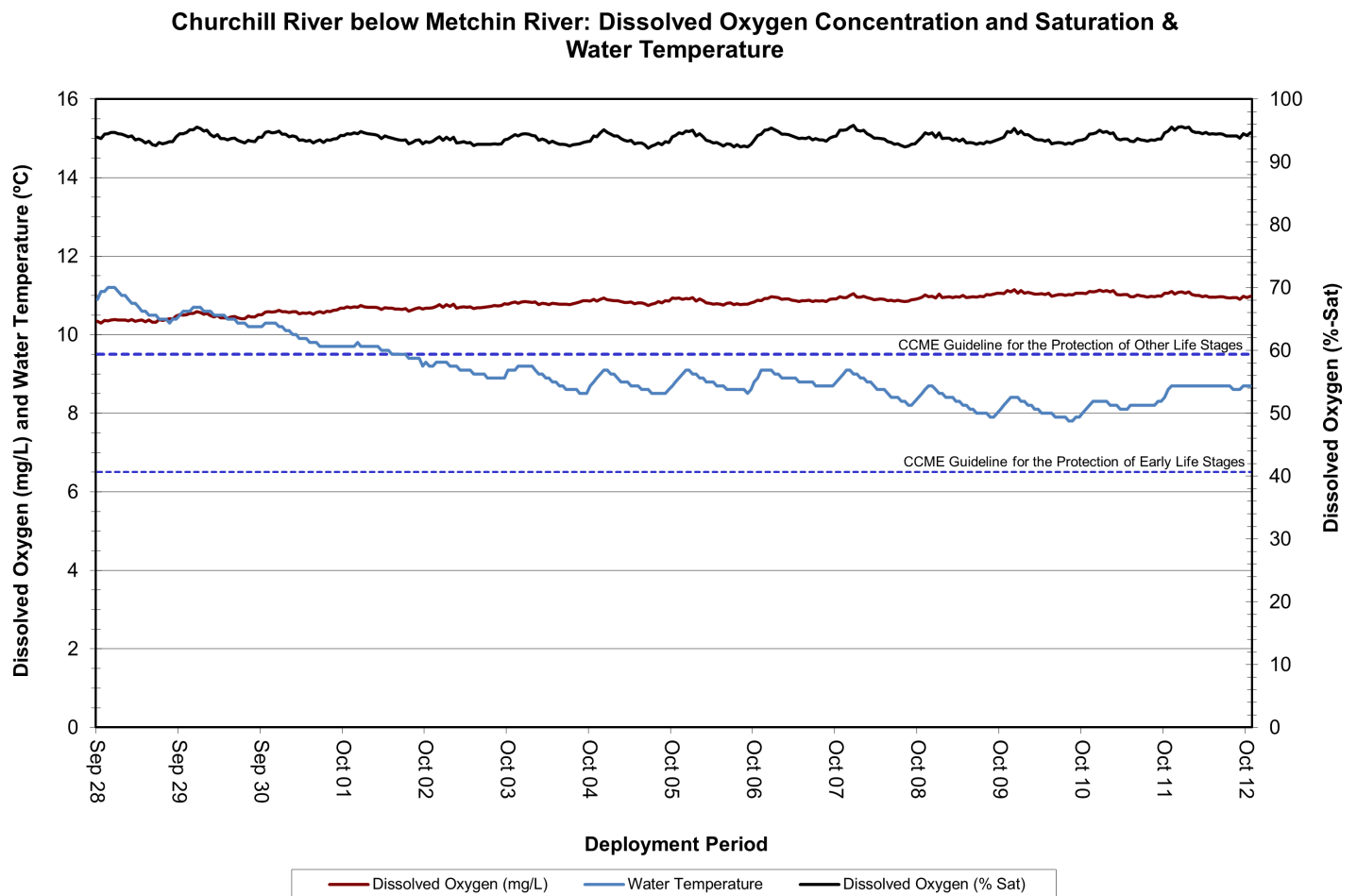


Figure 5: Dissolved Oxygen & Water Temperature at Churchill River below Metchin River

Turbidity

- Over the deployment period, turbidity ranged from 2.0 NTU to 28.3 NTU, with a median value of 13.5 NTU (Figure 6). This location normally has a much lower background turbidity level near 0.0NTU. Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Turbidity is generally impacted by precipitative episodes, however, this portion of the Churchill River is broad with a high depth, so it is less susceptible to such events. It should be noted that turbidity levels remained elevated throughout this deployment period. This is an unusual behavior and may be caused by a sensor discrepancy or build-up of sediment due to the natural sandy environment of this riverbed. QA/QC data points to this sensor ranking poorly by the removal date.
- 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.

Churchill River below Metchin River: Turbidity, Precipitation & Stage

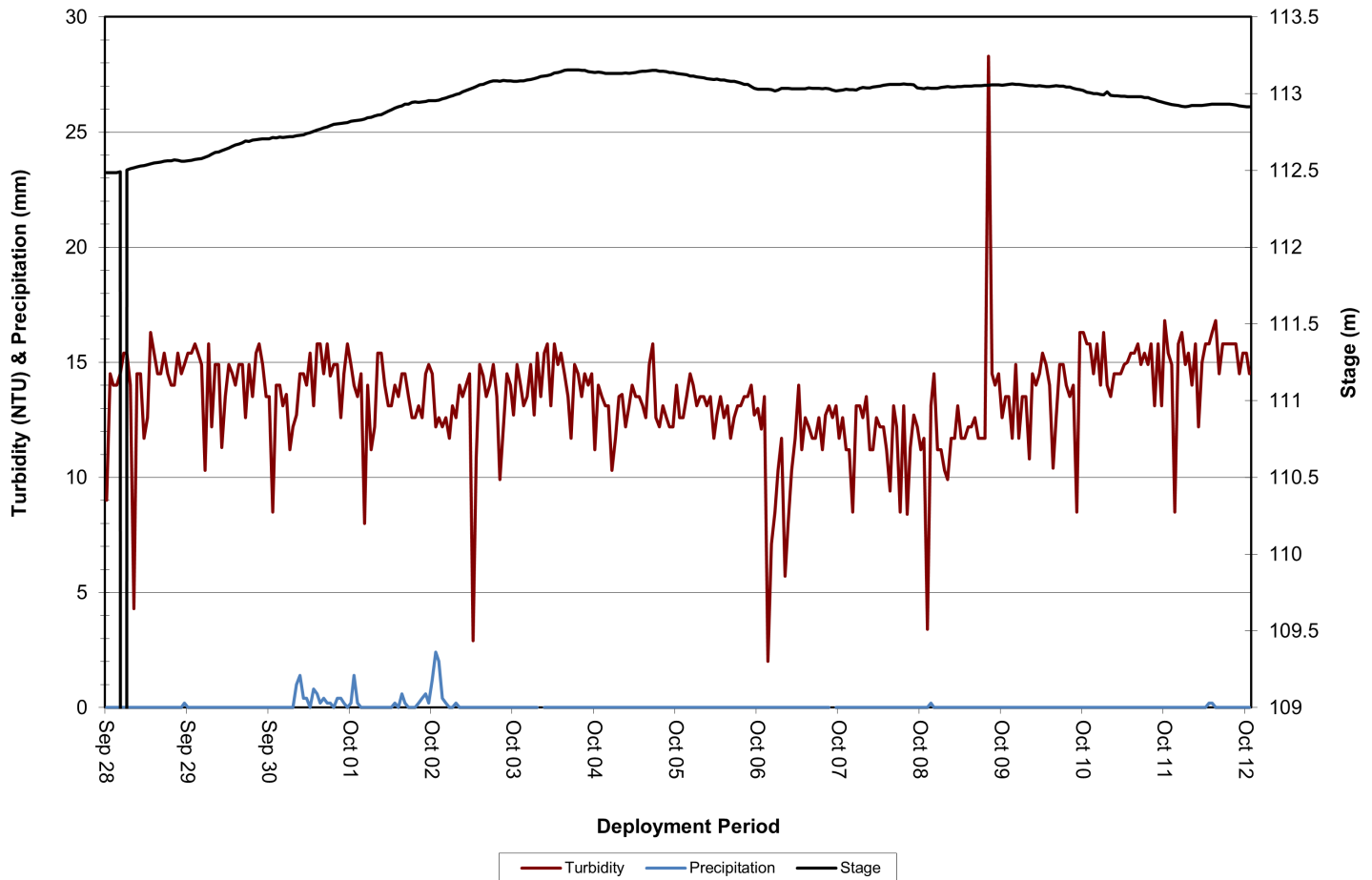


Figure 6: Turbidity, Precipitation & Stage at Churchill River below Metchin River

Stage and Flow

- Over the deployment period, stage levels ranged from 112.485 m to 113.156 m, with a median value of 113.028 m. Flow ranged from 1014.087 m³/s to 1255.136 m³/s, with a median value of 1217.049 m³/s (Figure 7). Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Stage and flow steadily increased across the first half of the deployment period, remaining steady thereafter. Both variables shared a positive relationship with precipitation, increasing during those episodes.
- 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.

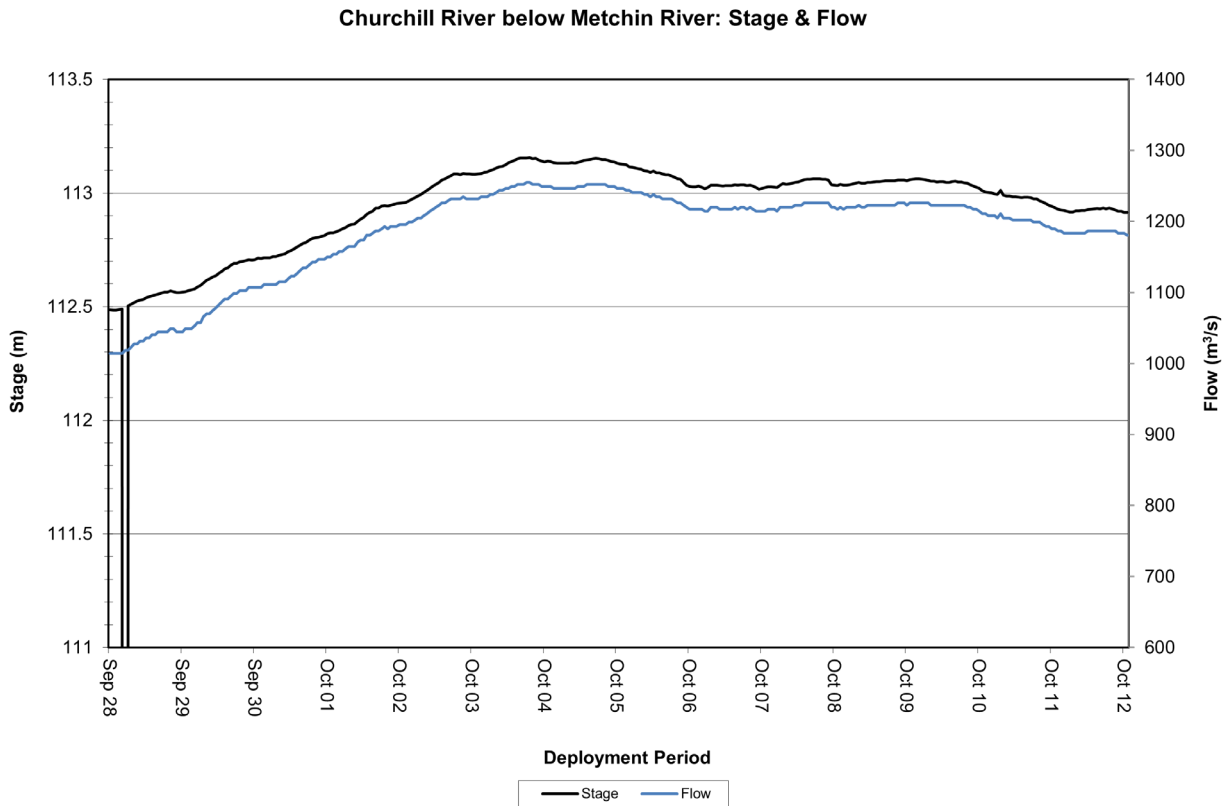


Figure 7: Stage & Flow at Churchill River below Metchin River

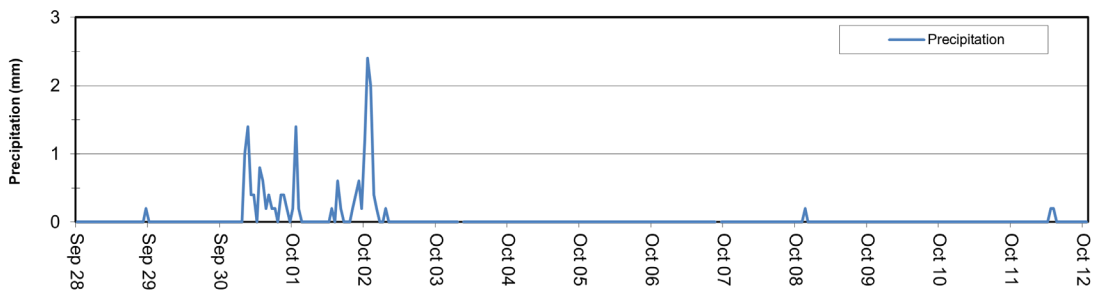


Figure 8: Precipitation at Churchill River below Metchin River

Churchill River above Grizzle Rapids

Water Temperature

- Over the deployment period, water temperature ranged from 7.12°C to 11.31°C, with a median value of 9.75°C (Figure 9). Air temperature data was obtained from the Muskrat Falls MET Station.
- Overall water temperature declined throughout this deployment period in line with the fall season. The period between October 10th – 12th brought mildly warm weather for this time of the year, resulting in the slight increase in temperature occurring around this time.
- 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.

Churchill River above Grizzle Rapids: Water and Air Temperature & Stage

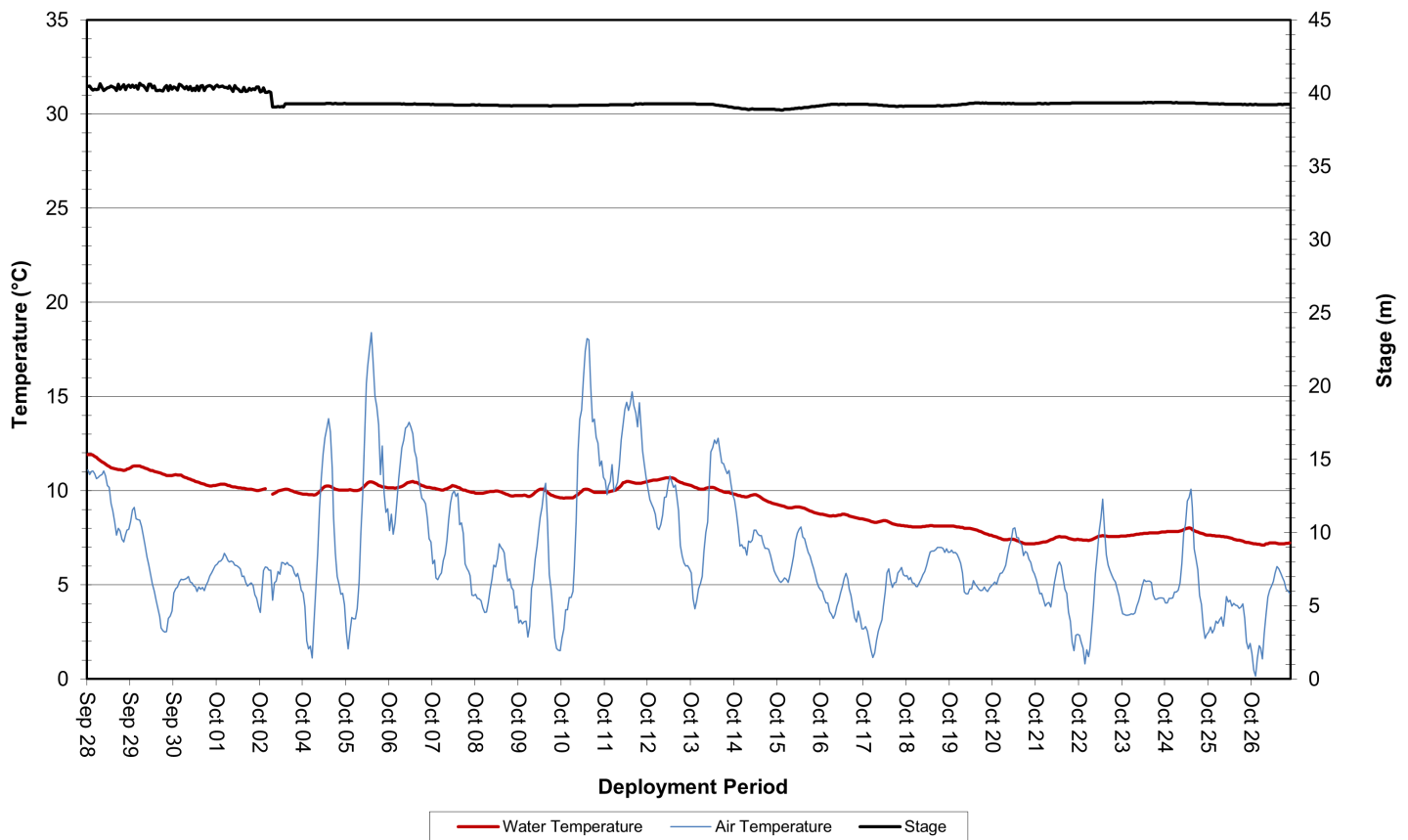


Figure 9: Water and Air Temperature & Stage at Churchill River above Grizzle Rapids

pH

- Over the deployment period, pH values ranged from 6.00 pH units to 7.06 pH units, with a median value of 6.99 (Figure 10).
- pH remained relatively stable throughout most of the deployment period as well as remained within the CCME's Guidelines for the Protection of Aquatic Life. The anomaly seen on October 2nd was likely related to the resetting of the Stage sensor. A brief decline occurred around October 19th, with supporting climate data indicating increased precipitation around that time. This evidence suggests that acidic rain was the primary contributor to the decreased pH. Impacts due to land runoff are negligible as this station is not near any anthropogenic sources of agriculture or recreation that are capable of acidic by-products.
- 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 illustrated by the diurnal fluctuations in pH values (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.

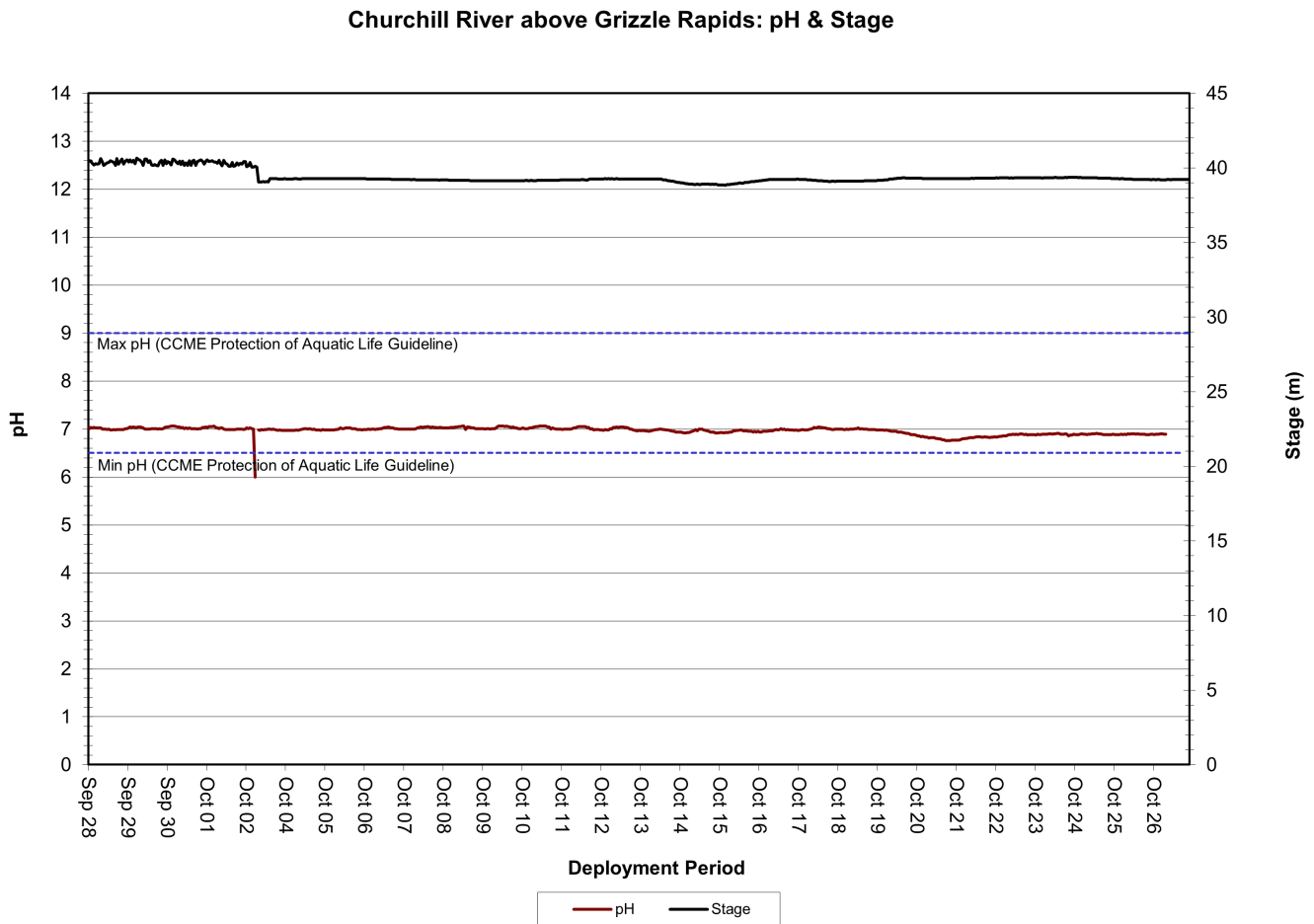


Figure 10: pH & Stage at Churchill River above Grizzle Rapids

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 16.1 $\mu\text{S}/\text{cm}$ to 20.3 $\mu\text{S}/\text{cm}$, with a median of 18.2 $\mu\text{S}/\text{cm}$ (Figure 11).
- Conductivity was inversely proportional to the stage and behaved negatively to precipitation events as the added water into the system decreased the concentration of solutes in the water, lowering the conductivity.
- 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.

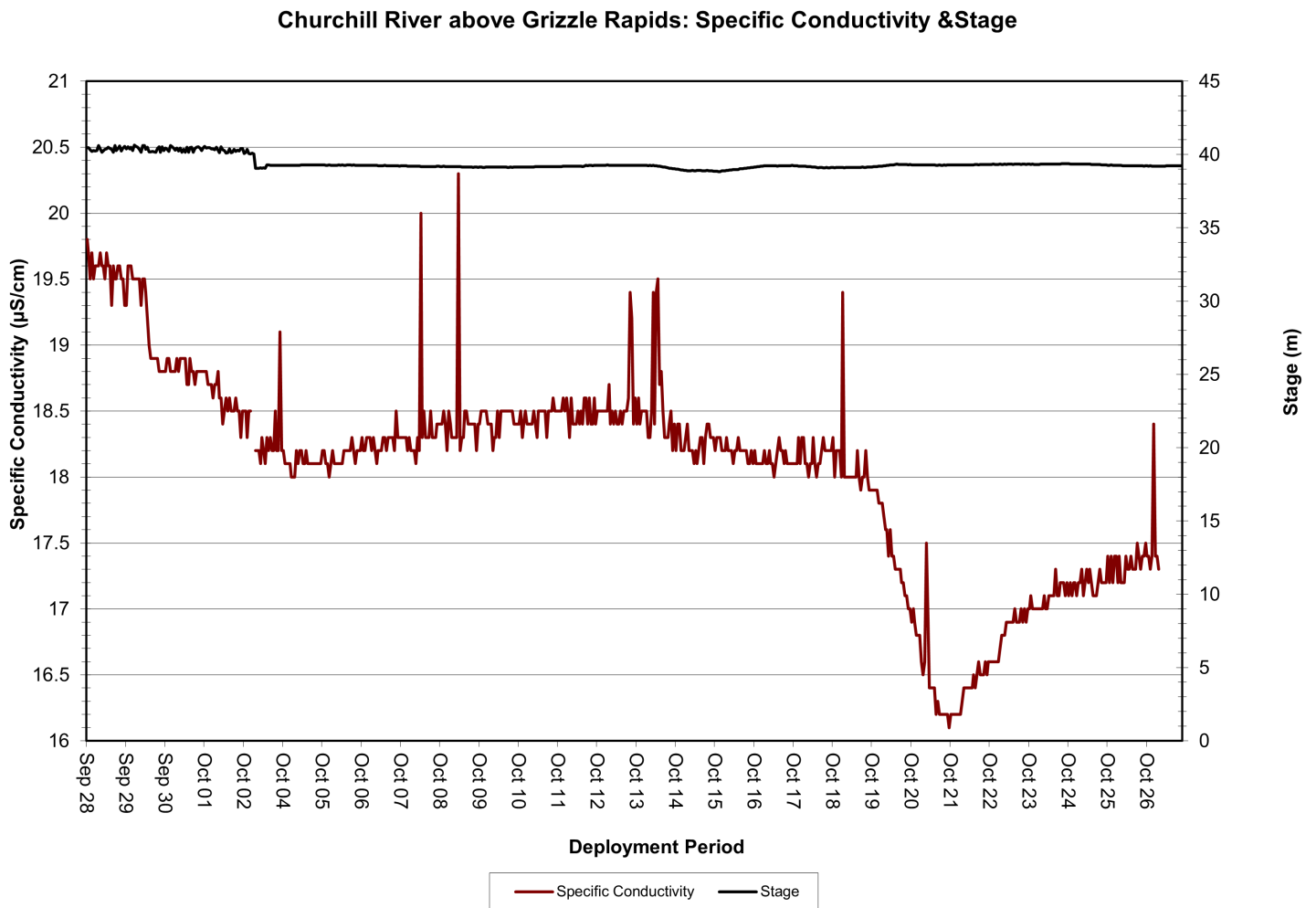


Figure 11: Specific Conductivity & Stage at Churchill River above Grizzle Rapids

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 10.55 mg/L to 11.77 mg/L, with a median value of 11.15 mg/L. Saturation of dissolved oxygen ranged from 95.1% saturation to 99.1% saturation, with a median value of 96.8% (Figure 12).
- Dissolved oxygen remained relatively stable throughout the deployment, increasing as the fall season progressed with decreasing water temperatures. This is normal as dissolved oxygen is inversely proportionate to water temperature.
- 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 minimum thresholds for CCME's Guidelines for the Protection of Early Life Stages and Other Life Stages throughout the deployment period.

Churchill River above Grizzle Rapids: Dissolved Oxygen Concentration and Saturation & Water Temperature

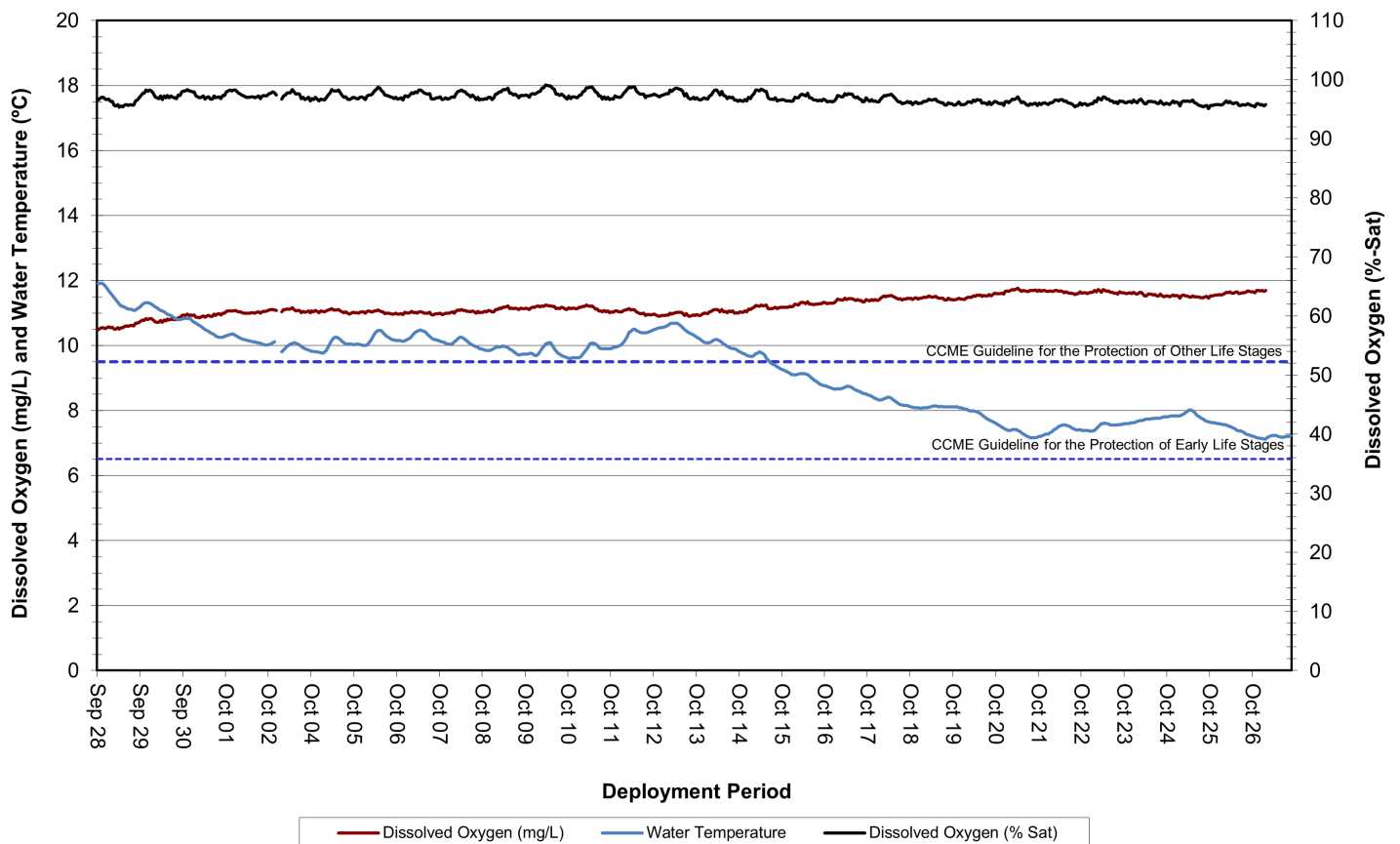


Figure 12: Dissolved Oxygen & Water Temperature at Churchill River above Grizzle Rapids

Turbidity

- Over the deployment period, turbidity ranged from 0.0 NTU to 1.5 NTU, with a median value of 0.0 NTU (Figure 13). A median value of 0.0 NTU indicates a very low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Muskrat Falls MET Station.
- Turbidity remained low throughout the deployment period, reacting to most precipitation events, spiking several times towards the end of the deployment. This station is generally less impacted by such events as it is located on a wide and deep portion of the river.
- 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.

Churchill River above Grizzle Rapids: Turbidity, Precipitation & Stage

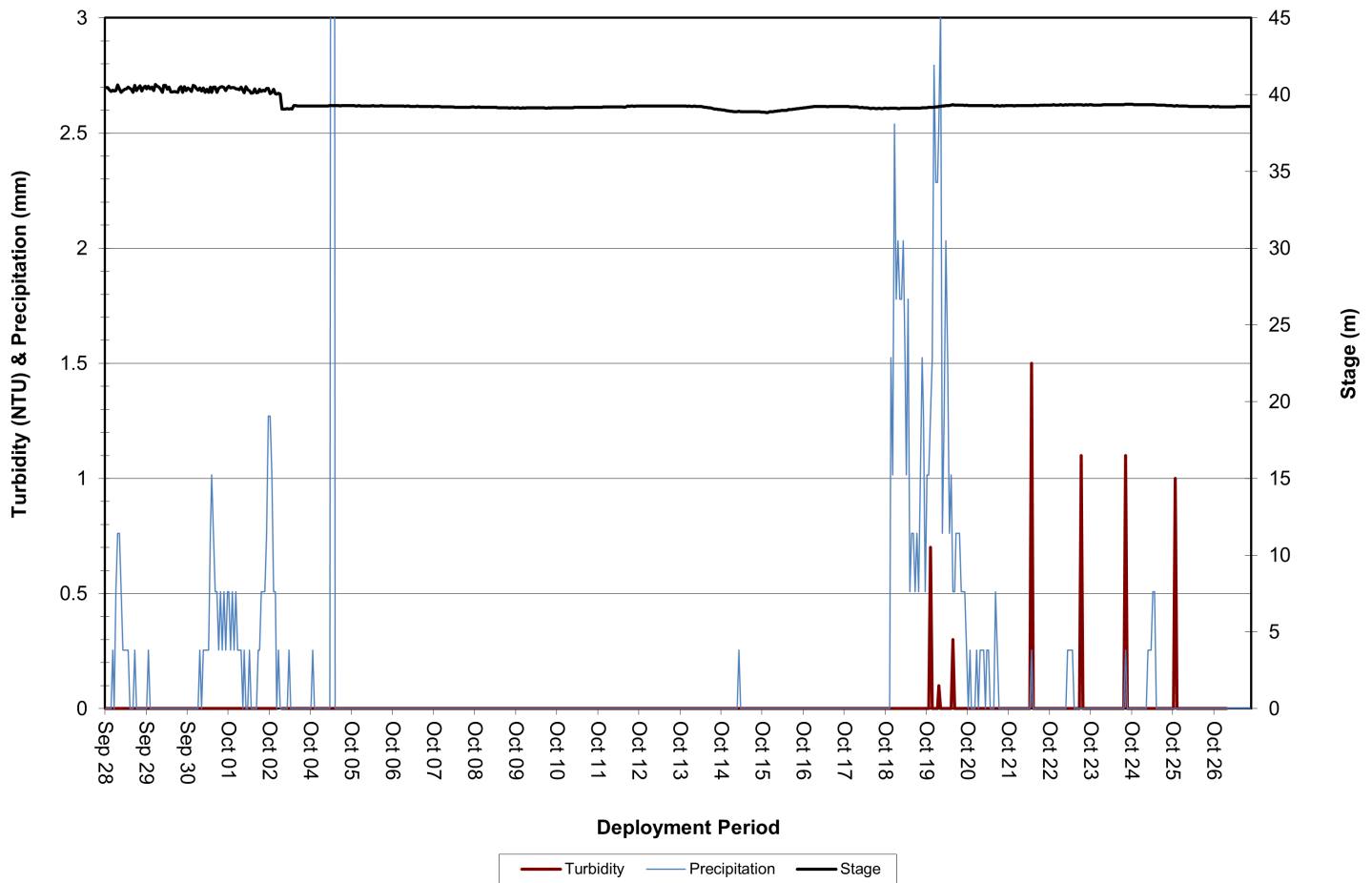


Figure 13: Turbidity, Precipitation & Stage at Churchill River above Grizzle Rapids

Stage

- Over the deployment period, stage ranged from 38.831 m to 40.653 m, with a median value of 39.254 m (Figure 14). Precipitation data was obtained from the Muskrat Falls MET Station.
- An issue with these sensors resulted in the first portion of data to be uninterpretable, but this was later corrected on October 2nd. Stage was considerably stable throughout the deployment period, with most of the data falling within a 0.5 m range for stage. Precipitative events correlated with increases to this variable.
- 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.

Churchill River above Grizzle Rapids: Stage & Precipitation

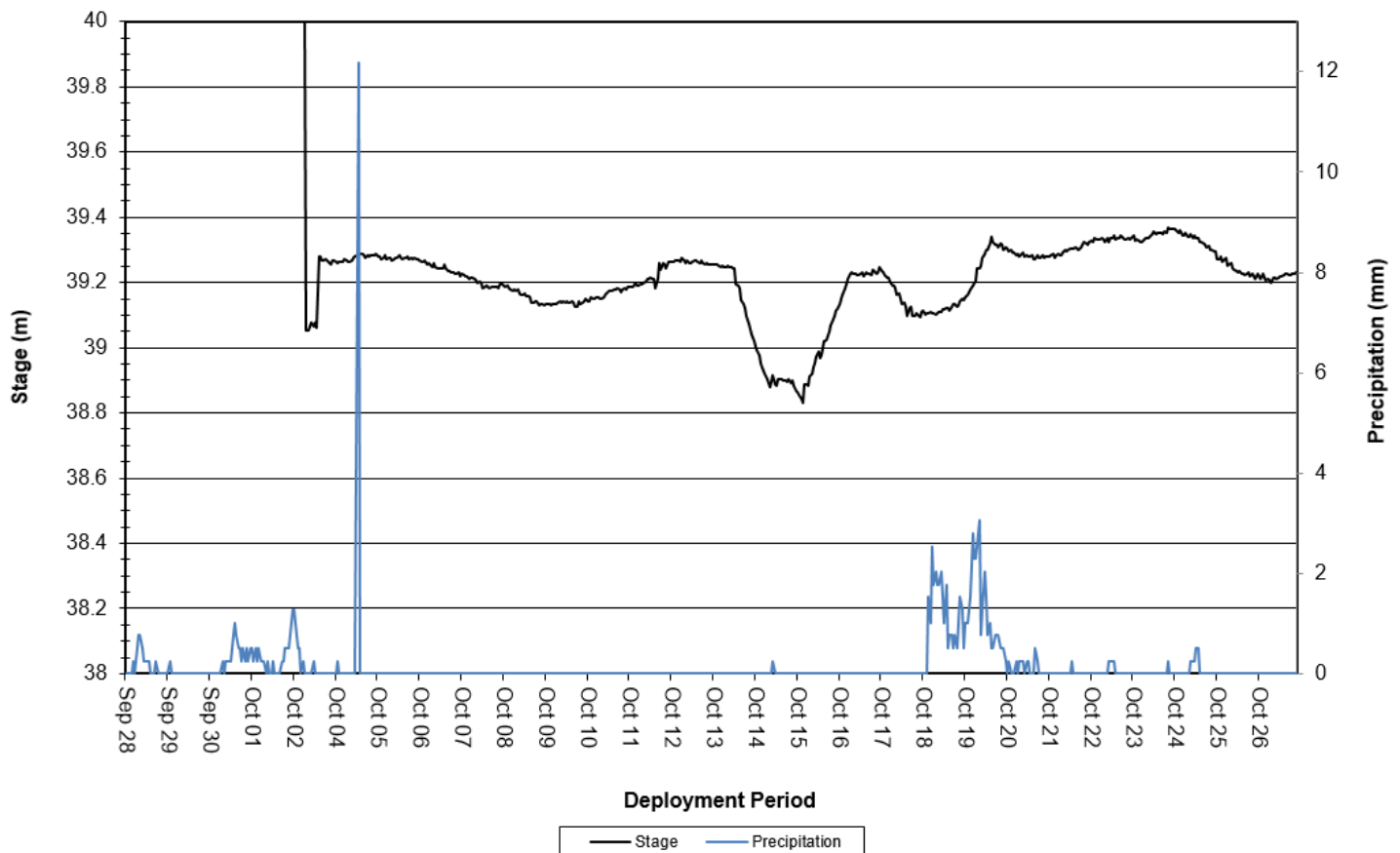


Figure 14: Stage & Precipitation at Churchill River above Grizzle Rapids

Churchill River below Muskrat Falls

Water Temperature

- Over the deployment period, water temperature ranged from 7.6°C to 12.9°C, with a median value of 10.1°C (Figure 15). Air temperature data was obtained from the Muskrat Falls MET Station.
- Overall water temperature declined throughout this deployment period in line with the fall season. Water temperatures closely correlate with ambient air temperatures as expected.
- 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.

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



Figure 15: Water and Air Temperature & Stage at Churchill River below Muskrat Falls

pH

- Over the deployment period, pH ranged from 6.88 pH units to 7.11 pH units, with a median value of 6.98 (Figure 16).
- pH remained stable throughout the deployment period. The data remained within the CCME’s Guidelines for the Protection of Aquatic Life throughout the deployment period (Figure 16).
- 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.

Churchill River below Muskrat Falls: pH & Stage

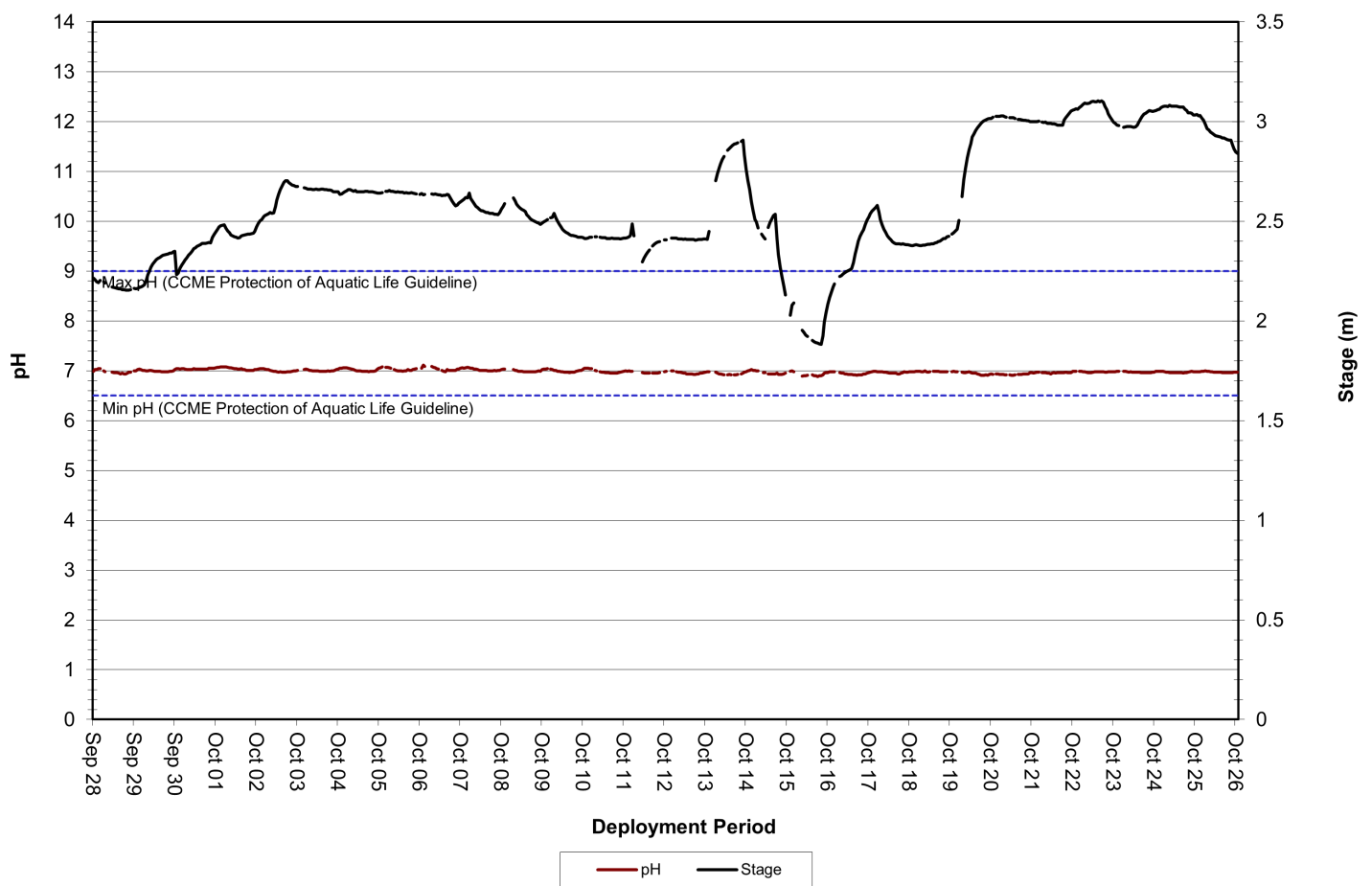


Figure 16: pH & Stage at Churchill River below Muskrat Falls

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 17.1 $\mu\text{S}/\text{cm}$ to 18.7 $\mu\text{S}/\text{cm}$, with a median value of 18.1 $\mu\text{S}/\text{cm}$ (Figure 17).
- 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 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.

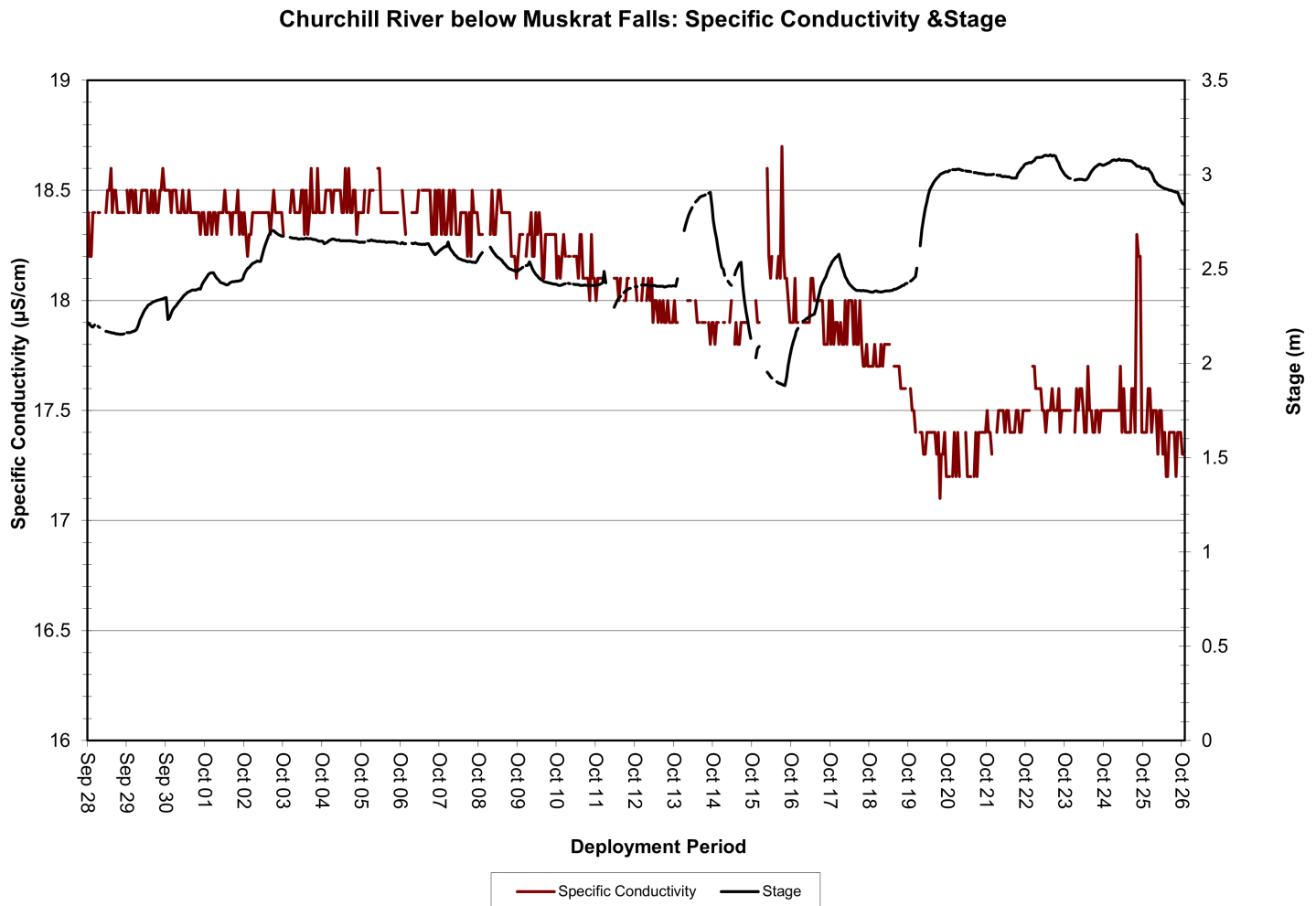


Figure 17: Specific Conductivity & Stage at Churchill River below Muskrat Falls

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 10.52 mg/L to 11.95 mg/L, with a median value of 11.44 mg/L. Saturation of dissolved oxygen ranged from 95.6% to 107.9%, with a median value of 100.9% (Figure 18).
- Dissolved oxygen and water temperature exhibit an inverse relationship: as one parameter increases, the other decreases, and vice versa. Dissolved oxygen levels slowly increased over the course of deployment. This is to be expected since water temperatures were slowly decreasing over the same period. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures. Data for this station was intermittent at times due to a sensor anomaly or transmission issue.
- Dissolved oxygen levels remained above the minimum thresholds for the CCME's Guidelines for the Protection of Early Life Stages and Other Life Stages throughout the deployment period.

Churchill River below Muskrat Falls: Dissolved Oxygen Concentration and Saturation & Water Temperature



Figure 18: Dissolved Oxygen & Water Temperature at Churchill River below Muskrat Falls

Turbidity

- Over the deployment period, turbidity ranged from 0 NTU to 12.1 NTU, with a median value of 0 NTU. A median value of 0 NTU indicates minimal natural background turbidity in the waterbody, which is typical of this station (Figure 19). Precipitation data was obtained from the Muskrat Falls MET Station (Figure 20).
- Turbidity did show some correlation to precipitation episodes, however, there were several spikes and fluctuations throughout the deployment period that occurred without those events. This is not unusual as this portion of the river is wide with a high depth, so precipitation is less likely to impact turbidity.
- 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.

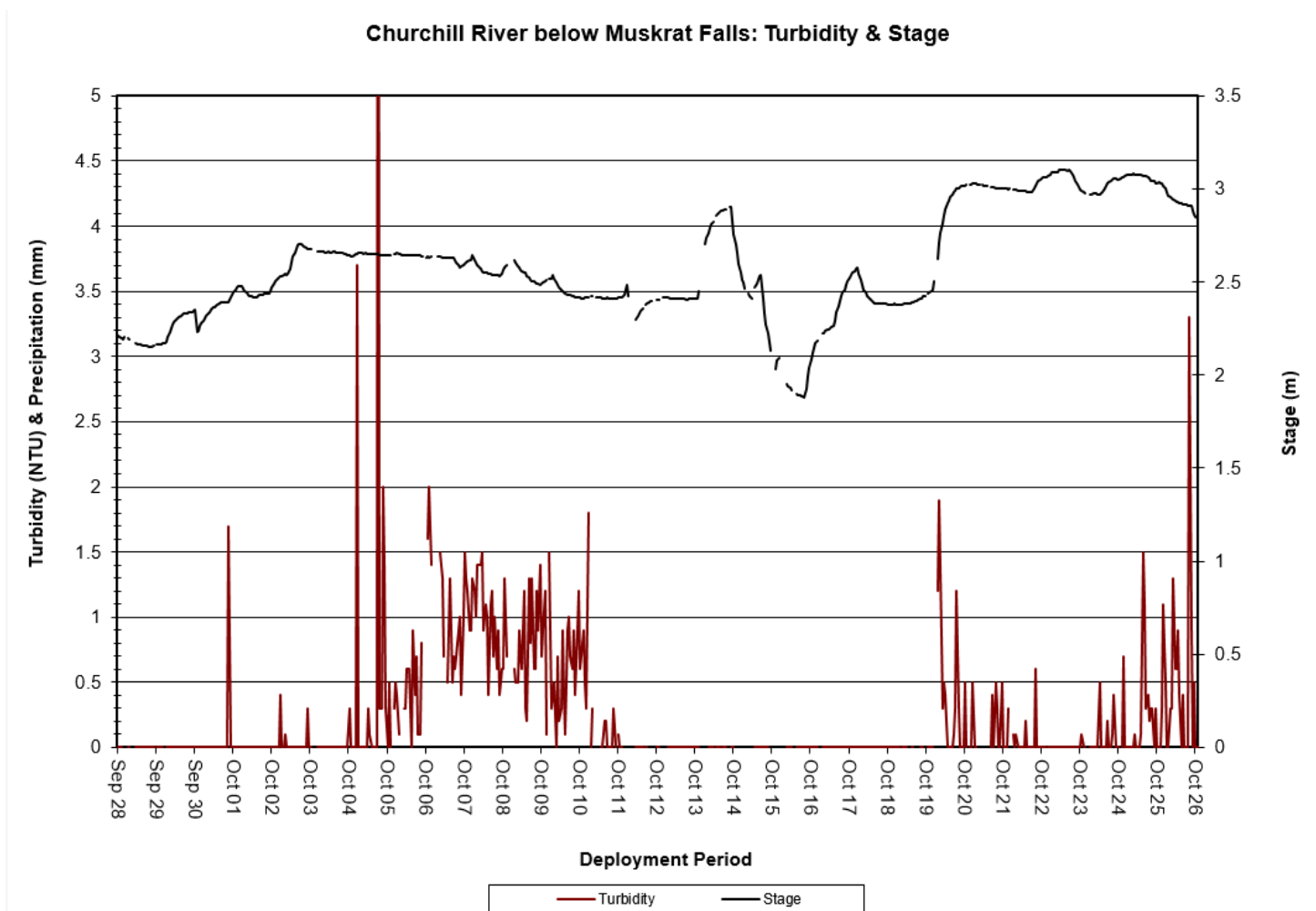


Figure 19: Turbidity & Stage at Churchill River below Muskrat Falls

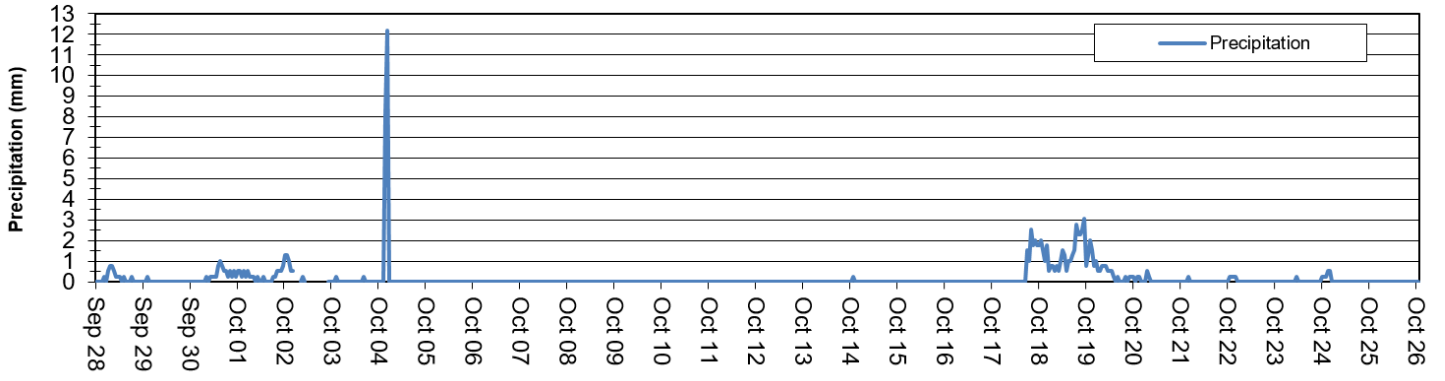


Figure 20: Precipitation at Churchill River below Muskrat Falls

Stage

- Over the deployment period, stage ranged from 1.88 m to 3.10 m, with a median value of 2.55 m (Figure 21). Precipitation data was obtained from the Muskrat Falls MET Station.
- Stage fluctuated much throughout this deployment period (more so in the latter half). While there were some correlations with precipitation episodes, this portion of the river is less impacted by those events due to the river's broad width and higher depth. Anthropogenic activity due to the upstream Muskrat Fall hydroelectric dam also influenced these variables.
- 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.

Churchill River below Muskrat Falls: Stage & Precipitation

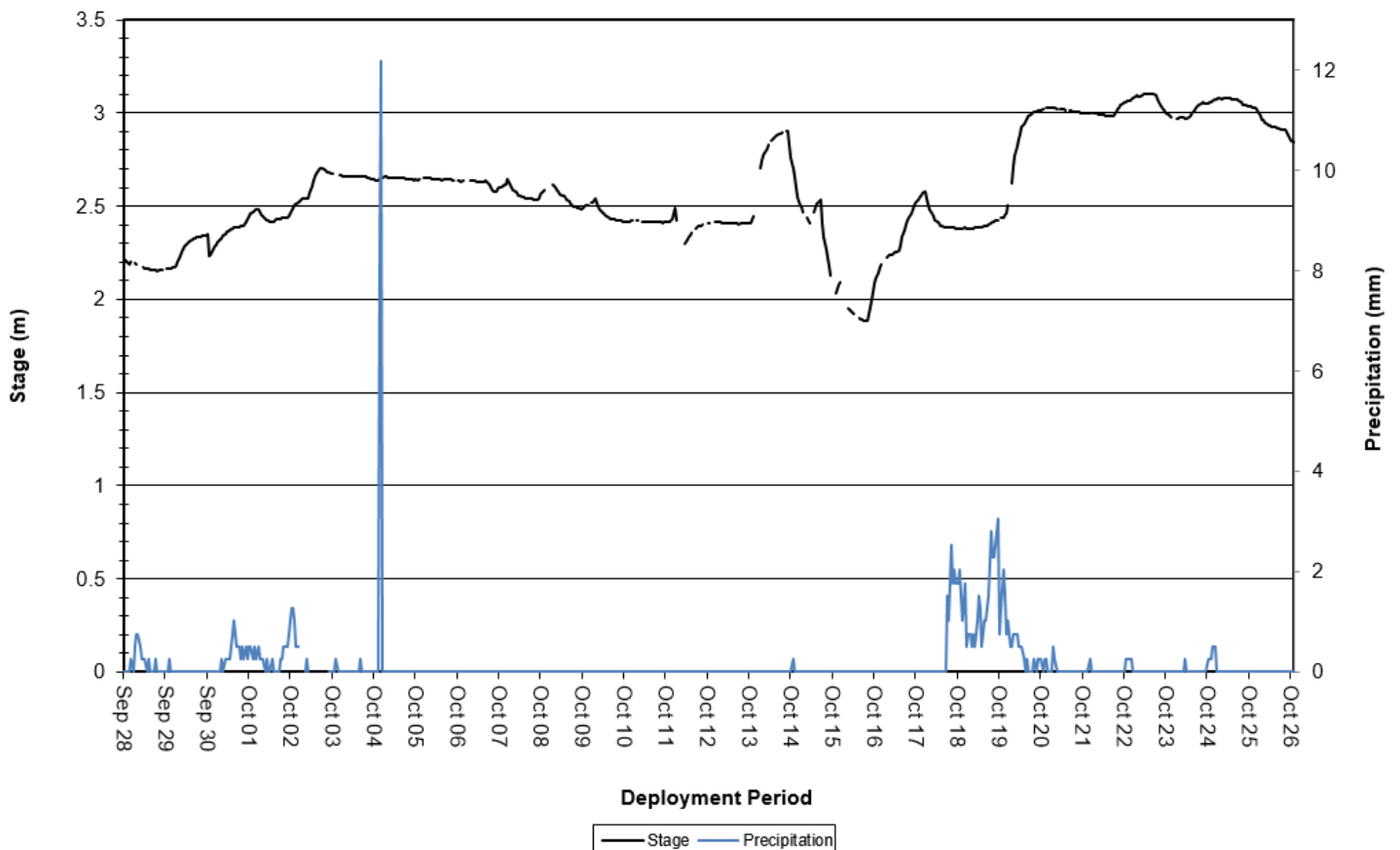


Figure 21: Stage & Precipitation at Churchill River below Muskrat Falls

Churchill River at English Point

Water Temperature

- Water temperature ranged from 6.6°C to 12.8°C, with a median value of 9.6°C (Figure 22). Air temperature data was obtained from the End of Mud Lake Road Weather Station.
- Overall water temperature declined throughout this deployment period in line with the fall season. Water temperature was insignificantly impacted during the warm weather episode between October 10th – 12th, with values remaining relatively constant. Diurnal fluctuations are better defined at this station due to proximity as English Point is located at the mouth of the Churchill River.
- 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.

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

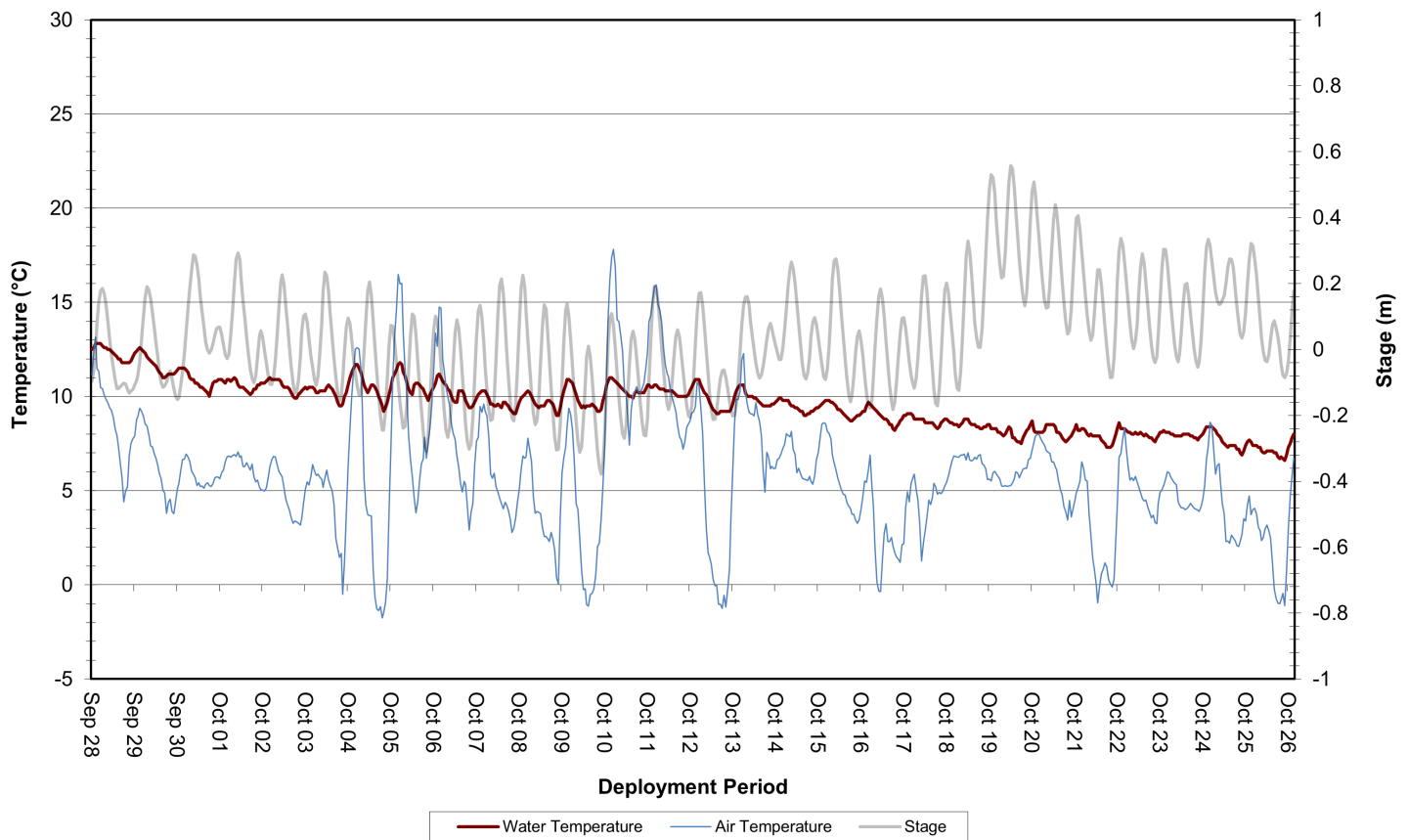


Figure 22: Water and Air Temperature & Stage at Churchill River at English Point

pH

- Over the deployment period, pH ranged from 6.45 pH units to 7.04 pH units, with a median value of 6.77 (Figure 23).
- pH remained relatively stable throughout most of the deployment period. Diurnal fluctuations dampened after the precipitation episode in the region on October 19th, resulting in slightly more acidic conditions thereafter with a longer recovery time towards the deployment period average. This is likely because there is less photosynthetic carbon-fixation at this time of the year due to shortened hours of daylight.
- pH values were very briefly outside the threshold of the CCME's Guidelines for the Protection of Aquatic Life at the start of the deployment, then fell within it for the remainder of the duration, however, data did hover just above the minimum threshold.
- 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.

Churchill River at English Point: pH & Stage

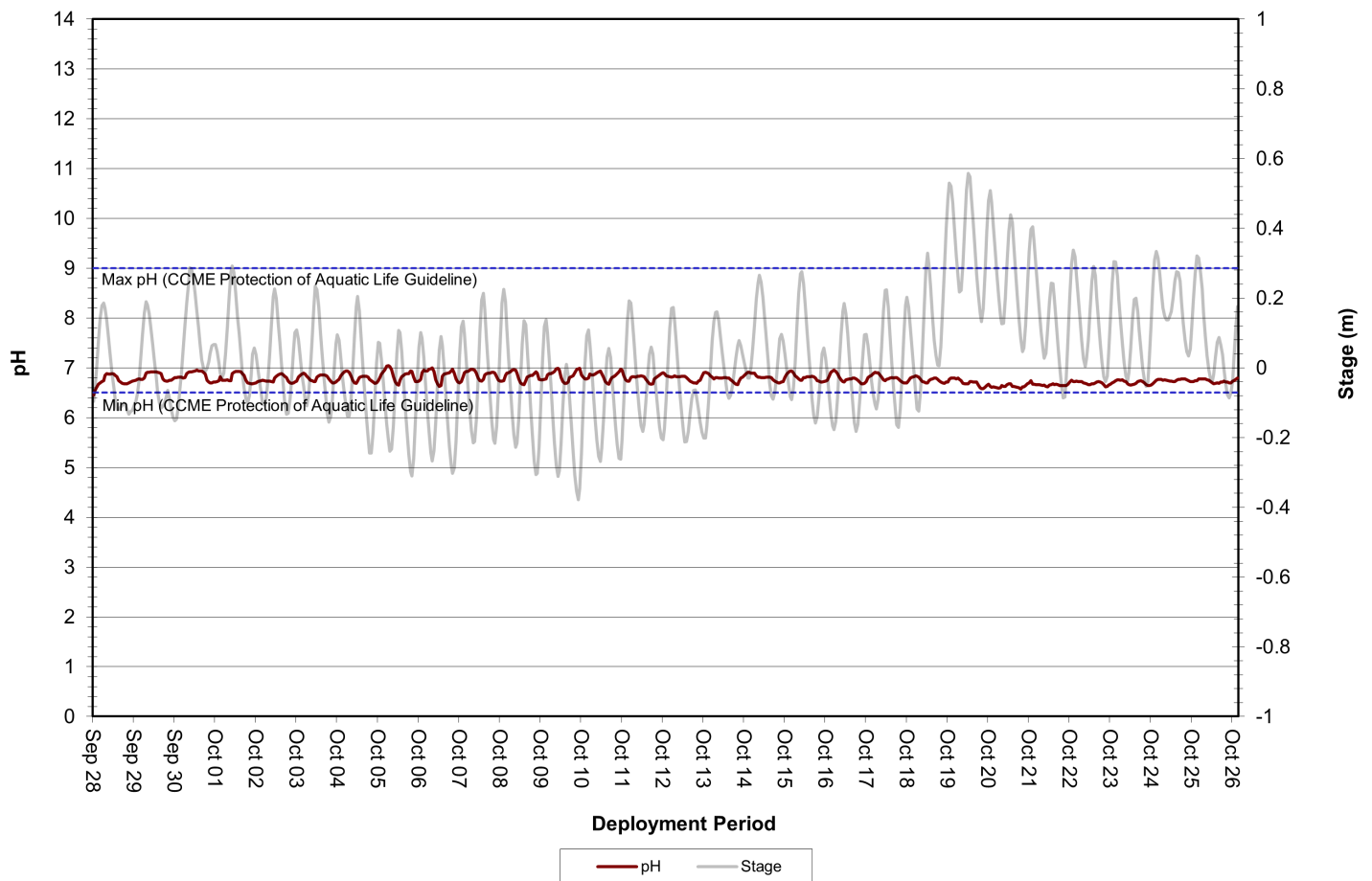


Figure 23: pH & Stage at Churchill River at English Point

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 14.0 $\mu\text{S}/\text{cm}$ to 52.6 $\mu\text{S}/\text{cm}$, with a median value of 28.0 $\mu\text{S}/\text{cm}$ (Figure 24).
- Conductivity was inversely proportional to the stage as the added water into the system from precipitation decreased the concentration of solutes in the water, lowering the conductivity. Fluctuations were more profound at this station due to the tidal influence of the Atlantic Ocean, as this station is adjacent to an open bay.
- 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.

Churchill River at English Point: Specific Conductivity & Stage



Figure 24: Specific Conductivity & Stage at Churchill River at English Point

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 9.08 mg/L to 10.89 mg/L, with a median value of 10.16 mg/L. Saturation of dissolved oxygen ranged from 82.8% to 98.0% saturation, with a median value of 88.7% (Figure 25).
- Dissolved oxygen remained relatively stable throughout the deployment, increasing as the fall season progressed with decreasing water temperatures as dissolved oxygen is inversely proportionate to water temperature. Diurnal impacts were more profound at this station, leading to notable diurnal fluctuations in dissolved oxygen concentrations. This is due to warmer temperatures during hours of daylight (less oxygen), and cooler temperatures during hours of darkness (more oxygen).
- Dissolved oxygen levels were below the CCME's Guideline for the Protection of Early Life Stages for the beginning of deployment, after which they hovered around and then rose above that Guideline as water temperatures decreased through October. Dissolved oxygen levels were above the CCME's Guidelines for the Protection of Other Life Stages for the duration of deployment (Figure 25).

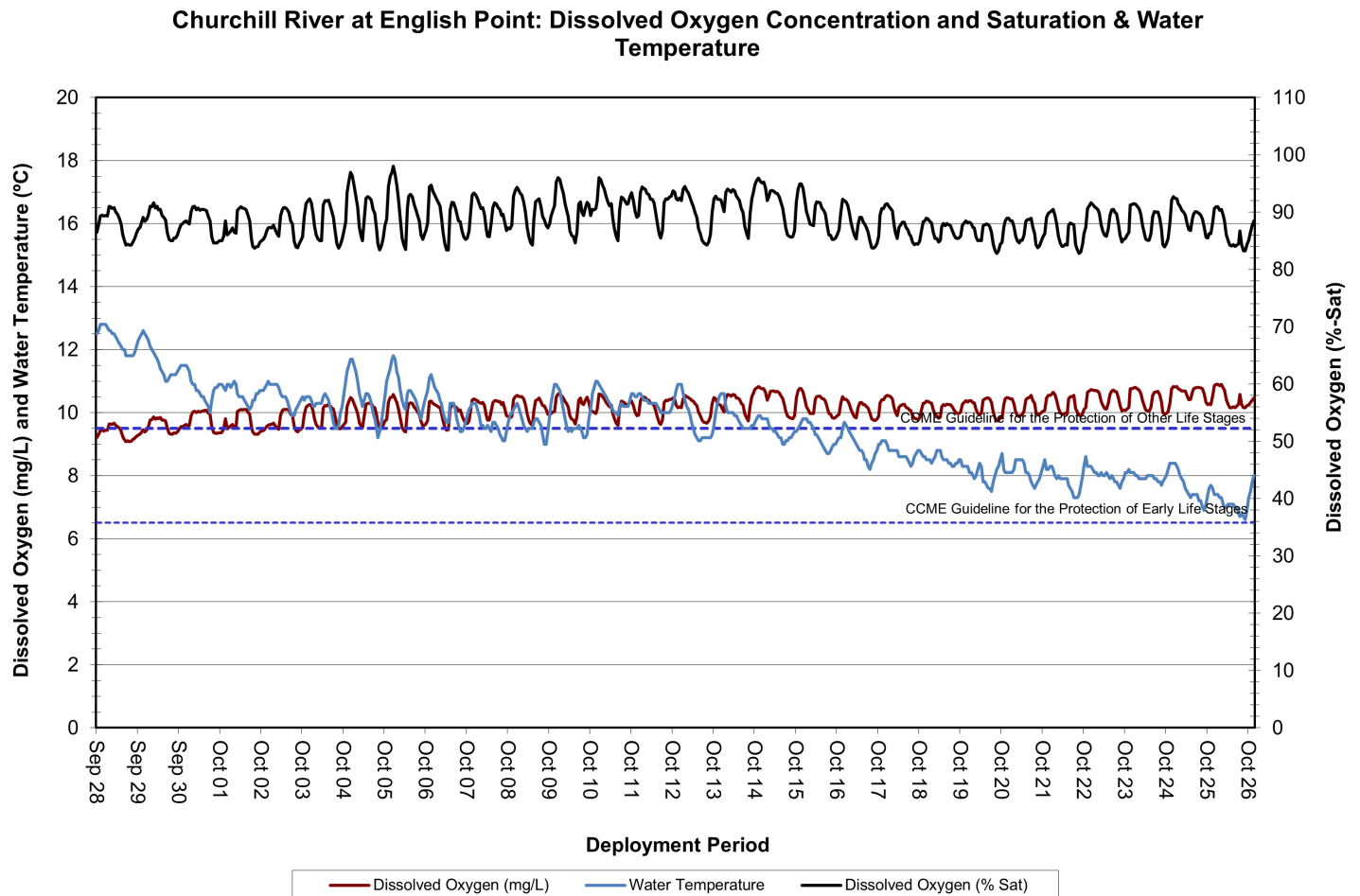


Figure 25: Dissolved Oxygen & Water Temperature at Churchill River at English Point

Turbidity

- Over the deployment period, turbidity ranged from 3.6 NTU to 48.7 NTU, with a median value of 9.7 NTU (Figure 26). A median value of 9.7 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 End of Mud Lake Road Weather Station.
- Turbidity spiked many times throughout this deployment period. This is not unusual for this station due to its proximity to an open bay, influenced by tidal changes, wind, waves and precipitation. There are several spikes seen across the data that were in correlation to precipitation events. Sediment near the instrumentation is easily disturbed due to the aforementioned variables, especially wave action, thus explaining the series of turbidity spikes; that is a normal behavior for this 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.

Churchill River at English Point: Turbidity, Precipitation & Stage

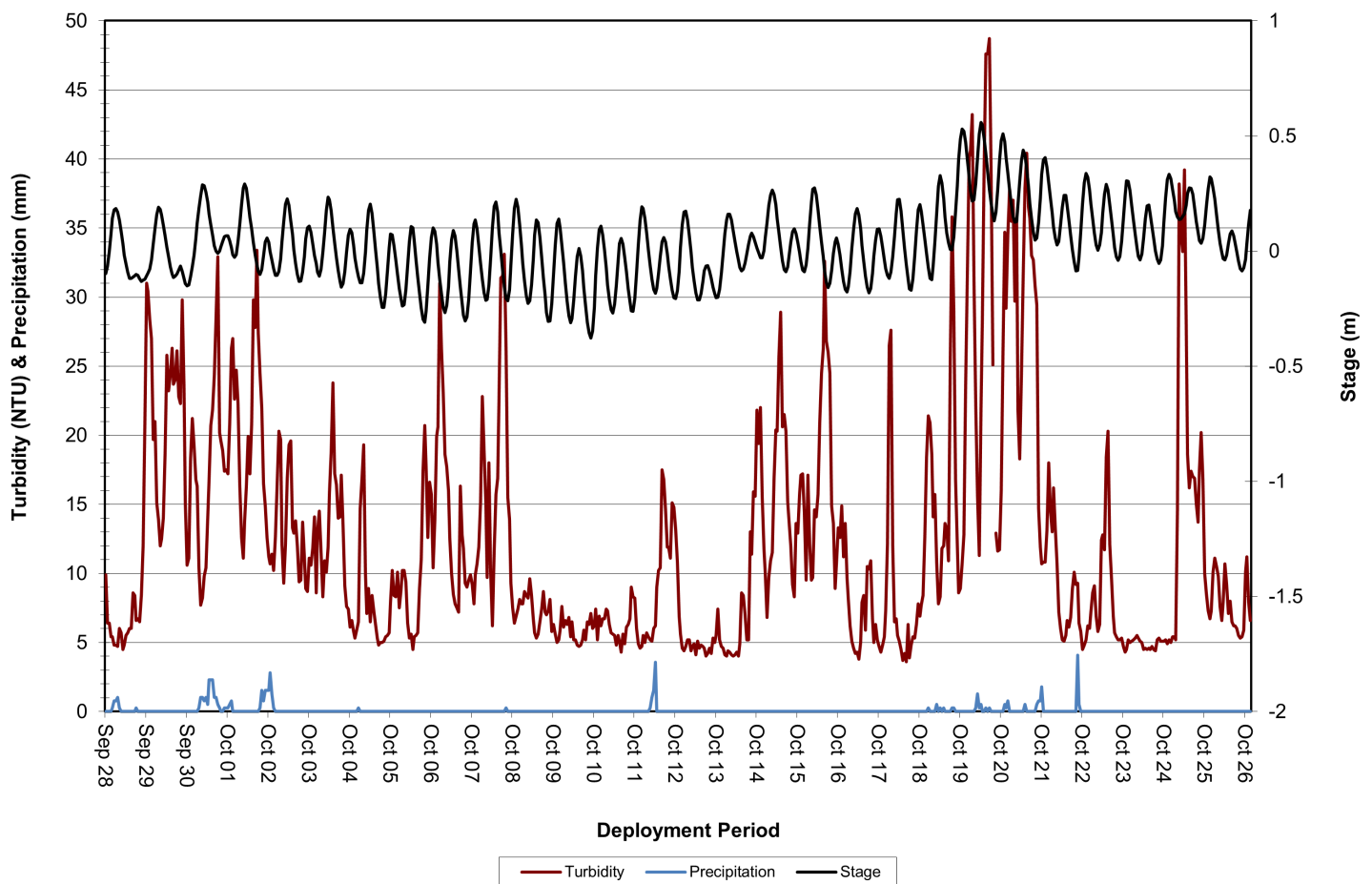


Figure 26: Turbidity, Precipitation & Stage at Churchill River at English Point

Stage

- Over the deployment period, stage ranged from -0.378 m to 0.558 m, with a median value of 0.027 m (Figure 27). Precipitation data was obtained from the End of Mud Lake Road Weather Station.
- Stage here is impacted by tidal changes from the Atlantic Ocean due to the station's proximity to an open bay. Stage was also influenced by precipitation events adding more water into the system.
- 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.

Churchill River at English Point: Stage and Precipitation

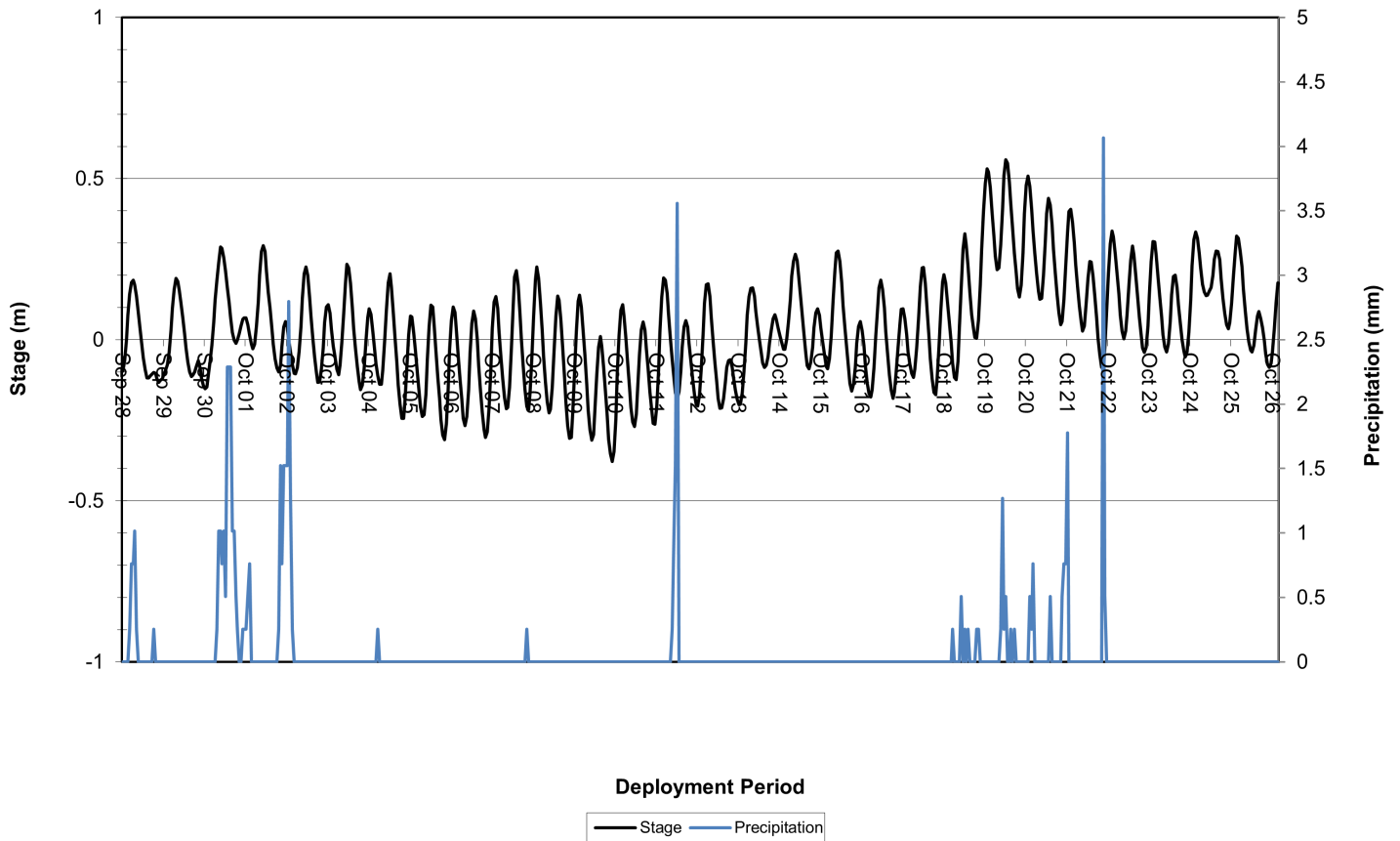


Figure 27: Stage & Precipitation at Churchill River at English Point

Conclusions

- Instruments at three water quality monitoring stations on the Lower Churchill River were already deployed from the previous report. The instrument at Churchill River below Metchin River was deployed on September 28, denoting the start of this deployment period for this report from that date through October 26, 2021.
- Water temperature decreased 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 September and October.
- pH was relatively stable at all stations over the course of deployment. pH was within the CCME's Guidelines for the Protection of Aquatic Life for the duration of deployment at Churchill River above Grizzle Rapids (ignoring one outlier due to possible sensor reset) and below Muskrat Falls, while pH remained within the Guidelines for all except the beginning of the deployment period at Churchill River at English Point. All pH data at Churchill River below Metchin River was outside the threshold (< 6.5)
- Specific conductivity was generally stable and behaved appropriately with the respective stage and precipitation inversed relationships 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 increased over the course of deployment at all stations as water temperatures decreased through the fall. 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 duration of deployment at all stations except at English Point; dissolved oxygen levels at this station were fluctuating below and above the minimum threshold for the first few days of deployment, rising and hovering above the threshold thereafter for the remainder of the duration. 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. In most cases, turbidity values returned to background levels following each observed event.

References

- Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated December, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. Available at: <http://sts.ccme.ca/en/index.html?chems=154,162&chapters=1> [Accessed December 12, 2017].
- Fondriest Environmental Inc. (2016a). Fundamentals of Environmental Measurements [Online]. Available at: <http://www.fondriest.com/environmental-measurements/parameters/water-quality/conductivity-salinity-tds/#cond15> [Accessed December 12, 2017].
- Fondriest Environmental Inc. (2016b). Fundamentals of Environmental Measurements [Online]. Available at: <http://www.fondriest.com/environmental-measurements/parameters/water-quality/water-temperature/#watertemp1> [Accessed December 12, 2017].
- Swenson, H.A., and Baldwin, H.L. (1965). A Primer on Water Quality, U.S. Geological Survey. Available at: <https://pubs.usgs.gov/gip/7000057/report.pdf> [Accessed December 12, 2017].
- United States Geological Survey. (2017). Water properties: Dissolved oxygen [Online]. Available at: <https://water.usgs.gov/edu/dissolvedoxygen.html> [Accessed December 12, 2017].

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

Bureau Veritas Job #: C1S6806
Report Date: 2021/10/18

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QVJ058 CR @ EP								
Sampling Date		2021/09/28 11:20						
Matrix		W						
Sample #		2021-6337-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	10	1.0	mg/L	N/A	2021/10/08		7616297
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/10/08		7616299
Total dissolved solids (calc., EC)	-	19	1.0	mg/L	N/A	2021/10/07		7616300
Inorganics								
Conductivity	-	34	1.0	uS/cm	N/A	2021/10/07	SHW	7623515
Chloride (Cl-)	-	6.1	1.0	mg/L	N/A	2021/10/12	FD	7629311
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/10/12	FD	7629311
Sulphate (SO4)	-	1.1	1.0	mg/L	N/A	2021/10/12	FD	7629311
Total Alkalinity (Total as CaCO3)	-	11	5.0	mg/L	N/A	2021/10/07	MCN	7621266
Colour	-	87	25	TCU	N/A	2021/10/07	MCN	7621284
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/10/07	SHW	7623518
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2021/10/13	2021/10/14	RTY	7633878
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2021/10/07	MCN	7621291
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/10/07	MCN	7621293
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/10/06	MCN	7621354
Dissolved Organic Carbon (C)	-	8.2	0.50	mg/L	N/A	2021/10/09	NGI	7626328
Total Organic Carbon (C)	-	8.1	0.50	mg/L	N/A	2021/10/08	NGI	7626322
pH	-	7.05		pH	N/A	2021/10/07	SHW	7623517
Total Phosphorus	-	0.019	0.004	mg/L	2021/10/13	2021/10/14	SSV	7633603
Total Suspended Solids	-	7.0	1.0	mg/L	2021/10/05	2021/10/13		7618944
Turbidity	-	12	0.10	NTU	N/A	2021/10/07	SHW	7623645
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/10/14	2021/10/14	NHU	7633189
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.45	0.0050	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Barium (Ba)	-	0.012	0.0010	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Boron (B)	-	ND	0.050	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Calcium (Ca)	-	2.2	0.10	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Chromium (Cr)	-	0.0014	0.0010	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Copper (Cu)	-	0.0019	0.00050	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Iron (Fe)	-	0.93	0.050	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Magnesium (Mg)	-	1.1	0.10	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Manganese (Mn)	-	0.028	0.0020	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/10/07	2021/10/08	MLB	7623511



BUREAU
VERITAS

Bureau Veritas Job #: C1S6806
Report Date: 2021/10/18

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QVJ058 CR @ EP								
Sampling Date 2021/09/28 11:20								
Matrix W								
Sample # 2021-6337-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Potassium (K)	-	0.64	0.10	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Sodium (Na)	-	4.4	0.10	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Strontium (Sr)	-	0.017	0.0020	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Uranium (U)	-	ND	0.00010	mg/L	2021/10/07	2021/10/08	MLB	7623511
Total Zinc (Zn)	-	0.0067	0.0050	mg/L	2021/10/07	2021/10/08	MLB	7623511



BUREAU
VERITAS

Bureau Veritas Job #: C1U3257
Report Date: 2021/11/01

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QYW368 CR BELOW MR								
Sampling Date		2021/10/12 14:00						
Matrix		W						
Sample #		2021-6339-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	9.4	1.0	mg/L	N/A	2021/10/21		7644904
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/10/29		7644907
Total dissolved solids (calc., EC)	-	10	1.0	mg/L	N/A	2021/10/22		7645123
Inorganics								
Conductivity	-	19	1.0	uS/cm	N/A	2021/10/22	SHW	7653378
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2021/10/25	FD	7655220
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/10/25	FD	7655220
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2021/10/25	FD	7655220
Total Alkalinity (Total as CaCO3)	-	10	5.0	mg/L	N/A	2021/11/01	EMT	7665907
Colour	-	18	5.0	TCU	N/A	2021/10/29	EMT	7665918
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/10/22	SHW	7653380
Total Kjeldahl Nitrogen (TKN)	-	0.13	0.10	mg/L	2021/10/25	2021/10/25	MJ1	7658028
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2021/10/29	EMT	7665922
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/10/29	EMT	7665927
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/10/27	MCN	7662913
Dissolved Organic Carbon (C)	-	3.3	0.50	mg/L	N/A	2021/10/22	NGI	7653396
Total Organic Carbon (C)	-	3.3	0.50	mg/L	N/A	2021/10/22	NGI	7653376
pH	-	6.82		pH	N/A	2021/10/22	SHW	7653379
Total Phosphorus	-	0.006	0.004	mg/L	2021/10/26	2021/10/27	SSV	7661349
Total Suspended Solids	-	1.6	1.0	mg/L	2021/10/19	2021/10/26	MKX	7645770
Turbidity	-	1.2	0.10	NTU	N/A	2021/10/22	SHW	7653510
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/10/29	2021/10/29	NHU	7666442
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.030	0.0050	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Barium (Ba)	-	0.0067	0.0010	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Boron (B)	-	ND	0.050	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Calcium (Ca)	-	2.4	0.10	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Copper (Cu)	-	ND	0.00050	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Iron (Fe)	-	0.14	0.050	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Magnesium (Mg)	-	0.82	0.10	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Manganese (Mn)	-	0.019	0.0020	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/10/20	2021/10/20	BAN	7647886



BUREAU
VERITAS

Bureau Veritas Job #: C1U3257
Report Date: 2021/11/01

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QYW368 CR BELOW MR								
Sampling Date		2021/10/12 14:00						
Matrix		W						
Sample #		2021-6339-00-SI-SP						
Registration #		WS-S-0000						
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Potassium (K)	-	0.27	0.10	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Sodium (Na)	-	0.54	0.10	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Strontium (Sr)	-	0.011	0.0020	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Uranium (U)	-	ND	0.00010	mg/L	2021/10/20	2021/10/20	BAN	7647886
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/10/20	2021/10/20	BAN	7647886



BUREAU
VERITAS

Bureau Veritas Job #: C1V9536
Report Date: 2021/11/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
RCH583 2021-6345-00-SI-SP								
Sampling Date		2021/10/26 10:30						
Matrix		W						
Sample #		2021-6345-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	7.9	1.0	mg/L	N/A	2021/11/04		7672949
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/11/10		7674720
Total dissolved solids (calc., EC)	-	9.7	1.0	mg/L	N/A	2021/11/05		7672636
Inorganics								
Conductivity	-	17	1.0	uS/cm	N/A	2021/11/05	SHW	7682332
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Total Alkalinity (Total as CaCO3)	-	10	5.0	mg/L	N/A	2021/11/10	EMT	7689032
Colour	-	31	5.0	TCU	N/A	2021/11/10	EMT	7691490
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/11/05	SHW	7682337
Total Kjeldahl Nitrogen (TKN)	-	0.13	0.10	mg/L	2021/11/08	2021/11/15	RTY	7688190
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2021/11/10	EMT	7691493
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/11/10	EMT	7691496
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/11/05	MCN	7679808
Dissolved Organic Carbon (C)	-	4.0	0.50	mg/L	N/A	2021/11/04	NGI	7679777
Total Organic Carbon (C)	-	4.3	0.50	mg/L	N/A	2021/11/04	NGI	7679760
pH	-	7.05		pH	N/A	2021/11/05	SHW	7682334
Total Phosphorus	-	0.011	0.004	mg/L	2021/11/16	2021/11/17	SSV	7703735
Total Suspended Solids	-	1.2	1.0	mg/L	2021/11/02	2021/11/04		7675543
Turbidity	-	1.0	0.10	NTU	N/A	2021/11/04	SHW	7679895
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/11/10	2021/11/10	NHU	7689454
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.068	0.0050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Barium (Ba)	-	0.0067	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Boron (B)	-	ND	0.050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Calcium (Ca)	-	2.0	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Copper (Cu)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Iron (Fe)	-	0.20	0.050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Magnesium (Mg)	-	0.69	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Manganese (Mn)	-	0.011	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321



BUREAU
VERITAS

Bureau Veritas Job #: C1V9536
Report Date: 2021/11/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
RCH583 2021-6345-00-SI-SP								
Sampling Date 2021/10/26 10:30								
Matrix W								
Sample # 2021-6345-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Potassium (K)	-	0.26	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Sodium (Na)	-	0.50	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Strontium (Sr)	-	0.010	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Uranium (U)	-	ND	0.00010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/11/03	2021/11/03	BAN	7677321



BUREAU
VERITAS

Bureau Veritas Job #: C1V9536
Report Date: 2021/11/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
RCH591 2021-6346-00-SI-SP								
Sampling Date		2021/10/26 13:50						
Matrix		W						
Sample #		2021-6346-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	9.0	1.0	mg/L	N/A	2021/11/04		7672949
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/11/10		7674720
Total dissolved solids (calc., EC)	-	9.7	1.0	mg/L	N/A	2021/11/05		7672636
Inorganics								
Conductivity	-	17	1.0	uS/cm	N/A	2021/11/05	SHW	7682332
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Total Alkalinity (Total as CaCO3)	-	10	5.0	mg/L	N/A	2021/11/10	EMT	7689032
Colour	-	36	5.0	TCU	N/A	2021/11/10	EMT	7691490
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/11/05	SHW	7682337
Total Kjeldahl Nitrogen (TKN)	-	0.19	0.10	mg/L	2021/11/08	2021/11/15	RTY	7688190
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2021/11/10	EMT	7691493
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/11/10	EMT	7691496
Nitrogen (Ammonia Nitrogen)	-	0.055	0.050	mg/L	N/A	2021/11/04	MCN	7679808
Dissolved Organic Carbon (C)	-	4.6	0.50	mg/L	N/A	2021/11/05	NGI	7679777
Total Organic Carbon (C)	-	4.6	0.50	mg/L	N/A	2021/11/04	NGI	7679760
pH	-	6.93		pH	N/A	2021/11/05	SHW	7682334
Total Phosphorus	-	0.009	0.004	mg/L	2021/11/16	2021/11/17	SSV	7703735
Total Suspended Solids	-	5.0	1.0	mg/L	2021/11/02	2021/11/04		7675543
Turbidity	-	4.7	0.10	NTU	N/A	2021/11/04	SHW	7679895
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/11/12	2021/11/12	NHU	7691770
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.19	0.0050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Barium (Ba)	-	0.0086	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Boron (B)	-	ND	0.050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Calcium (Ca)	-	2.3	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Copper (Cu)	-	0.00079	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Iron (Fe)	-	0.28	0.050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Magnesium (Mg)	-	0.79	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Manganese (Mn)	-	0.0099	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321



BUREAU
VERITAS

Bureau Veritas Job #: C1V9536
Report Date: 2021/11/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
RCH591 2021-6346-00-SI-SP								
Sampling Date 2021/10/26 13:50								
Matrix W								
Sample # 2021-6346-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Potassium (K)	-	0.33	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Sodium (Na)	-	0.59	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Strontium (Sr)	-	0.012	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Uranium (U)	-	ND	0.00010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/11/03	2021/11/03	BAN	7677321



BUREAU
VERITAS

Bureau Veritas Job #: C1V9536
Report Date: 2021/11/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
RCH604 2021-6348-00-SI-SP								
Sampling Date		2021/10/26 15:15						
Matrix		W						
Sample #		2021-6348-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	11	1.0	mg/L	N/A	2021/11/04		7672949
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/11/10		7674720
Total dissolved solids (calc., EC)	-	20	1.0	mg/L	N/A	2021/11/05		7672636
Inorganics								
Conductivity	-	35	1.0	uS/cm	N/A	2021/11/05	SHW	7682332
Chloride (Cl-)	-	6.2	1.0	mg/L	N/A	2021/11/08	FD	7683308
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2021/11/08	FD	7683308
Total Alkalinity (Total as CaCO3)	-	12	5.0	mg/L	N/A	2021/11/10	EMT	7689035
Colour	-	77	25	TCU	N/A	2021/11/10	EMT	7691525
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/11/05	SHW	7682337
Total Kjeldahl Nitrogen (TKN)	-	0.19	0.10	mg/L	2021/11/08	2021/11/15	RTY	7688190
Nitrate + Nitrite (N)	-	0.059	0.050	mg/L	N/A	2021/11/10	EMT	7691526
Nitrite (N)	-	0.063	0.010	mg/L	N/A	2021/11/10	EMT	7691527
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/11/05	MCN	7679808
Dissolved Organic Carbon (C)	-	8.1	0.50	mg/L	N/A	2021/11/05	NGI	7679777
Total Organic Carbon (C)	-	8.0	0.50	mg/L	N/A	2021/11/04	NGI	7679760
pH	-	6.93		pH	N/A	2021/11/05	SHW	7682334
Total Phosphorus	-	0.024	0.004	mg/L	2021/11/16	2021/11/17	SSV	7703735
Total Suspended Solids	-	12	1.0	mg/L	2021/11/02	2021/11/04		7675543
Turbidity	-	14	0.10	NTU	N/A	2021/11/04	SHW	7679895
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/11/12	2021/11/12	NHU	7691770
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.52	0.0050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Barium (Ba)	-	0.012	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Boron (B)	-	ND	0.050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Calcium (Ca)	-	2.3	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Chromium (Cr)	-	0.0013	0.0010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Copper (Cu)	-	0.0015	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Iron (Fe)	-	1.0	0.050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Magnesium (Mg)	-	1.2	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Manganese (Mn)	-	0.026	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321



BUREAU
VERITAS

Bureau Veritas Job #: C1V9536
Report Date: 2021/11/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
RCH604 2021-6348-00-SI-SP								
Sampling Date 2021/10/26 15:15								
Matrix W								
Sample # 2021-6348-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Potassium (K)	-	0.62	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Sodium (Na)	-	4.0	0.10	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Strontium (Sr)	-	0.019	0.0020	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Uranium (U)	-	ND	0.00010	mg/L	2021/11/03	2021/11/03	BAN	7677321
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/11/03	2021/11/03	BAN	7677321