APPENDIX

C

ASSOCIATED REPORTS

APPENDIX

C-1 HYDROGEOLOGICAL ASSESSMENTS

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
515 Beaverbrook Court
Fredericton, NB
E3B 1X6
Canada

March 24, 2017
Project No: 1307-004

Mr. John McKinney, P.Eng.
Manager, Municipal Engineering
Opus International Consultants (Canada)
80 Bishop Drive
Fredericton, NB, E3C 1B2

Dear Mr. McKinney,

Re: Groundwater Supply – Drilling and Test Pumping of Well TW-02, New Maryland

INTRODUCTION

On behalf of the Village of New Maryland (VNM), NB, Opus International Consultants (Canada) Limited (Opus) retained BGC Engineering Inc. (BGC) to provide hydrogeological support in the further development of the community's municipal groundwater supply. In this latest phase of the work an existing well (TW 05-02) on the Moomena property in New Maryland (PID 75062174, Figure 1) was deepened and a pumping test was carried out.

Figure 1 – Property Location Plan

This letter describes the work carried out on the property in February and March 2017. It follows your acceptance of our proposal dated December 1, 2016.

METHODOLOGY

BGC carried out the following tasks:

- Supervised the deepening of Well TW 05-02.
- Conducted a pumping test of the deepened well.
- Presented all findings in this letter report.

DRILLING

Between February 20 and 22, 2017 Well TW 05-02 was deepened at 0.2 m (8 inch) diameter from 109.7 m (360 feet) to 147.5 m (484 feet), the process being a lengthy one because steel was encountered at the bottom of the pre-deepened hole and had to be removed. The work was carried out by Sullivan's Well Drilling Ltd. The log of the well is attached. The upper 110 m of this log is based on the original (2005) well driller's report, whilst the lower part reflects the detailed examination of drill cuttings by our hydrogeologist (2017).

Prior to deepening, the well was overflowing by an estimated 500 m^3/d (~90 usgpm). At the end of the pumping tests, the shut-in pressure was measured; it was equivalent to a head of 3.376 m (11.1 feet) above the top of the steel well casing.

Based on the water return during drilling, the well yield was estimated to be in excess of 1,600 m^3/d (300 usgpm).

PUMPING TEST OF WELL TW 05-02

On February 27, 2017 a step-drawdown pumping test was carried out on Well TW 05-02. The well was tested at four incremental steps, these pumping rates being as shown in Table 1. Each rate was maintained for approximately 60 minutes before proceeding to the next step. Water levels were recorded both manually and with automatic dataloggers, by measuring the depth to groundwater below the top of casing (BTOC) in the available wells, then converting to drawdowns. The results are summarized in Table 1 and plotted in Figure 2. From the step test it was concluded that the constant rate pumping test should be carried out at 1,832 m^3/d (336 usgpm).

The constant rate test began at 1:40 pm on February 27, 2017, following the (almost) immediate recovery of the pumped well from the step testing. Water levels in the pumped well and in three observation wells (TW 05-01, 03 and 04 in Figure 1) were observed. The initial static water level in the pumped well (TW 05-02) was not measured, but was later assumed to be 3.376 m above the top of the casing, as measured after the test. The pumping phase of the test continued for 72 hours and both the drawdown and (post-pumping) recovery stages were measured manually and by datalogger. The water level data are plotted in Figure 3 (on a natural scale). Drawdown data are plotted on a logarithmic time scale in Figure 4.

Table 1. Step Test of Well TW 05-02

STEP	PUMPING RATE		DRAWDOWN AFTER 60 MINUTES	
	m^3/d	usgpm	metres	feet
1	916	168	3.61	11.84
2	1,177	216	4.76	15.61
3	1,472	270	6.57	21.54
4	1,832	336	9.39	30.80

NOTES:
Aquifer Loss Coefficient, B = 0.002 days/m^2 or 0.035 feet/usgpm
Well Loss Coefficient, C = 1.64 x 10^{-6} days/m^5 or 1.64 x 10^{-4} feet/usgpm^2

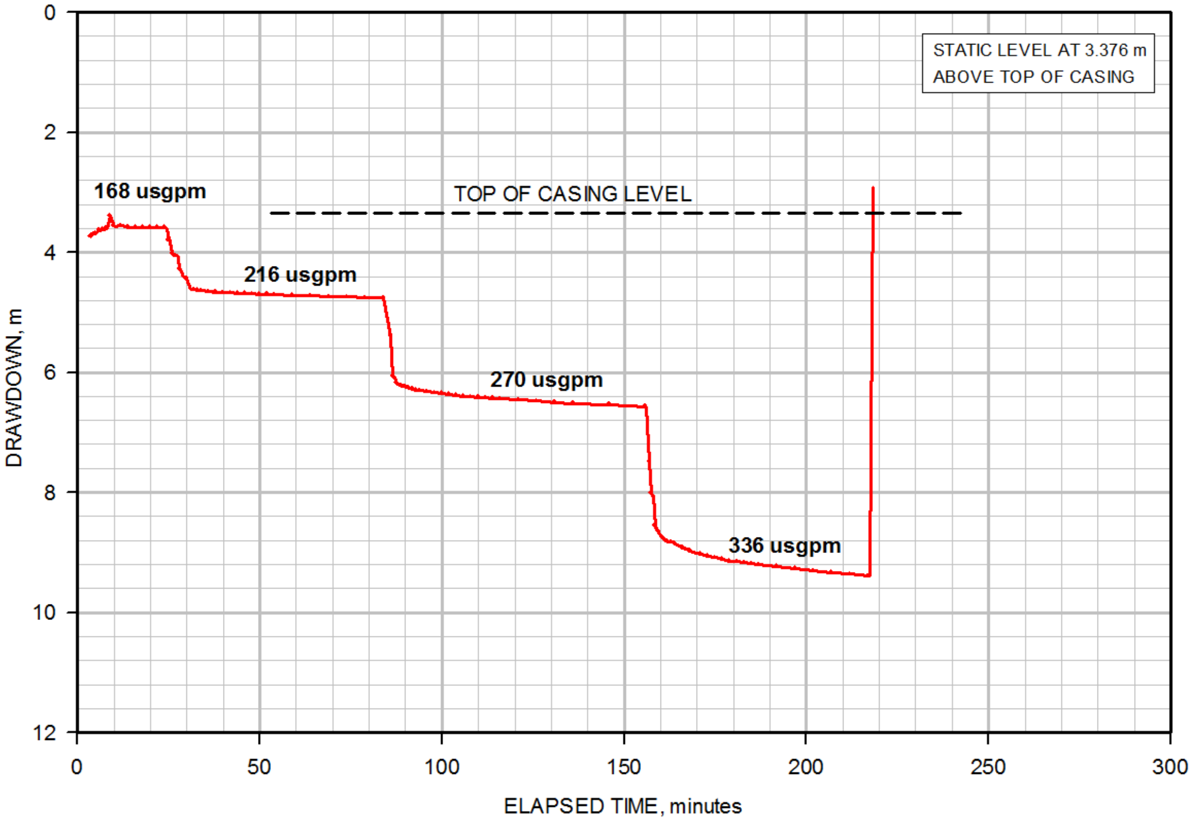

Figure 2. **Step Test of Well TW 05-02 – Drawdown vs. Time**

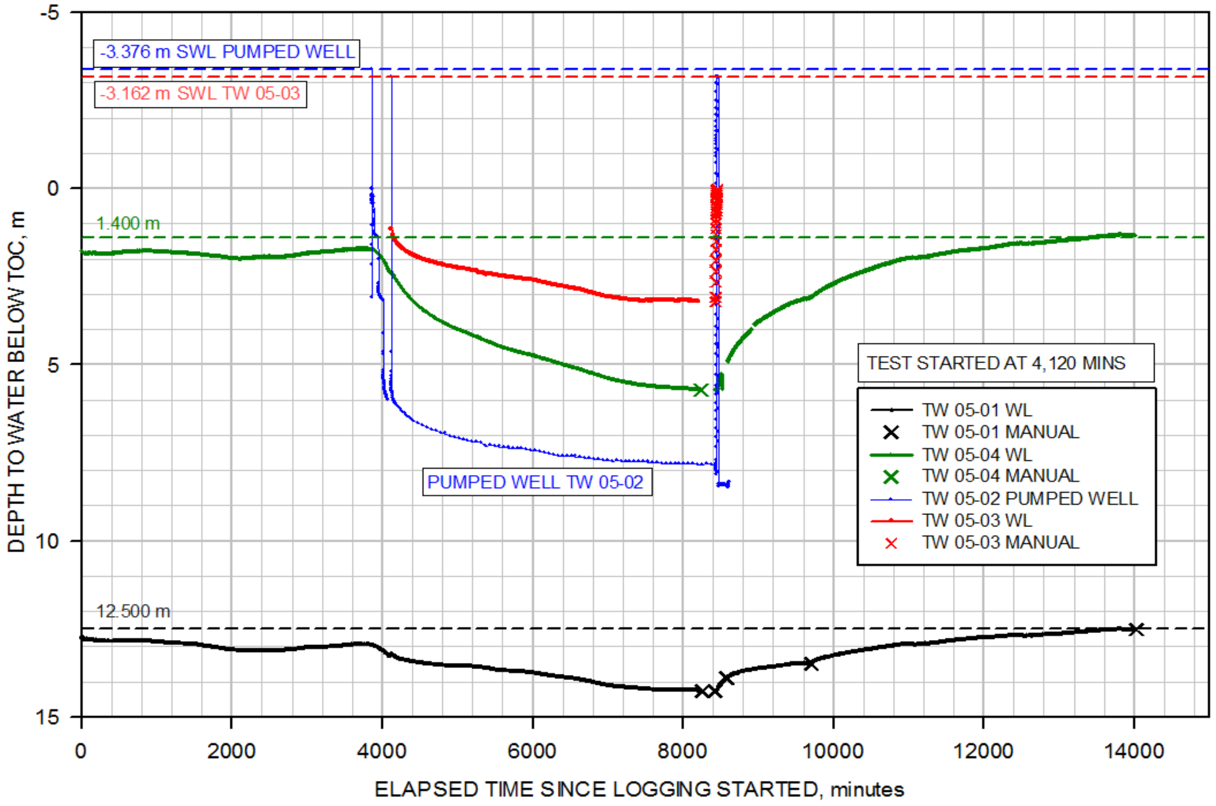

Figure 3. Step Test and Constant Rate Pumping Test of Well TW 05-02 – Water Levels vs. Time

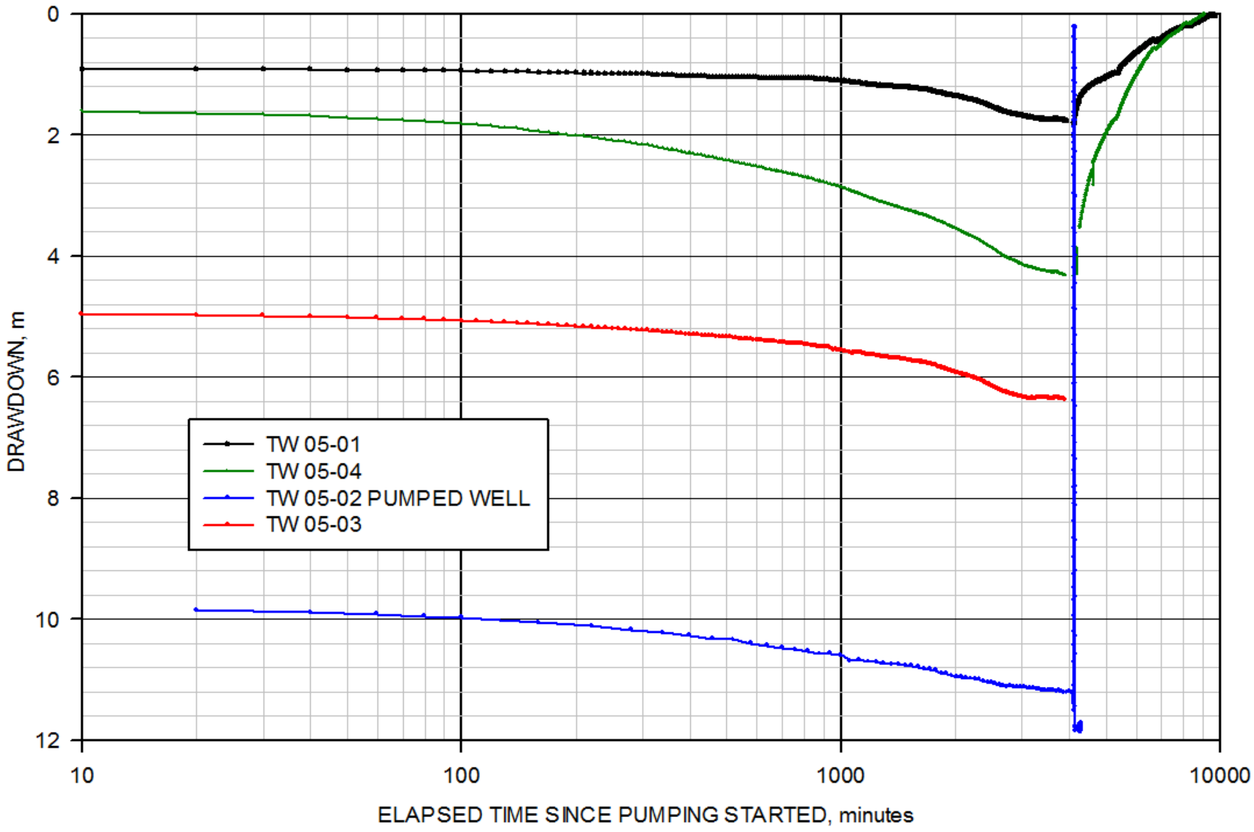

Figure 4. Constant Rate Pumping Test of Well TW 05-02 – Drawdown vs. Log Time

Analysis of the pumping test data was completed using traditional Cooper-Jacob (1946) and Theis (1935) analytical methods for the pumping and recovery phases. By this means, the aquifer's transmissivity and storativity properties were calculated.

After 72 hours (4,320 minutes) of continuous pumping, the drawdown in the pumped well was 11.22 m. From the slope of the drawdown versus log time plot (Figure 4), it was inferred that some recharge was intercepted two days into the test (~2,880 minutes) when the cone of depression had expanded some 600 m from the pumped well (inferred later from Figure 5). The data suggest an aquifer transmissivity of approximately 250 m^2/d (20,000 usgpd/ft) and a storativity of 3x10^{-3} or lower, the latter indicating confined aquifer conditions supported by the presence of artesian flow.

The drawdown in the closest observation well (TW 05-03), located 4.95 m from the pumped well (TW 05-02), was 6.45 m after 72 hours of pumping (refer to Figure 4).

The hydraulic responses of the two other observation wells (TW 05-01 and 04) during the pumping test are also presented in Figures 3 and 4. The drawdown in Well TW 05-04 (64 m from the pumped well) was 4.32 m at the end of the pumping period while the drawdown in Well TW 05-01 (145 m from the pumped well) was 1.77 m at the end of the test. Distance drawdown data are plotted in Figure 5, from which an aquifer transmissivity of 225 m^2/d (~18,200 usgpd/ft) is inferred.

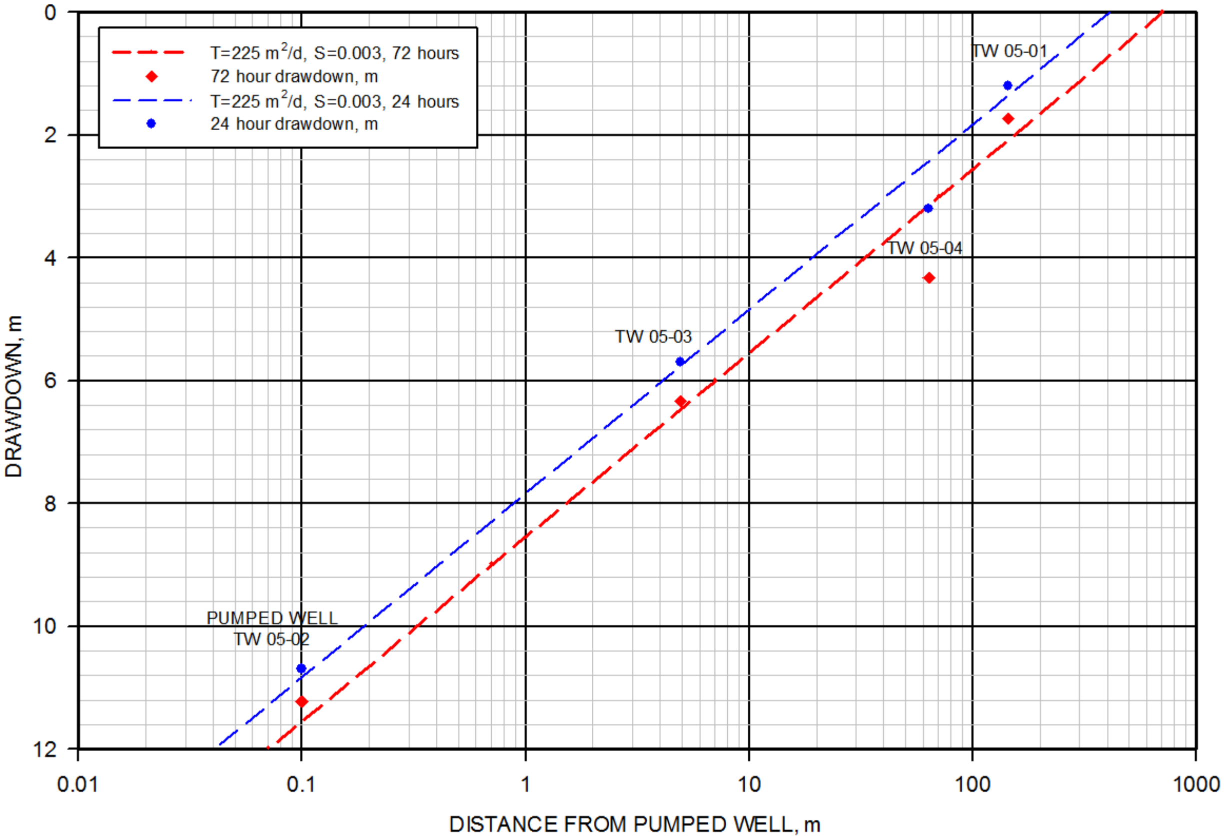

Figure 5. **Constant Rate Pumping Test of Well TW 05-02 – Distance Drawdown**

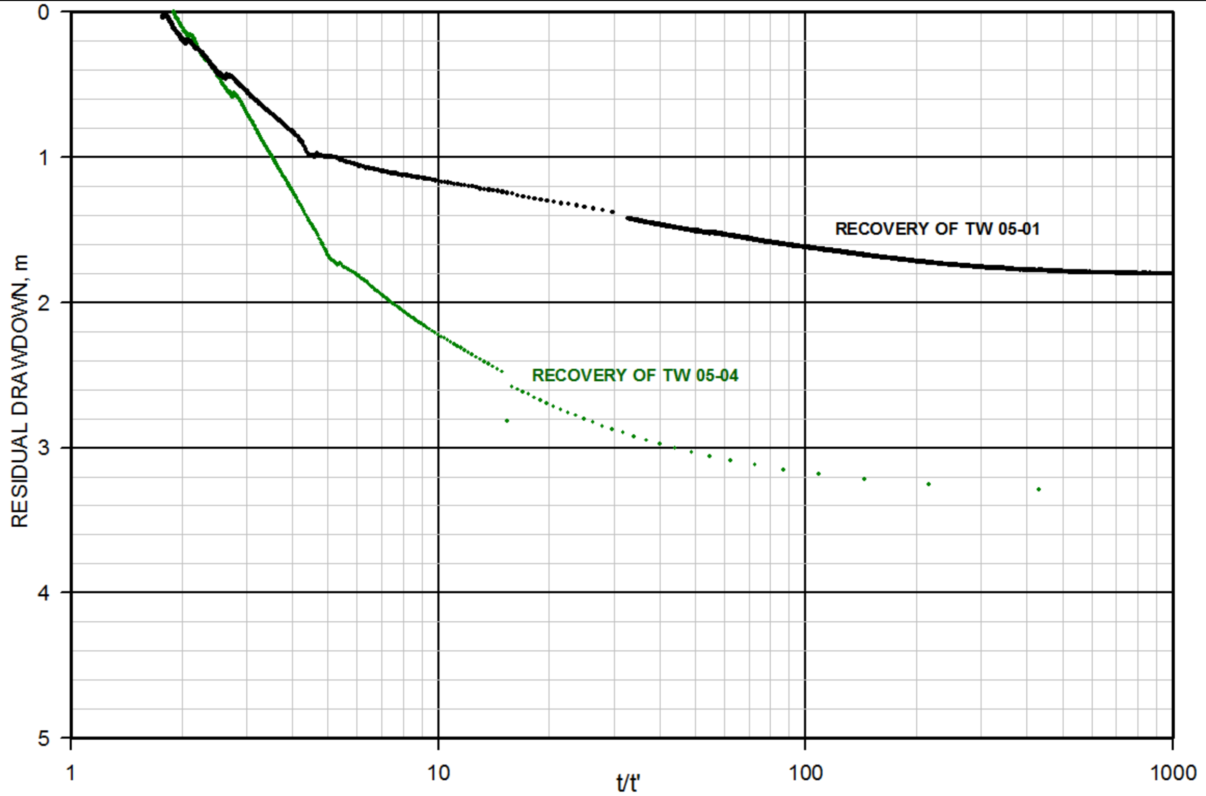

Figure 6. **Recovery of Wells TW 05-01 and TW 05-04**

The pumped well (TW 05-02) completely recovered in less than 24 hours from the end of the pumping portion of the test. The intercept of the log t/t' curve[1] with zero residual drawdown for observation wells TW 05-01 and 04 was at a t/t' value of approximately 2, confirming that impermeable boundaries were not encountered during the test.

WATER QUALITY

Water samples were recovered from Well TW 05-02 by others in 2005 when the well was first drilled. Those data are appended. in the associated report (GEMTEC, 2005). Three water samples were recovered by BGC during the current pumping test. Associated laboratory certificates are attached and these recent data are also summarized in Tables 2 and 3.

The sampled water from TW 05-02 is of a calcium bicarbonate type, meeting the Health Canada Guideline for Canadian Drinking Water Quality (CDWQG) except with respect to manganese for which, at 0.4 mg/L is 8 times the CDWQG concentration[2]. The manganese concentration remained fairly consistent with time.

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[1] t = time since pumping started; t' = time since pumping ceased

[2] The aesthetic objective concentration for manganese is <0.05 mg/L.

Table 2. General chemistry in water.

RPC Sample ID:					**277410-1**	**228195-1**	**28239-1**
BGC Sample ID: **Date Sampled:**					**TW 05-02** **21-Feb-17**	**TW 05-02** **1-Mar-17** **(48 hrs)**	**TW 05-02** **2-Mar-17** **(72 hrs)**
Analytes	**Units**	**RL**	**MAC**	**AO**			
Sodium	mg/L	0.05	-	200	34.6	35.6	34.7
Potassium	mg/L	0.02	-	-	0.54	0.49	0.48
Calcium	mg/L	0.05	-	-	45.2	42.8	41.7
Magnesium	mg/L	0.01	-	-	2.99	2.83	2.74
Iron	mg/L	0.02	-	0.3	0.02	< 0.02	0.02
Manganese	mg/L	0.001	-	0.05	0.417	0.399	0.382
Copper	mg/L	0.001	-	1.0	< 0.001	< 0.001	< 0.001
Zinc	mg/L	0.001	-	5.0	0.002	0.002	0.008
Ammonia (as N)	mg/L	0.05	-	-	< 0.05	< 0.05	< 0.05
pH	units	-	-	6.5 - 8.5	8.1	7.9	8.0
Alkalinity (as $CaCO_3$)	mg/L	2	-	-	97	105	104
Chloride	mg/L	0.5	-	250	53.1	52.9	46.1
Fluoride	mg/L	0.05	1.5	-	-	-	-
Sulfate	mg/L	1	-	500	21	21	21
Nitrate + Nitrite (as N)	mg/L	0.05	10	-	< 0.05	< 0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	-	-	< 0.01	0.02	0.02
r-Silica (as SiO_2)	mg/L	0.1	-	-	13.7	14.0	13.6
Carbon - Total Organic	mg/L	0.5	-	-	0.5	0.6	0.5
Turbidity	NTU	0.1	-	-	28.5	< 0.1	< 0.1
Conductivity	µS/cm	1	-	-	413	410	411
Calculated Parameters							
Bicarbonate (as $CaCO_3$)	mg/L	-	-	-	95.8	104.	103.
Carbonate (as $CaCO_3$)	mg/L	-	-	-	1.13	0.778	0.968
Hydroxide (as $CaCO_3$)	mg/L	-	-	-	0.063	0.040	0.050
Cation Sum	meq/L	-	-	-	4.04	3.94	3.84
Anion Sum	meq/L	-	-	-	3.87	4.03	3.82
Percent Difference	%	-	-	-	2.07	-1.07	0.34
Theoretical Conductivity	µS/cm	-	-	-	394	395	378
Hardness (as $CaCO_3$)	mg/L	0.2	-	-	125	118	115
Ion Sum	mg/L	-	-	500	231	234	224
Saturation pH (5°C)	units	-	-	-	8.0	8.0	8.0
Langelier Index (5°C)	-	-	-	-	0.11	-0.07	0.01

NOTE: RL=Reporting Limit; MAC=maximum acceptable concentration; AO=Aesthetic Objective. Exceedences of CDWQG are highlighted in yellow

Table 3. Metals in water.

RPC Sample ID:					**277410-1**	**228195-1**	**28239-1**
BGC Sample ID: **Date Sampled:**					**TW 05-02** **21-Feb-17**	**TW 05-02** **1-Mar-17** **(48 hrs)**	**TW 05-02** **2-Mar-17** **(72 hrs)**
Analytes	**Units**	**RL**	MAC	AO			
Aluminum	µg/L	1	-	-	5	2	4
Antimony	µg/L	0.1	6	-	0.3	< 0.1	< 0.1
Arsenic	µg/L	1	10	-	5	< 1	< 1
Barium	µg/L	1	1000	-	175	167	165
Beryllium	µg/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Bismuth	µg/L	1	-	-	< 1	< 1	< 1
Boron	µg/L	1	5000	-	21	22	21
Cadmium	µg/L	0.01	5	-	< 0.01	< 0.01	< 0.01
Calcium	µg/L	50	-	-	45200	42800	41700
Chromium	µg/L	1	50	-	< 1	< 1	< 1
Cobalt	µg/L	0.1	-	-	0.7	< 0.1	< 0.1
Copper	µg/L	1	-	1000	< 1	< 1	< 1
Iron	µg/L	20	-	300	20	< 20	20
Lead	µg/L	0.1	10	-	< 0.1	< 0.1	3.5
Lithium	µg/L	0.1	-	-	34.1	36.6	35.0
Magnesium	µg/L	10	-	-	2990	2830	2740
Manganese	µg/L	1	-	50	417	399	382
Mercury	µg/L	0.025	1	-			
Molybdenum	µg/L	0.1	-	-	1.3	0.4	0.3
Nickel	µg/L	1	-	-	< 1	< 1	< 1
Potassium	µg/L	20	-	-	540	490	480
Rubidium	µg/L	0.1	-	-	0.7	0.6	0.6
Selenium	µg/L	1	10	-	< 1	< 1	< 1
Silver	µg/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Sodium	µg/L	50	-	200000	34600	35600	34700
Strontium	µg/L	1	-	-	938	907	878
Tellurium	µg/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Thallium	µg/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Tin	µg/L	0.1	-	-	< 0.1	< 0.1	< 0.1
Uranium	µg/L	0.1	20	-	0.1	< 0.1	< 0.1
Vanadium	µg/L	1	-	-	< 1	< 1	< 1
Zinc	µg/L	1	-	5000	2	2	8

NOTE: RL=Reporting Limit; MAC=maximum acceptable concentration; AO=Aesthetic Objective. Exceedences of CDWQG are highlighted in yellow

DISCUSSION

The available drawdown is judged to be approximately 45 m (~150 feet, refer to the well log). Estimates of drawdown at various pumping rates and elapsed times since pumping started, are presented in Table 4. Comparing these estimates with 45 m, it is concluded that the safe yield of Well TW 05-02, as now constructed, exceeds 2,725 m^3/d (500 usgpm).

In addition to the available drawdown, however, the maximum rate at which this well could be pumped will be governed by: (a) the maximum size of pump that could be installed in a well of this diameter, and (b) the maximum permissible interference drawdown expected in the closest domestic wells. In this case the limiting criterion is interference drawdown. Pumping from Well TW 05-02 at 2,725 m^3/d (500 usgpm) for a prolonged period could cause interference drawdowns of 8 metres in the closest domestic wells, which is probably unacceptable (Table 5). At one half of this rate, or 1,360 m^3/d (250 usgpm) the predicted longer-term interference drawdown in the closest domestic well is 4 metres, which is much less likely to cause detrimental effect requiring mitigation (well deepening or replacement).

Table 4. Estimated Pumping Drawdown of Well TW 05-02

PUMPING RATE		DRAWDOWN IN PUMPED WELL			
		AFTER 1 YEAR		AFTER 10 YEARS	
m^3/d	usgpm	metres	feet	metres	feet
1,360	250	12.1	39.6	13.7	44.8
1,910	350	18.6	61.0	20.8	68.4
2,725	500	30.2	99.1	33.4	109.7

NOTES: The calculations above are based on:
(a) Aquifer Loss Coefficient, B = 2.0 x 10^{-3} days/m^2 or 0.035 feet/usgpm
(b) Well Loss Coefficient, C = 1.6 x 10^{-6} days/m^5 or 0.00016 feet/usgpm^2
(c) Transmissivity of between 225 m^2/d (18,200 usgpm/ft) and 280 m^2/d (22,500 usgpm/ft)

Table 5. Estimated Interference Drawdowns in Closest Domestic Wells

PUMPING RATE		DRAWDOWN IN CLOSEST DOMESTIC WELL (SAY 500 m DISTANT)			
		AFTER 1 YEAR		AFTER 10 YEARS	
m^3/d	usgpm	metres	feet	metres	feet
1,360	250	3.3	10.7	4.2	13.7
1,910	350	4.6	15.0	5.8	19.1
2,725	500	6.6	21.5	8.3	27.3

The yield of Well TW 05-02 is unusually high for a bedrock well developed in the Carboniferous bedrock of New Maryland. Given the lack of success achieved in groundwater exploration programs conducted in other parts of the Village, one or two production wells should probably be developed on this (Moobema) property or nearby. Three challenges have been identified:

- Water quality which does not meet CDWQ guidelines with respect to the aesthetic analyte manganese; such water will require treatment;
- The presence of artesian conditions which bring with it the risk of causing leakage of water around the well casing; and complicates the plumbing arrangement; and
- Interference with nearby domestic wells. This will require monitoring and could involve mitigation (well deepening or replacement or connection to a municipal supply).

CONCLUSIONS

1. The sandstone and fine conglomerate aquifer in the area explored by the TW 05 series test wells has a transmissivity of approximately 225 m^2/d (~18,200 usgpd/ft) and a storativity in the range 2 x 10^{-4} to 0.003. Well TW 05-02 has an Aquifer Loss Coefficient, B of 0.002 days/m^2 (or 0.035 feet/usgpm), and a Well Loss Coefficient, C of 1.64 x 10^{-6} days/m^5 (or 1.64 x 10^{-4} feet/usgpm^2).

2. The sustainable yield of well TW 05-02, as presently constructed, is estimated to be 1,360 m^3/d (250 usgpm), based on a predicted interference drawdown induced in the closest domestic wells of 4 metres, which is likely acceptable. The associated drawdown after 10 years of pumping this production well at this rate is estimated to be 13.7 m (~45 feet), which compares with a maximum available drawdown of 45 metres (148 feet).

3. Groundwater quality in TW 05-02 meets the Health Canada Canadian Drinking Water Quality Guidelines (CDWQG) except for manganese which was 8 times the CDWQG concentration. Although an aesthetic criterion, manganese will require treatment if this well is to be used as a municipal supply.

4. In practice, Well TW 05-02 should not be used for production purposes. Instead, a larger diameter well (300 mm minimum) should be constructed nearby with at least 20 m of casing grouted in to the bedrock to ensure that no leakage occurs around the casing under the pressure induced by the artesian head.

5. The TW-05-02/03 area should not be considered as a viable wellfield warranting the construction of piping to the community system until a second production well of similar yield has been proven to supplement the well near TW 05-02. It is suggested that a location at the back (southeast) of the property be explored for this purpose.

6. Pumping from TW 05-02 or from a production well drilled nearby, will cause interference drawdowns in nearby domestic wells. At the recommended pumping rate of 1,360 m^3/d (250 usgpm), the predicted long-term interference drawdown at the closest domestic wells is estimated to be 4 m. Such interference may have no adverse effect on those domestic wells which presently tap only part of the available drawdown, but marginal domestic wells could be impacted, and mitigation (well deepening or replacement or connection to a municipal supply) may be required.

7. Water quality in nearby domestic wells could be altered, but not necessarily degraded, by the operation of new higher capacity production wells on the Moobema property. Baseline and longer-term monitoring of water levels and water quality at selected domestic wells should be undertaken to address this possibility.

LIMITATIONS

BGC Engineering Inc. (BGC) prepared this document for the account of Opus International Consultants (Canada) and the Village of New Maryland. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this document.

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CLOSURE

Please contact either of the undersigned if we can clarify this report or otherwise be of further assistance.

Sincerely,

BGC ENGINEERING INC.
per:

Geoff Dickinson, M.Eng., P.Eng.
Principal Hydrogeologist

John Hart, B.Sc..
Consultant Hydrogeologist

gd170320/JH/mr/cr

Project: Well Pumping Test

DRILL HOLE # TW05-02

Page 1 **of** 3

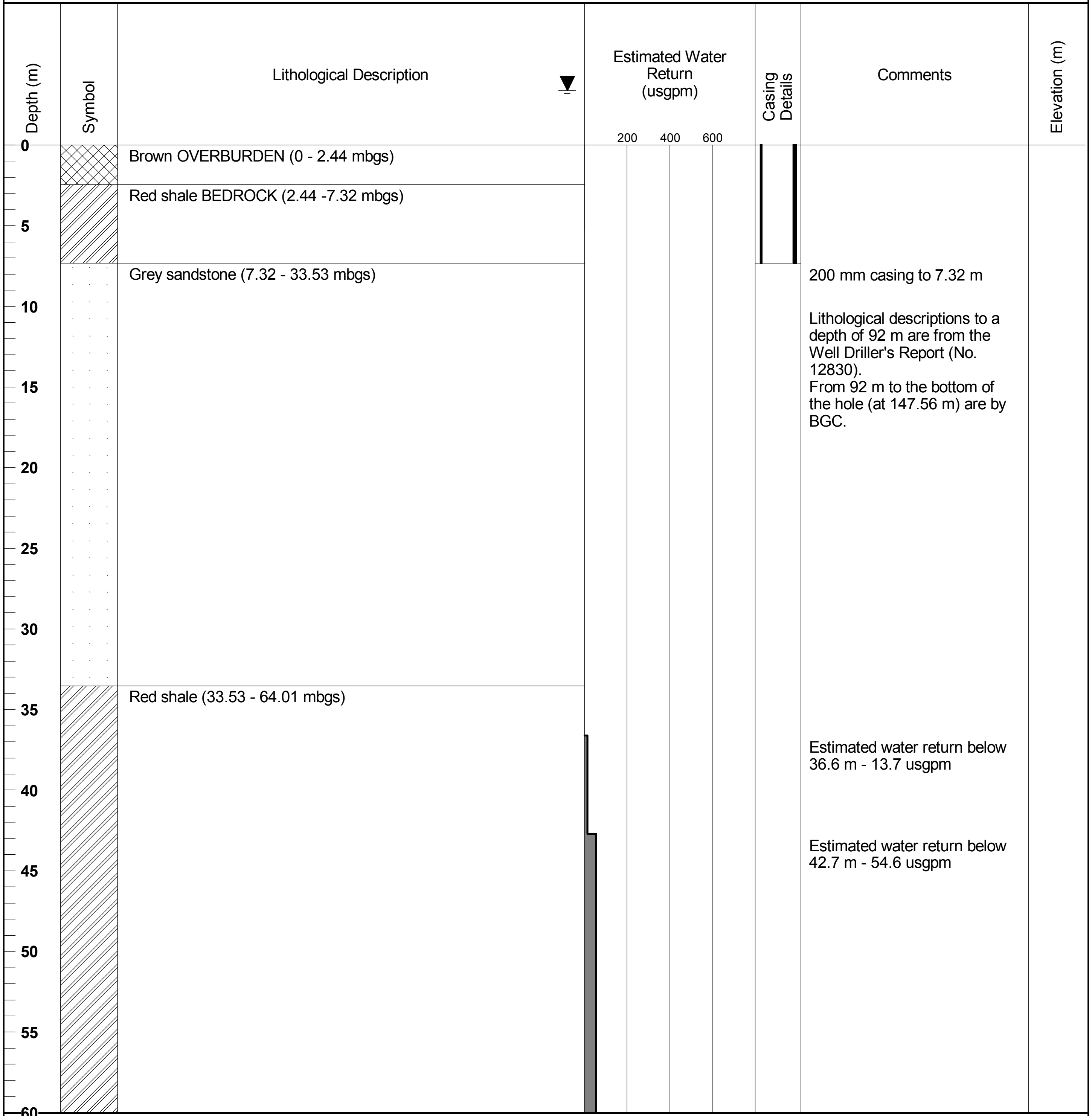
Location: New Maryland, NB

Project No.: 1307-004

Survey Method:
Coordinates (m):
Assumed Ground Elevation (m):
Datum: Geodetic
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation:
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary
Core:
Fluid: Air
Casing: 203 mm **Cased To (m):** 7.32

Start Date: 20 Feb 17
Finish Date: 22 Feb 17
Final Depth of Hole (m): 147.6
Logged by: JH/RP
Reviewed by: GD



Lithological Description	Comments
Brown OVERBURDEN (0 - 2.44 mbgs)	
Red shale BEDROCK (2.44 -7.32 mbgs)	
Grey sandstone (7.32 - 33.53 mbgs)	200 mm casing to 7.32 m Lithological descriptions to a depth of 92 m are from the Well Driller's Report (No. 12830). From 92 m to the bottom of the hole (at 147.56 m) are by BGC.
Red shale (33.53 - 64.01 mbgs)	Estimated water return below 36.6 m - 13.7 usgpm Estimated water return below 42.7 m - 54.6 usgpm

(Continued on next page)

All noted depths are in metres along hole.

Project: Well Pumping Test

DRILL HOLE # TW05-02

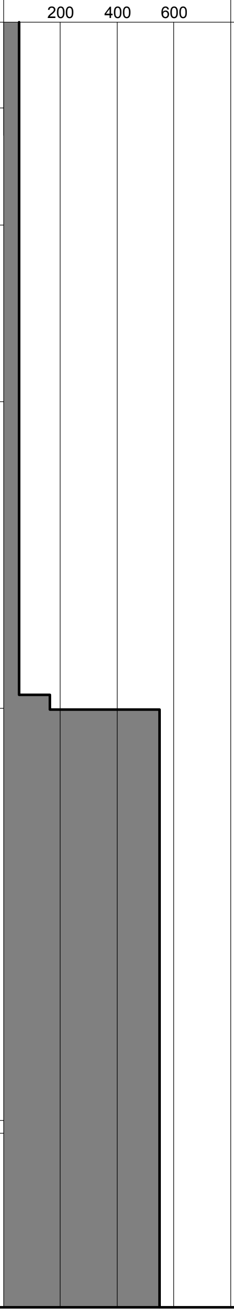
Location: New Maryland, NB

Project No.: 1307-004

Survey Method:
Coordinates (m):
Assumed Ground Elevation (m):
Datum: Geodetic
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation:
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary
Core:
Fluid: Air
Casing: 203 mm **Cased To (m):** 7.32

Start Date: 20 Feb 17
Finish Date: 22 Feb 17
Final Depth of Hole (m): 147.6
Logged by: JH/RP
Reviewed by: GD

Depth (m)	Symbol	Lithological Description	Estimated Water Return (usgpm)	Casing Details	Comments	Elevation (m)
60	▨	Red Shale (continued)				
65	▨	Grey shale (64.01 - 69.49 mbgs)			Estimated water return below 42.7 m - 54.6 usgpm	
70	⋯	Grey sandstone (69.49 - 77.72 mbgs)				
75	⋯				Lithological descriptions to a depth of 92 m are from the Well Driller's Report (No. 12830). From 92 m to the bottom of the hole (at 147.56 m) are by BGC.	
80	▨	Grey shale (77.72 - 92.05 mbgs)				
85	▨					
90	▨					
95	⋯	Grey quartz sandstone (92.05 - 111.28 mbgs)			Estimated water return below 91.4 m - 164 usgpm Estimated water return below 92.1 m - > 550 usgpm	
100	⋯	98.97 - 99.22 mbgs - quartz sandstone with coal				
105	⋯					
110	⋯	107.93 - 111.28 mbgs - grey quartz sandstone with minor mica				
115	◠◠◠ ⋯	Grey conglomerate (111.28 - 111.89 mbgs) Grey quartz sandstone (111.89 - 127.13 mbgs) 115.24 - 115.85 mbgs - grey quartz sandstone to conglomerate				
120						

(Continued on next page)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Opus International Consultants
Print Date: 3/29/2017

All noted depths are in metres along hole.

Project: Well Pumping Test

DRILL HOLE # TW05-02

Location: New Maryland, NB

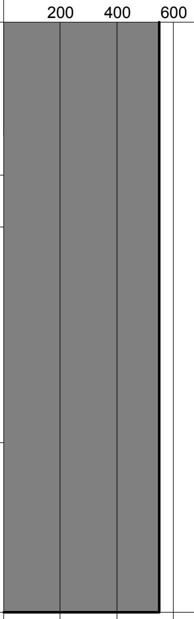
Project No.: 1307-004

Survey Method:
Coordinates (m):
Assumed Ground Elevation (m):
Datum: Geodetic
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation:
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary
Core:
Fluid: Air
Casing: 203 mm **Cased To (m):** 7.32

Start Date: 20 Feb 17
Finish Date: 22 Feb 17
Final Depth of Hole (m): 147.6
Logged by: JH/RP
Reviewed by: GD

Depth (m)	Symbol	Lithological Description	Estimated Water Return (usgpm)	Casing Details	Comments	Elevation (m)
120		Grey quartz sandstone (continued)			Estimated water return below 92.1 m > 550 usgpm	
125		124.7 - 127.13 mbgs - grey quartz sandstone with minor mica				
		Grey conglomerate (127.13 - 129.57 mbgs)				
130		Grey quartz sandstone (129.57 - 139.63 mbgs)			Lithological descriptions to a depth of 92 m are from the Well Driller's Report (No. 12830). From 92 m to the bottom of the hole (at 147.56 m) are by BGC.	
135						
140		Red-brown coarse sandstone (139.63 - 147.56 mbgs)				
145		143.59 - 147.56 mbgs - poorly cemented red-brown coarse sandstone				
		END OF TEST WELL 147.56 mbgs				



BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Opus International Consultants
Print Date: 3/29/2017

All noted depths are in metres along hole.

Report ID: 227410-IAS
Report Date: 03-Mar-17
Date Received: 22-Feb-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Geoff Dickinson
Project #: 1307.004
Location: New Maryland

Analysis of Water

RPC Sample ID:			227410-1
Client Sample ID:			Well 2 (334 ft)
Date Sampled:			21-Feb-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	34.6
Potassium	mg/L	0.02	0.54
Calcium	mg/L	0.05	45.2
Magnesium	mg/L	0.01	2.99
Iron	mg/L	0.02	0.02
Manganese	mg/L	0.001	0.417
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.002
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.1
Alkalinity (as $CaCO_3$)	mg/L	2	97
Chloride	mg/L	0.5	53.1
Sulfate	mg/L	1	21
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	< 0.01
r-Silica (as SiO_2)	mg/L	0.1	13.7
Carbon - Total Organic	mg/L	0.5	0.5
Turbidity	NTU	0.1	28.5
Conductivity	µS/cm	1	413
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	95.8
Carbonate (as $CaCO_3$)	mg/L	-	1.13
Hydroxide (as $CaCO_3$)	mg/L	-	0.063
Cation Sum	meq/L	-	4.04
Anion Sum	meq/L	-	3.87
Percent Difference	%	-	2.07
Theoretical Conductivity	µS/cm	-	394
Hardness (as $CaCO_3$)	mg/L	0.2	125
Ion Sum	mg/L	-	231
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	0.11

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Krista Skinner

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Krista Skinner
Chemical Technician
Inorganic Analytical Chemistry

Report ID: 227410-IAS
Report Date: 03-Mar-17
Date Received: 22-Feb-17

CERTIFICATE OF ANALYSIS

for
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Tel: 506.452.1212
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www.rpc.ca

Attention: Geoff Dickinson

Project #: 1307.004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			227410-1
Client Sample ID: Date Sampled:			Well 2 (334 ft) 21-Feb-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	5
Antimony	µg/L	0.1	0.3
Arsenic	µg/L	1	5
Barium	µg/L	1	175
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	21
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	45200
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	0.7
Copper	µg/L	1	< 1
Iron	µg/L	20	20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	34.1
Magnesium	µg/L	10	2990
Manganese	µg/L	1	417
Molybdenum	µg/L	0.1	1.3
Nickel	µg/L	1	< 1
Potassium	µg/L	20	540
Rubidium	µg/L	0.1	0.7
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	34600
Strontium	µg/L	1	938
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	2

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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	"Phenate" Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

Report ID: 228195-IAS
Report Date: 16-Mar-17
Date Received: 02-Mar-17

CERTIFICATE OF ANALYSIS

for
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Tel: 506.452.1212
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Attention: Geoff Dickinson
Project #: 1307-004
Location: New Maryland

Analysis of Water

RPC Sample ID:			228195-1
Client Sample ID: Date Sampled:			TW-05-02 (48Hr) 1-Mar-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	35.6
Potassium	mg/L	0.02	0.49
Calcium	mg/L	0.05	42.8
Magnesium	mg/L	0.01	2.83
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.399
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.002
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	7.9
Alkalinity (as $CaCO_3$)	mg/L	2	105
Chloride	mg/L	0.5	52.9
Sulfate	mg/L	1	21
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.02
r-Silica (as SiO_2)	mg/L	0.1	14.0
Carbon - Total Organic	mg/L	0.5	0.6
Turbidity	NTU	0.1	< 0.1
Conductivity	µS/cm	1	410
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	104.
Carbonate (as $CaCO_3$)	mg/L	-	0.778
Hydroxide (as $CaCO_3$)	mg/L	-	0.040
Cation Sum	meq/L	-	3.94
Anion Sum	meq/L	-	4.03
Percent Difference	%	-	-1.07
Theoretical Conductivity	µS/cm	-	395
Hardness (as $CaCO_3$)	mg/L	0.2	118
Ion Sum	mg/L	-	234
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	-0.07

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 228195-IAS
Report Date: 16-Mar-17
Date Received: 02-Mar-17

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Attention: Geoff Dickinson

Project #: 1307-004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			228195-1
Client Sample ID:			TW-05-02 (48Hr)
Date Sampled:			1-Mar-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	2
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	167
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	22
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	42800
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	36.6
Magnesium	µg/L	10	2830
Manganese	µg/L	1	399
Molybdenum	µg/L	0.1	0.4
Nickel	µg/L	1	< 1
Potassium	µg/L	20	490
Rubidium	µg/L	0.1	0.6
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	35600
Strontium	µg/L	1	907
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	2

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	"Phenate" Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

Report ID: 228239-IAS
Report Date: 16-Mar-17
Date Received: 03-Mar-17

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Fax: 506.452.0594
www.rpc.ca

Attention: Geoff Dickinson

Project #: 1307-004

Location: New Maryland

Analysis of Water

RPC Sample ID:			228239-1
Client Sample ID:			TW 05-02 (72Hr)
Date Sampled:			2-Mar-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	34.7
Potassium	mg/L	0.02	0.48
Calcium	mg/L	0.05	41.7
Magnesium	mg/L	0.01	2.74
Iron	mg/L	0.02	0.02
Manganese	mg/L	0.001	0.382
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.008
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.0
Alkalinity (as $CaCO_3$)	mg/L	2	104
Chloride	mg/L	0.5	46.1
Sulfate	mg/L	1	21
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.02
r-Silica (as SiO_2)	mg/L	0.1	13.6
Carbon - Total Organic	mg/L	0.5	0.5
Turbidity	NTU	0.1	< 0.1
Conductivity	µS/cm	1	411
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	103.
Carbonate (as $CaCO_3$)	mg/L	-	0.968
Hydroxide (as $CaCO_3$)	mg/L	-	0.050
Cation Sum	meq/L	-	3.84
Anion Sum	meq/L	-	3.82
Percent Difference	%	-	0.34
Theoretical Conductivity	µS/cm	-	378
Hardness (as $CaCO_3$)	mg/L	0.2	115
Ion Sum	mg/L	-	224
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	0.01

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Ross Kean

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Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

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Attention: Geoff Dickinson

Project #: 1307-004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			228239-1
Client Sample ID:			TW 05-02 (72Hr)
Date Sampled:			2-Mar-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	4
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	165
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	21
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	41700
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	20
Lead	µg/L	0.1	3.5
Lithium	µg/L	0.1	35.0
Magnesium	µg/L	10	2740
Manganese	µg/L	1	382
Molybdenum	µg/L	0.1	0.3
Nickel	µg/L	1	< 1
Potassium	µg/L	20	480
Rubidium	µg/L	0.1	0.6
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	34700
Strontium	µg/L	1	878
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	8

Report ID: 228239-IAS
Report Date: 16-Mar-17
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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	"Phenate" Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES

LEGEND

◆ NMC-10C (TW2016) PROPOSED TEST WELL

▣ NMC-10A EXISTING TEST WELL

OPUS
Fredericton Office

VILLAGE OF NEW MARYLAND
WATER SUPPLY EXPLORATION
WSSA PERMIT APPLICATION

LOCATION PLAN
EXPLORATORY TEST WELLS

C-84508.40

003

0

GEMTEC LIMITED
GROUND ENGINEERING
& MATERIALS TECHNOLOGY

191 Doak Road
Fredericton, NB E3C 2E6

TEL: (506) 453-1025
FAX: (506) 453-9470
E-mail: gemtecf@gemtec.ca

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JAN 10 2007
PROJECT ENGINEERING
LIMITED

July 14, 2005

File: 4231.04

ARSAM LTD
634 Brunswick Street
Fredericton, NB
E3B 1H6

Attention: Mr. Yves Chamberlain

RE: GROUNDWATER EXPLORATION, PID 75062174, NEW MARYLAND, NB

Between June 1st and July 7th, 2005, four wells were drilled on the above noted property. The locations of the three test wells (TW05-1, TW05-2, and TW05-4) and one observation well (TW05-3) are shown on the attached figure. A brief description of each well is provided in Table 1.

Table 1 - Well Summary

Well ID	TW05-1	TW05-2	TW05-3	TW05-4
Total Depth (m)	91.44	97.54	91.44	103.63
Well Diameter (m)	0.1524	0.2032[3]	0.1524	0.1524
Casing length (m)	6.1	12.2[4]	6.1	6.1
Estimated Yield[1] (igpm)	65	100+	20	60
Static Water Level[2], June 15th	12.40	Artesian[5]	Artesian	3.54

Notes:

1. Driller's estimated yield
2. Below top of casing
3. TW05-2 diameter increased from 0.1524 to 0.2032 to accommodate larger yield for potential use as production well
4. Additional 6.1 metres of casing installed (potential production well)
5. Overflowing well

Water samples were collected from test wells TW05-1, TW05-2, and TW05-4. The water samples were analysed for both organic and inorganic parameters as outlined in the NBDELG Water Supply Source Assessment (WSSA) Guidelines. The results are shown in Table 2. Overall the water quality is good. At TW05-2 a noticeable sulphide taste to the water is present. The sulphide (as H_2S) concentrations were all below the laboratory detection limit. However, treatment will likely be required. The manganese concentration was above the Canadian Drinking Water Quality Guidelines (CDWQG) in all three samples and will also likely require

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Environmental Engineering • Solid Waste Management • Transportation Engineering

HST # R101977536

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A283 Concrete

treatment. The 0.51 mg/L iron concentration in the sample collected from TW05-4 exceeded the CDWQG of 0.3 mg/L and is likely associated with the suspended material (turbidity) in the sample. The sulphide, manganese, and iron CDWQG are aesthetic objectives not related to human health.

As per the WSSA Guidelines, a pump test is required to determine the long-term sustainable yield of the aquifer. A step test should be performed first, which will provide data to determine the optimal pumping rate for a 72 hr constant rate pump test.

Please contact Shaun Pelkey or myself if you have any questions.

Sincerely,

Michael Fisher

Michael Fisher, EIT.

Enclosure

MJF/

4321.04\2005\r07132.doc

Village of New Maryland
Arsam Ltd. Property Well Information
Analytical Results and Well Summary

Analytes	Units	MAC/AO	Well ID		
			TW05-1	TW05-2	TW05-4
Well Data					
Estimated Yield	igpm	-	65	100+	60
Total Depth	m	-	91	97.54	104
Well Diam.	m	-	0.1524	0.2032	0.1524
Casing Legth	m	-	6	12.2	6
Static Water Level (June 15, 2005)	m	-	12.4000	Artesian	3.5400
General Chemistry					
Sodium	units	200	19	27.4	43.1
Potasium	mg/L	-	0.48	0.5	1.36
Calcium	mg/L	-	37.2	42.3	25.2
Mangnesium	mg/L	-	2.2	2.82	1.46
Iron	mg/L	0.3	<0.02	<0.02	0.51
Manganese	mg/L	0.05	0.534	0.413	0.141
Copper	mg/L	-	0.001	<0.001	<0.001
Zinc	mg/L	-	0.005	<0.001	0.015
Ammonia (as N)	mg/L	-	<0.05	<0.05	<0.05
pH (units)	mg/L	-	8	6	8
Alkalinity (as CaCO3)	mg/L	-	130	104	107
Chloride	mg/L	-	8.5	39.4	28.1
Fluride	mg/L	1.5	0.11	0.33	0.21
Sulfate	mg/L	500	6	22	20
Sulfide	mg/L	0.05	<0.05	<0.05	<0.05
Nitrate+Nitrite	mg/L	-	<0.05	<0.05	<0.05
o-Phosphate (as P)	mg/L	-	<0.01	0.03	<0.01
r-Silica (as SWiO2)	mg/L	-	13.6	13.8	10.9
Total Organix Carbon	mg/L	-	1.4	0.8	0.8
Turbidity (NTU)	mg/L	-	7.5	0.3	39
Conductivity (uS/cm)	mg/L	-	273	382	324

(6.5 min)

OPUS

Analytes	Units		Well ID		
			TW05-1	TW05-2	TW05-4
Trace Metals					
Aluminum	µg/L	-	2	<1	3
Antimony	µg/L	6	0.1	<0.1	0.2
Arsenic	µg/L	10	3	<1	
Barium	µg/L	1000	147	144	138
Beryllium	µg/L	-	<0.1	<0.1	<0.1
Bismuth	µg/L	-	<1	<1	<1
Boron	µg/L	-	22	17	32
Cadmium	µg/L	5	<0.1	<0.1	<0.1
Calcium	µg/L	-	37200	42300	25200
Chromium	µg/L	50	<1	1	<1
Cobalt	µg/L	-	0.2	<0.1	0.2
Copper	µg/L	-	1	<1	1
Iron	µg/L	300	<20	<20	510
Lead	µg/L	10	<0.1	<0.1	<0.1
Lithium	µg/L	-	14.6	27.6	24.1
Magnesium	µg/L	-	2200	2820	1460
Manganese	µg/L	50	534	413	141
Molybdenum	µg/L	-	1	1	2
Nickel	µg/L	-	<1	<1	<1
Potassium	µg/L	-	480	500	1360
Rubidium	µg/L	-	0.3	0.5	1
Selenium	µg/L	-	<1	<1	<1
Silver	µg/L	-	<0.1	<0.1	<0.1
Sodium	µg/L	200000	19000	27400	43100
Strontium	µg/L	-	862	834	755
Tellurium	µg/L	-	<0.1	<0.1	<0.1
Thallium	µg/L	-	<0.1	<0.1	<0.1
Tin	µg/L	-	<0.1	<0.1	<0.1
Uranium	µg/L	20	<0.1	0.1	<0.1
Vanadium	µg/L	-	<1	<1	<1
Zinc	µg/L	5000	5	<1	12
Calculated Parameters					
Bicarbonate as CaCO3	mg/L	-	104	129	106
Carbonate as CaCO3	mg/L	-	0.01	1.21	0.996
Hydroxide as CaCO3	mg/L	-	0.001	0.05	0.05
Cation Sum	meq/L	-	3.56	2.9	3.32
Anion Sum	meq/L	-	3.65	2.96	3.35
% Difference	-	-	-1.21	-1.14	-0.4
Theoretical Conductivity	-	-	356	268	320
Hardness as CaCO3	mg/L	-	117	102	68.9
Ion Sum	mg/L	-	212	167	196
Saturation pH (5C)	-	-	8	7.9	8.2
Langelier Index (5C)	-	-	-1.97	0.08	-0.18

OPUS

New Nouveau
Brunswick

Environment

Report Number **12829**

Well Driller's Report

TWOS-1

Date printed **2016/11/22**

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Other	**New Well**	**Rotary**	**06/01/2005**

Casing Information

Casing above ground **0.61m** Drive Shoe Used? **Yes**

Well Log	Casing Type	Diameter	From	End	Slotted?
12829	Steel	15.24cm	0m	6.10m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	**6.10m**	**273 lpm**	**1hr 40min**	**6.10m**	**0 lpm**	**No**	**0 lpm**

(BTC - Below top of casing)

Well Grouting

There is no Grout Information.

Drilling Fluids Used
None

Disinfectant
12% NaOCl

Qty **0L**

Pump Installed
N/A
Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
12829	0m	0.30m	Brown	Overburden
12829	0.30m	6.10m	Grey	Shale
12829	6.10m	17.68m	Red	Shale
12829	17.68m	42.67m	Grey	Shale
12829	42.67m	60.96m	Grey	Sandstone
12829	60.96m	92.96m	Grey	Shale
12829	92.96m	100.58m	Grey	Sandstone
12829	100.58m	109.73m	Grey	Sandstone

Overall Well Depth
109.73m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
12829	42.67m	18.2 lpm
12829	55.78m	27.3 lpm
12829	65.53m	54.6 lpm
12829	73.15m	68.25 lpm
12829	91.44m	91 lpm

Setbacks

Well Log	Distance	Setback From
12829	762.00m	Right of any Public Way Road

New Nouveau Brunswick

Environment

Report Number **12830**

Well Driller's Report

TW05-2

Date printed **2016/11/22**

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Other	**New Well**	**Rotary**	**06/03/2005**

Casing Information

Casing above ground **0.61m**

Drive Shoe Used? **Yes**

Well Log	Casing Type	Diameter	From	End	Slotted?
12830	**Steel**	15.24cm	0m	7.32m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	**0m**	**455 lpm**	**1hr 20min**	**0m**	**455 lpm**	**No**	**0 lpm**

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
None

Disinfectant
12% NaOCl

Qty **0L**

Pump Installed
N/A

Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
12830	81.08m	97.54m	Grey	Shale
12830	0m	2.44m	Brown	Overburden
12830	2.44m	7.32m	Red	Shale
12830	7.32m	33.53m	Grey	Sandstone
12830	33.53m	64.01m	Red	Shale
12830	64.01m	69.49m	Grey	Shale
12830	69.49m	77.72m	Grey	Sandstone
12830	77.72m	81.08m	Grey	Shale

Overall Well Depth
97.54m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
12830	36.58m	11.38 lpm
12830	42.67m	45.5 lpm
12830	60.96m	45.5 lpm
12830	91.44m	136.5 lpm
12830	92.05m	455 lpm

Setbacks

Well Log	Distance	Setback From
12830	762.00m	Right of any Public Way Road

New Nouveau Brunswick

Environment

Report Number **12831**

Well Driller's Report

TW05-3

Date printed **2016/11/22**

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	**New Well**	**Rotary**	**06/06/2005**

Casing Information — Casing above ground **0.61m** — Drive Shoe Used? **Yes**

There is no casing information.

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	**0m**	**0 lpm**	**1hr 20min**	**0m**	**91 lpm**	**No**	**0 lpm**

BTC - Below top of casing)

Well Grouting

There is no Grout Information.

Drilling Fluids Used
None

Disinfectant
12% NaOCl

Qty **0L**

Pump Installed
N/A

Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
12831	0m	2.44m	Brown	Overburden
12831	2.44m	4.57m	Grey	Shale
12831	4.57m	16.15m	Red	Shale
12831	16.15m	21.03m	Grey	Shale
12831	21.03m	31.09m	Red	Shale
12831	31.09m	65.53m	Grey	Shale
12831	65.53m	91.44m	Grey	Sandstone

Overall Well Depth
91.44m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
12831	30.48m	18.2 lpm
12831	60.96m	22.75 lpm
12831	91.44m	45.5 lpm
12831	68.58m	91 lpm

Setbacks

Well Log	Distance	Setback From
12831	762.00m	Right of any Public Way Road

New Nouveau Brunswick

Environment

Report Number **12832**

Well Driller's Report

TWOS-4

Date printed **2016/11/22**

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	**New Well**	**Rotary**	**06/07/2005**

Casing Information

Casing above ground **0.61m**

Drive Shoe Used? **Yes**

Well Log	Casing Type	Diameter	From	End	Slotted?
12832	Steel	15.24cm	0m	8.53m	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	**3.05m**	**273 lpm**	**1hr 25min**	**3.05m**	**273 lpm**	**No**	**0 lpm**

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
None

Disinfectant
12% NaOCl

Qty **0L**

Pump Installed
N/A

Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
12832	0m	7.92m	Brown	Overburden
12832	7.92m	11.58m	Red	Shale
12832	11.58m	21.95m	Grey	Shale
12832	21.95m	24.99m	Red	Shale
12832	24.99m	25.91m	Grey	Shale
12832	25.91m	33.53m	Red	Conglomerate
12832	33.53m	35.05m	Red	Shale
12832	35.05m	59.44m	Grey	Sandstone
12832	59.44m	103.63m	Grey	Sandstone

Overall Well Depth
103.63m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
12832	22.86m	22.75 lpm
12832	30.48m	45.5 lpm
12832	36.58m	68.25 lpm
12832	60.96m	91 lpm
12832	73.15m	136.5 lpm
12832	103.63m	273 lpm

Setbacks

Well Log	Distance	Setback From
12832	762.00m	Right of any Public Way Road

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

OPUS INTERNATIONAL

GROUNDWATER SUPPLY FOR THE VILLAGE OF NEW MARYLAND

HYDROGEOLOGICAL ASSESSMENT REPORT FOR TW17-01

FINAL

PROJECT NO.: 1307004 DATE: April 9, 2018

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY
515 Beaverbrook Court
Fredericton, NB Canada E3B 1X6
Telephone (506) 460-8660
Fax (506) 460-8679

April 9, 2018
Project No.: 1307004

Mr. John McKinney
Manager, Municipal Engineering
Opus International
80 Bishop Drive
Fredericton, NB E3C 1B2

Dear Mr. McKinney,

Re: Groundwater Supply – Hydrogeological Assessment of TW17-01, New Maryland, NB

As requested, BGC Engineering Inc. (BGC) is pleased to provide you with the following final report for the above-noted study relating to the Arsam Wellfield in New Maryland, NB.

In this latest phase of the project, a production-scale well (TW17-01) was drilled, developed, and tested on a property within the boundaries of the Village of New Maryland (PID 75062174 owned by Khaled Moomena). This work followed the Water Supply Source Assessment (WSSA) process, as directed by the Environmental Impact Assessment (EIA) Branch of the New Brunswick Department of Environmental and Local Government (NBDELG) and was initiated based on our earlier findings at the TW05-02 location on the same property (BGC 2017).

Should you have any questions regarding this report, please feel free to contact the undersigned.

Yours sincerely,

BGC ENGINEERING INC.
per:

Kent Wiezel, M.A.Sc., P.Eng.
Senior Hydrogeological Engineer

EXECUTIVE SUMMARY

On behalf of the Village of New Maryland (the Village), New Brunswick, Opus International Consultants (Opus) retained BGC Engineering Inc. (BGC) to provide hydrogeological support for the further development of the community's municipal groundwater supply. Ideally an additional 1,360 m^3/d (250 usgpm) from this area is being sought by the Village.

In this latest phase of the work, a 305 mm (12-inch) diameter production-scale well (TW17-01) was drilled in a sandstone-conglomerate aquifer in the Village, on PID 75062174 (owned by Khaled Moomena, herein referred to as the Property). Through the course of the drilling, developing and testing program, three step-drawdown tests and two 72-hour constant-rate pumping tests were completed at TW17-01. Two supplementary 6-hour step-drawdown tests were also completed, one each at nearby test wells TW05-02 and TW05-04. These tests were all critical in evaluating the hydraulic performance of TW17-01 at various check points, as the well and surrounding fracture network were methodically developed over several phases. Water quality analyses were completed during each phase of testing.

Following completion of the well development effort, the second, and final, 72-hour pumping test was completed in TW17-01 in January 2018 (pumping test #2) at a constant rate of 1,635 m^3/d (300 usgpm). The total drawdown induced in production-scale well TW17-01 after 72 hours of pumping at this rate was approximately 18 m, which is 35 m less than the drawdown experienced here during the initial 72-hour test (pumping test #1). The calculated well efficiency at the end of pumping test #2 was approximately 50%, which reflects the current hydraulic condition of TW17-01.

Based on the results of pumping test #2, it is recommended that production-scale well TW17-01 be brought on-line as a water supply production well for the Village. Rather than basing the operating water level on drawdown, which fluctuates with the seasonally varying static water level (historically up to 10 m), the pumping level in the well should be maintained above an elevation of 25.1 m (82.3 feet) asl (above sea level) at all times, which is the approximate elevation of the bottom of the casing, as currently constructed.

A maximum allowable withdrawal rate of 1,360 m^3/d (250 usgpm) is recommended to limit the amount of potential well interference, both in the nearby residential wells (BGC 2017), and in a potential second pumping well (most likely at the TW05-02 location). On the basis of an assumed contributing drainage area of 12 km^2, and a range of annual aquifer recharge from precipitation and snowmelt between 10% (110 mm) and 30% (330 mm), this recommended withdrawal rate represents between 13% and 38% of the assumed available groundwater recharge in the aquifer. The recommended withdrawal rate could be re-visited following an adequate period of operation and monitoring, as more data are gathered on regional water levels and drawdown due to longer-term pumping from the well and aquifer.

The yield of production-scale well TW17-01 is relatively high for a bedrock well developed in the Carboniferous bedrock of the New Maryland area, and appears sufficient to meet the Village's current demand. An additional production-scale well could be developed on the Property at the TW05-02 location, and in combination with TW17-01, this would give the Village an additional wellfield (referred to as the Arsam Wellfield) from which to derive a water supply. Three challenges have been identified in developing a viable wellfield at this location:

- Water quality that exceeds the Health Canada Guidelines for Canadian Drinking Water Quality (GCDWQ) with respect to the aesthetic objectives for manganese and sulfide, which are two to three times the guideline, and will require treatment.
- Artesian pressures and overflow conditions, which bring the risk of causing leakage of water around the well casing and complicates the surface plumbing arrangements.
- Interference with nearby domestic wells, which will require long-term monitoring and may involve mitigation (e.g., well deepening, well replacement, or connection to a municipal supply).

It is recommended that a second production well be constructed at test well TW05-02 location, by modifying TW05-02 to include 30.5 m (100 feet) of protective steel casing with drive-shoe seated into the bedrock, to help prevent potential leakage around the outside of the casing under artesian pressures. The completion of this work will be challenging during high groundwater level conditions (upwards of 3 m above ground surface), therefore, this work should be completed during a drier period of relatively low groundwater elevations (e.g., July or August). Pumping from TW17-01 (and/or TW05-03) to waste may also be considered throughout a portion of the recommended well construction process, to allow further lowering of the prevailing artesian pressures, if needed.

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ACRONYMS AND ABBREVIATIONS

Acronyms and abbreviations used in this report:

ATOC	Above Top of Casing
B	Aquifer Loss Coefficient
BGC	BGC Engineering Inc.
BTOC	Below Top of Casing
C	Well Loss Coefficient
ECCC	Environment and Climate Change Canada
EIA	Environmental Impact Assessment
GCDWQ	Guidelines for Canadian Drinking Water Quality
Opus	Opus International Consultants (Canada) Limited
NBDELG	New Brunswick Department of Environment and Local Government
Property	Moomena Property (PID 75062174)
RPC	Research and Productivity Council
S	Storativity
Sullivan’s	Sullivan’s Well Drilling Ltd.
T	Transmissivity
VOCs	Volatile Organic Compounds
VoNM	Village of New Maryland
WSSA	Water Supply Source Assessment
WfPADO	Wellfield Protected Area Designation Order
WSC	Water Survey of Canada

UNITS OF MEASURE

Units of measure used in this report:

asl	above sea level
bgs	below ground surface
km	kilometres
L/s	litres per second
L/d	litres per day
m	metres
mg/L	milligram per litre
mins	minutes
mm	millimetres
m^2/d	square metres per day
m^3/d	cubic metres per day
t	time since pumping started
t’	time since pumping ceased
t/t’	ratio of time since pumping started to time since pumping ceased
usgpm	US gallons per minute

LIMITATIONS

BGC Engineering Inc. (BGC) prepared this document for the account of Opus International. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. BGC accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this document.

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1.0 INTRODUCTION

On behalf of the Village of New Maryland (the Village), New Brunswick, Opus International Consultants (Opus) retained BGC Engineering Inc. (BGC) to provide hydrogeological support for the further development of the community's municipal groundwater supply. In this latest phase of the work, a 305 mm (12-inch) diameter production-scale well (TW17-01) was drilled on PID 75062174 (owned by Khaled Moomena, herein referred to as the Property) within the boundaries of the Village of New Maryland as shown in Figure 1-1. Subsequent hydraulic pumping tests and associated water quality analyses were completed.

Figure 1-1. Property location within the Village of New Maryland, NB.

This report describes the work completed on the Property between August 2017 and January 2018. It follows our groundwater supply report for the hydrogeological investigation completed at the existing test well TW05-02 in February and March 2017 (BGC 2017) and was completed as per the scope of work outlined in BGC (2016).

2.0 BACKGROUND

2.1. Site Description

The project site is located in the south-eastern portion of New Maryland, NB on PID 75062174 (as shown in Figure 2-1) and accessed by Route 101. The 45-hectare property is primarily composed of undeveloped, forested land, and has a wetland in the approximate centre (identified on Figure 2-1). In addition to TW17-01, there are four existing test wells located on the Property (TW05-01, TW05-02, TW05-03, and TW05-04). These test wells, along with two other observation wells located in the Sunrise Estates subdivision (Sunrise-OW and 112 Kingston), were monitored throughout the duration of the constant-rate pumping tests. Sunrise-OW is a supply well for the Village's Sanitary Pumping Station No. 2 (PID 75407429), and the Kingston well is a residential supply well for 112 Kingston Avenue (PID 75068122). Refer to Table 2-1 for a summary of construction details, and Appendix A for the available well logs.

Figure 2-1. Location of test wells and monitoring wells used in this investigation.

Table 2-1. Summary of well construction details.

WELL ID	DIAMETER (mm)	DEPTH (m)	CASING DEPTH (m)	CASING STICKUP (m)
TW05-01	152	109.73	6.10	0.65
TW05-02	203	147.60	7.32	0.75
TW05-03	152	91.44	Unknown[1]	0.50
TW05-04	152	143.80	7.60	0.62
TW17-01	305	148.40	30.50	0.54
Sunrise-OW	152	73.15	12.19	0.63
112 Kingston[2]	152	33.53[3]	30.50[3]	0.09

Notes:

1. Casing depth not available from well log but is assumed to be similar to that installed at TW05-02 (immediately nearby).
2. Well log not available.
3. Information provided by the home owner (January 19, 2018).

The TW05 series of test wells were originally drilled in 2005 by Capital Well Drillers. Following BGC's recommendation, test wells TW05-02 (97.5 to 147.5 m) and TW05-04 (103.6 to 144.1 m) were deepened on February 22 and July 11, 2017, respectively, as reported in BGC (2017). The discovery of high-yielding water bearing fractures and high artesian pressures at depth in these wells led to the drilling and subsequent testing of test well TW17-01.

2.2. Hydrogeologic Setting

2.2.1. Geology

The overburden on the Property is a silt-dominated till, which is typically 1 to 20 m (3 to 66 feet) thick, deposited by advancing glaciers (Allard and Gilmore 2016). The bedrock in the area is part of the Minto Formation of the Pictou Group of rocks, consisting of Late Carboniferous aged, coarse-to-fine-grained sediments, including grey and red-brown beds of conglomerate, sandstone, siltstone, mudstone, and shale, with thin seams of coal (St. Peter and Fyffe 2005).

2.2.2. Topography and Drainage

The surface elevation in the greater New Maryland area ranges from approximately 10 to 200 m (33 to 656 feet) asl (above sea level), with the highest ground elevation being to the north-west in Hanwell. The surface elevation of the Property ranges from approximately 50 to 70 m (164 to 230 feet) asl, and generally slopes to the southeast. Two brooks are located near the Property, Burpee Brook and its tributary, Berry Brook, identified on Figure 2-2. Burpee Brook flows north to south across the Property, and Berry Brook flows roughly parallel with the Property to the south before entering Burpee Brook. Burpee Brook then joins the North Branch Rusagonis Stream, which flows roughly northwest to southeast through the immediate project area. The Rusagonis Stream is a tributary to the Oromocto River, which ultimately drains into the St. John River.

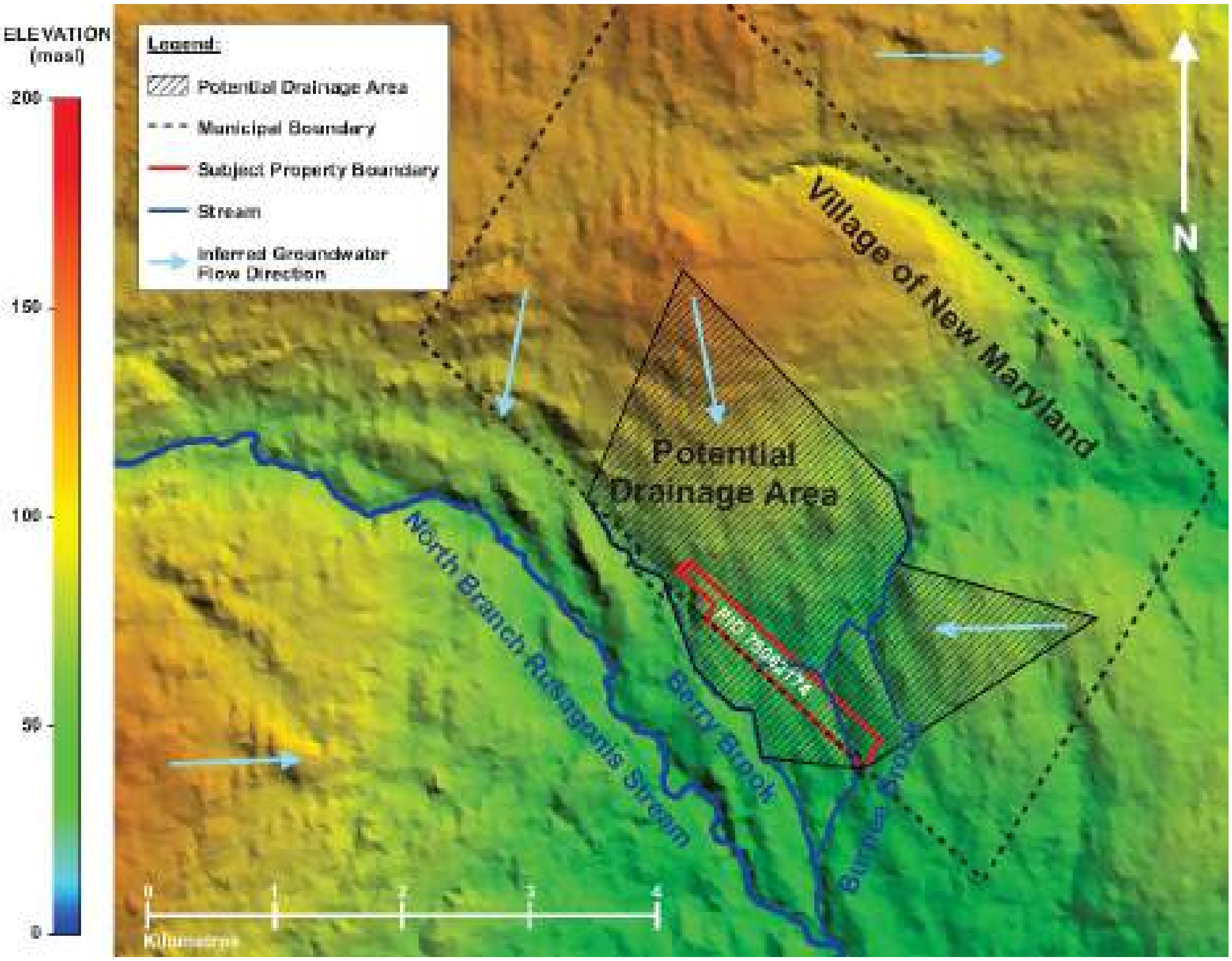

Figure 2-2. **Drainage area and topography around the subject Property.**

Based on topography, a 12 km^2 potential contributing drainage area to the aquifer was approximated (Figure 2-2). This potential drainage area is considered to provide recharge to the aquifer, based on local drainage divides as delineated using topography provided by the GeoNB data catalogue (SNB 2018). Using an average annual precipitation of approximately 1,100 mm (ECCC 2018), and an assumed annual aquifer recharge rate between 10% (110 mm/year) and 30% (330 mm/year), an estimated range for the total volume of groundwater recharge available in this aquifer is 1,320,000 to 3,960,000 m^3/year. Considering the presence of up to 400 domestic wells within this drainage area, each assuming to withdraw between 0.6 m^3/d (Opus 2018) and 1.0 m^3/d (DeOreo et. al. 2016)[1], up to approximately 146,000 m^3/year (between 4% and 11%) of the estimated available recharge may be extracted by domestic well use. A portion of this may be offset if some of these homes are eventually connected to the municipal system.

---

[1] Consumption data for the Village's current (existing) water supply system suggests an average of 580 L/d (0.6 m^3/d) per residence (Opus 2018). DeOreo et. al. (2016) incorporated data collected from approximately 24,000 homes throughout Canada and the US, with the average annual residential water use found to be 912 L/d per residence (or 88,000 us gallons per year). To remain conservative, and for ease of calculations, an assumed value of 1,000 L/d (1 m^3/d) was applied as a typical (average) residential water usage rate.

It is also important to note that less aquifer recharge may be available during extended dry periods. Under such prolonged dry conditions, there is a higher potential risk of increased drawdowns, and possibly over pumping, if water levels are left unchecked.

2.2.3. Hydrogeology

An interpreted sub-surface cross section of the Property from northwest to southeast (section A-A' as shown in Figure 2-1) is depicted in Figure 2-3. The general topography, bedding, and groundwater table slope from northwest to southeast. A large water bearing fracture was encountered at depth while deepening test wells TW05-02 and TW05-04, and during drilling of TW17-01. Test well TW05-01 may also intersect this fracture, within a likely zone between 65 and 95 m (213 and 312 feet) asl (refer to Appendix A for the well driller's log, and the identified zone on Figure 2-3) but this is not confirmed since this well was drilled by others. Due to an approximate 20 m difference in elevation between test well TW05-01 and the other wells on the Property, and the artesian pressures in the intercepted aquifer at depth, overflow conditions are only observed at the wells at lower elevation (TW05-02, TW05-03, TW05-04 and TW17-01) during the bulk of the year. Based on this information, it is suspected that overflow conditions are absent at TW05-01 due to its much higher elevation, as the conceptual model in Figure 2-3 depicts.

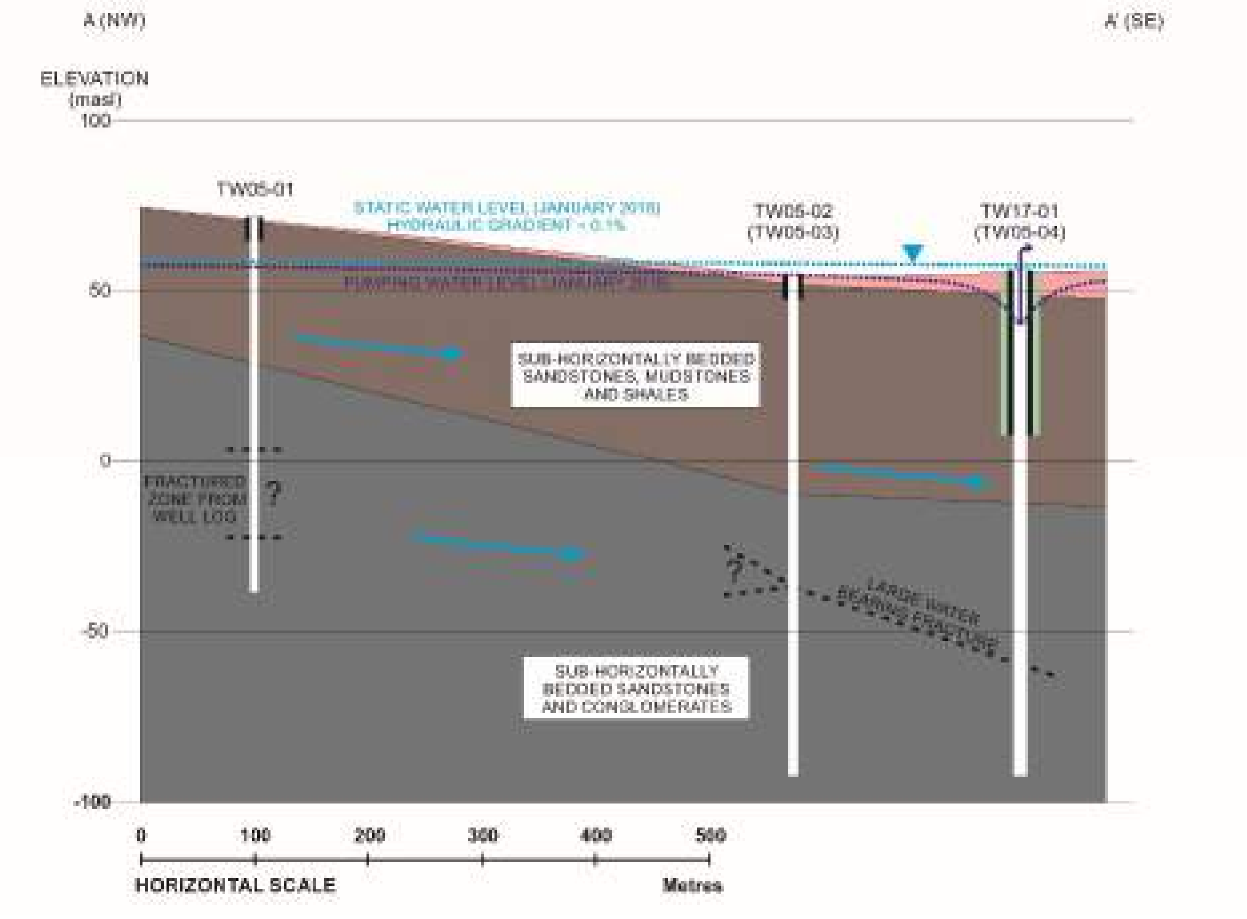

Figure 2-3. Conceptual cross-section along the test wells on the subject Property.

Groundwater levels at an observation well belonging to the Provincial monitoring network, located near Victoria Hall on PID 75064253 in New Maryland, have been monitored by the Government of New Brunswick since 1979 (NBDELG 2018). The Victoria Hall well (location identified on Figure 1-1) is located approximately 2 km from the subject Property (and approximately due north from the test wells), and on ground that is approximately 40 m higher in elevation. The historical data provide some indication of general water table trends in this aquifer. From January 2017 to January 2018, groundwater levels regularly fluctuated by 1 to 2 m, with a maximum fluctuation over that period of 6 m from May to October 2017, as shown in Figure 2-4. This prolonged decline in the groundwater level confirms the extremely dry conditions under which the drilling and initial testing were completed (refer to Figure 2-4).

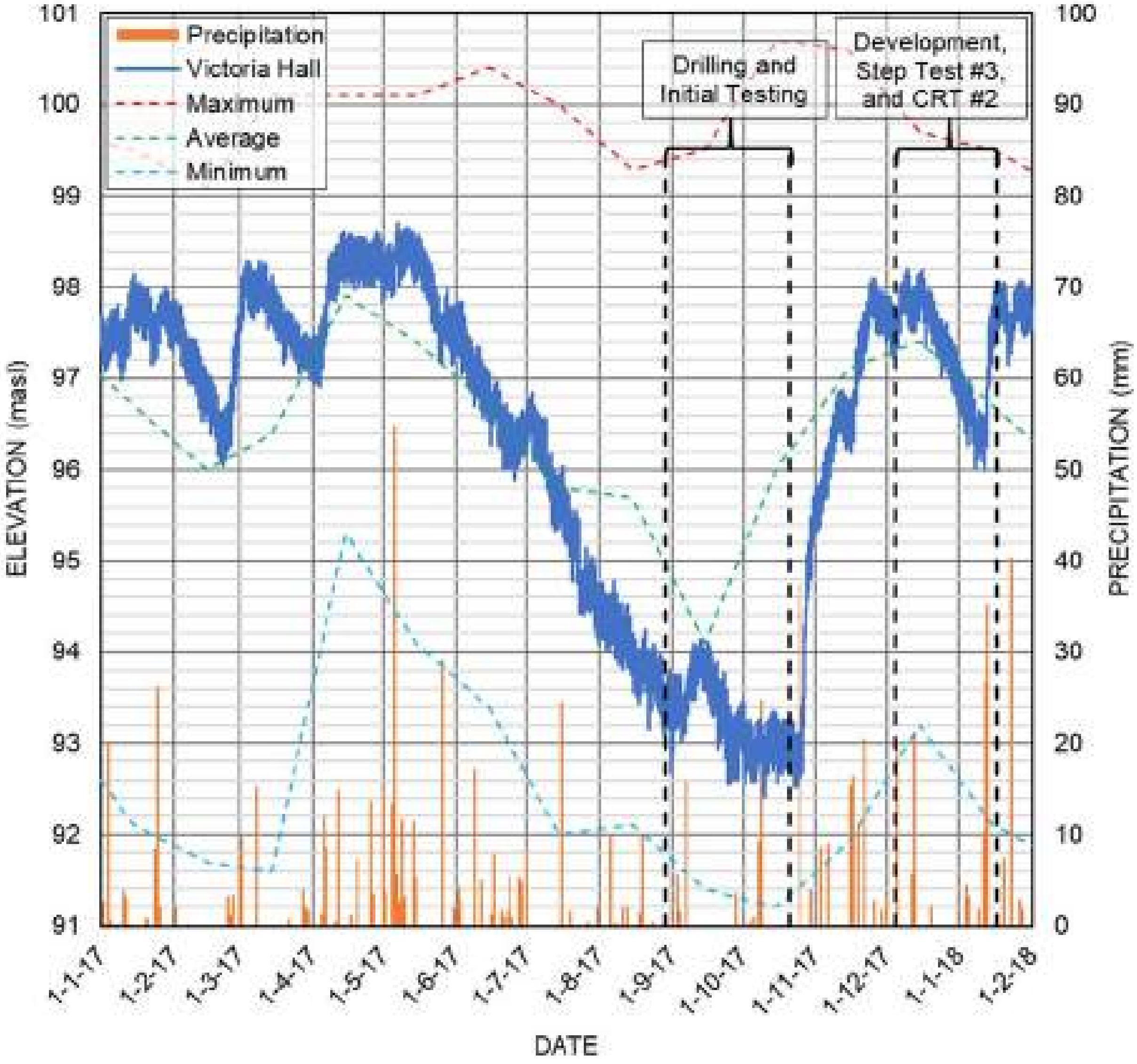

Figure 2-4. Groundwater elevations in the Victoria Hall well with precipitation.

The extended 6-month decline in groundwater levels had resulted in levels descending below the historical (39-year) average between July and November 2017 (green dahsed line in Figure 2-4). This decline is attributed to limited precipitation being received in the area over this period, (254 mm at the Fredericton International Airport monitoring station, ECCC 2018) which produced extremely dry (drought-like) conditions over these months (the precipitation is also shown in Figure 2-4 over that time period). The high variability in groundwater elevations measured at the Victoria Hall well, up to 10 m between the historical maximum and minimum water levels over the period of record (red and blue dashed lines, respectively), suggests that this aquifer is highly influenced by precipitation and snowmelt (with a time lag[2] of 5 days for its effects to reach the aquifer), and the antecedant moisture condition.

2.3. Regulatory Setting

Commercial, industrial and community groundwater supply investigations in New Brunswick follow the Water Supply Source Assessment (WSSA) process, as directed by the Environmental Impact Assessment (EIA) Branch of the New Brunswick Department of Environment and Local Government (NBDELG). The latest revision of the WSSA document can be found online (NBDELG 2017).

The intent of the WSSA process is to develop water supplies that are ultimately protected by controlling the potential factors that can be controlled during well construction and testing. These include mandating a minimum amount of protective casing, grouting around the protective casing, a minimum suite of chemical parameters for analytical groundwater sampling, and timing of pumping tests to coincide with relatively drier periods, when aquifer recharge is relatively low, to reduce the possibility of overestimating the sustainable well yield.

The WSSA process involves two main steps: the WSSA Initial Application (formerly ‘Step One’) and the Hydrogeological Assessment (formerly ‘Step Two’). The WSSA Initial Application involves siting drilling targets (typically a desktop evaluation supported by ground truthing, previously completed by BGC for this project), and the Hydrogeological Assessment includes the actual field program (drilling, well construction and development, hydraulic testing and analytical sampling), analysis and reporting.

As quoted in the WSSA document, “WSSAs must be completed to the satisfaction of the Department of Environment and Local Government. Incomplete or inadequate submissions will be returned to the applicant for completion. The Hydrogeological Assessment and yield testing must be completed under the direct supervision of a qualified Professional Engineer or Geoscientist registered with the Association of Professional Engineers and Geoscientists of New Brunswick. All final work must be signed and professionally sealed.” This report completes the requirement of the Hydrogeological Assessment portion of the WSSA process.

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[2] A subset of 31 precipitation events that occurred between 2001 and 2016, was used to approximate the time lag between a precipitation event and the associated peak in the groundwater level observed in the Victoria Hall monitoring well.

3.0 METHODS

As part of this scope of work, BGC completed the following tasks:

- Designed the test well TW17-01 as a production-scale well.
- Supervised the drilling, construction and development of TW17-01.
- Designed and monitored the hydraulic testing programs completed at test wells TW17-01, TW05-02 and TW05-04.
- Presented the associated methodology and findings in this report.

3.1. Production Well Drilling

Between August 29 and September 12, 2017, a 305 mm (12-inch) diameter production-scale well (TW17-01) was drilled on the Property, approximately 3 m (10 feet) west of the existing test well TW05-04. The production-scale well was drilled to a final depth of 148.4 m (487 feet), with an air-rotary drill supplied by Sullivan's Well Drilling Ltd. (Sullivan's). The upper 30.5 m (100 feet) was drilled at 406 mm (16-inch) diameter, and the annulus between the 305 mm (12-inch) diameter, 30.9 m (101.5 ft) long, protective steel casing and the outer borehole was grouted to surface. A cement-based grout was injected into the annular space from 10 to 30.5 m (32.8 to 100 feet) bgs (below ground surface) using a tremie pipe, and the upper 10 m (32.8 feet) of annular space was backfilled with bentonite clay.

Beneath the grouted, protective casing (with drive-shoe), the well consists of an open borehole in the bedrock. The bedrock was primarily sandstone and conglomerate, with beds of mudstone and shale, and occasional deposits of lignite (coal) and pyrite. Approximately 7 m (24 feet) of overburden was encountered above the surface of bedrock at TW17-01. Refer to Appendix A for a complete well log of production-scale well TW17-01.

3.2. Well Development

Production-scale well TW17-01 was initially developed, by means of an air-lift development tool, for eight hours on September 12 and 13, 2017. Following the initial well development, the well yield was estimated to be between 1,100 and 1,400 m^3/d (200 and 250 usgpm). However, follow-up hydraulic testing showed that the specific capacity of TW17-01 was much lower than anticipated, when compared to that measured in nearby test wells TW05-04 and TW05-02.

On September 19 and 20, 2017, an effort was made to hydraulically fracture the nearby test well TW05-04, in an attempt to increase the connectivity between TW05-04 and TW17-01. A 305-mm (12-inch) packer could not be obtained for TW17-01, therefore, the effort was focused on TW05-04. Fractures were targeted by sealing the well above the desired interval with an inflatable packer, and pumping water through the packer to increase the pressure in the section of the well beneath the sealed packer. The primary targets were the larger water bearing fractures, which were producing artesian pressures, located at approximately 114 and 116 m (374 and 380 feet) bgs. Hydraulic fracturing was also attempted at other potential water bearing fractures, between 99 and 144 m (326 and 473 feet) bgs in TW17-01, or 90 and 139 m (295 and 456 ft) in TW05-04.

An additional five hours of air-lift development was completed on September 20, 2017, with most of this time spent targeting fracture zones in TW17-01. A marginal increase in the specific capacity of TW17-01 was noted following this effort, and a decision was made to attempt a more aggressive, higher-energy well development method at TW17-01 to improve the well efficiency.

The more aggressive well development method was conducted at TW17-01 between December 5 and 8, 2017, using a dual surge block, which threaded onto the bottom of the drill rod while still allowing compressed air to be pumped into the well. This well development process consisted of a combination of surging and air jetting. In total, approximately twenty hours of well development was completed by means of this method, alternating between surging and jetting, mainly targeting the same fractured zones as previous. This involved the following steps:

- Rapidly raising and lowering the surge block the length of one drill rod (7.6 m or 25 feet).
- Pumping compressed air through the surge block at very specific targeted intervals.
- Monitoring the hydraulic response in TW17-01 and the adjacent test well TW05-04.

3.3. Hydraulic Testing

Through the course of the drilling, developing and testing program, a total of three step-drawdown tests and two 72-hour constant-rate pumping tests were completed at production-scale well TW17-01. Two 6-hour step-drawdown tests were also completed at test wells TW05-02 and TW05-04 in this process. The step-drawdown and constant-rate pumping tests were designed and monitored by BGC staff and conducted by Sullivan’s using a submersible pump and mobile generator. Water levels were recorded both manually and with automatic dataloggers, by measuring the distance to groundwater below the top of casing (BTOC) or above the top of casing (ATOC) depending on the artesian pressure and associated groundwater elevation in each well, then converting the collected water levels to drawdowns and elevations. Standpipes were installed on those wells where the groundwater level was ATOC due to artesian pressures causing overflowing conditions.

3.3.1. Step-Drawdown Tests

Three step-drawdown tests were completed in production-scale well TW17-01, respectively on September 18 (step test #1), September 21 (step test #2), and December 19, 2017 (step test #3). The first test was completed immediately after the drilling and initial well development, the second test was completed following hydraulic fracturing of TW05-04 and additional development at TW17-01, and the third test was completed following the more aggressive well development effort at TW17-01. Each test consisted of three to four incremental steps, with each rate being maintained for 60 minutes before proceeding to the next step.

Due to the significantly lower specific capacity measured at TW17-01 when compared to TW05-02, during the February 2017 step-test (BGC 2017), follow-up 6-hour step-drawdown tests were completed in test wells TW05-02 and TW05-04 on October 20 and 21, 2017, respectively. These tests were completed to asses if the initially low efficiency of TW17-01 may have been due in part to much lower (approximately 3 m, or 10 feet) groundwater elevations compared to

February 2017, or if this previously untested area has different hydraulic properties. Each test consisted of three incremental steps, maintaining the rate of steps 1 and 2 for 60 minutes each, before proceeding to a final 4-hour step.

3.3.2. Constant-Rate Pumping Tests

The first 72-hour constant-rate pumping test (pumping test #1) was completed at TW17-01 between September 25 and 28, 2017. Following the additional well development and step test #2, it was concluded that well TW17-01 should be pumped at a constant rate of 1,090 m^3/d (200 usgpm). The results of the pumping test were not encouraging at that time (high observed drawdown leading to low specific capacity and well efficiency; refer to next section), and the testing program was, therefore, paused until the additional, higher-energy, more aggressive well development method could be completed, and TW17-01 could be re-tested.

The second 72-hour constant-rate pumping test (pumping test #2) was completed at TW17-01 between January 9 and 12, 2018, following a relatively cold and dry month. Following the higher-energy well development and step test #3, it was concluded that well TW17-01 could be pumped at a constant rate of 1,635 m^3/d (300 usgpm), near the maximum capacity of the installed pump. Due to the lack of significant precipitation, and the frozen and snow-covered ground conditions, little aquifer recharge was likely occurring at the time of this test (i.e., approximate baseflow conditions had prevailed). Refer to Appendix B for river stage plots of the nearby St. John River at Fredericton (Figure B-1) and North Branch Oromocto River at Tracy (Figure B-2), between January 2017 and January 2018 (WSC 2018).

The initial static groundwater level in the pumped well (TW17-01) at 9:00 am on January 9, before the well seal was removed to install the pump, was 2.03 m ATOC. This static level was noticeably higher than what was measured prior to the first CRT here (0.16 m ATOC on September 21, 2017), when extremely dry (drought-like) site conditions had prevailed. Static groundwater levels for each of the observation wells were chosen as the water level that was collected from each well on January 9, 2018, immediately prior to removing the well seal from TW17-01.

Manual water level readings were measured in wells TW17-01 and TW05-04 every 30 seconds at the onset of pumping, and the frequency of readings were gradually reduced to hourly throughout the remainder of the test, following BGC's standard testing protocol. Manual levels were also recorded periodically from each of the observation wells throughout the test. Groundwater levels were also collected by means of dedicated automatic dataloggers from each of the six (6) observation wells, at a 10-minute frequency throughout the duration of the test.

The pumping phase of the CRT continued for 72 hours, and the pumping rate was monitored frequently with an in-line cumulative flow meter. The accuracy of this flow meter was confirmed by BGC field staff prior to the test, by means of a 500 L (132 usgal) reservoir. To help prevent direct artificial recharge to the aquifer during testing, the discharge water was piped roughly 30 m (100 feet) north toward the wetland. The risk of artificial recharge is considered to be low, due to the thick (7 m or 23 feet) silt-dominated till overburden, the 30.5 m (100 feet) of grouted and cased construction of TW17-01, and the confined nature of the fracture-flow aquifer itself (as evidenced by the artesian pressures observed).

Manual measurements were also recorded at TW17-01 and TW05-04 during the first 90 minutes of (post-pumping) recovery until the pumped well had returned to overflow conditions (equal to 89% recovery). The pump removal process began immediately after overflow conditions began. An automatic datalogger was installed in TW17-01 once the pump was removed, and the well seal was then replaced.

The results of the second pumping test are representative of the current hydraulic condition of TW17-01 and are therefore presented and discussed in the remainder of this report.

3.4. Groundwater Sampling

Through the course of this latest phase of the project, a total of eight groundwater samples were collected and submitted to the Research and Productivity Council (RPC) Analytical Services Laboratory in Fredericton, NB for chemical analysis. Three samples were taken during each of the 72-hour pumping tests completed on well TW17-01, at approximately 24 hours, 48 hours, and 72 hours, and at the end of each 6-hour pumping test completed on test wells TW05-02 and TW05-04. The groundwater samples were analyzed for general chemistry with dissolved trace metals (including mercury, fluoride, and sulfide), volatile organic compounds (VOCs), and microbiology (including total coliforms, total faecal coliforms, and E. coli).

Each of the groundwater samples were collected in sample containers provided by the analytical lab. The samples were kept in refrigerated storage until being submitted to RPC for analyses. RPC is accredited with the Standards Council of Canada (SCC), and the analytical results provided from the lab were compared against the most recent Guidelines for Canadian Drinking Water Quality (GCDWQ), as published by Health Canada (2017).

4.0 RESULTS

4.1. Step-Drawdown Tests

The results of the three step-drawdown tests completed on production-scale well TW17-01 are summarized in Table 4-1, Table 4-2, and Table 4-3, and graphically in Figure 4-1.

Table 4-1. TW17-01 Step-drawdown test #1 (September 18, 2017).

STEP	YIELD, Q		DRAWDOWN, s		TRANSMISSIVITY, T	INVERSE SPECIFIC CAPACITY, s/Q
	(m^3/d)	(usgpm)	(m)	(feet)	(m^2/d)	(m/m^3/d)
1	883	162	30.09	98.7	147	0.0341
2	1,177	216	53.57	175.8	121	0.0455
3	1,472	270	79.84	261.9	108	0.0543

Notes:

1. Aquifer Loss Coefficient, B = 4.26 x 10^{-3} days/m^2 (3.34 x 10^{-3} feet/usgpm).
2. Well Loss Coefficient, C = 3.43 x 10^{-5} day/m^5 (7.62 x 10^{-2} feet/usgpm^2).

Table 4-2. TW17-01 Step-drawdown test #2 (September 21, 2017).

STEP	YIELD, Q		DRAWDOWN, s		TRANSMISSIVITY, T	INVERSE SPECIFIC CAPACITY, s/Q
	(m^3/d)	(usgpm)	(m)	(feet)	(m^2/d)	(m/m^3/d)
1	785	144	13.77	45.2	230	0.0175
2	1,177	216	46.93	154.0	133	0.0399
3	1,472	270	75.46	247.6	112	0.0513
4	981	180	51.29	168.3	--	--

Notes:

1. Aquifer Loss Coefficient, B = -2.05 x 10^{-2} days/m^2 (-0.366 feet/usgpm).
2. Well Loss Coefficient, C = 4.95 x 10^{-5} day/m^5 (4.83 x 10^{-3} feet/usgpm^2).

Table 4-3. TW17-01 Step-drawdown test #3 (December 19, 2017).

STEP	YIELD, Q		DRAWDOWN, s		TRANSMISSIVITY, T	INVERSE SPECIFIC CAPACITY, s/Q
	(m^3/d)	(usgpm)	(m)	(feet)	(m^2/d)	(m/m^3/d)
1	883	162	5.81	19.1	443	0.0066
2	1,177	216	7.56	24.8	450	0.0064
3	1,472	270	11.75	38.5	389	0.0080
4	1,831	336	17.89	58.7	340	0.0098

Notes:

1. Aquifer Loss Coefficient, B = 2.88 x 10^{-3} days/m^2 (5.15 x 10^{-2} feet/usgpm).
2. Well Loss Coefficient, C = 3.59 x 10^{-6} day/m^5 (3.50 x 10^{-4} feet/usgpm^2).

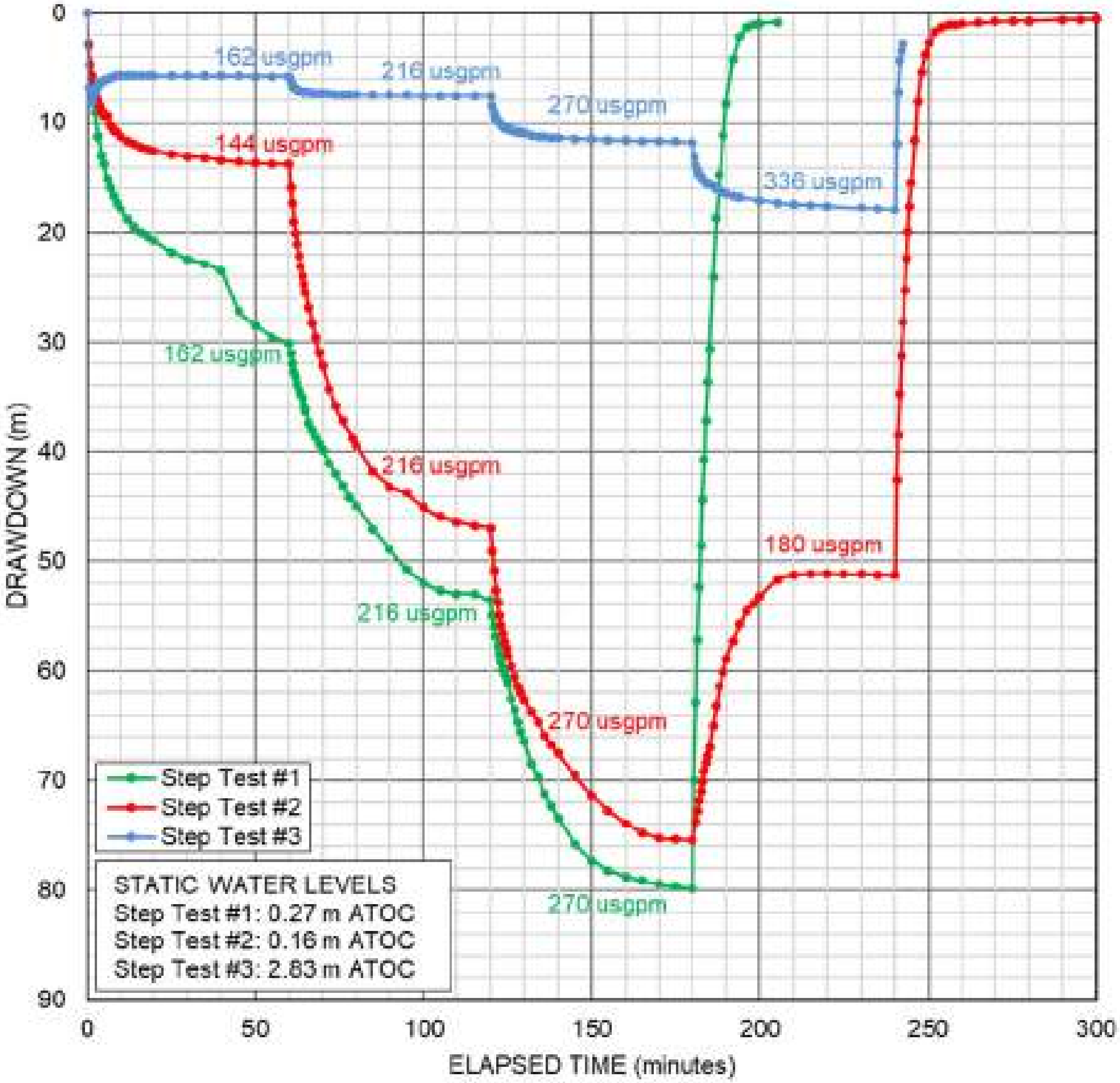


Figure 4-1. **TW17-01 step-drawdown tests – Drawdown vs. Time.**

The results of the step-drawdown tests completed on test wells TW05-02 (October 20, 2017), and TW05-04 (October 21, 2017) are summarized in Table 4-4 and Table 4-5, respectively, and graphically in Figure 4-2. A plot of inverse specific capacity (s/Q) versus well yield (Q), comparing results from the five-separate step-drawdown tests (i.e., step test #1, #2, and #3 completed in well TW17-01, and step-drawdown tests in TW05-02 and TW05-04), is shown in Figure 4-3.

Table 4-4. TW05-02 step-drawdown test (October 20, 2017).

STEP	YIELD, Q		DRAWDOWN, s		TRANSMISSIVITY, T	INVERSE SPECIFIC CAPACITY, s/Q
	(m^3/d)	(usgpm)	(m)	(feet)	(m^2/d)	(m/m^3/d)
1	1,177	216	4.63	15.17	626	0.0039
2	1,570	288	7.03	23.07	573	0.0045
3 (1-hr)	1,831	336	8.68	28.46	552	0.0047
3 (4-hr)	1,831	336	9.12	29.93	--	--

Notes:

1. Aquifer Loss Coefficient, B = 2.48 x 10^{-3} days/m^2 (4.43 x 10^{-2} feet/usgpm).
2. Well Loss Coefficient, C = 1.25 x 10^{-6} day/m^5 (1.22 x 10^{-4} feet/usgpm^2).

Table 4-5. TW05-04 step-drawdown test (October 21, 2017).

STEP	YIELD, Q		DRAWDOWN, s		TRANSMISSIVITY, T	INVERSE SPECIFIC CAPACITY, s/Q
	(m^3/d)	(usgpm)	(m)	(feet)	(m^2/d)	(m/m^3/d)
1	218	40	0.44	1.45	975	0.0020
2	382	70	0.95	3.10	853	0.0025
3 (1-hr)	545	100	1.51	4.94	793	0.0028
3 (4-hr)	545	100	1.67	5.48	--	--

Notes:

1. Aquifer Loss Coefficient, B = 1.57 x 10^{-3} days/m^2 (2.80 x 10^{-2} feet/usgpm).
2. Well Loss Coefficient, C = 2.24 x 10^{-6} day/m^5 (2.19 x 10^{-4} feet/usgpm^2).

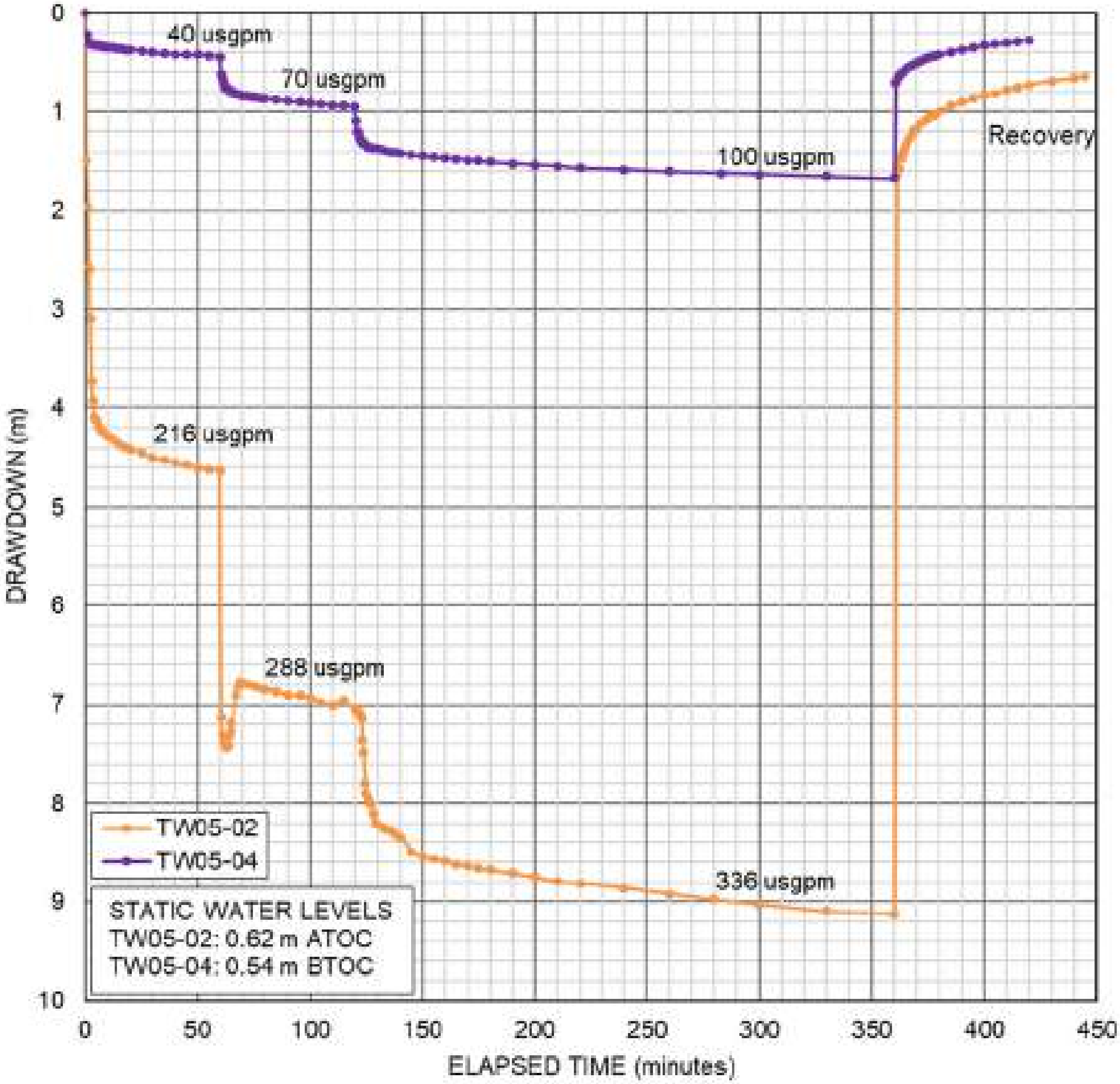
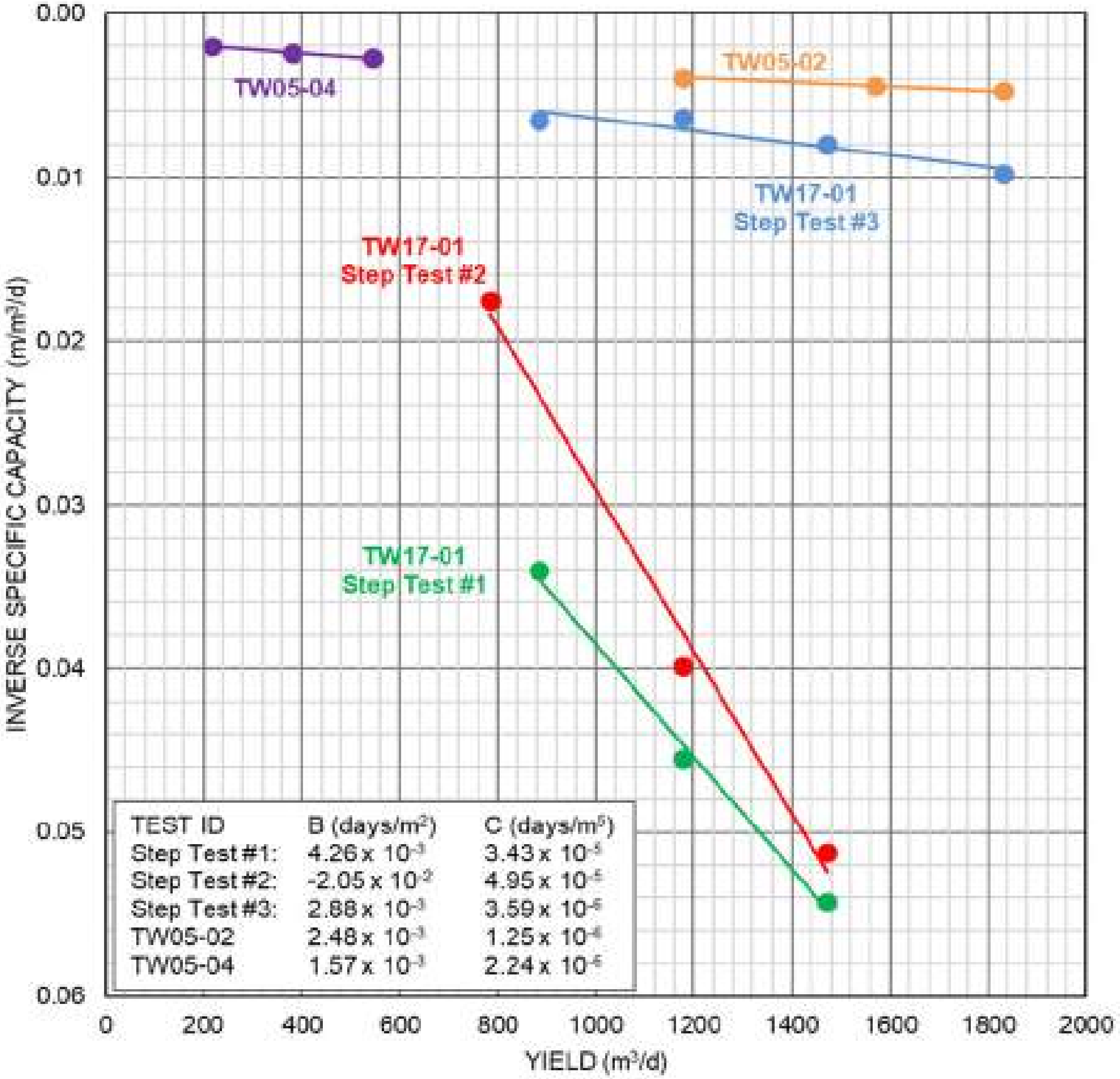


Figure 4-2. **TW05-02 and TW05-04 step-drawdown tests – Drawdown vs. Time.**



TEST ID	B (days/m²)	C (days/m⁵)
Step Test #1:	4.26×10^{-3}	3.43×10^{-5}
Step Test #2:	-2.05×10^{-2}	4.95×10^{-5}
Step Test #3:	2.88×10^{-3}	3.59×10^{-6}
TW05-02	2.48×10^{-3}	1.25×10^{-6}
TW05-04	1.57×10^{-3}	2.24×10^{-6}

Figure 4-3. **Inverse Specific Capacity vs. Yield for all step-drawdown tests.**

The resulting lines plotted for TW05-02 and TW05-04 in Figure 4-3 are considered to be more representative of the ‘true’ specific capacity for a well pumping from this aquifer. In completing the step tests at TW17-01, it becomes apparent that the initial two tests (step test #1 and step test #2) had produced much lower specific capacities, and thus much lower well efficiencies, than that produced in the dramatically improved step test #3. The TW17-01 step test #3 plot shows a significantly improved well performance, with similar Aquifer (B) and Well (C) Loss Coefficients to those previously measured at TW05-02 and TW05-04.

4.2. Constant-Rate Pumping Tests

Pumping test #1, at a constant discharge rate of 1,090 m^3/d (200 usgpm), resulted in relatively high drawdowns (approximately 55 m, or 180 feet after 72 hours), and a low calculated well efficiency of approximately 7%[3]. The results of pumping test #2 at a constant discharge rate of 1,635 m^3/d (300 usgpm) and a resulting drawdown of approximately 18 m are presented below and are representative of the latest hydraulic performance of TW17-01.

4.2.1. Drawdown

The measured drawdowns at the end of the CRT in each well within the monitoring network are shown in Table 4-6, including extrapolated drawdowns after 100 days and 10 years (assuming that no additional recharge or impermeable boundaries are encountered).

Table 4-6. TW17-01 constant-rate pumping test (January 2018) – Drawdown.

WELL ID	RADIUS FROM PUMPED WELL (m)	OBSERVED 72-HOUR DRAWDOWN (m)	EXTRAPOLATED 100-DAY DRAWDOWN (m)	EXTRAPOLATED 10-YEAR DRAWDOWN (m)
TW17-01	0.15[1]	18.025	22.2	26.0
TW05-04	3.0	4.523	6.8	9.0
TW05-03[2]	195	3.254	5.4	7.4
TW05-02	200	2.669	4.6	6.6
TW05-01	675	1.683	3.7	5.7
Sunrise-OW[2,3]	489	0.103	0.2	0.3
112 Kingston[2,3]	879	--[4]	--[4]	--[4]

Notes:

1. The distance of TW17-01 is taken as the well radius.
2. Well does not intersect large, artesian, water bearing fractures.
3. Used to monitor hydraulic response in the nearby residential area.
4. The observed hydraulic response from the constant-rate pumping test was negligible compared to daily use of this well.

Elevation data for each of the wells are plotted on Figure 4-4 from January 1 to 16, 2018, covering a period of background water levels from TW05-01, the pumping test, and recovery. Figure 4-4 also includes the North Branch Oromocto River water level over the same period (WSC 2018). Figure 4-5 and Figure 4-6 show drawdown vs. linear time and vs. logarithmic time, respectively. Figure 4-6 also includes extrapolated drawdown after 100 days and 10 years of continuous pumping.

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[3] Expected drawdown of approximately 4 m (13 feet) divided by the observed drawdown of 55 m (180 feet).

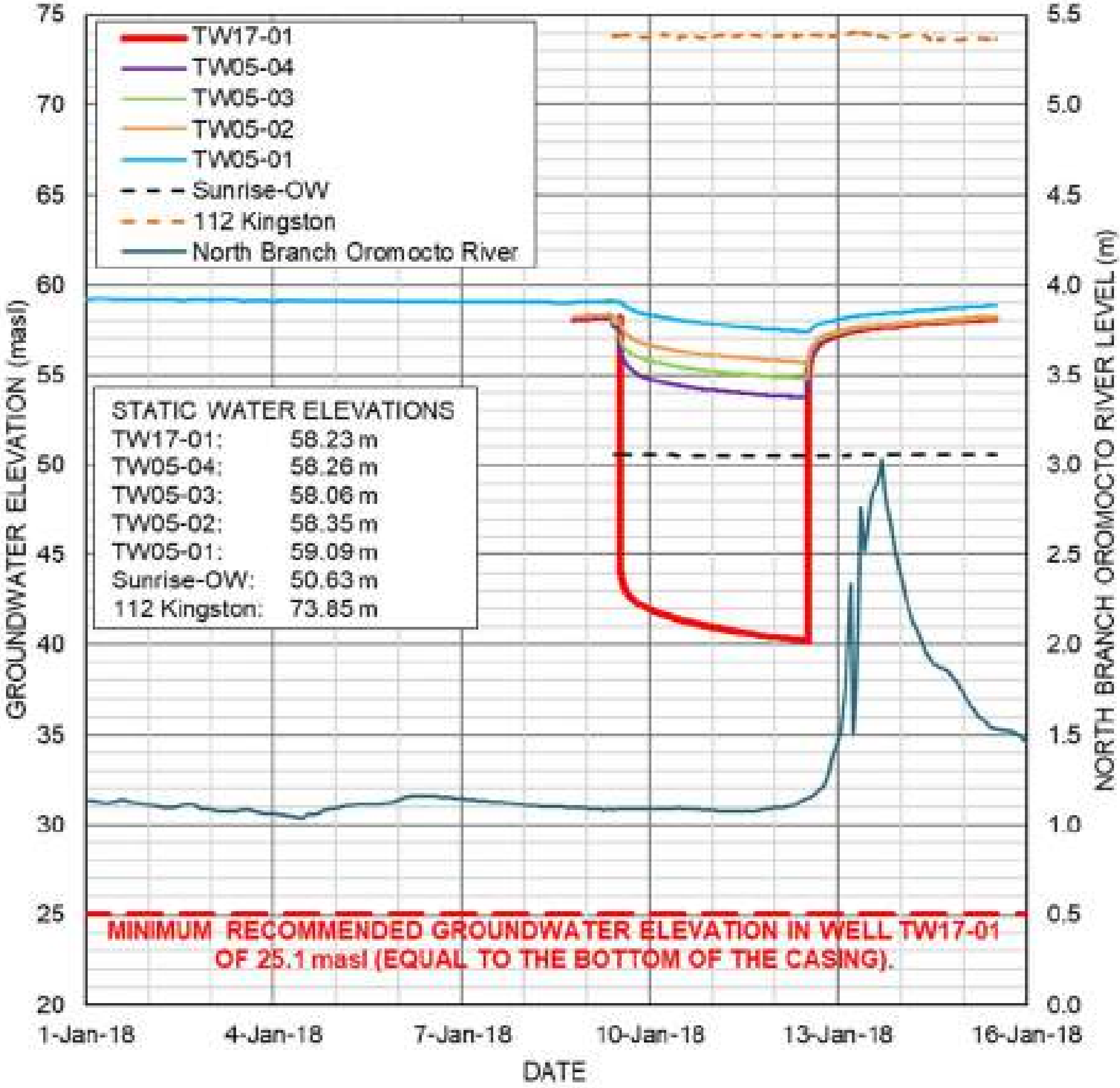

Figure 4-4. **TW17-01 constant-rate pumping test – Elevation vs. Time.**

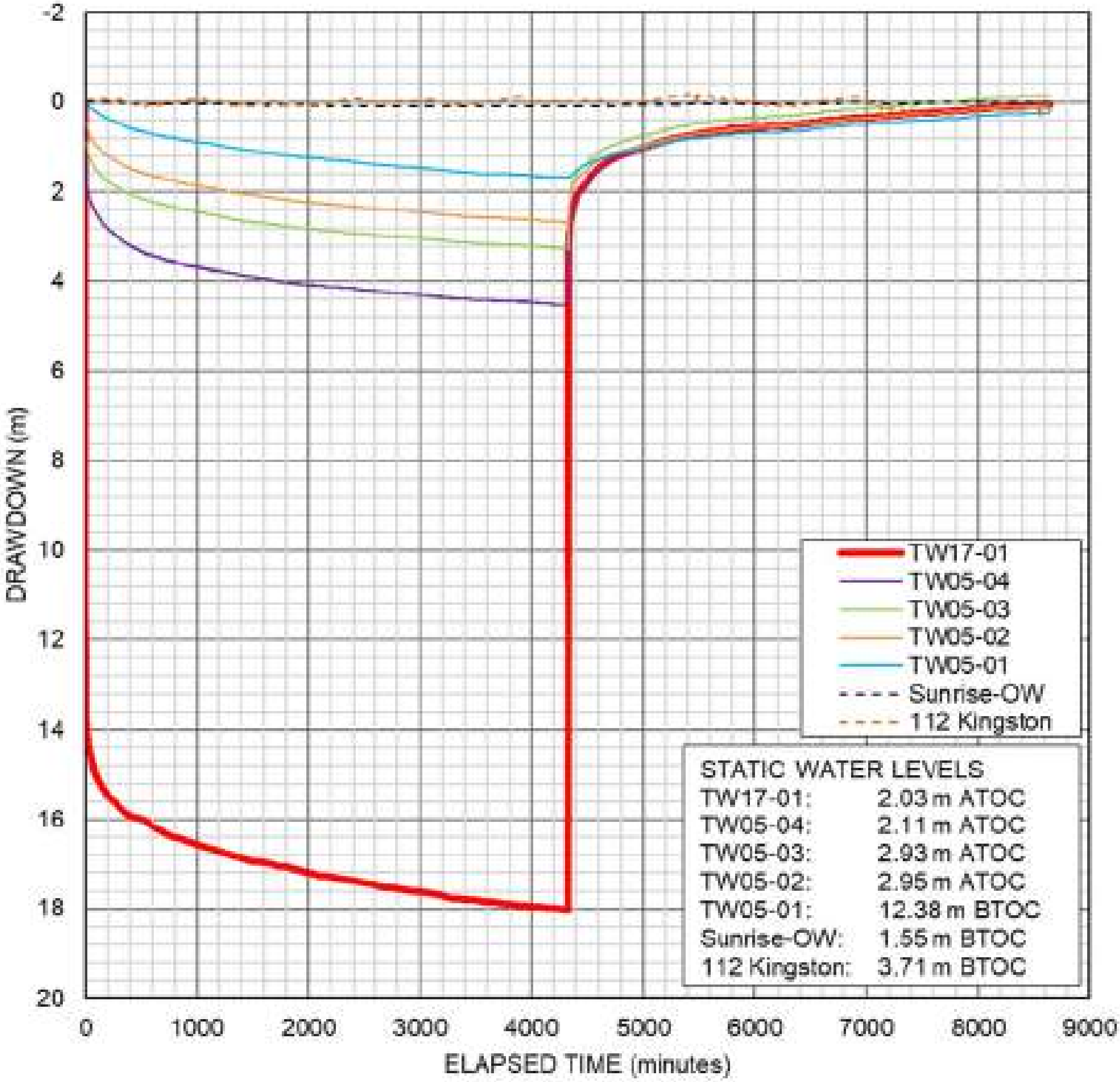

Figure 4-5. TW17-01 constant-rate pumping test – Drawdown vs. Linear Time.

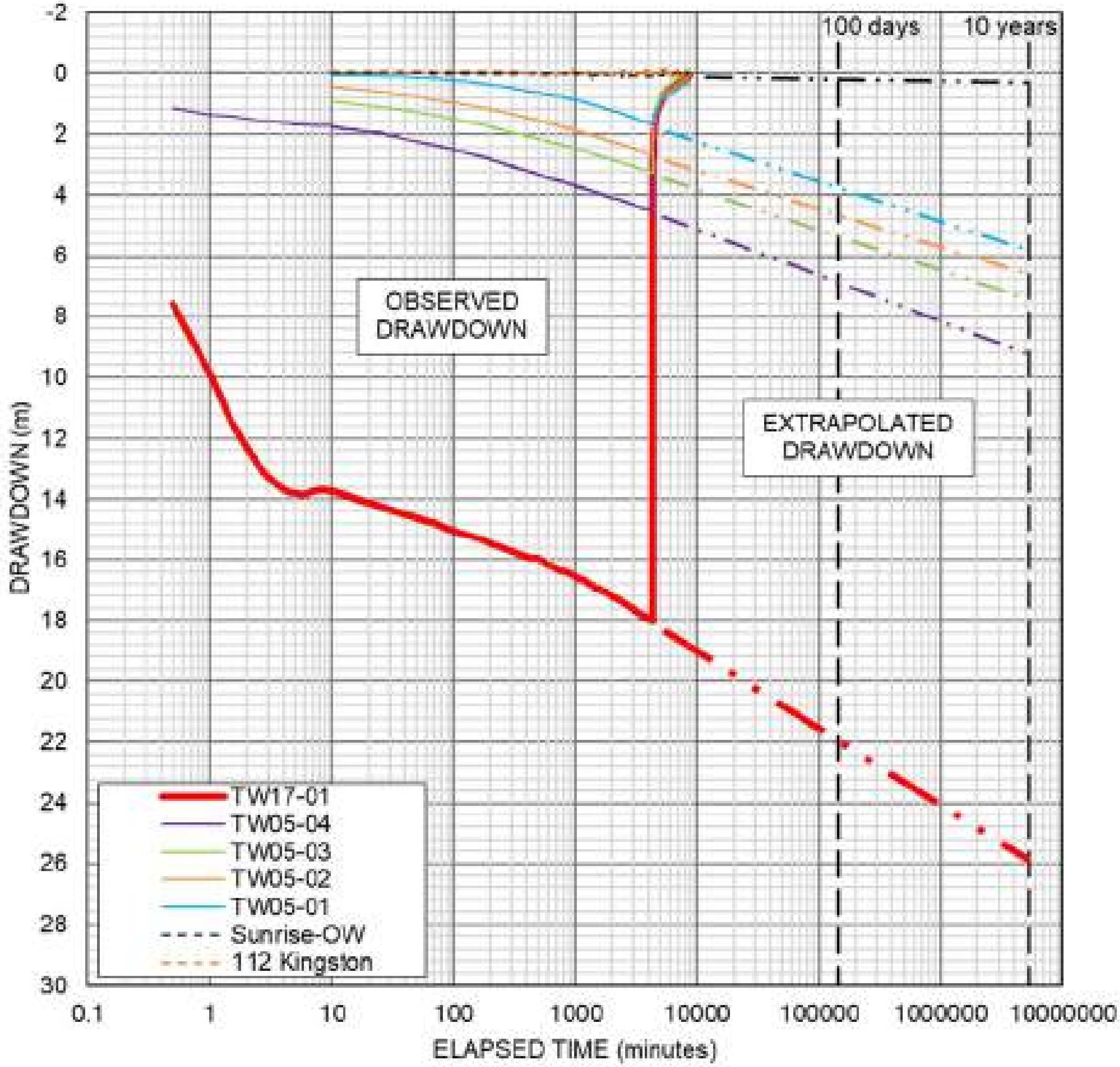

Figure 4-6. **TW17-01 constant-rate pumping test – Drawdown vs. Log Time.**

After 72 hours (4,320 minutes) of continuous pumping at 1,635 m^3/d (300 usgpm), the drawdown in the pumped well (TW17-01) was 18.025 m (59.14 feet), with an associated specific capacity of 91 m^3/d/m. From the slope of the drawdown versus log-time plot (Figure 4-6), it appears that an impermeable boundary was encountered within the first day of pumping (at approximately 500 minutes). These data also suggest an aquifer transmissivity (T) of approximately 230 m^2/d (19,000 usgpd/ft) and a storativity (S) of 6 x 10^{-4}, applying the analytical methods of Cooper-Jacob (1946) and Theis (1935), the latter indicating a response similar to that of a confined aquifer, supported by the presence of artesian pressure and overflow conditions.

The drawdown in the TW05-series of observation wells after 72 hours was 4.523 m in TW05-04, 3.254 m in TW05-03, 2.669 m in TW05-02, and 1.683 m in TW05-01 (refer to Table 4-6). These data are plotted versus their respective distances from the pumped well in the distance-drawdown plot as presented in Figure 4-7, from which an aquifer transmissivity of 300 m^2/d (24,000 usgpd/ft), and a well efficiency of approximately 50% for TW17-01, are inferred[4].

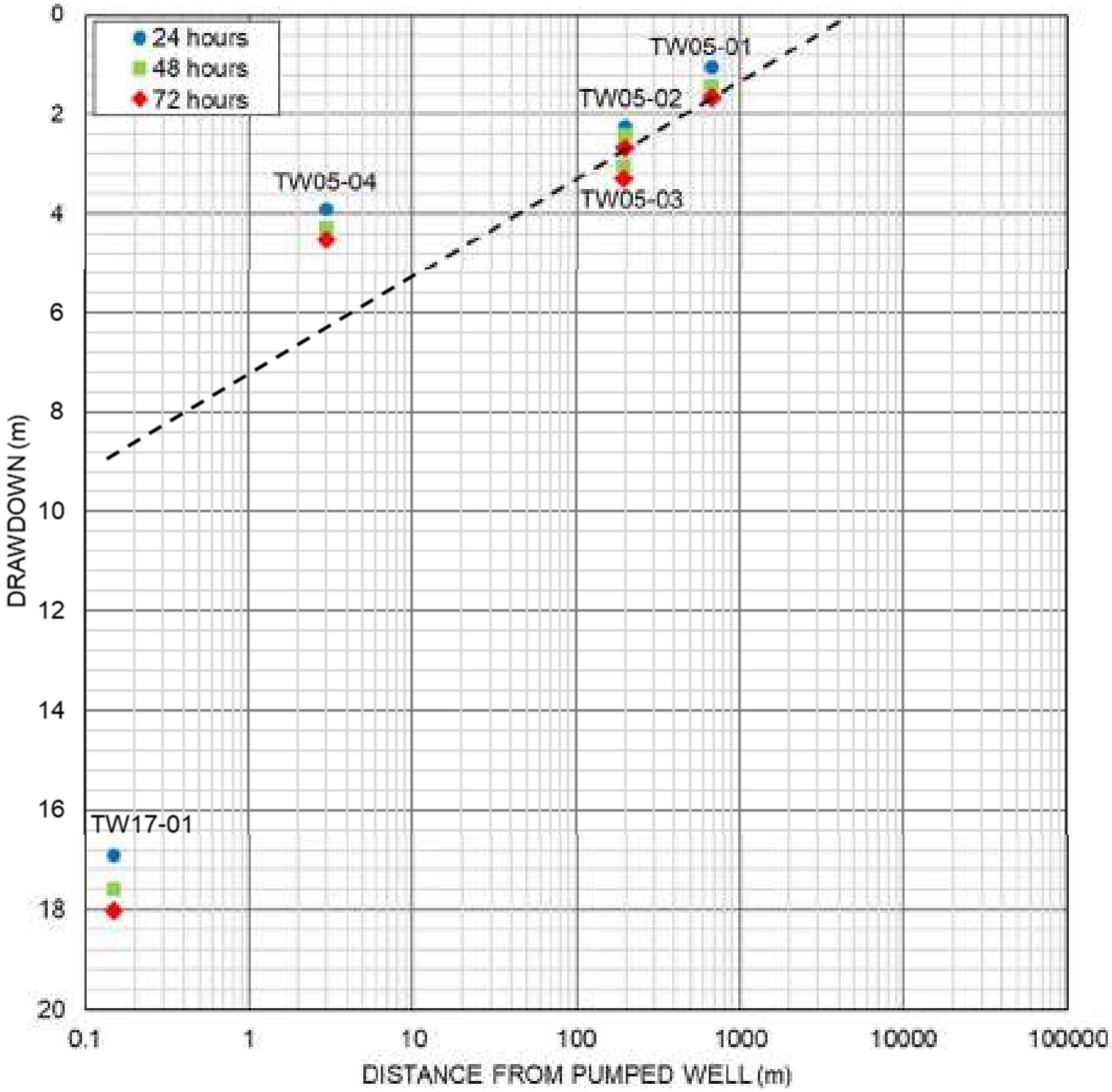

Figure 4-7. TW17-01 constant-rate pumping test – Distance-Drawdown.

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[4] Actual drawdown of 18 m (59 feet) compared to expected drawdown of 9 m (29.5 feet).

The Sunrise-OW well is located 489 m from the pumped well, in the southeastern end of the Sunrise Estates subdivision, and showed 0.103 m of drawdown after 72 hours of continuous pumping from TW17-01. The 112 Kingston well is located 879 m from the pumped well, near the middle of the Sunrise Estates subdivision, and showed a very minor response to the constant-rate pumping test. Well 112 Kingston varied by up to 0.20 m per day due to its use as a residential supply well, thus the hydraulic response to the constant-rate pumping test was not observed to be significant in comparison. Both of these wells are shallower than any of the other test wells on the Property and appear to be poorly connected to the pumped well, as they experienced significantly less drawdown than was expected. It is also possible that the 30.5 m (100 ft) of protective steel casing installed at TW17-01, and/or anisotropy in the aquifer itself, may have resulted in less hydraulic connection to these wells, and the less-than-anticipated drawdowns in Sunrise Estates.

4.2.2. Recovery

Recovery began at 12:30 pm on January 12, 2018, 72 hours after pumping began. A 35 cm gradual decline in the groundwater level in this aquifer was observed for an 18-day period leading up to the pumping test, as monitored via the dedicated pressure transducer at TW05-01 (Figure 4-4). A similar declining water level trend was generally noticed in the North Branch Oromocto River (also Figure 4-4). However, there was also approximately 60 mm of precipitation from January 12 to 13, and warm temperatures that caused the bulk of the snow cover to melt. Using an average time lag response of 5 days in this aquifer for the peak groundwater elevation to occur following a precipitation event, the full effects of the precipitation and snow melt event were likely not felt within 72 hours of the end of pumping. Therefore, the static groundwater levels prior to pumping began were used for recovery calculations.

Refer to Table 4-7 and Figure 4-8 for a summary of the recovery results. Note that the x-axis of Figure 4-8 is normalized to time since pumping started (t) over time since pumping ended (t'), resulting in time increasing to the left of the plot.

Table 4-7. TW17-01 constant-rate pumping test (January 2018) – Recovery.

WELL ID	RESIDUAL DRAWDOWN AFTER 72 HOURS (m)	PERCENT RECOVERED AFTER 72 HOURS (%)	TIME TO REACH 100% RECOVERY TO PRE-PUMPING WATER LEVEL (hours)
TW17-01	0.056	99.7	83.5
TW05-04	0.051	98.9	81.8
TW05-03	-0.151	104.6	57.8
TW05-02	0.071	97.3	83.7
TW05-01	0.228	86.3	99.8
Sunrise-OW	0.018	81.4	101
112 Kingston[1]	--	--	--

Note: 1. The recovery results are not shown, as they are not representative of the response to the constant-rate pumping test.

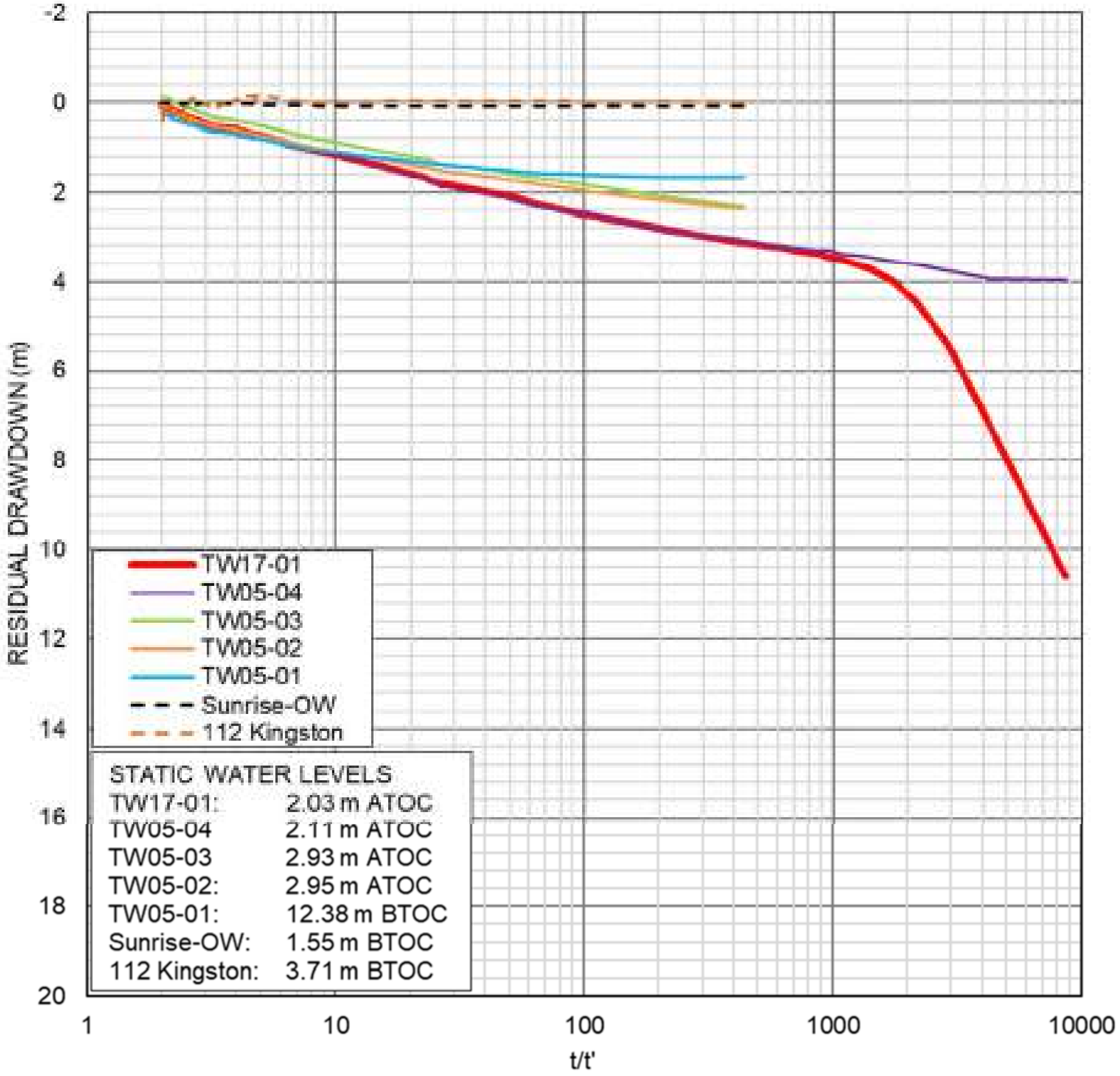

Figure 4-8. TW17-01 constant-rate pumping test – Recovery.

It appears that, based solely on the pre-pumping water levels, 100% recovery was not achieved in most wells within 72 hours from the end of pumping. As shown in Table 4-7, the time to 100% recovery ranged from 58 to 101 hours after pumping ceased (2.4 to 4.2 days).[5]

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[5] If the observed decline in the pre-pumping static water level in TW05-01 were applied to each well at the end of the pumping period, 100% recovery occurred at each monitoring well between 2 and 3 days into the recovery period.

4.2.3. Potential Impacts

The development of a new wellfield in the Village could result in interference drawdown in nearby residential wells (particularly the Sunrise Estates subdivision). Although the results from observation wells Sunrise-OW and 112 Kingston suggest that there is likely little connectivity between these wells and test wells on the Property at the rates tested, any marginal wells that are hydraulically connected to this aquifer could potentially be adversely affected, and mitigation (e.g., well deepening, well replacement, or connection to a municipal supply) may be required. Water quality in these nearby domestic wells may also be altered, but not necessarily degraded, by the operation of new higher capacity production wells on the Property. Baseline and longer-term monitoring of water levels and water quality at selected domestic wells should be undertaken by the Village to address this possibility. Streamflow in nearby water courses could also be affected, through a reduction in the component of baseflow (i.e., the amount of groundwater seepage being received by streams).

For this area to be considered a viable wellfield warranting the construction of piping to the community system, a second production well should be constructed in this aquifer, to provide redundancy. This second production well could be constructed at the previously tested TW05-02 location (BGC 2017), by modifying TW05-02 to include 30.5 m (100 feet) of protective steel casing with drive-shoe seated into the bedrock. This work will be difficult under significant artesian pressures (upwards of 3 m ATOC) and should, therefore, be planned during seasonally low groundwater conditions (e.g., July or August). Pumping from TW17-01 (or TW05-03) to waste may also be considered throughout a portion of the recommended well construction process, to allow further lowering of the prevailing artesian pressures, if needed.

It had been previously discussed in BGC (2017) that limiting the pumping rate from a new well at this location to 1,360 m^3/d (250 usgpm) would minimize impacts to the closest domestic water wells. Well interference at TW05-02 (potentially the second production well in a wellfield at this location) was approximately 3 m (10 feet) during the pumping test at TW17-01 and is expected to be 6.6 m (21.7 feet) after 10 years of continuous pumping (refer to Table 4-6). If both production wells are to be operated simultaneously, well interference and long-term aquifer yield would need to be evaluated and considered in the operational plans. Table 4-8 shows the estimated 10-year drawdowns caused from pumping each TW17-01 and TW05-02 at 1,360 m^3/d (250 usgpm) independently, and together for a total withdrawal of 2,720 m^3/d (500 usgpm). However, these cumulative yields and drawdowns have not yet been proven, and the long-term capacity of the aquifer to support these long-term withdrawals has not been evaluated. Further assessment, by means of additional testing and 3D numerical modelling, would likely be required to confirm this.

Table 4-8. Estimated interference drawdown of wells TW17-01 and TW05-02.

WELL ID	10-YEAR DRAWDOWN INDUCED FROM PUMPING TW17-01 (1,360 m^3/d [250 usgpm]) (m)	10-YEAR DRAWDOWN INDUCED FROM PUMPING TW05-02 (1,360 m^3/d [250 usgpm]) (m)	10-YEAR DRAWDOWN INDUCED BY SIMULTANEOUS PUMPING OF TW17-01 AND TW05-02 (m)
TW17-01	24.0	4.8	28.8
TW05-04	7.5	4.8	12.3
TW05-03	6.2	7.4	13.6
TW05-02	5.5	13.7	19.2
TW05-01	4.8	4.2	9.0
Sunrise-OW	0.2	0.2	0.4
Nearest potentially connected domestic wells (500 m)	5.0	4.2	9.2

Development of a new municipal wellfield will trigger the regulatory requirement for protection measures, which would be implemented within designated wellfield protection zones, as per New Brunswick's Wellfield Protected Area Designation Order (WfPADO), as released by NBDELG (2000). This is a proactive regulatory approach to protecting and maintaining both the water quality and quantity of municipal groundwater supplies and may impact current and future land use activity (e.g., gas stations, storage facilities, and farms), and can also impose restrictions on the storage and use of certain chemicals (e.g., petroleum, pesticides, and fertilizers) within the wellfield. We understand the Village's other existing municipal groundwater supply is already designated with the Province and is being managed in accordance with the WfPADO regulatory protocol.

4.2.4. Long-Term Safe Yield

Production-scale well TW17-01 is inferred to have a maximum available drawdown of 33 m (108 feet), which coincides with the bottom of the installed protective steel casing. The bottom of the casing is judged to be the minimum allowable pumping level, to help prevent the dewatering of fractures, and reduce the risk of over pumping. As groundwater levels in this aquifer have historically varied by up to 10 m, the total available drawdown could vary from approximately 27 to 37 m (89 to 121 feet), but the pumping level is recommended to remain within the casing at all times, above approximately 30.5 m (100 feet) bgs, as currently constructed, or at an elevation greater than 25.1 m (82.3 feet) asl.

To estimate the long-term safe yield of TW17-01, the pumping test data were extrapolated to estimate the drawdown that would occur after 100 days and 10 years of continuous pumping, as shown in Table 4-6 and Figure 4-6. If no recharge or impermeable boundaries are encountered with sustained pumping, the predicted (extrapolated) drawdown after 100 days and 10 years would be approximately 22.2 m (72.8 feet) and 26.0 m (85.3 feet), respectively.

The safe yield for TW17-01 was determined using the following limitations and assumptions:

- The trajectory of the drawdown curve remains constant with sustained pumping, to an approximate drawdown of 26 m after 10 years.
- The pumping level remains within the casing at all times, and above approximately 30.5 m (100 feet) bgs, or at an elevation greater than 25.1 m asl.
- The minimum available drawdown in the well, between the static water level and bottom of casing, is at least 27 m.
- The drawdown interference when pumping from other production wells around TW17-01, including that of the nearby domestic wells, is considered.
- An engineering factor of safety (of 1.25) is added to be conservative.

Based on the factors listed above, the preliminary long-term safe yield of TW17-01 is estimated to be 1,360 m^3/d (250 usgpm), with an interpolated as-built specific capacity of 130 m^3/d/m. This withdrawal rate is estimated to use between 13% and 38% of the assumed available groundwater recharge in the aquifer and is based on an assumed contributing drainage area of 12 km^2 for the Property, and annual aquifer recharge between 330 mm and 110 mm, respectively.

Table 4-9 summarizes the estimated usage of the annual aquifer recharge, for the operation of up to two production wells (TW17-01 and TW05-02), and up to 400 domestic wells within the assumed contributing drainage area (derived from Figure 2-2). If two production wells within this aquifer are operated simultaneously, the total groundwater availability will need to be considered further, by means of additional hydraulic testing and 3D numerical modelling.

Table 4-9. Estimated usage of annual aquifer recharge for the subject Property.

SOURCE OF WATER USAGE	ANNUAL AQUIFER RECHARGE[1] USAGE (%)		
	ASSUMING 110 mm/year AQUIFER RECHARGE	ASSUMING 220 mm/year AQUIFER RECHARGE	ASSUMING 330 mm/year AQUIFER RECHARGE
TW17-01[2]	38	19	13
TW05-02[2]	38	19	13
Domestic Wells[3]	11	6	4
Total (1 production well pumping at a time)	49	25	17
Total (2 production wells pumping simultaneously)	87	44	30

Notes:

1. Assumed as ranging between 10% and 30% of the average annual precipitation (1100 mm/year), over an estimated 12 km^2 potential contributing drainage area.
2. Water usage based on a well yield of 1,360 m^3/d (250 usgpm).
3. Water usage based on approximately 400 domestic wells each using 1 m^3/d (DeOreo et, al. 2016).

The percentages shown in Table 4-9 are estimates only and may change depending on the actual extraction from domestic wells, and the exact extents of the fractured bedrock aquifer. Also note that less recharge will likely be available during prolonged dry periods, which could cause increased drawdowns, and a higher risk of over pumping during those periods. However, it appears that on average, there is sufficient aquifer recharge to sustain the recommended use of TW17-01. This recommended withdrawal rate could be subject to change based on findings and confirmatory monitoring results from the subsequent longer-term operation of this well, and the broader wellfield.

4.3. Groundwater Quality

The sampled groundwater does not appear to have a dominant water type (refer to the Piper plot in Figure 4-9), ranging from "calcium-bicarbonate-type" to "sodium-chloride-type" to a mixture of both these types, as there are relatively equal percentages of sodium and calcium cations, and chloride and bicarbonate anions. The water chemistry changed slightly between pumping test #1 and pumping test #2, perhaps attributed to the additional development which removed material from the water bearing fractures. The prolonged, drier (drought-like) site conditions experienced in the area during initial testing may have also contributed to the slightly different chemistries.

In general, the water chemistry of each of the samples appears to be similar, except for the presence of elevated levels of sulfide in TW17-01. The presence of sulfide could be due to the intersection of lignite (coal) seams and pyrite at depth in the well, during the drilling process.

Analytical results were compared against the most recent GCDWQ (Health Canada 2017). Manganese concentrations averaged approximately three times the guideline, trending upward with increased time and pumping. Sulfide concentrations averaged approximately twice the guideline, trending slightly downward with increased time and pumping. Turbidity, total coliforms, total faecal coliforms, and E. coli were initially above the guideline but fell below with further development and pumping.

None of the 37 separate VOCs in the analysis suite were detected in the eight samples collected. Table 4-10 shows a summary of the exceedances observed in groundwater samples collected from well TW17-01. Refer also to Appendix C for complete tables of groundwater quality results: Table C-1 (general chemistry), Table C-2 (dissolved metals) and Table C-3 (microbiology and VOCs). Exceedances of the GCDWQ are flagged in the tables. Appendix D contains the signed laboratory certificates from the RPC analytical laboratory.

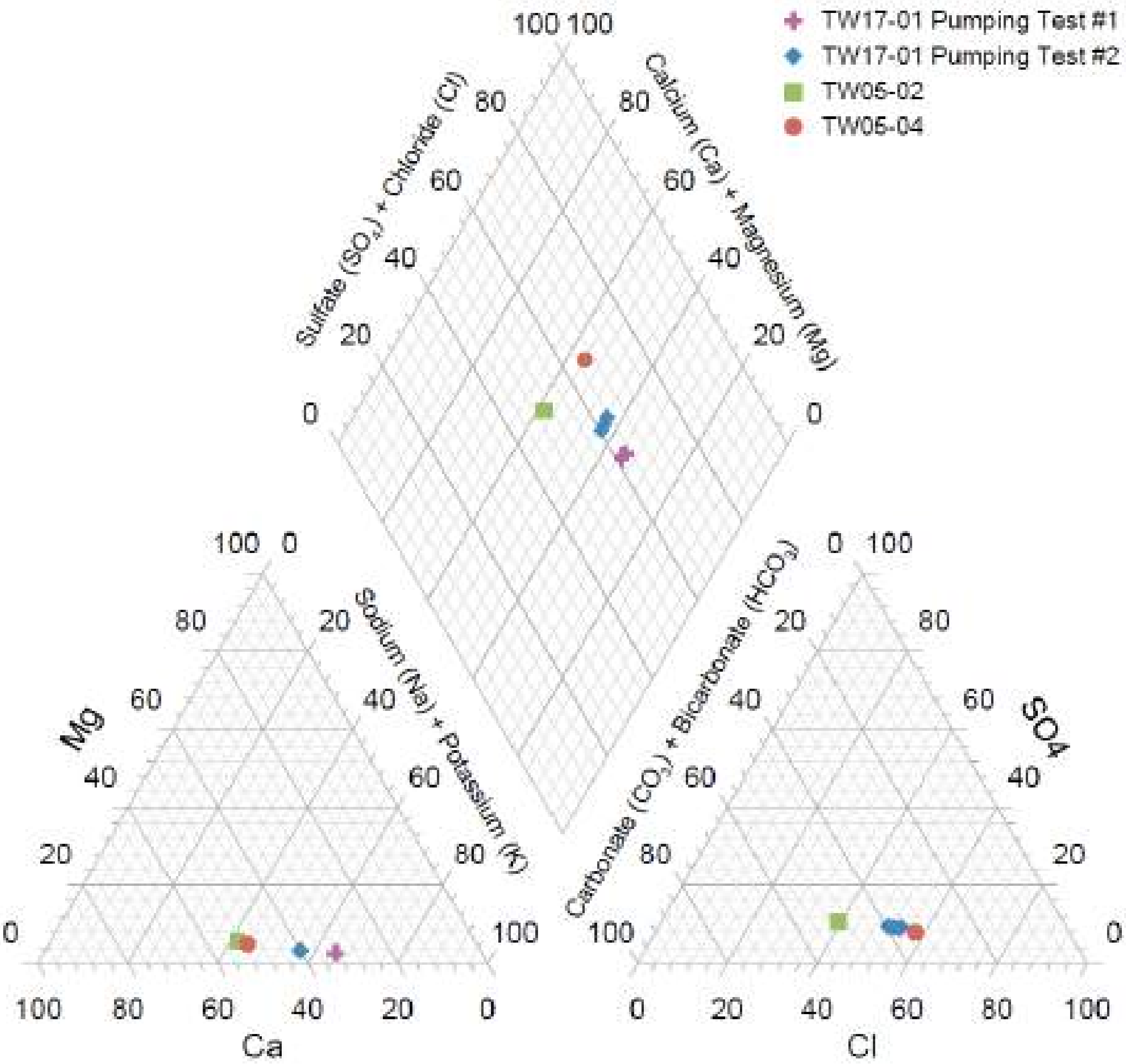

Figure 4-9. Piper plot of major ions of the groundwater samples.

Table 4-10. GCDWQ exceedances in TW17-01.

Parameter (units)	GCDWQ		TW17-01					
	MAC	AO	26/9/17	27/9/17	28/9/17	10/1/18	11/1/18	12/1/18
Dissolved Manganese (mg/L)	-	0.05	0.132	0.134	0.138	0.171	0.168	0.168
Dissolved Sulfide (mg/L)	-	0.05	0.07	0.11	0.10	0.08	0.08	0.07
Turbidity (NTU)	0.1	-	0.2	0.1	0.1	0.2	-	-
Total Coliforms (MPN/100mL)	0	-	6	11	-	-	-	-
E. coli (MPN/100mL)	0	-	1	-	-	-	-	-
Faecal Coliforms (MPN/100mL)	0	-	1	-	-	-	-	-

Notes:

1. GCDWQ = Guidelines for Canadian Drinking Water Quality.
2. MAC = Maximum Acceptable Concentration.
3. AO = Aesthetic Objective.

Since manganese and sulfide are aesthetic objectives (AO), these guidelines are established for parameters that may impair the taste, smell, or colour of water, or that may interfere with the supply of good quality water. Such AO exceedances are, therefore, not indicative of causing adverse health effects (Health Canada 2017). Turbidity and coliform exceedances are more likely to occur in the early stages of pumping, but typically fall and remain below their respective guidelines as pumping continues, as was the case at TW17-01. However, based on the preliminary chemistry collected from the well and aquifer thus far, manganese and sulfide will require treatment if TW17-01 is to be used as a potable supply. Future confirmatory monitoring of the well and aquifer chemistry during longer-term operation will determine if the implementation of additional treatment measures become warranted.

5.0 DISCUSSION

The constant-rate pumping test completed at TW17-01 in January 2018, followed a lengthy sequence of well development and other hydraulic testing carried out to assess and improve the hydraulic efficiency of the well, given the initially poor well efficiency that was observed when compared to that from previous work in the aquifer. In the end, the hydraulic efficiency of TW17-01 is broadly in line with what was originally expected for a high-capacity production well in this fracture-dominated bedrock setting. Large seasonal changes in groundwater levels (upwards of 3 m) and associated aquifer pressures do not appear to cause a significant change in the aquifer's overall hydraulic response to pumping or the calculated aquifer properties at the test wells (including specific capacity of the wells).

An impermeable boundary was likely encountered during the pumping test, as indicated by the inflection in the drawdown versus logarithmic time plot (Figure 4-6). A 35 cm decline in groundwater levels in the weeks prior to the pumping test suggests that each of the test wells within the monitoring network had recovered completely within 72-hours of the end of pumping. The seasonal variability in groundwater levels (Figure 2-4) also appeared to have a rather large impact on how the wells in the monitoring network recovered after pumping[6]. On average, it is considered that there is sufficient recharge in the aquifer to supply the recommended withdrawals on a sustainable basis.

The available drawdown was judged to be approximately 33 m (108 feet) at the time of testing but will change seasonally with the variable static groundwater levels. Rather than basing the operating water level on drawdown, which fluctuates with the seasonally varying static water level, the pumping level in the well should be maintained above an elevation of 25.1 m (82.3 feet) asl at all times, which is the approximate elevation of the bottom of the casing, as currently constructed (refer to Figure 4-4).

Based on a number of limitations and assumptions listed above, the preliminary long-term safe yield of TW17-01 is estimated to be 1,360 m^3/d (250 usgpm). This withdrawal is equal to approximately 13% to 38% of the assumed available groundwater recharge in the aquifer (derived from Figure 2-2). This recommended rate could be subject to change based on findings and confirmatory monitoring results from the subsequent operation of this well, and the broader wellfield (once one or more wells are added).

The yield of production-scale well TW17-01 is relatively high for a bedrock well developed in the Carboniferous bedrock of the New Maryland area, and appears sufficient to meet the Village's current demand. An additional production-scale well could be developed on the Property at the TW05-02 location, and in combination with TW17-01, would give the Village an additional wellfield (referred to as the Arsam Wellfield) from which to derive a water supply. The second production

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[6] Longer recovery time with possible signs of over pumping during the low (drought-like) water levels, and shorter recovery times with occasionally greater than 100% recovery during higher water levels, in relatively wetter site conditions.

well could be constructed at the test well TW05-02 location, by modifying TW05-02 to include 30.5 m (100 feet) of protective steel casing with drive-shoe seated into the bedrock.

Three challenges have been identified in developing a viable wellfield at this location:

- Water quality that exceeds the Health Canada GCDWQ with respect to the aesthetic objectives for manganese and sulfide, which will require treatment.
- Artesian pressures and overflow conditions, which bring the risk of causing leakage of water around the well casing and complicates the surface plumbing arrangements.
- Interference with nearby domestic wells, which will require long-term monitoring and may involve mitigation (e.g., well deepening, well replacement, or connection to a municipal supply).

6.0 CONCLUSIONS

1. The sandstone-conglomerate aquifer on the Property has a transmissivity of approximately 230 m^2/d (19,000 usgpd/ft) and a storativity of approximately 6 x 10^{-4} (dimensionless), indicating confined aquifer conditions. Production-scale well TW17-01 has an Aquifer Loss Coefficient, B, of 2.9 x 10^{-3} days/m^2 (5.2 x 10^{-2} feet/usgpm) and a Well Loss Coefficient, C, of 3.6 x 10^{-6} day/m^5 (3.5 x 10^{-4} feet/usgpm^2), with an interpolated as-built specific capacity of 130 m^3/d/m, at a discharge rate of 1,360 m^3/d (250 usgpm).
2. The sustainable yield of production-scale well TW17-01, as presently constructed, is estimated to be 1,360 m^3/d (250 usgpm), based on highly variable seasonal groundwater levels, a minimum pumping water level elevation of 25.1 m (82.3 feet) asl to prevent dewatering fractures, well interference with TW05-02 (potentially the second production well in a wellfield at this location) of approximately 6 m, and potential interference drawdown induced in nearby domestic wells. This recommended withdrawal rate is estimated to represent between 13% and 38% of the assumed available groundwater recharge in the aquifer, based on an assumed contributing drainage area of 12 km^2, and annual precipitation of 1,100 mm.
3. Groundwater quality in TW17-01 meets the Health Canada Guidelines for Canadian Drinking Water Quality except for manganese and sulfide, which were roughly two to three times over the guideline. Though these are aesthetic objectives, treatment will likely be required if this well is to be used as a municipal supply.
4. Groundwater levels in this aquifer have historically varied by up to 10 m in a given year and appear susceptible to the effects of precipitation and snow-melt, with a calculated time lag response of 5 days. During relatively wet periods associated with higher amounts of aquifer recharge, there will be more available drawdown and greater than 100% percent recovery, and during relatively drier periods, with lower amounts of recharge, there will be less available drawdown, during which times the water levels will require close monitoring to prevent over pumping. On average, it is considered that there is sufficient recharge to the aquifer to supply the recommended withdrawals on a sustainable basis. This recommended rate could be subject to change based on findings and confirmatory monitoring results from the subsequent longer-term operation of this well, and the broader wellfield.
5. Pumping from well TW17-01 or from another production-scale well nearby will cause interference drawdowns in nearby domestic wells. At the recommended pumping rate of 1,360 m^3/d (250 usgpm), the predicted long-term interference drawdown at the closest domestic wells is estimated to be 0.3 m, based on observation of wells in the Sunrise Estates subdivision, or up to 5 m for wells that are better connected to the primary water bearing fractures (or closer to TW17-01). This interference may have no adverse effect on domestic wells that have relatively high yields, but marginal domestic wells could be impacted, and require mitigation (e.g., well deepening, well replacement, or connection to a municipal supply).

6. Water quality in nearby domestic wells could be altered, but not necessarily degraded, by the operation of new higher-capacity production wells on the Property as the Arsam Wellfield is developed. Baseline and longer-term monitoring of water levels and water quality at selected domestic wells would help to address this possibility.

7.0 RECOMMENDATIONS

1. Connect production well TW17-01 to the Village of New Maryland's municipal water supply, as the primary potable supply well in the new Arsam Wellfield on the subject Property (PID 75062174 owned by Khaled Moomena).
2. Install nested monitoring wells along the municipal services easement south of the Sunrise Estates subdivision to act as sentinel monitoring points between the production wells and neighbouring domestic well users.
3. Monitor drawdown and water quality in the new monitoring wells and in several nearby domestic wells during operation of well TW17-01 to determine the long-term effects of well interference, and any potential changes in water quality.
4. Modify test well TW05-02 to also include 30.5 m (100 feet) of protective steel casing with drive-shoe seated into the bedrock, complete a 72-hour pumping test on the modified well, and submit a Hydrogeological Assessment such that it can then serve as a second production well in the Arsam Wellfield.
5. Complete the construction and follow-up testing of the second production well (TW05-02) during a period of relatively low groundwater elevations (e.g., July or August).
6. Initiate a Wellfield Protection Study for the Arsam Wellfield once the recommended work above is completed.

8.0 CLOSURE

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

BGC ENGINEERING INC.
per:

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REFERENCES

Allard, S., and Gilmore, W.F. 2016. Surficial geology of the Fredericton area (NTS 21 G/15), New Brunswick. New Brunswick Department of Energy and Mines, Plate 2016-1.

BGC Engineering Inc. 2017. Groundwater Supply – Drilling and Test Pumping of Well TW-02, New Maryland. Report prepared for Opus International Consultants (Canada) Limited and submitted on March 24, 2017.

BGC Engineering Inc. 2016. Proposal for Groundwater Supply Exploration and Development – Village of New Maryland, NB. Prepared for Opus International Consultants (Canada) Limited and submitted on December 1, 2016.

Cooper, H.H., and Jacob, C.E. 1946. A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans., 27: 526-534.

DeOreo, W.B., Mayer P., Dziegielewski, B., and Kiefer, J. 2016. Residential End Uses of Water, Version2: Executive Report. Water Research Foundation.

Environment and Climate Change Canada (ECCC). 2018. Historical Climate Data. http://climate.weather.gc.ca/historical_data/search_historic_data_e.html

Health Canada. 2017. Guidelines for Canadian Drinking Water Quality (GCDWQ). https://www.canada.ca/en/health-canada/services/environmental-workplace-health/water-quality/drinking-water/canadian-drinking-water-guidelines.html

New Brunswick Department of Environment and Local Government (NBDELG). 2018. Water Quantity Information. http:// www2.gnb.ca/content/gnb/en/departments/elg/environment/content/water/content/water_quantity.html

New Brunswick Department of Environment and Local Government. 2017. Water Supply Source Assessment Guidelines. Environmental Impact Assessment Branch, latest revision April 2017.

New Brunswick Department of Environment and Local Government. 2000. Wellfield Protected Area Designation Order – Clean Water Act. New Brunswick Regulation 2000-47, filed September 12, 2000.

New Brunswick Department of Environment and Local Government. Groundwater Supply Sources Well Construction and Water Well Testing, Development Officer’s Reference Manual on Environmental Issues. http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/land_waste/content/reference_manual/well_construction_well_water_testing.html

Opus International Consultants. 2018. Current consumption data for the existing Village of New Maryland water supply system. Pers. comm. with Mr. Stephen Pyke, April 5, 2018.

Service New Brunswick. 2018. GeoNB Data Catalogue. http://www.snb.ca/ geonb1/e/DC/catalogue-E.asp

St. Peter, C.J. and Fyffe, L.R. 2005. Bedrock geology of the Fredericton area (NTS 21 G/15), York and Sunbury counties, New Brunswick. New Brunswick Department of Natural Resources, Minerals, Policy and Planning Division, Plate 2005-38.

Theis, C.V. 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage. Transactions of the American Geophysical Union, 16(2): 519-524.

Water Survey of Canada (WSC). 2018. Historical Hydrometric Data.
https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html

APPENDIX A
WELL LOGS

New Nouveau Brunswick

Environment

Report Number **12829**

TW05-01

Well Driller's Report

Date printed 2/7/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Other	New Well	Rotary	06/01/2005

Casing Information

Casing above ground 0.61m

Drive Shoe Used? Yes

Well Log	Casing Type	Diameter	From	End	Slotted?
12829	**Steel**	**15.24cm**	**0m**	**6.10m**	

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	6.10m	273 lpm	1hr 40min	6.10m	0 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
None

Disinfectant
12% NaOCl

Qty 0L

Pump Installed
N/A

Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
12829	**0m**	**0.30m**	**Brown**	**Overburden**
12829	**0.30m**	**6.10m**	**Grey**	**Shale**
12829	**6.10m**	**17.68m**	**Red**	**Shale**
12829	**17.68m**	**42.67m**	**Grey**	**Shale**
12829	**42.67m**	**60.96m**	**Grey**	**Sandstone**
12829	**60.96m**	**92.96m**	**Grey**	**Shale**
12829	**92.96m**	**100.58m**	**Grey**	**Sandstone**
12829	**100.58m**	**109.73m**	**Grey**	**Sandstone**

Overall Well Depth
109.73m

Bedrock Level
0m

Water Bearing Fracture Zone

Well Log	Depth	Rate
12829	**42.67m**	**18.2 lpm**
12829	**55.78m**	**27.3 lpm**
12829	**65.53m**	**54.6 lpm**
12829	**73.15m**	**68.25 lpm**
12829	**91.44m**	**91 lpm**

Setbacks

Well Log	Distance	Setback From
12829	**762.00m**	**Right of any Public Way Road**

Project: Well Pumping Test

DRILL HOLE # TW05-02

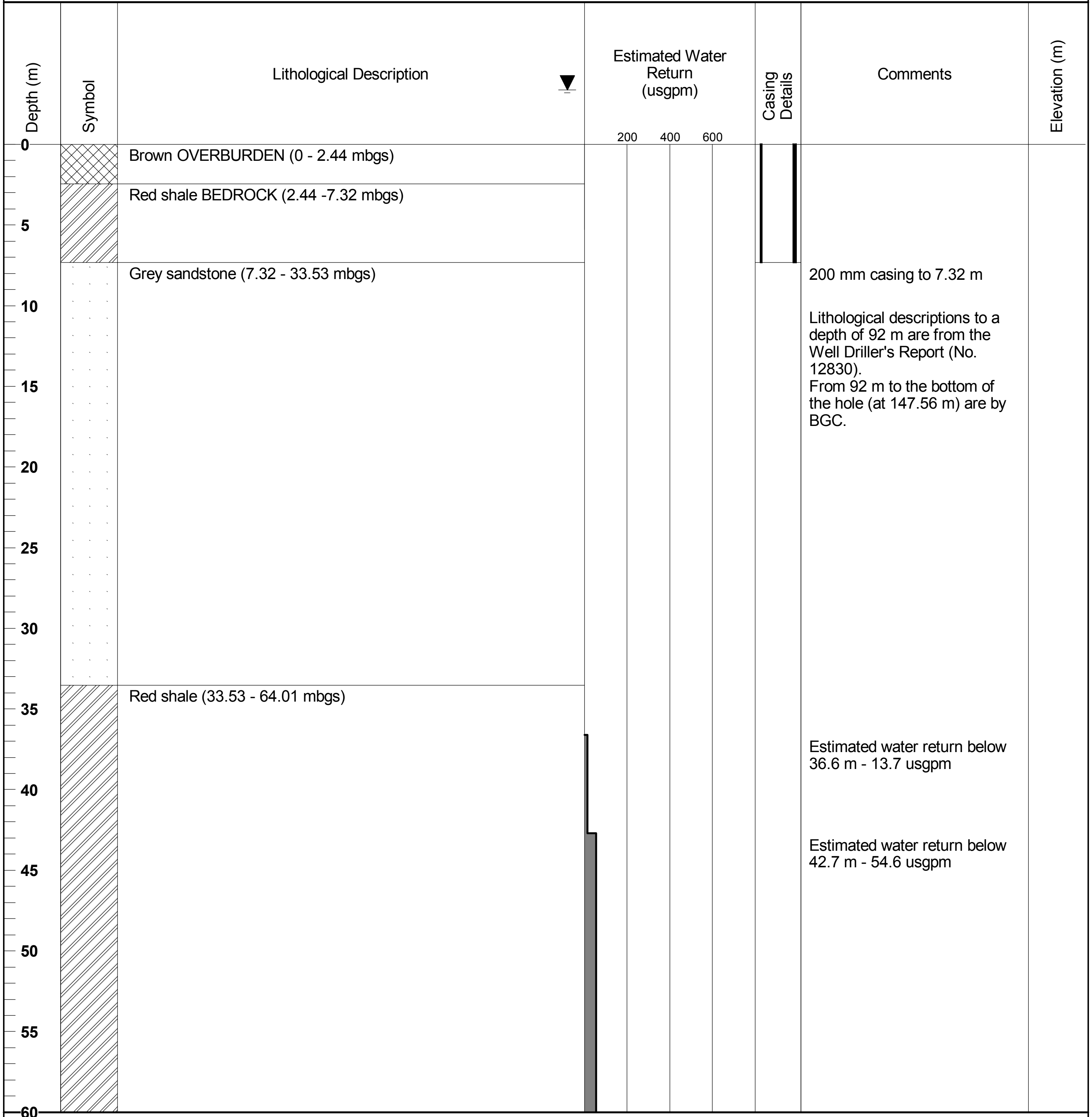
Location: New Maryland, NB

Project No.: 1307-004

Survey Method:
Coordinates (m):
Assumed Ground Elevation (m):
Datum: Geodetic
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation:
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary
Core:
Fluid: Air
Casing: 203 mm **Cased To (m):** 7.32

Start Date: 20 Feb 17
Finish Date: 22 Feb 17
Final Depth of Hole (m): 147.6
Logged by: JH/RP
Reviewed by: GD



Lithological Description	Comments
Brown OVERBURDEN (0 - 2.44 mbgs)	
Red shale BEDROCK (2.44 -7.32 mbgs)	
Grey sandstone (7.32 - 33.53 mbgs)	200 mm casing to 7.32 m Lithological descriptions to a depth of 92 m are from the Well Driller's Report (No. 12830). From 92 m to the bottom of the hole (at 147.56 m) are by BGC.
Red shale (33.53 - 64.01 mbgs)	Estimated water return below 36.6 m - 13.7 usgpm Estimated water return below 42.7 m - 54.6 usgpm

(Continued on next page)

All noted depths are in metres along hole.

Project: Well Pumping Test

DRILL HOLE # TW05-02

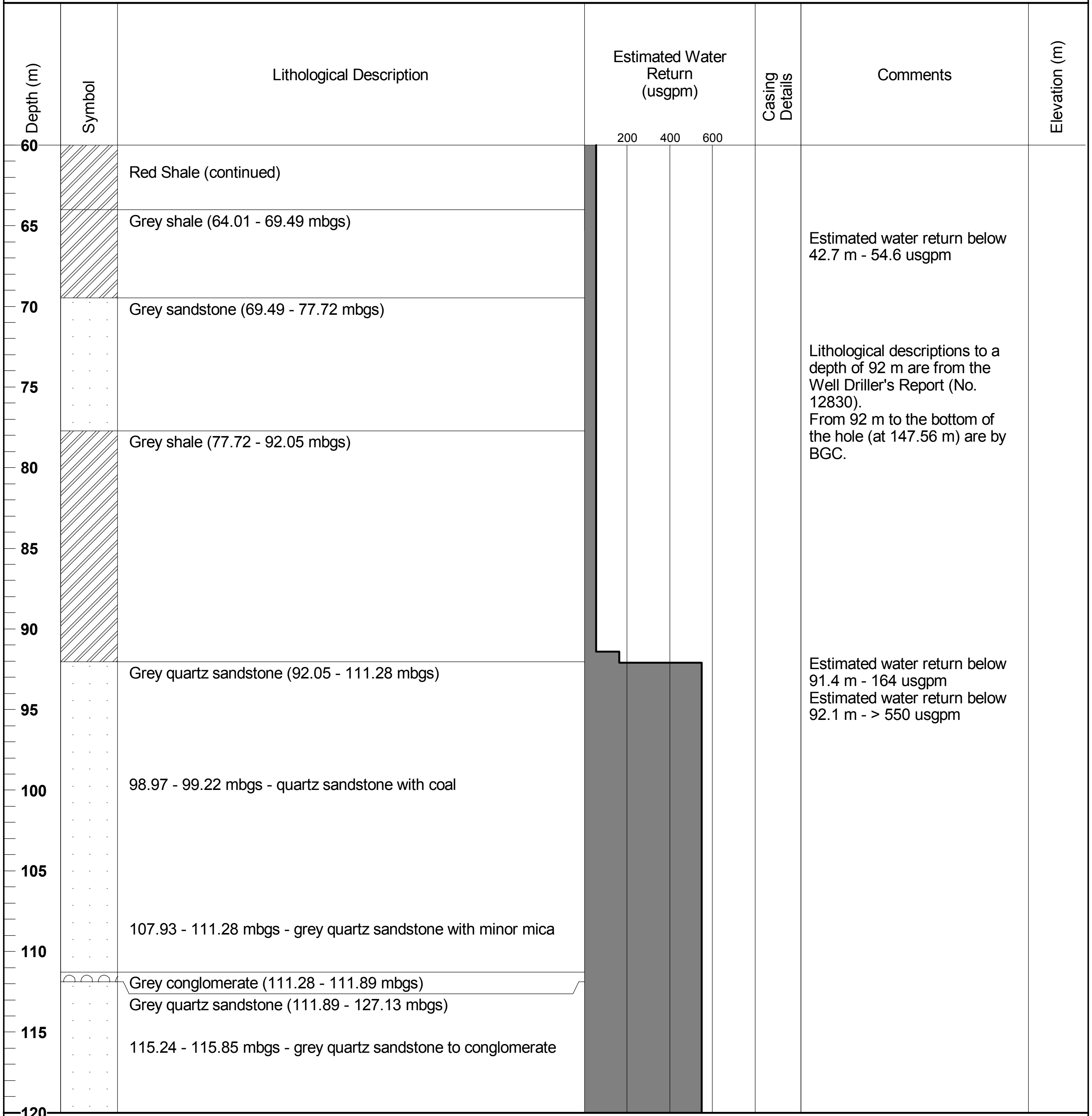
Location: New Maryland, NB

Project No.: 1307-004

Survey Method:
Coordinates (m):
Assumed Ground Elevation (m):
Datum: Geodetic
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation:
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary
Core:
Fluid: Air
Casing: 203 mm **Cased To (m):** 7.32

Start Date: 20 Feb 17
Finish Date: 22 Feb 17
Final Depth of Hole (m): 147.6
Logged by: JH/RP
Reviewed by: GD



Red Shale (continued)

Grey shale (64.01 - 69.49 mbgs)

Grey sandstone (69.49 - 77.72 mbgs)

Grey shale (77.72 - 92.05 mbgs)

Grey quartz sandstone (92.05 - 111.28 mbgs)

98.97 - 99.22 mbgs - quartz sandstone with coal

107.93 - 111.28 mbgs - grey quartz sandstone with minor mica

Grey conglomerate (111.28 - 111.89 mbgs)

Grey quartz sandstone (111.89 - 127.13 mbgs)

115.24 - 115.85 mbgs - grey quartz sandstone to conglomerate

Estimated water return below 42.7 m - 54.6 usgpm

Lithological descriptions to a depth of 92 m are from the Well Driller's Report (No. 12830). From 92 m to the bottom of the hole (at 147.56 m) are by BGC.

Estimated water return below 91.4 m - 164 usgpm
Estimated water return below 92.1 m - > 550 usgpm

(Continued on next page)

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Opus International Consultants
Print Date: 3/29/2017

All noted depths are in metres along hole.

Project: Well Pumping Test

DRILL HOLE # TW05-02

Location: New Maryland, NB

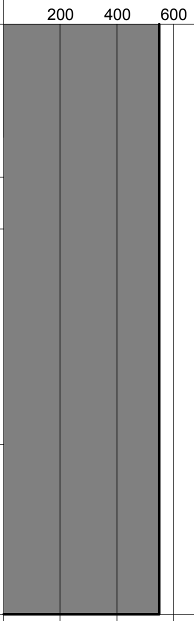
Page 3 **of** 3

Project No.: 1307-004

Survey Method:
Coordinates (m):
Assumed Ground Elevation (m):
Datum: Geodetic
Dip (degrees from horizontal): -90
Direction: N/A

Drill Designation:
Drilling Contractor: Sullivan's Well Drilling
Drill Method: Air Rotary
Core:
Fluid: Air
Casing: 203 mm **Cased To (m):** 7.32

Start Date: 20 Feb 17
Finish Date: 22 Feb 17
Final Depth of Hole (m): 147.6
Logged by: JH/RP
Reviewed by: GD



Depth (m)	Symbol	Lithological Description	Estimated Water Return (usgpm)	Casing Details	Comments	Elevation (m)
120		Grey quartz sandstone (continued)			Estimated water return below 92.1 m > 550 usgpm	
125		124.7 - 127.13 mbgs - grey quartz sandstone with minor mica				
		Grey conglomerate (127.13 - 129.57 mbgs)				
130		Grey quartz sandstone (129.57 - 139.63 mbgs)			Lithological descriptions to a depth of 92 m are from the Well Driller's Report (No. 12830). From 92 m to the bottom of the hole (at 147.56 m) are by BGC.	
135						
140		Red-brown coarse sandstone (139.63 - 147.56 mbgs)				
145		143.59 - 147.56 mbgs - poorly cemented red-brown coarse sandstone				
		END OF TEST WELL 147.56 mbgs				

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Client: Opus International Consultants
Print Date: 3/29/2017

All noted depths are in metres along hole.

New Nouveau Brunswick

Environment

Report Number **12831**

TW05-03

Well Driller's Report

Date printed 2/7/2018

Drilled by

Well Use	Work Type	Drill Method	Work Completed
Drinking Water, Domestic	New Well	Rotary	06/06/2005

Casing Information

Casing above ground 0.61m

Drive Shoe Used? Yes

There is no casing information.

Aquifer Test/Yield

Method	Initial Water Level (BTC)	Pumping Rate	Duration	Final Water Level (BTC)	Estimated Safe Yield	Flowing Well?	Rate
Air	0m	0 lpm	1hr 20min	0m	91 lpm	No	0 lpm

(BTC - Below top of casing)

Well Grouting

There is no Grout information.

Drilling Fluids Used
None

Disinfectant
12% NaOCl
Qty 0L

Pump Installed
N/A
Intake Setting (BTC)
0m

Driller's Log

Well Log	From	End	Colour	Rock Type
12831	**0m**	**2.44m**	**Brown**	**Overburden**
12831	**2.44m**	**4.57m**	**Grey**	**Shale**
12831	**4.57m**	**16.15m**	**Red**	**Shale**
12831	**16.15m**	**21.03m**	**Grey**	**Shale**
12831	**21.03m**	**31.09m**	**Red**	**Shale**
12831	**31.09m**	**65.53m**	**Grey**	**Shale**
12831	**65.53m**	**91.44m**	**Grey**	**Sandstone**

Overall Well Depth
91.44m

Bedrock Level
0m

Water Bearing Fracture Zone

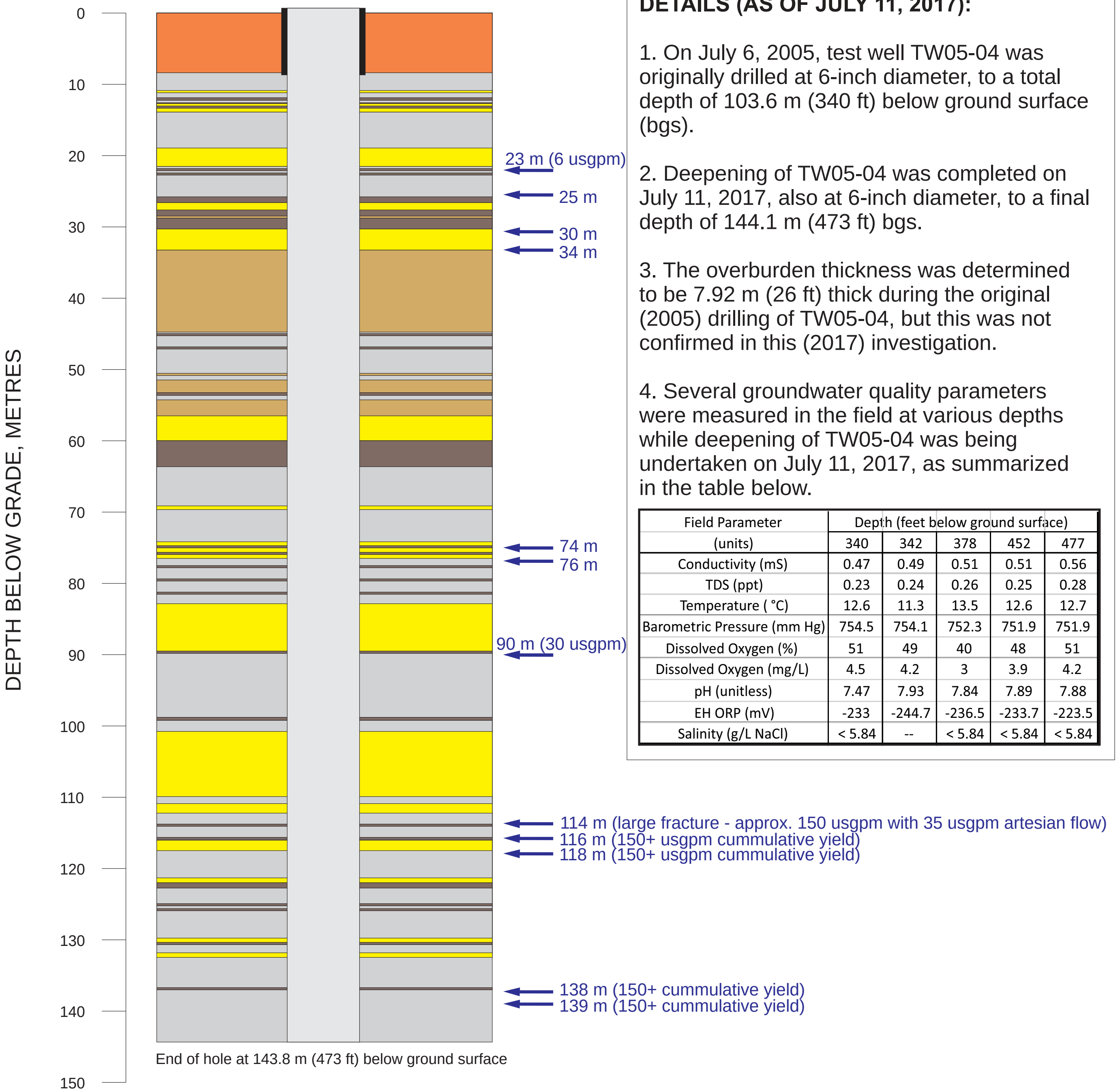
Well Log	Depth	Rate
12831	**30.48m**	**18.2 lpm**
12831	**60.96m**	**22.75 lpm**
12831	**91.44m**	**45.5 lpm**
12831	**68.58m**	**91 lpm**

Setbacks

Well Log	Distance	Setback From
12831	**762.00m**	**Right of any Public Way Road**

DETAILED LOG OF TEST WELL TW05-04
FOLLOWING DEEPENING ON JULY 11, 2017

150 mm (6-inch) diameter steel casing with drive-shoe
installed to 7.6 m (25 ft) below ground surface
(casing stick-up = 0.62 m (2 ft) above ground surface)



End of hole at 143.8 m (473 ft) below ground surface

TEST WELL TW05-04 CONSTRUCTION DETAILS (AS OF JULY 11, 2017):

1. On July 6, 2005, test well TW05-04 was originally drilled at 6-inch diameter, to a total depth of 103.6 m (340 ft) below ground surface (bgs).

2. Deepening of TW05-04 was completed on July 11, 2017, also at 6-inch diameter, to a final depth of 144.1 m (473 ft) bgs.

3. The overburden thickness was determined to be 7.92 m (26 ft) thick during the original (2005) drilling of TW05-04, but this was not confirmed in this (2017) investigation.

4. Several groundwater quality parameters were measured in the field at various depths while deepening of TW05-04 was being undertaken on July 11, 2017, as summarized in the table below.

Field Parameter	Depth (feet below ground surface)				
(units)	340	342	378	452	477
Conductivity (mS)	0.47	0.49	0.51	0.51	0.56
TDS (ppt)	0.23	0.24	0.26	0.25	0.28
Temperature (°C)	12.6	11.3	13.5	12.6	12.7
Barometric Pressure (mm Hg)	754.5	754.1	752.3	751.9	751.9
Dissolved Oxygen (%)	51	49	40	48	51
Dissolved Oxygen (mg/L)	4.5	4.2	3	3.9	4.2
pH (unitless)	7.47	7.93	7.84	7.89	7.88
EH ORP (mV)	-233	-244.7	-236.5	-233.7	-223.5
Salinity (g/L NaCl)	< 5.84	--	< 5.84	< 5.84	< 5.84

BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Legend:
■ STEEL CASING (WITH DRIVE-SHOE)
■ OVERBURDEN
■ BROWN SANDSTONE
■ CONGLOMERATE SANDSTONE
■ MUDSTONE / SHALE
■ GREY SANDSTONE
→ POSSIBLE WATER-BEARING FRACTURE

Project:
TEST WELL TW05-04 DEEPENING
AND ASSESSMENT - JULY 2017
VILLAGE OF NEW MARYLAND, NB

Drawn By: WT

Reviewed By: MH

Project No.: 1307-004 (PHASE 03)

Drawing:
FIGURE 1 - DETAILED LOG OF
DEEPENED TEST WELL TW05-04

Client:
OPUS INTERNATIONAL
CONSULTANTS (CANADA)

Date: JULY 20, 2017

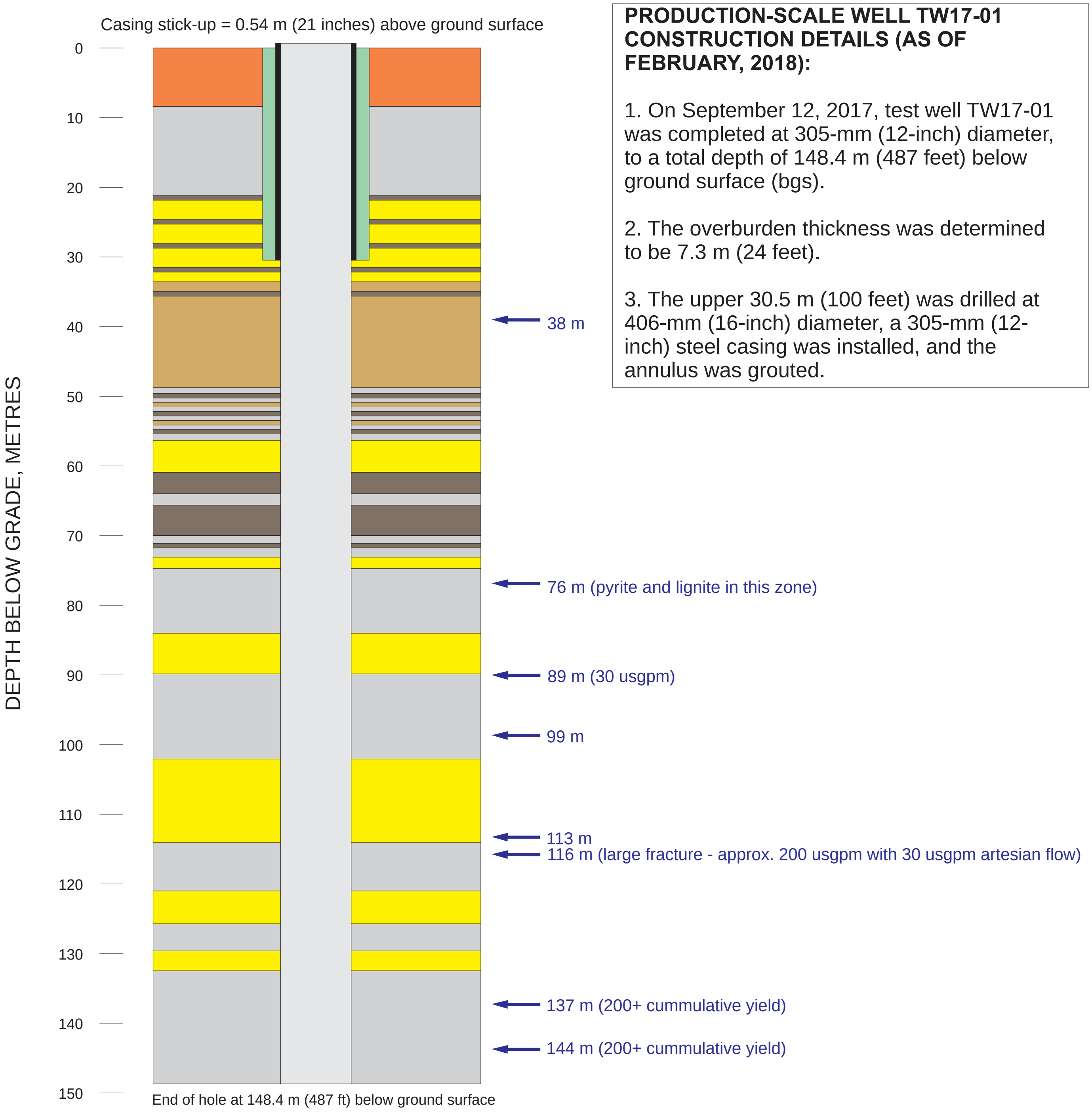
DETAILED LOG OF PRODUCTION-SCALE WELL TW17-01

PRODUCTION-SCALE WELL TW17-01 CONSTRUCTION DETAILS (AS OF FEBRUARY, 2018):

1. On September 12, 2017, test well TW17-01 was completed at 305-mm (12-inch) diameter, to a total depth of 148.4 m (487 feet) below ground surface (bgs).

2. The overburden thickness was determined to be 7.3 m (24 feet).

3. The upper 30.5 m (100 feet) was drilled at 406-mm (16-inch) diameter, a 305-mm (12-inch) steel casing was installed, and the annulus was grouted.



BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

Legend:
- ⬛ STEEL CASING (WITH DRIVE-SHOE)
- 🟩 GROUT
- 🟧 TILL OVERBURDEN
- 🟫 BROWN SANDSTONE
- 🟨 CONGLOMERATE SANDSTONE
- 🟫 MUDSTONE / SHALE
- ⬜ GREY SANDSTONE
- → POSSIBLE WATER-BEARING FRACTURE

Project:
PRODUCTION SCALE WELL
TW17-01 - FEBRUARY 2018
VILLAGE OF NEW MARYLAND, NB

Drawing:
FIGURE A-1 - DETAILED LOG OF
PRODUCTION-SCALE WELL
TW17-01

Drawn By: WT

Reviewed By: MH

Project No.: 1307-004 (PHASE 03)

Client:
OPUS INTERNATIONAL
CONSULTANTS (CANADA)

Date: FEBRUARY 12, 2018

M : CAPITAL WELL DRILLERS FAX NO. : 5064520966 Aug. 27 2004 09:53AM P3

Sunrise-OW

New Brunswick / Nouveau Brunswick

DEPARTMENT OF THE ENVIRONMENT AND LOCAL GOVERNMENT

WATER WELL DRILLER'S REPORT

00008284

OFFICE USE ONLY

FIELD NO.:

SEC TS SEQ

COUNTY CODE

HEALTH REGION

NBRC NO.:

NBGG NO.

EVENT NO.

SAMPLE RECEIVED DATE: YR MO DAY

TESTING VOUCHER INFORMATION

SEE BACK FOR DETAILS PLEASE PRINT

SAME AS WELL OWNER INFORMATION ..... OR

INFORMATION INCLUDED HEREIN SHOULD BE THE WELL OWNER AT TIME OF SAMPLING

LAST NAME: Village of New Maryland FIRST NAME:

P.O. BOX NO. CIVIC NO. STREET NAME: Waste Water Treatment Plant.

CITY/TOWN/VILLAGE: PROV. N.B. POSTAL CODE:

TEL. NO.: CELL NO.:

E-MAIL: SAMPLE COLLECTED YR MO DAY HR MIN AM / PM

DO YOU NEED A SAMPLE FOR YOUR MORTGAGE? SEE BACK FOR DETAILS

IF YOU WISH THE RESULTS TO BE RELEASED TO A MORTGAGE INSTITUTION PLEASE INCLUDE THE FOLLOWING CONTACT INFORMATION:

INSTITUTION:

LAST NAME: FIRST NAME:

FAX NO.: E-MAIL:

SIGNATURE OF WELL OWNER:

WAS THE COST OF THIS WELL FINANCED BY NB HOUSING?

YES ☐ ☐ NO

WELL / WATER USE:

INDUSTRIAL ☑ ABANDONED ☐ DOMESTIC ☐

EXPLORATORY ☐ MUNICIPAL ☐ MONITORING ☐

HEAT PUMP ☐ OBSERVATION ☐

OTHER ☐

TYPE OF WORK COMPLETED: NEW WELL ☐ DEEPENED ☐

OTHER:

METHOD:

CABLE TOOL ☐ ROTARY ☑ OTHER

CASING INSTALLED:

LENGTH OF CASING ABOVE GROUND: 2 FT. IN.

STEEL: 6 IN DIAM. FROM 0 FT. TO 40 FT.

PVC: IN DIAM. FROM FT. TO FT.

SLOTTED IN DIAM. FROM FT. TO FT.

SCREENS: TYPE: SLOT SIZE

IN DIAM. FROM FT. TO FT.

SETBACKS: SEE BACK FOR DETAILS SEPTIC TANK (1)

SEPTIC TANK (2) FT. FIELD (2) FT. FIELD (1)

*RIGHT OF WAY OF ANY PUBLIC ROAD (1) ROAD (2)

SETBACKS MEASURED (NEW CONSTRUCTION)

APPROXIMATE SETBACKS AS INDICATED BY HOMEOWNER (EXISTING WELLS)

FLOWING WELL? YES ☐ NO ☐ IF YES - RATE: Igpm (approx.)

AQUIFER TEST: METHOD: AIR ☑ BAILER ☐ PUMP ☐

INITIAL WATER LEVEL: FT BELOW TOP OF CASING

PUMPING RATE 25 Igpm DURATION: 1 hrs. min

FINAL WATER LEVEL: FT. BELOW TOP OF CASING

ESTIMATED SAFE YIELD: 20 Igpm

WELL GROUTED? YES ☐ NO ☑

FROM FT. TO FT. GROUT TYPE:

DRILLING FLUIDS USED: YES ☐ NO ☐

TYPE:

DRILLER'S COMMENTS Purchase E by Musician Construction.

THE WELL DESCRIBED HAS BEEN CONSTRUCTED IN ACCORDANCE

P.I.D. NO.: 75407429

WELL I.D. NO.: 30826

WELL OWNER INFORMATION

INFORMATION INCLUDED HEREIN SHOULD BE THE WELL OWNER AT TIME OF DRILLING

LAST NAME: FIRST NAME:

CITY/TOWN/VILLAGE: PROVINCE POSTAL CODE

WELL LOCATION: SAME AS ABOVE ..... OR

CIVIC NUMBER STREET NAME

CITY/TOWN/VILLAGE

WELL PAID FOR BY PROVINCIAL DEPT. OF

WELL ON RESERVE? YES ☐ NO ☐

WELL ALREADY TAGGED? YES ☐ NO ☐

OLD WELL I.D.

DRILLER'S LOG *

FROM (FT)	TO (FT)	COLOUR	ROCK TYPE
Ground Level	20	Brown	Overburden
28	42	Grey	Sandstone
47	200	Red	Shale

* IF INSUFFICIENT SPACE PLEASE USE ADDITIONAL SHEETS

TOTAL WELL DEPTH: 240 FT. DEPTH TO BEDROCK: 20 FT.

WATER BEARING 1 5 Igpm AT 82 FT. 2 5 Igpm AT 120 FT.

FRACTURE ZONES 3 15 Igpm AT 400 FT. 4 Igpm AT FT.

PUMP INSTALLATION: INSTALLED ☑ NOT INSTALLED ☐

PUMP INTAKE SETTING: FT. BELOW TOP OF CASING (if commissioned)

PUMP TYPE: SUBMERSIBLE ☑ JET ☐ TURBINE ☐

OTHER

WELL DISINFECTED? YES ☑ NO ☐

TYPE

DRILLING COMPANY: Capital Well Drillers

COMPLETION DATE: 04 08 19 (YR MO DAY)

LICENSE NO. 320

WHITE - NB DELG
YELLOW - Homeowner
BLUE - Homeowner / 1
PINK - Drilling Company

APPENDIX B
RIVER STAGE PLOTS

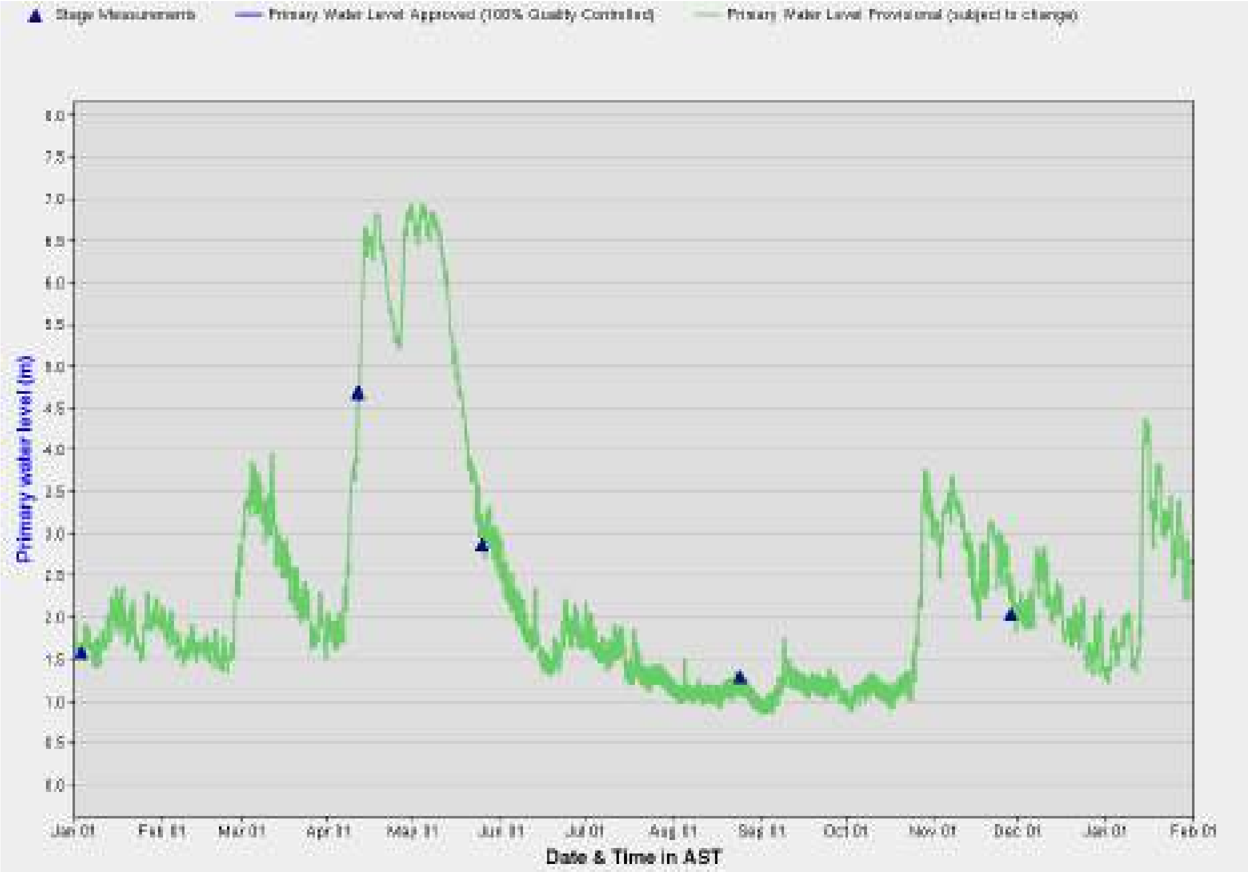


Figure B-1. St. John River level for January 2017 to January 2018 at the Fredericton monitoring station (WSC 2018).

Figure B-2. North Branch Oromocto River level for January 2017 to January 2018 at the Tracy monitoring station (WSC 2018).

APPENDIX C
WATER QUALITY RESULTS

Table C-1. General chemistry analytical results.

PARAMETER	UNITS	RL	GCDWQ		TW17-01			TW05-02	TW05-04	TW17-01		
			MAC	AO	26/9/17	27/9/17	28/9/17	20/10/17	21/10/17	10/1/18	11/1/18	12/1/18
Sodium	mg/L	0.05	-	200	67.3	67.0	67.0	34.6	47.4	57.5	56.6	56.6
Potassium	mg/L	0.02	-	-	0.40	0.40	0.40	0.44	0.47	0.43	0.42	0.42
Calcium	mg/L	0.05	-	-	29.1	28.9	29.7	38.8	47.9	36	34.7	34.9
Magnesium	mg/L	0.01	-	-	1.45	1.39	1.43	2.52	2.83	1.75	1.72	1.72
Iron	mg/L	0.02	-	0.3	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Manganese	mg/L	0.001	-	0.05	0.132	0.134	0.138	0.372	0.284	0.171	0.168	0.168
Copper	mg/L	0.001	-	1	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Zinc	mg/L	0.001		5	0.004	0.004	0.002	0.003	< 0.001	0.009	0.003	0.001
Ammonia (as N)	mg/L	0.05	-	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
pH	units	-	-	7.0 - 10.5	8.1	8.1	8.1	8.1	8.1	8.2	7.7	7.8
Alkalinity (as CaCo3)	mg/L	2	-	-	100	100	100	100	93	94	100	95
Chloride	mg/L	1.5	-	250	78.5	85.2	80.1	46.3	92.4	81.7	75	76.7
Fluoride	mg/L	0.05	1.5	-	0.41	0.42	0.43	0.36	0.29	0.35	0.37	0.37
Sulfate	mg/L	1	-	500	19	19	19	17	17	19	19	18
Sulfide	mg/L	0.05	-	0.05	0.07	0.11	0.10	< 0.05	< 0.05	0.08	0.08	0.07
Nitrate (as N)	mg/L	0.05	10.00	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Nitrite (as N)			1	-								
ortho-Phosphate (as P)	mg/L	0.01	-	-	< 0.01	< 0.01	0.01	0.02	0.01	0.01	0.02	0.01
r-Silica (as SiO2)	mg/L	0.1	-	-	12.2	12.5	12.1	13.6	13.8	12.1	12.5	12.1
Carbon - Total Organic	mg/L	0.5	-	-	< 0.5	0.5	0.5	0.6	< 0.5	1.1	< 0.5	< 0.5
Turbidity	NTU	0.1	0.1	-	0.2	0.1	0.1	< 0.1	< 0.1	0.2	< 0.1	< 0.1
Conductivity	uS/cm	1	-	-	490	489	498	384	515	469	470	457
Bicarbonate (as CaCO3)	mg/L	-	-	-	98.8	98.8	98.8	98.8	91.9	92.5	99.5	94.4
Carbonate (as CaCo3)	mg/L	-	-	-	1.17	1.17	1.17	1.17	1.09	1.38	0.469	0.56
Hydroxide (as CaCO3)	mg/L	-	-	-	0.063	0.063	0.063	0.063	0.063	0.079	0.025	0.032
Cation Sum	meq/L	-	-	-	4.51	4.49	4.53	3.67	4.71	4.46	4.35	4.36
Anion Sum	meq/L	-	-	-	4.61	4.80	4.65	3.66	4.82	4.58	4.51	4.44
Percent Difference	%	-	-	-	-1.03	-3.35	-1.35	0.19	-1.18	-1.33	-1.79	-0.85
Theoretical Conductivity	uS/cm	-	-	-	454	465	458	363	483	455	442	441
Hardness (as CaCO3)	mg/L	0.2	-	-	78.6	77.9	80.0	107	131	97.1	93.7	94.2
Ion Sum	mg/L	-	-	-	269	276	271	215	279	266	261	259
Saturation pH (5 degs C)	units	-	-	-	8.2	8.2	8.2	8.0	8.0	8.1	8.1	8.1
Langelier Index (5 degs C)	-	-	-	-	-0.07	-0.07	-0.06	0.07	0.11	0.1	-0.39	-0.31

Notes:

1. RL = Reporting Limit.
2. GCDWQ = Guidelines for Canadian Drinking Water Quality.
3. MAC = Maximum Acceptable Concentration.
4. AO = Aesthetic Objective.
5. Values highlighted in red are above the GCDWQ.

Table C-2. Dissolved trace metals analytical results.

PARAMETER	UNITS	RL	GCDWQ		TW17-01			TW05-02	TW05-04	TW17-01		
			MAC	AO	26/9/17	27/9/17	28/9/17	20/10/17	21/10/17	10/1/18	11/1/18	12/1/18
Aluminum	ug/L	1	-	100	3	2	2	1	3	3	2	2
Antimony	ug/L	0.1	6	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Arsenic	ug/L	1	10	-	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Barium	ug/L	1	1000	-	210	209	215	157	213	206	206	205
Beryllium	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	ug/L	1	-	-	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Boron	ug/L	1	5000	-	32	31	31	22	26	29	30	30
Cadmium	ug/L	0.01	5	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Calcium	ug/L	50	-	-	29100	28900	29700	38800	47900	36000	34700	34900
Chromium	ug/L	1	50	-	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Cobalt	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Copper	ug/L	1	-	1000	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Iron	ug/L	20	-	300	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Lead	ug/L	0.1	10	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.30	< 0.1	< 0.1
Lithium	ug/L	0.1	-	-	57.8	57.2	57.7	36.3	46.6	51.00	50.50	51.20
Magnesium	ug/L	10	-	-	1450	1390	1430	2520	2830	1750	1720	1720
Manganese	ug/L	1	-	50	132	134	138	372	284	171	168	168
Mercury	ug/L	0.025	1	-	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025	< 0.025
Molybdenum	ug/L	0.1	-	-	0.3	0.3	0.4	0.4	0.2	0.3	0.4	0.3
Nickel	ug/L	1	-	-	< 1	1	1	1	< 1	2	1	1
Potassium	ug/L	20	-	-	400	400	400	440	470	430	420	420
Rubidium	ug/L	0.1	-	-	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.5
Selenium	ug/L	1	50	-	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Silver	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Sodium	ug/L	50	-	200000	67300	67000	67000	34600	47400	57500	56600	56600
Strontium	ug/L	1	-	-	874	871	897	866	1340	1000	988	988
Tellurium	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thallium	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Tin	ug/L	0.1	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Uranium	ug/L	0.1	20	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Vanadium	ug/L	1	-	-	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Zinc	ug/L	1	-	5000	4	4	2	3	< 1	9	3	1

Notes:

1. RL = Reporting Limit.
2. GCDWQ = Guidelines for Canadian Drinking Water Quality.
3. MAC = Maximum Acceptable Concentration.
4. AO = Aesthetic Objective.
5. Values highlighted in red are above the GCDWQ.

Table C-3. Microbiology and volatile organic carbon analytical results.

PARAMETER	UNITS	RL	GCDWQ		TW17-01			TW05-02	TW05-04	TW17-01		
			MAC	AO	26/9/17	27/9/17	28/9/17	20/10/17	21/10/17	10/1/18	11/1/18	12/1/18
Total Coliforms	MPN/100mL	-	0	-	6	11	0	0	2	0	0	0
E. coli	MPN/100mL	-	0	-	1	0	0	0	0	0	0	0
Faecal Coliforms	MPN/100mL	-	0	-	1	0	0	0	0	0	0	0
Chloromethane	µg/L	5.0	-	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Vinyl Chloride	µg/L	0.5	0.002	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Bromomethane	µg/L	5.0	-	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Chloroethane	µg/L	5.0	-	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	-	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	0.014	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Methylene Chloride	µg/L	5.0	-	-	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Bromochloromethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chloroform	µg/L	0.5	0.1		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	0.002	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzene	µg/L	0.5	0.005	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	0.005	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Trichloroethylene	µg/L	0.5	0.005	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Bromodichloromethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Toluene	µg/L	0.5	0.06	0.024	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	0.01	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dibromochloromethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chlorobenzene	µg/L	0.5	0.005	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Ethylbenzene	µg/L	0.5	0.14	0.0016	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
m,p-Xylenes	µg/L	0.5	0.09	0.02	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
o-Xylene	µg/L	0.5			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Styrene	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Bromoform	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	0.005	0.001	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	0.2	0.003	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,2-Dichloroethane-d4	%				109	103	103	116	116	104	108	105
Toluene-d8	%				98	95	100	101	102	100	98	100
4-Bromofluorobenzene	%				104	105	103	108	108	102	100	99

Notes:

1. RL = Reporting Limit.
2. GCDWQ = Guidelines for Canadian Drinking Water Quality.
3. MAC = Maximum Acceptable Concentration.
4. AO = Aesthetic Objective.
5. Values highlighted in red are above the GCDWQ.

APPENDIX D
RPC CERTIFICATES

Report ID: 250425-IAS
Report Date: 04-Oct-17
Date Received: 26-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:			250425-1
Client Sample ID:			TW17-01 25hr
Date Sampled:			26-Sep-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	67.3
Potassium	mg/L	0.02	0.40
Calcium	mg/L	0.05	29.1
Magnesium	mg/L	0.01	1.45
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.132
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.004
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.1
Alkalinity (as $CaCO_3$)	mg/L	2	100
Chloride	mg/L	0.5	78.5
Fluoride	mg/L	0.05	0.41
Sulfate	mg/L	1	19
Sulfide	mg/L	0.05	0.07
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	< 0.01
r-Silica (as SiO_2)	mg/L	0.1	12.2
Carbon - Total Organic	mg/L	0.5	< 0.5
Turbidity	NTU	0.1	0.2
Conductivity	µS/cm	1	490
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	98.8
Carbonate (as $CaCO_3$)	mg/L	-	1.17
Hydroxide (as $CaCO_3$)	mg/L	-	0.063
Cation Sum	meq/L	-	4.51
Anion Sum	meq/L	-	4.61
Percent Difference	%	-	-1.03
Theoretical Conductivity	µS/cm	-	454
Hardness (as $CaCO_3$)	mg/L	0.2	78.6
Ion Sum	mg/L	-	269
Saturation pH (5°C)	units	-	8.2
Langelier Index (5°C)	-	-	-0.07

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 250425-IAS
Report Date: 04-Oct-17
Date Received: 26-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			250425-1
Client Sample ID: Date Sampled:			TW17-01 25hr 26-Sep-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	3
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	210
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	32
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	29100
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	57.8
Magnesium	µg/L	10	1450
Manganese	µg/L	1	132
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.3
Nickel	µg/L	1	< 1
Potassium	µg/L	20	400
Rubidium	µg/L	0.1	0.5
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	67300
Strontium	µg/L	1	874
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	4

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 250425-ML-W1
Date: 27-Sep-17
Date Received/Reçu: 26-Sep-17

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Marc Hodder / Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				250425-1
Client Sample ID/ID d'échantillon du client:				TW17-01 25hr
Date collected/Date du prélèvement				26-Sep-17
Time sampled/Heure du prélèvement				8:30:00 AM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	26-Sep-17	MPN/100mL	6
E. coli	FFA01	26-Sep-17	MPN/100mL	1
Faecal Coliforms/Coliformes fécaux	FFA01	26-Sep-17	MPN/100mL	1

This report relates only to the sample(s) and information provided to the laboratory.
Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.
Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Alicia Schroeder

Alicia Schroeder
Microbiology Technician
Food, Fisheries & Aquaculture

Report ID: 250425-OAS
Report Date: 03-Oct-17
Date Received: 26-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Attention: Marc Hodder
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			250425-1
Client Sample ID:			TW17-01 25hr
Date Sampled:			26-Sep-17
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Bruce Phillips

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 250425-OAS
Report Date: 03-Oct-17
Date Received: 26-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Attention: Marc Hodder
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			250425-1
Client Sample ID: Date Sampled: Matrix:			TW17-01 25hr 26-Sep-17 water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		109
Toluene-d8	%		98
4-Bromofluorobenzene	%		104

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 250425-OAS
Report Date: 03-Oct-17
Date Received: 26-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
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Canada E3B 6Z9
Tel 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 1307004
Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1352	SPIKEC1352
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	95%
Vinyl Chloride	µg/L	0.5	< 0.5	81%
Bromomethane	µg/L	5.0	< 5.0	84%
Chloroethane	µg/L	5.0	< 5.0	97%
Trichlorofluoromethane	µg/L	5.0	< 5.0	90%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	89%
Methylene Chloride	µg/L	5.0	< 5.0	97%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	97%
1,1-Dichloroethane	µg/L	0.5	< 0.5	96%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	101%
Bromochloromethane	µg/L	0.5	< 0.5	97%
Chloroform	µg/L	0.5	< 0.5	97%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	93%
Carbon Tetrachloride	µg/L	0.5	< 0.5	88%
Benzene	µg/L	0.5	< 0.5	109%
1,2-Dichloroethane	µg/L	0.5	< 0.5	95%
Trichloroethylene	µg/L	0.5	< 0.5	97%
1,2-Dichloropropane	µg/L	0.5	< 0.5	97%
Bromodichloromethane	µg/L	0.5	< 0.5	88%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	92%

RL = Reporting Limit

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
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Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 1307004
Location: New Maryland
QA/QC Report

RPC Sample ID:			BLANKC1352	SPIKEC1352
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	100%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	89%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	98%
Tetrachloroethylene	µg/L	0.5	< 0.5	102%
Dibromochloromethane	µg/L	0.5	< 0.5	91%
1,2-Dibromoethane	µg/L	0.5	< 0.5	92%
Chlorobenzene	µg/L	0.5	< 0.5	101%
Ethylbenzene	µg/L	0.5	< 0.5	106%
m,p-Xylenes	µg/L	0.5	< 0.5	105%
o-Xylene	µg/L	0.5	< 0.5	111%
Styrene	µg/L	0.5	< 0.5	107%
Bromoform	µg/L	0.5	< 0.5	82%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	100%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	92%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	104%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	97%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	96%

RL = Reporting Limit

Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
250425-1	26-Sep-17	26-Sep-17

Report ID: 250576-IAS
Report Date: 11-Oct-17
Date Received: 27-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:			250576-1
Client Sample ID:			TW17-01 48-hr
Date Sampled:			27-Sep-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	67.0
Potassium	mg/L	0.02	0.40
Calcium	mg/L	0.05	28.9
Magnesium	mg/L	0.01	1.39
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.134
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.004
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.1
Alkalinity (as $CaCO_3$)	mg/L	2	100
Chloride	mg/L	0.5	85.2
Fluoride	mg/L	0.05	0.42
Sulfate	mg/L	1	19
Sulfide	mg/L	0.05	0.11
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	< 0.01
r-Silica (as SiO_2)	mg/L	0.1	12.5
Carbon - Total Organic	mg/L	0.5	0.5
Turbidity	NTU	0.1	0.1
Conductivity	µS/cm	1	489
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	98.8
Carbonate (as $CaCO_3$)	mg/L	-	1.17
Hydroxide (as $CaCO_3$)	mg/L	-	0.063
Cation Sum	meq/L	-	4.49
Anion Sum	meq/L	-	4.80
Percent Difference	%	-	-3.35
Theoretical Conductivity	µS/cm	-	465
Hardness (as $CaCO_3$)	mg/L	0.2	77.9
Ion Sum	mg/L	-	276
Saturation pH (5°C)	units	-	8.2
Langelier Index (5°C)	-	-	-0.07

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 250576-IAS
Report Date: 11-Oct-17
Date Received: 27-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

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921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			250576-1
Client Sample ID: Date Sampled:			TW17-01 48-hr 27-Sep-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	2
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	209
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	31
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	28900
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	57.2
Magnesium	µg/L	10	1390
Manganese	µg/L	1	134
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.3
Nickel	µg/L	1	1
Potassium	µg/L	20	400
Rubidium	µg/L	0.1	0.5
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	67000
Strontium	µg/L	1	871
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	4

CERTIFICATE OF ANALYSIS

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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 250576-ML-W1
Date: 28-Sep-17
Date Received/Reçu: 27-Sep-17

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
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Attention: Marc Hodder / Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				250576-1
Client Sample ID/ID d'échantillon du client:				TW17-01 48-hr
Date collected/Date du prélèvement				27-Sep-17
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	27-Sep-17	MPN/100mL	11
E. coli	FFA01	27-Sep-17	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	27-Sep-17	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Cornelia Maston
Microbiology Technician
Food, Fisheries & Aquaculture

Report ID: 250576-OAS
Report Date: 04-Oct-17
Date Received: 27-Sep-17

CERTIFICATE OF ANALYSIS

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Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			250576-1
Client Sample ID:			TW17-01 48-hr
Date Sampled:			27-Sep-17
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Bruce Phillips

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 250576-OAS
Report Date: 04-Oct-17
Date Received: 27-Sep-17

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Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			250576-1
Client Sample ID:			TW17-01 48-hr
Date Sampled:			27-Sep-17
Matrix:			water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		103
Toluene-d8	%		95
4-Bromofluorobenzene	%		105

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 250576-OAS
Report Date: 04-Oct-17
Date Received: 27-Sep-17

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Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1352	SPIKEC1352
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	95%
Vinyl Chloride	µg/L	0.5	< 0.5	81%
Bromomethane	µg/L	5.0	< 5.0	84%
Chloroethane	µg/L	5.0	< 5.0	97%
Trichlorofluoromethane	µg/L	5.0	< 5.0	90%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	89%
Methylene Chloride	µg/L	5.0	< 5.0	97%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	97%
1,1-Dichloroethane	µg/L	0.5	< 0.5	96%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	101%
Bromochloromethane	µg/L	0.5	< 0.5	97%
Chloroform	µg/L	0.5	< 0.5	97%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	93%
Carbon Tetrachloride	µg/L	0.5	< 0.5	88%
Benzene	µg/L	0.5	< 0.5	109%
1,2-Dichloroethane	µg/L	0.5	< 0.5	95%
Trichloroethylene	µg/L	0.5	< 0.5	97%
1,2-Dichloropropane	µg/L	0.5	< 0.5	97%
Bromodichloromethane	µg/L	0.5	< 0.5	88%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	92%

RL = Reporting Limit

Report ID: 250576-OAS
Report Date: 04-Oct-17
Date Received: 27-Sep-17

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Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1352	SPIKEC1352
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	100%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	89%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	98%
Tetrachloroethylene	µg/L	0.5	< 0.5	102%
Dibromochloromethane	µg/L	0.5	< 0.5	91%
1,2-Dibromoethane	µg/L	0.5	< 0.5	92%
Chlorobenzene	µg/L	0.5	< 0.5	101%
Ethylbenzene	µg/L	0.5	< 0.5	106%
m,p-Xylenes	µg/L	0.5	< 0.5	105%
o-Xylene	µg/L	0.5	< 0.5	111%
Styrene	µg/L	0.5	< 0.5	107%
Bromoform	µg/L	0.5	< 0.5	82%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	100%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	92%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	104%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	97%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	96%

RL = Reporting Limit

Report ID: 250576-OAS
Report Date: 04-Oct-17
Date Received: 27-Sep-17

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Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
250576-1	27-Sep-17	27-Sep-17

Report ID: 250816-IAS
Report Date: 13-Oct-17
Date Received: 28-Sep-17

CERTIFICATE OF ANALYSIS

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Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:			250816-1
Client Sample ID: Date Sampled:			TW17-01 72-hr 28-Sep-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	67.0
Potassium	mg/L	0.02	0.40
Calcium	mg/L	0.05	29.7
Magnesium	mg/L	0.01	1.43
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.138
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.002
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.1
Alkalinity (as $CaCO_3$)	mg/L	2	100
Chloride	mg/L	0.5	80.1
Fluoride	mg/L	0.05	0.43
Sulfate	mg/L	1	19
Sulfide	mg/L	0.05	0.10
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.01
r-Silica (as SiO_2)	mg/L	0.1	12.1
Carbon - Total Organic	mg/L	0.5	0.5
Turbidity	NTU	0.1	0.1
Conductivity	µS/cm	1	498
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	98.8
Carbonate (as $CaCO_3$)	mg/L	-	1.17
Hydroxide (as $CaCO_3$)	mg/L	-	0.063
Cation Sum	meq/L	-	4.53
Anion Sum	meq/L	-	4.65
Percent Difference	%	-	-1.35
Theoretical Conductivity	µS/cm	-	458
Hardness (as $CaCO_3$)	mg/L	0.2	80.0
Ion Sum	mg/L	-	271
Saturation pH (5°C)	units	-	8.2
Langelier Index (5°C)	-	-	-0.06

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Krista Skinner

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Krista Skinner
Chemical Technician
Inorganic Analytical Chemistry

Report ID: 250816-IAS
Report Date: 13-Oct-17
Date Received: 28-Sep-17

CERTIFICATE OF ANALYSIS

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Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			250816-1
Client Sample ID:			TW17-01 72-hr
Date Sampled:			28-Sep-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	2
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	215
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	31
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	29700
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	57.7
Magnesium	µg/L	10	1430
Manganese	µg/L	1	138
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.4
Nickel	µg/L	1	1
Potassium	µg/L	20	400
Rubidium	µg/L	0.1	0.5
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	67000
Strontium	µg/L	1	897
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	2

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 250816-ML-W1
Date: 29-Sep-17
Date Received/Reçu: 28-Sep-17

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

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Attention: Marc Hodder / Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				250816-1
Client Sample ID/ID d'échantillon du client:				TW17-01 72-hr
Date collected/Date du prélèvement				28-Sep-17
Time sampled/Heure du prélèvement				7:20:00 AM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	28-Sep-17	MPN/100mL	0
E. coli	FFA01	28-Sep-17	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	28-Sep-17	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.
Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

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Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Breannah Collins
Micro Technician
Food, Fisheries & Aquaculture

Report ID: 250816-OAS
Report Date: 04-Oct-17
Date Received: 28-Sep-17

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Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			250816-1
Client Sample ID:			TW17-01 72-hr
Date Sampled:			28-Sep-17
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit

Bruce Phillips

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 250816-OAS
Report Date: 04-Oct-17
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Attention: Marc Hodder

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			250816-1
Client Sample ID: Date Sampled: Matrix:			TW17-01 72-hr 28-Sep-17 water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		103
Toluene-d8	%		100
4-Bromofluorobenzene	%		103

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Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 250816-OAS
Report Date: 04-Oct-17
Date Received: 28-Sep-17

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

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www.rpc.ca

Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1386	SPIKEC1386
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	91%
Vinyl Chloride	µg/L	0.5	< 0.5	76%
Bromomethane	µg/L	5.0	< 5.0	81%
Chloroethane	µg/L	5.0	< 5.0	80%
Trichlorofluoromethane	µg/L	5.0	< 5.0	98%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	91%
Methylene Chloride	µg/L	5.0	< 5.0	97%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	97%
1,1-Dichloroethane	µg/L	0.5	< 0.5	92%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	91%
Bromochloromethane	µg/L	0.5	< 0.5	92%
Chloroform	µg/L	0.5	< 0.5	96%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	95%
Carbon Tetrachloride	µg/L	0.5	< 0.5	95%
Benzene	µg/L	0.5	< 0.5	98%
1,2-Dichloroethane	µg/L	0.5	< 0.5	92%
Trichloroethylene	µg/L	0.5	< 0.5	97%
1,2-Dichloropropane	µg/L	0.5	< 0.5	88%
Bromodichloromethane	µg/L	0.5	< 0.5	90%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	104%

RL = Reporting Limit

CERTIFICATE OF ANALYSIS

for
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Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1386	SPIKEC1386
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	105%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	98%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	97%
Tetrachloroethylene	µg/L	0.5	< 0.5	102%
Dibromochloromethane	µg/L	0.5	< 0.5	102%
1,2-Dibromoethane	µg/L	0.5	< 0.5	97%
Chlorobenzene	µg/L	0.5	< 0.5	103%
Ethylbenzene	µg/L	0.5	< 0.5	104%
m,p-Xylenes	µg/L	0.5	< 0.5	108%
o-Xylene	µg/L	0.5	< 0.5	106%
Styrene	µg/L	0.5	< 0.5	102%
Bromoform	µg/L	0.5	< 0.5	92%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	106%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	94%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	106%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	100%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	98%

RL = Reporting Limit

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Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
250816-1	29-Sep-17	29-Sep-17

Report ID: 253248-IAS
Report Date: 06-Nov-17
Date Received: 20-Oct-17

CERTIFICATE OF ANALYSIS

for
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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:			253248-1
Client Sample ID:			TW05-02 6hr
Date Sampled:			20-Oct-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	34.6
Potassium	mg/L	0.02	0.44
Calcium	mg/L	0.05	38.8
Magnesium	mg/L	0.01	2.52
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.372
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	0.003
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.1
Alkalinity (as $CaCO_3$)	mg/L	2	100
Chloride	mg/L	0.5	46.3
Fluoride	mg/L	0.05	0.36
Sulfate	mg/L	1	17
Sulfide	mg/L	0.05	< 0.05
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.02
r-Silica (as SiO_2)	mg/L	0.1	13.6
Carbon - Total Organic	mg/L	0.5	0.6
Turbidity	NTU	0.1	< 0.1
Conductivity	µS/cm	1	384
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	98.8
Carbonate (as $CaCO_3$)	mg/L	-	1.17
Hydroxide (as $CaCO_3$)	mg/L	-	0.063
Cation Sum	meq/L	-	3.67
Anion Sum	meq/L	-	3.66
Percent Difference	%	-	0.19
Theoretical Conductivity	µS/cm	-	363
Hardness (as $CaCO_3$)	mg/L	0.2	107
Ion Sum	mg/L	-	215
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	0.07

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 253248-IAS
Report Date: 06-Nov-17
Date Received: 20-Oct-17

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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			253248-1
Client Sample ID: Date Sampled:			TW05-02 6hr 20-Oct-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	1
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	157
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	22
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	38800
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	36.3
Magnesium	µg/L	10	2520
Manganese	µg/L	1	372
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.4
Nickel	µg/L	1	1
Potassium	µg/L	20	440
Rubidium	µg/L	0.1	0.6
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	34600
Strontium	µg/L	1	866
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	3

Report ID: 253248-IAS
Report Date: 06-Nov-17
Date Received: 20-Oct-17

CERTIFICATE OF ANALYSIS

for
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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 253248-ML-W1
Date: 23-Oct-17
Date Received/Reçu: 20-Oct-17

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
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Attention: Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				253248-1
Client Sample ID/ID d'échantillon du client:				TW05-02 6hr
Date collected/Date du prélèvement				20-Oct-17
Time sampled/Heure du prélèvement				1:15:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	21-Oct-17	MPN/100mL	0
E. coli	FFA01	21-Oct-17	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	21-Oct-17	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.
Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.
Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Caroline St.Pierre

Caroline St. Pierre
Micro Technician
Food, Fisheries & Aquaculture

Report ID: 253248-OAS
Report Date: 01-Nov-17
Date Received: 20-Oct-17

CERTIFICATE OF ANALYSIS

for
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Attention: Wesley Tibbet
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			253248-1
Client Sample ID: Date Sampled: Matrix:			TW05-02 6hr 20-Oct-17 water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Bruce Phillips

Angela Colford

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 253248-OAS
Report Date: 01-Nov-17
Date Received: 20-Oct-17

CERTIFICATE OF ANALYSIS

for
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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			253248-1
Client Sample ID:			TW05-02 6hr
Date Sampled:			20-Oct-17
Matrix:			water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		116
Toluene-d8	%		101
4-Bromofluorobenzene	%		108

CERTIFICATE OF ANALYSIS
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Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 253248-OAS
Report Date: 01-Nov-17
Date Received: 20-Oct-17

CERTIFICATE OF ANALYSIS

for
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Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1587	SPIKEC1587
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	90%
Vinyl Chloride	µg/L	0.5	< 0.5	88%
Bromomethane	µg/L	5.0	< 5.0	77%
Chloroethane	µg/L	5.0	< 5.0	97%
Trichlorofluoromethane	µg/L	5.0	< 5.0	96%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	96%
Methylene Chloride	µg/L	5.0	< 5.0	103%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	101%
1,1-Dichloroethane	µg/L	0.5	< 0.5	99%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	103%
Bromochloromethane	µg/L	0.5	< 0.5	100%
Chloroform	µg/L	0.5	< 0.5	103%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	99%
Carbon Tetrachloride	µg/L	0.5	< 0.5	97%
Benzene	µg/L	0.5	< 0.5	105%
1,2-Dichloroethane	µg/L	0.5	< 0.5	104%
Trichloroethylene	µg/L	0.5	< 0.5	101%
1,2-Dichloropropane	µg/L	0.5	< 0.5	106%
Bromodichloromethane	µg/L	0.5	< 0.5	94%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	95%

RL = Reporting Limit

Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1587	SPIKEC1587
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	100%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	93%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	104%
Tetrachloroethylene	µg/L	0.5	< 0.5	93%
Dibromochloromethane	µg/L	0.5	< 0.5	95%
1,2-Dibromoethane	µg/L	0.5	< 0.5	101%
Chlorobenzene	µg/L	0.5	< 0.5	106%
Ethylbenzene	µg/L	0.5	< 0.5	99%
m,p-Xylenes	µg/L	0.5	< 0.5	106%
o-Xylene	µg/L	0.5	< 0.5	105%
Styrene	µg/L	0.5	< 0.5	99%
Bromoform	µg/L	0.5	< 0.5	82%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	99%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	95%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	107%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	99%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	98%

RL = Reporting Limit

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Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
253248-1	27-Oct-17	27-Oct-17

Report ID: 253267-IAS
Report Date: 03-Nov-17
Date Received: 22-Oct-17

CERTIFICATE OF ANALYSIS

for
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515 Beaverbrook Court
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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:			253267-1
Client Sample ID: Date Sampled:			TW05-04 6hr 21-Oct-17
Analytes	**Units**	**RL**	
Sodium	mg/L	0.05	47.4
Potassium	mg/L	0.02	0.47
Calcium	mg/L	0.05	47.9
Magnesium	mg/L	0.01	2.83
Iron	mg/L	0.02	< 0.02
Manganese	mg/L	0.001	0.284
Copper	mg/L	0.001	< 0.001
Zinc	mg/L	0.001	< 0.001
Ammonia (as N)	mg/L	0.05	< 0.05
pH	units	-	8.1
Alkalinity (as $CaCO_3$)	mg/L	2	93
Chloride	mg/L	0.5	92.4
Fluoride	mg/L	0.05	0.29
Sulfate	mg/L	1	17
Sulfide	mg/L	0.05	< 0.05
Nitrate + Nitrite (as N)	mg/L	0.05	< 0.05
o-Phosphate (as P)	mg/L	0.01	0.01
r-Silica (as SiO_2)	mg/L	0.1	13.8
Carbon - Total Organic	mg/L	0.5	< 0.5
Turbidity	NTU	0.1	< 0.1
Conductivity	µS/cm	1	515
Calculated Parameters			
Bicarbonate (as $CaCO_3$)	mg/L	-	91.9
Carbonate (as $CaCO_3$)	mg/L	-	1.09
Hydroxide (as $CaCO_3$)	mg/L	-	0.063
Cation Sum	meq/L	-	4.71
Anion Sum	meq/L	-	4.82
Percent Difference	%	-	-1.18
Theoretical Conductivity	µS/cm	-	483
Hardness (as $CaCO_3$)	mg/L	0.2	131
Ion Sum	mg/L	-	279
Saturation pH (5°C)	units	-	8.0
Langelier Index (5°C)	-	-	0.11

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; Organic Carbon and ion chemistries for turbid samples are determined on filtered aliquots.

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 253267-IAS
Report Date: 03-Nov-17
Date Received: 22-Oct-17

CERTIFICATE OF ANALYSIS

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www.rpc.ca

Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:			253267-1
Client Sample ID: Date Sampled:			TW05-04 6hr 21-Oct-17
Analytes	**Units**	**RL**	
Aluminum	µg/L	1	3
Antimony	µg/L	0.1	< 0.1
Arsenic	µg/L	1	< 1
Barium	µg/L	1	213
Beryllium	µg/L	0.1	< 0.1
Bismuth	µg/L	1	< 1
Boron	µg/L	1	26
Cadmium	µg/L	0.01	< 0.01
Calcium	µg/L	50	47900
Chromium	µg/L	1	< 1
Cobalt	µg/L	0.1	< 0.1
Copper	µg/L	1	< 1
Iron	µg/L	20	< 20
Lead	µg/L	0.1	< 0.1
Lithium	µg/L	0.1	46.6
Magnesium	µg/L	10	2830
Manganese	µg/L	1	284
Mercury	µg/L	0.025	< 0.025
Molybdenum	µg/L	0.1	0.2
Nickel	µg/L	1	< 1
Potassium	µg/L	20	470
Rubidium	µg/L	0.1	0.6
Selenium	µg/L	1	< 1
Silver	µg/L	0.1	< 0.1
Sodium	µg/L	50	47400
Strontium	µg/L	1	1340
Tellurium	µg/L	0.1	< 0.1
Thallium	µg/L	0.1	< 0.1
Tin	µg/L	0.1	< 0.1
Uranium	µg/L	0.1	< 0.1
Vanadium	µg/L	1	< 1
Zinc	µg/L	1	< 1

CERTIFICATE OF ANALYSIS

for
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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 253267-ML-W1
Date: 23-Oct-17
Date Received/Reçu: 22-Oct-17

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

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Attention: Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				253267-1
Client Sample ID/ID d'échantillon du client:				TW05-04 6hr
Date collected/Date du prélèvement				21-Oct-17
Time sampled/Heure du prélèvement				2:45:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	22-Oct-17	MPN/100mL	2
E. coli	FFA01	22-Oct-17	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	22-Oct-17	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.
Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.
Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Cornelia Maston
Microbiology Technician
Food, Fisheries & Aquaculture

Report ID: 253267-OAS
Report Date: 02-Nov-17
Date Received: 22-Oct-17

CERTIFICATE OF ANALYSIS

for
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Attention: Wesley Tibbet
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			253267-1
Client Sample ID:			TW05-04 6hr
Date Sampled:			21-Oct-17
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Bruce Phillips

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 253267-OAS
Report Date: 02-Nov-17
Date Received: 22-Oct-17

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Attention: Wesley Tibbet
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			253267-1
Client Sample ID:			TW05-04 6hr
Date Sampled:			21-Oct-17
Matrix:			water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		116
Toluene-d8	%		102
4-Bromofluorobenzene	%		108

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Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 253267-OAS
Report Date: 02-Nov-17
Date Received: 22-Oct-17

CERTIFICATE OF ANALYSIS

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Project #: 1307004
Location: New Maryland
QA/QC Report

RPC Sample ID:			BLANKC1587	SPIKEC1587
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	90%
Vinyl Chloride	µg/L	0.5	< 0.5	88%
Bromomethane	µg/L	5.0	< 5.0	77%
Chloroethane	µg/L	5.0	< 5.0	97%
Trichlorofluoromethane	µg/L	5.0	< 5.0	96%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	96%
Methylene Chloride	µg/L	5.0	< 5.0	103%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	101%
1,1-Dichloroethane	µg/L	0.5	< 0.5	99%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	103%
Bromochloromethane	µg/L	0.5	< 0.5	100%
Chloroform	µg/L	0.5	< 0.5	103%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	99%
Carbon Tetrachloride	µg/L	0.5	< 0.5	97%
Benzene	µg/L	0.5	< 0.5	105%
1,2-Dichloroethane	µg/L	0.5	< 0.5	104%
Trichloroethylene	µg/L	0.5	< 0.5	101%
1,2-Dichloropropane	µg/L	0.5	< 0.5	106%
Bromodichloromethane	µg/L	0.5	< 0.5	94%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	95%

RL = Reporting Limit

Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC1587	SPIKEC1587
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	100%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	93%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	104%
Tetrachloroethylene	µg/L	0.5	< 0.5	93%
Dibromochloromethane	µg/L	0.5	< 0.5	95%
1,2-Dibromoethane	µg/L	0.5	< 0.5	101%
Chlorobenzene	µg/L	0.5	< 0.5	106%
Ethylbenzene	µg/L	0.5	< 0.5	99%
m,p-Xylenes	µg/L	0.5	< 0.5	106%
o-Xylene	µg/L	0.5	< 0.5	105%
Styrene	µg/L	0.5	< 0.5	99%
Bromoform	µg/L	0.5	< 0.5	82%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	99%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	95%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	107%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	99%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	98%

RL = Reporting Limit

Report ID: 253267-OAS
Report Date: 02-Nov-17
Date Received: 22-Oct-17

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Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
253267-1	27-Oct-17	27-Oct-17

Report ID: 260455-IAS
Report Date: 22-Jan-18
Date Received: 10-Jan-18

CERTIFICATE OF ANALYSIS

for
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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:					260455-1
Client Sample ID: Date Sampled:					TW17-01 24 hr 10-Jan-18
Analytes	**Units**	**RL**	MAC	AO	
Sodium	mg/L	0.05	-	200	57.5
Potassium	mg/L	0.02	-	-	0.43
Calcium	mg/L	0.05	-	-	36.0
Magnesium	mg/L	0.01	-	-	1.75
Iron	mg/L	0.02	-	0.3	< 0.02
Manganese	mg/L	0.001	-	0.05	0.171
Copper	mg/L	0.001	-	1.0	< 0.001
Zinc	mg/L	0.001	-	5.0	0.009
Ammonia (as N)	mg/L	0.05	-	-	< 0.05
pH	units	-	-	7.0 - 10.5	8.2
Alkalinity (as $CaCO_3$)	mg/L	2	-	-	94
Chloride	mg/L	0.5	-	250	81.7
Fluoride	mg/L	0.05	1.5	-	0.35
Sulfate	mg/L	1	-	500	19
Sulfide	mg/L	0.05	-	0.05	0.08
Nitrate + Nitrite (as N)	mg/L	0.05	10	-	< 0.05
o-Phosphate (as P)	mg/L	0.01	-	-	0.01
r-Silica (as SiO_2)	mg/L	0.1	-	-	12.1
Carbon - Total Organic	mg/L	0.5	-	-	1.1
Turbidity	NTU	0.1	-	-	0.2
Conductivity	µS/cm	1	-	-	469
Calculated Parameters					
Bicarbonate (as $CaCO_3$)	mg/L	-	-	-	92.5
Carbonate (as $CaCO_3$)	mg/L	-	-	-	1.38
Hydroxide (as $CaCO_3$)	mg/L	-	-	-	0.079
Cation Sum	meq/L	-	-	-	4.46
Anion Sum	meq/L	-	-	-	4.58
Percent Difference	%	-	-	-	-1.33
Theoretical Conductivity	µS/cm	-	-	-	455
Hardness (as $CaCO_3$)	mg/L	0.2	-	-	97.1
Ion Sum	mg/L	-	-	500	266
Saturation pH (5°C)	units	-	-	-	8.1
Langelier Index (5°C)	-	-	-	-	0.10

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; MAC = Maximum Acceptable Concentration; AO = Aesthetic Objective

Guidelines are from Guidelines for Canadian Drinking Water Quality (February 2017).

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 260455-IAS
Report Date: 22-Jan-18
Date Received: 10-Jan-18

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www.rpc.ca

Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:					260455-1
Client Sample ID:					TW17-01 24 hr
Date Sampled:					10-Jan-18
Analytes	**Units**	**RL**	MAC	AO	
Aluminum	µg/L	1	-	-	3
Antimony	µg/L	0.1	6	-	< 0.1
Arsenic	µg/L	1	10	-	< 1
Barium	µg/L	1	1000	-	206
Beryllium	µg/L	0.1	-	-	< 0.1
Bismuth	µg/L	1	-	-	< 1
Boron	µg/L	1	5000	-	29
Cadmium	µg/L	0.01	5	-	< 0.01
Calcium	µg/L	50	-	-	36000
Chromium	µg/L	1	50	-	< 1
Cobalt	µg/L	0.1	-	-	< 0.1
Copper	µg/L	1	-	1000	< 1
Iron	µg/L	20	-	300	< 20
Lead	µg/L	0.1	10	-	0.3
Lithium	µg/L	0.1	-	-	51.0
Magnesium	µg/L	10	-	-	1750
Manganese	µg/L	1	-	50	171
Mercury	µg/L	0.025	1	-	< 0.025
Molybdenum	µg/L	0.1	-	-	0.3
Nickel	µg/L	1	-	-	2
Potassium	µg/L	20	-	-	430
Rubidium	µg/L	0.1	-	-	0.5
Selenium	µg/L	1	50	-	< 1
Silver	µg/L	0.1	-	-	< 0.1
Sodium	µg/L	50	-	200000	57500
Strontium	µg/L	1	-	-	1000
Tellurium	µg/L	0.1	-	-	< 0.1
Thallium	µg/L	0.1	-	-	< 0.1
Tin	µg/L	0.1	-	-	< 0.1
Uranium	µg/L	0.1	20	-	< 0.1
Vanadium	µg/L	1	-	-	< 1
Zinc	µg/L	1	-	5000	9

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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 260455-ML-W1
Date: 11-Jan-18
Date Received/Reçu: 10-Jan-18

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

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Attention: Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				260455-1
Client Sample ID/ID d'échantillon du client:				TW17-01 24 hr
Date collected/Date du prélèvement				10-Jan-18
Time sampled/Heure du prélèvement				12:30:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	10-Jan-18	MPN/100mL	0
E. coli	FFA01	10-Jan-18	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	10-Jan-18	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Gillian Travis
Acting Microbiology Supervisor
Food, Fisheries & Aquaculture

Breannah Collins
Micro Technician
Food, Fisheries & Aquaculture

Report ID: 260455-OAS
Report Date: 18-Jan-18
Date Received: 10-Jan-18

CERTIFICATE OF ANALYSIS

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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			260455-1
Client Sample ID:			TW17-01 24 hr
Date Sampled:			10-Jan-18
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Bruce Phillips

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID:	260455-OAS
Report Date:	18-Jan-18
Date Received:	10-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			260455-1
Client Sample ID: Date Sampled: Matrix:			TW17-01 24 hr 10-Jan-18 water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		104
Toluene-d8	%		100
4-Bromofluorobenzene	%		102

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 260455-OAS
Report Date: 18-Jan-18
Date Received: 10-Jan-18

CERTIFICATE OF ANALYSIS

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Project #: 1307004
Location: New Maryland
QA/QC Report

RPC Sample ID:			BLANKC2093	SPIKEC2093
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	117%
Vinyl Chloride	µg/L	0.5	< 0.5	103%
Bromomethane	µg/L	5.0	< 5.0	92%
Chloroethane	µg/L	5.0	< 5.0	105%
Trichlorofluoromethane	µg/L	5.0	< 5.0	103%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	96%
Methylene Chloride	µg/L	5.0	< 5.0	101%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	102%
1,1-Dichloroethane	µg/L	0.5	< 0.5	99%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	98%
Bromochloromethane	µg/L	0.5	< 0.5	100%
Chloroform	µg/L	0.5	< 0.5	100%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	100%
Carbon Tetrachloride	µg/L	0.5	< 0.5	98%
Benzene	µg/L	0.5	< 0.5	110%
1,2-Dichloroethane	µg/L	0.5	< 0.5	102%
Trichloroethylene	µg/L	0.5	< 0.5	103%
1,2-Dichloropropane	µg/L	0.5	< 0.5	104%
Bromodichloromethane	µg/L	0.5	< 0.5	95%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	95%

RL = Reporting Limit

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Project #: 1307004

Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC2093	SPIKEC2093
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	108%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	94%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	102%
Tetrachloroethylene	µg/L	0.5	< 0.5	104%
Dibromochloromethane	µg/L	0.5	< 0.5	98%
1,2-Dibromoethane	µg/L	0.5	< 0.5	97%
Chlorobenzene	µg/L	0.5	< 0.5	102%
Ethylbenzene	µg/L	0.5	< 0.5	105%
m,p-Xylenes	µg/L	0.5	< 0.5	103%
o-Xylene	µg/L	0.5	< 0.5	109%
Styrene	µg/L	0.5	< 0.5	105%
Bromoform	µg/L	0.5	< 0.5	86%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	100%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	97%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	104%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	100%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	100%

RL = Reporting Limit

Report ID: 260455-OAS
Report Date: 18-Jan-18
Date Received: 10-Jan-18

CERTIFICATE OF ANALYSIS

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Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
260455-1	11-Jan-18	11-Jan-18

Report ID: 260591-IAS
Report Date: 22-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:					260591-1
Client Sample ID:					TW17-01 48hr
Date Sampled:					11-Jan-18
Analytes	**Units**	**RL**	MAC	AO	
Sodium	mg/L	0.05	-	200	56.6
Potassium	mg/L	0.02	-	-	0.42
Calcium	mg/L	0.05	-	-	34.7
Magnesium	mg/L	0.01	-	-	1.72
Iron	mg/L	0.02	-	0.3	< 0.02
Manganese	mg/L	0.001	-	0.05	0.168
Copper	mg/L	0.001	-	1.0	< 0.001
Zinc	mg/L	0.001	-	5.0	0.003
Ammonia (as N)	mg/L	0.05	-	-	< 0.05
pH	units	-	-	7.0 - 10.5	7.7
Alkalinity (as $CaCO_3$)	mg/L	2	-	-	100
Chloride	mg/L	0.5	-	250	75.0
Fluoride	mg/L	0.05	1.5	-	0.37
Sulfate	mg/L	1	-	500	19
Sulfide	mg/L	0.05	-	0.05	0.08
Nitrate + Nitrite (as N)	mg/L	0.05	10	-	< 0.05
o-Phosphate (as P)	mg/L	0.01	-	-	0.02
r-Silica (as SiO_2)	mg/L	0.1	-	-	12.5
Carbon - Total Organic	mg/L	0.5	-	-	< 0.5
Turbidity	NTU	0.1	-	-	< 0.1
Conductivity	µS/cm	1	-	-	470
Calculated Parameters					
Bicarbonate (as $CaCO_3$)	mg/L	-	-	-	99.5
Carbonate (as $CaCO_3$)	mg/L	-	-	-	0.469
Hydroxide (as $CaCO_3$)	mg/L	-	-	-	0.025
Cation Sum	meq/L	-	-	-	4.35
Anion Sum	meq/L	-	-	-	4.51
Percent Difference	%	-	-	-	-1.79
Theoretical Conductivity	µS/cm	-	-	-	442
Hardness (as $CaCO_3$)	mg/L	0.2	-	-	93.7
Ion Sum	mg/L	-	-	500	261
Saturation pH (5°C)	units	-	-	-	8.1
Langelier Index (5°C)	-	-	-	-	-0.39

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; MAC = Maximum Acceptable Concentration; AO = Aesthetic Objective

Guidelines are from Guidelines for Canadian Drinking Water Quality (February 2017).

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

Report ID: 260591-IAS
Report Date: 22-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
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515 Beaverbrook Court
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921 College Hill Rd
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Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:					260591-1
Client Sample ID: Date Sampled:					TW17-01 48hr 11-Jan-18
Analytes	**Units**	**RL**	MAC	AO	
Aluminum	µg/L	1	-	-	2
Antimony	µg/L	0.1	6	-	< 0.1
Arsenic	µg/L	1	10	-	< 1
Barium	µg/L	1	1000	-	206
Beryllium	µg/L	0.1	-	-	< 0.1
Bismuth	µg/L	1	-	-	< 1
Boron	µg/L	1	5000	-	30
Cadmium	µg/L	0.01	5	-	< 0.01
Calcium	µg/L	50	-	-	34700
Chromium	µg/L	1	50	-	< 1
Cobalt	µg/L	0.1	-	-	< 0.1
Copper	µg/L	1	-	1000	< 1
Iron	µg/L	20	-	300	< 20
Lead	µg/L	0.1	10	-	< 0.1
Lithium	µg/L	0.1	-	-	50.5
Magnesium	µg/L	10	-	-	1720
Manganese	µg/L	1	-	50	168
Mercury	µg/L	0.025	1	-	< 0.025
Molybdenum	µg/L	0.1	-	-	0.4
Nickel	µg/L	1	-	-	1
Potassium	µg/L	20	-	-	420
Rubidium	µg/L	0.1	-	-	0.5
Selenium	µg/L	1	50	-	< 1
Silver	µg/L	0.1	-	-	< 0.1
Sodium	µg/L	50	-	200000	56600
Strontium	µg/L	1	-	-	988
Tellurium	µg/L	0.1	-	-	< 0.1
Thallium	µg/L	0.1	-	-	< 0.1
Tin	µg/L	0.1	-	-	< 0.1
Uranium	µg/L	0.1	20	-	< 0.1
Vanadium	µg/L	1	-	-	< 1
Zinc	µg/L	1	-	5000	3

Report ID: 260591-IAS
Report Date: 22-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
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Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 260591-ML-W1
Date: 12-Jan-18
Date Received/Reçu: 11-Jan-18

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
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515 Beaverbrook Court
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921 College Hill Rd
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Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:				260591-1
Client Sample ID/ID d'échantillon du client:				TW17-01 48hr
Date collected/Date du prélèvement				11-Jan-18
Time sampled/Heure du prélèvement				12:30:00 PM
Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	11-Jan-18	MPN/100mL	0
E. coli	FFA01	11-Jan-18	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	11-Jan-18	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Cornelia Maston
Microbiology Technician
Food, Fisheries & Aquaculture

Report ID: 260591-OAS
Report Date: 18-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

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Attention: Wesley Tibbet
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			260591-1
Client Sample ID:			TW17-01 48hr
Date Sampled:			11-Jan-18
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Bruce Phillips

Angela Colford

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 260591-OAS
Report Date: 18-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Attention: Wesley Tibbet
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			260591-1
Client Sample ID: Date Sampled: Matrix:			TW17-01 48hr 11-Jan-18 water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		108
Toluene-d8	%		98
4-Bromofluorobenzene	%		100

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 260591-OAS
Report Date: 18-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
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Project #: 1307004
Location: New Maryland
QA/QC Report

RPC Sample ID:			BLANKC2098	SPIKEC2098
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	114%
Vinyl Chloride	µg/L	0.5	< 0.5	109%
Bromomethane	µg/L	5.0	< 5.0	103%
Chloroethane	µg/L	5.0	< 5.0	109%
Trichlorofluoromethane	µg/L	5.0	< 5.0	111%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	98%
Methylene Chloride	µg/L	5.0	< 5.0	108%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	104%
1,1-Dichloroethane	µg/L	0.5	< 0.5	106%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	107%
Bromochloromethane	µg/L	0.5	< 0.5	107%
Chloroform	µg/L	0.5	< 0.5	111%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	104%
Carbon Tetrachloride	µg/L	0.5	< 0.5	102%
Benzene	µg/L	0.5	< 0.5	118%
1,2-Dichloroethane	µg/L	0.5	< 0.5	110%
Trichloroethylene	µg/L	0.5	< 0.5	106%
1,2-Dichloropropane	µg/L	0.5	< 0.5	111%
Bromodichloromethane	µg/L	0.5	< 0.5	100%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	92%

RL = Reporting Limit

Report ID: 260591-OAS
Report Date: 18-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Project #: 1307004
Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC2098	SPIKEC2098
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	110%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	90%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	105%
Tetrachloroethylene	µg/L	0.5	< 0.5	106%
Dibromochloromethane	µg/L	0.5	< 0.5	98%
1,2-Dibromoethane	µg/L	0.5	< 0.5	102%
Chlorobenzene	µg/L	0.5	< 0.5	107%
Ethylbenzene	µg/L	0.5	< 0.5	111%
m,p-Xylenes	µg/L	0.5	< 0.5	108%
o-Xylene	µg/L	0.5	< 0.5	114%
Styrene	µg/L	0.5	< 0.5	112%
Bromoform	µg/L	0.5	< 0.5	88%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	106%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	106%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	113%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	106%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	110%

RL = Reporting Limit

Report ID: 260591-OAS
Report Date: 18-Jan-18
Date Received: 11-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
260591-1	12-Jan-18	12-Jan-18

Report ID: 260707-IAS
Report Date: 29-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

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Tel: 506.452.1212
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Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Water

RPC Sample ID:					260707-1
Client Sample ID:					TW17-01 72hr
Date Sampled:					12-Jan-18
Analytes	**Units**	**RL**	MAC	AO	
Sodium	mg/L	0.05	-	200	56.6
Potassium	mg/L	0.02	-	-	0.42
Calcium	mg/L	0.05	-	-	34.9
Magnesium	mg/L	0.01	-	-	1.72
Iron	mg/L	0.02	-	0.3	< 0.02
Manganese	mg/L	0.001	-	0.05	0.168
Copper	mg/L	0.001	-	1.0	< 0.001
Zinc	mg/L	0.001	-	5.0	0.001
Ammonia (as N)	mg/L	0.05	-	-	< 0.05
pH	units	-	-	7.0 - 10.5	7.8
Alkalinity (as $CaCO_3$)	mg/L	2	-	-	95
Chloride	mg/L	0.5	-	250	76.7
Fluoride	mg/L	0.05	1.5	-	0.37
Sulfate	mg/L	1	-	500	18
Sulfide	mg/L	0.05	-	0.05	0.07
Nitrate + Nitrite (as N)	mg/L	0.05	10	-	< 0.05
o-Phosphate (as P)	mg/L	0.01	-	-	0.01
r-Silica (as SiO_2)	mg/L	0.1	-	-	12.1
Carbon - Total Organic	mg/L	0.5	-	-	< 0.5
Turbidity	NTU	0.1	-	-	< 0.1
Conductivity	µS/cm	1	-	-	457
Calculated Parameters					
Bicarbonate (as $CaCO_3$)	mg/L	-	-	-	94.4
Carbonate (as $CaCO_3$)	mg/L	-	-	-	0.560
Hydroxide (as $CaCO_3$)	mg/L	-	-	-	0.032
Cation Sum	meq/L	-	-	-	4.36
Anion Sum	meq/L	-	-	-	4.44
Percent Difference	%	-	-	-	-0.85
Theoretical Conductivity	µS/cm	-	-	-	441
Hardness (as $CaCO_3$)	mg/L	0.2	-	-	94.2
Ion Sum	mg/L	-	-	500	259
Saturation pH (5°C)	units	-	-	-	8.1
Langelier Index (5°C)	-	-	-	-	-0.31

This report relates only to the sample(s) and information provided to the laboratory.

RL = Reporting Limit; MAC = Maximum Acceptable Concentration; AO = Aesthetic Objective

Guidelines are from Guidelines for Canadian Drinking Water Quality (February 2017).

Ross Kean

A. Ross Kean, M.Sc.
Department Head
Inorganic Analytical Chemistry

Peter Crowhurst, B.Sc., C.Chem
Analytical Chemist
Inorganic Analytical Chemistry

WATER CHEMISTRY

Report ID: 260707-IAS
Report Date: 29-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS
for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Analysis of Metals in Water

RPC Sample ID:					260707-1
Client Sample ID:					TW17-01 72hr
Date Sampled:					12-Jan-18
Analytes	**Units**	**RL**	MAC	AO	
Aluminum	µg/L	1	-	-	2
Antimony	µg/L	0.1	6	-	< 0.1
Arsenic	µg/L	1	10	-	< 1
Barium	µg/L	1	1000	-	205
Beryllium	µg/L	0.1	-	-	< 0.1
Bismuth	µg/L	1	-	-	< 1
Boron	µg/L	1	5000	-	30
Cadmium	µg/L	0.01	5	-	< 0.01
Calcium	µg/L	50	-	-	34900
Chromium	µg/L	1	50	-	< 1
Cobalt	µg/L	0.1	-	-	< 0.1
Copper	µg/L	1	-	1000	< 1
Iron	µg/L	20	-	300	< 20
Lead	µg/L	0.1	10	-	< 0.1
Lithium	µg/L	0.1	-	-	51.2
Magnesium	µg/L	10	-	-	1720
Manganese	µg/L	1	-	50	168
Mercury	µg/L	0.025	1	-	< 0.025
Molybdenum	µg/L	0.1	-	-	0.3
Nickel	µg/L	1	-	-	1
Potassium	µg/L	20	-	-	420
Rubidium	µg/L	0.1	-	-	0.5
Selenium	µg/L	1	50	-	< 1
Silver	µg/L	0.1	-	-	< 0.1
Sodium	µg/L	50	-	200000	56600
Strontium	µg/L	1	-	-	988
Tellurium	µg/L	0.1	-	-	< 0.1
Thallium	µg/L	0.1	-	-	< 0.1
Tin	µg/L	0.1	-	-	< 0.1
Uranium	µg/L	0.1	20	-	< 0.1
Vanadium	µg/L	1	-	-	< 1
Zinc	µg/L	1	-	5000	1

Report ID: 260707-IAS
Report Date: 29-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
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Fax: 506.452.0594
www.rpc.ca

Methods

Analyte	RPC SOP #	Method Reference	Method Principle
Ammonia	4.M47	APHA 4500-NH_3 G	Phenate Colourimetry
pH	4.M03	APHA 4500-H^+ B	pH Electrode - Electrometric
Alkalinity (as $CaCO_3$)	4.M43	EPA 310.2	Methyl Orange Colourimetry
Chloride	4.M44	APHA 4500-CL E	Ferricyanide Colourimetry
Fluoride	4.M30	APHA 4500-F- D	SPADNS Colourimetry
Sulfate	4.M45	APHA 4500-SO_4 E	Turbidimetry
Sulfide	-	APHA 4500-S2- D	Methylene Blue Colourimetry
Nitrate + Nitrite (as N)	4.M48	APHA 4500-NO_3 H	Hydrazine Red., Derivitization, Colourimetry
o-Phosphate (as P)	4.M50	APHA 4500-P F	Molybdate/Ascorbic Acid Colourimetry
r-Silica (as SiO_2)	4.M46	APHA 4500-SI F	Heteropoly Blue Colourimetry
Carbon - Total Organic	4.M38	APHA 5310 C	UV-Persulfate Digestion, NDIR Detection
Turbidity	4.M06	APHA 2130 B	Nephelometry
Conductivity	4.M04	APHA 2510 B	Conductivity Meter, Pt Electrode
Trace Metals	4.M01/4.M29	EPA 200.8/EPA 200.7	ICP-MS/ICP-ES
Mercury	4.M52	EPA 245.1	Cold Vapor AAS

Report/Rapport: 260707-ML-W1
Date: 15-Jan-18
Date Received/Reçu: 12-Jan-18

CERTIFICATE OF ANALYSIS / CERTIFICAT D'ANALYSE

for/pour
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

rpc
921 College Hill Rd
Fredericton NB
Canada E3B 6Z9
Tel: 506.452.1368
Fax: 506.452.1395
www.rpc.ca

Attention: Wesley Tibbet

Project/Job #: 1307004

Client Location: New Maryland

Microbiological Examination of Water/Qualité microbiologique de l'eau potable

RPC Sample ID/No. d'échantillon de RPC:	260707-1
Client Sample ID/ID d'échantillon du client:	TW17-01 72hr
Date collected/Date du prélèvement	12-Jan-18
Time sampled/Heure du prélèvement	12:30:00 PM

Analytes/Paramètre(s)	**Method/Méthode**	**Date Analyzed Date Analysé**	**Units Unités**	
Total Coliforms/Coliformes totaux	FFA01	12-Jan-18	MPN/100mL	0
E. coli	FFA01	12-Jan-18	MPN/100mL	0
Faecal Coliforms/Coliformes fécaux	FFA01	12-Jan-18	MPN/100mL	0

This report relates only to the sample(s) and information provided to the laboratory.

Tests were performed according to the corresponding Compendium of Analytical Methods, Health Protection Branch and/or AOAC Official Methods.

Le présent rapport ne s'applique qu'aux échantillons et à l'information transmis au laboratoire.

Les analyses ont été menées conformément au Compendium de méthodes pour l'analyse correspondant ou aux méthodes officielles de la Direction générale de la protection de la santé ou de l'Association of Official Analytical Chemists (AOAC).

Cathy Hay

Cathy Hay
Microbiology Supervisor
Food, Fisheries & Aquaculture

Cornelia Maston
Microbiology Technician
Food, Fisheries & Aquaculture

Report ID: 260707-OAS
Report Date: 18-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

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921 College Hill Rd
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Canada E3B 6Z9
Tel 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Attention: Wesley Tibbet

Project #: 1307004

Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			260707-1
Client Sample ID:			TW17-01 72hr
Date Sampled:			12-Jan-18
Matrix:			water
Analytes	Units	RL	
Chloromethane	µg/L	5.0	< 5.0
Vinyl Chloride	µg/L	0.5	< 0.5
Bromomethane	µg/L	5.0	< 5.0
Chloroethane	µg/L	5.0	< 5.0
Trichlorofluoromethane	µg/L	5.0	< 5.0
1,1-Dichloroethylene	µg/L	0.5	< 0.5
Methylene Chloride	µg/L	5.0	< 5.0
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5
1,1-Dichloroethane	µg/L	0.5	< 0.5
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5
Bromochloromethane	µg/L	0.5	< 0.5
Chloroform	µg/L	0.5	< 0.5
1,1,1-Trichloroethane	µg/L	0.5	< 0.5
Carbon Tetrachloride	µg/L	0.5	< 0.5
Benzene	µg/L	0.5	< 0.5
1,2-Dichloroethane	µg/L	0.5	< 0.5
Trichloroethylene	µg/L	0.5	< 0.5
1,2-Dichloropropane	µg/L	0.5	< 0.5
Bromodichloromethane	µg/L	0.5	< 0.5
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5

This report relates only to the sample(s) and information provided to the laboratory.
RL = Reporting Limit

Bruce Phillips

Bruce Phillips
Department Head
Organic Analytical Services

Angela Colford

Angela Colford
Lab Supervisor
Organic Analytical Services

Report ID: 260707-OAS
Report Date: 18-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Attention: Wesley Tibbet
Project #: 1307004
Location: New Maryland

Volatile Organic Compounds in Water

RPC Sample ID:			260707-1
Client Sample ID: Date Sampled: Matrix:			TW17-01 72hr 12-Jan-18 water
Analytes	Units	RL	
Toluene	µg/L	0.5	< 0.5
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5
1,1,2-Trichloroethane	µg/L	0.5	< 0.5
Tetrachloroethylene	µg/L	0.5	< 0.5
Dibromochloromethane	µg/L	0.5	< 0.5
1,2-Dibromoethane	µg/L	0.5	< 0.5
Chlorobenzene	µg/L	0.5	< 0.5
Ethylbenzene	µg/L	0.5	< 0.5
m,p-Xylenes	µg/L	0.5	< 0.5
o-Xylene	µg/L	0.5	< 0.5
Styrene	µg/L	0.5	< 0.5
Bromoform	µg/L	0.5	< 0.5
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5
1,3-Dichlorobenzene	µg/L	0.5	< 0.5
1,4-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichlorobenzene	µg/L	0.5	< 0.5
1,2-Dichloroethane-d4	%		105
Toluene-d8	%		100
4-Bromofluorobenzene	%		99

Method Summary

OAS-HC02: Determination of Volatile Organic Compounds in Water.

Report ID: 260707-OAS
Report Date: 18-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Project #: 1307004
Location: New Maryland

QA/QC Report

RPC Sample ID:			BLANKC2106	SPIKEC2106
Matrix:			water	water
Analytes	Units	RL		% Recovery
Chloromethane	µg/L	5.0	< 5.0	116%
Vinyl Chloride	µg/L	0.5	< 0.5	107%
Bromomethane	µg/L	5.0	< 5.0	108%
Chloroethane	µg/L	5.0	< 5.0	109%
Trichlorofluoromethane	µg/L	5.0	< 5.0	110%
1,1-Dichloroethylene	µg/L	0.5	< 0.5	95%
Methylene Chloride	µg/L	5.0	< 5.0	102%
1,2-Dichloroethylene (trans)	µg/L	0.5	< 0.5	100%
1,1-Dichloroethane	µg/L	0.5	< 0.5	101%
1,2-Dichloroethylene (cis)	µg/L	0.5	< 0.5	100%
Bromochloromethane	µg/L	0.5	< 0.5	106%
Chloroform	µg/L	0.5	< 0.5	101%
1,1,1-Trichloroethane	µg/L	0.5	< 0.5	103%
Carbon Tetrachloride	µg/L	0.5	< 0.5	99%
Benzene	µg/L	0.5	< 0.5	109%
1,2-Dichloroethane	µg/L	0.5	< 0.5	103%
Trichloroethylene	µg/L	0.5	< 0.5	101%
1,2-Dichloropropane	µg/L	0.5	< 0.5	101%
Bromodichloromethane	µg/L	0.5	< 0.5	94%
1,3-Dichloropropylene (trans)	µg/L	0.5	< 0.5	94%

RL = Reporting Limit

Report ID: 260707-OAS
Report Date: 18-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
Fredericton, NB E3B 1X6

Project #: 1307004
Location: New Maryland
QA/QC Report

RPC Sample ID:			BLANKC2106	SPIKEC2106
Matrix:			water	water
Analytes	Units	RL		% Recovery
Toluene	µg/L	0.5	< 0.5	106%
1,3-Dichloropropylene (cis)	µg/L	0.5	< 0.5	94%
1,1,2-Trichloroethane	µg/L	0.5	< 0.5	103%
Tetrachloroethylene	µg/L	0.5	< 0.5	106%
Dibromochloromethane	µg/L	0.5	< 0.5	98%
1,2-Dibromoethane	µg/L	0.5	< 0.5	100%
Chlorobenzene	µg/L	0.5	< 0.5	103%
Ethylbenzene	µg/L	0.5	< 0.5	108%
m,p-Xylenes	µg/L	0.5	< 0.5	107%
o-Xylene	µg/L	0.5	< 0.5	110%
Styrene	µg/L	0.5	< 0.5	107%
Bromoform	µg/L	0.5	< 0.5	86%
1,1,1,2-Tetrachloroethane	µg/L	0.5	< 0.5	101%
1,1,2,2-Tetrachloroethane	µg/L	0.5	< 0.5	96%
1,3-Dichlorobenzene	µg/L	0.5	< 0.5	100%
1,4-Dichlorobenzene	µg/L	0.5	< 0.5	100%
1,2-Dichlorobenzene	µg/L	0.5	< 0.5	99%

RL = Reporting Limit

Report ID: 260707-OAS
Report Date: 18-Jan-18
Date Received: 12-Jan-18

CERTIFICATE OF ANALYSIS

for
BGC Engineering Inc.
515 Beaverbrook Court
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Canada E3B 6Z9
Tel: 506.452.1212
Fax: 506.452.0594
www.rpc.ca

Project #: 1307004

Summary of Date Analyzed

	VOC	
RPC Sample ID	**Extracted**	**Analyzed**
260707-1	15-Jan-18	15-Jan-18

APPENDIX

C-2 *BREEDING BIRD, RARE PLANT, AND WETLAND SURVEYS*

REPORT

(on behalf of WSP)

BREEDING BIRD, RARE PLANT AND
WETLAND SURVEY PROPOSED
WELLFIELD DEVELOPMENT SITE

VILLAGE OF NEW MARYLAND,
NEW BRUNSWICK

PROJECT NO. 18-0103

REPORT TO

WSP
80 Bishop Drive
Fredericton, NB
E3C 1B2

ON

Breeding Bird, Rare Plant and Wetland Survey, Proposed Wellfield Development

New Maryland, NB

Biologist Derrick Mitchell, *BSc.F*.

August, 2018

Boreal Environmental Inc.,
511 Bay Street
Saint John, New Brunswick
E2M 7L3

Phone: 506-651-1346

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1.0 INTRODUCTION

Boreal Environmental (Boreal) was contracted by WSP, in June of 2018 to conduct wetland, bird, and rare plant survey on the site of a proposed wellfield development site (PID 75062174, 75064840, 75349068) in the Village of New Maryland, New Brunswick (Figure 1). The purpose of the environmental constraints analysis was to determine location of to develop a wellfield in order to provide adequate water supply to the Village of New Maryland. The primary objective of these surveys was to determine if rare species and/or wetlands were present within the Project Area.

1.1 Regulatory Framework

The following sections outline the applicable regulatory legislation and requirements for plants, birds and wetlands.

1.1.1 Plants and wildlife

In 2002, SARA was created to provide additional protection for plant and wildlife species against extirpation, extinction or endangerment from human activities. Currently, only the species listed in Schedule 1 of *SARA* are protected federally (Government of Canada 2002). Provisions to protect and recover a species come into effect once it has been listed in Schedule 1 of SARA. The *New Brunswick Species at Risk Act or NBSAR* provides another level of legislative protection for species at risk and species of conservation concern. Different levels of protection are afforded for species listed within these acts depending on the species rarity ranking. Several agencies including the Atlantic Canada Conservation Data Center (AC CDC) and New Brunswick Department of Energy and Natural Resource Development (NB DERD) contribute lists of 'species of conservation concern' that are not protected by legislation.

The general location of species at risk and species of conservation concern from the AC CDC database search of the proposed Project located are provided in Appendix I.

“Species at risk” include all species listed in Schedule 1 of *SARA* as “Extirpated”, “Endangered” or “Threatened” or listed as endangered or regionally endangered in the NB *ESA*.

“Species of conservation concern” include listed species not under the protection of *SARA* or the NB *ESA* and include species listed as “Special Concern” in Schedule 1 of *SARA*; listed in Schedule 2 or 3 of *SARA*; or ranked as S1, S2, or S3 by AC CDC; and/or ranked “May Be At Risk” or “Sensitive” by NB DERD. It also includes species recently ranked Endangered or Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (therefore ranked “At Risk” by NBDERD) but not added to Schedule 1 of *SARA*.

“Secure” species are those ranked as S4 or S5 by AC CDC, and/or designated as “Secure” by NB DERD.

1.1.2 Wetlands

This report provides the results of a wetland delineation pursuant to the *Watercourse and Wetlands Alteration Regulation* under the *Clean Water Act*. Under this Act, wetlands are defined as:

(a) either periodically or permanently, has a water table at, near or above the land's surface or that is saturated with water; and

(b) sustains aquatic processes as indicated by the presence of hydric soils, hydrophytic vegetation and biological activities adapted to wet conditions.

Any proposed alterations within a watercourse and / or wetland, or within their 30 m regulated buffer, requires permitting through the New Brunswick Department of the Environment and Local Government (NB DELG) Watercourse and Wetlands Alteration (WAWA) Program. Any project that has the potential to impact a wetland ≥ 2 ha, and / or its regulated 30 m buffer, must be registered through the Environmental Impact Assessment Regulation [87-83] of the New Brunswick Clean Environment Act.

1.1.3 Migratory Birds

In Canada, the MBCA provides overarching protection for individual and populations of birds and their nests against harm or destruction (Government of Canada 1994a). The MBCA and associated regulations are administered by Environment Canada through the Canadian Wildlife Service (Government of Canada 1994a). Species groups protected by the MBCA include; songbirds, waterfowl, and seabirds; however, grouse, ptarmigan, hawks, eagles, owls, blackbirds or jays are not afforded protection under the MBCA (Environment Canada 1991).

“Species at Risk” include all species listed in Schedule 1 of SARA as “Extirpated”, “Endangered” or “Threatened” or listed in the NB SAR as “At Risk”.

”Species of Conservation Concern” include listed species not under the protection of SARA or the NB SAR and include species listed as “Special Concern” in Schedule 1 of SARA; listed in Schedule 2 or 3 of SARA; or ranked as S1, S2, or S3 by AC CDC; and/or ranked “May Be At Risk” or “Sensitive” by NB DERD.
“Secure” species are those ranked as S4 or S5 by AC CDC, or designated as “Secure” by NB DERD.

Project Location
Village of New Maryland

Figure 1

Map Features

🟩 Property boundary

N

Map Properties

Projection: NB Double Stereographic NAD83
Datum: NAD 83
Date: July 2018
Scale: 1:13000
Base Maps Provided By: Service New Brunswick

BOREAL
ENVIRONMENTAL

2.0 VEGETATION AND RARE FLORA SURVEY

A rare flora survey was carried out within the proposed Project Area. The scope of work carried out for the vegetation and rare flora survey included:

- A desktop Species at Risk (SAR) Study;
- Identifying all encountered vascular vegetation within the Project Area; and
- Identifying all encountered rare flora (vascular or non-vascular) within the Project Area.

2.1 Rare Plant Survey Methodology

Derrick Mitchell a biologist conducted a vascular vegetation and rare flora survey within the Project Area. A desktop review of SAR and areas of concern data from the AC CDC was carried prior to field studies. The AC CDC data request was limited to within a 5 km radius of the Project Area. The AC CDC database search provided the following:

- Reported observations of rare and endangered flora and fauna;
- Expert Opinion Maps information to identify species that have not been reported but are expected based upon estimates of habitat and wildlife distribution; and
- Locations of any Special Areas such as the following:
    - Managed areas with some level of protection;
    - Significant ecological areas of interest;
    - National Defense areas; and
    - First Nations areas.

The species listed within the AC CDC report were referenced to ranking outlined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), the *Species at Risk Act* (*SARA*), and the *New Brunswick Species at Risk Act* (*NBSAR*). During the site visit, comparison to habitats suited to any identified rare or endangered species of flora identified in the desktop study was completed.

The biologist traversed the site by foot in a random meandering fashion throughout the Project Area. The intent of using this methodology was to capture unique habitats that may be present within the Project Area (*i.e.,* rock outcrops, watercourses and wetlands). In general, these habitats have an elevated potential for the occurrence of rare species. The locations of all encountered rare flora were recorded using a handheld GPS unit. Specimens were collected if a species could not be identified in the field. The biologist also recorded an inventory of all plant species encountered while conducting the field reconnaissance program.

2.2 Summary of Results Rare Plant Surveys

The vegetation and rare flora surveys were conducted in mid-June to increase the likelihood of identification of plants while in flower. A complete inventory of plant species encountered within the Project Area is presented in Appendix II. No rare or uncommon plant species were found during the survey.

3.0 BREEDING BIRD SURVEYS

Breeding bird surveys in the Project Area focused on species at risk and species of conservation concern. There are, both, federal (*Species at Risk Act or SARA*) and provincial (New Brunswick *Species at Risk Act)* legislation for the protection of species at risk and species of conservation concern, and there are different levels of protection afforded a species within these acts depending on the species rarity ranking. For example, the federal Act protects only the species currently listed in Schedule 1 of *SARA.* Species designated as “Special Concern” are not protected by Sections 32-36 of *SARA*, but do require that provincial or regional management plans are developed to protect the species. Also, there are several agencies that provide lists of “species of conservation concern” that are not protected by legislation but may require special consideration in the environmental review process. Known locations of species at risk and species of conservation concern from the AC CDC database search are provided in Appendix I.

3.1 Breeding Bird Survey Methodology

A breeding bird survey was conducted using the methods outlined in the Maritime Breeding Bird Atlas (MBBA 2010). Preliminary site selection for the breeding bird survey locations were based on forest composition and development stage located within the Project Area determined from aerial photography and forest inventory data from the NBDERD. Actual survey locations were representative of all habitats identified along the pipeline RoW and spaced at least 250 m apart to avoid bird detection overlap. Point count locations can be viewed in Figure 3.

One round of point counts was conducted on June 12th, 2018 between 5:45 and 9:00 am. Each point count location was surveyed for a period of 10 minutes during the survey. The breeding status of each species was determined using the criteria used in the MBBA. Data were collected for each bird detected including; number, species, behavior, and location in relation to the survey point. Species observed or heard singing in suitable nesting habitat were classified as possible breeders. Species exhibiting the following behaviours were also classed as probable breeders:

- courtship behaviour between a male and female;
- birds visiting a probable nest site;

- birds displaying agitated behaviour; and
- male and female observed together in suitable nesting habitat.

Species were confirmed as breeding if any of the following items or activities were observed:

- nest building or adults carrying nesting material;
- distraction display or injury feigning;
- recently fledged young;
- occupied nest located; and
- adult observed carrying food or fecal sac for young.

Incidental birds were also recorded during rare plant and vegetation surveys to ensure that the diversity of bird species was captured in the Project Area.

3.2 Bird Habitat Description

The subject property is approximately 97 ha; however, only a small percentage of the property will be utilized for Project infrastructure including access roads and well pads. The dominant forested habitat tends to be in various stages of development due to forest harvesting activities. Habitat types identified in the NB DERD forest inventory were verified in field during the bird survey and adjusted accordingly where the forest inventory differed from 'high level' field survey. Notes were taken on development stage and forest species composition at each point count location.

Patches of mature contiguous forest greater than 10 ha and free from edge effects or 'Interior Forest' are important for a number of bird species that rely on this habitat type for foraging and breeding. Interior forest is preferred by some species that are less adaptable to disturbance than others. These patches do not necessarily fall entirely within the properties that make up the Project Area; however, they should be considered as important landscape features within the context of bird habitat. There are no patches of interior forest located in the Project Area.

The dominant forested habitat type within the Project Area was shade intolerant deciduous forest (YIHW, IIHW, MIHW) and ranges in age from approximately 30 to 50 years old. Intolerant hardwood habitat tends to be closed canopied and consists of early successional tree species approximately 35 years old. The tree layer is predominantly made up of shade intolerant trees species including; trembling aspen (*Populus tremuloides)*, gray birch *(Betula populifolia),* red maple *(Acer rubrum)*, white birch *(Betula papyrifera)* and balsam fir *(Abies balsamea)* in descending order. Herbaceous cover consists of wild lily-of-the-valley *(Maianthemum canadense)*, Canada bunchberry *(Cornus canadensis),* wild sarsaparilla *(Aralia nudicaulis),* evergreen woodfern *(dryopteris intermedia)*, and various sedge *(Carex spp.)* species.

Mixed forest (IMXD, MMXD) habitat type is ranges from 35 to 50 years old. The tree layer is dominated by balsam fir *(Abies balsaemea)*, red spruce *(Picea rubens)*, red maple, trembling aspen, and scattered white pine *(Pinus strobus)*. The shrub and herbaceous layers were very sparse due to high canopy closure; however, balsam fir, Canada bunchberry, starflower *(Trientalis borealis)* and wild lily-of-the-valley were scatted throughout the forest stands.

Mature softwood (MSWD) habitat type is ranges from 50 to 80 years old. The tree layer is dominated by balsam fir *(Abies balsaemea)*, red spruce *(Picea rubens)*, eastern white cedar *(Thuja occidentalis)* and scattered eastern white pine *(Pinus strobus)*. The shrub and herbaceous layers were very sparse due to high canopy closure; however, balsam fir, Canada bunchberry, starflower *(Trientalis borealis)* and wild lily-of-the-valley were scatted throughout the forest stands.

3.3 Summary of Bird Survey Results

A total of 40 bird species comprising 204 individuals were recorded during the Jun 13th, 2018 survey. The most numerous species recorded overall were ovenbird, American crow, black-throated green warbler, black-capped chickadee, red-breasted nuthatch, northern parula and red-eyed vireo in descending order. This would be expected given the development stage and species composition of the forest within the Project Area.

No raptor nests were noted in the vicinity of the Project Area. Observed bird species were characteristic of early successional forest that are typical of the region. Common nighthawk surveys were not conducted because suitable habitat did not exist in the Project area.

Table 1 is a summary of the breeding bird survey data collected during the survey on June 13th, 2018. Table 2 provides a summary of bird species detected during the survey and habitat types where they were detected.

Table 1. Bird species recorded on June 13th, 2018 during point count survey.

Common Name	Latin Name	S-Rank*	NBDERD General Status *	Highest breeding status†	Number Recorded
American Crow	Corvus brachyrhynchos	S5	Secure	PO	17
American Goldfinch	Spinus tristis	S5	Secure	PO	4
American Redstart	Setophaga ruticilla	S5B	Secure	PO	6
American Robin	Turdus migratorius	S5B	Secure	PO	1
Belted Kingfisher	Megaceryle alcyon	S5B	Secure	PO	1
Black-and-white Warbler	Mniotilta varia	S5B	Secure	CO	6
Black-capped Chickadee	Poecile atricapillus	S5	Secure	PO	15
Black-throated Green Warbler	Setophaga virens	S5B	Secure	PO	15
Blackburnian Warbler	Setophaga fusca	S5B	Secure	PO	7
Black-throated Blue Warbler	Setophaga caerulescens	S5B	Secure	PO	2
Blue Jay	Cyanocitta cristata	S5B	Secure	PO	3
Blue-headed Vireo	Vireo solitarius	S5B	Secure	PR	8
Canada Goose	Branta canadensis	S5B	Secure	PO	5
Canada Warbler	Cardellina canadensis	S3B	At Risk	PO	1
Cedar waxwing	Bombycilla cedrorum	S5B	Secure	PO	3
Chestnut-sided Warbler	Setophaga pensylvanica	S5B	Secure	PO	1

Table 1. Bird species recorded on June 13th, 2018 during point count survey.

Common Name	Latin Name	S-Rank*	NBDERD General Status *	Highest breeding status†	Number Recorded
Common Yellowthroat	Geothlypis trichas	S5B	Secure	PO	1
Common Raven	Corvus corax	S5B	Secure	PO	4
Downy Woodpecker	Picoides pubescens	S5B	Secure	PO	1
Eastern Kingbird	Tyrannus tyrannus	S3S4B	Sensitive	CO	4
Golden-crowned Kinglet	Regulus satrapa	S5B	Secure	PO	2
Gray Jay	Perisoreus canadensis	S5B	Secure	PO	1
Hairy Woodpecker	Dryobates villosus	S5	Secure	PO	4
Hermit Thrush	Catharus guttatus	S5B	Secure	CO	9
Magnolia Warbler	Setophaga magnolia	S5B	Secure	PO	1
Mourning Dove	Zenaida macroura	S5B	Secure	PO	1
Nashville Warbler	Oreothlypis ruficapilla	S5B	Secure	PO	1
Northern Flicker	Colaptes auratus	S5B	Secure	PO	1
Northern Parula	Setophaga americana	S5B	Secure	PR	12
Ovenbird	Seiurus aurocapilla	S5B	Secure	PO	25
Purple Finch	Haemorhous purpureus	S4S5B	Secure	PO	3
Red-breasted Nuthatch	Sitta canadensis	S5	Secure	PR	13
Red-eyed Vireo	Vireo olivaceus	S5B	Secure	PO	11
Ruffed Grouse	Bonasa umbellus	S5B	Secure	CO	3
Swamp Sparrow	Melospiza georgiana	S5B	Secure	PO	1
Veery	Catharus fuscescens	S4B	Secure	PO	1
White-throated Sparrow	Zonotrichia albicollis	S5B	Secure	PO	2
Winter Wren	Troglodytes hiemalis	S5B	Secure	PO	5
Yellow-bellied Sapsucker	Sphyrapicus varius	S5	Secure	CO	3
Yellow-rumped Warbler	Setophaga coronata	S5B	Secure	PO	2
Total:					**204**

Breeding Status Codes:
PO = possible breeder
PR = probable breeder
CO = confirmed breeder

Table 2. Summary of bird species and associated habitat within the Project Area.

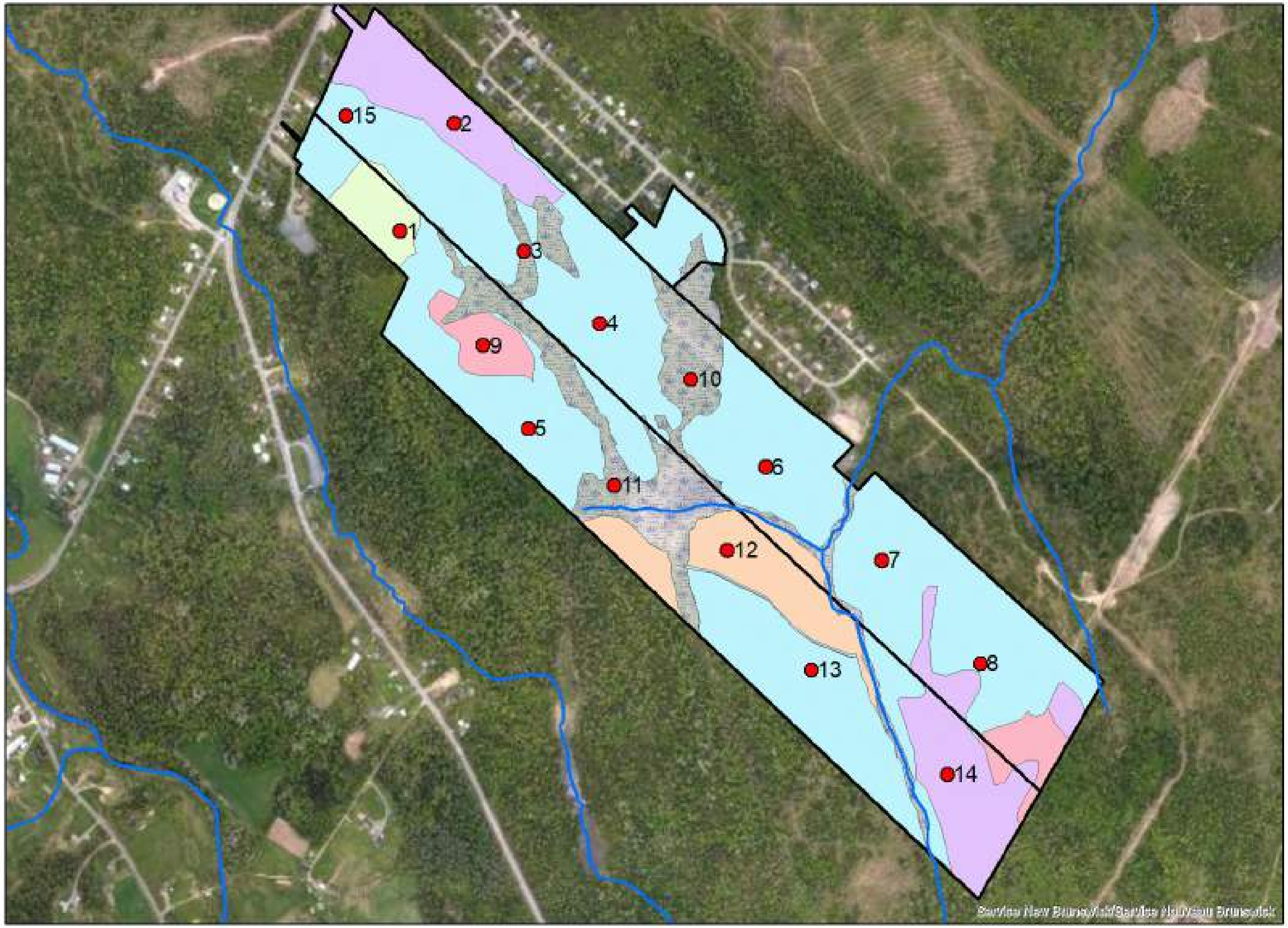
Common Name	Latin Name	Habitat Association†
American Crow	Corvus brachyrhynchos	IMXD, YIHW, MIHW
American Goldfinch	Spinus tristis	YIHW, MIHW
American Redstart	Setophaga ruticilla	YIHW, MIHW
American Robin	Turdus migratorius	MSWD, YIHW, IIHW, MIHW
Belted Kingfisher	Megaceryle alcyon	WL
Black-and-white Warbler	Mniotilta varia	YIHW, MIHW
Black-capped Chickadee	Poecile atricapillus	YIHW, MIHW
Black-throated Green Warbler	Setophaga virens	IMXD, MSWD, YIHW,MIHW
Blackburnian Warbler	Setophaga fusca	YIHW, MIHW
Black-throated Blue Warbler	Setophaga caerulescens	YIHW, MIHW
Blue Jay	Cyanocitta cristata	YIHW, MIHW

Common Name	Latin Name	Habitat Association[†]
Blue-headed Vireo	Vireo solitarius	IMXD, YIHW, MIHW, MMXD
Canada Goose	Branta canadensis	WL
Canada Warbler	Cardellina canadensis	YMXD
Cedar waxwing	Bombycilla cedrorum	WL
Chestnut-sided Warbler	Setophaga pensylvanica	MIHW
Common Yellowthroat	Geothlypis trichas	YIHW, MIHW
Common Raven	Corvus corax	MIHW
Downy Woodpecker	Picoides pubescens	MIHW
Eastern Kingbird	Tyrannus tyrannus	MIHW
Golden-crowned Kinglet	Regulus satrapa	IMXD, MIHW
Gray Jay	Perisoreus canadensis	MSWD
Hairy Woodpecker	Dryobates villosus	YIHW, MIHW
Hermit Thrush	Catharus guttatus	MSWD, YIHW, MIHW, YIHW, MMXD
Magnolia Warbler	Setophaga magnolia	MSWD
Mourning Dove	Zenaida macroura	YIHW
Nashville Warbler	Oreothlypis ruficapilla	IMXD
Northern Flicker	Colaptes auratus	MIHW
Northern Parula	Setophaga americana	MSWD, YIHW, YIHW, MIHW
Ovenbird	Seiurus aurocapilla	IMXD, YIHW, IIHW,MIHW, MMXD
Purple Finch	Haemorhous purpureus	IMXD, YIHW
Red-breasted Nuthatch	Sitta canadensis	MSWD, YIHW, MIHW, MMXD
Red-eyed Vireo	Vireo olivaceus	YIHW, IIHW, MIHW
Ruffed Grouse	Bonasa umbellus	YIHW, MIHW, MMXD
Swamp Sparrow	Melospiza georgiana	WL
Veery	Catharus fuscescens	WL
White-throated Sparrow	Zonotrichia albicollis	MIHW
Winter Wren	Troglodytes hiemalis	MSWD, YIHW, MIHW
Yellow-bellied Sapsucker	Sphyrapicus varius	IMXD
Yellow-rumped Warbler	Setophaga coronata	IMXD

Habitat Codes:
YIHW - Young intolerant hardwood
IIHW - Intolerant hardwood
MIHW - Mature intolerant hardwood
MSWD - Mature softwood
IMXD - Immature mixedwood
MMXD - Mature mixedwood
WL - Wetland

3.4 Bird Species at Risk and of Species of Conservation of Concern

Available information on the known occurrences of bird Species at Risk (SAR) and of Special Conservation Concern (SCC) near the Project Area was compiled and reviewed from the AC CDC. Only those species with potential habitat in close proximity of the Project Area are addressed in this report. Several SAR and SCC bird species were identified by the AC CDC as having been reported within a 5 km radius of the Project Area. Potential habitat for some of the species listed by the AC CDC exists within the Project Area. Table 3 provides a summary of these species and habitat requirements. It also provides a rating of the potential for these species to occur based of the habitat types that exist within the Project Area.



Breeding Bird Survey Village of New Maryland

Figure 2

Map Features

▭ Property boundary

▨ Delineated wetlands

Habitat

🟥	IIHW	🟧	IMXD
🟪	MMXD	🟦	MIHW
🟩	MSWD		

● Point count locations

— Mapped watercourses

N

Map Properties

Projection: NB Double Stereographic NAD83
Datum: NAD 83
Date: July 2018
Scale: 1:13000
Base Maps Provided By: Service New Brunswick

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Table 3. Bird Species at Risk and Special Conservation Concern reported by the AC CDC.

Common Name	**Scientific Name**	**Breeding habitat**	**Foraging habitat**	**Probability of occurrence**	**SARA (Schedule 1) NB ESA**	**S Rank**	**General Status**
Brown-headed Cowbird	*Molothrus ater*	Grasslands with low and scattered trees, forest edges, shrub thickets, fields, pastures, orchards, and residential areas.	Fields and pastures.	Low	NA	S3B,S3M	May Be At Risk
Canada warbler	*Wilsonia canadensis*	Moist dense thickets near wetlands .	Forages on ground or in dense understory thickets.	Recorded	Threatened	S3B,S3M	At Risk
Chimney Swift	*Chaetura pelagica*	Trunks of large, hollow trees, and occasionally on cave walls or in rocky crevices prior to European settlement. Post Euopean settlement house chimneys.	Same as nesting.	Low	Threatened	S2S3B,S2M	At Risk
Common Nighthawk	*Chordeiles minor*	Open area habitats, abandon agriculture, disturbed areas, bogs, rock outcrops and gravel roofs.	At high altitude or over open areas.	Low	Threatened	S3B	At Risk
Eastern Kingbird	*Tyrannus tyrannus*	Fields with scattered shrubs and trees, orchards, and forest edges. Edges of marshes and farmland.	Open habitat with scattered trees for perching.	Recorded	NA	S3S4B,S3S4 M	Sensitive
Evening Grosbeak	*Coccothraustes vespertinus*	Coniferous and mixed forests; often associated with spruce and fir.	Forages in trees and fruiting shrubs.	Moderate	Special concern	S3B, S3S4N, SUM	Sensitive
Great Crested Flycatcher	*Myiarchus crinitus*	Deciduous/mixed forests, and forest edges or abandoned orchards. Nests in natural cavity or old woodpecker holes.	Forest edge or open habitat with perches.	Moderate	NA	S2S3B, S2S3M	Sensitive
Killdeer	*Charadrius vociferus*	Various but prefer open habitat. Pastures, plowed fields, large lawns, mudflats, lake shores, coastal estuaries.	Forages in open areas typically near water.	Low	NA	S3B,S3M	Sensitive

Red-shouldered Hawk	*Buteo lineatus*	Nests in deciduous and mixed forest, with tall trees and relatively open understory, often along rivers and swamps.	Same as nesting	Low			
Scarlet Tanager	*Piranga olivacea*	Large undisturbed tracts of mature deciduous and mixed forests.	Same as nesting	Moderate	NA	S3B,S3M	Secure
Whip-Poor-Will	*Caprimulgus vociferus*	Rich moist woodlands, either deciduous or mixed forest with sparse understory, close to open areas.	Same as nesting	Moderate	Threatened	S2B, S2M	At Risk

4.0 WETLAND ASSESSMENT

A field survey was conducted between June 11th and June 16th (2018), by Derrick Mitchell, a qualified wetland delineator, of Boreal Environmental. Wetland assessment for each wetland encountered included the following parameters:

- Boundary delineation and characterization of each wetland; and
- A functional assessment for each wetland.

4.1 Wetland delineation methods

Wetland delineation was conducted in accordance with the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987). Wetland data were recorded on NB DELG Wetland Delineation Data Sheet which is provided in Appendix IV. Existing information (aerial photography and LiDAR) was used in the field to assist with delineation. Munsell Soil Color Charts (Kollmorgen Instruments Co. 1990) were used to identify hydric soils within the survey area. The Flora of New Brunswick (Hinds 2000) was consulted for plant nomenclature and identification.

Wetland habitat was identified using the following criteria in accordance with the Corps of Engineers Wetlands Delineation Manual:

- A majority of dominant vegetation species are wetland associated species;
- Hydrologic conditions exist that result in periods of flooding, ponding, or saturation during the growing season; and
- Hydric soils are present

Data point locations were sampled to evaluate vegetation, hydrology, and soil data to support a determination of wetland or non-wetland status. The data and boundary point locations were recorded using a Trimble Nomad GPS Unit with a ± 3 m accuracy.

4.1.1 Vegetation

The Corps of Engineers Wetlands Delineation Manual defines hydrophytic vegetation as the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanent or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present. To classify an area as ‘wetland’, hydrophytic vegetation should be the dominant plant type.

The "50/20 rule" was used to determine the dominant plant species at each data point location. Dominant plant species observed at each data point were classified according to their indicator status (probability of occurrence in wetlands). If the majority (greater than 50 percent) of the dominant vegetation with the assessment area were classified as obligate (OBL), facultative wetland (FACW), or facultative (FAC) (excluding FAC-), then the site was considered to be dominated by hydrophytic vegetation.

4.1.2 Soils

A hydric soil is formed when soil is saturated, flooded, or experiences ponding over an extended period during the growing season such that anaerobic conditions in the upper layer develop. Indicators that a hydric soil is present include soil color (gleyed soils and soils with bright mottles and/or low matrix chroma), aquic or preaquic moisture regime, reducing soil conditions, sulfidic material (odor), soils listed on hydric soils list, iron and manganese concretions, organic soils (Histosols), histic epipedon, high organic content in surface layer in sandy soils, and organic streaking in sandy soils.

At each data point, a soil pit was excavated to a minimum depth of 50 (cm) or refusal. The soil was then examined for hydric soil indicators. The matrix color and mottle color (if present) of the soil was determined using *Munsell Soil Color Charts*. To establish whether or not a soil was hydric, hydric indicators were determined using Filed Indicators of the Hydric Soils in the United States, A Guide to Identifying and Delineating Hydric Soils, Version 6.0 (United States Department of Agriculture and Natural Resources Conservation Service 2006) was used.

4.1.3 Hydrology

The presence of any hydrology indicators (primary and/or secondary) was recorded. Primary indicators of wetland hydrology include, but are not limited to: water marks; drift lines; sediment deposition; drainage patterns; visual observation of saturated soils; and visual observation of inundation.

In addition to the primary indicators, there is a variety of secondary wetland hydrology indicators. Secondary indicators include, but are not limited to: oxidized root channels in the upper 30 cm; water-stained leaves; and local soil survey data. If no primary indicators of wetland hydrology were observed at a data point, two or more secondary indicators were used to confirm wetland hydrology.

4.2 Wetland functional assessment

The Wetland Ecosystem Services Protocol for Atlantic Canada (WESP-AC) was used to assess the ecosystem function of WL 1 and WL 2. WESP-AC is a rapid assessment tool used to evaluate the function and value of non-tidal wetlands in Atlantic Canada. WESP-AC generates (0 to 10 scale) and ratings (Lower, Moderate, Higher) for each of the wetland's functions and benefits. The results of the assessment can be used to inform decisions with respect to impact avoidance, minimization, and compensation.

WESP-AC assesses wetland parameters at a landscape and site specific level and incorporates existing stressors. These scores estimate a wetland’s ability to support the following functions:

- Water Storage and Delay;
- Sediment Retention and Stabilization;

- Phosphorus Retention;
- Nitrate Removal and Retention;
- Thermoregulation;
- Carbon Sequestration;
- Organic Matter Export;
- Pollinator Habitat;
- Aquatic Invertebrate Habitat;
- Anadromous Fish Habitat;
- Non-anadromous Fish Habitat;
- Amphibian & Reptile Habitat;
- Waterbird Feeding Habitat;
- Waterbird Nesting Habitat;
- Songbird, Raptor and Mammal Habitat;
- Pollinator Habitat; and
- Native Plant Diversity.

Only high rated wetland functions are summarized in this report as these functions tend to indicate the important ecological processes that are a particular wetland performs within the environment. Benefit scores are not discussed as they describe the context that the function has been considered and developed; however, the benefit scores are presented and can be reviewed in the WESP-AC score sheets in Appendix V.

4.3 Wetland summary of results

Two unmapped wetlands, WL 1 and WL 2, were identified on the subject property. They were determined to be forested swamps of various types (Figure 3). WL 1 swamp complex 13.1 ha in size consisting of forested riverene swamp, forested slope swamp and sedge/reed riparian swamp. Several small unmapped intermittent and permanent watercourses flow through WL 1 which discharge to a mapped watercourse in the southeastern portion of the property. WL 2 was a determined to be a deciduous treed riverene swamp. The watercourse that flows through WL 2 discharges to WL 1. Representative photographs of plant communities within each wetland are provide in Appendix VI.

Wetland and Watercourse Village of New Maryland

Figure 3

Map Features

▭	Property boundaries
▨	Delineated wetlands
—	Delineated watercourses
—	Mapped watercourses
●	Wetland delineation data points

N

Map Properties

Projection: NB Double Stereographic NAD83
Datum: NAD 83
Date: July 2018
Scale: 1:13000
Base Maps Provided By: Service New Brunswick

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Table 4. Summary of delineated wetlands and functional assessments for PID 75062174, 75064840, 75349068 in the Village of New Maryland, NB.

Wetland ID	Wetland Size within Study Area (hectares)	Wetland Characteristics	High Rated Function Attributes
1	13.1	Wetland 1 (WL 1) is a large wetland complex made up of three different wetland types that are connected intermittent and permanent watercourse channels; deciduous and coniferous treed slope swamp, deciduous treed riverene swamp and sedge/reed riparian swamp. These channels are characterized as seasonal drainage channels that do not support fish or fish habitat. Three water test wells were observed overflowing and contributing a ground water to WL 1 (Photo 1). All wells were equipped with a valve that appeared to be fully open for a long period of time. Groundwater had been flowing for a period of time sufficient to develop a channel that discharged directly into the sedge/reed riparian swamp component of the WL 1. The tree layer of treed swamp (slope and riverene) components of WL 1 were dominated by red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), balsam fir (*Abies balsamea*), balsam poplar (*Populus balsamifera*), yellow birch (*Betula alleghaniensis*), and eastern white cedar (*Thuja occidentalis*). The shrub layer was dominated by speckled alder (*Alnus incana*), balsam fir (*Abies balsamea*) and beaked hazel (*Corylus cornuta*). While the herbaceous layer of the sensitive fern (*Onoclea sensibilis*), spotted touch-me-not (*Impatiens capensis*), cinnamon fern (*Osmunda cinnamonea*), blue-joint reedgrass (*Calamagrostus canadensis*), wood horsetail (*Equisetum sylvaticum*), dwarf raspberry (*Rubus pubescens*), three-seeded sedge (*Carex trisperma*), and tall meadow rue (*Thalictrum pubescens*) (Photos 2, 3, 4, 5 and 6), Appendix VI).	• Stream Flow Support • Water Cooling • Nitrate Removal & Retention • Organic Nutrient Export • Resident Fish Habitat • Waterbird Feeding Habitat • Waterbird Nesting Habitat • Songbird, Raptor, & Mammal Habitat • Pollinator Habitat • Native Plant Habitat

		The sedge/reed riparian swamp component of the wetland complex was dominated by tussock sedge (*Carex stricta*) and common woolgrass (*Scirpus cyperinus*) (Photo 5, Appendix VI). Wetland hydrology indicators included; high water table, soil saturation, and water stained leaves. These indicators are considered primary indicators of wetland hydrology. All components of the WL 1 contained depleted soils which are characterized by low chromo values. Detailed information with respect to WL 1 vegetation, hydrology and soils can be reviewed in the wetland delineation field forms (Appendix IV).	
Wetland ID	**Wetland Size within Study Area (hectares)**	**Wetland Characteristics**	**High Rated Function Attributes**
2	0.7	Wetland 2 (WL 2) is a small deciduous treed riverene swamp that includes a permanent watercourse channel. Although fish were not observed during the wetland survey this watercourse may be fish habitat due to observed flow despite dry weather conditions, gravel substrate and size of the channel. WL 2 was partially disturbed and intersected by a utility access road along the northern boundary. All terrain vehicle (ATV) use along this road was relatively heavy; however, erosion and rutting appeared to be localized to the road right of way. The aforementioned watercourse crosses the utility road via an open channel (i.e., not a culvert) into WL 2. The watercourse flows through WL 2 and eventually discharges into WL 1. The tree layer of WL 2 was dominated by black ash, red maple, balsam poplar, and balsam fir. The shrub strata was similar vegetatively to the tree layer and	• Water Cooling • Organic Nutrient Export • Waterbird Feeding Habitat • Waterbird Nesting Habitat • Songbird, Raptor, & Mammal Habitat • Pollinator Habitat • Native Plant Habitat

		comprised of scattered black ash and balsam fir, while the herbaceous layer was dominated by cinnamon fern, New York fern (*Thelypteris novaboracensis*), nodding sedge (*Carex gynandra*), sensitive fern (Photos 7, 8 and 9, Appendix VI). Wetland hydrology indicators included; high water table, soil saturation, and water stained leaves. These indicators are considered primary indicators of wetland hydrology. All components of the WL 2 contained depleted soils which are characterized by low chromo values. Detailed information with respect to WL 2 vegetation, hydrology and soils can be reviewed in the wetland delineation field forms (Appendix IV).	

4.4 Upland data point vegetation

Dominant upland vegetation at data point locations consisted of balsam fir, red maple, gray birch (*Betula populifolia*), yellow birch, white ash (*Fraxinus Americana*), false lily-of-the-valley, star flower (*Trientalis borealis*), intermediate wood fern (*Dryopteris intermedia*) and Canada bunchberry. A more complete inventory of vegetation at data point locations can be viewed in wetland delineation forms (Appendix IV).

5.0 CLOSURE AND DISCLAIMER

The sole purpose of this report and the associated services performed by Boreal Environmental was to conduct a rare plant, breeding bird and wetland survey, on behalf of Opus International Consultants, NB.

The observations made and facts presented in this report are based on several site visits and site investigations conducted between June 12th and 16th, 2018. Site conditions at the time of visitation / sampling are reflected in this document and no independent confirmation of this information was made.

The report expresses the professional opinion of Boreal Environmental and is based on technical / scientific knowledge. Boreal Environmental accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report or data by any third party.

6.0 REFERENCES

Canadian Wetland Classification System (2nd Ed.). (1997). University of Waterloo, Waterloo, ON.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. U. S. Army Engineer Waterways Experiment Station. Vicksburg, Mississippi.

Environment Canada (EC). 1991. Birds protected in Canada under the Migratory Birds Convention Act. Occasional Paper Number 1. Canadian Wildlife Service. Online: http://publications.gc.ca/collections/collection_2011/ec/CW69-1-1-1991.pdf. Accessed June, 2018.

Government of Canada. 1994a. Migratory Birds Convention Act. Online:
http://lawslois.justice.gc.ca/eng/acts/M-7.01/page-1.html. Accessed June, 2018.

Hinds, H.R. 2000. Flora of New Brunswick, 2nd Ed., University of New Brunswick Press, Fredericton, NB. 695 pp.

Kollmorgen Instruments Company. 1990. Munsell Soil Color Charts. Kollmorgen Corporation. Baltimore, Maryland.

Government of Canada. 2002. Species at Risk Act. Online: http://laws-lois.justice.gc.ca/eng/acts/S-15.3/ Accessed June, 2018.

Province of New Brunswick. 2012. Species at Risk. Online: http://laws.gnb.ca/en/showfulldoc/cs/2012-c.6//20160809 Accessed June, 2018.

Appendix I
AC CDC Report

Atlantic Canada Conservation Data Centre
Centre de données sur la conservation du Canada atlantique

DATA REPORT 5997: New Maryland, NB

Prepared 17 January 2018
by J. Churchill, Data Manager

CONTENTS OF REPORT

Map 1. A 100 km buffer around the study area

1.0 PREFACE

The Atlantic Canada Conservation Data Centre (ACCDC) is part of a network of NatureServe data centres and heritage programs serving 50 states in the U.S.A, 10 provinces and 1 territory in Canada, plus several Central and South American countries. The NatureServe network is more than 30 years old and shares a common conservation data methodology. The ACCDC was founded in 1997, and maintains data for the jurisdictions of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador. Although a non-governmental agency, the ACCDC is supported by 6 federal agencies and 4 provincial governments, as well as through outside grants and data processing fees. URL: www.ACCDC.com.

Upon request and for a fee, the ACCDC queries its database and produces customized reports of the rare and endangered flora and fauna known to occur in or near a specified study area. As a supplement to that data, the ACCDC includes locations of managed areas with some level of protection, and known sites of ecological interest or sensitivity.

1.1 DATA LIST

Included datasets:

Filename	Contents
NwMarylandNB_5997ob.xls	All Rare and legally protected *Flora and Fauna* in your study area
NwMarylandNB_5997ob100km.xls	A list of Rare and legally protected *Flora and Fauna* within 100 km of your study area
NwMarylandNB_5997ma.xls	All *Managed Areas* in your study area
NwMarylandNB_5997ff.xls	Rare and common *Freshwater Fish* in your study area (DFO database)

1.2 RESTRICTIONS

The ACCDC makes a strong effort to verify the accuracy of all the data that it manages, but it shall not be held responsible for any inaccuracies in data that it provides. By accepting ACCDC data, recipients assent to the following limits of use:

a) Data is restricted to use by trained personnel who are sensitive to landowner interests and to potential threats to rare and/or endangered flora and fauna posed by the information provided.
b) Data is restricted to use by the specified Data User; any third party requiring data must make its own data request.
c) The ACCDC requires Data Users to cease using and delete data 12 months after receipt, and to make a new request for updated data if necessary at that time.
d) ACCDC data responses are restricted to the data in our Data System at the time of the data request.
e) Each record has an estimate of locational uncertainty, which must be referenced in order to understand the record's relevance to a particular location. Please see attached Data Dictionary for details.
f) ACCDC data responses are not to be construed as exhaustive inventories of taxa in an area.
g) The absence of a taxon cannot be inferred by its absence in an ACCDC data response.

1.3 ADDITIONAL INFORMATION

The attached file DataDictionary 2.1.pdf provides metadata for the data provided.

Please direct any additional questions about ACCDC data to the following individuals:

Plants, Lichens, Ranking Methods, All other Inquiries
Sean Blaney, Senior Scientist, Executive Director
Tel: (506) 364-2658
sblaney@mta.ca

Animals (Fauna)
John Klymko, Zoologist
Tel: (506) 364-2660
jklymko@mta.ca

Plant Communities
Sarah Robinson, Community Ecologist
Tel: (506) 364-2664
srobinson@mta.ca

Data Management, GIS
James Churchill, Data Manager
Tel: (902) 679-6146
jlchurchill@mta.ca

Billing
Jean Breau
Tel: (506) 364-2657
jrbreau@mta.ca

Questions on the biology of Federal Species at Risk can be directed to ACCDC: (506) 364-2658, with questions on Species at Risk regulations to: Samara Eaton, Canadian Wildlife Service (NB and PE): (506) 364-5060 or Julie McKnight, Canadian Wildlife Service (NS): (902) 426-4196.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in New Brunswick, please contact Stewart Lusk, Natural Resources: (506) 453-7110.

For provincial information about rare taxa and protected areas, or information about game animals, deer yards, old growth forests, archeological sites, fish habitat etc., in Nova Scotia, please contact Sherman Boates, NSDNR: (902) 679-6146. To determine if location-sensitive species (section 4.3) occur near your study site please contact a NSDNR Regional Biologist:

Western: Duncan Bayne
(902) 648-3536
Duncan.Bayne@novascotia.ca

Western: Jason Power
(902) 634-7555
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Central: Shavonne Meyer
(902) 893-6353
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Central: Kimberly George
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Eastern: Lisa Doucette
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Lisa.Doucette@novascotia.ca

Eastern: Terry Power
(902) 563-3370
Terrance.Power@novascotia.ca

For provincial information about rare taxa and protected areas, or information about game animals, fish habitat etc., in Prince Edward Island, please contact Garry Gregory, PEI Dept. of Communities, Land and Environment: (902) 569-7595.

2.0 RARE AND ENDANGERED SPECIES

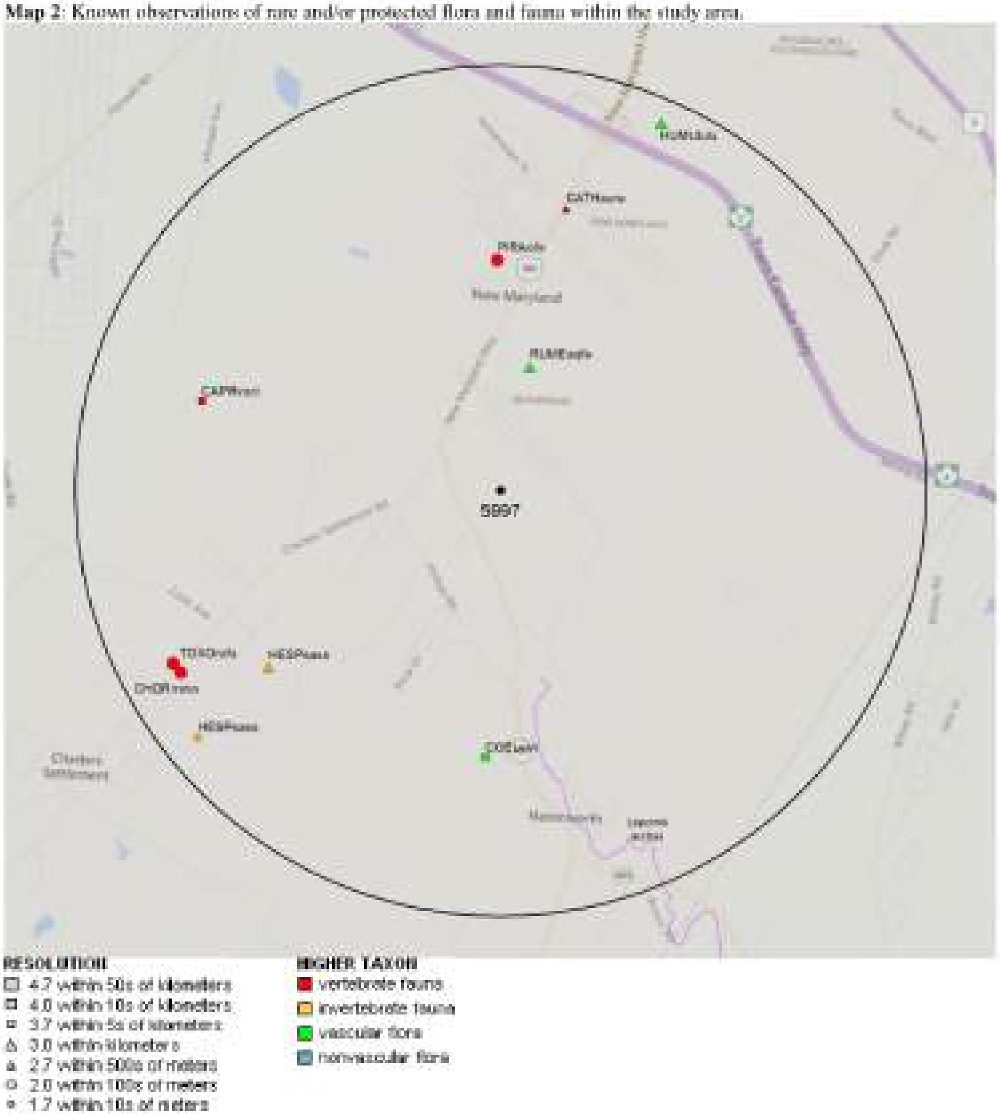
2.1 FLORA

The study area contains 5 records of 3 vascular, no records of nonvascular flora (Map 2 and attached: *ob.xls).

2.2 FAUNA

The study area contains 5 records of 5 vertebrate, 2 records of 1 invertebrate fauna (Map 2 and attached data files - see 1.1 Data List). Please see section 4.3 to determine if 'location-sensitive' species occur near your study site.

Map 2: Known observations of rare and/or protected flora and fauna within the study area.



3.0 SPECIAL AREAS

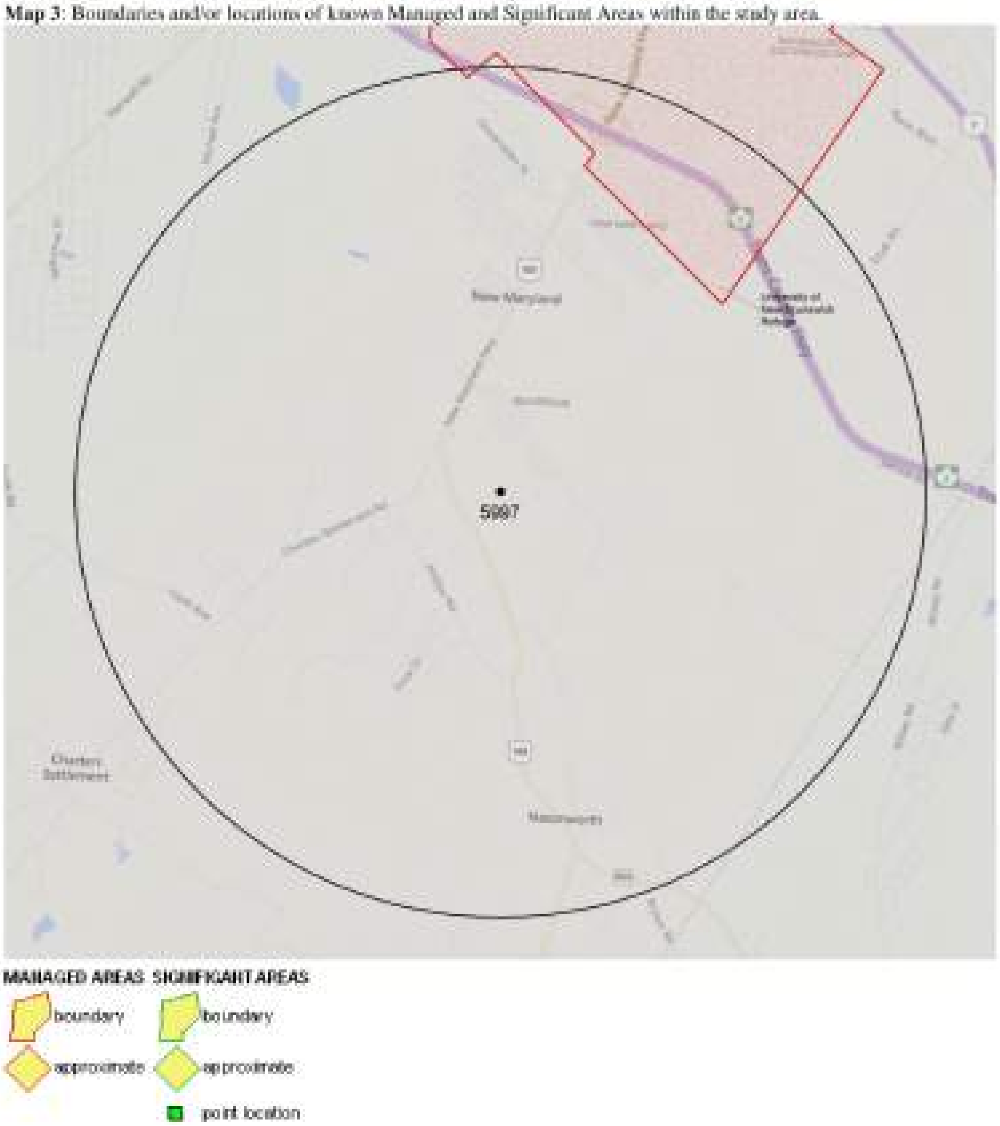
3.1 MANAGED AREAS

The GIS scan identified 1 managed area in the vicinity of the study area (Map 3 and attached file: *ma*.xls).

3.2 SIGNIFICANT AREAS

The GIS scan identified no biologically significant sites in the vicinity of the study area (Map 3).

Map 3: Boundaries and/or locations of known Managed and Significant Areas within the study area.



4.0 RARE SPECIES LISTS

Rare and/or endangered taxa (excluding "location-sensitive" species, section 4.3) within the study area listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record). [P] = vascular plant, [N] = nonvascular plant, [A] = vertebrate animal, [I] = invertebrate animal, [C] = community. Note: records are from attached files *ob.xls/*ob.shp only.

4.1 FLORA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)
P	*Rumex aquaticus var. fenestratus*	Western Dock				S1S2	2 May Be At Risk	1	1.5 ± 1.0
P	*Coeloglossum viride var. virescens*	Long-bracted Frog Orchid				S2	2 May Be At Risk	3	3.1 ± 5.0
P	*Humulus lupulus var. lupuloides*	Common Hop				S2?	3 Sensitive	1	4.7 ± 0.0

4.2 FAUNA

	Scientific *Name*	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)
A	*Caprimulgus vociferus*	Whip-Poor-Will	Threatened	Threatened	Threatened	S2B,S2M	1 At Risk	1	3.7 ± 7.0
A	*Chordeiles minor*	Common Nighthawk	Threatened	Threatened	Threatened	S3B,S4M	1 At Risk	1	4.3 ± 0.0
A	*Toxostoma rufum*	Brown Thrasher				S2B,S2M	3 Sensitive	1	4.4 ± 0.0
A	*Cathartes aura*	Turkey Vulture				S3B,S3M	4 Secure	1	3.4 ± 0.0
A	*Piranga olivacea*	Scarlet Tanager				S3B,S3M	4 Secure	1	2.7 ± 0.0
I	*Hesperia sassacus*	Indian Skipper				S3	4 Secure	2	3.4 ± 2.0

4.3 LOCATION SENSITIVE SPECIES

The Department of Natural Resources in each Maritimes province considers a number of species "location sensitive". Concern about exploitation of location-sensitive species precludes inclusion of precise coordinates in this report. Those intersecting your study area are indicated below with "YES".

New Brunswick

Scientific Name	Common Name	SARA	Prov Legal Prot	Known within the Study Site?
Chrysemys picta picta	Eastern Painted Turtle			No
Chelydra serpentina	Snapping Turtle	Special Concern	Special Concern	No
Glyptemys insculpta	Wood Turtle	Threatened	Threatened	No
Haliaeetus leucocephalus	Bald Eagle		Endangered	No
Falco peregrinus pop. 1	Peregrine Falcon - anatum/tundrius pop.	Special Concern	Endangered	No
Cicindela marginipennis	Cobblestone Tiger Beetle	Endangered	Endangered	No
Coenonympha nipisiquit	Maritime Ringlet	Endangered	Endangered	No
Bat Hibernaculum		[Endangered]1	[Endangered]1	YES

1 Myotis lucifugus (Little Brown Myotis), Myotis septentrionalis (Long-eared Myotis), and Perimyotis subflavus (Tri-colored Bat or Eastern Pipistrelle) are all Endangered under the Federal Species at Risk Act and the NB Species at Risk Act.

4.4 SOURCE BIBLIOGRAPHY

The recipient of these data shall acknowledge the ACCDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
2	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2003.
2	eBird. 2014. eBird Basic Dataset. Version: EBD_relNov-2014. Ithaca, New York. Nov 2014. Cornell Lab of Ornithology, 25036 recs.
2	Lepage, D. 2014. Maritime Breeding Bird Atlas Database. Bird Studies Canada, Sackville NB, 407,838 recs.
1	ARCAD
1	Benedict, B. Connell Herbarium Specimen Database Download 2004. Connell Memorial Herbarium, University of New Brunswick. 2004.
1	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2000.
1	Clayden, S.R. 1998. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 19759 recs.
1	Erskine, A.J. 1992. Maritime Breeding Bird Atlas Database. NS Museum & Nimbus Publ., Halifax, 82,125 recs.
1	Houston, J.J. 1990. Status of the Redbreast Sunfish (Lepomis auritus) in Canada. Can. Field-Nat. 104:64-68.
1	Klymko, J.J.D. 2012. Maritimes Butterfly Atlas, 2010 and 2011 records. Atlantic Canada Conservation Data Centre, 6318 recs.
1	Klymko, J.J.D. 2014. Maritimes Butterfly Atlas, 2012 submissions. Atlantic Canada Conservation Data Centre, 8552 records.

5.0 RARE SPECIES WITHIN 100 KM

A 100 km buffer around the study area contains 20817 records of 150 vertebrate and 1216 records of 84 invertebrate fauna; 10225 records of 379 vascular, 269 records of 113 nonvascular flora (attached: *ob100km.xls).

Taxa within 100 km of the study site that are rare and/or endangered in the province in which the study site occurs. All ranks correspond to the province in which the study site falls, even for out-of-province records. Taxa are listed in order of concern, beginning with legally listed taxa, with the number of observations per taxon and the distance in kilometers from study area centroid to the closest observation (± the precision, in km, of the record).

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Myotis lucifugus*	Little Brown Myotis	Endangered	Endangered	Endangered	S1	1 At Risk	62	9.8 ± 1.0	NB
A	*Myotis septentrionalis*	Northern Long-eared Myotis	Endangered	Endangered	Endangered	S1	1 At Risk	15	11.1 ± 1.0	NB
A	*Perimyotis subflavus*	Eastern Pipistrelle	Endangered	Endangered	Endangered	S1	1 At Risk	7	78.7 ± 0.0	NB
A	*Eubalaena glacialis*	North Atlantic Right Whale	Endangered	Endangered	Endangered	S1		1	97.4 ± 1.0	NB
A	*Sterna dougallii*	Roseate Tern	Endangered	Endangered	Endangered	S1?B,S1?M	1 At Risk	2	92.2 ± 5.0	NB
A	*Charadrius melodus melodus*	Piping Plover melodus ssp	Endangered	Endangered	Endangered	S1B,S1M	1 At Risk	7	82.8 ± 0.0	NB
A	*Dermochelys coriacea (Atlantic pop.)*	Leatherback Sea Turtle - Atlantic pop.	Endangered	Endangered	Endangered	S1S2N	1 At Risk	3	85.8 ± 0.0	NB
A	*Salmo salar pop. 1*	Atlantic Salmon - Inner Bay of Fundy pop.	Endangered	Endangered	Endangered	S2	2 May Be At Risk	430	23.3 ± 0.0	NB
A	*Calidris canutus rufa*	Red Knot rufa ssp	Endangered		Endangered	S2M	1 At Risk	24	82.2 ± 0.0	NB
A	*Pagophila eburnea*	Ivory Gull	Endangered	Endangered		SNA	8 Accidental	2	93.7 ± 14.0	NB
A	*Protonotaria citrea*	Prothonotary Warbler	Endangered	Endangered		SNA	8 Accidental	1	83.5 ± 2.0	NB
A	*Rangifer tarandus pop. 2*	Woodland Caribou (Atlantic-Gasp├⌐sie pop.)	Endangered	Endangered	Extirpated	SX	0.1 Extirpated	4	52.3 ± 1.0	NB
A	*Colinus virginianus*	Northern Bobwhite	Endangered	Endangered				4	57.3 ± 0.0	NB
A	*Sturnella magna*	Eastern Meadowlark	Threatened		Threatened	S1B,S1M	2 May Be At Risk	49	13.0 ± 7.0	NB
A	*Ixobrychus exilis*	Least Bittern	Threatened	Threatened	Threatened	S1S2B,S1S2M	1 At Risk	30	11.7 ± 0.0	NB
A	*Hylocichla mustelina*	Wood Thrush	Threatened		Threatened	S1S2B,S1S2M	2 May Be At Risk	241	6.1 ± 7.0	NB
A	*Caprimulgus vociferus*	Whip-Poor-Will	Threatened	Threatened	Threatened	S2B,S2M	1 At Risk	96	3.7 ± 7.0	NB
A	*Hirundo rustica*	Barn Swallow	Threatened		Threatened	S2B,S2M	3 Sensitive	1089	5.4 ± 7.0	NB
A	*Catharus bicknelli*	Bicknell's Thrush	Threatened	Special Concern	Threatened	S2B,S2M	1 At Risk	3	84.8 ± 1.0	NB
A	*Glyptemys insculpta*	Wood Turtle	Threatened	Threatened	Threatened	S2S3	1 At Risk	242	6.2 ± 0.0	NB
A	*Chaetura pelagica*	Chimney Swift	Threatened	Threatened	Threatened	S2S3B,S2M	1 At Risk	408	5.4 ± 7.0	NB
A	*Riparia riparia*	Bank Swallow	Threatened			S2S3B,S2S3M	3 Sensitive	332	6.1 ± 7.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Acipenser oxyrinchus*	Atlantic Sturgeon	Threatened		Threatened	S3	4 Secure	1	33.3 ± 1.0	NB
A	*Contopus cooperi*	Olive-sided Flycatcher	Threatened	Threatened	Threatened	S3B,S3M	1 At Risk	587	5.9 ± 0.0	NB
A	*Wilsonia canadensis*	Canada Warbler	Threatened	Threatened	Threatened	S3B,S3M	1 At Risk	1203	5.4 ± 0.0	NB
A	*Dolichonyx oryzivorus*	Bobolink	Threatened		Threatened	S3B,S3M	3 Sensitive	893	5.4 ± 7.0	NB
A	*Chordeiles minor*	Common Nighthawk	Threatened	Threatened	Threatened	S3B,S4M	1 At Risk	438	4.3 ± 0.0	NB
A	*Anguilla rostrata*	American Eel	Threatened		Threatened	S4	4 Secure	38	16.6 ± 0.0	NB
A	*Melanerpes erythrocephalus*	Red-headed Woodpecker	Threatened	Threatened		SNA	8 Accidental	5	10.0 ± 5.0	NB
A	*Osmerus mordax pop. 2*	Lake Utopia Smelt large-bodied pop.	Threatened		Threatened			2	77.3 ± 10.0	NB
A	*Coturnicops noveboracensis*	Yellow Rail	Special Concern	Special Concern	Special Concern	S1?B,SUM	2 May Be At Risk	3	33.8 ± 7.0	NB
A	*Histrionicus histrionicus pop. 1*	Harlequin Duck - Eastern pop.	Special Concern	Special Concern	Endangered	S1B,S1S2N,S2M	1 At Risk	106	15.1 ± 0.0	NB
A	*Falco peregrinus pop. 1*	Peregrine Falcon - anatum/tundrius	Special Concern	Special Concern	Endangered	S1B,S3M	1 At Risk	186	9.0 ± 0.0	NB
A	*Asio flammeus*	Short-eared Owl	Special Concern	Special Concern	Special Concern	S2B,S2M	3 Sensitive	15	36.2 ± 0.0	NB
A	*Bucephala islandica (Eastern pop.)*	Barrow's Goldeneye - Eastern pop.	Special Concern	Special Concern	Special Concern	S2M,S2N	3 Sensitive	54	8.4 ± 0.0	NB
A	*Balaenoptera physalus*	Fin Whale - Atlantic pop.	Special Concern	Special Concern	Special Concern	S2S3		2	87.7 ± 1.0	NB
A	*Acipenser brevirostrum*	Shortnose Sturgeon	Special Concern	Special Concern	Special Concern	S3	3 Sensitive	7	15.5 ± 10.0	NB
A	*Chelydra serpentina*	Snapping Turtle	Special Concern	Special Concern	Special Concern	S3	3 Sensitive	27	12.9 ± 1.0	NB
A	*Euphagus carolinus*	Rusty Blackbird	Special Concern	Special Concern	Special Concern	S3B,S3M	2 May Be At Risk	204	5.4 ± 7.0	NB
A	*Coccothraustes vespertinus*	Evening Grosbeak	Special Concern			S3B,S3S4N,SUM	3 Sensitive	314	5.4 ± 7.0	NB
A	*Phalaropus lobatus*	Red-necked Phalarope	Special Concern			S3M	3 Sensitive	6	84.2 ± 0.0	NB
A	*Phocoena phocoena (NW Atlantic pop.)*	Harbour Porpoise - Northwest Atlantic pop.	Special Concern	Threatened		S4		73	73.4 ± 100.0	NB
A	*Contopus virens*	Eastern Wood-Pewee	Special Concern		Special Concern	S4B,S4M	4 Secure	666	5.3 ± 0.0	NB
A	*Podiceps auritus*	Horned Grebe	Special Concern		Special Concern	S4N,S4M	4 Secure	94	17.4 ± 0.0	NB
A	*Tryngites subruficollis*	Buff-breasted Sandpiper	Special Concern			SNA	8 Accidental	16	83.8 ± 1.0	NB
A	*Bubo scandiacus*	Snowy Owl	Not At Risk			S1N,S2S3M	4 Secure	9	14.4 ± 1.0	NB
A	*Accipiter cooperii*	Cooper's Hawk	Not At Risk			S1S2B,S1S2M	2 May Be At Risk	13	12.0 ± 1.0	NB
A	*Fulica americana*	American Coot	Not At Risk			S1S2B,S1S2M	3 Sensitive	4	44.7 ± 7.0	NB
A	*Aegolius funereus*	Boreal Owl	Not At Risk			S1S2B,SUM	2 May Be At Risk	1	99.3 ± 0.0	NB
A	*Sorex dispar*	Long-tailed Shrew	Not At Risk	Special Concern		S2	3 Sensitive	2	54.4 ± 5.0	NB
A	*Buteo lineatus*	Red-shouldered Hawk	Not At Risk	Special Concern		S2B,S2M	2 May Be At Risk	59	9.0 ± 7.0	NB
A	*Chlidonias niger*	Black Tern	Not At Risk			S2B,S2M	3 Sensitive	136	9.0 ± 7.0	NB
A	*Globicephala melas*	Long-finned Pilot Whale	Not At Risk			S2S3		2	82.8 ± 1.0	NB
A	*Lynx canadensis*	Canadian Lynx	Not At Risk		Endangered	S3	1 At Risk	28	25.7 ± 0.0	NB
A	*Desmognathus fuscus*	Northern Dusky Salamander	Not At Risk			S3	3 Sensitive	91	11.1 ± 1.0	NB
A	*Megaptera novaeangliae*	Humpback Whale (NW Atlantic pop.)	Not At Risk	Special Concern		S3		1	97.4 ± 5.0	NB
A	*Sterna hirundo*	Common Tern	Not At Risk			S3B,SUM	3 Sensitive	159	9.0 ± 7.0	NB
A	*Podiceps grisegena*	Red-necked Grebe	Not At Risk			S3M,S2N	3 Sensitive	76	11.2 ± 0.0	NB
A	*Lagenorhynchus acutus*	Atlantic White-sided Dolphin	Not At Risk			S3S4		1	86.5 ± 1.0	NB
A	*Haliaeetus leucocephalus*	Bald Eagle	Not At Risk		Endangered	S4	1 At Risk	782	5.8 ± 0.0	NB
A	*Canis lupus*	Gray Wolf	Not At Risk		Extirpated	SX	0.1 Extirpated	4	28.8 ± 1.0	NB
A	*Puma concolor pop. 1*	Eastern Cougar	Data Deficient		Endangered	SU	5 Undetermined	62	8.2 ± 1.0	NB
A	*Morone saxatilis*	Striped Bass	E,E,SC			S3	2 May Be At Risk	10	20.0 ± 1.0	NB
A	*Salvelinus alpinus*	Arctic Char				S1	3 Sensitive	1	92.8 ± 1.0	NB
A	*Vireo flavifrons*	Yellow-throated Vireo				S1?B,S1?M	8 Accidental	15	12.3 ± 0.0	NB
A	*Tringa melanoleuca*	Greater Yellowlegs				S1?B,S5M	4 Secure	344	9.1 ± 70.0	NB
A	*Aythya americana*	Redhead				S1B,S1M	8 Accidental	4	53.0 ± 7.0	NB
A	*Gallinula chloropus*	Common Moorhen				S1B,S1M	3 Sensitive	21	11.7 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Grus canadensis*	Sandhill Crane				S1B,S1M	8 Accidental	10	55.9 ± 0.0	NB
A	*Bartramia longicauda*	Upland Sandpiper				S1B,S1M	3 Sensitive	39	15.7 ± 7.0	NB
A	*Phalaropus tricolor*	Wilson's Phalarope				S1B,S1M	3 Sensitive	42	6.1 ± 7.0	NB
A	*Leucophaeus atricilla*	Laughing Gull				S1B,S1M	3 Sensitive	9	9.8 ± 1.0	NB
A	*Progne subis*	Purple Martin				S1B,S1M	2 May Be At Risk	284	6.1 ± 7.0	NB
A	*Thryothorus ludovicianus*	Carolina Wren				S1B,S1M	8 Accidental	39	9.0 ± 0.0	NB
A	*Oxyura jamaicensis*	Ruddy Duck				S1B,S2S3M	4 Secure	45	10.9 ± 5.0	NB
A	*Uria aalge*	Common Murre				S1B,S3N,S3M	4 Secure	9	92.2 ± 0.0	NB
A	*Aythya affinis*	Lesser Scaup				S1B,S4M	4 Secure	198	8.4 ± 0.0	NB
A	*Aythya marila*	Greater Scaup				S1B,S4M,S2N	4 Secure	31	25.6 ± 7.0	NB
A	*Eremophila alpestris*	Horned Lark				S1B,S4N,S5M	2 May Be At Risk	34	8.8 ± 7.0	NB
A	*Sterna paradisaea*	Arctic Tern				S1B,SUM	2 May Be At Risk	7	92.2 ± 5.0	NB
A	*Fratercula arctica*	Atlantic Puffin				S1B,SUN,SUM	3 Sensitive	11	92.2 ± 0.0	NB
A	*Branta bernicla*	Brant				S1N, S2S3M	4 Secure	32	17.4 ± 0.0	NB
A	*Chroicocephalus ridibundus*	Black-headed Gull				S1N,S2M	3 Sensitive	9	9.8 ± 1.0	NB
A	*Butorides virescens*	Green Heron				S1S2B,S1S2M	3 Sensitive	21	6.1 ± 7.0	NB
A	*Nycticorax nycticorax*	Black-crowned Night-heron				S1S2B,S1S2M	3 Sensitive	10	50.5 ± 0.0	NB
A	*Empidonax traillii*	Willow Flycatcher				S1S2B,S1S2M	3 Sensitive	81	6.1 ± 7.0	NB
A	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow				S1S2B,S1S2M	2 May Be At Risk	28	6.1 ± 7.0	NB
A	*Troglodytes aedon*	House Wren				S1S2B,S1S2M	5 Undetermined	32	14.9 ± 7.0	NB
A	*Rissa tridactyla*	Black-legged Kittiwake				S1S2B,S4N,S5M	4 Secure	8	9.8 ± 1.0	NB
A	*Calidris bairdii*	Baird's Sandpiper				S1S2M	3 Sensitive	21	82.2 ± 0.0	NB
A	*Cistothorus palustris*	Marsh Wren				S2B,S2M	3 Sensitive	94	11.6 ± 0.0	NB
A	*Mimus polyglottos*	Northern Mockingbird				S2B,S2M	3 Sensitive	123	6.1 ± 7.0	NB
A	*Toxostoma rufum*	Brown Thrasher				S2B,S2M	3 Sensitive	109	4.4 ± 0.0	NB
A	*Pooecetes gramineus*	Vesper Sparrow				S2B,S2M	2 May Be At Risk	82	29.5 ± 7.0	NB
A	*Anas strepera*	Gadwall				S2B,S3M	4 Secure	78	11.0 ± 30.0	NB
A	*Alca torda*	Razorbill				S2B,S3N,S3M	4 Secure	8	88.9 ± 2.0	NB
A	*Pinicola enucleator*	Pine Grosbeak				S2B,S4S5N,S4S5M	3 Sensitive	53	15.3 ± 7.0	NB
A	*Tringa solitaria*	Solitary Sandpiper				S2B,S5M	4 Secure	121	9.4 ± 0.0	NB
A	*Oceanodroma leucorhoa*	Leach's Storm-Petrel				S2B,SUM	3 Sensitive	4	9.8 ± 1.0	NB
A	*Chen caerulescens*	Snow Goose				S2M	4 Secure	6	15.8 ± 0.0	NB
A	*Phalacrocorax carbo*	Great Cormorant				S2N,S2M	4 Secure	22	16.8 ± 0.0	NB
A	*Somateria spectabilis*	King Eider				S2N,S2M	4 Secure	5	93.2 ± 0.0	NB
A	*Larus hyperboreus*	Glaucous Gull				S2N,S2M	4 Secure	102	6.5 ± 0.0	NB
A	*Asio otus*	Long-eared Owl				S2S3	5 Undetermined	15	13.6 ± 7.0	NB
A	*Picoides dorsalis*	American Three-toed Woodpecker				S2S3	3 Sensitive	26	9.8 ± 1.0	NB
A	*Salmo salar*	Atlantic Salmon				S2S3	2 May Be At Risk	218	20.0 ± 1.0	NB
A	*Anas clypeata*	Northern Shoveler				S2S3B,S2S3M	4 Secure	75	7.3 ± 0.0	NB
A	*Myiarchus crinitus*	Great Crested Flycatcher				S2S3B,S2S3M	3 Sensitive	296	5.4 ± 7.0	NB
A	*Petrochelidon pyrrhonota*	Cliff Swallow				S2S3B,S2S3M	3 Sensitive	529	6.1 ± 7.0	NB
A	*Pluvialis dominica*	American Golden-Plover				S2S3M	3 Sensitive	53	8.7 ± 0.0	NB
A	*Calcarius lapponicus*	Lapland Longspur				S2S3N,SUM	3 Sensitive	17	8.2 ± 0.0	NB
A	*Cepphus grylle*	Black Guillemot				S3	4 Secure	110	78.8 ± 7.0	NB
A	*Loxia curvirostra*	Red Crossbill				S3	4 Secure	108	13.6 ± 7.0	NB
A	*Carduelis pinus*	Pine Siskin				S3	4 Secure	264	5.4 ± 7.0	NB
A	*Prosopium cylindraceum*	Round Whitefish				S3	4 Secure	3	32.2 ± 0.0	NB
A	*Salvelinus namaycush*	Lake Trout				S3	3 Sensitive	7	57.3 ± 0.0	NB
A	*Sorex maritimensis*	Maritime Shrew				S3	4 Secure	1	24.7 ± 1.0	NB
A	*Eptesicus fuscus*	Big Brown Bat				S3	3 Sensitive	46	7.2 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
A	*Cathartes aura*	Turkey Vulture				S3B,S3M	4 Secure	290	3.4 ± 0.0	NB
A	*Rallus limicola*	Virginia Rail				S3B,S3M	3 Sensitive	126	6.1 ± 7.0	NB
A	*Charadrius vociferus*	Killdeer				S3B,S3M	3 Sensitive	670	5.4 ± 7.0	NB
A	*Tringa semipalmata*	Willet				S3B,S3M	3 Sensitive	16	12.1 ± 0.0	NB
A	*Coccyzus erythropthalmus*	Black-billed Cuckoo				S3B,S3M	4 Secure	190	11.0 ± 0.0	NB
A	*Vireo gilvus*	Warbling Vireo				S3B,S3M	4 Secure	274	6.1 ± 7.0	NB
A	*Piranga olivacea*	Scarlet Tanager				S3B,S3M	4 Secure	337	2.7 ± 0.0	NB
A	*Passerina cyanea*	Indigo Bunting				S3B,S3M	4 Secure	132	6.1 ± 7.0	NB
A	*Molothrus ater*	Brown-headed Cowbird				S3B,S3M	2 May Be At Risk	287	5.4 ± 7.0	NB
A	*Icterus galbula*	Baltimore Oriole				S3B,S3M	4 Secure	222	5.4 ± 7.0	NB
A	*Somateria mollissima*	Common Eider				S3B,S4M,S3N	4 Secure	455	12.4 ± 199.0	NB
A	*Dendroica tigrina*	Cape May Warbler				S3B,S4S5M	4 Secure	162	8.6 ± 7.0	NB
A	*Anas acuta*	Northern Pintail				S3B,S5M	3 Sensitive	49	10.5 ± 1.0	NB
A	*Mergus serrator*	Red-breasted Merganser				S3B,S5M,S4S5N	4 Secure	74	12.6 ± 7.0	NB
A	*Arenaria interpres*	Ruddy Turnstone				S3M	4 Secure	106	47.0 ± 0.0	NB
A	*Phalaropus fulicarius*	Red Phalarope				S3M	3 Sensitive	2	88.1 ± 0.0	NB
A	*Melanitta nigra*	Black Scoter				S3M,S1S2N	3 Sensitive	145	9.6 ± 0.0	NB
A	*Bucephala albeola*	Bufflehead				S3M,S2N	3 Sensitive	627	8.4 ± 0.0	NB
A	*Calidris maritima*	Purple Sandpiper				S3M,S3N	4 Secure	117	82.8 ± 9.0	NB
A	*Uria lomvia*	Thick-billed Murre				S3N,S3M	5 Undetermined	11	91.8 ± 0.0	NB
A	*Synaptomys cooperi*	Southern Bog Lemming				S3S4	4 Secure	74	7.0 ± 1.0	NB
A	*Tyrannus tyrannus*	Eastern Kingbird				S3S4B,S3S4M	3 Sensitive	598	5.4 ± 7.0	NB
A	*Actitis macularius*	Spotted Sandpiper				S3S4B,S5M	4 Secure	638	6.1 ± 7.0	NB
A	*Gallinago delicata*	Wilson's Snipe				S3S4B,S5M	4 Secure	694	6.1 ± 7.0	NB
A	*Larus delawarensis*	Ring-billed Gull				S3S4B,S5M	4 Secure	186	9.4 ± 0.0	NB
A	*Dendroica striata*	Blackpoll Warbler				S3S4B,S5M	4 Secure	41	13.6 ± 7.0	NB
A	*Pluvialis squatarola*	Black-bellied Plover				S3S4M	4 Secure	213	12.1 ± 0.0	NB
A	*Limosa haemastica*	Hudsonian Godwit				S3S4M	4 Secure	25	80.5 ± 0.0	NB
A	*Calidris pusilla*	Semipalmated Sandpiper				S3S4M	4 Secure	362	11.2 ± 0.0	NB
A	*Calidris melanotos*	Pectoral Sandpiper				S3S4M	4 Secure	121	11.9 ± 0.0	NB
A	*Calidris alba*	Sanderling				S3S4M,S1N	3 Sensitive	140	11.2 ± 0.0	NB
A	*Morus bassanus*	Northern Gannet				SHB,S5M	4 Secure	41	71.6 ± 0.0	NB
C	*Quercus macrocarpa - Acer rubrum / Onoclea sensibilis - Carex arcta Forest*	Bur Oak - Red Maple / Sensitive Fern - Northern Clustered Sedge Forest				S2		1	39.3 ± 0.0	NB
C	*Acer saccharinum / Onoclea sensibilis - Lysimachia terrestris Forest*	Silver Maple / Sensitive Fern - Swamp Yellow Loosestrife Forest				S3		1	23.3 ± 0.0	NB
C	*Thuja occidentalis - Picea glauca / Mitella nuda - Athyrium filix-femina / Mnium spp. Forest*	Eastern White Cedar - White Spruce / Naked Bishop's-Cap - Common Lady Fern / Calcareous Moss Forest				S3		1	85.3 ± 0.0	NB
C	*Acer saccharum - Fraxinus americana / Gymnocarpium dryopteris - Deparia acrostichoides Forest*	Sugar Maple - White Ash / Common Oak Fern - Silvery Glade Fern Forest				S3		2	96.8 ± 0.0	NB
C	*Acer saccharum - Fraxinus americana / Polystichum acrostichoides Forest*	Sugar Maple - White Ash / Christmas Fern Forest				S3S4		1	78.0 ± 0.0	NB
I	*Cicindela marginipennis*	Cobblestone Tiger Beetle	Endangered	Endangered	Endangered	S1	1 At Risk	39	45.4 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
I	*Gomphus ventricosus*	Skillet Clubtail	Endangered		Endangered	S1S2	2 May Be At Risk	50	6.4 ± 1.0	NB
I	*Danaus plexippus*	Monarch	Endangered	Special Concern	Special Concern	S3B,S3M	3 Sensitive	70	5.8 ± 0.0	NB
I	*Ophiogomphus howei*	Pygmy Snaketail	Special Concern	Special Concern	Special Concern	S2	2 May Be At Risk	8	41.8 ± 0.0	NB
I	*Alasmidonta varicosa*	Brook Floater	Special Concern		Special Concern	S2	3 Sensitive	1	41.8 ± 0.0	NB
I	*Lampsilis cariosa*	Yellow Lampmussel	Special Concern	Special Concern	Special Concern	S2	3 Sensitive	103	8.4 ± 0.0	NB
I	*Bombus terricola*	Yellow-banded Bumblebee	Special Concern			S3?	3 Sensitive	25	35.4 ± 0.0	NB
I	*Appalachina sayana*	Spike-lip Crater	Not At Risk			S3?		2	70.4 ± 1.0	NB
I	*Haematopota rara*	Shy Cleg				S1	5 Undetermined	1	7.0 ± 1.0	NB
I	*Lycaena dorcas*	Dorcas Copper				S1	2 May Be At Risk	16	52.6 ± 0.0	NB
I	*Erora laeta*	Early Hairstreak				S1	2 May Be At Risk	5	16.3 ± 7.0	NB
I	*Somatochlora septentrionalis*	Muskeg Emerald				S1	2 May Be At Risk	1	34.5 ± 1.0	NB
I	*Arigomphus furcifer*	Lilypad Clubtail				S1	5 Undetermined	6	20.6 ± 0.0	NB
I	*Polites origenes*	Crossline Skipper				S1?	5 Undetermined	5	15.7 ± 0.0	NB
I	*Plebejus saepiolus*	Greenish Blue				S1S2	4 Secure	3	8.5 ± 1.0	NB
I	*Ophiogomphus colubrinus*	Boreal Snaketail				S1S2	2 May Be At Risk	36	6.4 ± 1.0	NB
I	*Cicindela ancocisconensis*	Appalachian Tiger Beetle				S2	5 Undetermined	3	82.8 ± 0.0	NB
I	*Encyclops caerulea*	a Longhorned Beetle				S2		1	89.2 ± 0.0	NB
I	*Brachyleptura circumdata*	a Longhorned Beetle				S2		6	20.3 ± 0.0	NB
I	*Satyrium calanus*	Banded Hairstreak				S2	3 Sensitive	16	8.9 ± 0.0	NB
I	*Satyrium calanus falacer*	Banded Hairstreak				S2	4 Secure	6	10.8 ± 1.0	NB
I	*Strymon melinus*	Grey Hairstreak				S2	4 Secure	3	24.0 ± 1.0	NB
I	*Aeshna clepsydra*	Mottled Darner				S2	3 Sensitive	12	56.4 ± 0.0	NB
I	*Somatochlora tenebrosa*	Clamp-Tipped Emerald				S2	5 Undetermined	5	7.2 ± 1.0	NB
I	*Ladona exusta*	White Corporal				S2	5 Undetermined	8	45.3 ± 0.0	NB
I	*Hetaerina americana*	American Rubyspot				S2	3 Sensitive	15	40.4 ± 0.0	NB
I	*Coenagrion interrogatum*	Subarctic Bluet				S2	3 Sensitive	1	73.2 ± 0.0	NB
I	*Ischnura posita*	Fragile Forktail				S2	2 May Be At Risk	5	6.6 ± 0.0	NB
I	*Callophrys henrici*	Henry's Elfin				S2S3	4 Secure	13	6.1 ± 7.0	NB
I	*Celithemis martha*	Martha's Pennant				S2S3	5 Undetermined	1	74.0 ± 0.0	NB
I	*Sphaeroderus nitidicollis*	a Ground Beetle				S3	4 Secure	1	32.2 ± 0.0	NB
I	*Lepturopsis biforis*	a Longhorned Beetle				S3		1	84.7 ± 1.0	NB
I	*Orthosoma brunneum*	a Longhorned Beetle				S3		1	41.8 ± 5.0	NB
I	*Elaphrus americanus*	a Ground Beetle				S3	4 Secure	1	20.6 ± 0.0	NB
I	*Desmocerus palliatus*	Elderberry Borer				S3		4	84.7 ± 1.0	NB
I	*Agonum excavatum*	a Ground Beetle				S3	4 Secure	1	20.6 ± 0.0	NB
I	*Clivina americana*	a Ground Beetle				S3	4 Secure	1	20.6 ± 0.0	NB
I	*Olisthopus parmatus*	a Ground Beetle				S3	4 Secure	1	32.2 ± 0.0	NB
I	*Paratachys scitulus*	a Ground Beetle				S3	5 Undetermined	1	20.6 ± 0.0	NB
I	*Coccinella hieroglyphica kirbyi*	a Ladybird Beetle				S3	4 Secure	1	84.7 ± 1.0	NB
I	*Hippodamia parenthesis*	Parenthesis Lady Beetle				S3	4 Secure	2	84.7 ± 1.0	NB
I	*Stenocorus vittigera*	a Longhorned Beetle				S3		1	20.6 ± 0.0	NB
I	*Gnathacmaeops pratensis*	a Longhorned Beetle				S3		5	84.7 ± 1.0	NB
I	*Pogonocherus mixtus*	a Longhorned Beetle				S3		1	84.7 ± 1.0	NB
I	*Badister neopulchellus*	a Ground Beetle				S3	4 Secure	1	20.6 ± 0.0	NB
I	*Saperda lateralis*	a Longhorned Beetle				S3		2	67.9 ± 0.0	NB
I	*Hesperia sassacus*	Indian Skipper				S3	4 Secure	11	3.4 ± 2.0	NB

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I	*Euphyes bimacula*	Two-spotted Skipper				S3	4 Secure	14	6.1 ± 7.0	NB
I	*Lycaena hyllus*	Bronze Copper				S3	3 Sensitive	4	45.6 ± 0.0	NB
I	*Satyrium acadica*	Acadian Hairstreak				S3	4 Secure	25	48.0 ± 0.0	NB
I	*Callophrys polios*	Hoary Elfin				S3	4 Secure	12	5.6 ± 0.0	NB
I	*Callophrys eryphon*	Western Pine Elfin				S3	4 Secure	1	84.2 ± 7.0	NB
I	*Plebejus idas*	Northern Blue				S3	4 Secure	8	77.3 ± 0.0	NB
I	*Plebejus idas empetri*	Crowberry Blue				S3	4 Secure	6	79.7 ± 1.0	NB
I	*Speyeria aphrodite*	Aphrodite Fritillary				S3	4 Secure	25	6.1 ± 7.0	NB
I	*Boloria eunomia*	Bog Fritillary				S3	5 Undetermined	2	49.2 ± 0.0	NB
I	*Boloria bellona*	Meadow Fritillary				S3	4 Secure	52	6.1 ± 7.0	NB
I	*Boloria chariclea*	Arctic Fritillary				S3	4 Secure	1	99.7 ± 7.0	NB
I	*Polygonia satyrus*	Satyr Comma				S3	4 Secure	21	6.1 ± 7.0	NB
I	*Polygonia gracilis*	Hoary Comma				S3	4 Secure	14	11.1 ± 1.0	NB
I	*Nymphalis l-album*	Compton Tortoiseshell				S3	4 Secure	15	6.1 ± 7.0	NB
I	*Gomphus vastus*	Cobra Clubtail				S3	3 Sensitive	58	6.4 ± 1.0	NB
I	*Gomphus abbreviatus*	Spine-crowned Clubtail				S3	4 Secure	51	9.5 ± 0.0	NB
I	*Gomphaeschna furcillata*	Harlequin Darner				S3	5 Undetermined	11	7.2 ± 1.0	NB
I	*Dorocordulia lepida*	Petite Emerald				S3	4 Secure	27	11.3 ± 1.0	NB
I	*Somatochlora albicincta*	Ringed Emerald				S3	4 Secure	1	84.2 ± 1.0	NB
I	*Somatochlora cingulata*	Lake Emerald				S3	4 Secure	11	24.9 ± 1.0	NB
I	*Somatochlora forcipata*	Forcipate Emerald				S3	4 Secure	20	10.4 ± 1.0	NB
I	*Williamsonia fletcheri*	Ebony Boghaunter				S3	4 Secure	17	9.0 ± 1.0	NB
I	*Lestes eurinus*	Amber-Winged Spreadwing				S3	4 Secure	9	28.3 ± 1.0	NB
I	*Lestes vigilax*	Swamp Spreadwing				S3	3 Sensitive	35	30.4 ± 0.0	NB
I	*Enallagma geminatum*	Skimming Bluet				S3	5 Undetermined	13	31.1 ± 0.0	NB
I	*Enallagma signatum*	Orange Bluet				S3	4 Secure	12	33.4 ± 0.0	NB
I	*Stylurus scudderi*	Zebra Clubtail				S3	4 Secure	70	9.5 ± 0.0	NB
I	*Alasmidonta undulata*	Triangle Floater				S3	3 Sensitive	51	20.7 ± 0.0	NB
I	*Leptodea ochracea*	Tidewater Mucket				S3	4 Secure	67	8.4 ± 0.0	NB
I	*Striatura ferrea*	Black Striate				S3		1	7.2 ± 1.0	NB
I	*Neohelix albolabris*	Whitelip				S3		2	7.2 ± 1.0	NB
I	*Spurwinkia salsa*	Saltmarsh Hydrobe				S3		34	52.1 ± 0.0	NB
I	*Pantala hymenaea*	Spot-Winged Glider				S3B,S3M	4 Secure	5	72.4 ± 0.0	NB
I	*Satyrium liparops*	Striped Hairstreak				S3S4	4 Secure	8	6.1 ± 7.0	NB
I	*Satyrium liparops strigosum*	Striped Hairstreak				S3S4	4 Secure	1	14.1 ± 10.0	NB
I	*Cupido comyntas*	Eastern Tailed Blue				S3S4	4 Secure	8	13.8 ± 0.0	NB
I	*Coccinella transversoguttata richardsoni*	Transverse Lady Beetle				SH	2 May Be At Risk	2	71.4 ± 0.0	NB
N	*Pseudevernia cladonia*	Ghost Antler Lichen	Not At Risk			S2S3	5 Undetermined	12	52.0 ± 0.0	NB
N	*Bryum muehlenbeckii*	Muehlenbeck's Bryum Moss				S1	2 May Be At Risk	1	72.2 ± 1.0	NB
N	*Sphagnum macrophyllum*	Sphagnum				S1	2 May Be At Risk	2	54.0 ± 0.0	NB
N	*Syntrichia ruralis*	a Moss				S1	2 May Be At Risk	1	96.9 ± 0.0	NB
N	*Coscinodon cribrosus*	Sieve-Toothed Moss				S1	2 May Be At Risk	1	83.6 ± 0.0	NB
N	*Atrichum angustatum*	Lesser Smoothcap Moss				S1?	2 May Be At Risk	1	76.2 ± 2.0	NB
N	*Calliergon trifarium*	Three-ranked Moss				S1?	2 May Be At Risk	1	77.4 ± 0.0	NB
N	*Dichelyma falcatum*	a Moss				S1?	2 May Be At Risk	2	12.9 ± 10.0	NB
N	*Dicranum bonjeanii*	Bonjean's Broom Moss				S1?	2 May Be At Risk	1	9.3 ± 1.0	NB
N	*Entodon brevisetus*	a Moss				S1?	2 May Be At Risk	1	90.4 ± 10.0	NB
N	*Eurhynchium hians*	Light Beaked Moss				S1?	2 May Be At Risk	2	11.1 ± 1.0	NB
N	*Homomallium adnatum*	Adnate Hairy-gray Moss				S1?	2 May Be At Risk	2	90.4 ± 10.0	NB
N	*Plagiothecium*	Alder Silk Moss				S1?	2 May Be At Risk	1	86.2 ± 0.0	NB

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	latebricola									
N	*Racomitrium ericoides*	a Moss				S1?	2 May Be At Risk	1	33.7 ± 3.0	NB
N	*Splachnum pennsylvanicum*	Southern Dung Moss				S1?	2 May Be At Risk	2	32.9 ± 1.0	NB
N	*Platylomella lescurii*	a Moss				S1?	5 Undetermined	1	72.2 ± 1.0	NB
N	*Jungermannia obovata*	Egg Flapwort				S1S2	6 Not Assessed	1	73.5 ± 0.0	NB
N	*Pallavicinia lyellii*	Lyell's Ribbonwort				S1S2	6 Not Assessed	2	90.4 ± 1.0	NB
N	*Reboulia hemisphaerica*	Purple-margined Liverwort				S1S2	6 Not Assessed	1	89.1 ± 1.0	NB
N	*Brachythecium acuminatum*	Acuminate Ragged Moss				S1S2	5 Undetermined	3	11.1 ± 10.0	NB
N	*Bryum salinum*	a Moss				S1S2	2 May Be At Risk	1	84.2 ± 1.0	NB
N	*Campylium radicale*	Long-stalked Fine Wet Moss				S1S2	5 Undetermined	1	11.1 ± 1.0	NB
N	*Ditrichum pallidum*	Pale Cow-hair Moss				S1S2	2 May Be At Risk	4	27.0 ± 1.0	NB
N	*Drummondia prorepens*	a Moss				S1S2	2 May Be At Risk	1	87.8 ± 1.0	NB
N	*Fissidens taxifolius*	Yew-leaved Pocket Moss				S1S2	2 May Be At Risk	4	73.1 ± 0.0	NB
N	*Seligeria brevifolia*	a Moss				S1S2	3 Sensitive	1	79.3 ± 1.0	NB
N	*Sphagnum platyphyllum*	Flat-leaved Peat Moss				S1S2	5 Undetermined	3	27.0 ± 1.0	NB
N	*Timmia norvegica*	a moss				S1S2	2 May Be At Risk	1	90.3 ± 0.0	NB
N	*Tomentypnum falcifolium*	Sickle-leaved Golden Moss				S1S2	2 May Be At Risk	1	84.9 ± 1.0	NB
N	*Pseudotaxiphyllum distichaceum*	a Moss				S1S2	2 May Be At Risk	2	9.8 ± 1.0	NB
N	*Hamatocaulis vernicosus*	a Moss				S1S2	2 May Be At Risk	1	92.9 ± 100.0	NB
N	*Calypogeia neesiana*	Nees' Pouchwort				S1S3	6 Not Assessed	1	78.2 ± 1.0	NB
N	*Cephaloziella elachista*	Spurred Threadwort				S1S3	6 Not Assessed	1	77.8 ± 5.0	NB
N	*Porella pinnata*	Pinnate Scalewort				S1S3	6 Not Assessed	2	67.5 ± 1.0	NB
N	*Amphidium mougeotii*	a Moss				S2	3 Sensitive	1	84.7 ± 8.0	NB
N	*Anomodon viticulosus*	a Moss				S2	2 May Be At Risk	5	78.2 ± 0.0	NB
N	*Cirriphyllum piliferum*	Hair-pointed Moss				S2	3 Sensitive	2	80.0 ± 1.0	NB
N	*Cynodontium strumiferum*	Strumose Dogtooth Moss				S2	3 Sensitive	1	84.7 ± 8.0	NB
N	*Dicranella palustris*	Drooping-Leaved Fork Moss				S2	3 Sensitive	2	57.1 ± 100.0	NB
N	*Didymodon ferrugineus*	a moss				S2	3 Sensitive	3	78.5 ± 0.0	NB
N	*Anomodon tristis*	a Moss				S2	2 May Be At Risk	1	36.8 ± 1.0	NB
N	*Hypnum pratense*	Meadow Plait Moss				S2	3 Sensitive	3	78.4 ± 0.0	NB
N	*Isopterygiopsis pulchella*	Neat Silk Moss				S2	3 Sensitive	1	87.9 ± 1.0	NB
N	*Meesia triquetra*	Three-ranked Cold Moss				S2	2 May Be At Risk	2	57.1 ± 100.0	NB
N	*Physcomitrium immersum*	a Moss				S2	3 Sensitive	6	11.1 ± 1.0	NB
N	*Sphagnum centrale*	Central Peat Moss				S2	3 Sensitive	1	81.6 ± 0.0	NB
N	*Sphagnum lindbergii*	Lindberg's Peat Moss				S2	3 Sensitive	7	76.6 ± 1.0	NB
N	*Tetraplodon mnioides*	Entire-leaved Nitrogen Moss				S2	3 Sensitive	3	79.9 ± 0.0	NB
N	*Thamnobryum alleghaniense*	a Moss				S2	3 Sensitive	2	90.4 ± 0.0	NB
N	*Tortula mucronifolia*	Mucronate Screw Moss				S2	3 Sensitive	1	82.5 ± 0.0	NB
N	*Ulota phyllantha*	a Moss				S2	3 Sensitive	1	84.2 ± 1.0	NB
N	*Anomobryum filiforme*	a moss				S2	5 Undetermined	1	11.1 ± 1.0	NB
N	*Leptogium corticola*	Blistered Jellyskin Lichen				S2	2 May Be At Risk	1	36.1 ± 0.0	NB
N	*Andreaea rothii*	a Moss				S2?	3 Sensitive	1	95.5 ± 0.0	NB
N	*Anomodon minor*	Blunt-leaved Anomodon Moss				S2?	2 May Be At Risk	1	88.6 ± 1.0	NB
N	*Brachythecium digastrum*	a Moss				S2?	3 Sensitive	2	11.1 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
N	*Bryum pallescens*	Pale Bryum Moss				S2?	5 Undetermined	2	41.6 ± 1.0	NB
N	*Dichelyma capillaceum*	Hairlike Dichelyma Moss				S2?	3 Sensitive	2	41.7 ± 4.0	NB
N	*Dicranum spurium*	Spurred Broom Moss				S2?	3 Sensitive	2	84.3 ± 0.0	NB
N	*Schistostega pennata*	Luminous Moss				S2?	3 Sensitive	3	11.1 ± 1.0	NB
N	*Seligeria campylopoda*	a Moss				S2?	3 Sensitive	2	78.5 ± 0.0	NB
N	*Seligeria diversifolia*	a Moss				S2?	3 Sensitive	1	46.0 ± 0.0	NB
N	*Sphagnum angermanicum*	a Peatmoss				S2?	3 Sensitive	3	54.4 ± 1.0	NB
N	*Plagiomnium rostratum*	Long-beaked Leafy Moss				S2?	3 Sensitive	1	90.6 ± 0.0	NB
N	*Bryum uliginosum*	a Moss				S2S3	3 Sensitive	1	93.8 ± 4.0	NB
N	*Buxbaumia aphylla*	Brown Shield Moss				S2S3	3 Sensitive	2	76.4 ± 15.0	NB
N	*Calliergonella cuspidata*	Common Large Wetland Moss				S2S3	3 Sensitive	4	78.9 ± 0.0	NB
N	*Campylium polygamum*	a Moss				S2S3	3 Sensitive	1	63.4 ± 1.0	NB
N	*Didymodon rigidulus*	Rigid Screw Moss				S2S3	3 Sensitive	1	25.1 ± 8.0	NB
N	*Ephemerum serratum*	a Moss				S2S3	3 Sensitive	2	97.0 ± 0.0	NB
N	*Fissidens bushii*	Bush's Pocket Moss				S2S3	3 Sensitive	3	79.0 ± 1.0	NB
N	*Orthotrichum speciosum*	Showy Bristle Moss				S2S3	5 Undetermined	3	28.3 ± 3.0	NB
N	*Racomitrium fasciculare*	a Moss				S2S3	3 Sensitive	1	82.8 ± 0.0	NB
N	*Scorpidium scorpioides*	Hooked Scorpion Moss				S2S3	3 Sensitive	5	77.4 ± 0.0	NB
N	*Sphagnum subfulvum*	a Peatmoss				S2S3	2 May Be At Risk	4	84.9 ± 1.0	NB
N	*Taxiphyllum deplanatum*	Imbricate Yew-leaved Moss				S2S3	3 Sensitive	2	78.4 ± 0.0	NB
N	*Zygodon viridissimus*	a Moss				S2S3	2 May Be At Risk	2	77.8 ± 5.0	NB
N	*Schistidium agassizii*	Elf Bloom Moss				S2S3	3 Sensitive	2	75.4 ± 2.0	NB
N	*Cynodontium tenellum*	Delicate Dogtooth Moss				S3	3 Sensitive	1	84.2 ± 1.0	NB
N	*Hypnum curvifolium*	Curved-leaved Plait Moss				S3	3 Sensitive	1	77.8 ± 5.0	NB
N	*Schistidium maritimum*	a Moss				S3	4 Secure	1	84.2 ± 1.0	NB
N	*Peltigera membranacea*	Membranous Pelt Lichen				S3	5 Undetermined	2	94.5 ± 0.0	NB
N	*Aulacomnium androgynum*	Little Groove Moss				S3?	4 Secure	2	76.3 ± 1.0	NB
N	*Dicranella rufescens*	Red Forklet Moss				S3?	5 Undetermined	2	10.4 ± 4.0	NB
N	*Sphagnum lescurii*	a Peatmoss				S3?	5 Undetermined	2	77.7 ± 0.0	NB
N	*Anomodon rugelii*	Rugel's Anomodon Moss				S3S4	3 Sensitive	4	89.7 ± 0.0	NB
N	*Barbula convoluta*	Lesser Bird's-claw Beard Moss				S3S4	4 Secure	1	25.1 ± 8.0	NB
N	*Brachythecium velutinum*	Velvet Ragged Moss				S3S4	4 Secure	5	30.9 ± 4.0	NB
N	*Dicranella cerviculata*	a Moss				S3S4	3 Sensitive	3	84.2 ± 1.0	NB
N	*Dicranum majus*	Greater Broom Moss				S3S4	4 Secure	3	76.4 ± 15.0	NB
N	*Fissidens bryoides*	Lesser Pocket Moss				S3S4	4 Secure	3	38.0 ± 4.0	NB
N	*Helodium blandowii*	Wetland-plume Moss				S3S4	4 Secure	2	87.9 ± 1.0	NB
N	*Heterocladium dimorphum*	Dimorphous Tangle Moss				S3S4	4 Secure	1	75.4 ± 2.0	NB
N	*Isopterygiopsis muelleriana*	a Moss				S3S4	4 Secure	6	30.9 ± 4.0	NB
N	*Myurella julacea*	Small Mouse-tail Moss				S3S4	4 Secure	1	84.7 ± 8.0	NB
N	*Physcomitrium pyriforme*	Pear-shaped Urn Moss				S3S4	3 Sensitive	6	11.1 ± 0.0	NB
N	*Pogonatum dentatum*	Mountain Hair Moss				S3S4	4 Secure	1	84.2 ± 1.0	NB
N	*Sphagnum torreyanum*	a Peatmoss				S3S4	4 Secure	4	82.0 ± 1.0	NB
N	*Sphagnum austinii*	Austin's Peat Moss				S3S4	4 Secure	1	82.3 ± 1.0	NB
N	*Sphagnum contortum*	Twisted Peat Moss				S3S4	4 Secure	1	78.4 ± 0.0	NB
N	*Tetraphis geniculata*	Geniculate Four-tooth Moss				S3S4	4 Secure	4	76.5 ± 0.0	NB
N	*Tetraplodon*	Toothed-leaved Nitrogen Moss				S3S4	4 Secure	1	84.2 ± 1.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
	angustatus									
N	*Tomentypnum nitens*	Golden Fuzzy Fen Moss				S3S4	4 Secure	1	72.1 ± 3.0	NB
N	*Trichostomum tenuirostre*	Acid-Soil Moss				S3S4	4 Secure	3	77.8 ± 5.0	NB
N	*Limprichtia revolvens*	a Moss				S3S4	4 Secure	2	76.5 ± 0.0	NB
N	*Rauiella scita*	Smaller Fern Moss				S3S4	3 Sensitive	4	81.1 ± 3.0	NB
N	*Pseudocyphellaria perpetua*	Gilded Specklebelly Lichen				S3S4	3 Sensitive	30	29.4 ± 0.0	NB
N	*Pannaria conoplea*	Mealy-rimmed Shingle Lichen				S3S4	3 Sensitive	1	36.1 ± 0.0	NB
N	*Grimmia anodon*	Toothless Grimmia Moss				SH	5 Undetermined	2	82.0 ± 10.0	NB
N	*Leucodon brachypus*	a Moss				SH	2 May Be At Risk	3	39.5 ± 10.0	NB
N	*Orthotrichum gymnostomum*	a Moss				SH	2 May Be At Risk	1	41.3 ± 10.0	NB
N	*Thelia hirtella*	a Moss				SH	2 May Be At Risk	1	57.1 ± 100.0	NB
N	*Cyrto-hypnum minutulum*	Tiny Cedar Moss				SH	2 May Be At Risk	3	85.0 ± 10.0	NB
P	*Juglans cinerea*	Butternut	Endangered	Endangered	Endangered	S1	1 At Risk	393	9.0 ± 1.0	NB
P	*Polemonium vanbruntiae*	Van Brunt's Jacob's-ladder	Threatened	Threatened	Threatened	S1	1 At Risk	72	76.5 ± 1.0	NB
P	*Symphyotrichum anticostense*	Anticosti Aster	Threatened	Threatened	Endangered	S2S3	1 At Risk	48	16.5 ± 0.0	NB
P	*Symphyotrichum praealtum*	Willow-leaved Aster	Threatened	Threatened		SNA	7 Exotic	1	89.8 ± 1.0	NB
P	*Isoetes prototypus*	Prototype Quillwort	Special Concern	Special Concern	Endangered	S2	1 At Risk	22	5.3 ± 0.0	NB
P	*Pterospora andromedea*	Woodland Pinedrops			Endangered	S1	1 At Risk	24	13.7 ± 0.0	NB
P	*Cryptotaenia canadensis*	Canada Honewort				S1	2 May Be At Risk	5	72.4 ± 1.0	NB
P	*Sanicula trifoliata*	Large-Fruited Sanicle				S1	2 May Be At Risk	21	64.6 ± 0.0	NB
P	*Antennaria parlinii*	a Pussytoes				S1	2 May Be At Risk	7	53.6 ± 1.0	NB
P	*Antennaria howellii ssp. petaloidea*	Pussy-Toes				S1	2 May Be At Risk	2	70.8 ± 1.0	NB
P	*Bidens discoidea*	Swamp Beggarticks				S1	2 May Be At Risk	3	31.2 ± 0.0	NB
P	*Pseudognaphalium obtusifolium*	Eastern Cudweed				S1	2 May Be At Risk	2	56.7 ± 0.0	NB
P	*Helianthus decapetalus*	Ten-rayed Sunflower				S1	2 May Be At Risk	20	14.9 ± 0.0	NB
P	*Hieracium kalmii*	Kalm's Hawkweed				S1	2 May Be At Risk	4	9.5 ± 6.0	NB
P	*Hieracium kalmii var. kalmii*	Kalm's Hawkweed				S1	2 May Be At Risk	4	10.1 ± 1.0	NB
P	*Hieracium paniculatum*	Panicled Hawkweed				S1	2 May Be At Risk	4	15.5 ± 0.0	NB
P	*Hieracium robinsonii*	Robinson's Hawkweed				S1	3 Sensitive	1	78.6 ± 0.0	NB
P	*Symphyotrichum laeve*	Smooth Aster				S1	5 Undetermined	6	61.9 ± 1.0	NB
P	*Canadanthus modestus*	Great Northern Aster				S1	2 May Be At Risk	12	91.1 ± 0.0	NB
P	*Cynoglossum virginianum var. boreale*	Wild Comfrey				S1	2 May Be At Risk	14	81.6 ± 0.0	NB
P	*Cardamine parviflora var. arenicola*	Small-flowered Bittercress				S1	2 May Be At Risk	4	64.6 ± 0.0	NB
P	*Cardamine concatenata*	Cut-leaved Toothwort				S1	2 May Be At Risk	11	20.0 ± 1.0	NB
P	*Draba arabisans*	Rock Whitlow-Grass				S1	2 May Be At Risk	3	73.8 ± 0.0	NB
P	*Draba breweri var. cana*	Brewer's Whitlow-grass				S1	2 May Be At Risk	10	16.7 ± 0.0	NB
P	*Draba glabella*	Rock Whitlow-Grass				S1	2 May Be At Risk	7	35.2 ± 1.0	NB
P	*Minuartia groenlandica*	Greenland Stitchwort				S1	2 May Be At Risk	1	64.8 ± 0.0	NB
P	*Chenopodium*	Strawberry-blite				S1	2 May Be At Risk	5	8.6 ± 6.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
	capitatum									
P	*Chenopodium simplex*	Maple-leaved Goosefoot				S1	2 May Be At Risk	7	10.3 ± 5.0	NB
P	*Callitriche terrestris*	Terrestrial Water-Starwort				S1	5 Undetermined	1	85.3 ± 0.0	NB
P	*Triadenum virginicum*	Virginia St John's-wort				S1	2 May Be At Risk	7	48.1 ± 0.0	NB
P	*Viburnum acerifolium*	Maple-leaved Viburnum				S1	2 May Be At Risk	10	96.7 ± 0.0	NB
P	*Drosera anglica*	English Sundew				S1	2 May Be At Risk	1	71.1 ± 0.0	NB
P	*Drosera linearis*	Slender-Leaved Sundew				S1	2 May Be At Risk	1	71.1 ± 0.0	NB
P	*Corema conradii*	Broom Crowberry				S1	2 May Be At Risk	1	83.6 ± 10.0	NB
P	*Vaccinium boreale*	Northern Blueberry				S1	2 May Be At Risk	1	69.3 ± 0.0	NB
P	*Vaccinium corymbosum*	Highbush Blueberry				S1	3 Sensitive	9	70.1 ± 0.0	NB
P	*Desmodium glutinosum*	Large Tick-Trefoil				S1	2 May Be At Risk	9	74.9 ± 1.0	NB
P	*Lespedeza capitata*	Round-headed Bush-clover				S1	2 May Be At Risk	7	44.7 ± 0.0	NB
P	*Gentiana rubricaulis*	Purple-stemmed Gentian				S1	2 May Be At Risk	14	54.6 ± 0.0	NB
P	*Ribes cynosbati*	Prickly Gooseberry				S1	2 May Be At Risk	1	78.1 ± 0.0	NB
P	*Proserpinaca pectinata*	Comb-leaved Mermaidweed				S1	2 May Be At Risk	1	72.4 ± 0.0	NB
P	*Pycnanthemum virginianum*	Virginia Mountain Mint				S1	2 May Be At Risk	4	64.7 ± 0.0	NB
P	*Decodon verticillatus*	Swamp Loosestrife				S1	2 May Be At Risk	3	50.3 ± 0.0	NB
P	*Polygala verticillata var. verticillata*	Whorled Milkwort				S1	5 Undetermined	2	79.5 ± 0.0	NB
P	*Lysimachia hybrida*	Lowland Yellow Loosestrife				S1	2 May Be At Risk	15	82.3 ± 0.0	NB
P	*Lysimachia quadrifolia*	Whorled Yellow Loosestrife				S1	2 May Be At Risk	14	61.6 ± 0.0	NB
P	*Ranunculus lapponicus*	Lapland Buttercup				S1	2 May Be At Risk	1	99.0 ± 1.0	NB
P	*Ranunculus sceleratus*	Cursed Buttercup				S1	2 May Be At Risk	6	9.6 ± 0.0	NB
P	*Crataegus jonesiae*	Jones' Hawthorn				S1	2 May Be At Risk	6	9.0 ± 1.0	NB
P	*Potentilla canadensis*	Canada Cinquefoil				S1	5 Undetermined	1	70.2 ± 0.0	NB
P	*Waldsteinia fragarioides*	Barren Strawberry				S1	2 May Be At Risk	27	64.6 ± 0.0	NB
P	*Galium brevipes*	Limestone Swamp Bedstraw				S1	2 May Be At Risk	3	46.7 ± 5.0	NB
P	*Saxifraga paniculata ssp. neogaea*	White Mountain Saxifrage				S1	2 May Be At Risk	7	73.8 ± 0.0	NB
P	*Agalinis paupercula var. borealis*	Small-flowered Agalinis				S1	2 May Be At Risk	8	9.7 ± 10.0	NB
P	*Agalinis tenuifolia*	Slender Agalinis				S1	2 May Be At Risk	6	9.6 ± 0.0	NB
P	*Gratiola aurea*	Golden Hedge-Hyssop				S1	3 Sensitive	2	69.7 ± 0.0	NB
P	*Pedicularis canadensis*	Canada Lousewort				S1	2 May Be At Risk	20	13.7 ± 0.0	NB
P	*Viola canadensis*	Canada Violet				S1	2 May Be At Risk	84	78.7 ± 0.0	NB
P	*Viola sagittata var. ovata*	Arrow-Leaved Violet				S1	2 May Be At Risk	10	12.4 ± 0.0	NB
P	*Alisma subcordatum*	Southern Water Plantain				S1	5 Undetermined	8	12.1 ± 0.0	NB
P	*Carex annectens*	Yellow-Fruited Sedge				S1	2 May Be At Risk	1	79.1 ± 0.0	NB
P	*Carex backii*	Rocky Mountain Sedge				S1	2 May Be At Risk	6	16.3 ± 1.0	NB
P	*Carex blanda*	Eastern Woodland Sedge				S1	2 May Be At Risk	1	78.9 ± 0.0	NB
P	*Carex cephaloidea*	Thin-leaved Sedge				S1	2 May Be At Risk	22	26.9 ± 0.0	NB
P	*Carex merritt-fernaldii*	Merritt Fernald's Sedge				S1	2 May Be At Risk	2	88.5 ± 0.0	NB
P	*Carex saxatilis*	Russet Sedge				S1	2 May Be At Risk	13	72.9 ± 0.0	NB
P	*Carex sterilis*	Sterile Sedge				S1	2 May Be At Risk	12	18.8 ± 0.0	NB
P	*Carex grisea*	Inflated Narrow-leaved Sedge				S1	2 May Be At Risk	11	11.9 ± 1.0	NB
P	*Cyperus diandrus*	Low Flatsedge				S1	2 May Be At Risk	7	9.4 ± 1.0	NB
P	*Cyperus lupulinus*	Hop Flatsedge				S1	2 May Be At Risk	6	39.2 ± 0.0	NB
P	*Cyperus lupulinus ssp. macilentus*	Hop Flatsedge				S1	2 May Be At Risk	16	39.3 ± 1.0	NB
P	*Eleocharis olivacea*	Yellow Spikerush				S1	2 May Be At Risk	3	84.7 ± 1.0	NB
P	*Rhynchospora capillacea*	Slender Beakrush				S1	2 May Be At Risk	3	16.0 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
P	*Sisyrinchium angustifolium*	Narrow-leaved Blue-eyed-grass				S1	2 May Be At Risk	3	65.0 ± 0.0	NB
P	*Juncus greenei*	Greene's Rush				S1	2 May Be At Risk	1	83.3 ± 0.0	NB
P	*Juncus subtilis*	Creeping Rush				S1	2 May Be At Risk	1	49.1 ± 5.0	NB
P	*Allium canadense*	Canada Garlic				S1	2 May Be At Risk	11	15.1 ± 0.0	NB
P	*Goodyera pubescens*	Downy Rattlesnake-Plantain				S1	2 May Be At Risk	1	9.8 ± 0.0	NB
P	*Malaxis brachypoda*	White Adder's-Mouth				S1	2 May Be At Risk	12	45.4 ± 0.0	NB
P	*Platanthera flava var. herbiola*	Pale Green Orchid				S1	2 May Be At Risk	13	13.3 ± 10.0	NB
P	*Platanthera macrophylla*	Large Round-Leaved Orchid				S1	2 May Be At Risk	3	9.3 ± 1.0	NB
P	*Spiranthes casei*	Case's Ladies'-Tresses				S1	2 May Be At Risk	6	13.7 ± 0.0	NB
P	*Bromus pubescens*	Hairy Wood Brome Grass				S1	5 Undetermined	6	38.8 ± 0.0	NB
P	*Cinna arundinacea*	Sweet Wood Reed Grass				S1	2 May Be At Risk	22	37.5 ± 0.0	NB
P	*Danthonia compressa*	Flattened Oat Grass				S1	2 May Be At Risk	3	47.8 ± 0.0	NB
P	*Dichanthelium dichotomum*	Forked Panic Grass				S1	2 May Be At Risk	19	68.8 ± 1.0	NB
P	*Dichanthelium xanthophysum*	Slender Panic Grass				S1	2 May Be At Risk	6	79.4 ± 0.0	NB
P	*Elymus hystrix var. bigeloviana*	Spreading Wild Rye				S1	2 May Be At Risk	26	64.5 ± 0.0	NB
P	*Festuca subverticillata*	Nodding Fescue				S1	2 May Be At Risk	9	88.8 ± 0.0	NB
P	*Glyceria obtusa*	Atlantic Manna Grass				S1	2 May Be At Risk	6	57.7 ± 0.0	NB
P	*Sporobolus compositus*	Rough Dropseed				S1	2 May Be At Risk	17	15.0 ± 0.0	NB
P	*Potamogeton friesii*	Fries' Pondweed				S1	2 May Be At Risk	6	11.1 ± 5.0	NB
P	*Potamogeton nodosus*	Long-leaved Pondweed				S1	2 May Be At Risk	14	9.4 ± 1.0	NB
P	*Potamogeton strictifolius*	Straight-leaved Pondweed				S1	2 May Be At Risk	2	72.7 ± 0.0	NB
P	*Xyris difformis*	Bog Yellow-eyed-grass				S1	5 Undetermined	3	66.0 ± 0.0	NB
P	*Asplenium ruta-muraria var. cryptolepis*	Wallrue Spleenwort				S1	2 May Be At Risk	3	73.8 ± 0.0	NB
P	*Dryopteris clintoniana*	Clinton's Wood Fern				S1	2 May Be At Risk	2	78.9 ± 0.0	NB
P	*Botrychium oneidense*	Blunt-lobed Moonwort				S1	2 May Be At Risk	8	16.0 ± 0.0	NB
P	*Botrychium rugulosum*	Rugulose Moonwort				S1	2 May Be At Risk	5	56.6 ± 1.0	NB
P	*Schizaea pusilla*	Little Curlygrass Fern				S1	2 May Be At Risk	16	82.5 ± 0.0	NB
P	*Hieracium kalmii var. fasciculatum*	Kalm's Hawkweed				S1?	5 Undetermined	2	10.2 ± 1.0	NB
P	*Cuscuta campestris*	Field Dodder				S1?	2 May Be At Risk	3	47.5 ± 10.0	NB
P	*Drosera rotundifolia var. comosa*	Round-leaved Sundew				S1?	5 Undetermined	2	99.7 ± 1.0	NB
P	*Galium trifidum ssp. subbiflorum*	Three-petaled Bedstraw				S1?	5 Undetermined	1	85.7 ± 1.0	NB
P	*Carex laxiflora*	Loose-Flowered Sedge				S1?	5 Undetermined	1	86.4 ± 0.0	NB
P	*Carex appalachica*	Appalachian Sedge				S1?	5 Undetermined	1	85.0 ± 0.0	NB
P	*Sisyrinchium mucronatum*	Michaux's Blue-eyed-grass				S1?	5 Undetermined	3	82.2 ± 0.0	NB
P	*Wolffia columbiana*	Columbian Watermeal				S1?	2 May Be At Risk	5	9.8 ± 0.0	NB
P	*Rumex aquaticus var. fenestratus*	Western Dock				S1S2	2 May Be At Risk	1	1.5 ± 1.0	NB
P	*Anemone multifida var. richardsiana*	Cut-leaved Anemone				S1S2	5 Undetermined	2	83.0 ± 5.0	NB
P	*Saxifraga virginiensis*	Early Saxifrage				S1S2	2 May Be At Risk	14	13.6 ± 0.0	NB
P	*Potamogeton bicupulatus*	Snailseed Pondweed				S1S2	2 May Be At Risk	5	47.8 ± 0.0	NB
P	*Selaginella rupestris*	Rock Spikemoss				S1S2	2 May Be At Risk	11	16.1 ± 1.0	NB
P	*Thelypteris simulata*	Bog Fern				S1S2	2 May Be At Risk	7	30.8 ± 0.0	NB
P	*Cuscuta cephalanthi*	Buttonbush Dodder				S1S3	2 May Be At Risk	2	72.4 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
P	*Listera australis*	Southern Twayblade			Endangered	S2	1 At Risk	15	28.7 ± 0.0	NB
P	*Osmorhiza longistylis*	Smooth Sweet Cicely				S2	3 Sensitive	8	21.2 ± 5.0	NB
P	*Sanicula odorata*	Clustered Sanicle				S2	2 May Be At Risk	22	21.3 ± 0.0	NB
P	*Pseudognaphalium macounii*	Macoun's Cudweed				S2	3 Sensitive	12	13.6 ± 0.0	NB
P	*Solidago simplex var. racemosa*	Sticky Goldenrod				S2	2 May Be At Risk	18	14.5 ± 0.0	NB
P	*Ionactis linariifolius*	Stiff Aster				S2	3 Sensitive	15	13.6 ± 0.0	NB
P	*Symphyotrichum racemosum*	Small White Aster				S2	3 Sensitive	9	15.4 ± 0.0	NB
P	*Impatiens pallida*	Pale Jewelweed				S2	2 May Be At Risk	5	76.6 ± 0.0	NB
P	*Alnus serrulata*	Smooth Alder				S2	3 Sensitive	57	39.8 ± 0.0	NB
P	*Arabis drummondii*	Drummond's Rockcress				S2	3 Sensitive	12	16.1 ± 0.0	NB
P	*Sagina nodosa*	Knotted Pearlwort				S2	3 Sensitive	4	83.3 ± 1.0	NB
P	*Sagina nodosa ssp. borealis*	Knotted Pearlwort				S2	3 Sensitive	1	87.4 ± 0.0	NB
P	*Stellaria longifolia*	Long-leaved Starwort				S2	3 Sensitive	12	11.1 ± 10.0	NB
P	*Atriplex franktonii*	Frankton's Saltbush				S2	4 Secure	1	89.8 ± 1.0	NB
P	*Chenopodium rubrum*	Red Pigweed				S2	3 Sensitive	4	73.5 ± 1.0	NB
P	*Hypericum dissimulatum*	Disguised St John's-wort				S2	3 Sensitive	3	15.0 ± 0.0	NB
P	*Triosteum aurantiacum*	Orange-fruited Tinker's Weed				S2	3 Sensitive	179	16.2 ± 1.0	NB
P	*Viburnum lentago*	Nannyberry				S2	4 Secure	130	42.8 ± 0.0	NB
P	*Viburnum recognitum*	Northern Arrow-Wood				S2	4 Secure	168	53.8 ± 0.0	NB
P	*Astragalus eucosmus*	Elegant Milk-vetch				S2	2 May Be At Risk	12	15.8 ± 1.0	NB
P	*Oxytropis campestris var. johannensis*	Field Locoweed				S2	3 Sensitive	12	15.3 ± 1.0	NB
P	*Quercus macrocarpa*	Bur Oak				S2	2 May Be At Risk	46	9.2 ± 0.0	NB
P	*Gentiana linearis*	Narrow-Leaved Gentian				S2	3 Sensitive	15	11.1 ± 5.0	NB
P	*Myriophyllum humile*	Low Water Milfoil				S2	3 Sensitive	10	15.0 ± 1.0	NB
P	*Proserpinaca palustris var. crebra*	Marsh Mermaidweed				S2	3 Sensitive	24	45.3 ± 0.0	NB
P	*Hedeoma pulegioides*	American False Pennyroyal				S2	4 Secure	15	23.0 ± 0.0	NB
P	*Nuphar lutea ssp. rubrodisca*	Red-disked Yellow Pond-lily				S2	3 Sensitive	14	13.5 ± 10.0	NB
P	*Orobanche uniflora*	One-Flowered Broomrape				S2	3 Sensitive	15	34.4 ± 1.0	NB
P	*Polygala paucifolia*	Fringed Milkwort				S2	3 Sensitive	16	10.2 ± 0.0	NB
P	*Polygala senega*	Seneca Snakeroot				S2	3 Sensitive	34	26.6 ± 1.0	NB
P	*Polygonum amphibium var. emersum*	Water Smartweed				S2	3 Sensitive	26	9.5 ± 1.0	NB
P	*Polygonum careyi*	Carey's Smartweed				S2	3 Sensitive	15	10.0 ± 1.0	NB
P	*Podostemum ceratophyllum*	Horn-leaved Riverweed				S2	3 Sensitive	45	21.9 ± 0.0	NB
P	*Anemone multifida*	Cut-leaved Anemone				S2	3 Sensitive	4	16.8 ± 0.0	NB
P	*Hepatica nobilis var. obtusa*	Round-lobed Hepatica				S2	3 Sensitive	54	13.7 ± 0.0	NB
P	*Ranunculus flabellaris*	Yellow Water Buttercup				S2	4 Secure	20	16.1 ± 1.0	NB
P	*Ranunculus longirostris*	Eastern White Water-Crowfoot				S2	5 Undetermined	8	7.8 ± 1.0	NB
P	*Crataegus scabrida*	Rough Hawthorn				S2	3 Sensitive	9	49.7 ± 1.0	NB
P	*Crataegus succulenta*	Fleshy Hawthorn				S2	3 Sensitive	1	11.1 ± 5.0	NB
P	*Rosa acicularis ssp. sayi*	Prickly Rose				S2	2 May Be At Risk	35	77.0 ± 0.0	NB
P	*Cephalanthus occidentalis*	Common Buttonbush				S2	3 Sensitive	66	34.7 ± 0.0	NB
P	*Salix candida*	Sage Willow				S2	3 Sensitive	10	25.8 ± 1.0	NB
P	*Castilleja*	Northeastern Paintbrush				S2	3 Sensitive	9	78.5 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
	septentrionalis									
P	*Euphrasia randii*	Rand's Eyebright				S2	2 May Be At Risk	5	87.5 ± 0.0	NB
P	*Scrophularia lanceolata*	Lance-leaved Figwort				S2	3 Sensitive	12	10.7 ± 100.0	NB
P	*Dirca palustris*	Eastern Leatherwood				S2	2 May Be At Risk	43	13.8 ± 0.0	NB
P	*Phryma leptostachya*	American Lopseed				S2	3 Sensitive	69	18.4 ± 1.0	NB
P	*Verbena urticifolia*	White Vervain				S2	2 May Be At Risk	28	13.6 ± 1.0	NB
P	*Viola novae-angliae*	New England Violet				S2	3 Sensitive	7	58.9 ± 10.0	NB
P	*Symplocarpus foetidus*	Eastern Skunk Cabbage				S2	3 Sensitive	70	39.4 ± 0.0	NB
P	*Carex comosa*	Bearded Sedge				S2	2 May Be At Risk	7	89.9 ± 0.0	NB
P	*Carex granularis*	Limestone Meadow Sedge				S2	3 Sensitive	9	9.2 ± 0.0	NB
P	*Carex gynocrates*	Northern Bog Sedge				S2	3 Sensitive	45	69.0 ± 0.0	NB
P	*Carex hirtifolia*	Pubescent Sedge				S2	3 Sensitive	78	17.0 ± 0.0	NB
P	*Carex livida var. radicaulis*	Livid Sedge				S2	3 Sensitive	5	83.6 ± 2.0	NB
P	*Carex plantaginea*	Plantain-Leaved Sedge				S2	3 Sensitive	101	78.6 ± 0.0	NB
P	*Carex prairea*	Prairie Sedge				S2	3 Sensitive	30	84.9 ± 0.0	NB
P	*Carex rostrata*	Narrow-leaved Beaked Sedge				S2	3 Sensitive	6	85.4 ± 0.0	NB
P	*Carex salina*	Saltmarsh Sedge				S2	3 Sensitive	2	82.8 ± 1.0	NB
P	*Carex sprengelii*	Longbeak Sedge				S2	3 Sensitive	46	13.6 ± 0.0	NB
P	*Carex tenuiflora*	Sparse-Flowered Sedge				S2	2 May Be At Risk	20	52.0 ± 0.0	NB
P	*Carex albicans var. emmonsii*	White-tinged Sedge				S2	3 Sensitive	4	45.5 ± 0.0	NB
P	*Cyperus squarrosus*	Awned Flatsedge				S2	3 Sensitive	31	9.3 ± 10.0	NB
P	*Eriophorum gracile*	Slender Cottongrass				S2	2 May Be At Risk	13	35.2 ± 0.0	NB
P	*Elodea nuttallii*	Nuttall's Waterweed				S2	3 Sensitive	9	9.7 ± 0.0	NB
P	*Juncus vaseyi*	Vasey Rush				S2	3 Sensitive	10	77.2 ± 0.0	NB
P	*Allium tricoccum*	Wild Leek				S2	2 May Be At Risk	22	64.6 ± 0.0	NB
P	*Najas gracillima*	Thread-Like Naiad				S2	3 Sensitive	11	31.6 ± 0.0	NB
P	*Calypso bulbosa var. americana*	Calypso				S2	2 May Be At Risk	39	9.3 ± 1.0	NB
P	*Coeloglossum viride var. virescens*	Long-bracted Frog Orchid				S2	2 May Be At Risk	8	3.1 ± 5.0	NB
P	*Cypripedium parviflorum var. makasin*	Small Yellow Lady's-Slipper				S2	2 May Be At Risk	11	8.6 ± 1.0	NB
P	*Galearis spectabilis*	Showy Orchis				S2	2 May Be At Risk	54	64.7 ± 0.0	NB
P	*Goodyera oblongifolia*	Menzies' Rattlesnake-plantain				S2	3 Sensitive	1	52.5 ± 0.0	NB
P	*Spiranthes lucida*	Shining Ladies'-Tresses				S2	3 Sensitive	26	8.2 ± 50.0	NB
P	*Spiranthes ochroleuca*	Yellow Ladies'-tresses				S2	2 May Be At Risk	2	52.7 ± 5.0	NB
P	*Agrostis mertensii*	Northern Bent Grass				S2	2 May Be At Risk	1	78.6 ± 0.0	NB
P	*Dichanthelium linearifolium*	Narrow-leaved Panic Grass				S2	3 Sensitive	13	17.3 ± 0.0	NB
P	*Elymus canadensis*	Canada Wild Rye				S2	2 May Be At Risk	20	8.4 ± 5.0	NB
P	*Leersia virginica*	White Cut Grass				S2	2 May Be At Risk	42	9.3 ± 1.0	NB
P	*Piptatherum canadense*	Canada Rice Grass				S2	3 Sensitive	5	28.6 ± 0.0	NB
P	*Poa glauca*	Glaucous Blue Grass				S2	4 Secure	1	83.6 ± 2.0	NB
P	*Puccinellia phryganodes*	Creeping Alkali Grass				S2	3 Sensitive	9	79.8 ± 0.0	NB
P	*Schizachyrium scoparium*	Little Bluestem				S2	3 Sensitive	48	10.1 ± 0.0	NB
P	*Zizania aquatica var. aquatica*	Indian Wild Rice				S2	5 Undetermined	6	11.1 ± 5.0	NB
P	*Piptatherum pungens*	Slender Rice Grass				S2	2 May Be At Risk	5	78.4 ± 0.0	NB
P	*Potamogeton vaseyi*	Vasey's Pondweed				S2	3 Sensitive	10	36.7 ± 0.0	NB
P	*Asplenium trichomanes*	Maidenhair Spleenwort				S2	3 Sensitive	9	21.2 ± 0.0	NB

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P	*Woodwardia virginica*	Virginia Chain Fern				S2	3 Sensitive	19	5.6 ± 0.0	NB
P	*Woodsia alpina*	Alpine Cliff Fern				S2	3 Sensitive	5	73.9 ± 0.0	NB
P	*Selaginella selaginoides*	Low Spikemoss				S2	3 Sensitive	4	75.3 ± 6.0	NB
P	*Toxicodendron radicans*	Poison Ivy				S2?	3 Sensitive	16	13.6 ± 0.0	NB
P	*Symphyotrichum novi-belgii var. crenifolium*	New York Aster				S2?	5 Undetermined	4	8.2 ± 1.0	NB
P	*Humulus lupulus var. lupuloides*	Common Hop				S2?	3 Sensitive	5	4.7 ± 0.0	NB
P	*Rubus recurvicaulis*	Arching Dewberry				S2?	4 Secure	5	34.7 ± 1.0	NB
P	*Galium obtusum*	Blunt-leaved Bedstraw				S2?	4 Secure	5	30.3 ± 1.0	NB
P	*Salix myricoides*	Bayberry Willow				S2?	3 Sensitive	14	14.9 ± 0.0	NB
P	*Carex vacillans*	Estuarine Sedge				S2?	3 Sensitive	3	83.3 ± 1.0	NB
P	*Platanthera huronensis*	Fragrant Green Orchid				S2?	5 Undetermined	3	44.2 ± 0.0	NB
P	*Solidago altissima*	Tall Goldenrod				S2S3	4 Secure	47	13.5 ± 0.0	NB
P	*Barbarea orthoceras*	American Yellow Rocket				S2S3	3 Sensitive	7	67.7 ± 0.0	NB
P	*Ceratophyllum echinatum*	Prickly Hornwort				S2S3	3 Sensitive	18	14.6 ± 0.0	NB
P	*Callitriche hermaphroditica*	Northern Water-starwort				S2S3	4 Secure	6	47.3 ± 0.0	NB
P	*Lonicera oblongifolia*	Swamp Fly Honeysuckle				S2S3	3 Sensitive	129	59.3 ± 0.0	NB
P	*Elatine americana*	American Waterwort				S2S3	3 Sensitive	8	32.2 ± 0.0	NB
P	*Bartonia paniculata*	Branched Bartonia				S2S3	3 Sensitive	4	85.2 ± 0.0	NB
P	*Bartonia paniculata ssp. iodandra*	Branched Bartonia				S2S3	3 Sensitive	12	55.0 ± 0.0	NB
P	*Geranium robertianum*	Herb Robert				S2S3	4 Secure	18	71.0 ± 1.0	NB
P	*Myriophyllum quitense*	Andean Water Milfoil				S2S3	4 Secure	71	62.1 ± 0.0	NB
P	*Epilobium coloratum*	Purple-veined Willowherb				S2S3	3 Sensitive	8	8.0 ± 1.0	NB
P	*Rumex pallidus*	Seabeach Dock				S2S3	3 Sensitive	4	44.5 ± 1.0	NB
P	*Amelanchier sanguinea var. gaspensis*	Round-Leaved Serviceberry				S2S3	5 Undetermined	1	78.7 ± 0.0	NB
P	*Rubus pensilvanicus*	Pennsylvania Blackberry				S2S3	4 Secure	12	7.3 ± 0.0	NB
P	*Galium labradoricum*	Labrador Bedstraw				S2S3	3 Sensitive	91	40.2 ± 0.0	NB
P	*Valeriana uliginosa*	Swamp Valerian				S2S3	3 Sensitive	47	59.1 ± 0.0	NB
P	*Carex adusta*	Lesser Brown Sedge				S2S3	4 Secure	6	28.0 ± 10.0	NB
P	*Juncus brachycephalus*	Small-Head Rush				S2S3	3 Sensitive	6	65.6 ± 0.0	NB
P	*Corallorhiza maculata var. occidentalis*	Spotted Coralroot				S2S3	3 Sensitive	7	9.3 ± 1.0	NB
P	*Corallorhiza maculata var. maculata*	Spotted Coralroot				S2S3	3 Sensitive	3	9.0 ± 1.0	NB
P	*Listera auriculata*	Auricled Twayblade				S2S3	3 Sensitive	9	13.6 ± 0.0	NB
P	*Spiranthes cernua*	Nodding Ladies'-Tresses				S2S3	3 Sensitive	13	10.6 ± 0.0	NB
P	*Eragrostis pectinacea*	Tufted Love Grass				S2S3	4 Secure	14	9.5 ± 0.0	NB
P	*Stuckenia filiformis ssp. alpina*	Thread-leaved Pondweed				S2S3	3 Sensitive	9	78.1 ± 0.0	NB
P	*Potamogeton praelongus*	White-stemmed Pondweed				S2S3	4 Secure	23	53.5 ± 0.0	NB
P	*Isoetes acadiensis*	Acadian Quillwort				S2S3	3 Sensitive	10	15.9 ± 1.0	NB
P	*Ophioglossum pusillum*	Northern Adder's-tongue				S2S3	3 Sensitive	9	31.6 ± 1.0	NB
P	*Panax trifolius*	Dwarf Ginseng				S3	3 Sensitive	14	12.3 ± 1.0	NB
P	*Arnica lanceolata*	Lance-leaved Arnica				S3	4 Secure	27	40.3 ± 0.0	NB
P	*Artemisia campestris*	Field Wormwood				S3	4 Secure	22	14.5 ± 0.0	NB
P	*Artemisia campestris ssp. caudata*	Field Wormwood				S3	4 Secure	80	13.6 ± 1.0	NB

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P	*Erigeron hyssopifolius*	Hyssop-leaved Fleabane				S3	4 Secure	26	38.0 ± 0.0	NB
P	*Prenanthes racemosa*	Glaucous Rattlesnakeroot				S3	4 Secure	59	9.7 ± 100.0	NB
P	*Tanacetum bipinnatum ssp. huronense*	Lake Huron Tansy				S3	4 Secure	35	13.7 ± 5.0	NB
P	*Symphyotrichum boreale*	Boreal Aster				S3	3 Sensitive	148	17.8 ± 10.0	NB
P	*Betula pumila*	Bog Birch				S3	4 Secure	43	13.9 ± 0.0	NB
P	*Arabis glabra*	Tower Mustard				S3	5 Undetermined	10	69.0 ± 0.0	NB
P	*Arabis hirsuta var. pycnocarpa*	Western Hairy Rockcress				S3	4 Secure	19	15.0 ± 0.0	NB
P	*Cardamine maxima*	Large Toothwort				S3	4 Secure	117	9.4 ± 0.0	NB
P	*Subularia aquatica var. americana*	Water Awlwort				S3	4 Secure	18	30.4 ± 0.0	NB
P	*Lobelia cardinalis*	Cardinal Flower				S3	4 Secure	378	21.8 ± 0.0	NB
P	*Stellaria humifusa*	Saltmarsh Starwort				S3	4 Secure	6	79.8 ± 0.0	NB
P	*Hudsonia tomentosa*	Woolly Beach-heath				S3	4 Secure	3	65.9 ± 0.0	NB
P	*Cornus amomum ssp. obliqua*	Pale Dogwood				S3	3 Sensitive	242	39.9 ± 0.0	NB
P	*Crassula aquatica*	Water Pygmyweed				S3	4 Secure	3	32.4 ± 1.0	NB
P	*Rhodiola rosea*	Roseroot				S3	4 Secure	25	71.9 ± 5.0	NB
P	*Penthorum sedoides*	Ditch Stonecrop				S3	4 Secure	64	11.1 ± 0.0	NB
P	*Elatine minima*	Small Waterwort				S3	4 Secure	56	30.6 ± 0.0	NB
P	*Astragalus alpinus var. brunetianus*	Alpine Milk-Vetch				S3	4 Secure	13	14.5 ± 0.0	NB
P	*Hedysarum alpinum*	Alpine Sweet-vetch				S3	4 Secure	35	78.4 ± 0.0	NB
P	*Gentianella amarella ssp. acuta*	Northern Gentian				S3	4 Secure	9	45.4 ± 0.0	NB
P	*Geranium bicknellii*	Bicknell's Crane's-bill				S3	4 Secure	10	30.5 ± 5.0	NB
P	*Myriophyllum farwellii*	Farwell's Water Milfoil				S3	4 Secure	22	20.1 ± 5.0	NB
P	*Myriophyllum heterophyllum*	Variable-leaved Water Milfoil				S3	4 Secure	49	28.7 ± 0.0	NB
P	*Myriophyllum verticillatum*	Whorled Water Milfoil				S3	4 Secure	22	10.6 ± 1.0	NB
P	*Stachys tenuifolia*	Smooth Hedge-Nettle				S3	3 Sensitive	14	13.4 ± 0.0	NB
P	*Utricularia radiata*	Little Floating Bladderwort				S3	4 Secure	52	43.1 ± 0.0	NB
P	*Nuphar lutea ssp. pumila*	Small Yellow Pond-lily				S3	4 Secure	23	18.4 ± 5.0	NB
P	*Epilobium hornemannii*	Hornemann's Willowherb				S3	4 Secure	4	79.9 ± 0.0	NB
P	*Epilobium strictum*	Downy Willowherb				S3	4 Secure	55	19.4 ± 1.0	NB
P	*Polygala sanguinea*	Blood Milkwort				S3	3 Sensitive	25	10.3 ± 1.0	NB
P	*Polygonum arifolium*	Halberd-leaved Tearthumb				S3	4 Secure	23	33.9 ± 0.0	NB
P	*Polygonum punctatum*	Dotted Smartweed				S3	4 Secure	2	33.4 ± 0.0	NB
P	*Polygonum punctatum var. confertiflorum*	Dotted Smartweed				S3	4 Secure	10	11.1 ± 5.0	NB
P	*Polygonum scandens*	Climbing False Buckwheat				S3	4 Secure	37	9.5 ± 1.0	NB
P	*Littorella uniflora*	American Shoreweed				S3	4 Secure	30	32.1 ± 0.0	NB
P	*Primula mistassinica*	Mistassini Primrose				S3	4 Secure	21	17.0 ± 1.0	NB
P	*Pyrola minor*	Lesser Pyrola				S3	4 Secure	2	74.8 ± 0.0	NB
P	*Clematis occidentalis*	Purple Clematis				S3	4 Secure	32	12.7 ± 0.0	NB
P	*Ranunculus gmelinii*	Gmelin's Water Buttercup				S3	4 Secure	42	28.8 ± 1.0	NB
P	*Thalictrum venulosum*	Northern Meadow-rue				S3	4 Secure	96	9.7 ± 0.0	NB
P	*Amelanchier canadensis*	Canada Serviceberry				S3	4 Secure	16	10.0 ± 1.0	NB
P	*Rosa palustris*	Swamp Rose				S3	4 Secure	46	32.1 ± 0.0	NB
P	*Rubus occidentalis*	Black Raspberry				S3	4 Secure	119	15.2 ± 0.0	NB
P	*Galium boreale*	Northern Bedstraw				S3	4 Secure	10	13.7 ± 0.0	NB
P	*Salix interior*	Sandbar Willow				S3	4 Secure	38	9.4 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
P	*Salix nigra*	Black Willow				S3	3 Sensitive	124	7.2 ± 5.0	NB
P	*Salix pedicellaris*	Bog Willow				S3	4 Secure	66	14.8 ± 1.0	NB
P	*Comandra umbellata*	Bastard's Toadflax				S3	4 Secure	1	48.4 ± 10.0	NB
P	*Parnassia glauca*	Fen Grass-of-Parnassus				S3	4 Secure	12	19.0 ± 10.0	NB
P	*Limosella australis*	Southern Mudwort				S3	4 Secure	1	88.9 ± 5.0	NB
P	*Veronica serpyllifolia ssp. humifusa*	Thyme-Leaved Speedwell				S3	4 Secure	6	8.6 ± 100.0	NB
P	*Boehmeria cylindrica*	Small-spike False-nettle				S3	3 Sensitive	148	14.2 ± 0.0	NB
P	*Pilea pumila*	Dwarf Clearweed				S3	4 Secure	57	9.0 ± 1.0	NB
P	*Viola adunca*	Hooked Violet				S3	4 Secure	11	44.8 ± 1.0	NB
P	*Viola nephrophylla*	Northern Bog Violet				S3	4 Secure	68	15.3 ± 0.0	NB
P	*Carex aquatilis*	Water Sedge				S3	4 Secure	2	92.5 ± 0.0	NB
P	*Carex arcta*	Northern Clustered Sedge				S3	4 Secure	56	13.3 ± 0.0	NB
P	*Carex atratiformis*	Scabrous Black Sedge				S3	4 Secure	4	81.1 ± 0.0	NB
P	*Carex capillaris*	Hairlike Sedge				S3	4 Secure	9	78.7 ± 0.0	NB
P	*Carex chordorrhiza*	Creeping Sedge				S3	4 Secure	79	16.0 ± 0.0	NB
P	*Carex conoidea*	Field Sedge				S3	4 Secure	23	19.3 ± 1.0	NB
P	*Carex eburnea*	Bristle-leaved Sedge				S3	4 Secure	7	91.1 ± 0.0	NB
P	*Carex exilis*	Coastal Sedge				S3	4 Secure	101	39.8 ± 0.0	NB
P	*Carex garberi*	Garber's Sedge				S3	3 Sensitive	14	34.5 ± 1.0	NB
P	*Carex haydenii*	Hayden's Sedge				S3	4 Secure	37	10.3 ± 1.0	NB
P	*Carex lupulina*	Hop Sedge				S3	4 Secure	117	10.9 ± 10.0	NB
P	*Carex michauxiana*	Michaux's Sedge				S3	4 Secure	59	50.2 ± 0.0	NB
P	*Carex ormostachya*	Necklace Spike Sedge				S3	4 Secure	19	16.2 ± 1.0	NB
P	*Carex rosea*	Rosy Sedge				S3	4 Secure	237	16.3 ± 0.0	NB
P	*Carex tenera*	Tender Sedge				S3	4 Secure	54	18.9 ± 1.0	NB
P	*Carex tuckermanii*	Tuckerman's Sedge				S3	4 Secure	75	14.1 ± 1.0	NB
P	*Carex vaginata*	Sheathed Sedge				S3	3 Sensitive	14	58.8 ± 0.0	NB
P	*Carex wiegandii*	Wiegand's Sedge				S3	4 Secure	36	23.3 ± 0.0	NB
P	*Carex recta*	Estuary Sedge				S3	4 Secure	5	42.3 ± 0.0	NB
P	*Cyperus dentatus*	Toothed Flatsedge				S3	4 Secure	147	14.7 ± 1.0	NB
P	*Cyperus esculentus*	Perennial Yellow Nutsedge				S3	4 Secure	45	11.0 ± 5.0	NB
P	*Eleocharis intermedia*	Matted Spikerush				S3	4 Secure	6	15.3 ± 0.0	NB
P	*Eleocharis quinqueflora*	Few-flowered Spikerush				S3	4 Secure	28	14.4 ± 0.0	NB
P	*Rhynchospora capitellata*	Small-headed Beakrush				S3	4 Secure	40	22.1 ± 0.0	NB
P	*Rhynchospora fusca*	Brown Beakrush				S3	4 Secure	41	25.4 ± 1.0	NB
P	*Trichophorum clintonii*	Clinton's Clubrush				S3	4 Secure	94	48.9 ± 1.0	NB
P	*Schoenoplectus fluviatilis*	River Bulrush				S3	3 Sensitive	46	20.4 ± 0.0	NB
P	*Schoenoplectus torreyi*	Torrey's Bulrush				S3	4 Secure	33	24.7 ± 0.0	NB
P	*Lemna trisulca*	Star Duckweed				S3	4 Secure	17	49.5 ± 0.0	NB
P	*Triantha glutinosa*	Sticky False-Asphodel				S3	4 Secure	85	15.2 ± 0.0	NB
P	*Cypripedium reginae*	Showy Lady's-Slipper				S3	3 Sensitive	112	59.2 ± 0.0	NB
P	*Liparis loeselii*	Loesel's Twayblade				S3	4 Secure	26	8.0 ± 0.0	NB
P	*Platanthera blephariglottis*	White Fringed Orchid				S3	4 Secure	50	6.4 ± 1.0	NB
P	*Platanthera grandiflora*	Large Purple Fringed Orchid				S3	3 Sensitive	39	24.5 ± 1.0	NB
P	*Bromus latiglumis*	Broad-Glumed Brome				S3	3 Sensitive	29	16.7 ± 0.0	NB
P	*Calamagrostis pickeringii*	Pickering's Reed Grass				S3	4 Secure	104	53.3 ± 0.0	NB
P	*Dichanthelium depauperatum*	Starved Panic Grass				S3	4 Secure	26	31.7 ± 0.0	NB
P	*Muhlenbergia richardsonis*	Mat Muhly				S3	4 Secure	34	14.9 ± 0.0	NB
P	*Heteranthera dubia*	Water Stargrass				S3	4 Secure	60	10.6 ± 0.0	NB

Taxonomic Group	Scientific Name	Common Name	COSEWIC	SARA	Prov Legal Prot	Prov Rarity Rank	Prov GS Rank	# recs	Distance (km)	Prov
P	*Potamogeton obtusifolius*	Blunt-leaved Pondweed				S3	4 Secure	36	35.0 ± 1.0	NB
P	*Potamogeton richardsonii*	Richardson's Pondweed				S3	3 Sensitive	16	11.2 ± 5.0	NB
P	*Xyris montana*	Northern Yellow-Eyed-Grass				S3	4 Secure	26	52.9 ± 0.0	NB
P	*Zannichellia palustris*	Horned Pondweed				S3	4 Secure	5	71.8 ± 0.0	NB
P	*Adiantum pedatum*	Northern Maidenhair Fern				S3	4 Secure	281	19.3 ± 5.0	NB
P	*Cryptogramma stelleri*	Steller's Rockbrake				S3	4 Secure	1	84.8 ± 1.0	NB
P	*Asplenium trichomanes-ramosum*	Green Spleenwort				S3	4 Secure	15	62.6 ± 0.0	NB
P	*Dryopteris fragrans var. remotiuscula*	Fragrant Wood Fern				S3	4 Secure	18	40.5 ± 0.0	NB
P	*Dryopteris goldiana*	Goldie's Woodfern				S3	3 Sensitive	183	17.9 ± 5.0	NB
P	*Woodsia glabella*	Smooth Cliff Fern				S3	4 Secure	1	99.1 ± 1.0	NB
P	*Equisetum palustre*	Marsh Horsetail				S3	4 Secure	8	10.6 ± 0.0	NB
P	*Isoetes tuckermanii*	Tuckerman's Quillwort				S3	4 Secure	20	26.6 ± 0.0	NB
P	*Lycopodium sabinifolium*	Ground-Fir				S3	4 Secure	12	30.5 ± 10.0	NB
P	*Huperzia appalachiana*	Appalachian Fir-Clubmoss				S3	3 Sensitive	2	80.7 ± 1.0	NB
P	*Botrychium dissectum*	Cut-leaved Moonwort				S3	4 Secure	52	10.8 ± 0.0	NB
P	*Botrychium lanceolatum var. angustisegmentum*	Lance-Leaf Grape-Fern				S3	3 Sensitive	17	10.2 ± 0.0	NB
P	*Botrychium simplex*	Least Moonwort				S3	4 Secure	12	12.6 ± 0.0	NB
P	*Polypodium appalachianum*	Appalachian Polypody				S3	4 Secure	25	9.0 ± 10.0	NB
P	*Utricularia resupinata*	Inverted Bladderwort				S3?	4 Secure	16	39.8 ± 0.0	NB
P	*Crataegus submollis*	Quebec Hawthorn				S3?	3 Sensitive	19	10.3 ± 1.0	NB
P	*Mertensia maritima*	Sea Lungwort				S3S4	4 Secure	16	80.4 ± 1.0	NB
P	*Lobelia kalmii*	Brook Lobelia				S3S4	4 Secure	47	11.7 ± 1.0	NB
P	*Suaeda calceoliformis*	Horned Sea-blite				S3S4	4 Secure	3	9.8 ± 0.0	NB
P	*Myriophyllum sibiricum*	Siberian Water Milfoil				S3S4	4 Secure	30	39.9 ± 0.0	NB
P	*Stachys pilosa*	Hairy Hedge-Nettle				S3S4	5 Undetermined	5	14.9 ± 0.0	NB
P	*Utricularia gibba*	Humped Bladderwort				S3S4	4 Secure	41	17.2 ± 0.0	NB
P	*Potentilla arguta*	Tall Cinquefoil				S3S4	4 Secure	49	9.3 ± 1.0	NB
P	*Rubus chamaemorus*	Cloudberry				S3S4	4 Secure	46	75.4 ± 0.0	NB
P	*Geocaulon lividum*	Northern Comandra				S3S4	4 Secure	9	82.7 ± 1.0	NB
P	*Juniperus horizontalis*	Creeping Juniper				S3S4	4 Secure	2	84.6 ± 1.0	NB
P	*Cladium mariscoides*	Smooth Twigrush				S3S4	4 Secure	87	25.6 ± 0.0	NB
P	*Eriophorum russeolum*	Russet Cottongrass				S3S4	4 Secure	9	35.7 ± 2.0	NB
P	*Triglochin gaspensis*	Gasp├⌐ Arrowgrass				S3S4	4 Secure	12	83.1 ± 0.0	NB
P	*Spirodela polyrrhiza*	Great Duckweed				S3S4	4 Secure	39	8.7 ± 1.0	NB
P	*Corallorhiza maculata*	Spotted Coralroot				S3S4	3 Sensitive	12	21.2 ± 0.0	NB
P	*Calamagrostis stricta*	Slim-stemmed Reed Grass				S3S4	4 Secure	1	70.7 ± 2.0	NB
P	*Distichlis spicata*	Salt Grass				S3S4	4 Secure	3	97.7 ± 1.0	NB
P	*Potamogeton oakesianus*	Oakes' Pondweed				S3S4	4 Secure	36	12.2 ± 0.0	NB
P	*Solidago caesia*	Blue-stemmed Goldenrod				SX	0.1 Extirpated	2	83.5 ± 1.0	NB
P	*Oligoneuron album*	Upland White Goldenrod				SX	0.1 Extirpated	3	75.6 ± 1.0	NB
P	*Celastrus scandens*	Climbing Bittersweet				SX	0.1 Extirpated	4	16.8 ± 1.0	NB

5.1 SOURCE BIBLIOGRAPHY (100 km)

The recipient of these data shall acknowledge the ACCDC and the data sources listed below in any documents, reports, publications or presentations, in which this dataset makes a significant contribution.

# recs	CITATION
6708	Lepage, D. 2014. Maritime Breeding Bird Atlas Database. Bird Studies Canada, Sackville NB, 407,838 recs.
3714	eBird. 2014. eBird Basic Dataset. Version: EBD_relNov-2014. Ithaca, New York. Nov 2014. Cornell Lab of Ornithology, 25036 recs.
3691	Erskine, A.J. 1992. Maritime Breeding Bird Atlas Database. NS Museum & Nimbus Publ., Halifax, 82,125 recs.
1891	Pardieck, K.L. & Ziolkowski Jr., D.J.; Hudson, M.-A.R. 2014. North American Breeding Bird Survey Dataset 1966 - 2013, version 2013.0. U.S. Geological Survey, Patuxent Wildlife Research Center <www.pwrc.usgs.gov/BBS/RawData/>.
1669	Morrison, Guy. 2011. Maritime Shorebird Survey (MSS) database. Canadian Wildlife Service, Ottawa, 15939 surveys. 86171 recs.
1274	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2014. Atlantic Canada Conservation Data Centre Fieldwork 2014. Atlantic Canada Conservation Data Centre, # recs.
1007	Blaney, C.S. & Mazerolle, D.M. 2011. NB WTF Fieldwork on Magaguadavic & Lower St Croix Rivers. Atlantic Canada Conservation Data Centre, 4585 recs.
825	Blaney, C.S.; Mazerolle, D.M. 2009. Fieldwork 2009. Atlantic Canada Conservation Data Centre. Sackville NB, 13395 recs.
808	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2015. Atlantic Canada Conservation Data Centre Fieldwork 2015. Atlantic Canada Conservation Data Centre, # recs.
734	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2003.
596	Cowie, F. 2007. Electrofishing Population Estimates 1979-98. Canadian Rivers Institute, 2698 recs.
544	Clayden, S.R. 1998. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 19759 recs.
502	Benedict, B. Connell Herbarium Specimens (Data) . University New Brunswick, Fredericton. 2003.
406	Blaney, C.S.; Mazerolle, D.M. 2008. Fieldwork 2008. Atlantic Canada Conservation Data Centre. Sackville NB, 13343 recs.
397	Brunelle, P.-M. (compiler). 2009. ADIP/MDDS Odonata Database: data to 2006 inclusive. Atlantic Dragonfly Inventory Program (ADIP), 24200 recs.
377	Blaney, C.S.; Mazerolle, D.M.; Belliveau, A.B. 2013. Atlantic Canada Conservation Data Centre Fieldwork 2013. Atlantic Canada Conservation Data Centre, 9000+ recs.
364	Tims, J. & Craig, N. 1995. Environmentally Significant Areas in New Brunswick (NBESA). NB Dept of Environment & Nature Trust of New Brunswick Inc, 6042 recs.
362	Hicks, Andrew. 2009. Coastal Waterfowl Surveys Database, 2000-08. Canadian Wildlife Service, Sackville, 46488 recs (11149 non-zero).
328	Blaney, C.S.; Mazerolle, D.M.; Klymko, J; Spicer, C.D. 2006. Fieldwork 2006. Atlantic Canada Conservation Data Centre. Sackville NB, 8399 recs.
273	Blaney, C.S. 2000. Fieldwork 2000. Atlantic Canada Conservation Data Centre. Sackville NB, 1265 recs.
267	Sollows, M.C,. 2008. NBM Science Collections databases: mammals. New Brunswick Museum, Saint John NB, download Jan. 2008, 4983 recs.
258	Hinds, H.R. 1986. Notes on New Brunswick plant collections. Connell Memorial Herbarium, unpubl, 739 recs.
231	Clayden, S.R. 2007. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, download Mar. 2007, 6914 recs.
196	Blaney, C.S. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 1042 recs.
191	Churchill, J.L.; Klymko, J.D. 2016. Bird Species at Risk Inventory on the Acadia Research Forest, 2016. Atlantic Canada Conservation Data Centre, 813 recs.
184	Blaney, C.S. & Mazerolle, D.M. 2011. Field data from NCC properties at Musquash Harbour NB & Goose Lake NS. Atlantic Canada Conservation Data Centre, 1739 recs.
168	Anonymous. 2017. Observations from protected sources. Atlantic Canada Conservation Data Centre.
165	Tranquilla, L. 2015. Maritimes Marsh Monitoring Project 2015 data. Bird Studies Canada, Sackville NB, 5062 recs.
161	Benedict, B. Connell Herbarium Specimen Database Download 2004. Connell Memorial Herbarium, University of New Brunswick. 2004.
147	Blaney, C.S.; Spicer, C.D.; Mazerolle, D.M. 2005. Fieldwork 2005. Atlantic Canada Conservation Data Centre. Sackville NB, 2333 recs.
146	Sollows, M.C,. 2009. NBM Science Collections databases: molluscs. New Brunswick Museum, Saint John NB, download Jan. 2009, 6951 recs (2957 in Atlantic Canada).
144	Blaney, C.S.; Mazerolle, D.M. 2012. Fieldwork 2012. Atlantic Canada Conservation Data Centre, 13,278 recs.
133	MacDougall, A.; Bishop, G.; et al. 1998. 1997 Appalachian Hardwood Field Data. Nature Trust of New Brunswick, 4473 recs.
129	Bagnell, B.A. 2001. New Brunswick Bryophyte Occurrences. B&B Botanical, Sussex, 478 recs.
129	Blaney, C.S.; Spicer, C.D.; Popma, T.M.; Hanel, C. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 2252 recs.
126	Gravel, Mireille. 2010. Coordonnées GPS et suivi des tortues marquées, 2005-07. Kouchibouguac National Park, 480 recs.
122	Sollows, M.C. 2008. NBM Science Collections databases: herpetiles. New Brunswick Museum, Saint John NB, download Jan. 2008, 8636 recs.
115	Blaney, C.S.; Mazerolle, D.M.; Oberndorfer, E. 2007. Fieldwork 2007. Atlantic Canada Conservation Data Centre. Sackville NB, 13770 recs.
113	Bishop, G. & Papoulias, M.; Arnold (Chaplin), M. 2005. Grand Lake Meadows field notes, Summer 2005. New Brunswick Federation of Naturalists, 1638 recs.
101	Sabine, D.L. 2005. 2001 Freshwater Mussel Surveys. New Brunswick Dept of Natural Resources & Energy, 590 recs.
100	Boyne, A.W. 2000. Tern Surveys. Canadian Wildlife Service, Sackville, unpublished data. 168 recs.
100	Erskine, A.J. 1999. Maritime Nest Records Scheme (MNRS) 1937-1999. Canadian Wildlife Service, Sackville, 313 recs.
97	Belliveau, A.G. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 10695 recs.
97	Thomas, A.W. 1996. A preliminary atlas of the butterflies of New Brunswick. New Brunswick Museum.
82	Bateman, M.C. 2001. Coastal Waterfowl Surveys Database, 1965-2001. Canadian Wildlife Service, Sackville, 667 recs.
80	Klymko, J.J.D. 2014. Maritimes Butterfly Atlas, 2012 submissions. Atlantic Canada Conservation Data Centre, 8552 records.
79	Robinson, S.L. 2015. 2014 field data.
75	Speers, L. 2008. Butterflies of Canada database: New Brunswick 1897-1999. Agriculture & Agri-Food Canada, Biological Resources Program, Ottawa, 2048 recs.
72	Belland, R.J. Maritimes moss records from various herbarium databases. 2014.
71	Blaney, C.S.; Spicer, C.D.; Rothfels, C. 2004. Fieldwork 2004. Atlantic Canada Conservation Data Centre. Sackville NB, 1343 recs.
71	Cowie, Faye. 2007. Surveyed Lakes in New Brunswick. Canadian Rivers Institute, 781 recs.
64	McAlpine, D.F. 1998. NBM Science Collections: Wood Turtle records. New Brunswick Museum, Saint John NB, 329 recs.

# recs	CITATION
63	Blaney, C.S.; Spicer, C.D. 2001. Fieldwork 2001. Atlantic Canada Conservation Data Centre. Sackville NB, 981 recs.
62	Scott, Fred W. 1998. Updated Status Report on the Cougar (Puma Concolor couguar) [Eastern population]. Committee on the Status of Endangered Wildlife in Canada, 298 recs.
58	Spicer, C.D. 2002. Fieldwork 2002. Atlantic Canada Conservation Data Centre. Sackville NB, 211 recs.
55	Klymko, J.J.D. 2016. 2015 field data. Atlantic Canada Conservation Data Centre.
49	Mills, E. Connell Herbarium Specimens, 1957-2009. University New Brunswick, Fredericton. 2012.
48	Manthorne, A. 2014. MaritimesSwiftwatch Project database 2013-2014. Bird Studies Canada, Sackville NB, 326 recs.
45	Wilhelm, S.I. et al. 2011. Colonial Waterbird Database. Canadian Wildlife Service, Sackville, 2698 sites, 9718 recs (8192 obs).
44	McAlpine, D.F. 1998. NBM Science Collections databases to 1998. New Brunswick Museum, Saint John NB, 241 recs.
41	Blaney, C.S.; Mazerolle, D.M. 2010. Fieldwork 2010. Atlantic Canada Conservation Data Centre. Sackville NB, 15508 recs.
37	Doucet, D.A. & Edsall, J.; Brunelle, P.-M. 2007. Miramichi Watershed Rare Odonata Survey. New Brunswick ETF & WTF Report, 1211 recs.
35	Doucet, D.A. 2008. Fieldwork 2008: Odonata. ACCDC Staff, 625 recs.
29	Stewart, J.I. 2010. Peregrine Falcon Surveys in New Brunswick, 2002-09. Canadian Wildlife Service, Sackville, 58 recs.
28	Benedict, B. Connell Herbarium Specimens, Digital photos. University New Brunswick, Fredericton. 2005.
27	Hinds, H.R. 1999. Connell Herbarium Database. University New Brunswick, Fredericton, 131 recs.
27	Speers, L. 2001. Butterflies of Canada database. Agriculture & Agri-Food Canada, Biological Resources Program, Ottawa, 190 recs.
26	Klymko, J.J.D.; Robinson, S.L. 2014. 2013 field data. Atlantic Canada Conservation Data Centre.
25	Kennedy, Joseph. 2010. New Brunswick Peregrine records, 2009. New Brunswick Dept Natural Resources, 19 recs (14 active).
23	Sollows, M.C,. 2009. NBM Science Collections databases: Coccinellid & Cerambycid Beetles. New Brunswick Museum, Saint John NB, download Feb. 2009, 569 recs.
22	Mazerolle, D.M. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 11311 recs.
20	Klymko, J.J.D. 2016. 2014 field data. Atlantic Canada Conservation Data Centre.
18	Benedict, B. Connell Herbarium Specimens. University New Brunswick, Fredericton. 2000.
18	Edsall, J. 2001. Lepidopteran records in New Brunswick, 1997-99. , Pers. comm. to K.A. Bredin. 91 recs.
17	Clayden, S.R. 2012. NBM Science Collections databases: vascular plants. New Brunswick Museum, Saint John NB, 57 recs.
15	Edsall, J. 2007. Personal Butterfly Collection: specimens collected in the Canadian Maritimes, 1961-2007. J. Edsall, unpubl. report, 137 recs.
15	Klymko, J.J.D. 2012. Maritimes Butterfly Atlas, 2010 and 2011 records. Atlantic Canada Conservation Data Centre, 6318 recs.
15	Tingley, S. (compiler). 2001. Butterflies of New Brunswick. , Web site: www.geocities.com/Yosemite/8425/buttrfly. 142 recs.
15	Webster, R.P. 2006. Survey for Suitable Salt Marshes for the Maritime Ringlet, New Populations of the Cobblestone Tiger Beetle, & New Localities of Three Rare Butterfly Species. New Brunswick WTF Report, 28 recs.
14	Spicer, C.D. 2001. Powerline Corridor Botanical Surveys, Charlotte & Saint John Counties. A M E C International, 1269 recs.
12	Downes, C. 1998-2000. Breeding Bird Survey Data. Canadian Wildlife Service, Ottawa, 111 recs.
11	Webster, R.P. 2004. Lepidopteran Records for National Wildlife Areas in New Brunswick. Webster, 1101 recs.
10	Noseworthy, J. 2013. Van Brunt's Jacob's-ladder observations along tributary of Dipper Harbour Ck. Nature Conservancy of Canada, 10 recs.
10	Pike, E., Tingley, S. & Christie, D.S. 2000. Nature NB Listserve. University of New Brunswick, listserv.unb.ca/archives/naturenb. 68 recs.
9	Bateman, M.C. 2000. Waterfowl Brood Surveys Database, 1990-2000 . Canadian Wildlife Service, Sackville, unpublished data. 149 recs.
9	Clayden, S.R. 2005. Confidential supplement to Status Report on Ghost Antler Lichen (Pseudevernia cladonia). Committee on the Status of Endangered Wildlife in Canada, 27 recs.
8	Blaney, C.S.; Mazerolle, D.M. 2011. Fieldwork 2011. Atlantic Canada Conservation Data Centre. Sackville NB.
8	Chaput, G. 2002. Atlantic Salmon: Maritime Provinces Overview for 2001. Dept of Fisheries & Oceans, Atlantic Region, Science Stock Status Report D3-14. 39 recs.
8	Goltz, J.P. & Bishop, G. 2005. Confidential supplement to Status Report on Prototype Quillwort (Isoetes prototypus). Committee on the Status of Endangered Wildlife in Canada, 111 recs.
8	Munro, Marian K. Nova Scotia Provincial Museum of Natural History Herbarium Database. Nova Scotia Provincial Museum of Natural History, Halifax, Nova Scotia. 2013.
7	Bredin, K.A. 2001. WTF Project: Freshwater Mussel Fieldwork in Freshwater Species data. Atlantic Canada Conservation Data Centere, 101 recs.
7	Goltz, J.P. 1994. In the Footsteps of Our Ancestors. NB Naturalists, 21 (2-4): 20. 8 recs.
7	Kennedy, Joseph. 2010. New Brunswick Peregrine records, 2010. New Brunswick Dept Natural Resources, 16 recs (11 active).
7	Klymko, J.J.D. 2012. Insect fieldwork & submissions, 2003-11. Atlantic Canada Conservation Data Centre. Sackville NB, 1337 recs.
7	McAlpine, D.F. 1983. Status & Conservation of Solution Caves in New Brunswick. New Brunswick Museum, Publications in Natural Science, no. 1, 28pp.
6	Brunelle, P.-M. (compiler). 2010. ADIP/MDDS Odonata Database: NB, NS Update 1900-09. Atlantic Dragonfly Inventory Program (ADIP), 935 recs.
6	Cronin, P. & Ayer, C.; Dubee, B.; Hooper, W.C.; LeBlanc, E.; Madden, A.; Pettigrew, T.; Seymour, P. 1998. Fish Species Management Plans (draft). NB DNRE Internal Report. Fredericton, 164pp.
6	Litvak, M.K. 2001. Shortnose Sturgeon records in four NB rivers. UNB Saint John NB. Pers. comm. to K. Bredin, 6 recs.
6	Marshall, L. 1998. Atlantic Salmon: Southwest New Brunswick outer-Fundy SFA 23. Dept of Fisheries & Oceans, Atlantic Region, Science. Stock Status Report D3-13. 6 recs.
6	Newell, R.E. 2008. Vascular Plants of Muzroll Lake. Pers. comm. to C.S. Blaney, 1 pg. 43 recs.
6	Popma, T.M. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre. Sackville NB, 113 recs.
5	Basquill, S.P. 2003. Fieldwork 2003. Atlantic Canada Conservation Data Centre, Sackville NB, 69 recs.
5	Goltz, J.P. 2001. Botany Ramblings April 29-June 30, 2001. N.B. Naturalist, 28 (2): 51-2. 8 recs.
5	Toner, M. 2005. Lynx Records 1996-2005. NB Dept of Natural Resources, 48 recs.
5	Wood Turtle (Glyptemys insculpta) Miramichi Watershed Synopsis 2013 Compiled by: Vladimir King Trajkovic, EPt Miramichi River Environmental Assessment Committee
4	Blaney, C.S. 2016. Atlantic Canada Conservation Data Centre Fieldwork 2016. Atlantic Canada Conservation Data Centre, 6719 recs.
4	Bredin, K.A. 2003. NB Freshwater Mussel Fieldwork. Atlantic Canada Conservation Data Centere, 20 recs.

# recs	CITATION
4	Christie, D.S. 2000. Christmas Bird Count Data, 1997-2000. Nature NB, 54 recs.
4	Doucet, D.A. & Edsall, J. 2007. Ophiogomphus howei records. Atlantic Canada Conservation Data Centre, Sackville NB, 21 recs.
4	Doucet, D.A. 2008. Wood Turtle Records 2002-07. Pers. comm. to S. Gerriets, 7 recs, 7 recs.
4	Gravel, Mireille. 2010. Coordonnées des tortues des bois Salmon River Road, 2005. Kouchibouguac National Park, 4 recs.
4	Klymko, J.J.D. 2012. Odonata specimens & observations, 2010. Atlantic Canada Conservation Data Centre, 425 recs.
4	Layberry, R.A. 2012. Lepidopteran records for the Maritimes, 1974-2008. Layberry Collection, 1060 recs.
4	Newell, R.E. 2000. E.C. Smith Herbarium Database. Acadia University, Wolfville NS, 7139 recs.
4	Sabine, D.L. 2011. Dorcas Copper records from 2001 Fieldwork. New Brunswick Dept of Natural Resources, 4 recs.
3	Bishop, G. 2012. Field data from September 2012 Anticosti Aster collection trip. , 135 rec.
3	Bishop, G., Bagnell, B.A. 2004. Site Assessment of Musquash Harbour, Nature Conservancy of Canada Property - Preliminary Botanical Survey. B&B Botanical, 12pp.
3	Blaney, C.S. Miscellaneous specimens received by ACCDC (botany). Various persons. 2001-08.
3	Brunelle, P.-M. 2005. Wood Turtle observations. Pers. comm. to S.H. Gerriets, 21 Sep. 3 recs, 3 recs.
3	Clayden, S.R. 2006. Pseudevernia cladonia records. NB Museum. Pers. comm. to S. Blaney, Dec, 4 recs.
3	Doucet, D.A. 2007. Lepidopteran Records, 1988-2006. Doucet, 700 recs.
3	Edsall, J. 1993. Spring 1993 Report. New Brunswick Bird Info Line, 3 recs.
3	Forbes, G. 2001. Bog Lemming, Phalarope records, NB. , Pers. comm. to K.A. Bredin. 6 recs.
3	Klymko, J.J.D. 2012. Insect fieldwork & submissions, 2011. Atlantic Canada Conservation Data Centre. Sackville NB, 760 recs.
3	Lautenschlager, R.A. 2005. Survey for Species at Risk on the Canadian Forest Service's Acadia Research Forest near Fredericton, New Brunswick. Atlantic Canada Conservation Data Centre, 6. 3 recs.
3	Sabine, D.L. 2013. Dwaine Sabine butterfly records, 2009 and earlier.
3	Webster, R.P. & Edsall, J. 2007. 2005 New Brunswick Rare Butterfly Survey. Environmental Trust Fund, unpublished report, 232 recs.
2	Bagnell, B.A. 2003. Update to New Brunswick Rare Bryophyte Occurrences. B&B Botanical, Sussex, 5 recs.
2	Boyne, A.W. 2000. Harlequin Duck Surveys. Canadian Wildlife Service, Sackville, unpublished data. 5 recs.
2	Chaput, G. 1999. Atlantic Salmon: Miramichi & SFA 16 Rivers. Dept of Fisheries & Oceans, Atlantic Region, Science Stock Status Report D3-05. 6 recs.
2	Edsall, J. 1992. Summer 1992 Report. New Brunswick Bird Info Line, 2 recs.
2	Goltz, J.P. 2002. Botany Ramblings: 1 July to 30 September, 2002. N.B. Naturalist, 29 (3):84-92. 7 recs.
2	Hay, G.U. 1883. Botany of the Upper St. John. Bulletin of the Natural History Society of New Brunswick, 2:21-31. 2 recs.
2	Hinds, H.R. 1999. A Vascular Plant Survey of the Musquash Estuary in New Brunswick. , 12pp.
2	Toner, M. 2001. Lynx Records 1973-2000. NB Dept of Natural Resources, 29 recs.
2	Walker, E.M. 1942. Additions to the List of Odonates of the Maritime Provinces. Proc. Nova Scotian Inst. Sci., 20. 4: 159-176. 2 recs.
1	Amirault, D.L. 1997-2000. Unpublished files. Canadian Wildlife Service, Sackville, 470 recs.
1	Benedict, B. 2006. Argus annotation: Salix pedicellaris. Pers. comm to C.S. Blaney, June 21, 1 rec.
1	Bredin, K.A. 2001. NB Freshwater Mussel Fieldwork. Atlantic Canada Conservation Data Centere, 16 recs.
1	Clayden, S.R. 2007. NBM Science Collections. Pers. comm. to D. Mazerolle, 1 rec.
1	Dadswell, M.J. 1979. Status Report on Shortnose Sturgeon (Acipenser brevirostrum) in Canada. Committee on the Status of Endangered Wildlife in Canada, 15 pp.
1	Dept of Fisheries & Oceans. 1999. Status of Wild Striped Bass, & Interaction between Wild & Cultured Striped Bass in the Maritime Provinces. , Science Stock Status Report D3-22. 13 recs.
1	Edsall, J. 1993. Summer 1993 Report. New Brunswick Bird Info Line, 2 recs.
1	Hicklin, P.W. 1990. Shorebird Concentration Sites (unpubl. data). Canadian Wildlife Service, Sackville, 296 sites, 30 spp.
1	Hinds, H.R. 2000. Flora of New Brunswick (2nd Ed.). University New Brunswick, 694 pp.
1	Holder, M. & Kingsley, A.L. 2000. Peatland Insects in NB & NS: Results of surveys in 10 bogs during summer 2000. Atlantic Canada Conservation Data Centre, Sackville, 118 recs.
1	Jessop, B. 2004. Acipenser oxyrinchus locations. Dept of Fisheries & Oceans, Atlantic Region, Pers. comm. to K. Bredin. 1 rec.
1	Jolicoeur, G. 2008. Anticosti Aster at Chapel Bar, St John River. QC DOE? Pers. comm. to D.M. Mazerolle, 1 rec.
1	Madden, A. 1998. Wood Turtle records in northern NB. New Brunswick Dept of Natural Resources & Energy, Campbellton, Pers. comm. to S.H. Gerriets. 16 recs.
1	McAlpine, D.F. & Cox, S.L., McCabe, D.A., Schnare, J.-L. 2004. Occurrence of the Long-tailed Shrew (Sorex dispar) in the Nerepis Hills NB. Northeastern Naturalist, vol 11 (4) 383-386. 1 rec.
1	Newell, R.E. 2005. E.C. Smith Digital Herbarium. E.C. Smith Herbarium, Irving Biodiversity Collection, Acadia University, Web site: http://luxor.acadiau.ca/library/Herbarium/project/. 582 recs.
1	Norton, Barb. 2010. Personal communication concerning Botrychium oneidense near Ayers Lake, NB. , One record.
1	Nye, T. 2002. Wood Turtle observations in Westmorland, Queens Cos. , Pers. com. to S.H. Gerriets, Dec. 3. 3 recs.
1	Olsen, R. Herbarium Specimens. Nova Scotia Agricultural College, Truro. 2003.
1	Sabine, D.L. & Goltz, J.P. 2006. Discovery of Utricularia resupinata at Little Otter Lake, CFB Gagetown. Pers. comm. to D.M. Mazerolle, 1 rec.
1	Sabine, D.L. 2004. Specimen data: Whittaker Lake & Marysville NB. Pers. comm. to C.S. Blaney, 2pp, 4 recs.
1	Sabine, D.L. 2012. Bronze Copper records, 2003-06. New Brunswick Dept of Natural Resources, 5 recs.
1	Singleton, J. 2004. Primula mistassinica record for Nashwaak NB. Pers. comm. to C.S. Blaney, 1 rec.
1	Taylor, Eric B. 1997. Status of the Sympatric Smelt (genus Osmerus) Populations of Lake Utopia, New Brunswick. Committee on the Status of Endangered Wildlife in Canada, 1 rec.
1	Toner, M. 2005. Listera australis population at Bull Pasture Plains. NB Dept of Natural Resources. Pers. comm. to S. Blaney, 8 recs.
1	Toner, M. 2009. Wood Turtle Sightings. NB Dept of Natural Resources. Pers. comm. to S. Gerriets, Jul 13 & Sep 2, 2 recs.
1	Toner, M. 2011. Wood Turtle sighting. NB Dept of Natural Resources. Pers. com. to S. Gerriets, Sep 2, photo, 1 rec.
1	Torenvliet, Ed. 2010. Wood Turtle roadkill. NB Dept of Transport. Pers. com. to R. Lautenschlager, Aug. 20, photos, 1 rec.
1	Tremblay, E. 2006. Kouchibouguac National Park Digital Database. Parks Canada, 105 recs.

Appendix II
Plant Inventory

Common Name	Scientific Name	S - Rank	General Status
Balsam Fir	Abies balsamea	S5	Secure
Red Maple	Acer rubrum	S5	Secure
Silver Maple	Acer saccharinum	S4	Secure
Speckled Alder	Alnus incana	S5	Secure
Large Sweet Vernal Grass	Anthoxanthum odoratum	SNA	Exotic
Wild Chervil	Anthriscus sylvestris	SNA	Exotic
Wild Sarsaparilla	Aralia nudicaulis	S5	Secure
Jack-in-the-pulpit	Arisaema triphyllum	S5	Secure
Common Lady Fern	Athyrium filix-femina	S5	Secure
Yellow Birch	Betula alleghaniensis	S5	Secure
Heart-leaved Birch	Betula papyrifera var. cordifolia	S5	Secure
Gray Birch	Betula populifolia	S5	Secure
Northern Shorthusk	Brachyelytrum septentrionale	S5	Secure
Bluejoint Reed Grass	Calamagrostis canadensis	S5	Secure
Black Sedge	Carex arctata	S5	Secure
Bromelike Sedge	Carex bromoides	S4	Secure
Brownish Sedge	Carex brunnescens	S5	Secure
Silvery Sedge	Carex canescens	S5	Secure
Fringed Sedge	Carex crinita	S5	Secure
Two-seeded Sedge	Carex disperma	S5	Secure
Nodding Sedge	Carex gynandra	S5	Secure
Inland Sedge	Carex interior	S5	Secure
Lenticular Sedge	Carex lenticularis var. lenticularis	S5	Secure
Bristly-stalked Sedge	Carex leptalea	S5	Secure
Chaffy Sedge	Carex paleacea	S5	Secure
Rough Sedge	Carex scabrata	S5	Secure
Broom Sedge	Carex scoparia	S5	Secure
Awl-fruited Sedge	Carex stipata	S5	Secure
Blunt Broom Sedge	Carex tribuloides	S4S5	Secure
Fox Sedge	Carex vulpinoidea	S4S5	Secure
Fireweed	Chamerion angustifolium	S5	Secure
White Turtlehead	Chelone glabra	S5	Secure
Small Enchanter's Nightshade	Circaea alpina	S5	Secure
Virginia Clematis	Clematis virginiana	S5	Secure
Goldthread	Coptis trifolia	S5	Secure
Alternate-leaved Dogwood	Cornus alternifolia	S5	Secure
Bunchberry	Cornus canadensis	S5	Secure
Beaked Hazel	Corylus cornuta	S5	Secure

Common Name	Scientific Name	S - Rank	General Status
Dewdrop	Dalibarda repens	S5	Secure
Hairy Flat-top White Aster	Doellingeria umbellata	S5	Secure
Crested Wood Fern	Dryopteris cristata	S5	Secure
Evergreen Wood Fern	Dryopteris intermedia	S5	Secure
Needle Spikerush	Eleocharis acicularis	S5	Secure
Field Horsetail	Equisetum arvense	S5	Secure
Woodland Horsetail	Equisetum sylvaticum	S5	Secure
Red Fescue	Festuca rubra	S5	Secure
Wild Strawberry	Fragaria virginiana	S5	Secure
Glossy Buckthorn	Frangula alnus	SNA	Exotic
White Ash	Fraxinus americana	S4S5	Secure
Black Ash	Fraxinus nigra	S4S5	Secure
Rough Bedstraw	Galium asprellum	S5	Secure
Three-petaled Bedstraw	Galium trifidum	S5	Secure
Creeping Snowberry	Gaultheria hispidula	S5	Secure
Eastern Teaberry	Gaultheria procumbens	S5	Secure
Yellow Avens	Geum aleppicum	S5	Secure
Water Avens	Geum rivale	S5	Secure
Northern Manna Grass	Glyceria borealis	S5	Secure
Slender Manna Grass	Glyceria melicaria	S5	Secure
Fowl Manna Grass	Glyceria striata	S5	Secure
Common Oak Fern	Gymnocarpium dryopteris	S5	Secure
Orange Hawkweed	Hieracium aurantiacum	SNA	Exotic
Field Hawkweed	Hieracium caespitosum	SNA	Exotic
American Marsh Pennywort	Hydrocotyle americana	S5	Secure
Northern St John's-Wort	Hypericum boreale	S5	Secure
Common St. John's-wort	Hypericum perforatum	SNA	Exotic
Spotted Jewelweed	Impatiens capensis	S5	Secure
Soft Rush	Juncus effusus	S5	Secure
Thread Rush	Juncus filiformis	S5	Secure
Slender Rush	Juncus tenuis	S5	Secure
Sheep Laurel	Kalmia angustifolia	S5	Secure
Tamarack	Larix laricina	S5	Secure
Fall Dandelion	Leontodon autumnalis	SNA	Exotic
Twinflower	Linnaea borealis	S5	Secure
Canada Fly Honeysuckle	Lonicera canadensis	S5	Secure
Common Woodrush	Luzula multiflora	S5	Secure
Round-branched Tree-clubmoss	Lycopodium dendroideum	S5	Secure
Northern Water Horehound	Lycopus uniflorus	S5	Secure
Fringed Yellow Loosestrife	Lysimachia ciliata	S5	Secure

Common Name	Scientific Name	S - Rank	General Status
Swamp Yellow Loosestrife	Lysimachia terrestris	S5	Secure
Wild Lily-of-The-Valley	Maianthemum canadense	S5	Secure
Ostrich Fern	Matteuccia struthiopteris	S5	Secure
Partridgeberry	Mitchella repens	S5	Secure
Variegated Pond-lily	Nuphar lutea	S5	Secure
Whorled Wood Aster	Oclemena acuminata	S5	Secure
Sensitive Fern	Onoclea sensibilis	S5	Secure
White-grained Mountain Rice	Oryzopsis asperifolia	S5	Secure
White-grained Mountain Rice	Oryzopsis asperifolia	S5	Secure
Cinnamon Fern	Osmunda cinnamomea	S5	Secure
Interrupted Fern	Osmunda claytoniana	S5	Secure
Royal Fern	Osmunda regalis	S5	Secure
Ironwood	Ostrya virginiana	S4S5	Secure
Common Wood Sorrel	Oxalis montana	S5	Secure
European Wood Sorrel	Oxalis stricta	S5	Secure
Northern Beech Fern	Phegopteris connectilis	S5	Secure
Red Spruce	Picea rubens	S5	Secure
Eastern White Pine	Pinus strobus	S5	Secure
Arrow-leaved Smartweed	Polygonum sagittatum	S5	Secure
Trembling Aspen	Populus tremuloides	S5	Secure
Old Field Cinquefoil	Potentilla simplex	S5	Secure
Common Self-heal	Prunella vulgaris	S5	Secure
Pin Cherry	Prunus pensylvanica	S5	Secure
Chokecherry	Prunus virginiana	S5	Secure
Bracken Fern	Pteridium aquilinum	S5	Secure
Northern Red Oak	Quercus rubra	S5	Secure
Kidney-Leaved Buttercup	Ranunculus abortivus	S5	Secure
Common Buttercup	Ranunculus acris	SNA	Exotic
Creeping Buttercup	Ranunculus repens	SNA	Exotic
Skunk Currant	Ribes glandulosum	S5	Secure
Smooth Gooseberry	Ribes hirtellum	S5	Secure
Bristly Black Currant	Ribes lacustre	S5	Secure
Swamp Red Currant	Ribes triste	S5	Secure
Alleghaney Blackberry	Rubus allegheniensis	S5	Secure
Bristly Dewberry	Rubus hispidus	S5	Secure
Red Raspberry	Rubus idaeus	S5	Secure
Dwarf Red Raspberry	Rubus pubescens	S5	Secure
Curled Dock	Rumex crispus	SNA	Exotic
Pussy Willow	Salix discolor	S5	Secure
Bebb's Willow	Salix bebbiana	S5	Secure
Common Woolly Bulrush	Scirpus cyperinus	S5	Secure

Common Name	Scientific Name	S - Rank	General Status
Small-fruited Bulrush	Scirpus microcarpus	S5	Secure
Marsh Skullcap	Scutellaria galericulata	S5	Secure
Mad-dog Skullcap	Scutellaria lateriflora	S5	Secure
Rough-stemmed Goldenrod	Solidago rugosa	S5	Secure
American Mountain Ash	Sorbus americana	S5	Secure
White Meadowsweet	Spiraea alba	S5	Secure
White Meadowsweet	Spiraea alba	S5	Secure
Steeplebush	Spiraea tomentosa	S5	Secure
New York Aster	Symphyotrichum novi-belgii	S5	Secure
Purple-stemmed Aster	Symphyotrichum puniceum	S5	Secure
Canada Yew	Taxus canadensis	S5	Secure
Tall Meadow-Rue	Thalictrum pubescens	S5	Secure
New York Fern	Thelypteris noveboracensis	S5	Secure
Eastern White Cedar	Thuja occidentalis	S5	Secure
Heart-leaved Foamflower	Tiarella cordifolia	S4	Secure
Northern Poison Oak	Toxicodendron rydbergii	S5	Secure
Fraser's Marsh St John's-wort	Triadenum fraseri	S5	Secure
Northern Starflower	Trientalis borealis	S5	Secure
White Clover	Trifolium repens	SNA	Exotic
Red Trillium	Trillium erectum	S5	Secure
Eastern Hemlock	Tsuga canadensis	S5	Secure
Broad-leaved Cattail	Typha latifolia	S5	Secure
Stinging Nettle	Urtica dioica	S4	Secure
Velvet-leaved Blueberry	Vaccinium myrtilloides	S5	Secure
Common Speedwell	Veronica officinalis	S5	Exotic
Thyme-Leaved Speedwell	Veronica serpyllifolia	SNA	Secure
Northern Wild Raisin	Viburnum nudum	S5	Secure
Highbush Cranberry	Viburnum opulus	S4	Secure
Marsh Blue Violet	Viola cucullata	S5	Secure
Small White Violet	Viola macloskeyi	S5	Secure

Appendix III
Point Count Data

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
1	Point count	AMRE	American Redstart	Setophaga ruticilla	2485186.13	7430523.22	PO	1	S
1	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485225.37	7430542.15	PO	1	S
1	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485224.20	7430525.37	PO	1	S
1	Point count	CAJA	Gray Jay	Perisoreus canadensis	2485166.42	7430510.53	PO	1	X
1	Point count	HETH	Hermit Thrush	Catharus guttatus	2485141.07	7430538.86	PO	1	S
1	Point count	HETH	Hermit Thrush	Catharus guttatus	2485121.52	7430549.57	PO	1	S
1	Point count	MAWA	Magnolia Warbler	Setophaga magnolia	2485149.63	7430535.91	PO	1	S
1	Point count	NOPA	Northern Parula	Setophaga americana	2485182.43	7430501.94	PO	1	S
1	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2485159.25	7430513.56	PO	1	S
1	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2485180.28	7430480.27	PO	2	S
1	Point count	WIWR	Winter Wren	Troglodytes hiemalis	2485226.15	7430567.92	PO	1	S
2	Point count	AMGO	American Goldfinch	Spinus tristis	2485328.50	7430650.46	PO	1	S
2	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485256.65	7430641.82	PO	1	S
2	Point count	HETH	Hermit Thrush	Catharus guttatus	2485230.18	7430644.12	PO	1	S
2	Point count	HETH	Hermit Thrush	Catharus guttatus	2485195.82	7430635.66	PO	1	S
2	Point count	MODO	Mourning Dove	Zenaida macroura	2485313.70	7430691.69	PO	1	S

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
2	Point count	NOPA	Northern Parula	Setophaga americana	2485282.09	7430662.87	PO	1	S
2	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485307.36	7430720.23	PO	1	S
2	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485281.45	7430739.26	PO	1	S
2	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485226.53	7430720.98	PO	1	S
2	Point count	RUGR	Ruffed Grouse	Bonasa umbellus	2485214.85	7430739.79	PO	1	X
3	Point count	BAWW	Black and White Warbler	Mniotilta varia	2485483.18	7430515.77	PO	1	S
3	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485496.67	7430491.47	PO	1	S
3	Point count	NOPA	Northern Parula	Setophaga americana	2485460.69	7430477.08	PR	1	S
3	Point count	NOPA	Northern Parula	Setophaga americana	2485530.86	7430481.58	PO	1	S
3	Point count	NOPA	Northern Parula	Setophaga americana	2485444.49	7430572.45	PO	1	S
3	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485579.07	7430483.79	PO	1	S
3	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485426.82	7430537.23	PO	1	S
3	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485528.17	7430500.47	PO	1	S
3	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485376.56	7430517.12	PO	1	S
3	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485474.73	7430547.78	PO	1	S
4	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485667.26	7430267.81	PO	3	X

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
4	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485619.38	7430461.19	PO	3	X
4	Point count	BAWW	Black and White Warbler	Mniotilta varia	2485605.40	7430376.59	PO	1	S
4	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485516.53	7430379.67	PO	1	S
4	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485593.55	7430471.38	PO	1	S
4	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485517.95	7430318.52	PO	1	S
4	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2485560.13	7430334.64	PO	1	X
4	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2485599.95	7430383.46	PO	2	X
4	Point count	BLJA	Blue Jay	Cyanocitta cristata	2485512.74	7430292.93	PO	1	X
4	Point count	HETH	Hermit Thrush	Catharus guttatus	2485548.76	7430354.07	PO	1	X
4	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485602.75	7430302.74	PO	1	S
4	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485585.49	7430398.39	PO	1	S
4	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485704.70	7430391.52	PO	1	S
4	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485551.37	7430376.11	PO	1	S
5	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485524.62	7430167.77	PO	1	X
5	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485505.57	7430103.91	PO	1	X
5	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485585.49	7430237.11	PO	2	X

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
5	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485433.61	7430164.25	PO	1	S
5	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2485460.30	7430185.96	PO	1	X
5	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2485447.03	7430197.95	PO	1	X
5	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2485497.97	7430145.30	PO	2	X
5	Point count	NOPA	Northern Parula	Setophaga americana	2485479.56	7430251.87	PO	1	X
5	Point count	NOPA	Northern Parula	Setophaga americana	2485459.02	7430205.22	PO	1	S
5	Point count	NOPA	Northern Parula	Setophaga americana	2485415.41	7430203.00	PO	1	S
5	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485472.71	7430105.93	PO	1	S
5	Point count	PUFI	Purple Finch	Haemorhous purpureus	2485439.76	7430180.40	PO	1	S
5	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485421.78	7430139.74	PO	1	S
5	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485398.24	7430155.15	PO	1	S
5	Point count	WIWR	Winter Wren	Troglodytes hiemalis	2485442.75	7430113.63	PO	1	S
6	Point count	AMRE	American Redstart	Setophaga ruticilla	2485894.87	7430036.32	PO	1	S
6	Point count	BLWA	Blackburnian Warbler	Setophaga fusca	2485930.15	7430066.00	PO	1	S
6	Point count	BLJA	Blue Jay	Cyanocitta cristata	2485933.51	7430081.68	PO	1	X
6	Point count	BHVI	Blue-headed Vireo	Vireo solitarius	2485936.87	7430067.12	PR	2	PR A

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
6	Point count	BHVI	Blue-headed Vireo	Vireo solitarius	2485931.27	7430016.15	PO	1	S
6	Point count	NOPA	Northern Parula	Setophaga americana	2485921.19	7430010.55	PO	1	S
6	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485920.07	7430072.72	PO	1	S
6	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2485895.99	7430012.23	PO	1	S
6	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485957.60	7430054.24	PO	1	S
6	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485957.04	7430015.03	PO	1	S
7	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2486167.28	7429810.50	PO	1	S
7	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2486153.82	7429901.36	PO	1	S
7	Point count	BHVI	Blue-headed Vireo	Vireo solitarius	2486211.03	7429862.10	PO	1	S
7	Point count	COYE	Common Yellowthroat	Geothlypis trichas	2486140.36	7429845.27	PO	1	S
7	Point count	HAWA	Hairy Woodpecker	Dryobates villosus	2486187.47	7429816.10	PO	1	X
7	Point count	HETH	Hermit Thrush	Catharus guttatus	2486191.96	7429906.97	PO	1	S
7	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2486130.26	7429860.97	PO	1	S
7	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2486195.33	7429794.79	PO	1	S
7	Point count	WIWR	Winter Wren	Troglodytes hiemalis	2486153.82	7429867.71	PO	1	S
8	Point count	AMCR	American Crow	Corvus brachyrhynchos	2486382.10	7429593.43	PO	1	X

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
8	Point count	AMGO	American Goldfinch	Spinus tristis	2486382.10	7429624.84	PO	1	FO
8	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2486398.93	7429676.44	PO	1	S
8	Point count	BLWA	Blackburnian Warbler	Setophaga fusca	2486345.08	7429666.35	PO	1	S
8	Point count	BHVI	Blue-headed Vireo	Vireo solitarius	2486342.84	7429618.11	PO	1	S
8	Point count	CORA	Common Raven	Corvus corax	2486395.56	7429703.37	PO	1	X
8	Point count	GCKI	Golden-crowned Kinglet	Regulus satrapa	2486380.98	7429688.78	PO	1	S
8	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2486428.09	7429669.71	PO	1	S
8	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2486324.89	7429624.84	PO	1	S
8	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2486426.97	7429648.40	PO	1	S
8	Point count	WTSP	White-throated Sparrow	Zonotrichia albicollis	2486409.02	7429747.12	PO	1	S
8	Point count	WIWR	Winter Wren	Troglodytes hiemalis	2486430.34	7429629.33	PO	1	S
9	Point count	AMRE	American Redstart	Setophaga ruticilla	2485299.13	7430290.93	PO	1	S
9	Point count	AMRE	American Redstart	Setophaga ruticilla	2485297.82	7430366.54	PO	1	S
9	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2485276.39	7430302.00	PO	2	X
9	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485418.06	7430360.30	PO	1	S
9	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485366.17	7430271.10	PO	1	S

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
9	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485318.36	7430363.22	PO	1	S
10	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485786.12	7430197.10	PO	1	X
10	Point count	HAWA	Hairy Woodpecker	Dryobates villosus	2485760.58	7430204.54	PO	1	X
10	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485731.15	7430177.95	PO	1	S
10	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485768.03	7430154.89	PO	1	S
10	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2485764.92	7430203.23	PO	1	S
10	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485759.87	7430198.16	PO		S
10	Point count	WTSP	White-throated Sparrow	Zonotrichia albicollis	2485732.92	7430145.32	PO	1	S
11	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485621.80	7430029.01	PO	2	X
11	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485665.99	7430007.43	PO	2	X
11	Point count	AMRE	American Redstart	Setophaga ruticilla	2485605.35	7430030.55	PO	1	S
11	Point count	AMRE	American Redstart	Setophaga ruticilla	2485640.81	7430039.29	PO	1	S
11	Point count	BEKI	Belted Kingfisher	Megaceryle alcyon	2485626.93	7430018.22	PO	1	X
11	Point count	BAWW	Black and White Warbler	Mniotilta varia	2485587.90	7430026.43	PO	1	S
11	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485685.67	7430020.74	PO	1	S
11	Point count	CEDW	Cedar Waxwing	Bombycilla cedrorum	2485637.21	7430006.40	PO	1	X

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
11	Point count	COYE	Common Yellowthroat	Geothlypis trichas	2485594.34	7429986.20	PO	1	S
11	Point count	COYE	Common Yellowthroat	Geothlypis trichas	2485637.21	7429969.92	PO	1	S
11	Point count	DOWO	Downy Woodpecker	Picoides pubescens	2485635.67	7430016.68	PO	1	X
11	Point count	HAWA	Hairy Woodpecker	Dryobates villosus	2485500.10	7429970.39	PO	1	X
11	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485562.70	7429982.76	PO	1	S
11	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2485625.91	7430001.26	PO	1	S
11	Point count	SWSP	Swamp Sparrow	Melospiza georgiana	2485672.16	7429969.92	PO	1	S
11	Point count	YRWA	Yellow-rumped Warbler	Setophaga coronata	2485625.91	7430041.86	PO	1	S
12	Point count	AMCR	American Crow	Corvus brachyrhynchos	2485848.55	7429928.77	PO	1	X
12	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485805.98	7429897.49	PO	1	S
12	Point count	BHVI	Blue-headed Vireo	Vireo solitarius	2485879.83	7429904.44	PO	1	S
12	Point count	GCKI	Golden-crowned Kinglet	Regulus satrapa	2485836.39	7429905.31	PO	1	S
12	Point count	NAWA	Nashville Warbler	Geothlypis philadelphia	2485866.80	7429925.30	PO	1	S
12	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485925.01	7429894.89	PO	1	S
12	Point count	PUFI	Purple Finch	Haemorhous purpureus	2485818.14	7429888.80	PO	1	S
13	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2485987.53	7429642.46	PO	1	S

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
13	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2486076.87	7429688.34	PO	1	S
13	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2486028.58	7429658.16	PO	1	X
13	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2486035.82	7429665.40	PO	1	S
13	Point count	BLJA	Blue Jay	Cyanocitta cristata	2486050.31	7429658.16	PO	1	X
13	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2486090.15	7429642.46	PO	1	S
13	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2486076.87	7429664.19	PO	1	S
14	Point count	BTNW	Black -throated Green Warbler	Setophaga virens	2486260.09	7429432.12	PO	1	S
14	Point count	BCCH	Black-capped Chickadee	Poecile atricapillus	2486294.71	7429404.26	PO	1	S
14	Point count	BTBW	Black-throated Blue Warbler	Setophaga caerulescens	2486275.29	7429411.86	PO	1	S
14	Point count	HETH	Hermit Thrush	Catharus guttatus	2486344.53	7429450.70	PO	1	S
14	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2486333.55	7429465.89	PO	1	S
14	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2486298.09	7429462.52	PO	1	S
15	Point count	AMGO	American Goldfinch	Spinus tristis	2485137.56	7430752.50	PO	2	FO
15	Point count	BAWW	Black and White Warbler	Mniotilta varia	2485076.23	7430741.29	PO	1	S
15	Point count	NOPA	Northern Parula	Setophaga americana	2485064.02	7430732.40	PO	1	S
15	Point count	NOPA	Northern Parula	Setophaga americana	2485130.55	7430715.53	PO	1	S

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
15	Point count	NOPA	Northern Parula	Setophaga americana	2485030.76	7430789.55	PO	1	S
15	Point count	OVEN	Ovenbird	Seiurus aurocapilla	2485083.23	7430855.14	PO	1	S
15	Point count	RBNU	Red-breated Nuthatch	Sitta canadensis	2485007.04	7430755.92	PO	1	S
15	Point count	REVI	Red-eyed Vireo	Vireo olivaceus	2485073.86	7430798.92	PO	1	S
NA	Incidental	BAWW	Black and White Warbler	Mniotilta varia	2485216.17	7430310.63	CO	1	PR A
NA	Incidental	BAWW	Black and White Warbler	Mniotilta varia	2486135.20	7429633.18	PO	1	S
NA	Incidental	BTNW	Black -throated Green Warbler	Setophaga virens	2486182.77	7429458.57	PO	1	S
NA	Incidental	BLWA	Blackburinan Warbler	Setophaga fusca	2485373.44	7430505.35	PO	1	S
NA	Incidental	BLWA	Blackburinan Warbler	Setophaga fusca	2485373.44	7430505.35	PO	1	S
NA	Incidental	BLWA	Blackburnian Warbler	Setophaga fusca	2486160.17	7429500.01	PO	1	S
NA	Incidental	BLWA	Blackburnian Warbler	Setophaga fusca	2485734.26	7429786.21	PO	1	S
NA	Incidental	BLWA	Blackburnian Warbler	Setophaga fusca	2485912.65	7429984.66	PO	1	S
NA	Incidental	BCCH	Black-capped Chickadee	Poecile atricapillus	2486117.26	7429915.26	PO	1	S
NA	Incidental	BTBW	Black-throated Blue Warbler	Setophaga caerulescens	2485203.93	7430378.81	PO	1	S
NA	Incidental	BHVI	Blue-headed Vireo	Vireo solitarius	2485914.90	7429781.99	PR	2	PR A
NA	Incidental	CANG	Canada Goose	Branta canadensis	2485639.21	7430047.93	CO	5	NY
NA	Incidental	CAWA	Canada Warbler	Cardellina canadensis	2485790.34	7429731.55	PO	1	S X
NA	Incidental	CEDW	Cedar Waxwing	Bombycilla cedrorum	2485703.95	7430091.97	PO	1	S
NA	Incidental	CEDW	Cedar Waxwing	Bombycilla cedrorum	2485703.95	7430091.97	PO	1	S
NA	Incidental	CSWA	Chestnut-sided Warbler	Setophaga pensylvanica	2486058.22	7430026.28	PO	1	S
NA	Incidental	COYE	Common Yellowthroat	Geothlypis trichas	2486175.84	7429953.95	PO	1	S
NA	Incidental	EAKI	Eastern Kingbird	Tyrannus tyrannus	2485731.43	7430335.55	CO	4	FY
NA	Incidental	HAWA	Hairy Woodpecker	Dryobates villosus	2485819.62	7430102.06	PO	1	X
NA	Incidental	HETH	Hermit Thrush	Catharus guttatus	2486103.18	7429953.36	CO	1	NV

Point ID	Point type	Code	Scientific Name	Common Name	Coord X	Coord Y	Code	Count	Breeding code
NA	Incidental	HETH	Hermit Thrush	Catharus guttatus	2485492.15	7430038.75	CO	1	NY
NA	Incidental	OVEN	Ovenbird	Seiurus aurocapilla	2485541.15	7430316.61	PO	1	S
NA	Incidental	OVEN	Ovenbird	Seiurus aurocapilla	2485541.15	7430316.61	PO	1	S
NA	Incidental	PUFI	Purple Finch	Haemorhous purpureus	2486083.79	7429826.83	PO	1	S
NA	Incidental	RBNU	Red-breated Nuthatch	Sitta canadensis	2485535.40	7430495.56	PR	2	P
NA	Incidental	RBNU	Red-breated Nuthatch	Sitta canadensis	2485540.27	7430276.39	PO	1	S
NA	Incidental	RBNU	Red-breated Nuthatch	Sitta canadensis	2485540.27	7430276.39	PO	1	S
NA	Incidental	RUGR	Ruffed Grouse	Bonasa umbellus	2485352.80	7430409.22	CO	1	NY
NA	Incidental	RUGR	Ruffed Grouse	Bonasa umbellus	2485763.88	7429751.02	CO	1	NY
NA	Incidental	VEER	Veery	Catharus fuscescens	2486061.14	7430090.57	PO	1	S
NA	Incidental	WIWR	Winter Wren	Troglodytes hiemalis	2485600.67	7430453.02	PO	1	S
NA	Incidental	YBSA	Yellow-bellied Sapsucker	Sphyrapicus varius	2486065.53	7430067.19	PO	1	S
NA	Incidental	YBSA	Yellow-bellied Sapsucker	Sphyrapicus varius	2486214.42	7429444.85	PO	1	X
NA	Incidental	YBSA	Yellow-bellied Sapsucker	Sphyrapicus varius	2485740.40	7429860.66	CO	1	X
NA	Incidental	YRWA	Yellow-rumped Warbler	Setophaga coronata	2485795.64	7429855.50	PO	1	S

Appendix IV

Wetland Delineation Forms

New Brunswick Department of Environment Wetland Delineation Data Sheet

Hydrology

WL 1a wet

Primary Hydrological Indicators: (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☑ High Water Table (A2)
- ☑ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☑ Water Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15)
- ☑ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron reduction in tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators: (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Stunted or Stressed Plants (D1)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ Microtopographic Relief (D4)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☑ Depth ___

Water Table Present? Yes ☑ No ☐ Depth 30

Saturation Present? Yes ☑ No ☐ Depth 5

Wetland Hydrology Present? Yes ☑ No ☐

Comments:

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix		Redox Features				Texture	Remarks
	Color(moist)	%	Color(moist)	%	Type[1]	Loc[2]		
8-0	—	—	—	—	—	—	Organic	
0-41	7.5YR/5/2	80	7.5YR/6/2	20	D	M	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☑ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 5cm Mucky Peat or Peat (S3)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surfaces (S7)
- ☐ Polyvalue Below Surface (S8)
- ☐ Thin Dark Surface (S9)
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Restrictive Layer (if observed): Type Clay Depth: 41

Hydric Soil Present? Yes ☑ No ☐

Comments:

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New Brunswick Department of Environment Wetland Delineation Data Sheet

Project Site: Argam
Date: Jun 12/2018 Sample Point: WL 1a up
Applicant/Owner: New Maryland
Field Investigator(s): Derrick Mitchell
County: York
Coordinates: 2485730/7430120
PID: 75349068, 75064840 75062174
Do normal environmental conditions exist on-site? Yes ☑ No ☐
If no explain:
Atypical Situation? Yes ☐ No ☑ Explain
Is this a potential **Problem Area**? Yes ☐ No ☑ Explain

Wetland Determination

(Check One Only For Each Criteria)

Dominant Hydrophytic Vegetation (50/20 rule) Yes ☑ No ☒
Wetland Hydrology Yes ☒ No ☑
Hydric Soils Yes ☒ No ☑
Wetland Type: N/A
Rational for Determination: N/A

Wetland Determination
YES ☐ **NO** ☑

Vegetation

Tree Stratum: (Plot size: 15m	%Cover	Dominant Species	Indicator Status
1. Acer rub	20	✓	FAC
2. Betu pop	5		FAC
3.			
4. Abie bal	45	✓	FAC
5.			
	70 = Total Cover		

Shrub Stratum: (Plot size: 5m			
1. Abies bal	5	✓	FAC
2.			
3.			
4.			
5.			
	5 = Total Cover		

Herb Stratum: (Plot size: 1m			
1. Dryo int	5		FAC
2. Adia can	15	✓	FAC
3.			
4. Trie bor	5		FAC
5. osmu cin	5		FAC
	= Total Cover = 30		

Comments

Dominance Test Worksheet:

# of Dominant Species that are OBL,FACW,FAC: 4 (A)
Total # of Dominant Species across all strata: 4 (B)
% of Dominant Species that are OBL,FACW,FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL Species		x1 =	
FACW Species		x2 =	
FAC Species	85	x3 =	255
FACU Specie		x4 =	
UPL Species		x5 =	
Column Totals:	85	x1 =	255

Prevalence Index = B/A = 3

Hydrophytic Vegetation Indicators:
✓ Rapid Test for Hydrophytic Vegetation
✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
__ Morphological Adaptations[1] (explain)
__ Problematic Hydrophytic Vegetation[1] (explain)
[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ✓ No ___

New Brunswick Department of Environment Wetland Delineation Data Sheet

Hydrology

WL 1a up

Primary Hydrological Indicators: *(minimum of one is required; check all that apply)*

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron reduction in tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators: *(minimum of two required)*

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes___ [✓ No] Depth___

Water Table Present? Yes___ [✓ No] Depth___

Saturation Present? Yes___ [✓ No] Depth___

Wetland Hydrology Present? Yes___ [✓ No]

Comments:___

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix		Redox Features				Texture	Remarks
	Color(moist)	%	Color(moist)	%	Type[1]	Loc[2]		
9-0	—	—	—	—	—	—	Organic	
0-19	7.5YR/4/4	100	—	—	—	—	Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 5cm Mucky Peat or Peat (S3)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Dark Surfaces (S7)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)

Restrictive Layer (if observed): Type Rock Depth 28cm

Hydric Soil Present? Yes___ [✓ No]

Comments:___

version 1.8 June 1, 2009

New Brunswick Department of Environment Wetland Delineation Data Sheet

Project Site: Arsaun
Date: Jun 12/2018
Sample Point: WL1b wet
Applicant/Owner: New Maryland
Field Investigator(s): Derrick Mitchell
County: York
Coordinates: 2485750/7430120
PID: 75549068, 75064840, 75062174
Do normal environmental conditions exist on-site? Yes ☑ No ☐
If no explain:
Atypical Situation? Yes ☐ No ☑ Explain
Is this a potential **Problem Area?** Yes ☐ No ☑ Explain

Wetland Determination

(Check One Only For Each Criteria)

Dominant Hydrophytic Vegetation (50/20 rule) Yes ☐ No ☐
Wetland Hydrology Yes ☑ No ☐
Hydric Soils Yes ☑ No ☐
Wetland Type: Wetland complex
Rational for Determination: 3 indicators present

Wetland Determination
YES ☑ **NO** ☐

Vegetation

Tree Stratum: (Plot size: 15m)

	%Cover	Dominant Species	Indicator Status
1.			
2.			
3.			
4.			
5.			
= Total Cover			

Shrub Stratum: (Plot size: 5m)

1.			
2.			
3.			
4.			
5.			
= Total Cover			

Herb Stratum: (Plot size: 1m)

1. Cala can	45	✓	FACW
2. Care str	35	✓	OBL
3.			
4. Scir cyp	5		FACW
5.			
= Total Cover	85		

Comments:

Dominance Test Worksheet:

# of Dominant Species that are OBL,FACW,FAC: 2 (A)
Total # of Dominant Species across all strata: 2 (B)
% of Dominant Species that are OBL,FACW,FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL Species	35	x1 =	35
FACW Species	45	x2 =	90
FAC Species		x3 =	
FACU Specie		x4 =	
UPL Species		x5 =	
Column Totals:	80	x1 =	125

Prevalence Index = B/A = 1.6

Hydrophytic Vegetation Indicators:

- ✓ Rapid Test for Hydrophytic Vegetation
- ✓ Dominance Test is >50%
- ✓ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (explain)
- __ Problematic Hydrophytic Vegetation[1] (explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ✓ No ___

New Brunswick Department of Environment Wetland Delineation Data Sheet

WL 16 wet

Hydrology

Primary Hydrological Indicators (minimum of one is required; check all that apply)

- ✓ Surface Water (A1)
- ✓ High Water Table (A2)
- ✓ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- ✓ Inundation Visible on Aerial Imagery (B7)
- ✓ Sparsely Vegetated Concave Surface (B8)
- __ Water Stained Leaves (B9)
- ✓ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- ✓ Hydrogen Sulfide Odor (C1)
- ✓ Oxidized Rhizospheres on Living Roots (C3)
- ✓ Presence of Reduced Iron (C4)
- __ Recent Iron reduction in tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators: (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No__ Depth 50

Water Table Present? Yes ✓ No__ Depth 10

Saturation Present? Yes ✓ No__ Depth 0

Wetland Hydrology Present? Yes ✓ No__

Comments: Old beaver pond (dam breached)

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix		Redox Features				Texture	Remarks
	Color(moist)	%	Color(moist)	%	Type[1]	Loc[2]		
16-0	—	—	—	—	—	—	Organic	
0-34	Gley 1/6/10Y	100	—	—	—	—	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- ✓ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 5cm Mucky Peat or Peat (S3)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Dark Surfaces (S7)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Gleyed Matrix (F2)
- ✓ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)

Restrictive Layer (if observed): Type N/A Depth: N/A

Hydric Soil Present? Yes ✓ No__

Comments:

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New Brunswick Department of Environment Wetland Delineation Data Sheet

Project Site: Arsam
Date: Jun 12/2018
Sample Point: WL 1e wet
Applicant/Owner: New Maryland
Field Investigator(s): Derrick Mitchell
County: York
Coordinates: 2485730/7430120
PID: 7534068, 75064840, 75062174
Do normal environmental conditions exist on-site? Yes ☑ No ☐
If no explain:
Atypical Situation? Yes ☐ No ☑ Explain
Is this a potential **Problem Area**? Yes ☐ No ☐ Explain

Wetland Determination

(Check One Only For Each Criteria)

Dominant Hydrophytic Vegetation (50/20 rule) Yes ☑ No ☐
Wetland Hydrology Yes ☑ No ☐
Hydric Soils Yes ☑ No ☐
Wetland Type: Wetland complex
Rational for Determination: 3 indicators present

Wetland Determination
YES ☑ **NO** ☐

Vegetation

Tree Stratum: (Plot size: 15M)	%Cover	Dominant Species	Indicator Status
1. Acer rub	15	✓	FAC
2. Abie bal	25	✓	FAC
3. Frax Nig	20	✓	FACW
4. Betu all	5		FAC
5. Thuj occ	2		FACW
	=67 = Total Cover		

Shrub Stratum: (Plot size 5M)			
1. Cory cor	5	✓	FAC
2. Abies bal	5	✓	FAC
3. Frax nig	2		
4.			FACW
5.			
	= 12 = Total Cover		

Herb Stratum: (Plot size: 1m)			
1. Onoc sen	20	✓	FACW
2. Corn can	15	✓	FAC
3. Athy fil	10		FAC
4. Care int	10		FAC
5. Rubu pub	10		FACW
	= 65 = Total Cover		

Comments

Dominance Test Worksheet:

\# of Dominant Species that are OBL,FACW,FAC: 7 (A)
Total # of Dominant Species across all strata: 7 (B)
% of Dominant Species that are OBL,FACW,FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL Species		x1 =	
FACW Species	40	x2 =	80
FAC Species	65	x3 =	195
FACU Specie		x4 =	
UPL Species		x5 =	
Column Totals:	105	x1 =	275

Prevalence Index = B/A = 2.6

Hydrophytic Vegetation Indicators:
✓ Rapid Test for Hydrophytic Vegetation
✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
__ Morphological Adaptations[1] (explain)
__ Problematic Hydrophytic Vegetation[1] (explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ✓ **No**

New Brunswick Department of Environment Wetland Delineation Data Sheet

WL 1c wet

Hydrology

Primary Hydrological Indicators: (minimum of one is required; check all that apply)

✓ Surface Water (A1)
✓ High Water Table (A2)
✓ Saturation (A3)
__ Water Marks (B1)
__ Sediment Deposits (B2)
__ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Sparsely Vegetated Concave Surface (B8)

✓ Water Stained Leaves (B9)
__ Aquatic Fauna (B13)
__ Marl Deposits (B15)
__ Hydrogen Sulfide Odor (C1)
__ Oxidized Rhizospheres on Living Roots (C3)
✓ Presence of Reduced Iron (C4)
__ Recent Iron reduction in tilled Soils (C6)
__ Thin Muck Surface (C7)
__ Other (Explain in Remarks)

Secondary Indicators: (minimum of two required)

__ Surface Soil Cracks (B6)
__ Drainage Patterns (B10)
__ Moss Trim Lines (B16)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)

__ Stunted or Stressed Plants (D1)
__ Geomorphic Position (D2)
__ Shallow Aquitard (D3)
__ Microtopographic Relief (D4)
__ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ✓ No___ Depth 20
Water Table Present? Yes ✓ No___ Depth 25
Saturation Present? Yes ✓ No___ Depth 5

Wetland Hydrology Present? Yes ✓ No__

Comments:

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix Color(moist)	%	Redox Features Color(moist)	%	Type¹	Loc²	Texture	Remarks
5-0	—	—	—	—	—	—	Organic	
0-32	7.5YR/5/2	95	7.5YR/6/4	5	D	M	Sandy/silt	

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains ²Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 5cm Mucky Peat or Peat (S3)
__ Sandy Gleyed Matrix (S4)

__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Dark Surfaces (S7)
__ Polyvalue Below Surface (S8)
__ Thin Dark Surface (S9)
__ Loamy Gleyed Matrix (F2)
✓ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)

Restrictive Layer (if observed): Type Rock Depth: 37 cm

Hydric Soil Present? Yes ✓ No__

Comments:

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New Brunswick Department of Environment Wetland Delineation Data Sheet

Project Site Arsam
Date Jun 12/2018 Sample Point WL/c up
Applicant/Owner New Maryland
Field Investigator(s) Derrick Mitchell
County York
Coordinates 2485730/7430120
PID 75349069, 75064840, 75062174
Do normal environmental conditions exist on-site? Yes ☑ No ☐
If no explain:
Atypical Situation? Yes ☐ No ☑ Explain
Is this a potential **Problem Area**? Yes ☐ No ☑ Explain

Wetland Determination

(Check One Only For Each Criteria)

Dominant Hydrophytic Vegetation (50/20 rule) Yes ☑ No ☐
Wetland Hydrology Yes ☐ No ☑
Hydric Soils Yes ☐ No ☑
Wetland Type: N/A
Rational for Determination: N/A

Wetland Determination
YES ☐ **NO** ☑

Vegetation

Tree Stratum: (Plot size: 15m)	%Cover	Dominant Species	Indicator Status
1. Abiebal	50	✓	FAC
2. Acer rub	20	✓	FAC
3.			
4. Frax nig	5		FACW
5.			
	75 = Total Cover		

Shrub Stratum: (Plot size: 5m)	%Cover	Dominant Species	Indicator Status
1. Betu all	2	✓	FAC
2.			
3.			
4.			
5.			
	2 = Total Cover		

Herb Stratum: (Plot size: 1m)	%Cover	Dominant Species	Indicator Status
1. Acer rub	1	✓	FAC
2.			
3.			
4.			
5.			
	1 = Total Cover		

Comments

Dominance Test Worksheet:

# of Dominant Species that are OBL,FACW,FAC: 4 (A)
Total # of Dominant Species across all strata: 4 (B)
% of Dominant Species that are OBL,FACW,FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL Species		x1 =	
FACW Species		x2 =	
FAC Species	73	x3 =	219
FACU Specie		x4 =	
UPL Species		x5 =	
Column Totals:	73	x1 =	219

Prevalence Index = B/A = 3.0

Hydrophytic Vegetation Indicators:
✓ Rapid Test for Hydrophytic Vegetation
✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
__ Morphological Adaptations[1] (explain)
__ Problematic Hydrophytic Vegetation[1] (explain)
[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ✓ No ____

New Brunswick Department of Environment Wetland Delineation Data Sheet

WL 1 c up

Hydrology

Primary Hydrological Indicators: (minimum of one is required; check all that apply)

__ Surface Water (A1)
__ High Water Table (A2)
__ Saturation (A3)
__ Water Marks (B1)
__ Sediment Deposits (B2)
__ Drift Deposits (B3)
__ Algal Mat or Crust (B4)
__ Iron Deposits (B5)
__ Inundation Visible on Aerial Imagery (B7)
__ Sparsely Vegetated Concave Surface (B8)

__ Water Stained Leaves (B9)
__ Aquatic Fauna (B13)
__ Marl Deposits (B15)
__ Hydrogen Sulfide Odor (C1)
__ Oxidized Rhizospheres on Living Roots (C3)
__ Presence of Reduced Iron (C4)
__ Recent Iron reduction in tilled Soils (C6)
__ Thin Muck Surface (C7)
__ Other (Explain in Remarks)

Secondary Indicators: (minimum of two required)

__ Surface Soil Cracks (B6)
__ Drainage Patterns (B10)
__ Moss Trim Lines (B16)
__ Dry-Season Water Table (C2)
__ Crayfish Burrows (C8)
__ Saturation Visible on Aerial Imagery (C9)

__ Stunted or Stressed Plants (D1)
__ Geomorphic Position (D2)
__ Shallow Aquitard (D3)
__ Microtopographic Relief (D4)
__ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes___ No___ Depth___
Water Table Present? Yes___ No___ Depth___
Saturation Present? Yes___ No___ Depth___

Wetland Hydrology Present? Yes___ No ✓

Comments:

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix Color(moist)	%	Redox Features Color(moist)	%	Type[1]	Loc[2]	Texture	Remarks
3-0	—	—	—	—	—	—	Organic	
0-10	7.5YR/4/2	100	—	—	—	—	Sandy	
10-25	7.5YR/5/4	100	—	—	—	—	Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

__ Histosol (A1)
__ Histic Epipedon (A2)
__ Black Histic (A3)
__ Hydrogen Sulfide (A4)
__ Stratified Layers (A5)
__ Depleted Below Dark Surface (A11)
__ Thick Dark Surface (A12)
__ Sandy Mucky Mineral (S1)
__ 5cm Mucky Peat or Peat (S3)
__ Sandy Gleyed Matrix (S4)

__ Sandy Redox (S5)
__ Stripped Matrix (S6)
__ Dark Surfaces (S7)
__ Polyvalue Below Surface (S8)
__ Thin Dark Surface (S9)
__ Loamy Gleyed Matrix (F2)
__ Depleted Matrix (F3)
__ Redox Dark Surface (F6)
__ Depleted Dark Surface (F7)
__ Redox Depressions (F8)

Restrictive Layer (if observed): Type Rock Depth: 28cm

Hydric Soil Present? Yes___ No ✓

Comments:

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New Brunswick Department of Environment Wetland Delineation Data Sheet

Project Site: Arsam
Date: Jun 15/2018
Sample Point: WLZ wet
Applicant/Owner: New Maryland
Field Investigator(s): Derrick Mitchell
County: York
Coordinates: 2485730/7430120
PID: 75349068, 75064840, 75062174
Do normal environmental conditions exist on-site? Yes ☑ No ☐
If no explain:
Atypical Situation? Yes ☐ No ☑ Explain
Is this a potential **Problem Area?** Yes ☐ No ☑ Explain

Wetland Determination

(Check One Only For Each Criteria)

Dominant Hydrophytic Vegetation (50/20 rule) Yes ☑ No ☐
Wetland Hydrology Yes ☑ No ☐
Hydric Soils Yes ☑ No ☐
Wetland Type: Forested Riverene swamp
Rational for Determination: 3 indicaters present

Wetland Determination
YES ☑ **NO** ☐

Vegetation

Tree Stratum: (Plot size: 15m)

	%Cover	Dominant Species	Indicator Status
1. Frax nig	30	✓	FACW
2.			
3. Acer rub	20	✓	FAC
4. Abie bal	10		FAC
5.			
	=60 = Total Cover		

Shrub Stratum: (Plot size: 5m)

1.			
2. Frax nig	25	✓	FACW
3. Abie bal	5		FAC
4.			
5.			
	= 30 = Total Cover		

Herb Stratum: (Plot size: 1m)

1. Osmu cin	15	✓	FAC
2. Thel nova	15	✓	FAC
3.			
4. Care gyn	10		FACW
5. Onoc sen	5		FACW
	= 55 = Total Cover		

Dominance Test Worksheet:

# of Dominant Species that are OBL,FACW,FAC: 5 (A)
Total # of Dominant Species across all strata: 5 (B)
% of Dominant Species that are OBL,FACW,FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:
OBL Species		x1 =
FACW Species	55	x2 = 110
FAC Species	50	x3 = 150
FACU Specie		x4 =
UPL Species		x5 =
Column Totals:	105	x1 = 260

Prevalence Index = B/A = 2.5

Hydrophytic Vegetation Indicators:

✓ Rapid Test for Hydrophytic Vegetation
✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
_ Morphological Adaptations[1] (explain)
_ Problematic Hydrophytic Vegetation[1] (explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Comments

Hydrophytic Vegetation Present? Yes ✓ No___

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New Brunswick Department of Environment Wetland Delineation Data Sheet

Hydrology

WL2 wet

Primary Hydrological Indicators: (minimum of one is required; check all that apply)

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- ✓ Water Marks (B1)
- ✓ Sediment Deposits (B2)
- ✓ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- ✓ Presence of Reduced Iron (C4)
- __ Recent Iron reduction in tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators: (minimum of two required)

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes___ No ✓ Depth___

Water Table Present? Yes___ No ✓ Depth___

Saturation Present? Yes___ No ✓ Depth___

Comments:

Wetland Hydrology Present? Yes ✓ No__

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix		Redox Features				Texture	Remarks
	Color(moist)	%	Color(moist)	%	Type[1]	Loc[2]		
1-0	—	—	—	—	—	—	Organic	
0-20	7.5YR/5/2	95	7.5YR/6/4	5	D	M	Silt	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 5cm Mucky Peat or Peat (S3)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Dark Surfaces (S7)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)

Restrictive Layer (if observed): Type Rock Depth: 21 cm

Hydric Soil Present? Yes ✓ No__

Comments:

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New Brunswick Department of Environment Wetland Delineation Data Sheet

Project Site: Arsam
Date: Jun 15/2018
Sample Point: WL2 up
Applicant/Owner: New Maryland
Field Investigator(s): Derrick Mitchell
County: York
Coordinates: 2485730/ 7430120
PID: 75349069, 75064840, 75062174
Do normal environmental conditions exist on-site? Yes ☑ No ☐
If no explain:
Atypical Situation? Yes ☐ No ☑ Explain
Is this a potential **Problem Area**? Yes ☐ No ☑ Explain

Wetland Determination

(Check One Only For Each Criteria)

Dominant Hydrophytic Vegetation (50/20 rule) Yes ☑ No ☐
Wetland Hydrology Yes ☐ No ☑
Hydric Soils Yes ☐ No ☑
Wetland Type: N/A
Rational for Determination: N/A

Wetland Determination
YES ☐ **NO** ☑

Vegetation

Tree Stratum: (Plot size: 15m)	%Cover	Dominant Species	Indicator Status
1. Acer rub	40	✓	FAC
2. Abie bal	20	✓	FAC
3. Thuj occ	10		FACW
4.			
5. Betu all	5		FAC
	=75 = Total Cover		

Shrub Stratum: (Plot size: 5m)			
1. Abie bal	5	✓	FAC
2.			
3.			
4.			
5.			
	=5 = Total Cover		

Herb Stratum: (Plot size: 1m)			
1. Trie bal	2	✓	FAC
2.			
3.			
4.			
5.			
	=2 = Total Cover		

Comments:

Dominance Test Worksheet:

\# of Dominant Species that are OBL,FACW,FAC: 4 (A)

Total # of Dominant Species across all strata: 4 (B)

% of Dominant Species that are OBL,FACW,FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply by:	
OBL Species		x1 =	
FACW Species		x2 =	
FAC Species	67	x3 =	201
FACU Specie		x4 =	
UPL Species		x5 =	
Column Totals:		x1 =	

Prevalence Index = B/A = 3.0

Hydrophytic Vegetation Indicators:
✓ Rapid Test for Hydrophytic Vegetation
✓ Dominance Test is >50%
✓ Prevalence Index is ≤3.0[1]
__ Morphological Adaptations[1] (explain)
__ Problematic Hydrophytic Vegetation[1] (explain)
[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ✓ No

New Brunswick Department of Environment Wetland Delineation Data Sheet

Hydrology

WLZ up

Primary Hydrological Indicators *(minimum of one is required; check all that apply)*

- __ Surface Water (A1)
- __ High Water Table (A2)
- __ Saturation (A3)
- __ Water Marks (B1)
- __ Sediment Deposits (B2)
- __ Drift Deposits (B3)
- __ Algal Mat or Crust (B4)
- __ Iron Deposits (B5)
- __ Inundation Visible on Aerial Imagery (B7)
- __ Sparsely Vegetated Concave Surface (B8)
- __ Water Stained Leaves (B9)
- __ Aquatic Fauna (B13)
- __ Marl Deposits (B15)
- __ Hydrogen Sulfide Odor (C1)
- __ Oxidized Rhizospheres on Living Roots (C3)
- __ Presence of Reduced Iron (C4)
- __ Recent Iron reduction in tilled Soils (C6)
- __ Thin Muck Surface (C7)
- __ Other (Explain in Remarks)

Secondary Indicators *(minimum of two required)*

- __ Surface Soil Cracks (B6)
- __ Drainage Patterns (B10)
- __ Moss Trim Lines (B16)
- __ Dry-Season Water Table (C2)
- __ Crayfish Burrows (C8)
- __ Saturation Visible on Aerial Imagery (C9)
- __ Stunted or Stressed Plants (D1)
- __ Geomorphic Position (D2)
- __ Shallow Aquitard (D3)
- __ Microtopographic Relief (D4)
- __ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes__ No ✓ Depth__

Water Table Present? Yes__ No ✓ Depth__

Saturation Present? Yes__ No ✓ Depth__

Wetland Hydrology Present? Yes__ No ✓

Comments:

Soil Profile

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators)

Depth(cm)	Matrix		Redox Features				Texture	Remarks
	Color(moist)	%	Color(moist)	%	Type[1]	Loc[2]		
7-0	—	—	—	—	—	—	Organic	
0-22	7.5YR/5/4	100	—	—	—	—	Sandy	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators:

- __ Histosol (A1)
- __ Histic Epipedon (A2)
- __ Black Histic (A3)
- __ Hydrogen Sulfide (A4)
- __ Stratified Layers (A5)
- __ Depleted Below Dark Surface (A11)
- __ Thick Dark Surface (A12)
- __ Sandy Mucky Mineral (S1)
- __ 5cm Mucky Peat or Peat (S3)
- __ Sandy Gleyed Matrix (S4)
- __ Sandy Redox (S5)
- __ Stripped Matrix (S6)
- __ Dark Surfaces (S7)
- __ Polyvalue Below Surface (S8)
- __ Thin Dark Surface (S9)
- __ Loamy Gleyed Matrix (F2)
- __ Depleted Matrix (F3)
- __ Redox Dark Surface (F6)
- __ Depleted Dark Surface (F7)
- __ Redox Depressions (F8)

Restrictive Layer (if observed): Type N/A Depth: N/A

Hydric Soil Present? Yes__ No ✓

Comments:

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Appendix V
WESP-AC Scores

Wetland ID:	WL1
Date:	06/13/2018
Observer:	Derrick Mitchell
Latitude & Longitude (decimal degrees):	

Scores will appear below after data are entered in worksheets OF, F, and S. See Manual for definitions and descriptions of how scores were computed. Note: Benefits scores will be provided in the final calculator for WBF, WBN, SBM, and POL; their models are currently being revised.

Results for this Assessment Area (AA):

Wetland Functions or Other Attributes:	**Function** Score (normalized)	Function Rating	**Benefits** Score (normalized)	Benefits Rating	Function Score (raw)	Benefits Score (raw)
Surface Water Storage (WS)	2.55	Lower	7.14	Higher	3.54	5.00
Stream Flow Support (SFS)	10.00	Higher	9.18	Higher	6.06	6.90
Water Cooling (WC)	7.54	Higher	5.12	Moderate	5.03	3.30
Sediment Retention & Stabilisation (SR)	3.39	Moderate	7.05	Moderate	5.33	4.28
Phosphorus Retention (PR)	3.59	Moderate	7.39	Higher	5.76	7.01
Nitrate Removal & Retention (NR)	6.07	Higher	10.00	Higher	6.02	10.00
Carbon Sequestration (CS)	3.91	Moderate			6.16	
Organic Nutrient Export (OE)	8.55	Higher			6.78	
Anadromous Fish Habitat (FA)	0.00	Lower	0.00	Lower	0.00	0.00
Resident Fish Habitat (FR)	8.09	Higher	3.83	Moderate	5.63	2.72
Aquatic Invertebrate Habitat (INV)	6.17	Moderate	7.31	Higher	5.79	5.20
Amphibian & Turtle Habitat (AM)	5.46	Moderate	10.00	Higher	6.36	6.91
Waterbird Feeding Habitat (WBF)	9.46	Higher			7.58	
Waterbird Nesting Habitat (WBN)	6.20	Higher			5.17	
Songbird, Raptor, & Mammal Habitat (SBM)	7.82	Higher			6.48	
Pollinator Habitat (POL)	9.06	Higher			7.30	

Native Plant Habitat (PH)	7.51	Higher	10.00	Higher	6.54	6.81
Public Use & Recognition (PU)			2.03	Lower		1.54
Wetland Sensitivity (Sens)			6.31	Higher		4.23
Wetland Ecological Condition (EC)			5.63	Moderate		7.36
Wetland Stressors (STR) (higher score means more)			10.00	Higher		6.16
Summary Ratings for Grouped Functions:						
HYDROLOGIC Group (WS)	2.55	Lower	7.14	Higher	3.54	5.00
WATER QUALITY SUPPORT Group (max+avg/2 of SR, PR, NR, CS)	2.36	0.00	10.00	Higher	5.99	8.55
AQUATIC SUPPORT Group (max+avg/2 of SFS, INV, OE, WC)	9.14	0.00	8.76	Higher	6.35	6.02
AQUATIC HABITAT Group (max+avg/2 of FA, FR, AM, WBF, WBN)	7.89	0.00	8.48	Higher	6.27	5.06
TRANSITION HABITAT Group (max+avg/2 of SBM, PH, POL)	7.04	0.00	10.00	Higher	7.03	6.81
WETLAND CONDITION (EC)			5.63	Moderate		7.36
WETLAND RISK (average of Sensitivity & Stressors)			10.00	Higher		5.19

Wetland ID:	WL2
Date:	06/13/2018
Observer:	Derrick Mitchell
Latitude & Longitude (decimal degrees):	

Scores will appear below after data are entered in worksheets OF, F, and S. See Manual for definitions and descriptions of how scores were computed. Note: Benefits scores will be provided in the final calculator for WBF, WBN, SBM, and POL; their models are currently being revised.

Results for this Assessment Area (AA):

Wetland Functions or Other Attributes:	**Function** Score (normalized)	Function Rating	**Benefits** Score (normalized)	Benefits Rating	Function Score (raw)	Benefits Score (raw)
Surface Water Storage (WS)	2.11	Lower	7.14	Higher	3.19	5.00
Stream Flow Support (SFS)	5.94	Moderate	8.74	Higher	3.17	6.57
Water Cooling (WC)	7.17	Higher	5.12	Moderate	4.78	3.30
Sediment Retention & Stabilisation (SR)	2.40	Moderate	7.15	Moderate	4.63	4.34
Phosphorus Retention (PR)	2.83	Moderate	6.08	Higher	5.26	5.83
Nitrate Removal & Retention (NR)	2.07	Lower	10.00	Higher	4.78	10.00
Carbon Sequestration (CS)	4.01	Moderate			6.20	
Organic Nutrient Export (OE)	8.44	Higher			6.70	
Anadromous Fish Habitat (FA)	0.00	Lower	0.00	Lower	0.00	0.00
Resident Fish Habitat (FR)	5.27	Moderate	3.49	Moderate	3.67	2.47
Aquatic Invertebrate Habitat (INV)	6.11	Moderate	6.50	Higher	5.76	4.78
Amphibian & Turtle Habitat (AM)	5.33	Moderate	10.00	Higher	6.30	6.85
Waterbird Feeding Habitat (WBF)	7.93	Higher			6.36	
Waterbird Nesting Habitat (WBN)	5.79	Higher			4.83	
Songbird, Raptor, & Mammal Habitat (SBM)	9.10	Higher			7.53	
Pollinator Habitat (POL)	9.83	Higher			7.92	

Native Plant Habitat (PH)	6.43	Higher	10.00	Higher	6.09	7.37
Public Use & Recognition (PU)			2.38	Moderate		1.78
Wetland Sensitivity (Sens)			5.59	Moderate		4.00
Wetland Ecological Condition (EC)			5.63	Moderate		7.36
Wetland Stressors (STR) (higher score means more)			10.00	Higher		7.88
Summary Ratings for Grouped Functions:						
HYDROLOGIC Group (WS)	2.11	Lower	7.14	Higher	3.19	5.00
WATER QUALITY SUPPORT Group (max+avg/2 of SR, PR, NR, CS)	1.78	0.00	9.85	Higher	5.71	8.36
AQUATIC SUPPORT Group (max+avg/2 of SFS, INV, OE, WC)	8.05	0.00	8.25	Higher	5.90	5.73
AQUATIC HABITAT Group (max+avg/2 of FA, FR, AM, WBF, WBN)	5.94	0.00	8.33	Higher	5.29	4.98
TRANSITION HABITAT Group (max+avg/2 of SBM, PH, POL)	8.26	0.00	10.00	Higher	7.55	7.37
WETLAND CONDITION (EC)			5.63	Moderate		7.36
WETLAND RISK (average of Sensitivity & Stressors)			10.00	Higher		5.94

Appendix VI
Site Photographs

Photo 1. Test wells located along access road and adjacent to the west central portion of Wetland 1.

Photo 2. Representative photograph of deciduous treed slope swamp component of Wetland 1 complex. Note vegetated intermittent watercourse channel.

Photo 3. Representative photograph of permanent watercourse channels flowing through Wetland 1.

Photo 4. Representative photograph of coniferous slope swamp component of Wetland 1 complex.

Photo 5. Representative photograph of deciduous treed riverene swamp component of Wetland 1 complex.

Photo 6. Photograph of sedge/reed riparian swamp component of Wetland 1 complex.

Photo 7. Photograph of utility road intersecting the northeastern boundary of Wetland 2 viewed southeast. Note watercourse crossing the utility road in the background and evidence of ATV use.

Photo 8. Photograph of watercourse crossing the utility road and flowing into Wetland 2 viewed northwest.

Photo 9. Photograph of Wetland 2 (deciduous treed riverene swamp) and permanent watercourse channel viewed northwest from outlet.

APPENDIX

C-3 ARCHAEOLOGICAL FIELD RESEARCH

Archaeological Field Research Permit
Final Report

Village of New Maryland
Arsam Property Wellfield Development

AFRP No. 2018 NB 133

Prepared by
Stratis Consulting Inc.

Archaeological Field Research Permit Final Report
Village of New Maryland
Arsam Property Wellfield Development

AFRP No. 2018 NB 133

Report to:

Archaeological Services
Heritage Branch
Department of Tourism, Heritage and Culture
Province of New Brunswick
P.O. Box 6000
Fredericton, NB E3B 5H1

Proponent:

WSP Canada
80 Bishop Drive,
Fredericton, NB E3C 1B2

On behalf of:
Village of New Maryland
584 New Maryland Highway
New Maryland, NB E3C 1K1

Submitted by:

Stratis Consulting Inc.
527 Dundonald Street, Suite 115
Fredericton, NB E3B 1X5

25 January 2019
Revised 11 April 2019

Grant Aylesworth, PhD, RPA (Reg. No. 15583)

Principal Investigator and Author

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List of Archival Photographs, Documents, and Drawing

List of Field Photographs

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List of Generally Used Abbreviations

AFRP	Archaeological Field Research Permit
ASB	Archaeological Services Branch, GNB
GNB	Government of New Brunswick
GPS	Global Positioning System
HRIA	Heritage Resource Impact Assessment
MARI	Maritime Archaeological Resource Inventory
NAPL	National Air Photo Library
NB	New Brunswick
NTS	National Topographic Service
PANB	Provincial Archives of New Brunswick
RoW	Right of Way
RPA	Registered Professional Archaeologist
Stratis	Stratis Consulting Inc.
WSP	WSP Canada
VONM	Village of New Maryland

Executive Summary

The Village of New Maryland plans to improve its water distribution system. As part of environmental work prior to construction, Stratis Consulting Inc. completed this Heritage Resource Impact Assessment. Under the Heritage Resource Impact Assessment permit, this report is required to be filed for review and approval with Archaeological Services Branch, Government of New Brunswick.

Stratis undertook three phases of work: Documentary Research, Direct Consultation (consultation with First Nations, if any is required for the Project, was not part of the Stratis scope of work), and a Preliminary Field Examination. The scope of the assessment was developed in consultation with Archaeological Services Branch. Stratis found that the Project's assessment area does not have medium or high potential to contain unknown heritage resources. Nevertheless, the possibility of accidental discovery of heritage resources remains, as for any project; therefore, Stratis provided protocols to be followed in the unlikely event of accidental discovery.

One historic period site was identified during this assessment: St. Mary the Virgin Anglican Church and Cemetery, located along New Maryland Highway. Since project-related construction is across the highway from the cemetery and the work is being done in a previously disturbed area, archaeological monitoring of construction near the church is not recommended. Stratis noted that some of the stone monuments in the cemetery are leaning and in poor condition and recommended that this may be considered as a public safety issue. No pre-contact artifacts were found during the field visits. Archaeological testing is not recommended.

Introduction

WSP Canada (WSP) retained Stratis Consulting Inc. (Stratis) to complete a Heritage Resource Impact Assessment (HRIA) of the Village of New Maryland's (VONM) planned wellfield development project.

Stratis undertook documentary research prior to field visits to the project area on 31 October 2018 and 1 November 2018. Work was done under Archaeological Field Research Permit (AFRP) 2018 NB 133, issued to Dr. Grant Aylesworth, RPA No. 15583.

This report has information in appendices, including:

• Appendix A	Archival Photographs and Photo Overlays
• Appendix B	Field Photographs
• Appendix C	Potential Model, Archaeological Services New Brunswick
• Appendix D	AFRP
• Appendix E	Field Notes
• Appendix F	NAPL (National Air Photo Library) Metadata
• Appendix G	Project-Related Infrastructure Locations, courtesy WSP
• Appendix H	Accidental Discovery Protocols

Stratis will deposit a hard copy of this Final Report with ASB along with a CD containing GPS track logs for the visual survey, a PDF of this report, copies of historic aerial photographs, and field notes. Stratis does not recommend further archaeological work such as testing or monitoring of construction, except for the project using “Accidental Discovery Protocols”, samples of which are provided in Appendix H.

Proponent

At the request of WSP, Stratis completed this HRIA on behalf of VONM. Contact information for WSP is as follows:

Stephen Pyke M.A.Sc., P.Eng.
WSP Canada
80 Bishop Drive, Fredericton, NB E3C 1B2
+1 506 451 0076
Email: Stephen.Pyke@wsp.com

Project

The Project is located in the Village of New Maryland, south of Sunrise Estates and along and west of the New Maryland Highway (Route 101) in York County.

The Project includes a Right of Way (RoW) for a water supply and transmission/distribution pipeline, access to monitoring wells, a water treatment plant, and a water distribution line (Appendix G). The water treatment plant will be built on a previously disturbed and decommissioned lagoon site south of Sunrise Park. Access to the monitoring wells is along an existing road. The water distribution line passes through some previously unexcavated areas south of Sunrise Estates Drive then follows an existing sanitary easement to the New Maryland Highway. The distribution system then follows alongside the New Maryland Highway and will be installed parallel to the highway in the existing longitudinal ditch. There will be two spurs along the transmission/distribution pipeline: one along Lark Street and a second leading to Sandcherry Lane. The transmission/distribution line ends with a connection at Daniel Drive.

Project Assessment Area

The Assessment Area is defined as the area in which project-related infrastructure will be constructed, as shown in Appendix G. In consultation with Archaeological Services Branch (ASB), Government of New Brunswick, it was determined that the assessment area would include all areas for project-related infrastructure, from the well locations to the Daniel Drive connection, including the Lark Street Spur and the Sandcherry connection and along the New Maryland Highway. Along Highway 101 (New Maryland Highway), the assessment was undertaken with the understanding that pipe would be installed in the existing ditch along the west side of the highway. As such, with the exception of the cemetery, the assessment was limited to the area immediately adjacent to the highway and did not consider heritage potential nearby buildings as these will not be disturbed during construction. An exception to this was a visual survey of the St. Mary the Virgin Church and Cemetery as the regulated buffer zone for these falls into the assessment area.

Methodology

The method for this HRIA followed ASB Guidelines and generally accepted principles as well as professional standards and ethics dictated by the Register of Professional Archaeologists. The methods included searches at the Provincial Archives of New Brunswick (PANB) and the National Air Photo Library (NAPL), a review of the Archaeological Potential Model from ASB, direct consultation with ASB and PANB staff, and a preliminary field examination. Local history societies are sometimes contacted in the course of HRIA research. The York Sunbury Historical Society has not provided any comment to Stratis on any past inquiries and was, therefore, not contacted for this project. Archival aerial photographs from NAPL (Appendix A) were obtained and reviewed prior to fieldwork.

The preliminary field examination included a visual survey of the assessment area, as shown in Appendix G. The length of water supply and transmission pipeline from the wells to the water treatment plant location were walked over and photographed, as well as the RoW for the transmission/distribution pipeline along the existing sanitary easement south of Sunrise Estates. The Lark Street Spur was also walked over. The Sandcherry Connection/spur was also walked over. The transmission/distribution pipeline RoW along the New Maryland Highway was surveyed as a combined windshield survey and walkover survey. The walkover included areas where watercourse crossings were inferred on the ASB Potential Model. The walkover survey also included a visit to the grounds of St. Mary the Virgin Anglican church, located on the across the New Maryland Highway just south of the Sandcherry connection/spur. The church grounds and cemetery were visited because the archaeological buffer zone surrounding the church extends to within the assessment area on the west side of the New Maryland Highway (this buffer zone is shown as a blue circle on ASB’s Potential model in Appendix C).

Date and location stamped photographs (Appendix B) were taken, field notes were written (Appendix E), and a GPS track log was recorded during the field survey. GPS track log files will be given to ASB with a hard copy of this Final Report. No shovel tests were undertaken.

Documentary Research, Direct Consultation, and Preliminary Field Examination

The ASB Potential Model shows one known cemetery in the assessment area and one area of medium and high archaeological potential for Pre-Contact heritage resources along a tributary to Burpee Brook, located in the southern end of the Assessment area near the well locations and transmission pipeline RoW (Appendix C). The model also shows six interpreted water course crossings along Route 101.

The cemetery surrounds St. Mary the Virgin Church located near the northern end of the assessment area across Route 101 from the Sandcherry Connection. The cemetery appears on the potential model as a red dot with a 100 m radius buffer zone, shown in light blue. The church and cemetery appear not to have been catalogued as an archaeological site and have no Borden Number (assigned to archaeological sites of all time periods catalogued on the provincial and federal site cataloguing system) on the Potential model.

Registered historic places were also searched at the provincial and federal level. The New Brunswick Register of Historic Places was searched and St. Mary the Virgin Church is listed on the Register. The church was also listed on the Register of Canada’s Historic Places in 1994. The church building is pre-Confederation (Petz 2017) and the associated cemetery contains interments ranging in date from the 19th century to recent. Details about the church are recorded by the historic places registers and so are not repeated here.

The records of the Provincial Archives of New Brunswick (PANB) were consulted along with staff experts who indicated that they knew of little in the holdings related to the history of New Maryland and that there were no publications in the New Brunswick literature collection regarding New Maryland.

The National Air Photo Library (NAPL) was searched for the earliest aerial photographs of the assessment area. This resulted in eight photos, mostly dating to 1925, being located and included Appendix A with metadata in Appendix F.

A review of surficial geology (Rampton 1984) and bedrock geology (NBDNRE 2000) showed no issues of concern with respect to heritage resources. This review was undertaken with reference to well logs provided to Stratis by WSP. In addition, Stratis reviewed as-built plans for the Wastewater Collection System Upgrade, dating to 2005.

A visual survey of the project area was undertaken on 31 October 2018 and 1 November 2018.

Findings

This section further outlines the findings of the Documentary Research and Preliminary Field Examination.

General

In terms of settlers of European descent, the area was settled by descendants of Loyalists from Maryland, United States of America in the early 1800s with the Parish of New Maryland created in 1846 (Welch and Payne 2012). Indigenous people have lived in New Brunswick for at least 13,000 years and although there are currently no catalogued Indigenous archaeological sites in the assessment area, this does not mean they do not exist. Areas within 80 m of watercourses have been found to have medium to high potential to contain Indigenous archaeological sites in New Brunswick.

ASB Potential Model

There are no known pre-historic sites in the project area, as indicated on the ASB Potential Model. With respect to historic period sites that appear on the Potential Model, only St. Mary the Virgin Anglican Church and cemetery is within the assessment area, located near the northern end of the assessment area, across the highway and south of the Sandcherry connection (Potential Model, Appendix C).

The Potential Model shows only one watercourse with high archaeological potential. This watercourse is an unnamed tributary to Burpee Brook and does not appear on 1:50 000 NTS maps of the area. This area was further assessed during the Preliminary Field Examination.

National Air Photo Library

Eight historic aerial photographs were required to cover the assessment area. These were obtained from NAPL and reviewed prior to fieldwork. Seven of the photos date to 1925, which is the earliest the author has seen for New Brunswick, and the eighth dated to 1945. The photos are given in Appendix A with metadata from NAPL in Appendix F.

The photos show that the alignment of Highway 101 ("New Maryland Highway") was the same in the early 20th century as today. The presence of some buildings pre-dating the 20th century indicates that the road alignment was likely similar since the 1800s, with some variation for approaches to watercourses, the largest of which is outside the project area, to the north at Baker Brook, where the road used to curve west of its current location to approach the watercourse (Item A6, Appendix A).

The aerial photographs show that, in general, the assessment area was farm land such as pasture and apple orchards. The orchards are largely gone but some apple trees remain throughout parts of New Maryland. Near the present-day subdivision known as Sunrise Estates, a watercourse that is a tributary to Burpee Brook ran across the location of Sunrise Estates Drive, south under Sunrise Park, then along the eastern edge of the decommissioned lagoon site property. This watercourse appears present currently as a culvert that runs under Sunrise Park. The aerial photograph shows the area of this watercourse, near the former lagoon site, to be a somewhat steep valley (Items A8-A9, Appendix A).

Google Earth

Stratis created an overlay of the portion of the transmission pipeline and wells area that is located within the medium to high potential areas shown on the Potential Model. This was created with the Potential Model added as a transparent layer above Google Earth satellite imagery and shows the previous disturbance in the area from the existing road cut (Item A10, Appendix A).

Surficial and Bedrock Geology

Prior to fieldwork, Stratis obtained and reviewed test well logs from WSP. The geological information on these logs corresponded to the information available from Rampton (1984) and NBDNRE (2000). Specifically, that the assessment area is underlain by late Wisconsinan morainal sediments and late Carboniferous sandstone that underlies most of eastern and central New Brunswick. These deposits did not, in themselves, indicate elevated areas of archaeological concern and fossils of natural heritage interest are unlikely to be encountered by the project.

Direct Consultation

Direct Consultation was undertaken with ASB in relation to the scope of the assessment and to review the archaeological potential model during the drafting of the report. Staff at PANB were consulted regarding materials related to the history of New Maryland.

Preliminary Field Investigation

The assessment area was visited twice, on 31 October 2018 and 1 November 2018. A GPS track log, photographs, and field notes were taken. A digital version of the GPS track log will be submitted to Archaeological Services with the Final Report. Photographs from the visual survey are in Appendix B.

Wells and Transmission Pipeline to Treatment Plant

The area of the wells and water transmission pipeline are at the southeastern end of the assessment area. This area has been previously logged and a rough road runs across and near much of the RoW for the transmission pipeline. The area near existing wells, shown as medium to high archaeological potential on the Potential Model, does not, in fact, have high potential. This is because it has been previously excavated and disturbed for road construction (Photographs B13-B15, Appendix B). The area contains numerous bulldozer or grader cuts and push-ups. The road cuts were visually surveyed for artifacts and features and nothing was found. The transmission pipeline RoW in the medium to high potential areas is also sloped to a greater degree than shown on the potential mode, mostly sloping down to the wet area north of the assessment area and north of the existing wells. Given the slope, previous ground disturbance, and negative results of the visual survey of the road cuts, this area is not interpreted to have high or medium archaeological potential. The watercourse that triggered the high potential zone was flooded with water over the road at the time of the Preliminary Field Examination. In general, the high potential area has been heavily modified by previous activities.

Along the RoW for the Transmission Pipeline after it turns towards the Water Treatment location, it crosses two small watercourses. These are very small streams in a mostly low-lying area that is very wet and contained numerous cedar stumps (Photograph B12, Appendix B). The area had been previously logged, including selective logging for cedar. This cedar was likely used for fences as can be seen throughout New Maryland in the historic aerial photographs. This area was also criss-crossed with overgrown roads and ground disturbance such as bulldozer/grader push-ups from previous activities. The area around one watercourse was identified by a biologist as delineated wetland and the surrounding forest was described as “mature intolerant hardwood”, referring to shade intolerant forest that is 30-50-year-old[1]. The combination of the delineated wetland, low-lying marshy area, and very small watercourses suggest low archaeological potential for this area.

The Water Treatment plant location has been previously disturbed and is a decommissioned lagoon site. The northern part of this area consists of a park and a tributary to Burpee Brook runs in a culvert under the park. Adjacent to the park and on the former lagoon property is a large borrow pile that is overgrown with trees and located next to the tributary. This is the steep area visible in the 1945 aerial photograph. Although there is a nearby watercourse, no work is planned near the watercourse and the area has been previously excavated for the former lagoon. As such, this area does not archaeological potential.

Transmission/Distribution Line from Treatment Plant to New Maryland Highway

This part of the assessment area is along an existing and previously disturbed sanitary easement. The only watercourse crossing in this area is the unnamed tributary to Burpee Brook that runs along the area of the Lark Street Spur. This watercourse has been heavily modified and follows a straight line, as a longitudinal ditch along the existing easement. As such, this watercourse does not have archaeological potential and does not warrant archaeological testing. Photographs B10 and B16 (Appendix B) provide overviews of this area.

Lark Street Spur

This area parallels a small heavily modified water course and runs north from the area of the existing sanitary easement to Lark Street. Nearby areas have been previously excavated and the watercourse channel modified and riprap placed along it (Photograph B9, Appendix B). The nearby houses sit atop fill

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[1] Boreal Environmental. Report to WSP on Breeding Bird, Rare Plant and Wetland Survey, Proposed Wellfield Development, New Maryland, NB. August, 2018.

as the unfilled surrounding area is relatively low and wet. Given these conditions, this area does not warrant archaeological testing.

Transmission/Distribution Line along New Maryland Highway

The assessment area along New Maryland Highway crossed six interpreted watercourse crossings that appear on the Potential Model. Each of these locations was visited and none are of archaeological concern. Just north of St. Mary the Virgin Church, an inferred watercourse is present as a small drainage along the eastern side of the highway (Photograph B18, Appendix B). There will be no project-related ground disturbance in this area. Along the western side of the highway at this inferred crossing, a storm water attenuation feature has been built and therefore this area has no archaeological potential.

The remaining parts of the assessment area along New Maryland Highway to Daniel Drive do not have elevated archaeological potential due to watercourse crossings. In addition, ground disturbance will take place immediately adjacent to the existing highway, an area already disturbed by fill and a longitudinal ditch. Other interpreted watercourse crossings found in the potential model did not contain channels or water-related features (e.g., Photograph B2, Appendix B).

Sandcherry Connection/Spur

The area of the Sandcherry connection or spur to connect to a new subdivision has seen relatively recent disturbance for the construction of a storm water drainage channel and a storm water attenuation feature located beside the highway (Photographs B6-B8, Appendix B). Given the previous construction, this area does not warrant archaeological testing.

St. Mary the Virgin Anglican Church and Cemetery

The northern part of the transmission pipeline, just south of the Sandcherry Connection, crosses within the buffer zone of St. Mary the Virgin Anglican Church and cemetery (photograph B2, Appendix B). This area, including the church grounds, was visually surveyed because of the extent of the 100 m radius buffer zone given by the Potential Model. The area is not recommended for archaeological monitoring because construction will be away from the cemetery on the opposite side of the highway.

Resource Inventory

No new heritage resources were found within the project area. St. Mary the Virgin Church and Cemetery is across the highway from the planned construction area.

Conclusions and Recommendations

Archaeological testing is not recommended. Archaeological monitoring is not recommended. No further follow-up or mitigation is recommended other than the adoption of “accidental discovery protocols” that must be followed, and these follow provincial laws and regulations.

The only area showing high or medium archaeological potential on the ASB Potential model is in the southeastern end of the project area near the wells. The watercourse in this area is connected to a large wet area that is likely the result of beaver dams. The area within the predicted high potential and medium potential buffers (up to 80 m from the watercourse as shown in light blue and darker blue around the watercourse on the Potential model) has been previously disturbed by road construction, previous bulldozing, and other ground disturbance, logging, and other activities. In addition, parts of the area leading down to the wet area have a greater slope than is predicted on the model and this mitigates against the presence of archaeological sites. The road that leads to the wells cuts through the high and medium potential areas. The road cut, which is along and across with project RoW, was visually surveyed and no artifacts or features were noted. Together, these factors mitigate against the potential of this area to contain heritage resources.

Accidental discovery of heritage resources, however unlikely, remains possible whenever ground is disturbed. Therefore, an “accidental discovery protocol”, one for artifacts or archaeological features, and another for human remains, is recommended for the project. Draft protocols are included in Appendix H. Since pipeline construction is planned across the street from the cemetery, in the existing ditch area, archaeological monitoring is not recommended during construction near the cemetery in the 100 m radius buffer zone shown on the Potential Model from ASB. The likelihood of accidental discovery is low for that particular area.

Accidental Discovery

Accidental discovery of heritage resources is possible during any ground disturbance. This likelihood for the project is considered low so archaeological monitoring during construction is not recommended. With respect to ASB’s Potential Model, project-related excavation will pass through the regulated buffer zone for the cemetery at St. Mary the Virgin Anglican Church. Since the pipeline will be installed across the highway from the cemetery, accidental discovery is unlikely. If archaeological materials are encountered, ASB must be notified and any ASB protocols related to accidental discovery of heritage resources must be followed. If human remains are accidentally discovered, protocols must be followed. Draft protocols are included in Appendix H.

Cemetery Monuments and Public Safety

The visual survey around St. Mary the Virgin Anglican Church identified the possibility, though remote, that stone monuments in the cemetery may present a risk to public safety because of their condition, such as leaning (e.g. Photographs B4-B5, Appendix B). Exhaustive research was not done related to this potential but some preliminary comments are offered here for information purposes only.

Since the cemetery is open for public access, VONM may wish to consider follow-up with respect to the condition of headstones and/or other stone and metal monuments and objects in the cemetery. Such follow-up may include notifying the Anglican Diocese or local parish officials who may be responsible for the condition of the cemetery. Although unlikely, fatal accidents have occurred involving cemetery monuments falling on people. Local governments have been found responsible in some cases but not others (e.g., Press Association 2018, Tribune Wire Reports 2015). In particular, injury or death may be a possibility when leaning headstones are not remediated. In general, responsible authorities adopt a risk-based approach to cemetery monuments in the United Kingdom (e.g., Ministry of Justice 2009) and Canadian-centred information is available from insurers in Ontario (e.g., Ecclesiastical Insurance 2011) and other sources.

Closing

This report is subject to review and acceptance by ASB. Written notification about the acceptability of this report is issued at the discretion of ASB. Other agencies and stakeholders may review this report before it is deemed acceptable.

This report has been prepared as a requirement of AFRP No. 2018 NB 133 for the sole benefit of WSP and VONM and is not intended to be used by any other person or entity, other than for its intended purposes, without the written consent of Stratis, WSP, and VONM. Use of this report by third parties is the responsibility of such third party. This report is copyrighted by Stratis with all rights reserved.

The information and recommendations in this report are based upon work undertaken in accordance with ASB Guidelines and generally accepted practices at the time the work was undertaken. The information and recommendations in this report are in accordance with the author's understanding of the project as it was presented at the time the work was undertaken.

This report was reviewed and approved by WSP and VONM before submission to ASB. This report was authored by the undersigned.

[submitted hard copy to be signed]

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References

Ecclesiastical Insurance. 2011. Keeping Cemeteries Safe. Focus. 10 February 2011. Available online at: https://niagaraanglican.ca/resources/docs/cemeteries/Keeping%20Cemeteries%20Safe.pdf

Ministry of Justice. 2009. Managing the Safety of Burial Ground Memorials: Practical Advice for dealing with Unstable Memorials. Government of the United Kingdom. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/326725/safety-burial-grounds.pdf

NBDNRE (New Brunswick Department of Natural Resources and Energy). 2000. Bedrock Geology of New Brunswick. Minerals and Energy Division. Map Nr-1 (2000 Edition). Scale 1:500 000.

Petz, Sarah. 2017. Vacant New Maryland church 'an absolute stunner', says Fredericton architect. CBC News. Online article available at: https://www.cbc.ca/news/canada/new-brunswick/new-maryland-church-heritage-1.4430862, published 3 December 2017.

Press Association. 2018. Family of Glasgow boy crushed by gravestone win compensation. The Guardian. 18 June 2018. Available online at: https://www.theguardian.com/uk-news/2018/jun/18/family-glasgow-boy-ciaran-williamson-crushed-gravestone-compensation

Rampton, V. N. 1984. Generalized surficial geology map of New Brunswick. Department of Natural Resources and Energy. Minerals, Policy and Planning Division, NR-8 (scale 1:500 000).

Tribune Wire Reports. 2015. Utah cemetery not negligent in death of boy crushed by headstone. Chicago Tribune. 30 October 2015. Available online at: https://www.chicagotribune.com/news/nationworld/ct-boy-crushed-by-headstone-20151030-story.html

Welch, Deborah, and Michael Payne. 2012. New Maryland in The Canadian Encyclopedia. Available online at: https://www.thecanadianencyclopedia.ca/en/article/new-maryland

Appendix A

Archival Photographs and Photo Overlays

Historical Aerial Photograph (KA33/28), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A1 Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (KA33/53), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A2
	Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (KA33/54), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A3 Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (KA33/55), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A4 Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (KA33/66), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A5 Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (KA33/86), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A6 Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (KA33/100), dating to 16 July 1925.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A7 Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

Historical Aerial Photograph (A8237/100), dating to 4 July 1945.	
Village of New Maryland Arsam Property Wellfield Development	Item No: A8
	Refer to meta data in Appendix F for photo location and other details.
Client: WSP Canada	Source: NAPL

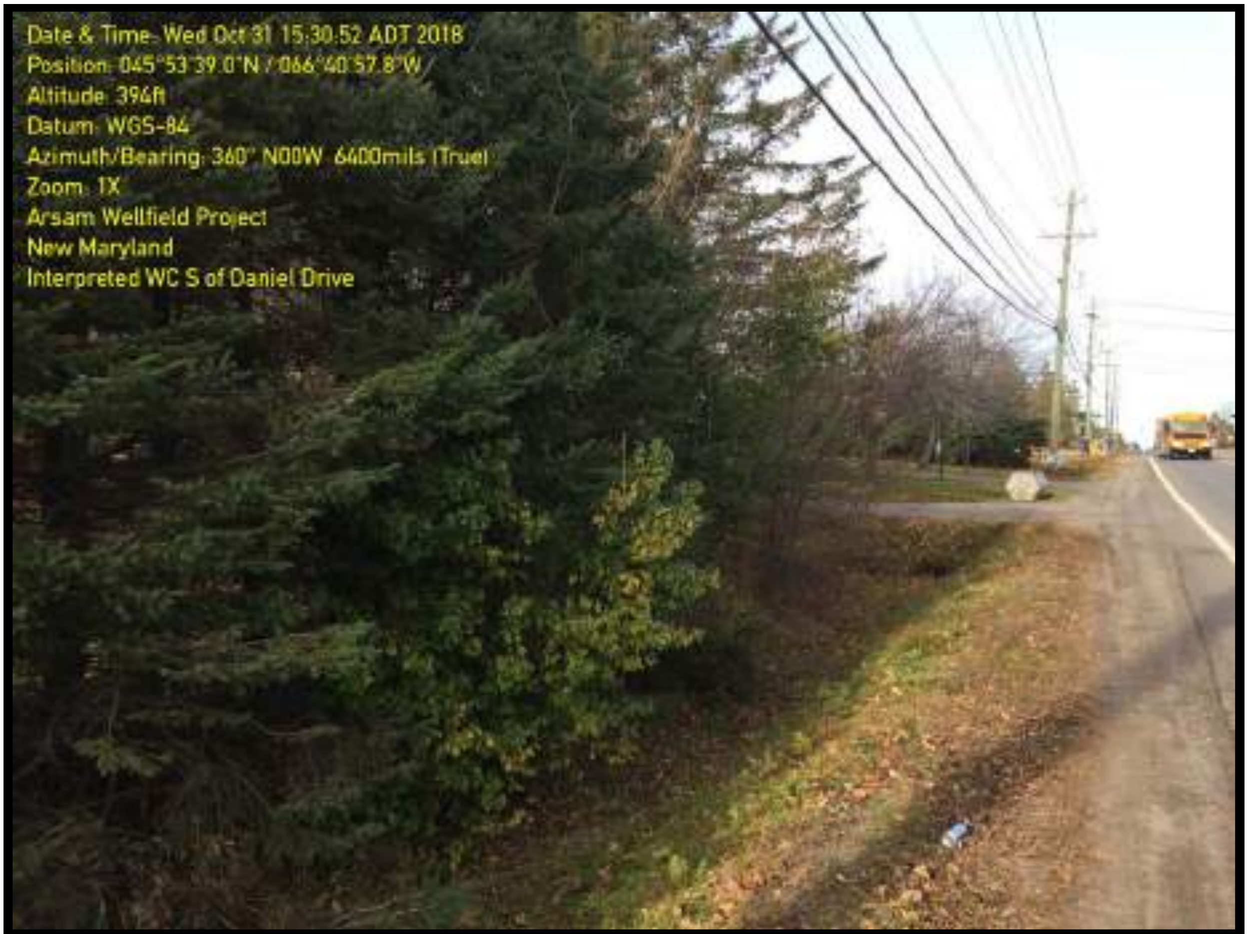
Overlay of Project-Related Infrastructure on Historical Aerial Photograph (A8237/100), dating to 4 July 1945.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A9
Client: WSP Canada	Source: NAPL, Google Earth Pro, Stratis

Overlay of Archaeological Potential Model on contemporary Google Earth Pro imagery. Transmission pipeline route is along existing road near unnamed tributary to Burpee Brook.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Item No: A10
Client: WSP Canada	Source: ASB, Google Earth Pro, Stratis

Appendix B

Field Photographs

Daniel Drive Connection area	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B1
Client: WSP Canada	Source: Stratis



Model interpreted watercourse area south of Daniel Drive	
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B2
Client: WSP Canada	Source: Stratis

St. Mary the Virgin Anglican Church and Cemetery from area west of New Maryland Highway.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B3
Client: WSP Canada	Source: Stratis

Example of leaning stone monuments in St. Mary the Virgin Cemetery.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B4
Client: WSP Canada	Source: Stratis

Example of fallen stone monument in St. Mary the Virgin Cemetery.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B5
Client: WSP Canada	Source: Stratis

Sandcherry connection area, facing towards New Maryland Highway.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B6
Client: WSP Canada	Source: Stratis

Sandcherry connection area, facing towards New Maryland Highway	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B7
Client: WSP Canada	Source: Stratis

Existing storm water attenuation feature near Sandcherry connection.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B8
Client: WSP Canada	Source: Stratis

Modified watercourse along Lark Street Spur area.	
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B9
Client: WSP Canada	Source: Stratis

Transmission pipeline area near intersection with New Maryland Highway.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B10
Client: WSP Canada	Source: Stratis

Water Treatment area.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B11
Client: WSP Canada	Source: Stratis

Small unnamed watercourse along Transmission Pipeline, south of Water Treatment area.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B12
Client: WSP Canada	Source: Stratis

Gravel road running through southern part of Transmission Pipeline area.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B13
Client: WSP Canada	Source: Stratis

Existing ground disturbance and push-ups near existing wells.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B14
Client: WSP Canada	Source: Stratis

Soil push-up disturbance along existing road in Transmission Pipeline RoW.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B15
Client: WSP Canada	Source: Stratis

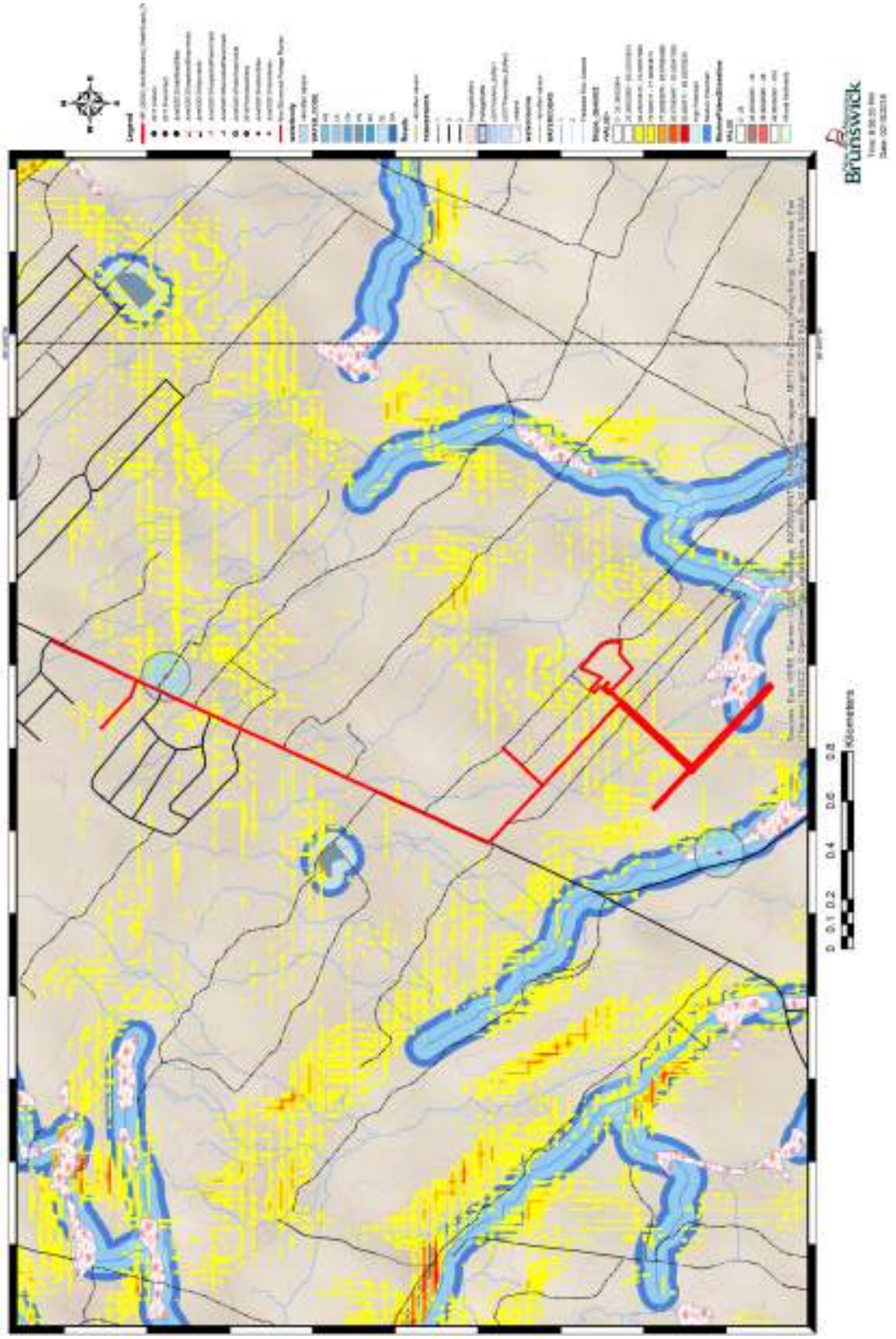
Existing sanitary easement along Distribution Pipeline RoW.	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B16
Client: WSP Canada	Source: Stratis

Potential Model inferred water course area near civic number 469, New Maryland Highway	
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B17
Client: WSP Canada	Source: Stratis

Potential Model inferred water course area near St. Mary the Virgin Church	Stratis
Village of New Maryland Arsam Property Wellfield Development	Photo No.: B18
Client: WSP Canada	Source: Stratis

Appendix C

Potential Model, Courtesy of ASB


Legend
0 0.1 0.2 0.4 0.6 0.8 Kilometers
Brunswick

Appendix D

Archaeological Field Research Permit

New Nouveau Brunswick

The Province of New Brunswick
Archaeological Field Research Permit

Under the provisions of Sections 13 and 14 of the *Heritage Conservation Act*,
a permit is hereby granted to:

Province du Nouveau-Brunswick
Permis de travaux archéologiques sur le terrain

En vertu des l'articles 13 et 14 de la *Loi sur la conservation du patrimoine*,
un permis est octroyé à:

Grant Aylesworth

to undertake the following archaeological field research project entitled:

pour entreprendre le projet de recherches archéologiques mentionné ci-après et intitulé :

Village of New Maryland Arsam Property Wellfield Development

in the county(ies) of:

dans le (s) comté (s) de :

York

under the following conditions:

1. The Permit shall be issued on the understanding the investigations are to be conducted for the sole purpose of recovering information and materials for scientific and historical study, and for the preservation of New Brunswick's historic resources; and that the research shall conform to the best scientific standards available.
2. The archaeological field research being carried out under this Permit may be inspected at any reasonable times; and this Permit may be revoked at any time by the Minister.
3. The holder of this Permit will report to Archaeological Services Section, Heritage Branch, any archaeological site found during the archaeological field research being carried out under this Permit within two (2) working days of the find.
4. This Permit shall be valid until December 31, 2018
5. A final technical report will be due March 31, 2019
6. The holder of this Permit must provide copies to Archaeological Services Section, Heritage Branch, of all field records, notes, maps, drawings, catalogues, and photographs pertaining to the description and context of all objects recovered under this Permit.
7. All cultural material recovered under this Permit must be deposited with Archaeological Services Section, Heritage Branch, upon termination of the Permit.

aux conditions suivantes :

1. Le permis est émis à condition que les recherches soient effectuées dans le seul but d'obtenir des renseignements et du matériel pour des études scientifiques et historiques et de préserver les ressources historiques du Nouveau-Brunswick; la recherche se conformera aux normes scientifiques les plus rigoureuses parmi celles disponibles.
2. Les recherches archéologiques menées dans le cadre de ce permis peuvent faire l'objet d'une inspection à n'importe quelle heure raisonnable, et le ministre peut révoquer le permis en tout temps.
3. Le détenteur du permis signalera à la Section des services d'archéologie de la Direction du patrimoine tout site archéologique trouvé au cours des recherches archéologiques réalisées dans le cadre du permis et ce, dans un délai de deux jours de travail après la découverte.
4. Le permis sera valide jusqu'au 31 décembre 2018
5. Un rapport technique final sera rédigé pour le 31 mars 2019
6. Le détenteur du permis fournira à la Section des services d'archéologie, Direction du patrimoine, une copie de tous les documents, dessins et catalogues ainsi que de toutes les notes, cartes et photographies servant à la description et à l'établissement du contexte pour les objets trouvés dans le cadre du permis.
7. Tout article culturel découvert dans le cadre du permis doit être confié à la Section des services d'archéologie de la Direction du patrimoine à l'expiration du permis.

APPROVED: / APPROUVÉ :

Brent Suttie

Brent Suttie,
Director / Directeur
Archaeological Services Branch /Lieux Service d'archéologie
Department of Tourism, Heritage and Culture/ Ministère du Tourisme, du Patrimoine et de la Culture
(A person duly designated by the Minister of Tourism, Heritage and Culture pursuant to Sec. 100 of the Heritage Conservation Act to sign this permit on his behalf)
(Une personne dûment désignée par le Ministre du Tourisme, du Patrimoine et de la Culture en vertu de l'article 100 de la Loi sur la conservation du patrimoine pour signer ce permit à sa place)

October 24, 2018
Date granted / Date d'octroi

PERMIT NO. / N° DU PERMIS : 2018 NB 133 (Impact Study / Étude d'impact)

Appendix E

Field Notes

Digitized field notes are provided to ASB with two hard copies.

Appendix F

NAPL Metadata

Government of Canada Gouvernement du Canada

Canada

National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

Dataset Attribute	Attribute Value
Photo Number	66
Acquisition (UTC)	1925-07-16
Scale	5000
Altitude	5000 (ft)
Original Negative Available (photo)	Yes
Negative size (WxH)	7 x 9
Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

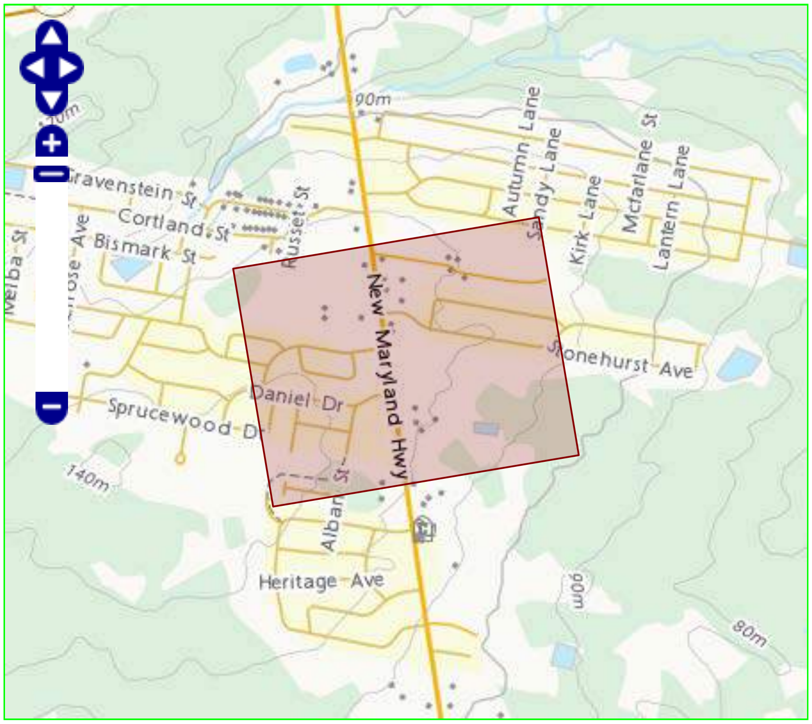
Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.90
South	45.89
East	-66.67
West	-66.69

Location



Government of Canada Gouvernement du Canada

Canada

National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

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Photo Number	54
Acquisition (UTC)	1925-07-16
Scale	5000
Altitude	5000 (ft)
Original Negative Available (photo)	Yes
Negative size (WxH)	7 x 9
Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

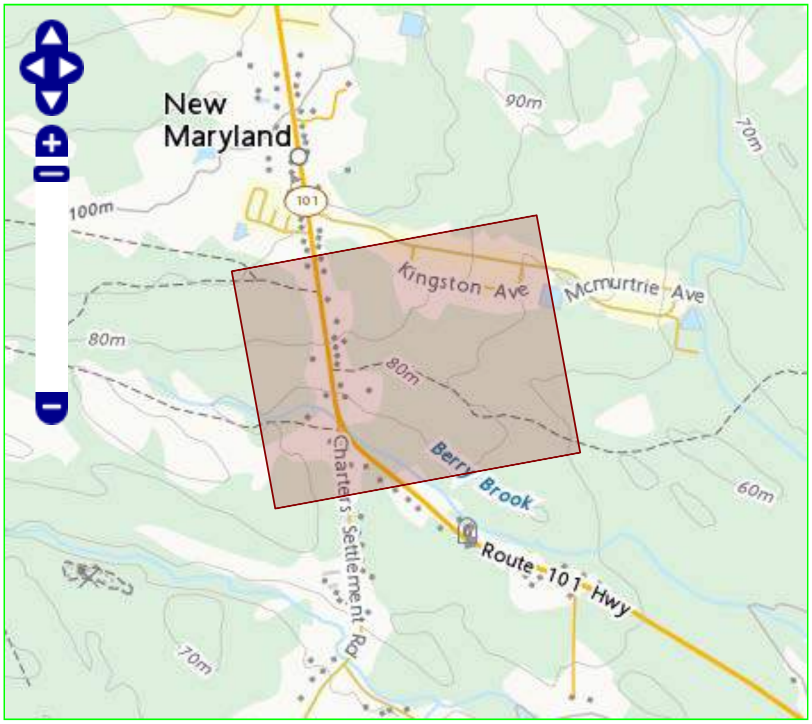
Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.88
South	45.87
East	-66.68
West	-66.70

Location



National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

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Acquisition (UTC)	1925-07-16
Scale	5000
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Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.89
South	45.87
East	-66.68
West	-66.70

Location

National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

Dataset Attribute	Attribute Value
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Scale	5000
Altitude	5000 (ft)
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Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

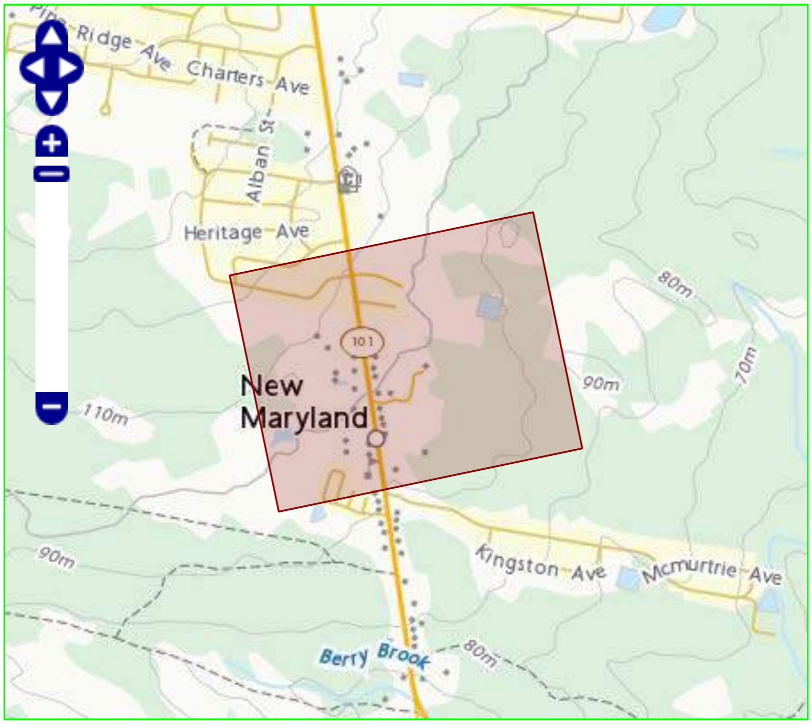
Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.89
South	45.88
East	-66.68
West	-66.70

Location


National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

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Scale	5000
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Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.90
South	45.88
East	-66.67
West	-66.69

Location

Government of Canada Gouvernement du Canada

Canada

National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

Dataset Attribute	Attribute Value
Photo Number	28
Acquisition (UTC)	1925-07-16
Scale	5000
Altitude	5000 (ft)
Original Negative Available (photo)	Yes
Negative size (WxH)	7 x 9
Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

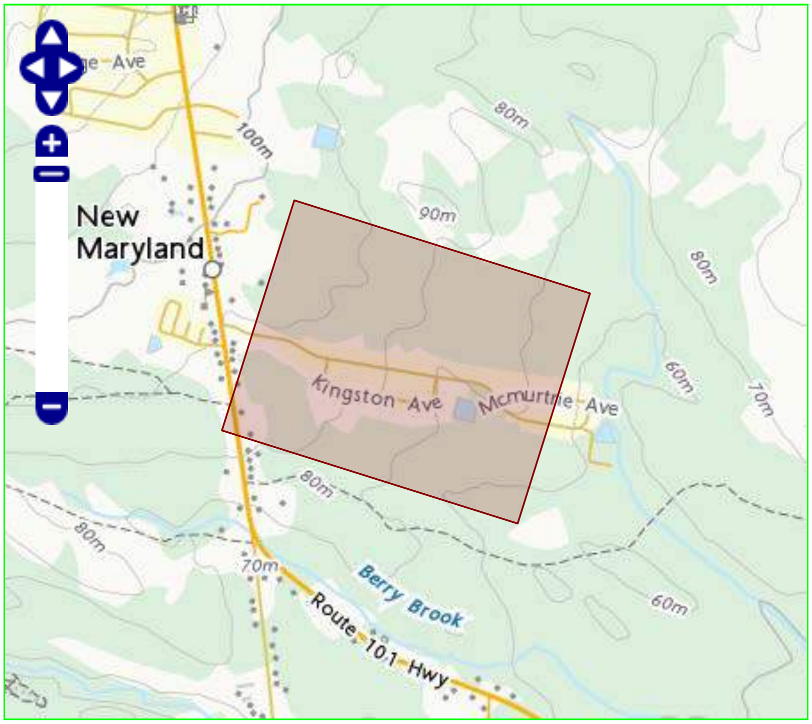
Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.88
South	45.87
East	-66.68
West	-66.69

Location



National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

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Altitude	5000 (ft)
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Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	
Frame Start	1
Frame End	103

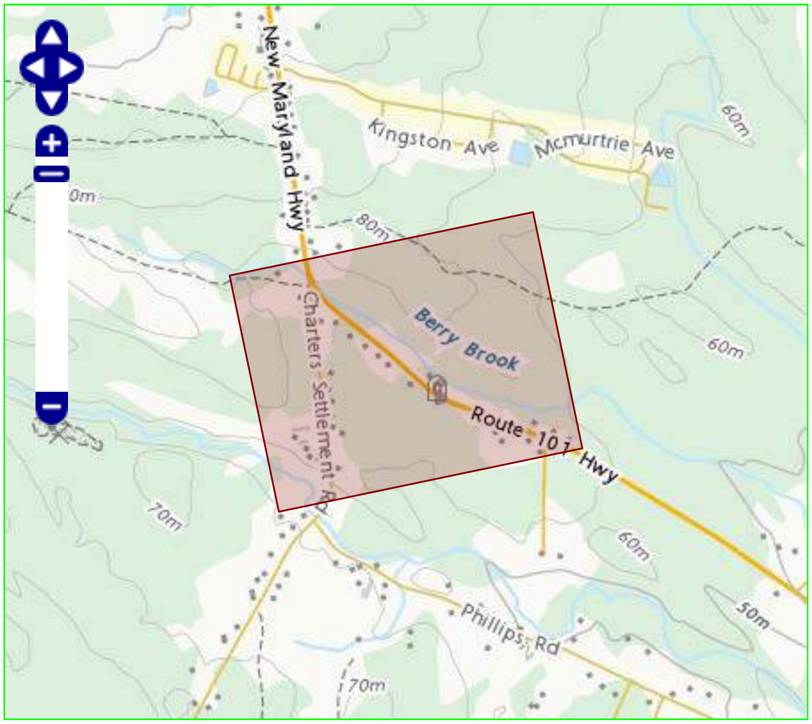
Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	KA33
Viewing Angle	Vertical
Spectral Range	Black&White
Area	FREDERICTON
Roll Date	1925-07-16
Camera Name/Number	K3-5
Lens Name/Number	K3-5-12
Focal length (mm)	304.8
Camera Filter	
Film Type	DUP NEGS
ASL	Yes
Total Frames	103

Geographic extent	Value

Geographic extent	Value
North	45.88
South	45.87
East	-66.68
West	-66.70

Location



National Earth Observation Data Framework Catalogue

Metadata summary and geographic extent

Photo Metadata

Dataset Attribute	Attribute Value
Photo Number	11
Acquisition (UTC)	1945-07-04
Scale	20000
Altitude	12000 (ft)
Original Negative Available (photo)	No
Negative size (WxH)	9 x 9
Overlap	60
NTS Map	021G15
Season	Summer

Flight Line Metadata

Dataset Attribute	Attribute Value
Line Number	102W
Frame Start	1
Frame End	92

Roll Metadata

Dataset Attribute	Attribute Value
Roll Number	A8237
Viewing Angle	Vertical
Spectral Range	Black&White
Area	
Roll Date	1945-07-04
Camera Name/Number	F3-5
Lens Name/Number	NOT SPECIFIED
Focal length (mm)	209.55
Camera Filter	
Film Type	SUPER XX PAN
ASL	Yes
Total Frames	92

Geographic extent	Value

Geographic extent	Value
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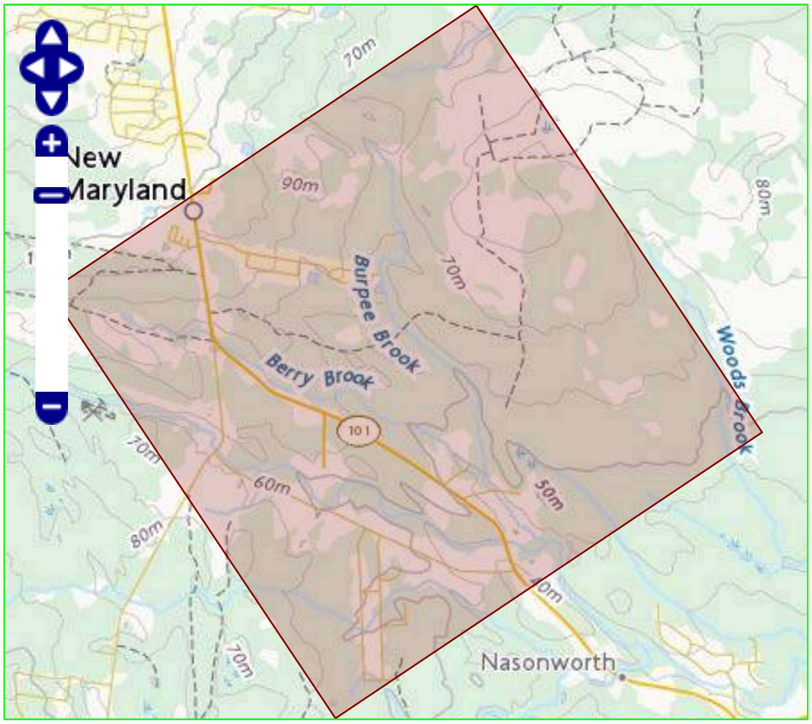
South	45.85
East	-66.65
West	-66.71

Location



Appendix G

Project-Related Infrastructure Locations

Courtesy of WSP

wsp

Fredericton Office
+1 506 451 0055

80 Bishop Drive
Fredericton NB E3C 1B2
Canada

Designed	Approved	Approved Date

Drawn	Scales
	1:10000

Project

VILLAGE OF NEW MARYLAND
WATER SUPPLY EXPLORATION
PROJECT OVERVIEW

Sheet

PRELIMINARY CONCEPT

Project No.	Sheet. No.	Revision
C-84510.70	001	0

Original Sheet Size ANSI B [11"x17"]   Plot Date 2018-09-10 at 4:56:17 PM   Path G:\JOBFILES\800\845_NewMaryland\C-84510.70 - Arsam Property - EIA For Wellfield Development (2018)\04_Project Working Files\CADD\C-84510.70 building footprint.dwg 11 x 17 for VONM update

Project
VILLAGE OF NEW MARYLAND
WATER SUPPLY EXPLORATION
PROPOSED ROW

wsp
Fredericton Office
+1 506 451 0055

80 Bishop Drive
Fredericton NB E3C 1B2
Canada

Sheet
PRELIMINARY CONCEPT
Archaeological Impact Assessment

Designed	Approved	Approved Date

Drawn	Scales	Project No.	Sheet. No.	Revision
	1:4000	C-84510.70	001	0

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Appendix H

Accidental Discovery Protocols

PROTOCOL FOR ACCIDENTAL DISCOVERY OF ARCHAEOLOGICAL RESOURCES[2]

DOES NOT INCLUDE HUMAN REMAINS

Arsam Wellfield Development

No person, other than one authorized by the Minister responsible for the Department of Tourism, Heritage and Culture, may move, destroy, damage, deface, obliterate, alter, add to, mark or in any other way interfere with an archaeological resource.

Applicable Legislation:

New Brunswick *Heritage Conservation Act*

Agencies Involved:

Archaeological Services Branch (ASB), Department of Tourism, Heritage and Culture

Protocol for Accidental Discovery of Heritage Resources (*e.g.,* artifacts or features)

Identify

All construction personnel are responsible for reporting any unusual materials unearthed during construction activities to the Construction Supervisor.

Stop Work

In those situations where the find is believed to be an archaeological resource (including artifacts or features), the Construction Supervisor will immediately stop work in the vicinity of the find and notify their immediate supervisor. As per the *Heritage Conservation Act*, the find must be reported to ASB who can be reached at (506) 453-3014. This notification can be done directly by VONM or through any consulting archaeologist. Dr. Grant Aylesworth completed the Heritage Resource Impact Assessment prior to the construction and can be reached at (506) 999-0151 or grant.aylesworth@stratis.consulting

Investigate

ASB will respond to the find and investigate. If ASB is unable to respond, a consulting archaeologist holding a permit from the Government of New Brunswick will investigate the find and, if it is determined to be an archaeological artifact or feature, must consult

---

[2] Sourced and lightly edited from: Guidelines and Procedures for Conducting Professional Archaeological Assessments in New Brunswick. Archaeological Services, Heritage Branch, Department of Culture, Tourism and Healthy Living, Fredericton. May 31, 2012.

with ASB. If ASB has been contacted directly and responds to the find, this consultation is not required.

Mitigate

An appropriate mitigation strategy with respect to the accidental discovery must be developed and implemented in consultation with ASB. If the find is Indigenous in nature, input may be sought from Indigenous representatives, typically from the closest First Nation community.

Resuming Work:

Work can only resume in the vicinity of the find when authorized by the Environmental Manager and/or the Construction Manager once clearance has been received from ASB (Government of New Brunswick).

PROTOCOL FOR ACCIDENTAL DISCOVERY OF HUMAN REMAINS[3]

Arsam Wellfield Development

Human remains will likely fall into the following four categories:

1. **Legal evidence**. All human remains that are discovered must be initially treated as potential forensic evidence.
2. **Cemeteries registered under the New Brunswick Cemetery Companies Act**
3. **Historic Cemeteries and Family plots**. These include human remains buried in currently neglected and overgrown cemeteries and family plots. Living relatives or descendants may exist.
4. **Archaeological remains**. Archaeological human remains include Pre-European Contact human remains and Historic period remains that were interred as a result of religious/social burial practices. Pre-Contact human remains may occur as a single burial or as multiple burials such as unrecorded Indigenous burial sites. Historic period archaeological human remains typically occur in historic cemeteries and long forgotten (pre-twentieth century) family plots.

Applicable Legislation:

Section 182(b) of the Criminal Code of Canada states: “Every one who improperly or indecently interferes with or offers any indignity to a dead human body or human remains, whether buried or not, is guilty of an indictable offence and liable to imprisonment for a term not exceeding five years.”

Section 11 of the New Brunswick *Heritage Conservation Act* prohibits the alteration of any burial ground without an Archaeological Site Alteration Permit.

Agencies Involved:

Depending on the circumstances surrounding the discovery of human remains, several agencies may be involved and include:

- **Lead police agency** (RCMP). The lead police agency will decide what course of action to initiate.

- **Regional Coroner’s Office**. The Coroner’s Office may become involved in criminal investigations and in determining the cause of death.

- **Chief Medical Officer’s Office**. The interest of the Chief Medical Officer relates to health issues.

- **Archaeological Services Branch**, Department of Tourism, Heritage and Culture.

---

[3] Sourced and lightly edited from: Guidelines and Procedures for Conducting Professional Archaeological Assessments in New Brunswick. Archaeological Services, Heritage Branch, Department of Culture, Tourism and Healthy Living, Fredericton. May 31, 2012.

If it is determined that the human remains are not associated with a forensic matter or recent mishap, Archaeological Services Branch (ASB) will be consulted to determine the proper course of action. Pre- Contact burials are an extremely sensitive issue and will require the involvement of Indigenous representatives, typically from the closest First Nations community.

Protocol for accidental discovery of human remains

- Halt all Activities

  Halt all activities in the vicinity (minimum 10 metre x 10 metre area) of the human remains at once. Until determined otherwise, the remains must be treated as evidence in a forensic investigation. If the remains are found in the bucket of heavy equipment, the bucket must not be emptied as physical evidence may be destroyed. When remains are found, the potential for additional burials or human remains must be acknowledged and future project activities must reflect this elevated potential.

- Secure the Area

  The area must immediately be designated as “Out of Bounds” to all personnel and the public. Depending on the weather and other conditions, the human remains discovered must be provided with non-intrusive protection, such as covering with a cloth or canvas tarp (non-plastic preferred). All personnel and traffic must exit the site by one common non-intrusive path. Curiosity seekers must be kept off the site.

- Inform the Lead Police Agency (RCMP)

  The nearest detachment of the lead police agency must be informed immediately – this is not an emergency call and do not use 911. For reasons of site security and sensitivity, it is recommended not to use a cell phone but cell phone use may be necessary. Upon verbal description of the situation, the lead police agency may dispense with a site visit to view the site/remains. The lead police agency will make a decision as to whether the Coroner and/or Archaeological Services Branch must be involved.

  RCMP
  584 New Maryland Highway
  New Maryland NB E3C 1K11

  Telephone: (506) 357-4300

  The lead police agency specialists may be called to determine if the situation is associated with a crime or an archaeological feature. If it is concluded to be related to a crime, the lead police agency specialist will follow their own protocols and procedures, such as informing the Coroner, collecting data, and removing the remains.

  If the lead police agency determines the situation not to be associated with a criminal matter, then Archaeological Services Branch will be consulted at (506) 453-3014 to determine the proper course of action in consultation with stakeholders.

If Archaeological Services Branch determines that the human remains are not associated with an archaeological feature but still have to be removed, certificates of removal are required from both the Coroner's Office and the Chief Medical Officer of New Brunswick.

Resuming Work:

Work can only resume in the vicinity of the discovery once clearance has been received from all of the authorities and agencies concerned.

Stratis Consulting Inc.
527 Dundonald Street, Suite 115
Fredericton, NB E3B 1X5
Web: stratis.consulting

Stratis

APPENDIX

C-4 *WSSA INITIAL APPLICATION*

Water Supply Source Assessment

Step One Application

1) ***Name of proponent:***

Village of New Maryland

Contact Information:

Cynthia Geldart - Chief Administrative Officer

Email: Cynthia.Geldart@vonm.ca

Phone: 506-451-8508

Fax: 506-450-1605

2) ***The location of drill targets (including property PID) and purpose of the proposed water supply:***

In 2005 four (4) test water wells were drilled on PID 75062174 by the property Owner, ARSAM Ltd. The company's original intent was to develop the land for mixed-use residential purposes. However, these plans did not materialize or come to fruition and the property has been on the real estate market for sale for a number of years. PID 75062174 is currently owned by Khaled Jameel Moomena, who was one of the original investors and/or principals of ARSAM Ltd.

The test wells were drilled under the direction and supervision of GEMTEC Limited, who prepared and issued a letter report summarizing their findings on July 14, 2005, a copy of GEMTEC's report is attached.

The Village of New Maryland plans to complete an investigation of these existing wells and wellfield in two (2) phases:

Phase 1 – Extend the total depth of TW05-2 to 165 metres from the present depth of 97.5 metres in an attempt to penetrate and enter The Boss Point Formation which is recognized as hosting substantial aquifers where bedrock structures are present. Complete subsequent step testing and a 72-hour constant rate pumping test at TW05-2 to establish an appropriate pumping rate. Water levels in test holes TW05-1, TW05-3, TW05-4 and yet to be determine locations in Sunrise Estates and on Route 101 (south of TW05-2) will be monitored during testing to determine distance-drawdown impacts. Consideration will be given to the eventual pumping rate to reduce possible interference with existing wells.

Phase 2 – Depending on the results of a detailed assessment of the geophysical data from Phase 1, additional test holes may possibly be drilled within identified bedrock structural zones. Prior to drilling any new or additional test wells the Technical Review Committee would be consulted and apprised accordingly.

Well ID	Location	PID	Purpose
TW05-1	Close to South Property Line & Village Boundary	75062174	Observation Well (Existing)
TW05-2	Close to South Property Line & Village Boundary	75062174	Existing Test Well To Be Deepened
TW05-3	Close to South Property Line & Village Boundary	75062174	Observation Well (Existing)
TW05-4	Close to South Property Line & Village Boundary	75062174	Observation Well (Existing)
Residential Well #1	Sunrise Estates, Yet to be determined		Monitoring Well
Residential Well #2	Route 101, South of TW05-2, Yet to be determined		Monitoring Well

3) ***Required Water Quantity (in m^3/day):***

Estimated 500 - 1000 m^3/day

4) ***List alternate water supply sources in area (including municipal systems):***

Within 500 metres of TW05-2 there are approximately 10 private domestic wells, and all are located near the extremity of the 500 metre radius from TW05-2. There are no municipal water systems located within 500 metres of TW05-2.

5) ***Discuss area hydrogeology as it relates to the project requirements:***

See attached Well Driller's Reports for TW05-1, TW05-2, TW05-3 and TW05-4. Water quality analytical results are also attached for all wells, except TW05-3. Given the very close proximity of test wells TW05-2 and TW05-3, water chemistry should be the same.

6) ***Outline the proposed hydrogeological testing work schedule:***

Phase 1:

a. February 2017: Deepen test well TW05-2, perform hydraulic step testing and subsequent 72-hr constant rate pumping test.
b. March/April 2017: Assessment of drilling and hydrogeological properties of test wells (including anticipated water quality and quantity).
c. May - July 2017: Confirm well field characteristics, perform additional pump tests if required and confirm water quality and quantity.
d. October – December 2017: Prepare EIA submission.
e. January – June 2018: Detailed design of water supply and, if required, treatment system.

Phase 2: If Required or Deemed Necessary

f. June 2017: Drill additional exploratory test wells, number and location yet to be determined

g. July 2017: Assessment of drilling and hydrogeological properties of the test wells (including anticipated water quality and quantity)

h. August/September 2017: Pump test wells and confirm water quality and quantity

i. October – December 2017: Prepare EIA submission

j. January – June 2018: Detailed design of water supply and, if required, treatment system

7) Identify any existing pollution or contamination hazards within a minimum radius of 500m from the proposed drill targets. Historical land use that might pose a contamination hazard (i.e. tannery, industrial, waste disposal, etc.) should also be discussed:

Within 500 metres of TW05-2 there are approximately 4 private residential septic tanks, all are located on Route 101 near the extremity of the 500 metre radius south of TW05-2.

Approximately 400 metres to the north of TW05-2 there is a trunk sanitary sewer main which flows west to east and is located approximately 50 metres south of Sunrise Estates' southerly boundary on PID 75064840. This is a relatively new sanitary sewer main which is operated and maintained by the Village of New Maryland.

There are no other known existing pollution or contamination hazards within the 500m radius.

8) Identify any groundwater use problems (quantity or quality) that have occurred in the area:

None identified.

9) Identify any water course(s) (stream, brook, river, wetland, etc.) within 60m of proposed drill targets:

There are no streams, brooks or rivers within 60m of TW05-1, TW05-2, TW05-3 or TW05-4. There is however a poorly defined unnamed drainage course some 100 metres or so to the south east of test wells TW05-2 and TW05-3 which is a tributary to Barry Brook.

Approximately 50 metres due north of TW05-4 there is a wetland area.

10) Identify site supervisory personnel involved in the source development (municipal officials, consultants and drillers):

Representatives from Opus International, Village of New Maryland and BGC Engineering have been and will be involved with this project.

11) Attach a 1:10,000 map and/or recent air photo clearly identifying the proposed location of drill targets and property PID, the domestic or production wells with a 500m radius from the drill target(s), and any potential hazards identified in question 7:

See attached 1:10,000 map “Location Plan – Existing Test Wells”. There are no existing Village municipal production wells within 500m of any of the existing test wells drilled by ARSAM Ltd. It is assumed every residence/dwelling within the 500m radius has its own private domestic well, residences in Sunrise Estates are connected to the Village’s sanitary sewer system, residences on Route 101 are assumed to have their own septic tank/disposal fields.

12) Attach a land use/zoning map of the area (if any). Superimpose drill targets on this map:

The location of existing test wells TW05-1, TW05-2, TW05-3 and TW05-4 are shown on the attached Village Zoning Map. Test wells TW05-1, TW05-2 and TW05-3 are located in Residential Zone 2 (R-2) and test well TW05-4 is located on land Zoned Rural.

13) Contingency plan for open loop energy systems:

Not applicable (no open loop energy system to be developed as part of this work).

Water Supply Source Assessment

Step One Application #2 for PID 75062174

1) ***Name of proponent:***

Village of New Maryland

Contact Information:

Cynthia Geldart - Chief Administrative Officer

Email: Cynthia.Geldart@vonm.ca

Phone: 506-451-8508

Fax: 506-450-1605

2) ***The location of drill targets (including property PID) and purpose of the proposed water supply:***

In 2005 four (4) test water wells were drilled on PID 75062174 by the property Owner, ARSAM Ltd. The company's original intent was to develop the land for mixed-use residential purposes. However, these plans did not materialize or come to fruition and the property has been on the real estate market for sale for a number of years. PID 75062174 is currently owned by Khaled Jameel Moomena, who was one of the original investors and/or principals of ARSAM Ltd.

The test wells were drilled under the direction and supervision of GEMTEC Limited, who prepared and issued a letter report summarizing their findings on July 14, 2005, a copy of GEMTEC's report is attached.

The Village of New Maryland just recently completed investigation work on Well TW05-02. A summary of the tasks performed and results obtained are outlined and detailed in the attached document titled "Groundwater Supply – Drilling and Test Pumping of Well TW-02, New Maryland", which was prepared by BGC Engineering Inc.

As Phase 2, the Village would now like to turn its attention to Well TW05-04 and complete a very similar investigation program to what was recently performed on Well TW05-02. Task to be undertaken include: extension of the total depth of TW05-4 to 150 metres from the present depth of 103.6 metres in an attempt to penetrate and enter The Boss Point Formation which is recognized as hosting substantial aquifers where bedrock structures are present. Complete subsequent step testing and a 72-hour constant rate pumping test at TW05-4 to establish an appropriate pumping rate. Water levels in test holes TW05-1, TW05-3, the Village's wastewater pumping station in Sunrise Estates and at the existing unnamed artesian well on Route 101 (south east of TW05-4) will be monitored during testing to determine distance-drawdown impacts. Consideration will be given to the eventual pumping rate to reduce possible interference with existing wells.

Phase 3 – Depending on the results of a detailed assessment of the geophysical data from Phase 1 and 2, additional test holes may possibly be drilled within identified bedrock structural zones. Prior to drilling any new or additional test wells the Technical Review Committee would be consulted and apprised accordingly.

Well ID	Location	PID	Purpose
TW05-1	Close to South Property Line & Village Boundary	75062174	Observation Well (Existing)
TW05-2	Close to South Property Line & Village Boundary	75062174	Could Be Used For Observation If Needed
TW05-3	Close to South Property Line & Village Boundary	75062174	Observation Well (Existing)
TW05-4	Close to South Property Line & Village Boundary	75062174	Existing Test Well To Be Deepened
Village Owned Well	Sunrise Estates, Wastewater PS		Observation Well (Existing)
Existing Artesian Well	Close To Route 101, South East of TW05-4, (yet to be field located)	75061754	Monitoring Well

3) ***Required Water Quantity (in m^3/day):***

Estimated 500 - 1000 m^3/day

4) ***List alternate water supply sources in area (including municipal systems):***

Within 500 metres of TW05-4 there are approximately 10 private domestic wells, and all are located near the extremity of the 500 metre radius from TW05-4. There are no municipal water systems located within 500 metres of TW05-4.

5) ***Discuss area hydrogeology as it relates to the project requirements:***

See attached Capital Well Driller's Reports for TW05-1, TW05-3 and TW05-4. See attached Sullivan's Well Drilling Report for TW05-2. Water quality analytical results are also attached for all wells, except TW05-3. Given the very close proximity of test wells TW05-2 and TW05-3, water chemistry should be the same. See attached report titled "Groundwater Supply – Drilling and Test Pumping of Well TW-02, New Maryland", prepared by BGC Engineering Inc. for updated or recent water quality analytical results for Well TW05-2 and other pertinent hydrogeological information.

6) ***Outline the proposed hydrogeological testing work schedule:***

Phase 2:

a. July 2017: Deepen test well TW05-4, perform hydraulic step testing and subsequent 72-hr constant rate pumping test.

b. July/August 2017: Assessment of drilling and hydrogeological properties of test wells (including anticipated water quality and quantity).

c. August/September: Confirm well field characteristics, perform additional pump tests if required and confirm water quality and quantity.

d. October 2017 – January 2018: Prepare EIA submission.

e. February – July 2018: Detailed design of water supply and treatment system.

Phase 2: If Required or Deemed Necessary

f. September 2017: Drill additional exploratory test wells, number and location yet to be determined

g. September 2017: Assessment of drilling and hydrogeological properties of the test wells (including anticipated water quality and quantity)

h. October 2017: Pump test wells and confirm water quality and quantity

i. November 2017 – March 2018: Prepare EIA submission

j. April – September 2018: Detailed design of water supply and treatment system

7) Identify any existing pollution or contamination hazards within a minimum radius of 500m from the proposed drill targets. Historical land use that might pose a contamination hazard (i.e. tannery, industrial, waste disposal, etc.) should also be discussed:

Within 500 metres of TW05-4 there are approximately 4 private residential septic tanks, all are located on Route 101 near the extremity of the 500 metre radius south of TW05-4.

Approximately 400 metres to the north of TW05-4 there is a trunk sanitary sewer main which flows west to east and is located approximately 50 metres south of Sunrise Estates' southerly boundary on PID 75064840. This is a relatively new sanitary sewer main which is operated and maintained by the Village of New Maryland.

There are no other known existing pollution or contamination hazards within the 500m radius.

8) Identify any groundwater use problems (quantity or quality) that have occurred in the area:

None identified.

9) Identify any water course(s) (stream, brook, river, wetland, etc.) within 60m of proposed drill targets:

There are no streams, brooks or rivers within 60m of TW05-1, TW05-2, TW05-3 or TW05-4. There is however a poorly defined unnamed drainage course some 100 metres or so to the south of test well TW05-4 which is a tributary to Barry Brook.

Approximately 50 metres due north of TW05-4 there is a wetland area.

10) ***Identify site supervisory personnel involved in the source development (municipal officials, consultants and drillers):***

Representatives from Opus International, Village of New Maryland and BGC Engineering have been and will be involved with this project.

11) ***Attach a 1:10,000 map and/or recent air photo clearly identifying the proposed location of drill targets and property PID, the domestic or production wells with a 500m radius from the drill target(s), and any potential hazards identified in question 7:***

See attached 1:10,000 map “Location Plan – Existing Test Wells”. There are no existing Village municipal production wells within 500m of any of the existing test wells drilled by ARSAM Ltd. It is assumed every residence/dwelling within the 500m radius has its own private domestic well, residences in Sunrise Estates are connected to the Village’s sanitary sewer system, residences on Route 101 are assumed to have their own septic tank/disposal fields.

12) ***Attach a land use/zoning map of the area (if any). Superimpose drill targets on this map:***

The location of existing test wells TW05-1, TW05-2, TW05-3 and TW05-4 are shown on the attached Village Zoning Map. Test wells TW05-1, TW05-2 and TW05-3 are located in Residential Zone 2 (R-2) and test well TW05-4 is located on land Zoned Rural.

13) ***Contingency plan for open loop energy systems:***

Not applicable (no open loop energy system to be developed as part of this work).