

Real-Time Water Quality Deployment Report

Paddy's Pond at Outlet

November 2, 2022 to December 5, 2022



Government of Newfoundland & Labrador
Department of Environment and Climate Change
Water Resources Management Division
St. John's, NL, A1B 4J6 Canada

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General

The Department of Environment and Climate Change, Water Resources Management Division staff monitor water quality in real-time at Paddy's Pond at outlet to Three Arm Pond (47.488129N, 52.893809W).



Figure 1: Paddy's Pond at Outlet Real-Time Water Quality Station location

Maintenance and Calibration of Instrument

As part of the Quality Assurance and Quality Control protocol (QAQC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.

Upon deployment, a QA/QC Sonde is temporarily deployed *in situ*, adjacent to the Field Sonde. Depending on the degree of difference between each parameter from the Field and QA/QC sondes, a qualitative rank is assigned (See Table). The possible ranks, from most to least desirable, are; Excellent, Good, Fair, Marginal, and Poor. A grab sample is also taken for additional confirmation of conditions at deployment and to allow for future modelling studies.

Table 1: 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 > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

At the end of a deployment period, a freshly cleaned and calibrated QA/QC Sonde is placed *in situ*, adjacent to the Field Sonde. Deployment and removal comparison rankings for the station at Paddy's Pond deployed between November 2, 2022 to December 5, 2022 are summarized in Table 2.

Table 2: Qualitative QA/QC comparison rankings for Paddy's Pond at outlet station November 2, 2022 through December 5, 2022.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Paddy's Pond at Outlet	2022-11-02	Deployment	Excellent	Excellent	Poor	Excellent	Excellent
	2022-11-02	Grab Sample #2021-1727-00-SI-SP	N/A	Marginal	Poor	N/A	Excellent
	2022-12-05	Removal	Good	Good	Poor	Marginal	Excellent

- On November 2, 2022, a real-time water quality monitoring instrument was deployed at the station Paddy's Pond at Outlet. The instrument was deployed for a period of 34 days and was removed on December 5, 2022.
- Upon deployment, sensors ranked 'Excellent' against the calibrated QA/QC sonde with exception of conductivity, which ranked 'Poor'. This may be the result of inadequate time provided for the sensor to stabilize, stirring up of sediments, calibration error and/or sensor issues. This assumption is supported by a conductivity ranking of 'Poor', upon comparison with the grab sample (2022-1727-00-SI-SP) and the field sonde.
- At removal of the instrument, parameter rankings varied between 'Excellent', 'Good' and 'Fair' against the QA/QC sonde with exception of Conductivity which ranked 'Poor'. This ranking was expected given the ranking upon deployment and is indicative of a calibration error or sensor issue.

DATA INTERPRETATION

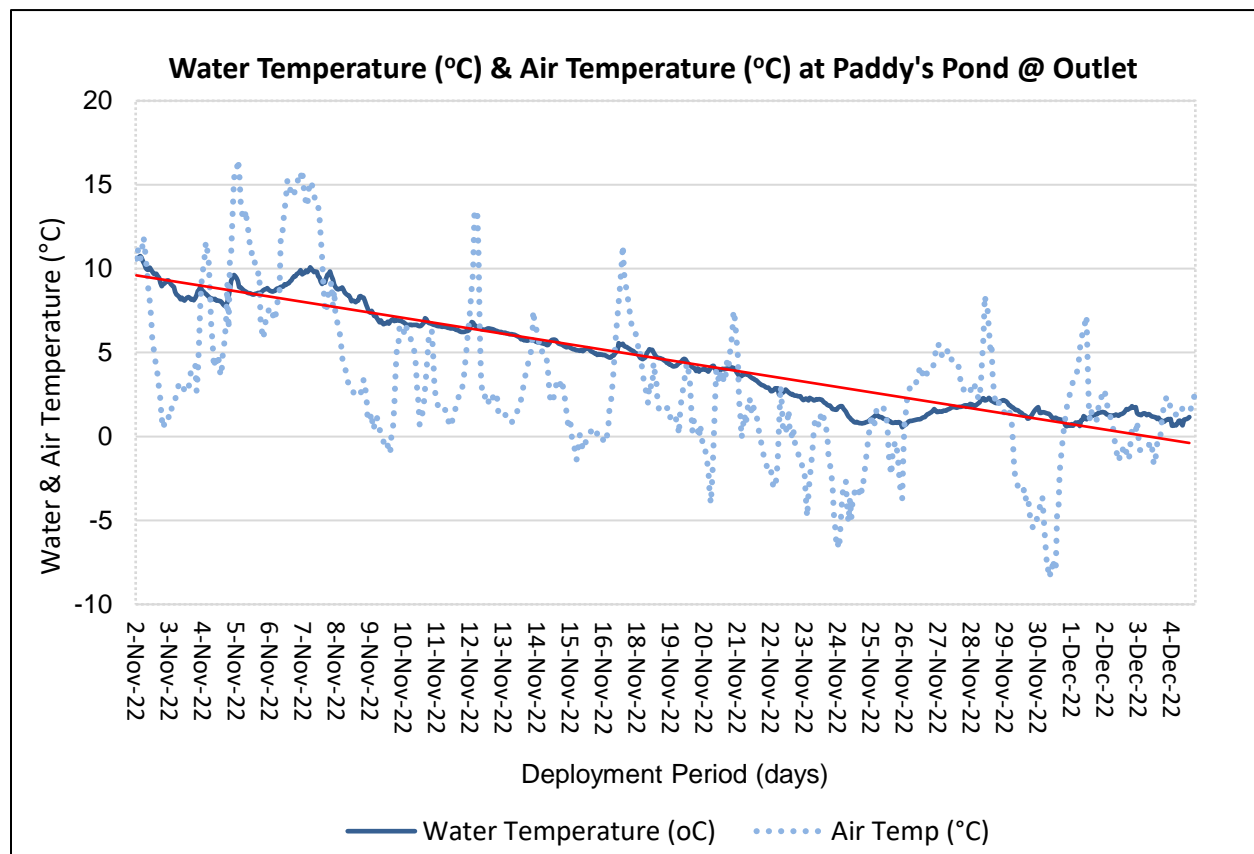
The following graphs and discussion illustrate water quality data obtained hourly from November 2, 2022 through December 5, 2022 at Paddy's Pond at outlet to Three Arm Pond, St. John's, NL.

Stage is not monitored at this station to date and as such cannot be discussed with respect to other monitored water quality parameters. All data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol.

Mean daily temperature and total precipitation data was obtained from the Department of Environment and Climate Change Canada (ECCC) historical weather data at https://climate.weather.gc.ca/historical_data/search_historic_data_e.html and can be found illustrated in Appendix A. Gaps in available daily data were removed for graphing purposes.

Water Temperature

- Water Temperature is a major factor used to describe water quality. Temperature has major implications on both the ecology and chemistry of a water body, governing processes such as the metabolic rate of aquatic plants and animals and the degree of dissolved oxygen saturation.
- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependent, temperature compensated and temperature independent. As the temperature sensor is not isolated from the rest of the sonde, the entire sonde 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.



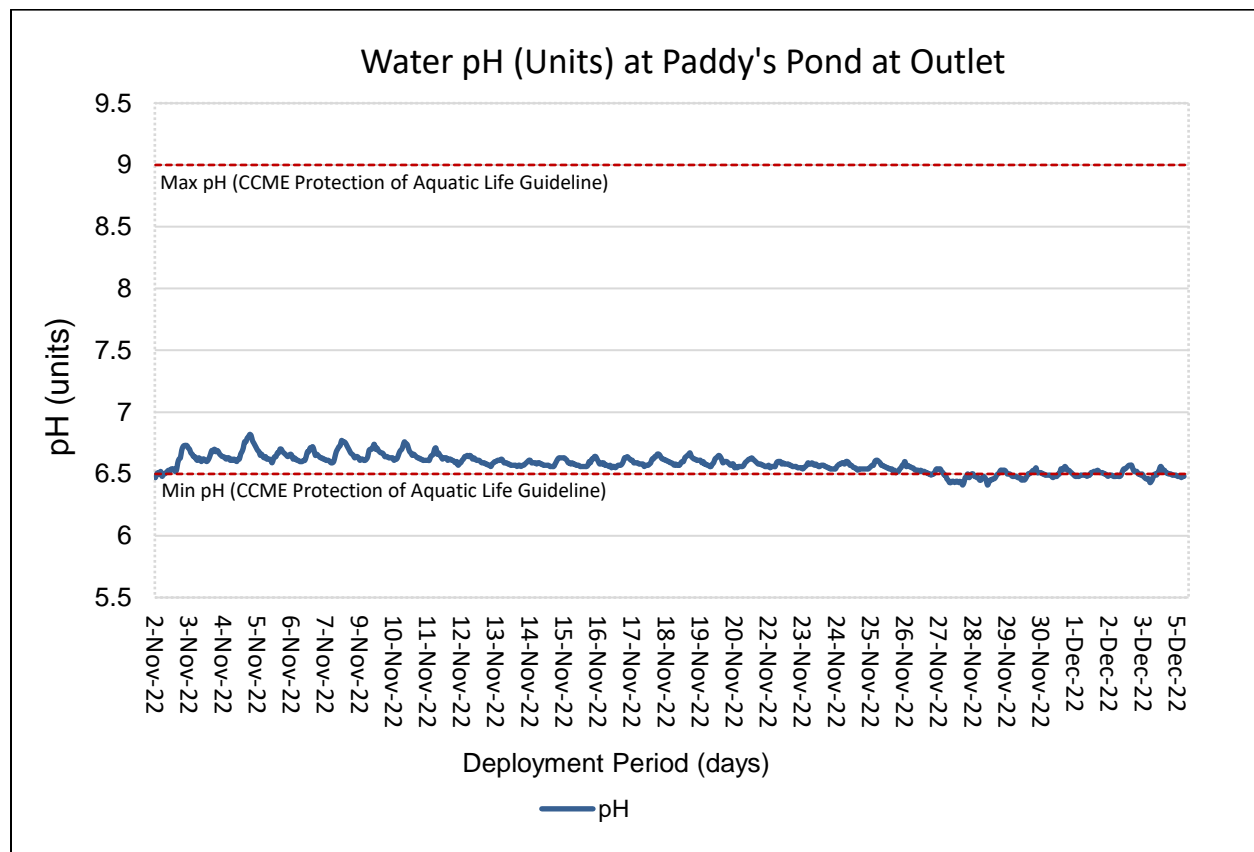
Mean	Median	Min	Max
4.61	4.61	0.55	10.75

Figure 2: Water temperature (°C) values at Paddy's Pond at Outlet.

- Over the 34-day deployment period, water temperature fluctuated naturally in correlation to air temperature. The mean temperature was 4.61°C with a median of 4.61°C.
- Minimum water temperature of 0.55°C was observed on November 26, 2022 and a maximum water temperature of 10.75 °C was observed on November 2, 2022 (Figure 2).
- Water temperature gradually decreased over the deployment period until plateauing near November 24, 2022 for the remainder of the deployment period. This is an expected seasonal trend this time of year due to the onset of winter. (See Figure 7- Appendix A).
- A natural diurnal pattern was minimal throughout the deployment period as temperature fluctuations from day and overnight were low, as expected for this time of the year.

pH

- pH is used to give an indication of the acidity or basicity of a solution. A pH of seven (7) denotes a neutral solution while lower values are acidic and higher values are basic. Technically, the pH of a solution indicates the availability of protons to react with molecules dissolved in water. Such reactions can affect how molecules function chemically and metabolically.
- pH values are temperature dependant as well as influenced by photosynthesis and respiration by aquatic organisms. The concentration of dissolved carbon dioxide in the water throughout the day, especially overnight when oxygen production is reduced relative to carbon dioxide levels. Carbon dioxide dissolved in water yields a slightly acidic solution.



Mean	Median	Min	Max
6.58	6.58	6.41	6.82

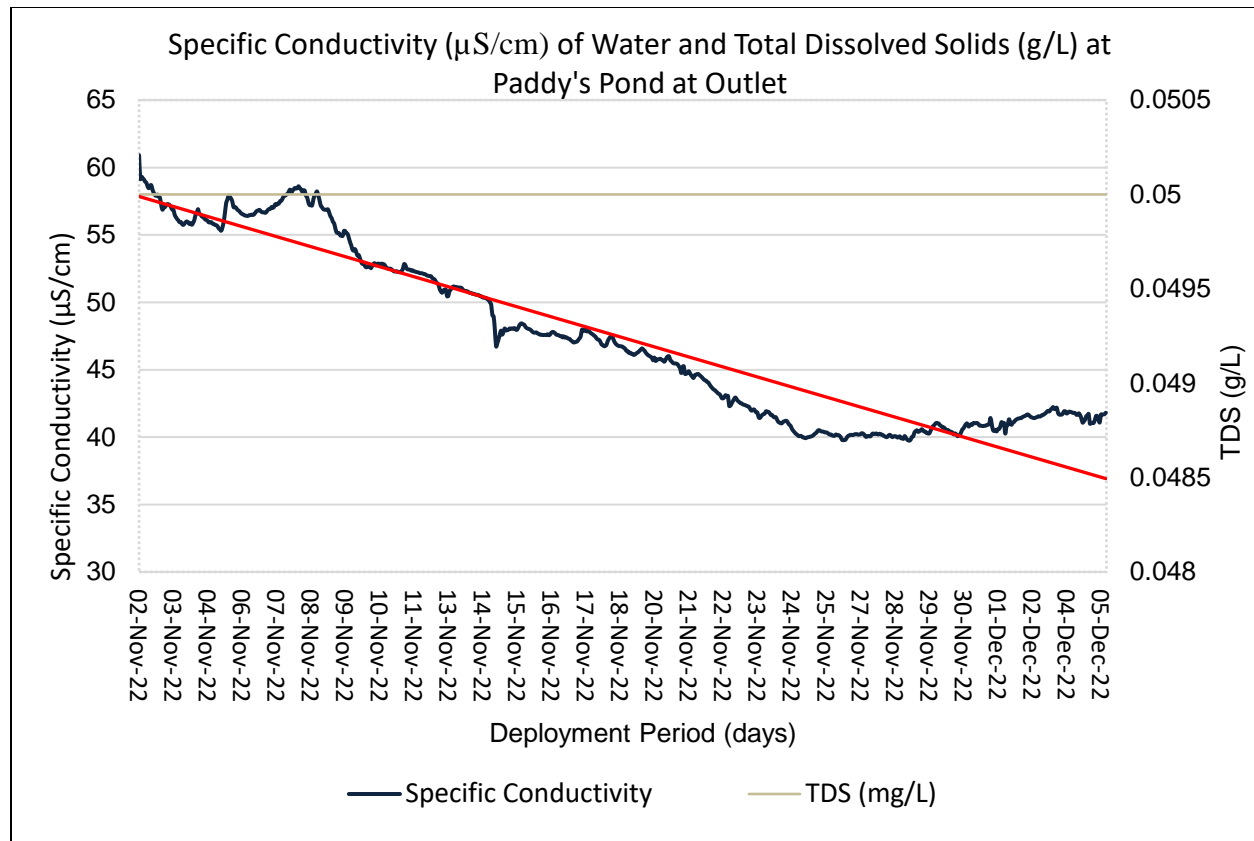
Figure 3: pH (pH units) at Paddy's Pond at outlet from November 2, 2022 through December 5, 2022.

- Throughout the deployment period, pH values were stable within 6.41 to 6.82 pH units, with a mean unit value of 6.58 and median of 6.58 units (Figure 3).
- A gradual decrease in pH (Figure 2) was observed over the duration of the deployment period in correlation with a decrease in air and water temperatures.

- The CCME guideline for the protection of aquatic life states the requirement of a minimum pH value of 6.5 and maximum value of 9.0. This guideline provides a basis for the overall health of the waterbody. Paddy's Pond at Outlet pH values decreased slightly below the minimum guideline and remained near 6.5 pH units after the November 27, 2022 precipitation event. This is likely the result of the addition of more acidic rainwater. (See Figure 7 – Appendix A).
- Diurnal variation pattern was visible throughout the deployment period. The magnitude of variation correlates to daily water temperature range, length of days and fluctuations in photosynthesis and respiration rates. As such, the observed decrease in the diurnal pattern is expected due to the reduction in aquatic biotic activity and lower daily temperature ranges during late fall-winter season.

Specific Conductivity

- Conductivity relates to the ease of passing an electric charge – or resistance – through a solution. Conductivity is highly influenced by the concentration of dissolved ions in solution: distilled water has zero conductivity (infinite resistance) while salty solutions have high conductivity (low resistance). Specific Conductivity is corrected to 25°C to allow comparison across variable temperatures.



Mean	Median	Min	Max
47.4	46.7	39.7	60.9

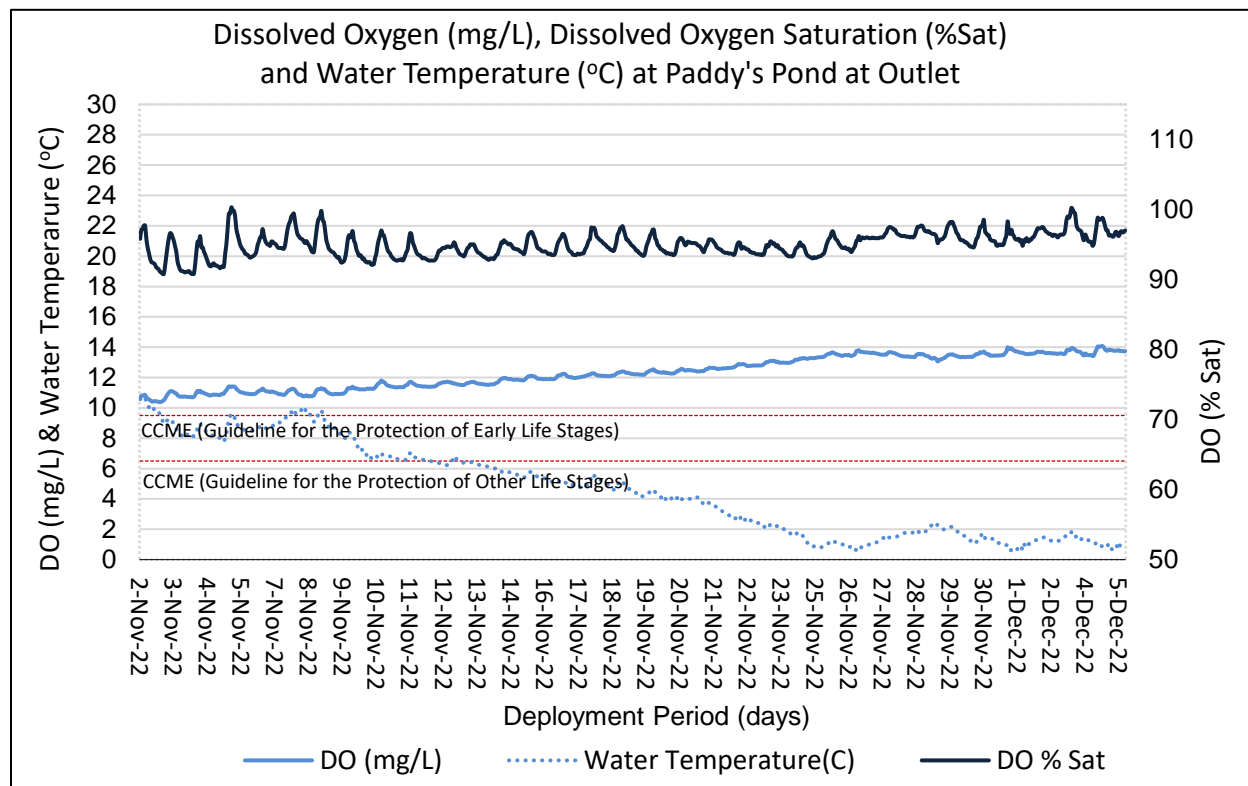
Figure 4: Specific Conductivity ($\mu\text{S}/\text{cm}$) values at Paddy's Pond at Outlet.

- Specific conductivity values fluctuated slightly throughout the deployment. Conductivity decreased from the beginning of the deployment period until November 24, 2022 and began to increase through December 5, 2022.
- The overall decreasing trend in conductivity is expected, due to seasonal water temperature changes from fall to winter. As temperatures decrease, the passing of electric charge becomes more difficult. The increase in conductivity from the end of November to the remainder of the deployment period is likely the result of precipitation events and the increase in dissolved ion concentration from runoff as well as the stabilization and slight increase in water temperature. (Appendix A – Figure 7)
- It is noted during the QA/QC comparison rankings that the field conductivity sensor provided concentration data lower than that observed with the QAQC sonde, as well observed from the third-party lab analyzed grab sample. As such, data interpretation focused on concentration variability versus actual data values.

- Given the isolated station location, sources of disturbances that may affect conductivity are considered minimal.
- The calculated Total Dissolved Solids (TDS) value stable at 0.05 g/L throughout the deployment period.

Dissolved Oxygen

- Dissolved oxygen is a metabolic requirement of aquatic plants and animals. The concentration of oxygen in water depends on many factors, especially temperature – the saturation of oxygen in water is inversely proportional to water temperature. Oxygen concentrations also tend to be higher in flowing water compared to still, lake environments. Low oxygen concentrations can give an indication of excessive decomposition of organic matter or the presence of oxidizing materials.



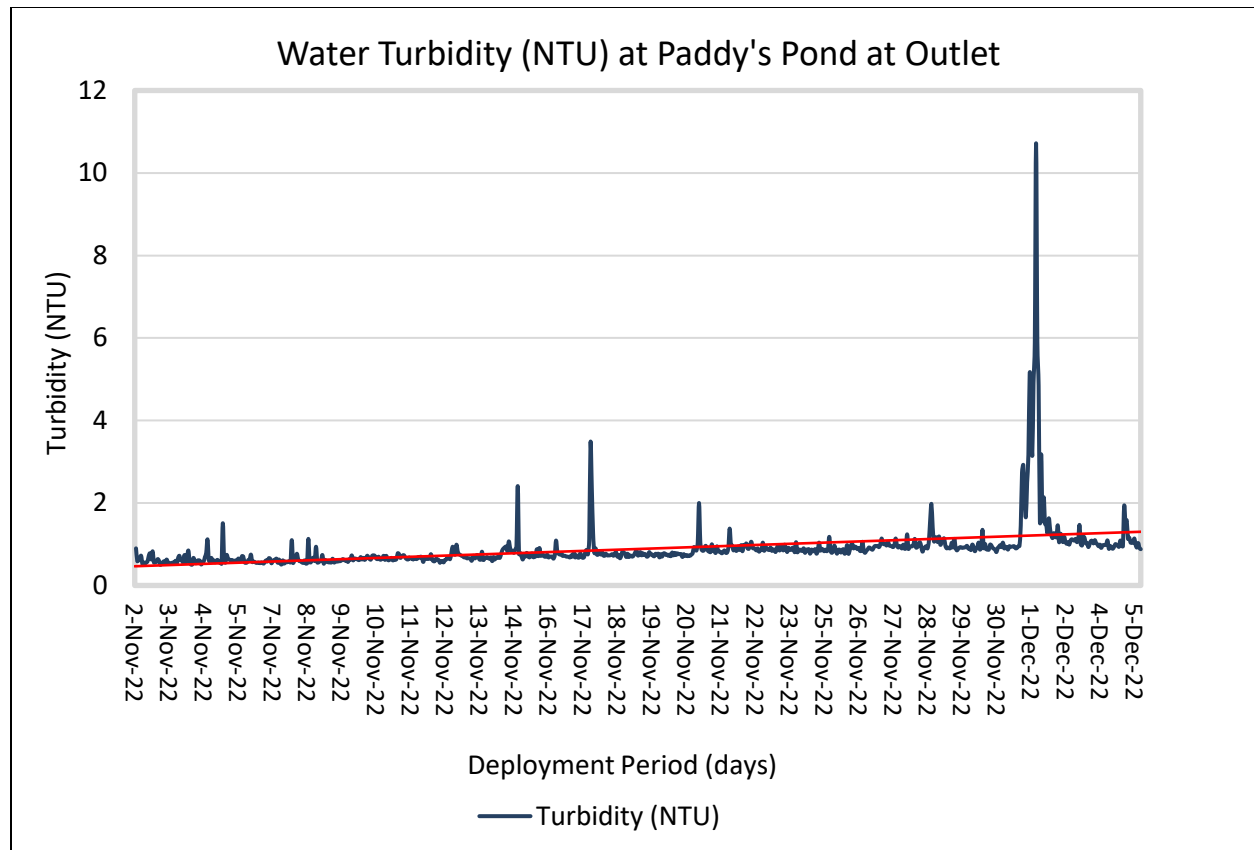
Parameter	Mean	Median	Min	Max
DO (mg/L)	12.32	12.27	10.39	14.07
DO (% Sat)	95.0	95.0	90.8	100.3

Figure 5: Dissolved Oxygen (mg/L & Percent (%) Saturation) values at Paddy's Pond at Outlet.

- In correlation with decreasing water temperatures, dissolved oxygen (DO) concentrations (mg/L) gradually increased throughout the deployment period until November 24, 2022. As water temperature stabilized, the DO concentration levels then plateaued until December 5, 2022. A maximum DO of 14.07 mg/L (100.3 % Sat) to a minimum DO of 10.39 mg/L (90.8 % Sat) were observed.
- Diurnal variations were observed throughout the deployment period due to temperature ranges from day to night. Variations can be influenced by water depth during deployment as shallow water temperatures will change more rapidly, especially in a lake environment such as Paddys Pond.
- The dissolved oxygen values were above the CCME Guideline for the Protection of Early Life Stages (9.5 mg/L) and remained above the CCME Guideline for the Protection of Other Life Stages (6.5mg/L) for the entire deployment period.

Turbidity

- Turbidity is typically caused by fine suspended solids such as silt, clay, or organic material. Consistently high levels of turbidity tend to block sunlight penetration into a waterbody, discouraging plant growth. High turbidity can also damage the delicate respiratory organs of aquatic animals and cover spawning areas.



Mean	Median	Min	Max
0.9	0.8	0.5	10.7

Figure 6: Water turbidity (NTU) values at Paddy's Pond at Outlet during deployment period November 2, 2022 through December 5, 2022.

- Turbidity measurements throughout the deployment period indicated very low turbidity. This is consistent with historical data for this location. A gradual increase in turbidity was observed and may be a result of sensor bio-fouling and/or sediment build-up around the sensor as a result of wave action.
- Turbidity values range from 0.5 to 10.7 NTU, with a mean of 0.9 NTU and a median value of 0.8 NTU (Figure 6).
- Turbidity levels were low during the deployment period; however, events above baseline levels did occur. For example, a turbidity peak was observed on December 1, 2022 (10.7 NTU) of which are likely influenced by debris, suspended algae, suspended sediment or siltation due to wave action and precipitation events.

APPENDIX A : MEAN DAILY TEMPERATURE AND TOTAL PRECIPITATION

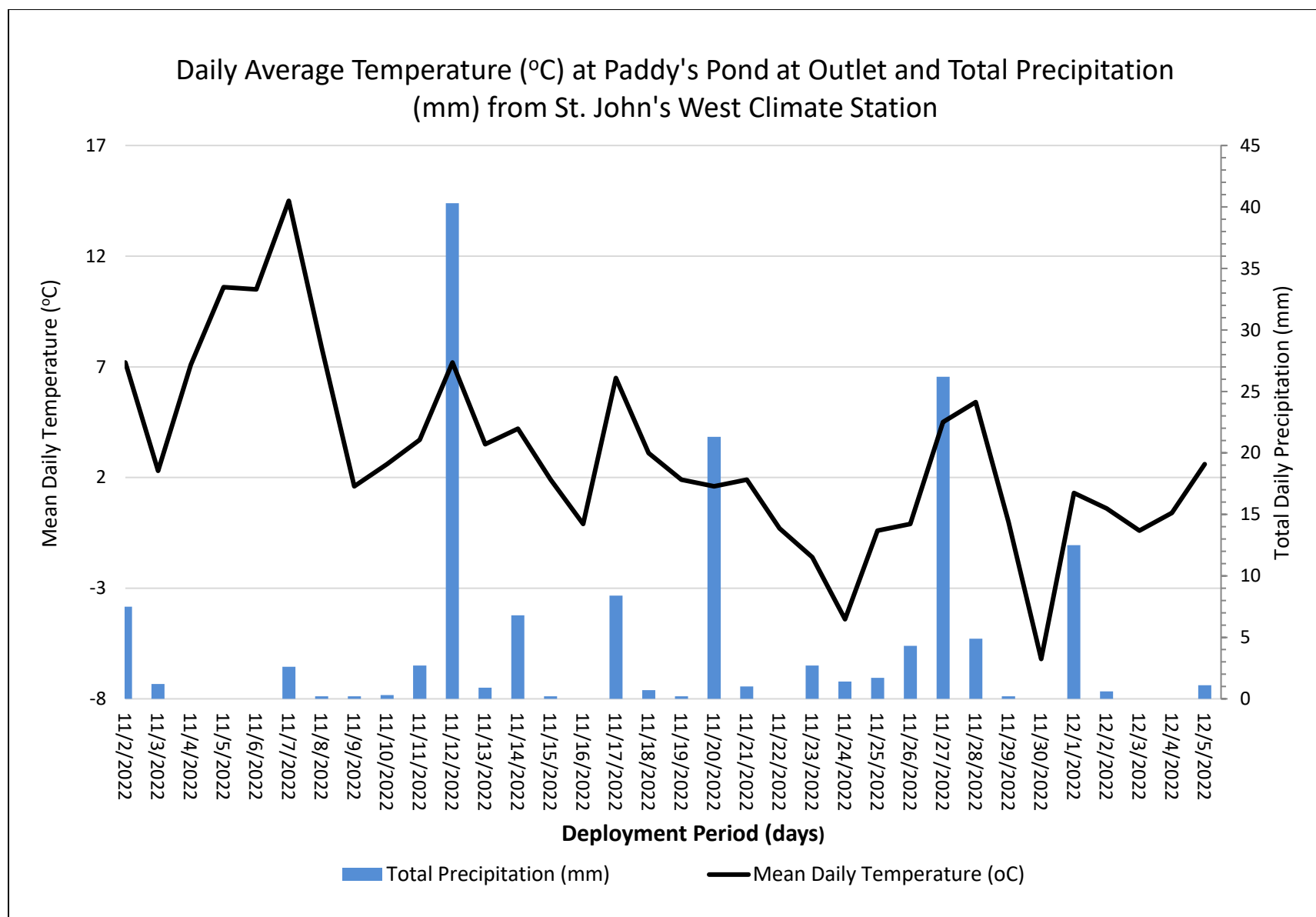


Figure 7: Mean daily air temperature and total precipitation at St. John's West near Paddy's Pond September 20, 2022 to November 2, 2022.

APPENDIX B : QA/QC GRAB SAMPLE FIELD RESULTS



Your P.O. #: 220028978-6
 Site Location: PADDY'S POND @ OUTLET
 Your C.O.C. #: N/A, 2022-1727-00-SI-SP

Attention: Robert Richard Harvey

NL Department of Environment, Climate Change and Municipalities
 Water Resources
 PO Box 8700
 St. John's, NL
 CANADA A1B 4J6

Report Date: 2022/11/22
 Report #: R7399285
 Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2W6831

Received: 2022/11/03, 10:25

Sample Matrix: Water
 # Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Alkalinity	1	N/A	2022/11/14	ATL SOP 00142	SM 23 2320 B
Anions (1)	1	N/A	2022/11/11	CAM SOP-00435	SM 23 4110 B m
Colour	1	N/A	2022/11/22	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (2)	1	N/A	2022/11/14	ATL SOP 00203	SM 23 5310B m
Conductance - water	1	N/A	2022/11/14	ATL SOP 00004	SM 23 2510B m
Fluoride	1	N/A	2022/11/14	ATL SOP 00043	SM 23 4500-F- C m
Hardness (calculated as CaCO3)	1	N/A	2022/11/21	ATL SOP 00048	Auto Calc
Mercury - Total (CVAA,LL)	1	2022/11/17	2022/11/17	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Total MS	1	2022/11/16	2022/11/18	ATL SOP 00058	EPA 6020B R2 m
Nitrogen Ammonia - water	1	N/A	2022/11/13	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	1	N/A	2022/11/22	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	1	N/A	2022/11/22	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	1	N/A	2022/11/22	ATL SOP 00018	ASTM D3867-16
pH (3)	1	N/A	2022/11/14	ATL SOP 00003	SM 23 4500-H+ B m
Calculated TDS (DW Pkg)	1	N/A	2022/11/15	N/A	Auto Calc
Total Kjeldahl Nitrogen in Water (1)	1	2022/11/10	2022/11/11	CAM SOP-00938	OMOE E3516 m
Organic carbon - Total (TOC) (2)	1	N/A	2022/11/10	ATL SOP 00203	SM 23 5310B m
Total Phosphorus (Colourimetric) (1)	1	2022/11/10	2022/11/10	CAM SOP-00407	SM 23 4500-P I
Total Suspended Solids	1	2022/11/09	2022/11/10	ATL SOP 00007	SM 23 2540D m
Turbidity	1	N/A	2022/11/14	ATL SOP 00011	EPA 180.1 R2 m

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

(1) This test was performed by Bureau Veritas Mississauga, 6740 Campobello Rd , Mississauga, ON, L5N 2L8

(2) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.

(3) The APHA Standard Method requires pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.



Your P.O. #: 220028978-6
Site Location: PADDY'S POND @ OUTLET
Your C.O.C. #: N/A, 2022-1727-00-SI-SP

Attention: Robert Richard Harvey

NL Department of Environment, Climate Change and Municipalities
Water Resources
PO Box 8700
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Report Date: 2022/11/22
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CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2W6831
Received: 2022/11/03, 10:25

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Gemarie Balatico, Project Manager
Email: Gemarie.Balatico@bureauveritas.com
Phone# (905)817-5787

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Bureau Veritas Job #: C2W6831
Report Date: 2022/11/22

NL Department of Environment, Climate Change and
Municipalities

Site Location: PADDY'S POND @ OUTLET

Your P.O. #: 220028978-6

Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
UFW417 PADDY'S POND @OUTLET								
Sampling Date		2022/11/02 13:41						
Matrix		W						
Sample #		2022-1727-00-SI-SP						
Registration #		SA-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	8.0	1.0	mg/L	N/A	2022/11/21		8332628
Nitrate (N)	-	ND	0.050	mg/L	N/A	2022/11/22		8332436
Total dissolved solids (calc., EC)	-	42	1.0	mg/L	N/A	2022/11/15		8332439
Inorganics								
Conductivity	-	76	1.0	uS/cm	N/A	2022/11/14	KMC	8342890
Chloride (Cl-)	-	17	1.0	mg/L	N/A	2022/11/11	LKH	8339495
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/11/11	LKH	8339495
Sulphate (SO4)	-	3.0	1.0	mg/L	N/A	2022/11/11	LKH	8339495
Total Alkalinity (Total as CaCO3)	-	3.7	2.0	mg/L	N/A	2022/11/14	KMC	8342892
Colour	-	27	5.0	TCU	N/A	2022/11/22	TGO	8357415
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/11/14	KMC	8342893
Total Kjeldahl Nitrogen (TKN)	-	0.14	0.10	mg/L	2022/11/10	2022/11/11	RTY	8338757
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2022/11/22	TGO	8357419
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/11/22	TGO	8357420
Nitrogen (Ammonia Nitrogen)	-	0.072	0.050	mg/L	N/A	2022/11/13	TGO	8343026
Dissolved Organic Carbon (C)	-	5.2	0.50	mg/L	N/A	2022/11/14	RSL	8338271
Total Organic Carbon (C)	-	5.5	0.50	mg/L	N/A	2022/11/10	RSL	8335838
pH	-	6.74		pH	N/A	2022/11/14	KMC	8342891
Total Phosphorus	-	0.009	0.004	mg/L	2022/11/10	2022/11/10	SPC	8338769
Total Suspended Solids	-	3.0	1.0	mg/L	2022/11/09	2022/11/10	RMK	8334879
Turbidity	-	1.0	0.10	NTU	N/A	2022/11/14	AAO	8343622
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/11/17	2022/11/17	EPU	8348937
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.072	0.0050	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Barium (Ba)	-	0.0024	0.0010	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Boron (B)	-	ND	0.050	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Calcium (Ca)	-	2.2	0.10	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Copper (Cu)	-	0.00055	0.00050	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Iron (Fe)	-	0.20	0.050	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Magnesium (Mg)	-	0.63	0.10	mg/L	2022/11/16	2022/11/18	JHY	8348346



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Report Date: 2022/11/22

NL Department of Environment, Climate Change and
Municipalities

Site Location: PADDY'S POND @ OUTLET

Your P.O. #: 220028978-6

Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
UFW417 PADDY'S POND @OUTLET								
Sampling Date 2022/11/02 13:41								
Matrix W								
Sample # 2022-1727-00-SI-SP								
Registration # SA-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.067	0.0020	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Potassium (K)	-	0.44	0.10	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Sodium (Na)	-	12	0.10	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Strontium (Sr)	-	0.0067	0.0020	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Uranium (U)	-	ND	0.00010	mg/L	2022/11/16	2022/11/18	JHY	8348346
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/11/16	2022/11/18	JHY	8348346



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NL Department of Environment, Climate Change and
Municipalities
Site Location: PADDY'S POND @ OUTLET
Your P.O. #: 220028978-6
Sampler Initials: LB

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	10.0°C
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Results relate only to the items tested.



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VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Anastassia Hamanov, Scientific Specialist

Janah Rhyno, Metals Supervisor-Bedford

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