NOVA SCOTIA DEPARTMENT OF MINES

GROUNDWATER SECTION

Preliminary Report

GROUNDWATER RESOURCES FOR IRRIGATION USE AT NICTAUX WEST, NOVA SCOTIA

by

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June 1, 1971

Halifax, Nova Scotia

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ABSTRACT

Three sources of groundwater are available to meet the irrigation water requirements at Nictaux West:

(1) A shallow well capable of yielding at least 250 igpm can be constructed in alluvial deposits of the Annapolis River, if the distribution problem can be solved;

(2) Large quantity of groundwater may be obtained from a series of well points constructed in the permeable outwash sand and gravel deposits, if there is a sufficient saturated thickness and lateral extent as well at Nictaux West; and

(3) A well capable of yielding at least 200 igpm may also be constructed in a bedrock sandstone aquifer at a depth of 300 to 400 feet. Because the sandstone is relatively soft and poorly sorted, squeezing of the formation and caving in the borehole may pose problems to such a deep well. Such a bedrock well would have to be screened and gravel packed to be used.

The groundwaters from both the outwash and the sandstone aquifers are of excellent chemical quality and are suitable for domestic as well as agricultural requirements. Since the utilization of the second source of groundwater is the most feasible practice and has important implications to the future development of groundwater resources for irrigation use in the valley, additional test drilling is recommended to delineate the full areal extent and saturated thickness of the important outwash aquifer in the Nictaux West area.

INTRODUCTION

The Problem

Most farmers in the Annapolis-Cornwallis valley currently obtain their irrigation water from rivers and irrigation ponds formed by damming streams or brooks. Additional water may be obtained from irrigation wells constructed into potential groundwater aquifers. Though the damming of small streams is a common practice, such irrigation ponds often have a sandy bottom and do not fill up rapidly and may dry up completely during the summer months when the regional water table is lowered.

The Groundwater Section of the Nova Scotia Department of Mines was asked to investigate the possibility of using groundwater as a resource during the summer months for 230 acres of cash crop land at Nictaux West, Annapolis County. The irrigation water requirement for the period between June 1 and August 31 was about 20 million gallons. Hence, a supply of 250 imperial gallons per minute would be more than enough to meet such a demand. This report presents the preliminary results of the groundwater resources for irrigation use in the Nictaux West area.

Location, Drainage and Climate

The farmland under consideration is a strip of land located in between Jones Brook and Longing Brook (Fig.1). The Jones Brook has an extremely low discharge of 0.168 cubic feet per second, based on the records at Paradise Brook, 7 miles southwest of Nictaux West (Dept. of Forestry and Rural Development, 1968). The Longing Brook, however, is dry during most of the summer months.

The annual precipitation amounts to 44.5 inches and the temperature averages 44.8°F. The monthly precipitation together with temperature from May to September

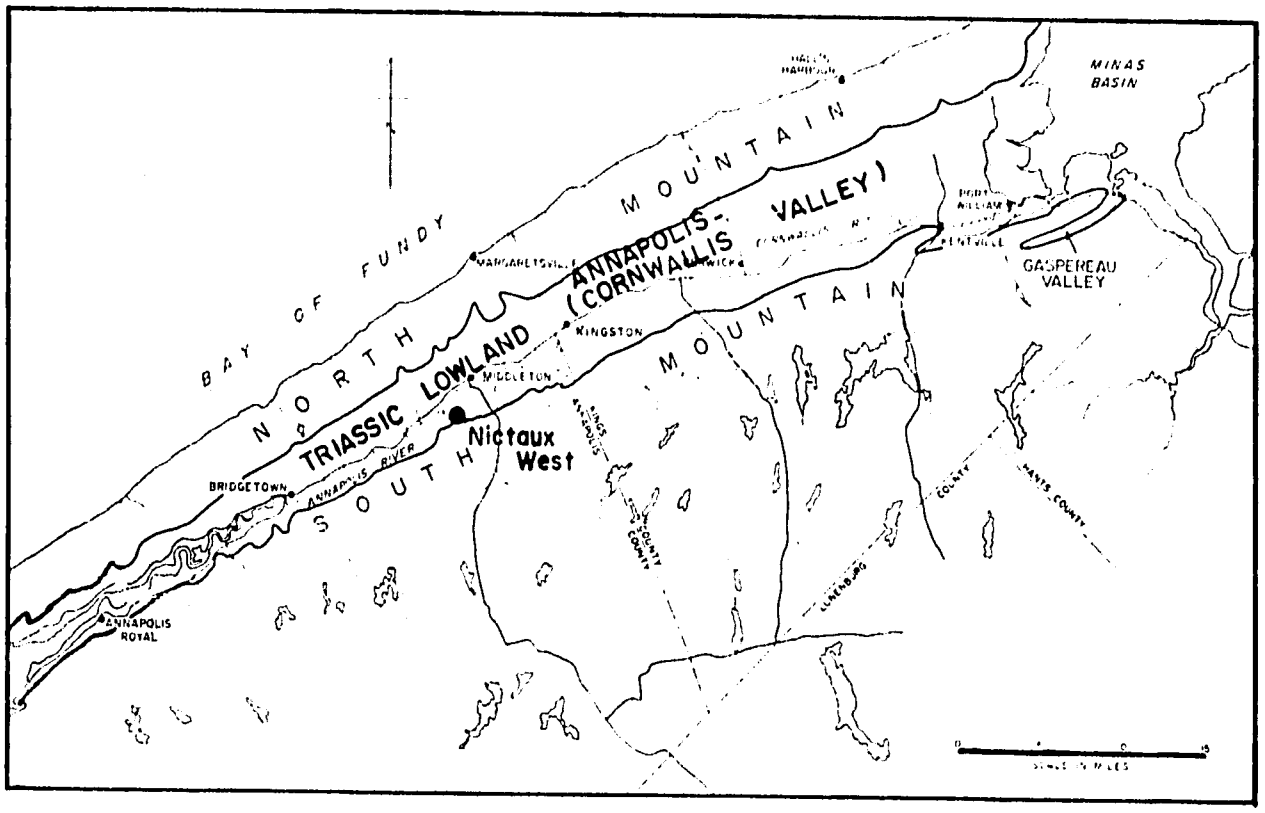

FIGURE 1. Physiography of Nictaux West.

is as follows:

	May	June	July	August	September
Precipitation (inches)* Middleton	3.17	3.19	2.82	3.21	3.87
Temperature (°F)* Greenwood A	52.0	60.8	67.4	65.9	58.3

* data from Trescott (1968, p. 54).

General Geology

Nictaux West is geologically located near the southern flank of the Triassic lowland of the Annapolis-Cornwallis valley (Fig. 1). The surficial unconsolidated deposits include estuarine silt and clay, glacial till, outwash sand and gravel, ice-contact sand and gravel, and sand and silty alluvium. The total thickness of the surficial deposits varies from 0 to 67 feet with 25 feet as an average thickness. The bedrocks of the valley floor are mainly soft claystones, siltstones, and sandstones of the Wolfville Formation. On the upland areas immediately south of Nictaux West, the bedrocks are dense granite, slate, and quartzite (Fig.2).

Acknowledgments

This report is based in part on the unpublished data collected by Dr. P. C. Trescott formerly of the Nova Scotia Department of Mines. Any errors in the interpretations presented are, however, soley those of the author.

HYDROGEOLOGY

Introduction

As part of general study of the Annapolis-Cornwallis valley, Trescott (1968) initiated the hydrogeological study of the Nictaux West area. Specifically, he conducted a pump test (TH #80) in wells drilled into alluvial deposits of the Annapolis River, located 1.5 miles north of Nictaux West and 0.5 mile southwest of Middleton. During the recent test drilling along the Longing Brook at Nictaux West, Nova Scotia Department of Mines carried out two additional pump tests, one from bedrock aquifer (TH #406) and the other from a stream alluvium (TH #416) in Mr. Morse's farm (Fig. 3). Table 1 summarizes the aquifer characteristics of the bedrock as well as the surficial aquifers. The lithologic logs are listed in Appendix A.

Surficial Aquifers

The surficial deposits of the area consist of three hydrostratigraphic units: (1) the impermeable estuarine silt and clay, and glacial till in the bottom, (2) the permeable outwash sand and gravel in the middle, and (3) the semi-permeable ice-contact poorly sorted sand and gravel, as well as interbedded silty alluvium on the top (Fig. 4). Because of the high silt or clay content, the estuarine, glacial till, and alluvial deposits are relatively impermeable, and seldom yield more than domestic water supply. Although the ice-contact deposits are relatively permeable, they are unsaturated during most of the summer months. This then leaves the outwash sand and gravel deposits in the middle as the only potential surficial aquifer of the area.

The sand and gravel aquifer at Middleton (TH #80) is 27 feet thick and consists mostly of sand semi-confined by about 10 feet of stream alluvium. The coefficients of transmissibility, T, are high, ranging from 1.0×10^4 to 7.2×10^4 igpd/ft and average

Table 1. Summary of the hydraulic properties of the aquifers near Nictaux West.

Type of Aquifer	Well Location	Coefficient of Transmissibility, igpd/ft (average)	Coefficient of Storage (average)	Depth, feet/ saturated thickness
Sand and gravel (outwash aquifer)	(a) Middleton TH #80	$1.0 \times 10^4 - 7.2 \times 10^4$ (5.0×10^4)	$1.3 \times 10^{-4} - 6.1 \times 10^{-3}$ (1.9×10^{-3})	75/27
	Nictaux West TH #416	(b) $1.0 \times 10^3 - 2.6 \times 10^4$ (1.0×10^4)	$1.2 \times 10^{-3} - 2.6 \times 10^{-3}$ (1.8×10^{-3})	30/14
		(c) 2.6×10^3	—	
Sandstone (bedrock aquifer)	Nictaux West TH #406	1.0×10^3	—	460/440

(a) data from Trescott (1968).
(b) from time-drawdown plot.
(c) from distance-drawdown plot.

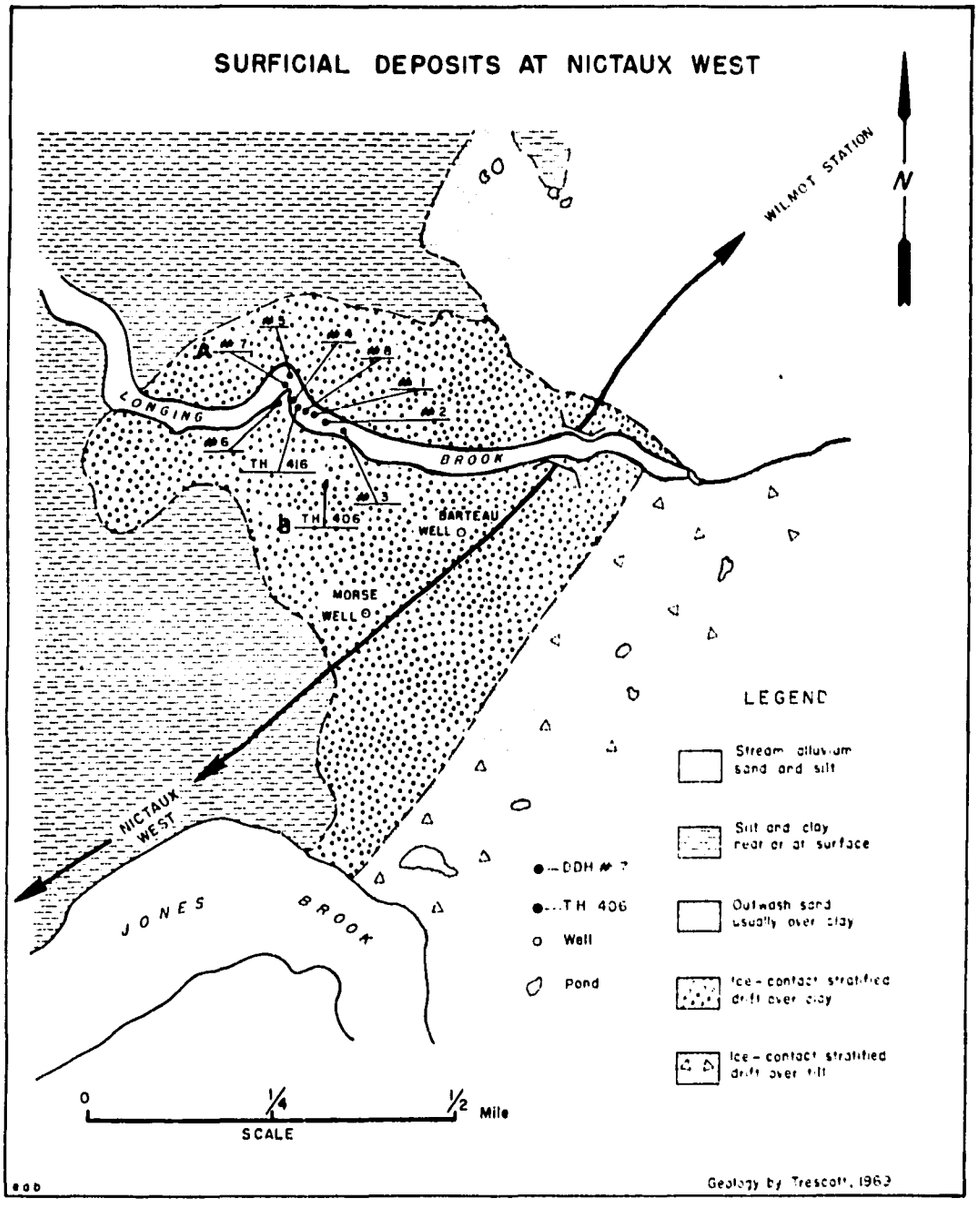

FIGURE 3. Surficial geology at Nictaux West.
(Cross Section AB is shown in Figure 4.)

5.0×10^4 igpd/ft (Table 1). If the distribution system is economically feasiable a yield of 250 igpm can be easily supplied by a shallow well in the vicinity of TH #80.

At Nictaux West (TH #416) the saturated thickness of the sand and gravel becomes 14 feet only. The coefficient of transmissibility varies considerably from 1.0×10^3 to 2.6×10^4 igpd/ft (Table 1). This was probably resulted from (1) the complexity of the geological materials and (2) the proximity of irregular impermeable boundaries. The calculated transmissibility indicates that 70 igpm is the maximum yield which can be expected from a single well in the Nictaux West area. Although the residual saturated thickness of the aquifer at the pumping well was only one foot at the end of 20 hours of pumping at a rate of 50 igpm, a definite sign of recharge was shown in the time-drawdown plot. Besides, the saturated thickness of the outwash sand and gravel tends to gradually increase downstream (Fig. 4). Although the outwash sand and gravel deposits encountered thus far are mostly overlain by stream alluvium (Fig. 5), this by no means suggests that the outwash aquifer is confined only to the areal extent of the present stream alluvium. In other words, the occurrence of the outwash sand and gravel deposits may be much more extensive than previously thought. This can only be proven by additional test drilling in the area labelled in Figure 5.

By far, the most serious drawback associated with the outwash sand and gravel aquifer is its limited saturated thickness, which is seldom over 15 feet. This then rules out the use of large production wells because the total available drawdown is small. To take advantage of its high permeability, large scale utilization of groundwater in most of the outwash plain should best be confined into a series of individual low yielding well points connected to a common suction pump, via header pipes. Technically, such an assembly often has the following advantages: (1) a small pumping lift; (2) a saving

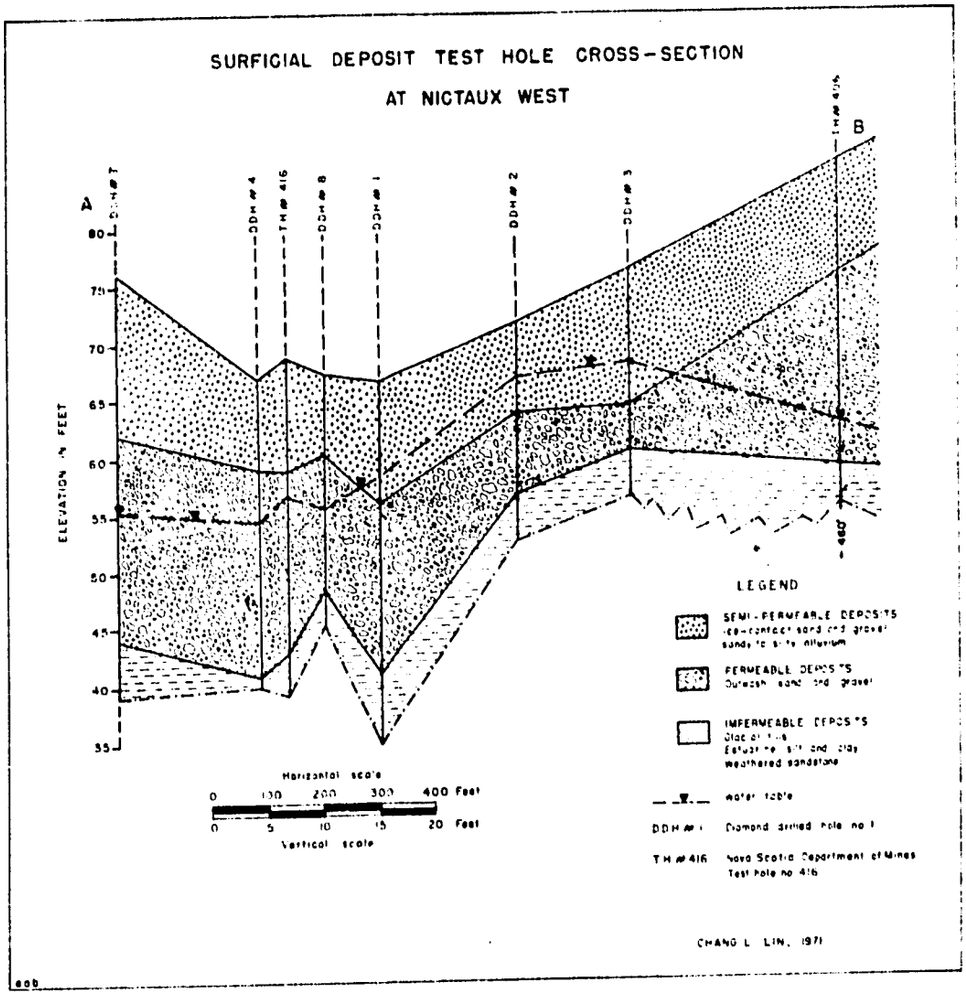

FIGURE 4. Surficial deposit test-hole cross-section at Nictaux West.

in well screen and well casing; and (3) a minimum cost in operation and maintenance. The optimal well yield, spacing, location may be resolved by digital modelling of the aquifer system (Lin, 1970).

Bedrock Aquifers

Underlying the surficial aquifers is the Wolfville Formation, which consists of soft sandstone interbedded with siltstone, and claystone. A test well of 460 feet deep was constructed with 122 feet of casing in TH#406. It was not possible to set the pump below 200 feet because of constant caving in the borehole. This results in a low coefficient of transmissibility for the bedrock aquifer (Table 1). If the test had been properly conducted, the coefficients of transmissibility are likely to be in the range from 2.0×10^3 to 6.4×10^3 igpd/ft (Trescott, 1968, p.42). A yield in the order of at least 200 igpm may be possible if the pump could be set down to a depth of 300 to 400 feet. As the sandstone is relatively soft and poorly sorted, squeezing of the formation and caving in the borehole may pose considerable problems to such a deep well. To properly construct a well in these materials, the well would have to be screened and gravel packed.

Of two domestic drilled wells in the area, Mr. Morse's well, drilled about ten years ago, was tested at 15 gallons per minute for 24 hours. Mr. Morse reported that the log of Mr. Barteau's well was similar to that of his own except very little gravel was present near the surface. Mr. Morse's well will likely yield more than 15 igpm, since it penetrated a sandstone of nearly 150 feet thick. However, it is impossible to tell how much more without a proper pumping test. It should also be noted that a large capacity production well will interfere with Mr. Morse's and Mr. Barteau's wells. If an irrigation well is constructed in the bedrock in this area their wells may require new pump settings or may even be rendered unserviceable. In such a case, provision will have to be made to divert some water from the irrigation well to these homes for domestic use.

GROUNDWATER QUALITY

A number of chemical analyses of groundwater are available for Nictaux West and its immediate vicinity. The groundwaters from outwash sand and gravel as well as sandstones are low in hardness, sulfate, iron, total dissolved solids and low in sodium adsorption ratio (SAR) (see Appendix B). They are suitable for both domestic and irrigation use without treatment.

RECOMMENDATIONS AND CONCLUSIONS

1. If the distribution problems can be solved a shallow well capable of yielding at least 250 igpm can be constructed in the vicinity of TH#80 to meet the irrigation requirement at Nictaux West.

2. The outwash sand and gravel deposits with high permeability appear to be the large potential surficial aquifer in the Nictaux West area if there is sufficient saturated thickness and areal extent. Further shallow drilling should be undertaken in the target area labelled in Figure 5 to delineate the full areal extent and actual saturated thickness of the important aquifer.

3. Because the saturated thickness of the outwash aquifer is seldom over 15 feet and hence the total available drawdown is small, large volume of groundwater supply can best be obtained from a series of low yielding well points, which are connected to a common suction pump, via header pipes.

4. If shallow test drilling fails to find additional outwash deposits in the Nictaux West area, another pump test should be conducted at the deep hole (TH#406) to determine the actual capacity of the well. The well should be properly screened and fully developed, with the pump column set at a depth greater than 350 feet.

5. The groundwaters from both the outwash and the bedrock aquifers are of excellent chemical quality being suitable for domestic as well as irrigation use.

REFERENCES

Department of Forestry and Rural Development, 1968, Nictaux West Irrigation, Annapolic County, N. S. : preliminary report, ADRA 47-NS

Lin, C. L. , 1970, Digital simulation of a stream-aquifer system: University of Illinois Ph.D thesis, 68 pp.

Trescott, P. C. , 1968, Groundwater resources and hydrogeology of the Annapolis-Cornwallis valley, Nova Scotia, N. S. Dept of Mines, Mem.6, 169 pp.

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Groundwater Geologist

June 1, 1971
Halifax, Nova Scotia

APPENDIX A

Lithologic logs of the wells drilled in the Nictaux West - Middleton area.

DDH #1 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 11	Sand, fine
11 - 13	Sand and gravel
13 - 25	Sand, fine
25 - 26	Sand and gravel
26 - 32	Sandstone, cemented, clayey

W.L. 5.0'; El. 69.8'

DDH #2 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 6	Sand, fine to coarse
6 - 8	Clay, sandy
8 - 11.5	Sand and gravel
11.5	Sandstone

W.L. 5.1'; El. 71.9'

DDH #3 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 12	Sand, fine
12 - 14	Sand and gravel (clay at 14')
14 - 16	Sand and gravel
16 - 20	Clay, sandy

W.L. 8.4'; El. 76.6'

DDH #4 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 4	No record
4 - 6	Sand and gravel
6 - 7	Clay, sandy
7 - 12	Sand and gravel
12 - 13.5	Gravel, fine
13.5 - 14	Sand, fine
14 - 26	Sand and gravel
26 - 27	Clay

W.L. 3.7'; El. 68.6'

DDH #6 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 12	No record
12 - 18	Sand, v. fine
18 - 23	Sand, fine to coarse
23 - 24	Sand, fine
24 - 25	Sand and gravel
25 - 26	Sand, fine
26 - 28	Sand and gravel
28 - 33.5	Sand and gravel, clayey (bedrock ?)
33.5 - 34	Sand, clayey (hard)

W.L. 22.5'; El. 78.4'

DDH #7 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 12	No record
12 - 14	Sand, fine
14 - 16	Sand and gravel
16 - 18	Sand, fine to coarse
18 - 26	No sample, v. soft
26 - 32	Sand and gravel
32 - 37	Sandstone, clayey, (soft) (bedrock ?)

W.L. 20.5'; El. 77.8'

DDH #8 Location: 21-A-14-D-45-C (Nictaux West)

Depth (feet)	Description
0 - 4	Sand, fine
4 - 7	Sand gravel, clayey
7 - 13.5	Sand and gravel
13.5 - 14	Sand and gravel, clayey
14 - 16	Sand, fine
16 - 19	Sand and gravel
19 - 24	Sand and gravel, cemented, (bedrock ?)

W.L. 6.4'; El. 69.5'

DDH #416 Location: 21-A-14-D-45-C

Depth (feet)	Description
0 - 7	Sand, fine to coarse, clayey
7 - 10	Sand, fine to coarse
10 - 20	Sand and gravel
20 - 26	Gravel, fine to coarse
26 - 30	Sandstone

W.L. 13.1'; El. 69.3'

TH #406 Location: 21-A-14-D-28-P (Nictaux West)

Depth (feet)	Description
0 - 10	Clay, sandy
10 - 27	Sand, fine
27 - 40	Till
40 - 49	Gravel, fine
49 - 82	Sand, gravel, clayey
82 - 87	Clay, red & grey
87 - 120	Medium gravel & clay (interbedded)
120 - 180	Sandstone, soft
180 - 220	Sandstone, hard
220 - 430	Sandstone, coarse grained, soft
430 - 460	Granite (?), soft

W.L. 24.3'; El. 86.9'

TH #51 Location: 21-A-14-D-71-G (Wilmot)

Depth (feet)	Description
0 - 7	Clay
7 - 25	Gravel, fine to coarse
25 - 60	Gravel, clayey

TH #65 Location: 21-A-14-D-26-L (Middleton)

Depth (feet)	Description
0 - 18	Gravel
18 - 30	Slate

TH # 66 Location: 21-A-14-D-46-A (Middleton)

Depth (feet)	Description
0 - 30	Gravel
30 - 64	Sandstone (some clay) soft
64 - 75	Sandstone & shale (interbedded)

TH #67 Location: 21-A-14-D-46-P (Middleton)

Depth (feet)	Description
0 - 23	Gravel
23 - 75	Red clay & soft shale (bedrock ?)

TH #68 Location: 21-A-14-D-51-K (Middleton)

Depth (feet)	Description
0 - 67	Red clay
67 - 75	Sandstone & red brown shale

TH #69 Location: 21-A-14-D-70-A (Middleton)

Depth (feet)	Description
0 - 7	Sand
7 - 15	Clay, gravelly
15 - 54	Sand, fine to coarse
54 - 90	Bedrock sandstone

TH #70 Location: 21-A-14-D-75-C (Middleton)

Depth (feet)	Description
0 - 14	Sand, fine
14 - 29	Clay
29 - 37	Clay & gravel
37 - 43	Gravel & clay (till ?)
43 - 60	Bedrock

TH #71 Location: 21-A-14-D-75-M (Middleton)

Depth (feet)	Description
0 - 10	Soft red clay
10 - 45	Bedrock, interbedded, red, blue, grey shale

TH #72 Location: 21-A-14-D-93-A (Middleton)

Depth (feet)	Description
0 - 19	Sand, fine
19 - 45	Shale, grey & red

TH #80 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 10	Silt and clay
10 - 15	Sand, silt and clay, with organic debris
15 - 30	Sand and gravel, with organic debris
30 - 35	Sand and gravel
35 - 52	Sand, fine to coarse
52 - 75	Shale, red and grey

W.L. 8.8'

TH #81 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 11	Clay, sandy
11 - 30	Till, with wood

TH #82 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 4	Clay
4 - 15	Sand, fine to coarse
15 - 30	Sand, fine

TH #83 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 4	Clay
4 - 15	Sand and gravel
15 - 30	Sand, v. fine

TH #84 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 2	Clay
2 - 5	Gravel & clay
5 - 7	Gravel & sand
7 - 30	Clay & medium sand

TH #85 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 28	No record

TH #86 Location: 21-A-14-D-52-D (Middleton)

Depth (feet)	Description
0 - 23	No record

TH #231 Location: 21-A-14-D53-K (Middleton)

Depth (feet)	Description
0 - 7	Sand, fine to medium
8 - 14	Clay

Richard Morse (Nictaux West)

Depth (feet)	Description
0 - 12	Soil
12 - 52	Gravel
52 - 150	Clay
150 - 205	Sandstone

W.L. 40'; El. 100'

APPENDIX B

Selected chemical analyses of groundwater samples taken from outwash aquifers (TH #80 and TH #416) and bedrock aquifer (TH #406).

NOVA SCOTIA WATER AUTHORITY

CHEMICAL ANALYSIS OF WATER

TH 50
21 A 14 1) 52 D
Middleton
3 7
Sand

LOCATION: Annapolis County DATE SAMPLED: 4:00 P.M. June 15, 1966

DATE RECEIVED: 27/6/66

IDENTIFICATION MARK: #3 - Test well #50 SAMPLED BY: E. Trescott

SUBMITTED BY: E. Trescott

Depth - 37
Aquifer - Sand & gravel

	ppm	epm		
Calcium	8.1	0.42	Alkalinities –Phenolphthalein as $CaCO_3$	0
Magnesium	1.4	0.12	–Methyl Orange as $CaCO_3$	20
Sodium	11.9	0.52	Hardness (Total as $CaCO_3$)	28.1
Iron Total	0.03	0.001	Loss on Ignition (1 hr. @500°C)	
Manganese Total	Trace	--	Total Dissolved Solids	
Sulphate	12	0.25	Suspended Matter	Trace
Chloride	18.6	0.52	Specific Conductance (mhos. x 10^{-5})	10
Nitrate	2	0.03	pH Value	6.8
			Color	<5
			Turbidity	
			SAR	1.00

REMARKS: 1.06 SSP 49

TOTAL HARDNESS - DETERMINED BY EDTA TITRATION.
Mn - T DENOTES TRACE AMOUNT (LESS THAN 0.01 p.p.m).
Fe - T DENOTES TRACE AMOUNT (LESS THAN 0.01 p.p.m).
Na - DETERMINED BY FLAME PHOTOMETER.

DATE: Oct. 31/66 ANALYSED BY: H. E. Bryan

37567/2

1331

NOVA SCOTIA WATER AUTHORITY

CHEMICAL ANALYSIS OF WATER

LOCATION: Middleton
Nictaux West

DATE SAMPLED: 18/9/70

DATE RECEIVED: 5/10/70

IDENTIFICATION MARK: TH#416 S-1 2/10/45

SAMPLED BY: Chang L. Lin

SUBMITTED BY: T. Hennigar
N.S.D.M., Box 1087, Halifax, N.S.

	ppm	epm
Calcium	8.8	.439
Magnesium	1.5	.123
Sodium	3.0	.131
Iron Total	0.22	.012
Manganese Total		
Sulphate	4	.083
Chloride	14.2	.400
Nitrate	T	

Alkalinities –Phenolphthalein as $CaCO_3$	0
–Methyl Orange as $CaCO_3$	24
Hardness (Total as $CaCO_3$)	29.3
Loss on Ignition (1 hr. @ 500°C)	
Total Dissolved Solids	
Suspended Matter	
Specific Conductance (mhos. x 10^{-5})	8
pH Value	7.0
Color	<5
Turbidity	9
SSP	19. [redacted]
SAR	2.4

REMARKS: Outwash sand and gravel

TOTAL HARDNESS - DETERMINED BY EDTA TITRATION.
Mn - T DENOTES TRACE AMOUNT LESS THAN 0.01 p.p.m.
Fe - T DENOTES TRACE AMOUNT LESS THAN 0.01 p.p.m.
Na - DETERMINED BY FLAME PHOTOMETER.

DATE: November 9, 1970

ANALYSED BY: [signature]

48379/1

1295

NOVA SCOTIA WATER AUTHORITY

CHEMICAL ANALYSIS OF WATER

LOCATION: Nictoux West

Anna. Co. 21-A-14-D-14-F

IDENTIFICATION MARK: S-1295 TH#406

SUBMITTED BY: N.S.D.M.

DATE SAMPLED: 9/7/70

DATE RECEIVED: 13/7/70

SAMPLED BY: J.B. MacNeil

	ppm	epm
Calcium	15.2	.758
Magnesium	2.1	.173
Sodium	8.2	.357
Iron Total	0.08	.004
Manganese Total	0.02	.001
Sulphate	5	.104
Chloride	~~13.2~~	~~.400~~
Nitrate	T	

Alkalinities –Phenolphthalein as $CaCO_3$ –Methyl Orange as $CaCO_3$	 0 56
Hardness (Total as $CaCO_3$)	46.8
Loss on Ignition (1 hr. 500°C)	
Total Dissolved Solids	
Suspended Matter	
Specific Conductance (mhos. x 10^{-5})	18
pH Value	7.0
Color	5
Turbidity	5
SSP	27.7
SAR	1.65

REMARKS: Bedrock - Red Shale & Sandstone
Well Depth 460' Csg length 122'
Test Hole N.S.D.M. 1970

TOTAL HARDNESS - DETERMINED BY EDTA TITRATION.
Mn - T DENOTES TRACE AMOUNT (LESS THAN 0.01 p.p.m).
Fe - T DENOTES TRACE AMOUNT (LESS THAN 0.01 p.p.m).
Na - DETERMINED BY FLAME PHOTOMETER.

DATE: _____ ANALYSED BY: _____

47830/2