Appendix XII: ESA & Groundwater Survey

ENVIRONMENTAL ASSESSMENT and GROUNDWATER MONITORING PROGRAM PHASE I

REGARDING

TWIN MOUNTAIN CONSTRUCTION LIMITED

WATERVILLE AGGREGATE PIT EXPANSION

KINGS COUNTY

NOVA SCOTIA

BY

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INTRODUCTION

This report addresses the requirement for a hydrogeology and groundwater component of the environmental assessment of the Twin Mountain Construction Limited sand and gravel aggregate operation in Waterville. This site is located south of No.1 Highway, and east of the Bond Road. A groundwater monitoring program is also presented as typically required in the terms and conditions included in Environmental Assessment Approvals as issued by the Nova Scotia department of the Environment and Labour for similar aggregate pit operations.

Description of the Aggregate Extraction Operation

Twin Mountain Construction Limited has been operating an aggregate extraction facility under approval from the Province of Nova Scotia under the Environment Act, S.N.S. 1994-95, c.1. This environmental assessment is for an expansion of the sand and gravel extraction operation and associated works at Waterville, Kings County.

Location of site:

The Twin Mountain Construction Limited sand and gravel extraction operation and facility is located in the village of Waterville, approximately 10 kilometres west of the town of Kentville. The site is specifically located south of Highway #1. Rochford Brook flows through the central portion of the property from south to north. Figure 1 shows the location of the existing sand and gravel extraction operation, and the area of interest for the expansion, in relation to the topography, drainage, highways, and structures in the Waterville area.

Precipitation:

Table 1 shows the amount of precipitation, and the variance from the long-term average, as reported at the Agriculture Research Station at Kentville during the growing seasons of the years 2002 and 2003. Several points of interest are worthy of note from this data.

The growing season for year 2002 was considered by many in the agricultural community to be a drought year for growing many crops in the valley. The growing season for year 2003 was considered as a wet year by most growers of field crops. The major influence during year 2002 may be the lack of precipitation received during the middle of the growing season during June, July, and August. Precipitation during May and September in year 2002 was well above average, while the precipitation during June, July, and August in year 2002 was well below average. What may be the most critical period of low precipitation occurs during three successive months during the growing season as seen during 2002. Precipitation during September 2002 and during August 2003 was nearly double the normal for those months.

Precipitation reported at the Kentville Agricultural Research Centre during the growing seasons for years 2002 and 2003 is presented in Appendix A.

Knowledge of the precipitation patterns in the area during the growing season will help understand the potential groundwater recharge periods when high water tables may interfere with extraction operations, and increase the potential for contaminants on the surface to be carried down into the groundwater system underlying the site.

FIGURE 1

LOCATION MAP SHOWING AGGREGATE PITS
TWIN MOUNTAIN CONSTRUCTIO OPERATION
WATERVILLE, NS

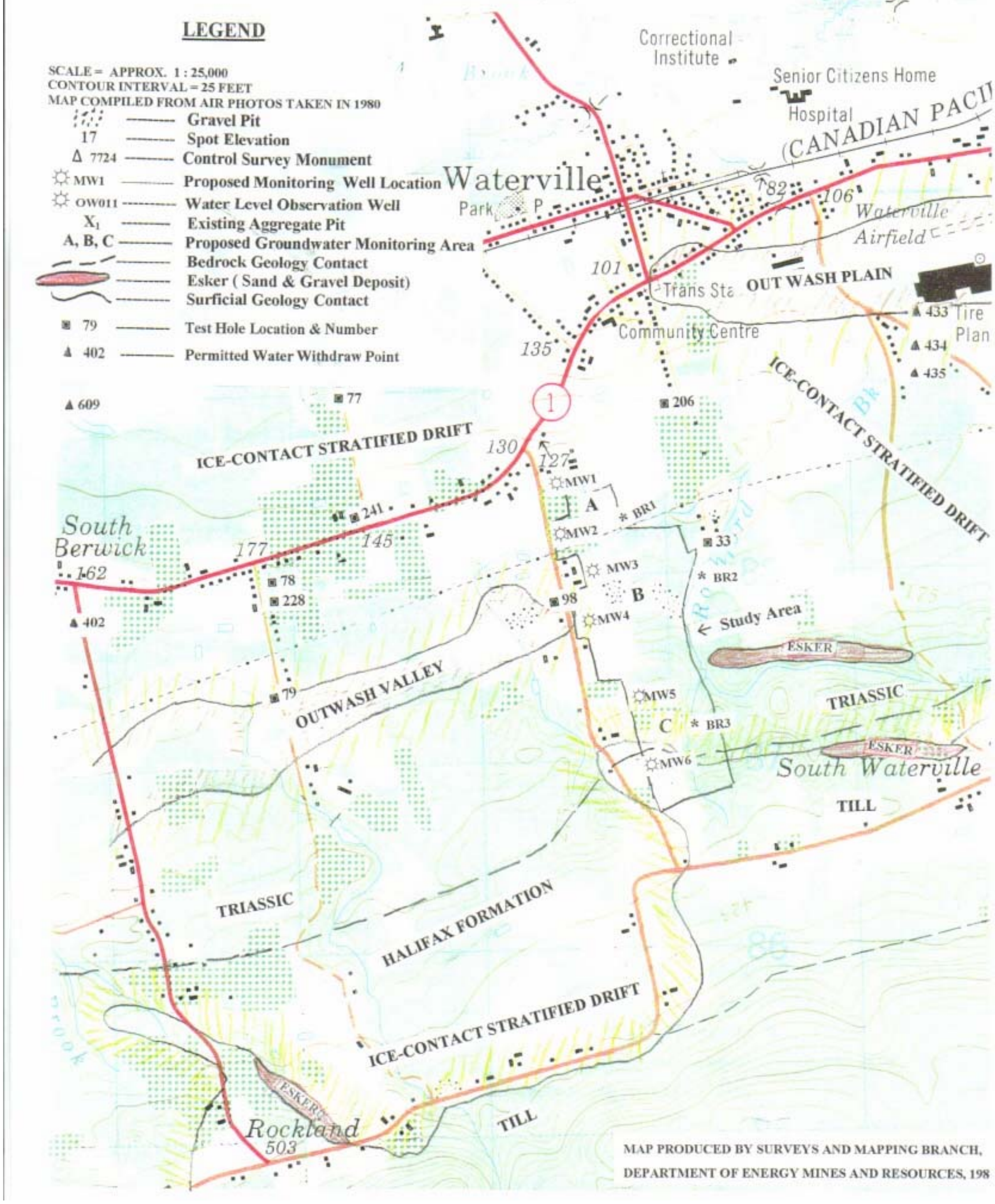


TABLE 1 Summary Of Precipitation Data From The AGRI-Food Canada Research Station, Kentville.

Month	Precipitation	Long-Term Average	Variance From Long-Term Average	
			Mm	Percentage
YEAR 2002				
MAY	85.2	78.9	6.3	+ 8
JUNE	45.8	67.5	21.7	- 32
JULY	58.1	69.1	11.0	- 16
AUGUST	59.3	88.9	29.6	- 33
SEPTEMBER	175.4	93.0	82.4	+ 87
YEAR 2003				
MAY	57.5	79.0	21.5	- 27
JUNE	66.3	67.0	0.7	< 1
JULY	78.5	68.8	9.7	+ 14
AUGUST	165.3	88.2	77.1	+ 87
SEPTEMBER	92.8	95.0	2.2	- 2.3

Land use and zoning in the area:

The area of the Twin Mountain aggregate operation is located south of the Waterville Growth Centre. Land use in the area of the Waterville Growth Centre is a mix of residential, commercial, open space, and institutional developments. The area surrounding the Twin Mountain Sand and Gravel Extraction Operation is Agricultural. The sand and gravel extraction operation is located entirely within an area zoned as A1 which permits topsoil and aggregate extraction operations. Figure 2 shows the mix of land use and urban zoning in the area as mapped by the Municipality of the County of Kings. Properties immediately adjacent to the site are zoned as follows:

East side: Zoning is A1, Agricultural district.

North side: Zoning is A1, Agricultural district.

West side: Zoning is A1, Agricultural District.

South side: Zoning is A1, Agricultural district.

A listing of property owners with addresses, property identification numbers, and other relevant information is included in Appendix B. A map of the study area showing the properties on which aggregate extraction is planned and adjacent properties, with the PID numbers is also included in Appendix B.

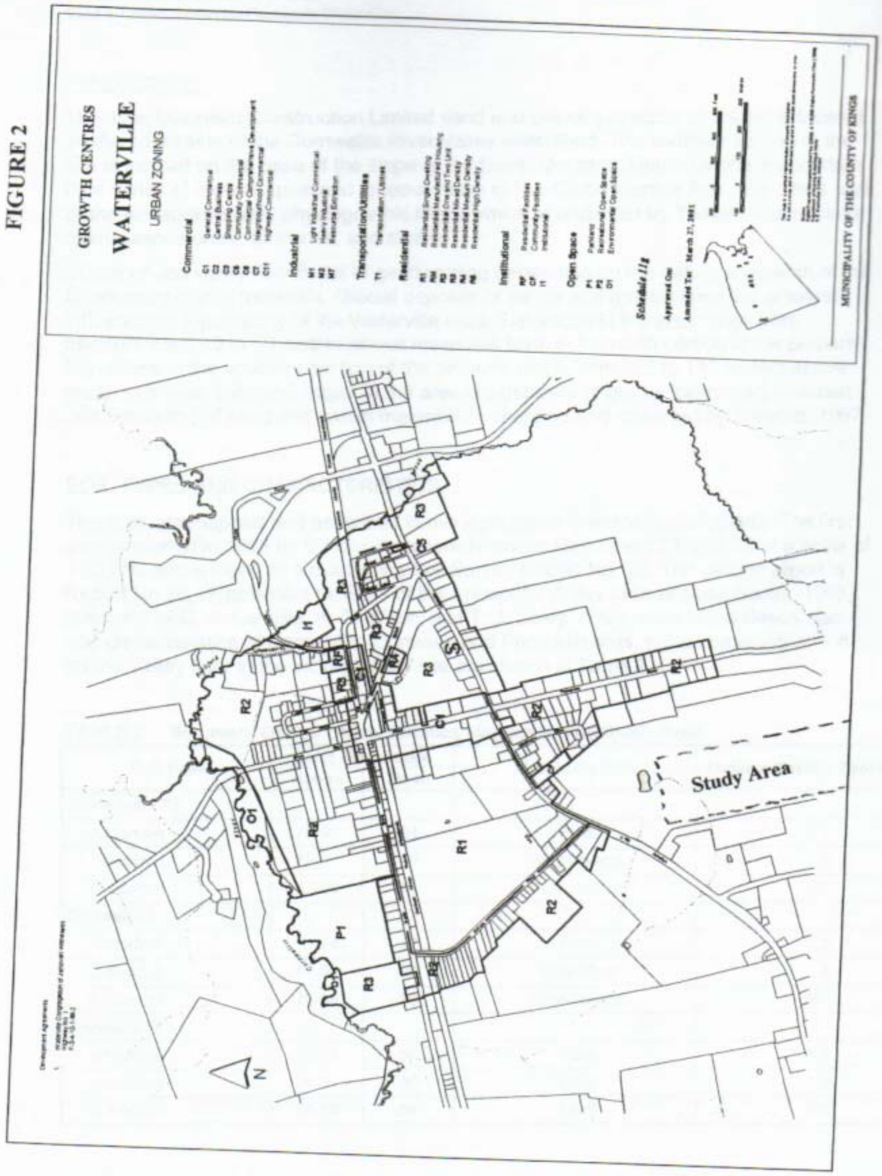


FIGURE 2
GROWTH CENTRES
WATERVILLE
URBAN ZONING
Study Area
MUNICIPALITY OF THE COUNTY OF KINGS

Physiography:

The Twin Mountain Construction Limited sand and gravel extraction operation is located on the south side of the Cornwallis River Valley watershed. The southern portion of the site is located on the base of the slope of the South Mountain Upland which is underlain by a series of metamorphic and igneous rocks of Pre-Carboniferous Age. The site is part of the Annapolis Valley physiographic region which is underlain by Triassic sediments of mainly sandstones, siltstones, and shales.

Relief on the valley floor is flat to gently rolling depending on the nature and depth of the Quaternary glacial materials. Glacial deposits of sands and gravels have the greatest influence on topography of the Waterville area. Elevations in the area range from approximately 40 to 50 metres above mean sea level in the north portion of the property. Elevations in the southern portion of the property range from 105 to 115 meters above mean sea level. Hills and ridges in the area are deposits of glacial ice-contact stratified drift consisting of sand and gravel materials as mapped and classified by Trescott, 1967.

SOIL TYPES AND CHARACTERISTICS

The soils are mapped and described in two Agriculture Canada Soils Reports. The first was published in 1988 by D Holmstrom which covers Map Sheet 21H/02-T3 at a scale of 1:20,000 and is listed as Nova Scotia Soil Survey Report No. 25. The second report is Report No.26, Supplement to: Soils of the Annapolis Valley Area of Nova Scotia, 1993, authored by D. R. Langille, K. T. Webb, and T. J. Soley. A summary of the description and characteristics of Cornwallis, Comeau, and Pugwash soils, types commonly found on the Valley floor in the vicinity of the site are shown in Table 2.

TABLE 2 Summary Of Soil Characteristics Mapped In The Study Area

Soil Type	Sand Percentage		Dominant Size	Organic Carbon Percentage
	Range	Mean		
Cornwallis 85				
A Horizon	75-95	84	Fine	2.1
B Horizon	72-97	90	Very Coarse	0.6
C Horizon	67-99	91	Very Coarse	NA
Comeau 53				
A Horizon	51-74	67	Fine	2.3
B Horizon	67-94	80	Very Fine	1.4
C Horizon	75-98	90	Very Coarse	NA
Pugwash 52				
A Horizon	35-77	58	Fine	3.4
B Horizon	24-77	60	Fine	1.3
C Horizon	28-76	58	Fine	NA

One of the characteristics of the Cornwallis soils that make them distinctive from the Pugwash and Comeau soils in the Valley is the dominant very coarse sand size in the B and C horizons. Of the three soil types summarized in Table 2 the Cornwallis soils have the highest percent of sand overall in the A, B, and C horizons and increasing with depth. These attributes of coarse sand and low percentage of finer grained soil particles contributes to the well drained nature, and low soil moisture holding capacity, of the soils.

Table 3 shows a summary of information on thickness and hydraulic conductivity of the same three soil types summarized above. This information also shows the higher order of hydraulic conductivity of Cornwallis soils compared to the Comeau and Pugwash soils in the area. The two attributes of Cornwallis Soils that account for heavier water demands in agricultural use include their high hydraulic conductivity and low silt/clay content which reduce the water holding capacity during the growing season.

A review of the data in Table 3 shows that the thickness of the three soil types is very similar. The average thickness of the Cornwallis soils to the bottom of the B Horizon is 29.5 cm while the thickness of the Comeau soils is 27.5 cm, and the Pugwash soils is 28.5 cm. Again the main distinctive difference among these soil types is the hydraulic conductivity of the soils. For the Cornwallis soils the average hydraulic conductivity is 11.9 cm/hr, as compared to 1.1 cm/hr for the Debert soils. Although there is no hydraulic conductivity data available for the Comeau soils, the drainage characteristics for these soils is described as 'imperfect', suggesting lower values than those for the Cornwallis and Pugwash soils which are described as being better drained.

Table 3 Summary of Hydraulic Conductivity of three soil types in the study area (After Holmstrom and Thompson, 1989)

Soils Type	Thickness (cm)		Hydraulic Conductivity (cm/hr)	
	Range	Mean	Range	Mean
Cornwallis 85				
A Horizon	12-57	26	7.2 - 24.9	14
B Horizon	6 - 75	33	8.2 - 23.0	14.1
C Horizon	NA	NA	5.2 - 9.3	7.6
Comeau 53				
A Horizon	17 - 36	24	NA	NA
B Horizon	19 - 48	31	NA	NA
C Horizon	NA	NA	NA	NA
Pugwash 52				
A Horizon	7 - 55	26	0.0 - 19.9	2.5
B Horizon	10 - 62	31	0.0 - 11.1	1.3
C Horizon	NA	NA	0.0 - 0.9	0.3

Notes:
1. Drainage of Cornwallis 85 soils ranges from well to rapid.
2. Drainage of Comeau 53 soils reported as imperfect.
3. Drainage of Pugwash 52 soils ranges from moderately well to well.

GEOLOGY OF THE AREA

Overview:

The Annapolis-Cornwallis Valley is bounded on the south by the South Mountain, which is composed of a mix of igneous and metamorphic rocks. These resistant rocks form a large part of the watersheds that drain the Valley's south flank. The structural geological orientation of these rocks trend approximately parallel to the axis of the Valley in a northeast-southwest direction. These rocks are classed as non-porous, but fractured which host small aquifers defined entirely by the nature of structural stress breaks that occurred during the past several hundred million years of tectonic activity in Nova Scotia.

The thickness of these igneous and metamorphic rocks is believed to be several tens of thousands of feet thick in total. A number of Formations have been mapped in the metamorphic class of rocks. These include, from the oldest to the youngest, the: Goldenville Formation; Halifax Formation; White Rock Formation; Kentville Formation; New Canaan Formation; and Torbrook Formation. The angle at which the surface of these rocks dip underneath the Valley is reported to be approximately 25 degrees. However, the subsurface topography of their eroded surface, and the nature of their contact with the overlying rocks, is not known.

These igneous and metamorphic rocks are generally overlain by glacial till deposits, which vary in thickness from 0 to approximately 5 metres. Thickness of these deposits may be over 10 metres where drumlins have formed. Along the Valley flanks and in glacial valleys cut into these rocks, local deposits of glaciofluvial sands and gravels may be found to depths of 100 feet (30 m) or more.

Bedrock Units Under The Site:

The Valley floor is underlain by soft Triassic sediments, which have been eroded to form an open-ended valley, bounded by the Minas Basin in the east. These sediments are made up of weakly cemented, and easily eroded, sandstones, and sandy shales, which are the most common rock types. The Cornwallis Valley in the vicinity of Waterville is drained by Cornwallis River, and contributing tributaries, flowing east. The lower reaches of the river, and tributaries, have been drowned as sea level has risen during the past 4,000 years or so, leaving the stream channels below present day sea level. These Triassic rocks dip 4 to 12 degrees to the northwest towards the Bay of Fundy and overlie with angular unconformity the deformed much older Paleozoic metamorphic rocks forming the South Mountain, which dip beneath the Valley.

The Triassic sediments under the Valley floor in the Waterville area have been classified into the Wolfville Formation. The Wolfville Formation increases in thickness northward across the outcrop belt to a maximum of over 3,000 feet in places at the base of the North Mountain escarpment. This formation is composed of interbedded red and grey conglomerates, sandstones, siltstones, and claystones. The sandstones and conglomerates are poorly sorted, cross-stratified, contain intraformational claystone and siltstone, and show lateral changes in stratification, composition, and thickness. The composition of the Wolfville Formation may vary widely from place to place along the Valley floor.

Although the formation has been described as being composed almost entirely of coarse clastics the majority of the section in some places is made up of silty sandstone, arenaceous sandstone, siltstone, and claystone. Test holes drilled into the Wolfville Formation and logged by geologists show the type of variation in rock types over relatively short distances. For example, a test hole (T.H. #372) was drilled and logged by a qualified hydrogeologist with the Nova Scotia Department of Mines, in 1968 in the Coldbrook area, approximately 8 km east of the Twin Mountain aggregate site. The log from this test hole showed a percentage of sandstone and conglomerate, at 22% over a drilled depth of 314 feet in the Triassic sediments. The largest portion of the property is underlain by the Wolfville Formation. The extreme southern portion of the site the Wolfville Formation makes contact with the much older Halifax Formation slates and other metamorphic rocks as shown in Figure 1.

Quaternary Units Under The Site:

Over lying the bedrock units in the vicinity of the sand and gravel extraction operation are surficial glacial materials, collectively referred to as Quaternary deposits. These deposits are reported to be greater than 39 feet thick in TH#33, and greater than 60 feet in TH#206 (Trescott, 1968) drilled near the study area, as shown on Figure 1. The depths to bedrock, as reported by drilling contractors, for other water supply wells in the area are shown in Table 4.

During the Quaternary Period, which covers the 1.6 million years of earth history, the climate cooled and large glaciers periodically covered Eastern Canada. Nova Scotia was affected by at least four ice advances from 75,000 to 10,000 years ago. During these glacial periods ice advanced from different directions. During the first and second glacial periods the ice advanced from the North. During the third period ice advanced from the Scotian Ice Divide to the South, which extended from Yarmouth east to Canso. Ice advanced from the Antigonish Highland Ice Cap during the last ice period about 30,000 years ago.

Today, ridges and hills of sand and gravel deposits called eskers and kames respectively, form the topography on the valley floor in the vicinity of the sand and gravel operation. These deposits vary widely over short distances both laterally and vertically. The distribution of these deposits both laterally and with depth are of particular interest because of their potential as aquifers to store and transmit large quantities of good quality groundwater. The largest portion of the property is underlain by ice-contact stratified drift (sand and gravel deposits). The extreme southern portion of the property is underlain by glacial till (deposits of nonstratified clay, silt, sand, and gravel. These areas are shown on Figure 1. An example of the complex stratigraphy in the Quaternary sand and gravel deposits is shown in Photo #1, Appendix G. More detail on the stratigraphy of the Quaternary deposits is provided in the report augmenting the environmental assessment, prepared by Dr. Ian Spooner.

HYDROGEOLOGY OF THE SITE

Two major hydrostratigraphic units, as previously mapped within the study area by Trescott (1968), underly the major portion of the site. These units were reviewed and delineated on Figure 1 for the study area. The Wolfville Formation is referred to as the Wolfville Hydrostratigraphic Unit (Wolfville HU), while the ice-contact stratified drift deposits are referred to as the Quaternary Hydrostratigraphic Unit (Quaternary HU). The Halifax Formation (Halifax HU) underlies the southern extremity of the property.

In addition, values of transmissivity, storativity, and safe yield have been summarized from the Pumping Test Database provided by the Nova Scotia Department of the Environment. Data from three of the high capacity wells for which pumping test data exists in the database are representative of Quaternary HUs in the area. These wells, #433, #434, and # 435, (see Table 5) are located within 2 kilometers east of the Twin Mountain site. One pumping test data set from the Wolfville HU, #421, is from a well located approximately six kilometers east of the site. The available records for water wells in the area as reported to, and obtained from the NSDEL data base, is presented in Table 4. A summary of all readily available pumping test data for high capacity wells in the Waterville area is shown in Table 5.

A partial record of a time series of groundwater hydrographs from the 1960's to the present are in various databases maintained by the Nova Scotia Department of the Environment & Labour. These records were published in a report entitled 'Groundwater Hydrographs In Nova Scotia 1965-1981, by the NSDOEL. The closest groundwater hydrograph records available to the sand and gravel extraction operation are in the Coldbrook, Berwick, and Prospect areas. These records were reviewed and interpreted to determine natural seasonal changes in the groundwater reservoir in the study area. A summary of the published hydrograph data from (McIntosh, 1984) for the observation well located in Prospect is presented in Figure 3. Hydrographs for observation wells in Coldbrook and Berwick are shown in Appendix C and D respectively.

Water Well Records

Any well constructed since 1965 should have a well record on file with the Nova Scotia Department of the Environment & Labour (NSDOEL). The record will be entered under the name of the original owner of the well. Well records submitted between 1965 and 1978 were published in annual reports available from NSDOEL. Records submitted since 1978 are on a computerized database and have been assigned a unique well log number.

For domestic well records there is no detailed geological log required under the well construction regulations in Nova Scotia. It is the responsibility of the applicant for a groundwater withdrawal permit to provide the water well record along with a hydrogeological description of the site. If no record is available, a well log can be obtained by a TV video well inspection carried out by a certified person.

Available databases on groundwater resources and existing supply records were reviewed, interpreted, and assessed in terms of capability of these records to assist in providing an understanding of the hydrogeological framework of the sand and gravel extraction area, and designing a groundwater monitoring plan for the site.

The Nova Scotia Water Well Records database maintained by the Department of the Environment was reviewed and summarized. Records were abstracted from this database and summarized on a grid basis to determine the number of wells in the area, range of values for total depth, yield, and depth to bedrock for Waterville area. These records available for the Waterville area and presented in Table 4.

The Water well records database for Nova Scotia includes information on over 60,000 wells throughout the province. This database was initiated and set up when the Well Drilling Act was first passed in 1963. At that time, well drillers were required to register with the regulatory agency and to keep records of wells constructed, documenting the geological conditions encountered, groundwater occurrences, well construction details, and an estimate of well yield.

Up until about 1988, well locations were determined by using the National Topographic Map Series, and locating the well site down to the nearest mining tract, which covers an area of one square mile. The sand and gravel extraction operation is partly located in two mining tracts of map sheet 21H2A. No water well information for wells drilled prior to 1979 in these mining tracts, #16 and #33, was found in the data base. Grid 21H2A33 represents the northern portion of the study area, while grid 21H2A16 represents the southern portion of the area.

In 1988 a new map reference system was introduced based on the 1: 250,000 scale provincial map booklet. This system allows location by page number and site within a 10 square kilometer area, and further by a secondary grid determining the well site within a one square kilometer area. The sand and gravel extraction operation is partly located in two grids. Grid P14B1N8 covers the northern portion of the area. Grid P14B1N9 covers the southern portion of the site. Water well records shown in Appendix C include wells reportedly drilled in these grids. Table 4 shows a summary of water well data as recorded in the NSDEL records for wells reported to be drilled in these grids within the study area.

Depth of casing used in well construction was selected as the indicator parameter to give an estimate of the depth to bedrock, or the depth of the overlying Quaternary deposits in Kings County. In most cases of well construction, the amount of casing required is dependent on the depth of these unconsolidated and unstable glacial deposits of clay, silt, sand, and gravel. Since approximately 95%+ wells drilled in the Province are for domestic water supplies, the target aquifer is the underlying bedrock, therefore it is assumed that this depth of casing is considered as a reasonable estimate of the depth to bedrock.

As seen in the data presented in Table 4, 20 water wells are reported in the vicinity of map grid locations in the general area where the sand and gravel extraction operation is located. The data recorded for wells in the area also show that well depths vary

TABLE 4

SUMMARY OF WATER WELL RECORDS IN THE WATERVILLE AREA (POST 1979) OCT.'03

WELL #	DREG	OWNER	WCOMMUNITY	WCOMPLET	WMAPLOC	WDEPT	WCASE	WDIAM	WYIELD	WYIE	STATD	WSTATUS
811034	110	BROWN, ARNOLD	LLOYDS	5/12/1981	21H2A16	250.0	72.0	6.0	2.0		50.0	A1
811039	110	CONNORS, RETTA	LLOYDS	12/10/1981	21H2A16	130.0	27.0	6.0	7.0		30.0	A1
800734	18	DOREY, MERRILL	LLOYDS	10/20/1980	21H2A33	50.0	47.0	4.0	20.0	A	14.0	A1
810607	18	SALSMAN, FREDA	WATERVILLE	10/7/1982	21H2A33	165.0	80.0	4.0	15.0	A	32.0	A1
891143	18	ROBINSON, BETTY MRS	SOUTH WATER	6/1/1989	P14B1N8	60.0	21.0	4.0	10.0	A	10.0	
890559	110	N S DEPT OF HOUSING	WATERVILLE	2/7/1989	P14B1N8	120.0	65.0	6.0	15.0	A	2.5	
900833	110	DAVISON, MARTY	WATERVILLE	5/4/1990	P14B1N8	160.0	72.0	6.0	25.0	A	15.0	
911506	110	KENNEDY, DOREEN	WATERVILLE	4/22/1991	P14B1N8	180.0	84.0	6.0	25.0	A	15.0	A1
911507	110	ACA CO-OPERATIVE LTD	WATERVILLE	4/25/1991	P14B1N8	120.0	60.0	6.0	25.0	A	4.0	A1
931516	110	VENTURES VIKING	WATERVILLE	10/26/1993	P14B1N8	55.0	40.0	6.0	25.0	A	15.0	A1
960994	110	BUDDE, BOB	WATERVILLE	10/18/1996	P14B1N8	175.0	144.0	6.0	45.0	A	40.0	A8
962017	110	BUDDE, BOB	WATERVILLE	10/18/1996	P14B1N8	175.0	144.0	6.0	45.0	A	40.0	A1
971933	110	MILNE, NORMA & ALEX	WATERVILLE	8/25/1997	P14B1N8	160.0	117.0	6.0	20.0	A	30.0	A1
972290	255	WHITMAN, GARFIELD	WATERVILLE	11/26/1997	P14B1N8	65.0	28.0	6.0	10.0	A	9.0	A1
972301	256	WENTZELL, KELLY	WATERVILLE	7/25/1997	P14B1N8	140.0	75.0	6.0	6.0	A	25.0	A1
982060	255	F. B. SPINNEY BUILDERS	WATERVILLE	3/10/1998	P14B1N8	65.0	40.0	6.0	4.0	A	6.0	A1
900413	307	DOHERTY, CLIFF	SOUTH WATER	7/25/1990	P14B1N9	80.0	60.0	6.0	10.0	A	0.0	
902663	110	LUTZ, DOUG	SOUTH WATER	6/3/1990	P14B1N9	360.0	47.0	6.0	1.0	A	25.0	
941828	110	GATES, VAUGHN	SOUTH WATER	11/4/1994	P14B1N9	120.0	77.0	6.0	15.0	A	40.0	A1
951604	110	VANDERTVIN, EDWIN	SOUTH WATER	12/21/1995	P14B1N9	95.0	65.0	6.0	25.0	A	10.0	A1

NOTES:

Lic. No.	Drilling Contractor
307	K. D. Rogers Well Drilling Ltd.
110	Valley Well Drillers Ltd.
255	Spencer's Well Drilling Ltd.
59	Harry F. Spencer
18	S. G Trask & Sons

WELL # — UNIQUE REFERENCE NUMBER IN COMPUTER DATABASE
DREG —— WELL DRILLER REGISTRATION NUMBER
WDEP —— WELL DEPTH IN FEET
WCAS— LENGTH OF CASING INSTALLED IN WELL
WDIA— WELL DIAMETER IN INCHES
WYIE— ESTIMATED WELL YIELD IN GALLONS PER MINUTE
WYM— METHOD OF ESTIMATING WELL YIELD WITH AIRLIFT TECHNIQUE
STATD— DEPTH TO STATIC WATER LEVEL IN WELL AT TIME OF DRILLING

considerably, from 50 feet to 360 feet. Depths to water level in wells also vary from at surface, or flowing artesian wells, to water depths down to 50 below ground surface. Reported well yields ranged from 1 to 45 gallons per minute.

The water well data is summarized in Table 5 by grid area. This table shows the number of wells, range of depth to bedrock, range of depth to water level, and range of well yield in each grid area.

Table 5. Summary Of Water Well Records Found In The Study Area.

Grid Area	Number of wells	Range of depth to bedrock	Range of depth to Water level	Range of yield
21H2A16	2	27 - 72	30 - 50	2 - 7
21H2A33	2	47 - 80	14 - 32	15 - 20
P14B1N8	12	21 - 144	2.5 - 40	4 - 45
P14B1N9	4	47 - 77	0 - 40	1 - 25

Notes: 1. Depths in feet.
2. '0' may represent flowing well.
3. Yield in gallons per minute.

Pumping Test Data

The pumping test database for large capacity wells and public water supplies was initiated in the 1960's. Geological data collected for such wells was often logged by a professional hydrogeologist. In addition a properly organized and conducted pumping test was carried out, the data interpreted and analyzed, and a safe yield based on a continuous 20 year production life was determined. This database was reviewed and all data sets for the Waterville area were interpreted and summarized. Ten sets of pumping test data from test wells, or large capacity wells, were found for the Waterville area. Five pumping tests were carried out on wells constructed in the Wolfville Hydrostratigraphic Unit (HU), and five tests were carried out on wells constructed in the Quaternary sand and gravel Hydrostratigraphic Unit. A summary of the pertinent and related information from this database for the Waterville area is presented in Table 6.

The information in Table 6 shows the hydrostratigraphic units, transmissivity, storativity, and expected yields from wells drilled into these units. Expected well yields shown in the tables are based on the average T and a total available drawdown of 100 feet. No wells found in this database are located within the study area, but are located nearby and are considered to be representative and typical of the hydrogeological conditions found within the site.

Based on the pumping test data available for wells constructed in the Wolfville Hydrostratigraphic Unit in the Waterville area, the average Transmissibility (T) is 1,033 imperial gallons per day per foot (igpd/ft). The range of T is 230 to 2,200 igpd/ft. The average storativity (S) for wells in the Wolfville HU in the Waterville area is 1.7×10^{-4}.

The specific capacities of wells tested in the Wolfville HU averaged 0.45 imperial gallons per minute per foot of drawdown(igpm/ft), and ranged from 0.17 to 0.97 igpm/ft. Using the above values of T and S and an available drawdown of 100 feet the average 20 year continuous safe yield of the wells constructed in the Wolfville HU is 44.4 imperial gallons per minute (igpm), with a range of 11.2 to 105 igpm.

Based on the pumping test data available for wells constructed in the Quaternary (sand and gravel) Hydrostratigraphic Unit in the Waterville area, the average Transmissibility (T) is 23,960 imperial gallons per day per foot (igpd/ft). The range of T is 6,294 to 63,360 igpd/ft. The average storativity (S) for wells in the Wolfville HU in the Waterville area is 1.2×10^{-2} with a range of 4.5×10^{-4} to 3.3×10^{-2}. The specific capacities of wells tested in the Quaternary HU averaged 23.7 imperial gallons per minute per foot of drawdown (igpm/ft), and ranged from 1.6 to 65.3 igpm/ft. Using the above values of T and S and an available drawdown of 100 feet the average 20 year continuous safe yield of the wells constructed in the Quaternary HU is 588 imperial gallons per minute (igpm), with a range of 141 to 1,543 igpm.

Aquifer testing is a very important component in development of any water supply that withdraws more than 23,000 liters per day from an aquifer. Under the Well Construction Regulations of Nova Scotia, a pump test of not less than 72 hours duration is required for all non-domestic wells, unless otherwise approved in writing (variance) by an inspector. The purpose of the test is to determine the long-term safe yield of the well, potential impacts on other existing wells in the area, and other environmental impacts. Municipal and industrial wells may require a longer test, if there is a perceived, or potential, environmental concern related to the withdrawal of large volumes of groundwater in the area.

Pumping tests are carried out by certified individuals and follow a well established protocol. The typical data and procedure followed in conducting such a test includes the following:

- Regulating and monitoring pumping rate;
- Measuring and recording water levels in the pumping well and nearby observation wells;
- Collection of samples for water quality analyses;
- Interpretation and analysis of the pumping test data;
- Determination of the sustainable yield of the well; and
- Reporting to the Nova Scotia Department of the Environment.

The above data is required by the Nova Scotia Department of the Environment & Labour for the processing of water approvals to withdraw groundwater for non-domestic water supply purposes.

TABLE 6

SUMMARY OF PUMPING TEST DATA IN THE WATERVILLE AREA DEC. '03

REC	NS_GRID	DRILL_D	HYDRO_UN	DUR	DEPTH	WELL_DI	STATIC	AVG_DDO	AVG_P_R	TRANSMI	STORATIV	SPEC_CA	TOT_DD	Q20_SA	PCT.DD	STABI
388	21 H 2 A 39	4/1/73	WOLFVILLE	72	210	6	51.9	128.0	20.0	230	0.000000	0.240	83.7	11.2	65	1
433	21 H 2 A 41	12/1/79	SAND & GR	72	100	6	16.7	64.3	60.0	63360	0.033000	8.070	7.4	1543.0	12	0
434	21 H 2 A 41	3/1/81	SAND & GR	168	138	10	0.0	75.0	325.0	24000	0.000450	40.630	8.0	682.0	11	0
435	21 H 2 A 41	1/1/81	SAND & GR	168	111	8	20.3	59.0	185.0	6294	0.000000	11.120	16.6	141.0	28	1
404	21 H 2 A 45	7/1/64	SAND & GR	48	79	8	10.2	60.0	400.0	16246	0.002600	65.250	6.1	369.0	10	0
383	21 H 2 A 51	2/1/72	WOLFVILLE	72	180	6	51.8	98.0	30.0	1300	0.000000	0.970	30.8	48.3	31	1
408	21 H 2 A 52	1/1/74	WOLFVILLE	1	232	0	43.6	159.0	2.0	0	0.000000	0.170	11.4	0.0	7	0
421	21 H 2 A 53	2/1/81	WOLFVILLE	72	200	6	44.0	126.0	15.0	2200	0.000000	0.600	25.0	105.0	20	0
430	21 H 2 A 55 I	3/1/77	WOLFVILLE	24	143	6	26.2	87.0	15.0	400	0.000170	0.270	56.0	13.2	64	0
429	21 H 2 A 58	2/1/79	SAND & GR	72	106	6	30.2	55.0	30.0	9900	0.000000	1.630	18.4	206.0	33	1

NOTES:

1. Hydro. = Hydrostratigraphic unit
2. Static = Depth to static water level in well in feet.
3. Depth = Depth of well in feet.
4. Avail. = Available drawdown in well in feet.
5. T = Transmissivity of aquifer as calculated from pumping test data units in gallons per day per foot
6. S = Storativity of the aquifer as calculated from the pump test data, units are dimensionless.
7. Spec. = Specific capacity of the well in imperial gallons per minute per foot of drawdown.
8. D.D. = Maximum drawdown, in feet, recorded during the pump test.
9. Q20 = Estimated safe yield of the well in igpm.
10. % DD = % of the available drawdown used during the pumping test.
11. REC 383 = Location of well not known
12. REC 404 = Location of well on Scotian Gold property, well abandoned.
13. REC 408 = Well Coldbrook Park
14. REC 421 = Well located at Coldbrook school.

Although an equal number of pumping test records are for wells completed in the Wolfville HU and the Quaternary HU this is not a reflection of the wider distribution of the use of these hydrogeological units under the Valley floor. The Wolfville HU contains the major bedrock aquifers under the Valley floor and is the source of water for most domestic supplies. The wells reported to be completed in a Quaternary sand and gravel aquifer may or may not overlie the Wolfville Formation on the Valley floor. Some of these Quaternary aquifers are, although thought to be extensive over the Valley floor, are also found on the south flank of the Valley overlying other bedrock types, such as the Halifax Formation. The Quaternary aquifers are also known to produce large quantities of very good quality water in other parts of the province of Nova Scotia. Wells drilled into the Halifax HU produce only marginal yields of water that often contains minerals at levels that are problematic as a drinking water source.

Groundwater Hydrographs

The Province of Nova Scotia initiated, in 1964, a systematic evaluation of regional groundwater resources through the Groundwater Section of the Department of Mines. This work continued with the assistance of various federal programs and Departments until the mid 1980's. Exploratory wells developed for the various regional projects were monitored to obtain specific baseline data of groundwater elevations and to document groundwater level fluctuations. A report "Groundwater Hydrographs in Nova Scotia 1965-1981" was published by the Nova Scotia Department of the Environment in 1984. This report presents a summary of recorded groundwater levels in tabular and graphical formats. These data and graphs illustrate the probable occurrence, by extension, of groundwater levels in the hydrogeologic units surrounding the wells.

Groundwater hydrograph records in the general area of Waterville indicate periods of recession during the summer months followed by recovery during the autumn over a 16 year period from 1965 – 1981. The groundwater level monitoring wells were constructed in different hydrostratigraphic units in the Valley. Observation well #001 (OW#001) was constructed in the Quaternary sand and gravel HU aquifer, in 1964, underlying the Coldbrook area north of Highway #1. It is located approximately 8 km east of the Twin Mountain Construction aggregate site at Waterville. Observation well #011 was constructed in the Halifax HU underlying the Prospect/Lloyds area in 1971. It is located approximately 3 km southeast of the study area of this EA and the location is shown in Figure 1. Observation well #032 was constructed in the Wolfville HU underlying the Berwick area in 1964. It is located approximately 5 km northwest of the aggregate site.

During the period of record water level fluctuations of approximately 10 feet were documented, in the Coldbrook area, where water levels fluctuated between 40 and 50 feet above mean sea level. Over the sixteen year period of record a maximum water level of 49.90 feet above mean sea level was recorded on 31 May 1971. The minimum water level was recorded at 39.62 feet above mean sea level on 28 November 1965. The range of fluctuations and seasonal trends in groundwater levels are shown in the hydrographs included in Appendix C.

Observation well #001 was drilled to a depth of 86 feet through Quaternary sand and gravel deposits. Triassic sandstones (Wolfville Formation) was encountered between 86 and 93 feet where drilling was discontinued. A well screen was installed in the well over the interval between 81 and 93 feet below ground surface. The well was used as an observation well during a pumping test of a nearby well also constructed in the Quaternary HU. From these data a value for T was calculated as 85,000 igpd/ft, and a value of S was calculated to be 2.21×10^{-4}.

Observation well #011 (OW#011) was constructed in the Halifax HU, on the south flank of the Valley at Prospect near Sharpe Brook. This well was drilled during September 1970, to a depth of 100 feet below ground surface. The well penetrated Quaternary sand and gravel deposits from 0 to 11 feet, where slates of the Halifax Formation were encountered to the bottom of the well at 100 feet. The graphical hydrograph records of this groundwater observation well is shown in Figure 3.

During the ten year period of record at the Prospect site water level fluctuations of approximately 8.6 feet were documented, where water levels in that well fluctuated between 430.09 and 438.66 feet above mean sea level. The maximum water recorded was 438.66 feet ASL on 29 January 1979. The minimum water recorded in OW #011 during the period of record was 430.09 feet ASL on 31 October 1973. No pumping test was carried out on OW #011. However T values from wells constructed in the Halifax HU south of the Valley average approximately 415 igpd/ft, and S values average approximately 4×10^{-5}.

During the period of record water level fluctuations of approximately 13 feet were documented, in the Berwick area, where water levels fluctuated between 128 and 141 feet above mean sea level. Over the nine year period of record a maximum water level of 141.12 feet above mean sea level was recorded on 16 March 1965. The minimum water level was recorded at 127.60 feet above mean sea level on 2 November 1970. The water level hydrograph record for OW #032 is shown in Appendix D.

Observation well #032 was drilled to a depth of 705 feet through siltstones, sandstones, and conglomerates of Triassic Age (Wolfville HU). Bedrock was encountered at approximately 20 feet below ground surface. Casing was installed in the well to a depth of 84 feet below ground surface because of soft, weathered, and unstable bedrock. No pumping test was conducted on this well. However pumping tests carried out on wells constructed in the Wolfville HU throughout the valley typically show values for T in the range of 2,000 to 3,000 igpd/ft, and values of S in the range of 1.5×10^{-4} to 2.5×10^{-4}.

Note that the minimum recorded low water levels fall on dates late in the growing season Whereas the maximum recorded high water levels occur during the winter or spring seasons. This distribution of lows and highs strongly suggests that there is no downward trend in groundwater levels in the area during that period. These lows are related to climatic cycles of low precipitation rather than increased withdrawals of groundwater.

Table 7 identifies three groundwater observation wells near the study area that have been, or are now being, monitored by staff of the NSDEL. The status of a number of other former monitoring wells is being reviewed and their condition assessed for reactivation and upgrading with new digital recording equipment.

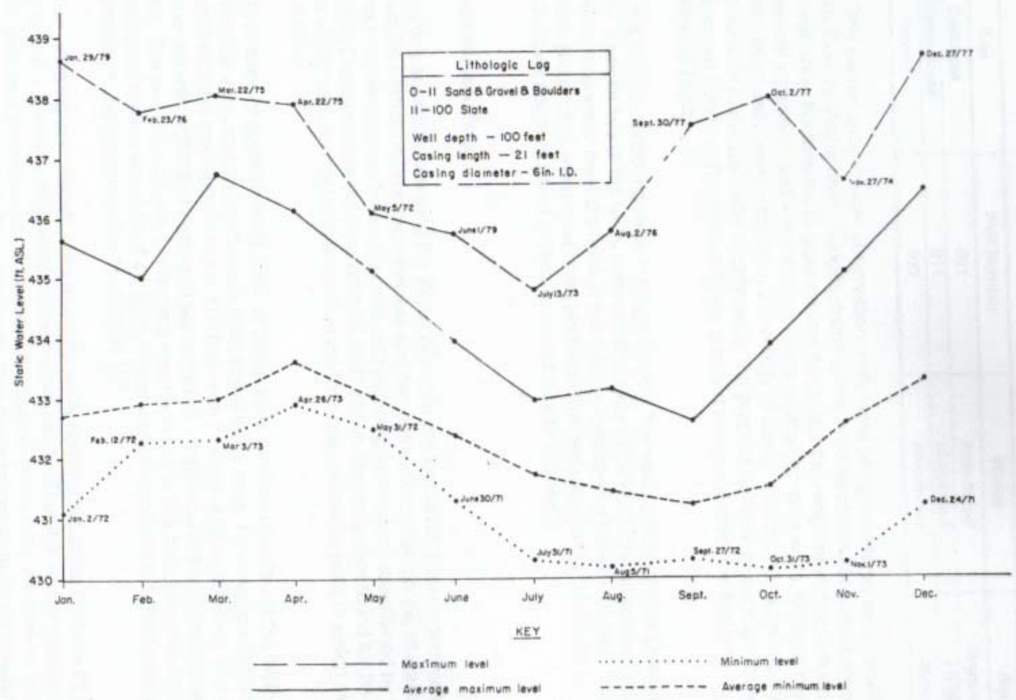


FIGURE 3 SHARPE BROOK—N.S.D.O.E. OBSERVATION WELL 011, 1971–1981

TABLE 7. Groundwater Observation Wells Near The Study Area.

Site	Well Number	Status	Aquifer
Coldbrook	001	Abandoned	Quaternary HU
Sharpe Brook	011	Abandoned	Halifax HU
Berwick	032	Abandoned	Wolfville HU

In 1984 eleven groundwater observation wells were being monitored were located in Kings County. Water level changes documented in these observation well network records show fluctuations in groundwater levels due to precipitation, tidal influence, seasonal variations, and water removal from nearby pumping wells. Many of these observation wells were installed in the vicinity of newly constructed, large capacity industrial or municipal water supply wells, the purpose being to monitor and observe drawdown trends in the aquifers being pumped at high rates for the first time on a sustained basis.

Of the eleven monitoring wells in Kings County, five were constructed in Quaternary HUs. Another five of the wells were constructed in Wolfville HUs, and one monitoring well records water level changes in the Halifax Formation (Halifax HU) near Sharpe Brook. Records of water level changes in the five wells located in the Quaternary sand and gravel deposits are of particular importance to this study.

Bedrock Aquifers

Bedrock aquifers underlying the Waterville area are located in Triassic sediments of the Wolfville Formation. The most reliable and complete information on the characteristics of these aquifers comes from water well and pumping test records maintained by the Nova Scotia Department of the Environment and Labour. Records were found for 20 wells in the water well records database within the four map reference grids in which the study area lies.

Seventeen, or approximately 85%, of these wells were constructed in the Wolfville HU within, or very near, the northern portion of the study area. The average depth of well constructed in the Wolfville HU is 126 feet, with a range of 55 to 360 feet. The deepest reported well is 360 feet deep and was rated at 1.0 igpm based on a preliminary air lift test. The bedrock well with the highest reported yield is 175 feet deep and has a estimated preliminary yield of 45 igpm. Three wells located in the Lloyds area are believed to be constructed in the Halifax HU.

Five pumping test records were found for wells constructed in the Wolfville HU. The yield of a well is primarily dependent on the transmissivity (T) of the aquifer supplying water to the well, and the saturated thickness of the section penetrated. As seen in Table 6, T values vary significantly from site to site thus giving higher yields for shallower wells with higher T values. The variation of T in these aquifers is related to the grain size and fracturing, which can be seen to vary over short vertical and horizontal distances in local outcrops. The range of T values in the Wolfville HU underlying the Waterville area varies from 230 igpd/ft to 2,200 igpd/ft. Based on these values of T and 100 feet of available drawdown, the safe 20 year continuous well yield ranges from 11 to 105 igpm.

Quaternary Aquifers

The shallow Quaternary deposits, those most recently deposited by the last glacial activity on the Valley floor have been mapped in two dimensions at a reconnaissance scale by Trescott, 1968. The depth, stratigraphy, subsurface extension, and distribution of older deposits are not known. However, water well records and pumping test data suggest a complex system of interstratified deposits of different ages underlying the Valley floor in the vicinity of the aggregate extraction site in Waterville. The most productive wells, i.e. highest capacity, have been constructed in Quaternary aquifers from Wolfville through to Greenwood.

Nineteen records were found for wells constructed in Quaternary deposits near the study area of the sand and gravel operation in Waterville. These records are included in Table 4. Five pumping test records were found for wells in the Quaternary HU in the general area of Waterville. A summary of the well and pumping test information is provided in Table 6. The depths of these wells are significantly less than that for bedrock wells, and the yield is much higher, which is normal for well constructed in these types of aquifers. The range of T values in the Quaternary deposits underlying the Waterville area varies from 6,294 igpd/ft to 63,360 igpd/ft. From the above values of T, and a total available drawdown of 100 feet, the 20 year continuous safe yield of wells constructed in the Quaternary HU range from 141 to 1,543 igpm. The average depth of these wells is 79 feet, and range from 79 to 138 feet.

An indication of expected yields from properly located and constructed wells in aquifers in the Waterville area is available from a review of the pumping test data. Based on the average transmissivity 1,032 igpd/ft for the Wolfville HU, yields in the range of approximately 40 gpm. can be expected from wells with 100 feet of available drawdown. The average transmissivity of 23,960 igpd/ft in the Quaternary HU in the area suggests that well yields in the order of 900 igpm can be expected from wells with 100 feet of available drawdown.

Groundwater Quality

Groundwater quality can change significantly over a very short horizontal and or vertical distance because of the influence of minerals in the host bedrock or overburden materials. A distinctive difference between water from the Wolfville HU and the Halifax HU is often the presence of metals in water from the latter HU. Two metals of concern from a health and environmental perspective include arsenic and uranium that are known to occur in units of the Halifax Formation.

Because of the nature of the sand and gravel extraction operation at the Waterville site, and the proximity of the contact to the Halifax Formation, the main chemicals of concern with respect to groundwater contamination are pH, iron, manganese, sulphate, arsenic, cadmium, uranium, and total dissolved solids. The sulphide mineral components of the underlying Halifax Formation may be a source of the above chemicals. These components in an acidified groundwater flow system are very mobile and can move down gradient in the groundwater flow system. Under these acidic conditions other mineral constituents such as aluminum, copper, lead, zinc, arsenic, cadmium, and uranium which are present as minerals in the Halifax Formation in many parts of the

Province may also be introduced into the groundwater and the nearby aquatic ecosystem as contaminants.

Arsenic compounds derived from acid producing slates may exceed the Guidelines for Canadian Drinking Water Quality. Arsenic is classed as being carcinogen to humans. On the basis of a carcinogenic risk of arsenic compounds to humans a maximum acceptable concentration (MAC) for arsenic in drinking water of 0.025 milligrams per litre (mg/L) is recommended as an interim level in the Guidelines for Canadian Drinking Water Quality by Health Canada.

Uranium is a naturally occurring element associated with mineralization in various rock types found in Nova Scotia. The maximum acceptable concentration for uranium in drinking water, as derived from the acceptable daily intake of the compound, is 0.02 mg/L. The guideline for uranium is currently under review for possible revision owing to new data being considered for Canadian Drinking Water Quality.

A number of studies have been carried out on the quality of groundwater in the Halifax Formation across the province. Some of these studies have focused on arsenic and uranium because of the indication that a presence of these compounds in groundwater may be related to mining, aggregate extraction operations, and general disturbance of sulphide bearing material that are acid producing when exposed to the elements. Maps showing the areas along the south flank of the Valley where elevated levels of arsenic and or uranium in groundwater may be associated with geological and mineral occurrences related to the Halifax Formation are shown in Appendix E and Appendix F.

The only available data of unbiased background groundwater quality in the valley is that collected and reported by Trescott (1968) as part of the Groundwater and Hydrogeology Study of the Annapolis-Cornwallis Valley. A summary of the findings of groundwater quality based on the Trescott study is presented in Table 8 for the hydrostratigraphic units occurring under the area of Waterville. The parameters selected for comparison

Table 8. Summary of Groundwater Quality in the Waterville Area.

	pH	T.H. mg/L	Fe mg/L	Mn mg/L	$S0_4$ mg/L	Cl mg/L	TDS mg/L	$N0_3$-N mg/L
Wolfville HU	7.4	117	0.22	0.02	20.0	33.7	190	2.1
Quaternary HU	6.8	62	0.30	0.04	11.7	19.2	120	1.7
Halifax HU	6.6	57	0.34	0.09	6.3	23.8	100	1.2

as shown in Table 8 are pH, total hardness (T.H.), iron (Fe), manganese (Mn), sulphate ($S0_4$), chloride (Cl), total dissolved solids (TDS), and nitrate-nitrogen ($N0_3$-N).

GROUNDWATER MONITORING PROGRAM

Water quality monitoring in the vicinity of the sand and gravel extraction operation will serve four main purposes. These are listed as:

- To determine the background quality of groundwater in the area upgradient of the extraction operation.
- To assess whether groundwater contamination is occurring from the sand and gravel extraction operations.
- To assess and characterize potential migration pathways of potential contaminants off the site.
- To determine presence of, and risk to, receptors of contamination if it does exist.

The groundwater monitoring program planned for the aggregate extraction operation is scheduled to operate during the life of the aggregate extraction activities.

This report presents the results of the Phase I work carried out during December, 2003. Field work included a reconnaissance of the area, a review of groundwater data available, and selection of sites for future monitoring wells.

During the first year of sand and gravel extraction operations in the expansion area, Phase II will be implemented. This work will include drilling of boreholes, construction of monitoring wells, sample collection from the monitoring wells for chemical analyses, water level observations will be taken and recorded, groundwater flow patterns will be determined, and vertical field hydraulic gradient determinations will be made in strategic areas of the site. A report will be prepared and submitted to NSDEL reporting progress, results, and interpretation of the data over the first quarter for water quality and water level data.

Monitoring Wells

Overview

Strategic locations for boreholes, in which monitoring wells will be constructed, will be identified based on the hydrogeological setting of the site, soils types, drainage patterns, topography, and proposed active extraction areas. Locations and construction details of monitoring wells constructed on the site for this phase of the project will be documented. Most of the monitoring wells will be single level structures which penetrate the water table in the underlying surficial and/or bedrock materials. Two monitoring wells will be multilevel types with a shallow and a deeper portion designed to determine vertical groundwater gradients in selected area of the site. Following well development, water levels will be determined for each of the monitoring wells. Water samples will be collected and analysed for selected chemical and physical parameters. Elevations of all monitoring wells will be determined to assist in calculating groundwater flow gradients and groundwater flow directions.

Well construction will be accomplished with either a hydraulic rotary drill using a tricone bit, or a hollow stem auger drill, operated by an experienced drilling company. Temporary six inch diameter casing, or a hollow stem auger, will be driven into the geological materials, and the samples will be collected from inside the casing by drilling out the plug at 10 foot intervals, or when a change in geology is noted. Two inch diameter PVC casing and screens will be installed at selected depth intervals in the wells, gravel packing will be installed around the screen, and the upper cased portion of the wells will be grouted with bentonite. Once the casing, screen, gravel, and bentonite are in place the six inch diameter casing will be withdrawn to expose the screen to the water bearing zone to be monitored. Well development will be carried out by pumping with a bailer and/or a Waterra sampling device. Typical design and construction of monitoring wells to be used for this project is shown in Figure 2.

Existing wells:

There appears to be no existing wells in strategic areas on or around the property that are considered suitable for monitoring groundwater quality of relevance to this project. It was reported by the proponent that six monitoring wells were constructed north of the existing aggregate pit, and south of Rochford Brook. These monitoring wells were reported to have been installed as part of requirements for another project dealing with composted soils. Construction characteristics of the 6 monitoring wells located around the perimeter of the composting site are not available. These wells will therefore not be considered unless it can be determined that: 1. the construction of the MWs meets the standards of the typical design as presented in Figure 2; and 2. the location(s) of the MW meet the objectives of a groundwater monitoring program for this project. Three of these monitoring wells are shown in Photo #2 in Appendix G.

All private water supply wells in the area are either too far removed from the site, or occur on the other side of a natural hydraulic barrier provided by the Rochford Brook. Construction characteristics of the wells in the area are presented in Table 4. Assuming that each residence in the area has a water supply well, it can be expected that a well northwest of the site may be within 100 metres (300 feet) of the active working face at some stage during the history of the excavation project. During work for Phase II of the groundwater monitoring program it is proposed that a 'Water Supply Investigation' be carried out for wells within a 100 metre radius of the proposed active extraction area. There are no wells reported to be within 500 metres (1,500 feet) of the proposed active working area of other parts of the site. The separation distances from the sand and gravel pit operations can be seen in a general sense on Figure 1.

A review was carried out of the Public Drinking Water registration data base for Kings County as maintained by the NSDEL. Based on this review there are no public drinking water supplies registered in the immediate study area. The nearest public drinking water supplies registered are in the Berwick area and the Cambridge area, both areas are several kilometers from the site of interest for this study.

The nearest farm water supply well west of the existing extraction area is shown in Photo #3 in Appendix G, and in Figure 2, p. 10. of this document (red dot)

New Monitoring Wells

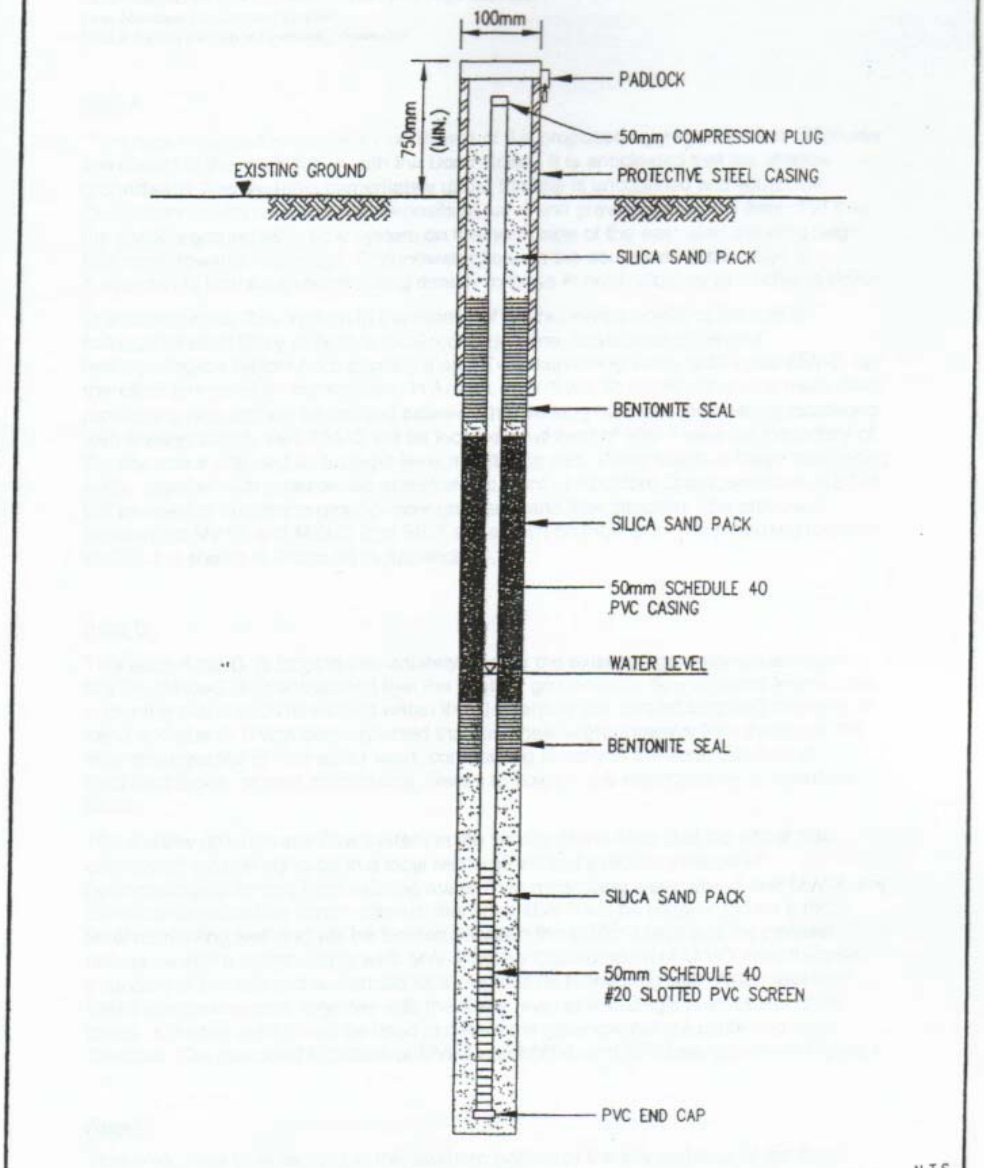
The location, design, and construction of monitoring wells will follow approved methods adopted as standard operating procedures for the industry and are appropriate for the site and nature of groundwater monitoring planned for the site. Basic criteria for the location, design, and construction of the monitoring wells include the following:

- Separation distances in compliance with well construction regulations.
- Location and number of monitoring wells based on consideration of the hydrogeological frame work of the site and sensitive area identified in the environmental assessment report.

- Depths of wells determined by the stratigraphic sequence encountered during drilling, depth to water table, and expected annual and seasonal groundwater level range of fluctuations.
- Minimum diameter of wells to be 50 mm inside diameter.
- Use of PVC schedule 40 flush joint pipe and screens with a minimum 50 mm thick gravel pack and bentonite grout in the appropriate sections of the borehole surrounding the well casing and screen.
- An approved plug on the bottom and an approved cap on the top of the casing will be placed to ensure the integrity of the monitoring well from the intrusion of surface water.
- The selection of screened sections will be based on the hydrogeologic conditions encountered and the stratigraphic section penetrated.
- Groundwater and well head elevations, and horizontal references for the well head, will be determined and documented as part of the record of the monitoring well construction.
- A graphic sketch of the typical well construction planned during this project is included in Figure 2 showing construction details and the use of casing, screens, sand, and grout to ensure integrity of the sample source.
- Well heads will be protected from traffic in the area by use of locking plugs in above grade steel casing serving as manholes to provide protective cover and security.

Monitoring well design and construction applied during this project are those that are typical of acceptable standards in the environmental industry. Figure 4 shows the typical design characteristics for monitor well construction planned for use during this project. All monitoring wells completed will have protective steel casing installed with caps locked in place to ensure security and protection of the monitoring system.

Monitoring well locations will be selected after consideration of local hydrogeological conditions of the site, traffic patterns in the area, and sensitive environmental components identified in the Environmental Assessment Report prepared by Hendricus Van Wilgenburg. For planning purposes at this point in the environmental assessment, three areas of the proposed operation are identified as being potential concerns for impacting on groundwater supplies adjacent to the site. These areas are shown as A, B, and C on Figure 1. The proposed locations for monitoring wells to be constructed during Phase II of the groundwater monitoring program, and stream points of reference, for this project are also shown in Figure 1.



TITLE	PROJECT No.
TYPICAL MONITOR WELL CONSTRUCTION	
PROJECT	FIGURE 4
DATE	

Area A

This area is located immediately northwest of the proposed aggregate pit near Highway 1 and east of the intersection with the Bond Road. It is anticipated that the shallow groundwater flow systems immediately under the site is unconfined and within the Quaternary ice-contact stratified deposits of sand and gravel. It was also expected that the shallow groundwater flow system on the north side of the east-west trending ridge flow north towards Highway1. Groundwater flow on the south side of the ridge is suspected to flow south contributing directly to flows in north tributary of Rochford Brook.

The groundwater flow system in the vicinity of the northwest corner of the site is considered most likely to be in a local recharge zone, based on a review of hydrogeological factors from existing maps. Two monitoring wells, MW-1 and MW-2, are therefore proposed for construction in Area A. MW-1 will be constructed as a multi- level monitoring well and will be located between the working face and the nearest residence with a water supply well. MW-2 will be located southeast of MW-1 near the boundary of the site and is planned as a single-level monitoring well. Water levels in these monitoring wells, together with water levels at a strategic point of Rochford Brook, selected at BR-1 will be used to determine groundwater gradients and flow direction. The proposed locations of MW-1 and MW-2, and BR-1 are shown on Figure 1. The proposed location for BR-1 is shown in Photo #4 in Appendix G.

Area B

This area, Area B, is located immediately west of the existing aggregate pit and east of the Bond Road. It is anticipated that the shallow groundwater flow systems immediately under the site is unconfined and within the Quaternary ice-contact stratified deposits of sand and gravel. It was also expected that the shallow groundwater flow system in this area is suspected to flow either west, contributing directly to the north tributary of Rochford Brook, or east contributing directly to flows in the east tributary of Rochford Brook.

The shallow groundwater flow system in the vicinity of the Area B of the site is also considered most likely to be in a local recharge zone, based on a review of hydrogeological factors from existing maps. Two monitoring wells, MW-3 and MW-4, are therefore proposed for construction in this area. MW-3 will be constructed as a multi-level monitoring well and will be located between the working face and the nearest residence with a water supply well. MW-4 will be located south of MW-3 near the west boundary of the site and is planned as a single-level monitoring well. Water levels in these monitoring wells, together with the water level at a strategic point of Rochford Brook, selected at BR-2 will be used to determine groundwater gradients and flow direction. The proposed locations of MW-3 and MW-4, and BR-2 are shown on Figure 1.

Area C

This area, Area C, is located in the southern portion of the site and east of the Bond Road. It is anticipated that the shallow groundwater flow system immediately under the site is unconfined and within the Quaternary ice-contact stratified deposits of sand and gravel. It was also expected that the shallow groundwater flow system in this area is suspected to flow either west, contributing directly to the west tributary of Rochford Brook, or east contributing directly to flows in the east tributary of Rochford Brook.

The shallow groundwater flow system in the vicinity of the Area C of the site is also considered most likely to be in a local recharge zone, based on a review of hydrogeological factors from existing maps. Two monitoring wells, MW-5 and MW-6, are therefore proposed for construction in this area. MW-5 will be constructed as a multi-level monitoring well and will be located between the working face and the nearest residence with a water supply well, west of the proposed extraction area. MW-6 will be located south of MW-5 near the west boundary of the site and is planned as a single-level monitoring well. Water levels in these monitoring wells, together with the water level at a strategic point of Rochford Brook, selected at BR-3 will be used to determine groundwater gradients and flow direction. The proposed locations of MW-5 and MW-6, BR-3 are shown on Figure 1.

Groundwater Flow Patterns

Elevations and horizontal location coordinates of the monitoring well reference points and surface water points of interest will be determined. Elevations will be referenced to mean sea level within approximately 1.2 inch (3.0cm). Horizontal location coordinates will be determined within 0.40 inch (10 mm). The locations and elevations of the points of interest will be shown in the Phase II report.

Groundwater flow patterns will be determined for each if the three areas within the sand and gravel extraction Waterville operation. A general groundwater flow pattern, and gradient, will be determined for Area A, Area B, and Area C, by using data from the monitoring wells and the surface reference points.

An assessment of groundwater flow in the vicinity of existing water supply wells near each of the monitoring areas will also made based on water heads and the stratigraphic sections interpreted in the monitoring wells.

Static water levels for the monitoring wells will be measured using an electronic water level meter in as short a time interval among readings as is practical. The static water levels will be referenced to the top of the monitoring well casings, and converted to head above mean sea level.

The groundwater elevations from the monitoring wells and the surface water reference points will be used to calculate the hydraulic gradient and determine groundwater flow direction in the vicinity of each designated area. The control point locations, separation distances of the control points, equipotential lines, and groundwater flow direction in each area will be shown figures.

The vertical groundwater flow gradient will be determined in MW-1, MW-3, and MW-5 to assess whether theses areas are located in recharge or discharges parts of the groundwater flow system(s) in the area. This information will also allow interpretation of flow between the overlying Quaternary sand deposits and the underlying Triassic sandstones underlying the site.

WATER QUALITY

Sampling Protocols and Procedures

All monitoring wells will be developed by pumping at rates varying between one and two gallons per minute. Pumping will be carried out initially by bailing with one litre volume disposable plastic bailers. After this initial development, a dedicated Waterra sampling device will be installed in each well for the purpose of purging and sampling.

When collecting samples from monitoring wells for chemical analyses, protocols developed and used in the industry will be followed to ensure representative samples of groundwater are obtained. At the time of entry to a monitoring well a measurement of the depth to water will be taken and recorded for later use in determining groundwater flow. Prior to sampling the well will be purged to remove at least 3 pore volumes of water from the monitoring well before a sample is collected.

Water samples will be collected using approved equipment. For this project dedicated Waterra tubing and foot valves will be installed in all nine monitoring wells for the purposes of well development and collection of water samples. Samples will be collected in clean plastic bottles, as supplied by an approved Laboratory. These bottles are of sufficient quantity for the desired suite of parameters for RaCAP-MS analyses. Storage of the samples will be in a controlled cool environment and delivered to the analytical laboratory within 24 hours of sample collection for analyses.

One of the concerns with respect to groundwater quality and the gravel extraction operation in this area is the potential for acid rock drainage from slate particles encountered as clasts, or components, in the gravel deposits. The proximity to the Halifax Formation as shown in Figure 1 give rise to this concern. The potential is only identified for the aggregate pit portion of the operation in the southern portion of the site. For example, a significant portion of the gravel particles from the extreme south part of the site may reflect the nature of the underlying bedrock slate (Halifax Formation), as seen in Figure1, where it makes geologic contact with the Triassic sediments.

Monitoring Schedule

For operation of the facility the suite of parameters and frequency of sampling and analyses is based on requirements to determine the chemical characteristics of groundwater in the vicinity of the site. This information will be used for future comparisons of groundwater quality within the area of influence of the sand and gravel extraction operation and the quality of groundwater in the immediate vicinity outside the area of influence of the aggregate extraction operations. The water quality parameters of interest include those of general chemical, metals, and physical nature.

During Phase II of the program, or the first month of monitoring, a water sample will be collected from each of the monitoring wells. Analyses for these samples will include the following parameters: calcium; magnesium; sodium; potassium, chloride; sulphate; iron; arsenic, uranium, manganese; copper; nitrate; nitrite; ammonia; alkalinity; pH; total hardness; total dissolved solids; specific conductance; a metal scan, and temperature.

Sampling frequency, wells to be sampled, and parameters of interest during phase III, the first year of monitoring, will be determined on the basis of results obtained during phase II and discussions with staff of the NSDEL. In the interim a schedule of monitoring requirements is presented in Table 9.

As a guide for future seamless planning and operation of the groundwater monitoring program for the Twin Mountain Construction Aggregate Extraction undertaking at the Waterville site, a schedule of monitoring is being proposed. This schedule will assist future work and allow for a continuity of sampling and analyses of the environmental groundwater conditions of the site. This schedule is outlined in Table 9 below.

Table 9. Proposed Monitoring Requirements During Extraction Operations

Parameter	Source	Frequency	Reporting
Quantity			
Water Level	MWs	Quarterly	Quarterly
" "	BRs	"	"
Quality			
Field Measurements:			
Conductance	All MWs	"	"
Temperature	All MWs	"	"
PH	All MWs	"	"
Laboratory Analyses:			
RcAP-MS	All MWs	Annual	Annual
Iron	All MWs	Quarterly	Quarterly
Manganese	"	"	"
Calcium	"	"	"
Magnesium	"	"	"
Potassium	"	"	"
Chloride	"	"	"
Total hardness	"	"	"
Alkalinity	"	"	"
pH	"	"	"
Sulphate	"	"	"
Specific conductance	"	"	"
Copper	"	"	"
Zinc	"	"	"
Nitrate-N	"	"	"
Sodium	"	"	"
Ammonia	"	"	"
Arsenic	"	"	"
Uranium	"	"	"
Total Dissolved solids	"	"	"

Water quality monitoring in the vicinity of the sand and gravel extraction operation will serve four main purposes. The first objective is to determine the background quality of groundwater in the area up-gradient of the extraction operation. The second objective is to assess whether groundwater contamination is occurring from the sand and gravel extraction operations. The third objective is to assess and characterize potential migration pathways of potential contaminants off the site. The fourth objective is to determine presence of, and risk to, receptors of contamination if it does exist. The groundwater monitoring program planned for the aggregate extraction operation is scheduled to be fully implemented over a six month period.

This report is intended to serve as Phase I which documents the physical setting, describes the related available data bases for the area, and outlines the scope of work to be carried out during Phase II and Phase III.

Phase I - Completed during December, 2003, and included compilation of data and documentation on geology, hydrogeology, and water quality in the area. This information was assessed and interpreted to design a drilling and monitoring well construction program. This report is to be submitted to the NSDEL, as part of the Environmental Assessment of the project, to outline the plan and maintain dialogue on the monitoring program.

Phase II - During June, 2004, construct a minimum of six (6) groundwater monitoring wells, prepare a log of the stratigraphy under the site, determine groundwater levels, sample groundwater for initial water quality characteristics, determine groundwater flow patterns and gradients, and identify potential down gradient receptors. A report would be prepared and submitted to the NSDEL for their review and information.

Phase III - During the first year of sand and gravel extraction operations, June 2004 to June 2005, samples would be collected from the monitoring wells for chemical analyses. A report will be prepared and submitted to NSDEL reporting progress, results, and trends in data over the one year period for water quality and water level data.

SUMMARY OF FINDINGS

The following summarizes the findings of this environmental assessment and groundwater monitoring plan for the proposed expansion of the aggregate extraction operation by Twin Mountain Construction at the Waterville site:

- The aggregate materials of interest under the site are classified as Ice-contact Stratified Drift of Quaternary age.
- No existing, private or public, water supplies are believed to exist within the footprint of the proposed expanded aggregate extraction area.
- The nearest private water supply well to the proposed expanded area appears to be in the northwest portion of the site identified as Area A.
- Bedrock aquifers underlying the area north, east, and west of the site are classified as the Wolfville Hydrostratigraphic Unit.
- The bedrock units and aquifer underlying the area south of the site is classified as the Halifax Formation and Hydrostratigraphic Unit.
- Bedrock units of the Halifax Formation may contain sulphide mineralization that can potentially produce acid rock drainage if they are disturbed during the aggregate extraction operations.
- No points of permitted water withdraw as allocated by the NSDEL are located within or near the site.
- A groundwater monitoring program has been outlined for implementation as part of the environmental assessment for this project.
- Groundwater sampling protocols, procedures, and a monitoring schedule have been outlined for this project.

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APPENDIX A

Summary of Monthly Weather Data Recorded at Kentville For Growing Season 2002 and 2003.

Atlantic Food & Horticulture Research Centre, KENTVILLE, N.S.

MONTHLY SUMMARY - JUNE 2002

	Degree C			Heat Units Degree C				Precipitation			
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	25.4	8.9	17.2	12.2	7.1	0.9	20.0	0.0	11.4	14.8	6.8
2	18.2	4.7	11.5	6.5	1.4	6.6	11.0	1.9	4.2	13.1	2.5
3	14.2	4.9	9.6	4.6	0.0	8.5	6.0	0.0	6.7	13.3	3.6
4	18.2	4.0	11.1	6.1	1.1	6.9	11.0	0.0	12.2	6.5	4.8
5	16.2	10.3	13.3	8.3	3.3	4.8	13.0	0.7	0.0	11.6	1.7
6	16.2	9.8	13.0	8.0	3.0	5.0	13.0	2.3	0.0	5.0	0.0
7	14.8	1.2	8.0	3.0	0.0	10.0	7.0	0.0	1.3	5.8	0.0
8	19.1	9.6	14.4	9.4	4.4	3.6	17.0	0.0	10.4	6.0	0.0
9	19.5	9.1	14.3	9.3	4.3	3.7	17.0	6.8	2.9	10.4	0.4
10	15.3	5.1	10.2	5.2	0.2	7.8	8.0	0.4	4.0	10.0	2.8
11	14.1	6.6	10.4	5.4	0.3	7.7	8.0	0.6	0.0	3.8	0.6
12	17.1	1.7	9.4	4.4	0.0	8.6	10.0	0.0	2.6	6.2	3.8
13	20.6	6.6	13.6	8.6	3.6	4.4	16.0	0.0	11.8	6.0	4.8
14	21.9	4.5	13.2	8.2	3.2	4.8	14.0	0.6	11.8	4.7	6.6
15	16.2	6.4	11.3	6.3	1.3	6.7	10.0	16.1	0.9	9.0	1.7
16	11.7	6.6	9.2	4.1	0.0	8.9	5.0	0.7	0.0	4.0	0.0
17	16.2	9.8	12.5	7.5	2.5	5.5	12.0	0.0	0.7	4.4	1.6
18	20.5	8.2	14.4	9.4	4.4	3.7	16.0	0.0	8.1	5.0	2.3
19	20.9	7.5	14.2	9.2	4.2	3.8	16.0	0.0	6.2	5.2	1.6
20	26.7	9.0	17.9	12.9	7.9	0.1	20.0	0.0	12.6	5.2	2.5
21	28.6	14.5	21.6	16.6	11.6	0.0	28.0	0.0	12.8	10.9	12.9
22	23.8	7.4	15.6	10.6	5.6	2.4	17.0	0.0	4.1	5.1	4.8
23	25.3	13.7	19.5	14.5	9.5	0.0	24.0	10.6	7.2	11.4	1.0
24	18.1	12.9	15.5	10.5	5.5	2.5	18.0	0.0	3.8	19.8	7.0
25		9.3	9.3	4.3	0.0	8.7	19.0	0.0	12.2	9.8	4.8
26	27.2	15.0	21.1	16.1	11.1	0.0	26.0	3.7	11.8	6.9	6.3
27	29.1	15.8	22.5	17.5	12.5	0.0	27.0	0.7	6.1	13.0	2.6
28	24.1	15.4	19.8	14.8	9.8	0.0	25.0	0.7	3.0	4.0	3.1
29	24.3	12.5	18.4	13.4	8.4	0.0	23.0	0.0	9.7	9.0	9.6
30	26.6	11.5	19.1	14.1	9.1	0.0	23.0	0.0	8.8	4.1	4.8
SUM				280.5	135.1	125.3	478	45.8	167.3		105.0
MEAN	20.3	8.8	14.4							8.1	
SAME MONTH LAST YEAR											
	24.1	12.6	18.3	400.3	250.6	46.2	654	80.4	212.5	8.0	133.8
41 YEAR AVERAGE (1961-2001)											
	22.0	10.2	16.1	332.9	184.8	79.9		67.5	211.9		
5 YEAR AVERAGE (1997-2001)											
	22.8	11.3	17.0	361.0	213.7	68.1	588	51.4	213.2	8.0	133.2
EXTREME											
MAX	29.1	15.8	22.5	17.5	12.5	10.0	27.0	16.1	12.8	19.8	12.9
MIN	11.7	1.2	8.0	3.0	0.0	0.0	5.0	0.0	0.0	3.8	0.0
T=trace											

- 32 %

Atlantic Food & Horticulture Research Centre, KENTVILLE, N.S.

MONTHLY SUMMARY - JUNE 2002

	Degree C			Heat Units Degree C				Precipitation			
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	25.4	8.9	17.2	12.2	7.1	0.9	20.0	0.0	11.4	14.8	6.8
2	18.2	4.7	11.5	6.5	1.4	6.6	11.0	1.9	4.2	13.1	2.5
3	14.2	4.9	9.6	4.6	0.0	8.5	6.0	0.0	6.7	13.3	3.6
4	18.2	4.0	11.1	6.1	1.1	6.9	11.0	0.0	12.2	6.5	4.8
5	16.2	10.3	13.3	8.3	3.3	4.8	13.0	0.7	0.0	11.6	1.7
6	16.2	9.8	13.0	8.0	3.0	5.0	13.0	2.3	0.0	5.0	0.0
7	14.8	1.2	8.0	3.0	0.0	10.0	7.0	0.0	1.3	5.8	0.0
8	19.1	9.6	14.4	9.4	4.4	3.6	17.0	0.0	10.4	6.0	0.0
9	19.5	9.1	14.3	9.3	4.3	3.7	17.0	6.8	2.9	10.4	0.4
10	15.3	5.1	10.2	5.2	0.2	7.8	8.0	0.4	4.0	10.0	2.8
11	14.1	6.6	10.4	5.4	0.3	7.7	8.0	0.6	0.0	3.8	0.6
12	17.1	1.7	9.4	4.4	0.0	8.6	10.0	0.0	2.6	6.2	3.8
13	20.6	6.6	13.6	8.6	3.6	4.4	16.0	0.0	11.8	6.0	4.8
14	21.9	4.5	13.2	8.2	3.2	4.8	14.0	0.6	11.8	4.7	6.6
15	16.2	6.4	11.3	6.3	1.3	6.7	10.0	16.1	0.9	9.0	1.7
16	11.7	6.6	9.2	4.1	0.0	8.9	5.0	0.7	0.0	4.0	0.0
17	16.2	9.8	12.5	7.5	2.5	5.5	12.0	0.0	0.7	4.4	1.6
18	20.5	8.2	14.4	9.4	4.4	3.7	16.0	0.0	8.1	5.0	2.3
19	20.9	7.5	14.2	9.2	4.2	3.8	16.0	0.0	6.2	5.2	1.6
20	26.7	9.0	17.9	12.9	7.9	0.1	20.0	0.0	12.6	5.2	2.5
21	28.6	14.5	21.6	16.6	11.6	0.0	28.0	0.0	12.8	10.9	12.9
22	23.8	7.4	15.6	10.6	5.6	2.4	17.0	0.0	4.1	5.1	4.8
23	25.3	13.7	19.5	14.5	9.5	0.0	24.0	10.6	7.2	11.4	1.0
24	18.1	12.9	15.5	10.5	5.5	2.5	18.0	0.0	3.8	19.8	7.0
25		9.3	9.3	4.3	0.0	8.7	19.0	0.0	12.2	9.8	4.8
26	27.2	15.0	21.1	16.1	11.1	0.0	26.0	3.7	11.8	6.9	6.3
27	29.1	15.8	22.5	17.5	12.5	0.0	27.0	0.7	6.1	13.0	2.6
28	24.1	15.4	19.8	14.8	9.8	0.0	25.0	0.7	3.0	4.0	3.1
29	24.3	12.5	18.4	13.4	8.4	0.0	23.0	0.0	9.7	9.0	9.6
30	26.6	11.5	19.1	14.1	9.1	0.0	23.0	0.0	8.8	4.1	4.8
SUM				280.5	135.1	126.3	478	45.8	167.3		105.0
MEAN	20.3	8.8	14.4							8.1	
SAME MONTH LAST YEAR											
	24.1	12.6	18.3	400.3	250.6	46.2	654	80.4	212.5	8.0	133.8
41 YEAR AVERAGE (1961-2001)											
	22.0	10.2	16.1	332.9	184.8	79.9		67.5	211.9		
5 YEAR AVERAGE (1997-2001)											
	22.8	11.3	17.0	361.0	213.7	68.1	588	51.4	213.2	8.0	133.2
EXTREME											
MAX	29.1	15.8	22.5	17.5	12.5	10.0	27.0	16.1	12.8	19.8	12.9
MIN	11.7	1.2	8.0	3.0	0.0	0.0	5.0	0.0	0.0	3.8	0.0
T=trace											

- 32 %

MONTHLY SUMMARY - JULY 2002

	Degree C			Heat Units Degree C							
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	24.3	14.5	19.4	14.4	9.4	0.0	25	0.0	3.6	6.7	2.4
2	27.9	15.3	21.6	16.6	11.6	0.0	26	0.0	6.1	4.7	4.8
3	30.2	18.5	24.4	19.4	14.4	0.0	30	0.0	8.8	4.8	3.4
4	32.6	18.1	25.4	20.4	15.4	0.0	28	0.0	8.9	6.0	6.0
5	26.8	15.3	21.0	16.0	11.0	0.0	26.0	0.0	6.0	6.1	4.8
6	22.9	12.8	17.9	12.9	7.9	0.1	22.0	0.0	10.5	7.7	6.8
7	21.1	12.7	16.9	11.9	6.9	1.1	21.0	0.6	3.7	4.7	0.0
8	25.9	16.6	21.3	16.3	11.3	0.0	27.0	3.1	8.0	8.6	7.9
9	25.7	16.6	21.2	16.2	11.2	0.0	27.0	4.6	3.6	8.3	0.0
10	23.9	9.7	16.8	11.8	6.8	1.2	20.0	0.7	10.4	11.3	9.5
11	20.2	12.5	16.4	11.4	6.4	1.6	20.0	0.0	8.7	14.2	7.2
12	23.6	11.7	17.7	12.7	7.6	0.4	22.0	0.0	12.6	10.5	8.2
13	27.8	15.3	21.6	16.6	11.6	0.0	26.0	0.0	10.6	10.8	7.2
14	26.8	15.5	21.2	16.2	11.2	0.0	27.0	0.0	10.8	5.3	4.8
15	27.3	14.3	20.8	15.8	10.8	0.0	25.0	0.0	10.9	9.0	7.1
16	22.4	14.0	18.2	13.2	8.2	0.0	23.0	5.7	4.4	6.1	3.3
17	22.1	14.6	18.4	13.4	8.4	0.0	23.0	0.0	4.1	6.6	2.4
18	23.7	11.0	17.4	12.4	7.4	0.6	21.0	0.0	3.6	1.0	2.4
19	25.5	14.6	20.1	15.1	10.1	0.0	25.0	41.4	9.0	6.4	5.4
20	18.4	8.8	13.6	6.6	3.6	4.4	15.0	0.6	1.5	7.3	2.6
21	24.9	12.0	18.5	13.5	8.5	0.0	22.0	0.0	12.3	4.8	6.4
22	28.3	18.5	23.4	18.4	13.4	0.0	29.0	0.0	11.3	13.0	7.2
23	33.5	13.8	23.7	18.7	13.7	0.0	24.0	0.8	9.8	11.7	8.0
24	22.8	8.2	15.5	10.5	5.5	2.5	18.0	0.0	12.9	6.1	7.2
25	21.9	7.1	14.5	9.5	4.5	3.5	16.0	0.0	13.5	13.5	4.8
26	23.6	9.7	16.7	11.7	6.6	1.4	20.0	0.0	12.1	5.8	9.6
27	19.3	9.5	14.4	9.4	4.4	3.6	17.0	0.0	3.7	5.0	2.4
28	23.1	14.2	18.7	13.7	8.7	0.0	23.0	0.0	5.0	5.1	4.8
29	23.4	18.6	21.0	16.0	11.0	0.0	26.0	0.0	2.9	7.2	2.4
30	25.9	18.6	22.3	17.3	12.3	0.0	29.0	0.6	2.6	4.5	2.8
31	28.3	17.0	22.7	17.7	12.7	0.0	28.0	0.0	12.4	10.2	9.6
SUM				446.7	291.8	20.6	733	68.1	244.4		161.4
MEAN	25.0	13.9	19.4							7.5	
SAME MONTH LAST YEAR											
	25.0	12.9	19.0	433.4	278.4	19.2	703	27.0	252.4	8.0	160.2
41 YEAR AVERAGE (1961-2001)											
	25.0	13.5	19.3	442.7	287.7	19.8		69.1	232.8		157.4
5 YEAR AVERAGE (1997-2001)											
	26.0	13.9	19.9	462.4	307.4	10.7	743	35.7	257.8	8.2	160.7
EXTREME											
MAX	33.5	18.6	25.4	20.4	15.4	4.4	30	41.4	13.5	14.2	9.6
MIN	18.4	7.1	13.6	6.6	3.6	0.0	15	0	1.5	1	0

– 16 %

09/10/03 WED 10:59 FAX 902 679 5784 AGRI-FOOD CANADA
Atlantic Food & Horticulture Research Centre, KENTVILLE, N.S.

MONTHLY SUMMARY - AUGUST 2002

	Degree C			Heat Units Degree C							
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	MEAN	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	24.9	11.6	18.3	13.3	8.3	0.0	22	0.0	9.1	7.0	4.0
2	24.3	15.8	20.1	15.1	10.1	0.0	25	0.0	10.3	7.6	7.2
3	23.8	18.4	21.1	16.1	11.1	0.0	27	0.0	0.0	6.0	2.4
4	29.1	17.5	23.3	18.3	13.3	0.0	29	0.6	7.5	4.6	5.4
5	29.2	18.5	23.9	18.9	13.9	0.0	30	8.1	1.8	9.8	3.3
6	19.9	13.2	16.6	11.5	6.5	1.5	20	31.2	0.2	10.1	2.4
7	20.2	9.6	14.9	9.9	4.9	3.1	17	0.7	9.6	10.0	4.7
8	24.0	9.7	16.9	11.9	6.9	1.1	20	0.0	9.0	5.9	4.0
9	22.7	10.2	16.5	11.5	6.5	1.6	20	0.0	12.8	5.9	4.8
10	27.5	13.5	20.5	15.5	10.5	0.0	25	0.0	12.0	7.0	7.2
11	30.5	17.0	23.8	18.8	13.6	0.0	28	0.0	12.2	9.4	7.2
12	30.3	14.8	22.6	17.6	12.6	0.0	26	0.0	10.8	4.7	7.2
13	31.6	18.6	25.1	20.1	15.1	0.0	29	0.0	11.8	5.2	6.0
14	33.9	18.0	26.0	21.0	16.0	0.0	28	0.0	10.3	5.2	7.2
15	32.6	21.3	27.0	22.0	17.0	0.0	31	0.0	9.6	6.0	7.2
16	31.4	20.9	26.2	21.2	16.2	0.0	31	0.0	7.7	8.8	5.4
17	32.1	16.5	24.3	19.3	14.3	0.0	28	0.0	11.3	6.7	7.2
18	32.4	18.6	25.5	20.5	15.5	0.0	29	0.0	11.2	4.7	4.2
19	30.7	17.2	24.0	19.0	14.0	0.0	28	0.0	9.6	5.5	5.8
20	25.0	11.4	18.2	13.2	8.2	0.0	21	0.0	3.8	6.1	2.8
21	25.5	10.5	18.0	13.0	8.0	0.0	22	0.0	12.6	6.9	4.6
22	27.0	15.2	21.1	16.1	11.1	0.0	26	2.1	6.8	10.3	6.9
23	22.2	8.7	16.5	10.5	5.5	2.6	18	0.0	11.3	5.9	4.8
24	24.4	14.4	19.4	14.4	9.4	0.0	24	10.0	5.7	5.9	5.2
25	19.6	11.7	15.7	10.7	5.7	2.4	19	1.4	1.3	7.4	0.0
26	25.9	13.1	19.5	14.5	9.5	0.0	24	0.6	11.5	9.4	7.8
27	25.3	10.5	17.9	12.9	7.9	0.1	21	0.4	10.7	5.9	5.2
28	23.2	9.7	16.5	11.5	6.5	1.6	20	0.0	8.7	5.7	6.8
29	23.6	14.0	18.8	13.8	8.8	0.0	24	2.7	5.8	5.1	0.3
30	21.2	6.5	13.9	8.9	3.9	4.2	16	1.5	4.0	8.5	5.3
31	19.1	5.6	12.4	7.4	2.4	5.6	13	0.0	10.8	7.8	4.8
SUM				467.7	312.7	23.6	741	59.3	259.8		152.5
MEAN	26.2	13.9	20.1							6.9	
SAME MONTH LAST YEAR											
	27.5	16.1	21.3	505.6	350.6	11.1	789	11.6	239.4	7.8	163.9
41 YEAR AVERAGE (1961-2001)											
	24.2	13.2	18.7	424.4	269.4	27.5		88.9	217.4	9.1	
5 YEAR AVERAGE (1997-2001)											
	25.2	14.1	19.7	454.4	299.4	15.8	736	52.9	223.1	7.7	129.8
EXTREME											
MAX	33.9	21.3	27.0	22.0	17.0	5.6	31	31.2	12.8	10.3	7.8
MIN	19.1	5.6	12.4	7.4	2.4	0.0	13	0.0	0.0	4.6	0.0

- 33 %

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MONTHLY SUMMARY - SEPTEMBER 2002

	Degree C			Heat Units Degree C						
				Growing		Heating		Rain	SUN	Wind
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h
1	22.1	6.9	14.5	9.5	4.5	3.5	16.0	0.0	2.2	7.1
2	22.0	10.9	16.5	11.5	6.5	1.6	20.0	0.0	11.0	4.7
3	24.4	17.2	20.8	15.8	10.8	0.0	26.0	0.6	3.2	6.0
4	25.4	17.4	21.4	16.4	11.4	0.0	20.0	3.5	8.5	12.4
5	21.6	10.6	16.1	11.1	6.1	1.9	20.0	0.0	8.2	12.4
6	20.0	9.2	14.6	9.6	4.6	3.4	17.0	0.0	11.3	9.2
7	25.7	12.0	18.9	13.9	8.9	0.0	23.0	0.0	6.3	5.7
8	29.6	19.6	24.6	19.6	14.6	0.0	31.0	0.0	5.8	12.6
9	22.3	14.9	18.6	13.6	8.6	0.0	23.0	0.0	3.3	5.2
10	33.2	17.9	25.6	20.6	15.6	0.0	28.0	0.0	10.7	10.5
11	23.7	8.2	16.0	11.0	6.0	2.1	18.0	71.3	0.0	12.1
12	14.7	3.9	9.3	4.3	0.0	8.7	7.0	5.4	3.5	11.1
13	21.8	8.0	14.9	9.9	4.9	3.1	17.0	0.7	7.5	11.1
14	20.8	11.8	16.3	11.3	6.3	1.7	20.0	0.0	9.4	6.3
15	23.6	16.1	19.9	14.9	9.9	0.0	25.0	17.1	4.3	11.2
16	20.5	11.0	15.8	10.8	5.8	2.3	19.0	16.7	0.0	5.2
17	19.6	10.1	14.9	9.9	4.9	3.1	17.0	0.6	5.3	5.3
18	18.1	5.0	11.6	6.6	1.6	6.5	11.0	0.0	10.1	7.2
19	22.0	9.4	15.7	10.7	5.7	2.3	18.0	0.0	10.6	8.9
20	25.3	16.4	20.9	15.9	10.9	0.0	26.0	0.0	7.1	13.6
21	27.5	15.6	21.6	16.6	11.6	0.0	27.0	0.0	5.2	7.0
22	27.4	16.8	22.1	17.1	12.1	0.0	27.0	0.0	9.3	5.1
23	27.8	14.6	21.2	16.2	11.2	0.0	26.0	37.4	7.7	6.3
24	15.4	10.3	12.9	7.9	2.9	5.1	12.0	5.1	0.0	4.1
25	19.9	5.7	12.8	7.8	2.8	5.2	14.0	0.6	10.5	6.1
26	20.1	10.8	15.5	10.5	5.5	2.5	18.0	0.0	9.0	3.4
27	21.7	12.7	17.2	12.2	7.2	0.8	22.0	15.8	0.0	5.4
28	17.9	4.5	11.2	6.2	1.2	6.8	11.0	0.0	1.0	12.6
29	12.2	0.4	6.3	1.3	0.0	11.7	3.0	0.0	10.3	10.6
30	16.3	4.4	10.4	5.4	0.4	7.6	8.0	0.6	8.2	9.9
SUM				347.5	201.8	79.9	570	175.4	189.5	
MEAN	22.1	11.1	16.6							8.3
SAME MONTH LAST YEAR										
	22.3	9.6	16.0	329.0	180.2	84.2	548.0	77.4	232.5	7.0
41 YEAR AVERAGE (1961-2001)										
	19.8	9.3	14.6	285.7	141.2	116.9		93.0	164.6	10.4
5 YEAR AVERAGE (1997-2001)										
	21.2	10.7	15.9	328.4	181.7	86.5	546.2	108.8	185.4	7.7
EXTREME										
MAX	33.2	19.6	25.6	20.6	15.6	11.7	31.0	71.3	11.3	13.6
MIN	12.2	0.4	6.3	1.3	0.0	0.0	3.0	0.0	0.0	3.4

T=trace

+ 87%

Atlantic Food & Horticulture Research Centre, KENTVILLE, N.S.

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MONTHLY SUMMARY - MAY 2003

	Degree C			Heat Units Degree C				Precipitation			
				Growing		Heating		Snow	Total*	SUN	Wind
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	cm	mm	Hr	Km/h
1	14.0	7.3	10.7	5.7	0.7	7.4	8	0.0	3.2	2.9	11.3
2	11.2	3.5	7.4	2.4	0.0	10.7	2	0.0	3.9	0.0	8.2
3	8.2	-0.7	3.7	0.0	0.0	14.3	0	0.0	0.7	6.3	11.4
4	17.5	0.8	9.2	4.2	0.0	8.9	11	0.0	0.0	13.9	10.0
5	19.3	1.5	10.4	5.4	0.4	7.6	12	0.0	0.0	11.5	5.0
6	17.9	7.4	12.7	7.6	2.8	5.4	13	0.0	1.4	3.8	10.5
7	14.6	8.0	11.3	6.3	1.3	6.7	10	0.0	0.0	5.2	12.4
8	13.5	2.7	8.1	3.1	0.0	9.9	6	0.0	0.0	4.3	7.5
9	7.2	3.1	5.2	0.2	0.0	12.9	0	0.0	0.0	0.0	15.7
10	5.7	2.6	4.2	0.0	0.0	13.9	0	0.0	2.1	0.2	17.1
11	7.7	3.4	5.6	0.5	0.0	12.5	0	0.0	0.0	0.2	9.0
12	6.6	4.3	5.5	0.4	0.0	12.6	0	0.0	11.4	0.0	8.1
13	9.6	4.6	7.1	2.1	0.0	10.9	1	0.0	0.0	0.8	7.2
14	12.2	4.5	8.4	3.4	0.0	9.7	4	0.0	0.0	1.8	8.7
15	6.9	1.1	4.0	0.0	0.0	14.0	0	0.0	0.0	0.0	12.7
16	12.3	0.3	6.3	1.3	0.0	11.7	3	0.0	0.0	8.4	6.1
17	21.4	4.0	12.7	7.7	2.7	5.3	13	0.0	0.0	13.4	4.3
18	25.2	2.7	14.0	9.0	3.9	4.1	16	0.0	0.7	13.1	7.3
19	24.7	5.9	15.3	10.3	5.3	2.7	17	0.0	0.0	13.4	5.2
20	26.2	6.0	16.1	11.1	6.1	1.9	17	0.0	0.0	8.6	4.1
21	25.6	7.7	16.7	11.7	6.7	1.3	19	0.0	0.0	4.9	5.9
22	17.2	6.6	11.9	6.9	1.9	6.1	12	0.0	0.0	5.3	8.2
23	17.8	3.4	10.6	5.6	0.6	7.4	11	0.0	0.0	7.2	6.2
24	18.4	6.9	12.7	7.6	2.6	5.4	13	0.0	1.9	0.0	7.0
25	9.2	6.9	8.1	3.1	0.0	10.0	2	0.0	11.8	0.0	12.4
26	11.0	7.0	9.0	4.0	0.0	9.0	4	0.0	0.0	0.0	7.6
27	14.9	6.6	10.8	5.8	0.8	7.3	10	0.0	0.0	0.0	4.5
28	16.7	8.7	12.7	7.7	2.7	5.3	14	0.0	14.0	1.6	4.0
29	15.1	10.3	12.7	7.7	2.7	5.3	12	0.0	0.0	0.0	5.6
30	20.2	11.5	15.9	10.9	5.9	2.2	19	0.0	5.8	5.1	4.6
31	20.4	9.4	14.9	9.9	4.9	3.1	17	0.0	0.6	6.3	4.6
SUM				161.3	51.8	244.8	266	0	57.5	137.0	
MEAN	15.1	5.1	10.1								8.1
SAME MONTH LAST YEAR											
	17.1	5.6	11.3	196.6	83.2	214.1	338	0.4	85.2	274.4	12.2
42 YEAR AVERAGE (1961-2001)											
	16.3	4.9	10.6	176.8	59.6	231.3		2.1	79.0	203.7	
5 YEAR AVERAGE (1997-2002)											
	17.9	6.4	12.1	227.6	96.5	179.7	385	0.1	67.1	233.1	8.9
EXTREME											
MAX	26.2	11.5	16.7	11.7	6.7	14.3	19	0.0	14.0	13.9	17.1
MIN	5.7	-0.7	3.7	0.0	0.0	1.3	0	0.0	0.0	0.0	4.0

* Rain plus snow melted T=trace

-27 % of mean

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MONTHLY SUMMARY - JUNE 2003

	Degree C			Heat Units Degree C				Precipitation			
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	17.9	9.7	13.8	8.8	3.8	4.2	16	28.1	0.0	8.2	8.3
2	17.9	8.6	13.3	8.3	3.3	4.8	15	0.0	7.2	15.6	4.8
3	17.1	5.3	11.2	6.2	1.2	6.8	10	0.0	13.1	14.6	6.6
4	19.8	4.4	12.1	7.1	2.1	5.9	12	0.0	12.5	9.7	5.6
5	18.0	10.5	14.3	9.3	4.3	3.8	17	3.5	0.4	6.7	0.1
6	19.6	8.0	13.8	8.8	3.8	4.2	16	0.6	2.6	11.0	2.8
7	24.5	11.1	17.8	12.8	7.8	0.2	21	0.0	4.4	4.6	2.4
8	19.5	11.0	15.3	10.3	5.3	2.8	18	0.0	5.0	6.4	2.4
9	15.1	9.8	12.5	7.5	2.4	5.6	12	0.0	0.0	6.5	1.6
10	20.4	10.2	15.3	10.3	5.3	2.7	17	0.0	7.0	11.5	4.4
11	24.7	13.8	19.3	14.3	9.3	0.0	24	10.2	8.4	10.8	5.8
12	20.5	7.2	13.9	8.9	3.9	4.2	16	0.0	7.4	5.8	2.4
13	20.9	9.9	15.4	10.4	5.4	2.6	18	0.0	12.0	6.7	8.6
14	13.6	7.0	10.3	5.3	0.3	7.7	8	12.4	0.0	10.7	2.0
15	12.8	7.7	10.3	5.3	0.3	7.8	8	0.0	0.2	10.4	1.0
16	19.8	9.1	14.6	9.5	4.5	3.6	17	0.0	8.6	9.2	4.8
17	24.6	11.9	18.3	13.3	8.3	0.0	22	0.6	12.0	13.1	7.8
18	25.3	16.3	20.8	15.8	10.8	0.0	26	0.0	10.1	12.9	7.2
19	24.0	14.1	19.1	14.1	9.1	0.0	24	0.0	1.5	7.9	1.6
20	24.4	10.5	17.5	12.5	7.5	0.6	21	0.0	12.6	6.4	4.8
21	27.9	12.8	20.4	15.4	10.4	0.0	24	0.0	10.8	4.9	8.2
22	26.6	11.6	19.1	14.1	9.1	0.0	23	0.0	6.2	5.3	4.8
23	25.0	12.9	19.0	14.0	9.0	0.0	23	0.0	7.7	5.5	4.0
24	27.1	11.1	19.1	14.1	9.1	0.0	22	0.0	9.4	5.9	7.2
25	26.0	13.0	19.5	14.5	9.5	0.0	24	0.0	8.7	4.4	2.4
26	29.2	14.9	22.1	17.1	12.1	0.0	26	0.0	11.7	3.1	6.6
27	31.4	16.1	23.8	18.8	13.8	0.0	27	0.0	12.0	4.7	8.2
28	27.3	15.7	21.5	16.5	11.5	0.0	27	0.0	4.1	5.0	4.6
29	29.4	14.8	22.1	17.1	12.1	0.0	26	0.0	11.8	4.4	7.0
30	29.0	15.2	22.1	17.1	12.1	0.0	26	10.9	7.3	7.1	4.1
SUM				356.8	206.8	67.1	586	66.3	214.7		140.3
MEAN	22.6	11.1	16.9							8.0	
SAME MONTH LAST YEAR											
	20.3	8.8	14.4	260.5	135.1	125.3	478	45.8	187.3	8.1	105.0
42 YEAR AVERAGE (1961-2002)											
	21.9	10.2	16.1	331.6	183.6	81.0		67.0	211.3		
5 YEAR AVERAGE (1998-2002)											
	22.6	11.0	16.8	353.2	205.8	75.3	577	49.2	209.8	8.1	129.2
EXTREME											
MAX	31.4	16.3	23.8	18.8	13.8	7.8	27.0	28.1	13.1	15.6	8.6
MIN	12.8	4.4	10.3	5.3	0.3	0.0	8.0	0.0	0.0	3.1	0.1

T=trace

0.01

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MONTHLY SUMMARY - JULY 2003

	Degree C			Heat Units Degree C							
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	26.5	15.6	21.1	16.1	11.1	0.0	27	0.0	10.5	10.8	8.6
2	23.6	12.6	18.1	13.1	8.1	0.0	23	0.0	7.5	7.1	4.8
3	27.9	18.0	23.0	18.0	13.0	0.0	29	0.7	7.9	7.0	4.8
4	29.9	17.3	23.6	18.6	13.6	0.0	28	0.0	10.6	6.8	7.2
5	30.3	16.1	23.2	18.2	13.2	0.0	27.0	0.0	8.7	4.8	7.2
6	28.6	15.9	22.3	17.3	12.3	0.0	27.0	0.0	12.8	11.9	9.2
7	26.8	12.1	19.5	14.5	9.5	0.0	23.0	0.0	12.7	7.1	7.2
8	27.0	16.8	22.9	17.9	12.9	0.0	29.0	0.0	5.1	10.2	5.8
9	24.5	12.1	18.3	13.3	8.3	0.0	22.0	0.0	5.9	10.9	6.2
10	24.1	10.0	17.1	12.1	7.1	0.9	20.0	0.0	10.3	5.4	5.8
11	21.8	14.4	18.1	13.1	8.1	0.0	23.0	11.9	1.0	6.5	0.0
12	27.8	13.5	20.7	15.7	10.7	0.0	25.0	0.7	10.5	7.2	4.8
13	28.9	15.1	22.0	17.0	12.0	0.0	26.0	0.0	9.8	4.9	4.8
14	27.4	16.6	22.0	17.0	12.0	0.0	27.0	0.0	8.6	5.6	4.8
15	22.4	15.4	18.9	13.9	8.9	0.0	23.0	13.2	0.3	4.7	1.2
16	27.0	16.2	21.6	16.6	11.6	0.0	32.0	0.0	8.2	3.1	4.4
17	25.8	17.3	21.6	16.6	11.6	0.0	27.0	19.9	2.6	4.2	0.7
18	26.7	17.8	22.3	17.3	12.3	0.0	28.0	0.8	8.2	3.7	8.0
19	26.2	16.3	21.3	16.3	11.3	0.0	26.0	15.9	2.7	3.5	3.9
20	24.7	14.4	19.6	14.6	9.6	0.0	24.0	0.0	7.0	3.4	2.4
21	27.9	14.9	21.4	16.4	11.4	0.0	26.0	0.6	8.3	4.7	3.0
22	28.9	18.4	23.7	18.7	13.7	0.0	29.0	5.0	9.5	10.5	7.4
23	29.2	20.8	25.0	20.0	15.0	0.0	31.0	8.5	6.4	12.8	3.7
24	28.9	22.7	25.8	20.8	15.8	0.0	33.0	0.7	3.6	13.0	5.3
25	26.3	15.9	21.1	16.1	11.1	0.0	26.0	0.0	2.0	10.0	4.0
26	28.7	18.3	23.5	18.5	13.5	0.0	29.0	0.6	9.6	9.7	7.8
27	25.2	17.4	21.3	16.3	11.3	0.0	27.0	0.0	1.1	12.1	2.4
28	22.7	15.2	19.0	14.0	9.0	0.0	24.0	0.0	13.1	19.1	7.2
29	24.6	11.4	18.0	13.0	8.0	0.0	21.0	0.0	13.0	7.8	4.2
30	27.8	12.6	20.2	15.2	10.2	0.0	24.0	0.0	12.5	5.0	7.2
31	27.2	13.0	20.1	15.1	10.1	0.0	24.0	0.0	13.3	4.9	7.2
SUM				500.7	345.7	0.9	810	78.5	243.3		161.2
MEAN	26.6	15.7	21.2							7.7	
SAME MONTH LAST YEAR											
	25.0	13.9	19.4	446.7	291.8	20.5	733	58.1	244.4	7.5	161.4
42 YEAR AVERAGE (1961-2002)											
	25.0	13.5	19.3	442.8	287.8	19.8		68.8	233.0		157.5
5 YEAR AVERAGE (1998-2002)											
	25.6	13.9	19.7	457.2	302.2	13.4	741	42.6	246.6	8.0	150.2
EXTREME											
MAX	30.3	22.7	25.8	20.8	15.8	0.9	33	19.9	13.3	19.1	9.2
MIN	21.8	10.0	17.1	12.1	7.1	0.0	20	0	0.3	3.1	0
T=trace											

+ 14 %

Atlantic Food & Horticulture Research Centre, KENTVILLE, N.S.

MONTHLY SUMMARY - AUGUST 2003

	Degree C			Heat Units Degree C							
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	MEAN	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	27.9	15.7	21.8	16.8	11.8	0.0	27	10.6	5.9	4.8	5.8
2	18.6	16.0	17.3	12.3	7.3	0.7	22	7.5	0.0	2.8	0.0
3	20.7	17.0	18.9	13.9	8.9	0.0	25	0.0	0.0	2.0	0.0
4	24.8	18.2	21.5	16.5	11.5	0.0	28	82.0	0.6	3.4	22.0
5	20.8	18.4	19.6	14.6	9.6	0.0	25	21.4	0.0	4.6	0.0
6	28.2	18.8	23.5	18.5	13.5	0.0	29	3.5	3.9	3.9	2.3
7	22.0	20.3	21.2	16.2	11.2	0.0	28	3.3	1.3	3.8	0.0
8	24.3	20.3	22.3	17.3	12.3	0.0	29	6.9	0.0	1.9	1.7
9	25.2	20.5	22.9	17.9	12.9	0.0	30	0.6	0.4	4.0	0.6
10	30.2	21.3	25.8	20.8	15.8	0.0	31	0.0	7.4	10.4	3.4
11	26.3	19.1	22.7	17.7	12.7	0.0	29	0.6	0.7	7.5	3.0
12	25.6	17.3	21.5	16.5	11.5	0.0	27	0.0	2.7	4.0	2.4
13	26.6	16.4	21.5	16.5	11.5	0.0	27	4.9	3.2	4.8	0.0
14	25.6	13.3	19.5	14.5	9.5	0.0	24	0.0	10.6	6.7	4.8
15	25.7	13.1	19.4	14.4	9.4	0.0	24	0.0	11.9	5.7	7.2
16	28.8	20.3	24.6	19.6	14.6	0.0	30	0.7	10.2	11.3	7.2
17	23.9	14.6	19.3	14.3	9.3	0.0	25	0.0	1.4	8.8	1.4
18	20.1	9.6	14.9	9.9	4.9	3.1	17	0.0	4.8	6.3	2.4
19	26.7	17.5	22.1	17.1	12.1	0.0	28	0.0	12.1	9.6	6.4
20	27.5	15.6	21.6	16.6	11.6	0.0	27	0.0	8.9	5.3	4.4
21	29.6	18.5	24.1	19.1	14.1	0.0	30	0.0	4.8	5.6	3.4
22	29.3	19.6	24.5	19.5	14.5	0.0	30	5.8	10.3	9.2	3.4
23	25.4	8.2	16.8	11.8	6.8	1.2	19	0.8	9.2	12.9	7.8
24	15.3	8.0	11.7	6.7	1.7	6.4	10	0.0	0.0	12.0	6.0
25	19.7	12.7	16.2	11.2	6.2	1.8	20	0.0	12.1	8.3	4.4
26	22.2	12.9	17.6	12.6	7.6	0.4	22	0.0	2.7	2.9	1.4
27	25.7	13.6	19.7	14.7	9.7	0.0	24	0.7	6.2	9.3	4.5
28	21.1	10.4	15.8	10.8	5.8	2.3	18	0.0	12.0	12.6	6.2
29	21.7	13.8	17.8	12.8	7.8	0.3	23	13.9	10.4	10.9	6.4
30	20.8	8.3	14.6	9.6	4.6	3.4	16	2.1	0.0	8.0	0.0
31	20.2	7.6	13.9	8.9	3.9	4.1	16	0.0	10.3	5.2	4.8
SUM				458.7	303.7	23.7	760	165.3	164.0		118.5
MEAN	24.2	15.4	19.8							6.7	
SAME MONTH LAST YEAR											
	26.2	13.9	20.1	467.7	312.7	23.8	741	59.3	259.8	6.9	152.5
42 YEAR AVERAGE (1961-2002)											
	24.3	13.2	18.7	425.4	270.5	27.4		88.2	218.4	9.0	
5 YEAR AVERAGE (1998-2002)											
	25.7	14.2	20.0	464.0	309.0	16.9	745	54.5	241.5	7.7	136.2
EXTREME											
MAX	30.2	21.3	25.8	20.8	15.8	6.4	31	82.0	12.1	12.9	22.0
MIN	15.3	7.6	11.7	6.7	1.7	0.0	10	0.0	0.0	1.9	0.0
T=trace											

+ 87%

Atlantic Food & Horticulture Research Centre, KENTVILLE,

MONTHLY SUMMARY - SEPTEMBER 2003

			Degree	Heat Units Degree C							
				Growing		Heating		Rain	SUN	Wind	Evap
Day	Max	Min	Mean	5.0	10.0	18.0	CHU	mm	Hr	Km/h	mm
1	20.2	10.8	15.5	10.5	5.5	2.5	18.0	0.0	1.1	9.2	2.2
2	18.5	4.4	11.5	6.5	1.4	6.6	12.0	0.0	5.2	4.2	2.4
3	21.9	7.8	14.9	9.9	4.9	3.2	17.0	0.0	11.4	3.4	4.0
4	21.0	13.6	17.3	12.3	7.3	0.7	22.0	56.6	0.0	7.3	0.0
5	20.0	13.6	16.8	11.8	6.8	1.2	21.0	3.7	0.3	4.1	0.0
6	23.3	10.5	16.9	11.9	6.9	1.1	20.0	0.0	10.2	4.2	4.8
7	23.1	9.5	16.3	11.3	6.3	1.7	20.0	0.0	11.6	9.4	4.8
8	19.3	6.2	12.8	7.8	2.8	5.3	13.0	0.0	8.9	8.0	4.0
9	17.3	3	10.2	5.2	0.2	7.9	10.0	0.0	11.3	5.5	3.8
10	19.8	6.0	12.9	7.9	2.9	5.1	14.0	0.0	9.6	10.6	4.4
11	17.4	4.2	10.8	5.8	0.8	7.2	10.0	0.0	10.7	7.3	4.8
12	21.8	9.0	15.4	10.4	5.4	2.6	18.0	0.0	10.5	8.1	3.6
13	25.4	8.9	17.2	12.2	7.1	0.9	20.0	0.0	11.1	8.3	4.8
14	25.4	13.4	19.4	14.4	9.4	0.0	23.0	0.0	10.7	7.8	2.4
15	27.5	16.5	22.0	17.0	12.0	0.0	28.0	0.0	9.8	6.5	2.4
16	27.4	17.6	22.5	17.5	12.5	0.0	28.0	0.7	7.4	6.7	3.1
17	24.4	8.3	16.4	11.4	6.4	1.6	18.0	0.0	10.1	8.1	5.8
18	23.8	8.6	16.2	11.2	6.2	1.8	19.0	0.0	10.0	3.8	3.8
19	24.9	7.0	16.0	11.0	6.0	2.1	18.0	0.0	8.3	3.6	5.4
20	21.3	13.4	17.4	12.4	7.4	0.6	21.0	1.5	0.7	2.6	0.5
21	21.0	15.8	18.4	13.4	8.4	0.0	24.0	0.0	0.5	2.9	1.2
22	22.9	13.1	18.0	13.0	8.0	0.0	22.0	0.0	8.9	4.2	4.0
23	24.6	18.3	21.5	16.5	11.5	0.0	28.0	4.6	6	10.6	2.2
24	22.0	7.1	14.6	9.6	4.6	3.4	16.0	0.6	9.8	7.8	5.2
25	19.9	5.7	12.8	7.8	2.8	5.2	14.0	0.6	9.2	6.1	4.8
26	25.0	14.4	19.7	14.7	9.7	0.0	24.0	0.0	8.3	4.1	2.4
27	25.5	19.2	22.4	17.4	12.4	0.0	29.0	0.0	7.7	7.6	4.8
28	23.7	18.3	21.0	16.0	11.0	0.0	27.0	23.1	1.3	13.2	6.3
29	26.7	12.2	19.5	14.5	9.5	0.0	23.0	1.4	7.3	9.2	2.7
30	20.2	6.0	13.1	8.1	3.1	4.9	14.0	0.0	10.1	6.3	2.4
SUM				348.8	198.8	65.5	591	92.8	228.0		103.0
MEAN	22.5	10.7	16.6							6.7	
SAME MONTH LAST YEAR	22.1	11.1	16.6	347.5	201.8	79.9	570.0	175.4	189.5	8.3	112.1
42 YEAR AVERAGE (1961-2002)	19.8	9.3	14.6	287.2	142.6	116.0		95.0	165.2	10.3	
5 YEAR AVERAGE (1998-2002)	21.7	10.8	16.2	336.5	189.7	83.7	558.2	131.9	197.4	7.7	70.0
EXTREME MAX	27.5	19.2	22.5	17.5	12.5	7.9	29.0	56.6	11.6	13.2	6.3

-2%

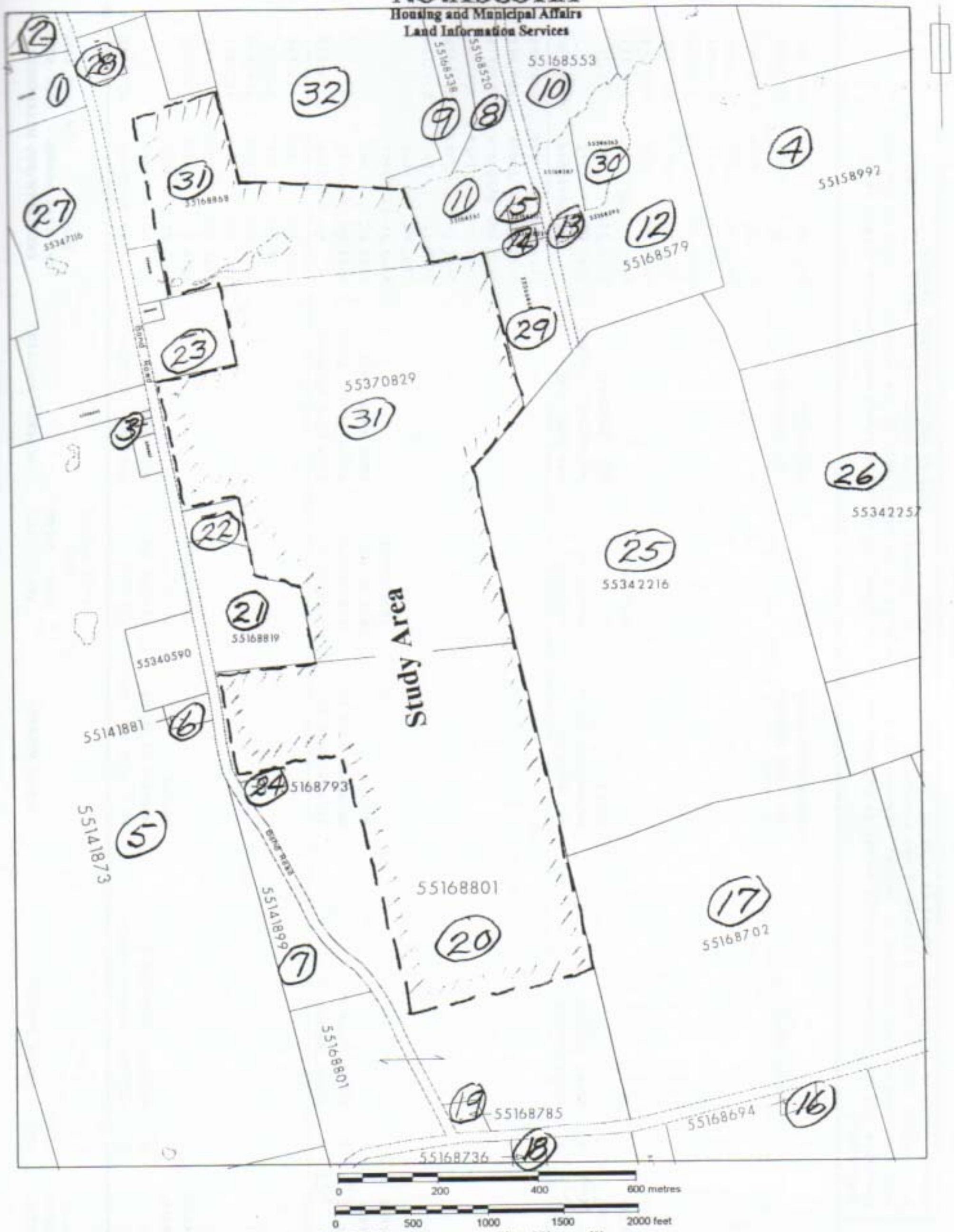
APPENDIX B

Map And Property Identification Numbers In the Immediate Area

Kings County Registry Office
Land Information Services Division

NOVA SCOTIA
Housing and Municipal Affairs
Land Information Services

87 Cornwallis St · Kentville · NS
Ph: 902-679-4320 · Fax: 902-679-6175



Printed for: Twin Mountain Construction Limited Aggregate Site, Waterville

Date printed: Wednesday, November 26, 2003 Scale 1 : 10000

Time printed: 15:53:17 PM

While this map may not be free from error or omission, care has been taken to ensure the best possible quality. This map is a graphical representation of property boundaries which approximates the size, configuration and location of properties. It is not a survey and is not intended to be used for legal descriptions or to calculate exact dimensions or area.

PID STATUS DIST:MUN:CO:OS TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT 2003 VALUE AREA LAST UPDATE	PROPERTY LOCATION	- XREF/PLAN/DOC REFERENCES - YEAR TYPE PRB	NUMBER	BOOK/PAGE OR FILE REFS
55141766	D	CHINERY ANTHONY JOSEPH	RR 1 5022 NO 1 HWY	00243841	5022 NO 1 HIGHWAY	FC	05006000	00243841
8:69:11:JT	D	CHINERY CATHERINE E	WATERVILLE NS CA	$225200.00	WATERVILLE ([M])	1993 NS	5300163	
0245030064680			B0P1V0	73 Ac +/-		2002 DT	4613	
1045000064600				2002-07-12		1958 101	1958	190/187
MU1107						1961 101	1961	200/540
						1977 101	1977	427/847
						1987 101	15705	716/894
						1994 101	3241	976/25
						2002 101	1070	1307/899
55141816 (1)	A	BUDDE ROBERT G	5110 HIGHWAY 1	02508621	5108 NO 1 HIGHWAY	FC	05003000	02508621
8:69:11:JT	B	BUDDE LAURA L	WATERVILLE NS CA	$131500.00	WATERVILLE (-5110-	1993 NS	5300163	
0245030064680			B0P1V0	6.0 Ac +/-	ALSO BOND ROAD)	1995 DT	246	
1045000064600				2002-04-23		1995 IP	55332605	
MU1107						1997 DT	1635	
						1963 101	1963	220/177
						1967 101	1967	254/625
						1972 101	1972	326/704
						1972 101	Z3150119	315/119
						1992 101	10519	926/861
						1996 101	438	1045/900
55141840 (2)	A	COREY ROBERT J	483 BOND RD	01568671	483 BOND ROAD	FC	05033000	01568671
8:69:11:JT	B	COREY PAMELA L	WATERVILLE NS CA	$93700.00	WATERVILLE (CORNER	1997 DT	1635	
0245030064680			B0P1V0	2.0 Ac +/-	NO 1 HIGHWAY)	1965 101	1965	241/39
0245040064680				2002-04-23		1980 101	Z5030213	503/213
1045000064600						1981 101	1981	515/364
MU1107						1986 101	11018	670/459
						1992 101	5717	908/134
						1994 101	1593	970/225
						1999 101	5037	1197/556
						1999 201	5038	1197/559
55141857	D	MUNRO STEPHEN L	RR 1 307 BOND RD	04355628	307 BOND ROAD	FC	05032002	04355628
8:69:11:			WATERVILLE NS CA	$39100.00	WATERVILLE ([M])	1972 401	1972	324/99

HISTORIC LISTING

PID STATUS DIST:MUN:CO:OS TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT 2003 VALUE AREA LAST UPDATE	PROPERTY LOCATION	- XREF/PLAN/DOC REFERENCES - YEAR TYPE NUMBER PRB	BOOK/PAGE OR FILE REFS
0245030064680			B0P1V0	38100 FT +/-		1973 101 1973	344/544
1045000064600				2002-04-18		1994 102 2807	974/306
MU1107						1994 101 4489	980/785
						1994 101 5541	984/538
						1995 101 1928	1011/242
						2000 201 3539	1229/170
55141865 (3)	D	MARCHETTA ARTHUR	68 MAPLE ST BELMONT	03021289	BOND ROAD WATERVILLE	FC 02218000	03021289
8:69:11:			MA US 02478	$10000.00		1952 101 1950	180/677
0245030064680				15390 FT +/-		1968 101 1968	266/156
1045000064600				2002-04-18		1969 101 1969	278/148
MU1107						1971 101 1971	307/689
						1971 101 Z3070632	307/632
55141873 (5)	D	MARSH DONALD G	RR 1 WATERVILLE NS	03043355	277 BOND ROAD	FC 05032000	03043355
8:69:11:			CA B0P1V0	$196700.00	WATERVILLE	1972 T3 P34 FC	
0245030064680				190 Ac +/-		1973 T3 P421 FP	
1045000064600				2002-04-23		1968 101 1968	266/156
MU1107						1972 101 1972	323/40
55141881 (6)	D	REIMER JOEL MARK	209 BOND RD	03735885	209 BOND ROAD	FC 05031000	03735885
8:69:11:			WATERVILLE NS CA	$45500.00	WATERVILLE ([M])	1972 T3 P34 FP	
1045000064600			B0P1V0	1.2 Ac +/-		1966 101 1966	253/28
MU1107				2003-05-05		1979 101 1979	478/314
						1999 101 4972	1197/311
						2003 101 2109	1373/376
						2003 201 2110	1373/379
55141899 (7)	R	LIGHTFOOT ERIC	RR 1 WATERVILLE NS	02558467	BOND ROAD SOUTH	FC 05030000	02558467
8:69:11:FE	A	CONNORS COREY R	CA B0P1V0	$12500.00	WATERVILLE	1972 T3 P34 FC	
1045000064600	B	CONNORS CHRISTINE G		8.5 Ac +/-		1973 T3 P315 FP	
MU1107				1998-12-16		1973 T3 P421 FP	
						1963 101 1963	211/390
						1969 101 1969	273/717
						1973 101 1973	336/317
						1996 101 2125	1052/411

Disclaimer:
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Date: November 26, 2003 LORIS USER : QUERY2 Page 000002

HISTORIC LISTING

PID STATUS DIST:MUN:CO:OS TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT 2003 VALUE AREA LAST UPDATE	PROPERTY LOCATION	- XREF/PLAN/DOC REFERENCES - YEAR TYPE NUMBER PRB	BOOK/PAGE OR FILE REFS
55158992 (4) 9:69:11: 0245040064660 0245040064640 0245050064660 1045000064600 1045050064600 MU1107	P	ACA CO-OPERATIVE LTD	43 MINAS WAREHOUSE RD NEW MINAS NS CA B4N5A5	01400711 $467500.00 220 Ac +/- 2002-08-30	5504 NO 1 HIGHWAY WATERVILLE (ALSO WATERVILLE MOUNTAIN ROAD-REMAINDER)	FC 01925000 1998 DT 2185 2002 DT 4664 2002 IP 55445423 1970 T3 HC45198 FC 1992 T1 P8841 FP 1984 101 14903 1992 101 Z2170215 1992 101 Z2360251 1992 101 Z2640514 1992 101 Z5880705 2001 201 7505	01400711 612/617 217/215 236/251 264/514 588/705 1297/288
55159511 (32) 9:69:11: 0245040064680 0245040064660 1045000064600 0245030064680 MU1107	O P	RAFUSE A D & SONS FARMS LTD A D RAFUSE & SONS FARM LTD	RR 1 WATERVILLE NS CA B0P1V0	03866203 $262200.00 97 Ac +/- 2003-02-18	5250 NO 1 HIGHWAY WATERVILLE (-5256)	FC 13033400 1965 T3 A729 FP 1989 101 16210	03866203 797/770
55168348 9:69:11:TC 0245040064660 1045000064600 MU1107	D D	WENTZELL GARY WALTER WENTZELL IVAN BRADFORD	PO BOX 36 WATERVILLE NS CA B0P1V0	02135035 $6500.00 7.7 Ac +/- 2002-04-18	THOMPSON ROAD WATERVILLE (EAST OF)	FC 02003300 1969 101 1969 1995 101 7112	02135035 271/277 1031/239
55168520 (8) 9:69:11:TC 0245040064660 1045000064600 MU1107	D D	WENTZELL GARY WALTER WENTZELL IVAN BRADFORD	PO BOX 36 WATERVILLE NS CA B0P1V0	02134993 $1500.00 7.9 Ac +/- 2002-04-23	THOMPSON ROAD WATERVILLE	FC 02004305 1946 301 1944 1995 101 7112	02134993 170/453 1031/239
55168538 (9) 9:69:11: 0245040064660	P O	A D RAFUSE & SONS FARMS LIMITED RAFUSE A D & SONS FARMS	R R 1 WATERVILLE NS CA B0P1V0	05954819 $9600.00 17 Ac +/-	THOMPSON ROAD WATERVILLE PARCEL C (WEST OF)	1984 S1 84248 69 1984 S1 P5845 FP 1985 101 2055	 618/63

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Date: November 26, 2003 LORIS USER : QUERY2 Page 000003

HISTORIC LISTING

PID STATUS DIST:MUN:CO:OS TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT 2003 VALUE AREA LAST UPDATE	PROPERTY LOCATION	- XREF/PLAN/DOC REFERENCES - YEAR TYPE NUMBER PRB	BOOK/PAGE OR FILE REFS
1045000064600 MU1107		LIMITED		2002-04-23		1989 101 Z7970770	797/770
55168553 (10) 9:69:11: 0245040064660 1045000064600 MU1107	D	MCGILL CARL V	RR 1 WATERVILLE NS CA B0P1V0	03132897 $52500.00 1 Vol. 1998-12-16	840 THOMPSON ROAD WATERVILLE ([M])		
55168561 (11) 9:69:11:JT 1045000064600 MU1107	A B D	SWINAMER REGINALD K SWINAMER OLIVE E SWINAMER JUDY	RR 1 WATERVILLE NS CA B0P1V0	05756138 $1400.00 1 Vol. 1998-12-16	THOMPSON ROAD WATERVILLE	1983 101 14139	584/819
55168579 (12) 9:69:11:T 1045000064600 MU1107	D D	RAFUSE KENNETH D RAFUSE HAROLD A	919 MAPLE ST WATERVILLE NS CA B0P1V0	05954797 $8200.00 24.70 Ac 1999-11-30	THOMPSON ROAD WATERVILLE PARCEL D	FC 02004502 1984 S1 84247 69 1984 S1 P5855 FP 1985 101 2055 1989 101 Z7970770 1992 101 Z6160329 1996 101 6279	05954797 618/63 797/770 616/329 1068/357
55168587 9:69:11: 1045000064600 MU1107	D	WALSH JOHN JOSEPH	RR 1 768 THOMPSON RD WATERVILLE NS CA B0P1V0	00097888 $118700.00 2.8 Ac +/- 2003-09-08	768 THOMPSON ROAD WATERVILLE ([M])	FC 02004600 1997 DT 1756 1972 101 1972 1979 101 4460 1979 201 4461 1980 101 5702 1989 301 15089 1992 101 Z3180113 1995 101 8472 1999 101 6275 1999 201 6276 2003 101 3596 2003 201 3597 2003 301 5578	00097888 321/337 464/109 464/113 493/51 795/298 318/113 1036/346 1203/710 1203/713 1382/925 1382/930 1396/926

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HISTORIC LISTING

PID STATUS DIST:MUN:CO:OS TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT 2003 VALUE AREA LAST UPDATE	PROPERTY LOCATION	- XREF/PLAN/DOC REFERENCES - YEAR TYPE NUMBER PRB	BOOK/PAGE OR FILE REFS
55168595 (13)	D	KEDDY SYLVIA A	4377 HWY 1 BERWICK	02314126	760 THOMPSON ROAD	FC 02004800	02314126
9:69:11:			NS CA B0P1E0	$41900.00	WATERVILLE LOT A	1997 DT 1756	
1045000064600				15400 FT +/-	([M])	1976 S3 76179 69	
MU1107				1999-12-01		1976 S3 P2260 FP	
						1972 101 1972	321/337
						1976 101 7689	406/292
						1976 201 7690	406/295
						1981 301 9763	528/226
55168603 (14)	D	SWINAMER JUDY D	RR 1 WATERVILLE NS	04513002	761 THOMPSON ROAD	FC 02004900	04513002
9:69:11:JT	D	SWINAMER KEITH W	CA B0P1V0	$80800.00	WATERVILLE LOT 1	1977 S3 P2843 FP	
1045000064600				21780 FT +/-	([M])	1977 101 9467	428/123
MU1107				2003-07-17		2003 101 4118	1386/784
55168611 (15)	D	SWINAMER OLIVE E	RR 1 WATERVILLE NS	04513789	769 THOMPSON ROAD	1975 101 Z2300330	230/330
9:69:11:JT	D	SWINAMER KEITH W	CA B0P1V0	$104500.00	WATERVILLE ([M])	1979 101 1979	473/785
1045000064600				1 Vol.		2003 101 4119	1386/788
MU1107				2003-07-17			
55168694 (16)	D	DUNN MURRAY ALLEN	1940 PROSPECT RD S	05589096	1940 PROSPECT ROAD	FC 02005501	05589096
9:69:11:	D	DUNN ROSETTA	WATERVILLE NS CA	$91100.00	SOUTH WATERVILLE	1970 T3 A1426 FP	
1045000064600			B0P1V0	3716.00 SqM.	PARCEL A ([M])	1972 T3 P33 FP	
MU1107				1998-12-16		1973 T3 P298 FP	
						1973 T3 P300 FP	
						1973 T3 P303 FP	
						1973 T3 P304 FP	
						1973 T3 P322 FP	
						1973 T3 P389 FP	
						1983 S1 P5464 FP	
						1983 101 12398	581/278
						1988 101 15990	755/835
55168702 (17)	D	MACDONALD EDWARD THOMAS	RR 1 WATERVILLE NS	02685086	1929 PROSPECT ROAD	FC 02005600	02685086
9:69:11:			CA B0P1V0	$134000.00	SOUTH WATERVILLE	1995 DT 113	
1045000064600				96 Ac +/-		1970 T3 A1426 FP	
MU1107				1998-12-16		1972 T3 P33 FP	

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						1973 T3 P298 FP	
						1973 T3 P300 FP	
						1973 T3 P303 FP	
						1973 T3 P304 FP	
						1973 T3 P322 FP	
						1973 T3 P389 FP	
						1950 101 1944	176/790
						1970 101 1970	288/313
						1973 101 DOT	335/680
						1978 101 9197	448/700
55168728	D	MURRAY MERLE C	1912 PROSPECT RD S.	01340123	1912 PROSPECT ROAD	FC 02005800	01340123
9:69:11:			WATERVILLE NS CA	$79600.00	SOUTH WATERVILLE	1993 IP 55368195	
1045000064600			B0P1V0	28 Ac +/-	(ALSO LITTLE BROWN	1997 DT 1710	
MU1107				2000-03-13	ROAD- [M])	1972 T3 P33 FP	
						1973 T3 P298 FP	
						1973 T3 P300 FP	
						1973 T3 P304 FP	
						1973 T3 P322 FP	
						1993 S1 P9523 FP	
						1984 101 11482	606/345
						1992 101 Z3360587	336/587
						1992 101 Z5100135	510/135
						1992 101 Z5990248	599/248
55168736	D	PARRISH ANGELA MAE	RR 1 WATERVILLE NS	08066701	1830 PROSPECT ROAD	FC 02005801	08066701
9:69:11:J	D	PARRISH DAVID	CA B0P1V0	$126900.00	SOUTH WATERVILLE	1970 T3 A1426 FP	
1045000064600				50052.90 SqF	LOT DLP-1 ([M])	1972 T3 P33 FP	
MU1107				2001-05-04		1973 T3 P298 FP	
						1973 T3 P300 FP	
						1973 T3 P303 FP	
						1973 T3 P304 FP	
						1973 T3 P322 FP	
						1973 T3 P389 FP	
						1976 T3 P2255 FP	

HISTORIC LISTING

PID / STATUS / DIST:MUN:CO:OS / TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT / 2003 VALUE / AREA / LAST UPDATE	PROPERTY LOCATION	YEAR	TYPE / PRB	NUMBER	BOOK/PAGE OR FILE REFS
						1991	S1	910182 69	
						1991	S1	P8710 FP	
						1992	101	7939	916/775
55168751	D	PARRISH HAROLD L	RR 1 WATERVILLE NS	03460509	PROSPECT ROAD SOUTH		FC	02006000	03460509
9:69:11:JT	D	PARRISH ESTER	CA B0P1V0	$26100.00	WATERVILLE (NSFLB	2001	DT	4061	
1045000064600				59 Ac +/-	LB-76-76)	1970	T3	A1426 FP	
MU1107				2002-04-23		1972	T3	P33 FP	
						1973	T3	P298 FP	
						1973	T3	P300 FP	
						1973	T3	P303 FP	
						1973	T3	P304 FP	
						1973	T3	P322 FP	
						1973	T3	P389 FP	
						1972	101	1972	320/603
						1976	101	1976	406/146
						1999	420	NR325	NR/325
						2001	101	2371	1263/488
						2001	312	NR585	NR/585
55168785 (19)	D	WARD MANSON LAMONT	RR 1 KINGSTON NS CA	04816706	1805 PROSPECT ROAD		FC	02006300	04816706
9:69:11:			B0P1R0	$30800.00	SOUTH WATERVILLE	1970	T3	A1426 FP	
1045000064600				1.0 Ac +/-	(CORNER BOND ROAD)	1972	T3	P33 FP	
MU1107				2002-04-23		1973	T3	P298 FP	
						1973	T3	P300 FP	
						1973	T3	P303 FP	
						1973	T3	P304 FP	
						1973	T3	P322 FP	
						1973	T3	P389 FP	
						1976	T3	P2255 FP	
						1981	101	1981	532/453
						1991	101	Z8660188	866/188
						1992	101	Z2060359	206/359
						1992	101	Z2730176	273/176
						1994	101	2670	973/869

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						1996 101 7750	1074/246
						2000 101 5977	1242/690
						2000 201 5978	1242/694
55168793 (24)	D	GEDDES DARREL B	RR 1 WATERVILLE NS	01668056	172 BOND ROAD	FC 02006400	01668056
9:69:11:			CA B0P1V0	$48600.00	WATERVILLE	1970 101 1970	282/531
1045000064600				1 Vol.		1992 101 Z1600175	160/175
MU1107				2002-04-23			
55168801 (20)	D	GEDDES DARREL B	R R 1 WATERVILLE NS	01666061	180 BOND ROAD	FC 02006500	01666061
9:69:11:JT	D	GEDDES DORIS	CA B0P1V0	$180000.00	WATERVILLE (CORNER	1982 101 102651	546/109
1045000064600				130 Ac +/-	PROSPECT ROAD)	1992 101 9785	924/348
MU1107				2002-04-23		1992 101 Z3350674	335/674
						1992 101 Z4580601	458/601
55168819 (21)	D	CORKUM KELLY	1610 VICTORIA RD	08056676	244 BOND ROAD	FC 02006501	08056676
9:69:11:			AYLESFORD NS CA	$20100.00	WATERVILLE LOT NT-1	1990 S1 900017 69	
1045000064600			B0P1C0	9.8 Ac +/-		1990 S1 P8019 FP	
0245030064680				2002-04-23		1990 101 4630	814/828
MU1107						1994 101 3313 P	976/264
55168827 (22)	D	AVILA MARIANO A	RR 1 WATERVILLE NS	00339199	276 BOND ROAD	1976 S3 P2313 FP	
9:69:11:	D	AVILA IRENE P	CA B0P1V0	$118400.00	WATERVILLE LOT A	1984 101 5589	596/323
1045000064600				3.0 Ac +/-		1992 101 Z2740153	274/153
0245030064680				2002-04-23		1992 101 Z4080549	408/549
MU1107						2001 201 2624	1265/1
55168835 (23)	P	ABS POULTRY LIMITED	43 MINAS WAREHOUSE	00008052	344 BOND ROAD	FC 02006700	00008052
9:69:11:	O	A B S POULTRY LIMITED	RD NEW MINAS NS CA	$227100.00	WATERVILLE (-358)	1979 S3 P3740 FP	
0245030064680			B4N5A5	1 Vol.		1979 101 1979	482/192
1045000064600				2002-04-23		2001 201 7505	1297/288
MU1107							
55168843	D	SCOTNEY TERRY SOUTH BER	RR 1 BERWICK NS CA	05097916	364 BOND ROAD	1980 101 1980	501/466
9:69:11:			B0P1E0	$55000.00	WATERVILLE ([M])	2001 201 7823	1299/601
0245030064680				1 Vol.			
1045000064600				2002-04-18			

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MU1107									
55170823	D	LUTZ LEROY C	R R 1 WATERVILLE NS	08073961	PROSPECT ROAD SOUTH		FC	30787005	08073961
9:69:11:	D	LUTZ RAE H	CA B0P1V0	$147800.00	WATERVILLE (ALSO	1970	T3	A1426 FP	
1045000064600				140 Ac +/-	LITTLE BROWN ROAD)	1972	T3	P33 FP	
MU1107				2000-03-13		1973	T3	P298 FP	
						1973	T3	P300 FP	
						1973	T3	P303 FP	
						1973	T3	P304 FP	
						1973	T3	P322 FP	
						1973	T3	P389 FP	
						1992	S1	P8940 FP	
						1992	101	4700	904/72
55332605	D	ROGERS JORDAN MICHAEL	RR 1 WATERVILLE NS	08098727	335 BOND ROAD	1995	DT	246	
8:69:11:			CA B0P1V0	$82500.00	WATERVILLE LOT 1	1995	PP	55141816	
0245030064680				2.47 Ac	([M])	1995	S1	950082 69	
1045000064600				2003-05-07		1995	S1	P9974 FP	
MU1107						1995	101	5110	1023/165
						2003	101	2334	1374/781
						2003	201	2335	1374/784
55340590	D	GATES H VAUGHAN	PO BOX 18	08088985	215 BOND ROAD	1972	T3	P34 FP	
8:69:11:U	D	GATES JOY D	WATERVILLE NS CA	$155000.00	WATERVILLE LOT 1	1994	S1	P9651 FP	
1045000064600			B0P1V0	5.26 Ac		1994	101	6749	989/521
MU1107				2003-03-03		2003	201	1097	1366/633
55342216 (25)	P	PROSPECT INDUSTRIAL	PO BOX 87 CAMBRIDGE	08102023	THOMPSON ROAD	1995	DT	113	
9:69:11:		EQUIPMENT SALES AND RENTALS L	NS CA B0P1G0	$19900.00	WATERVILLE PARCEL	1995	PP	55168868	
1045000064600				132.66 Ac	1-MNT	1995	S1	950144 69	
MU1107				2002-04-23		1995	S1	P10037 FP	
						1995	101	6967	1030/428
55342224	P	PROSPECT INDUST EQUIP SALES	PO BOX 87 CAMBRIDGE	08102031	WATERVILLE MOUNTAIN	1995	DT	113	
9:69:11:		& RENTLTD	NS CA B0P1G0	$3000.00	ROAD SOUTH	1998	DT	2610	
1045000064600				20 Ac +/-	WATERVILLE LOT G-B	1950	S3	A214 FP	
MU1107				2002-04-23	(WEST OF)	1994	S1	940248 69	

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						1994 S1 P9823 FP 1998 S1 980113 69 1998 S1 P11084 FP 1991 101 11156 873/93 1998 101 5602 1160/50 1998 201 5603 1160/59 2000 301 303 1212/684
55342232 9:69:11: 1045000064600 MU1107	P	PROSPECT INDUST EQUIP SALES & RENTLTD	PO BOX 87 CAMBRIDGE NS CA B0P1G0	08102058 $4100.00 27.00 Ac 2000-02-01	PROSPECT ROAD SOUTH WATERVILLE LOT F	1995 DT 113 1998 DT 2610 1950 S3 A214 FP 1998 S1 980113 69 1998 S1 P11084 FP 1991 101 11156 873/93 1998 101 5602 1160/50 1998 201 5603 1160/59 2000 301 303 1212/684
55342257 (26) 9:69:11: 1045000064600 MU1107	P	PROSPECT INDUST EQUIP SALES & RENTLTD	PO BOX 87 CAMBRIDGE NS CA B0P1G0	08102074 $18600.00 76 Ac +/- 2002-04-23	WATERVILLE MOUNTAIN ROAD CAMBRIDGE (REMAINDING LANDS)	1995 DT 113 1998 DT 2610 1998 IP 55374441 1994 S1 940248 69 1994 S1 P9823 FP 1998 S1 980113 69 1998 S1 P11084 FP 1991 101 11156 873/93 1998 101 5602 1160/50 1998 201 5603 1160/59 2000 301 303 1212/684
55347116 (27) 8:69:11:J 0245030064680 1045000064600 MU1107	A B	BUDDE ROBERT G BUDDE LAURA L	5110 HIGHWAY 1 WATERVILLE NS CA B0P1V0	08102198 $22000.00 29 Ac +/- 2002-04-18	BOND ROAD WATERVILLE	1995 DT 246 1992 101 10519 926/861 1996 101 438 1045/900

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PID STATUS DIST:MUN:CO:OS TYPE / MAP(S)	OD CODE	OWNER NAME(S)	OWNER ADDRESS	TAX ACCOUNT 2003 VALUE AREA LAST UPDATE	PROPERTY LOCATION	- XREF/PLAN/DOC REFERENCES - YEAR TYPE NUMBER BOOK/PAGE PRB OR FILE REFS
55365829 (28) 9:69:11:JT 0245030064680 1045000064600 MU1107	D D	TWEEDIE NORMA MILNE ALEXANDER	RR 1 164 BOND RD WATERVILLE NS CA B0P1V0	08115966 $58600.00 1.78 Ac 2002-04-23	464 BOND ROAD WATERVILLE LOT 1-97	1997 DT 1117 1997 PP 55168868 1997 S1 970124 69 1997 S1 P10709 FP 1997 101 5983 1110/821
55366868 (29) 9:69:11: 1045000064600 MU1107	D D	TWEEDIE MURRAY H TWEEDIE NORMA	RR 1 WATERVILLE NS CA B0P1V0	08117020 $5700.00 8.21 Ac 2002-04-23	THOMPSON ROAD WATERVILLE LOT 3-97	1997 DT 1493 1997 PP 55168868 1997 S1 970179 69 1997 S1 P10773 FP
55368195 8:69:11:JT 1045000064600 MU1107	D D	FORD ANDREW G FORD DENISE S	1880 PROSPECT AVE WATERVILLE NS CA B0P1V0	08084696 $94300.00 2.98 Ac 1998-12-16	1880 PROSPECT ROAD SOUTH WATERVILLE LOT 1 ([M])	1993 PP 55168728 1997 DT 1710 1993 S1 P9523 FP 1993 101 8237 958/387
55370829 9:69:11: 0245040064680 1045000064600 MU1107	P	TWIN MOUNTAIN CONSTRUCTION LTD	RR 2 WATERVILLE NS CA B0P1V0	08122881 $32800.00 90.00 Ac 2002-04-23	BOND ROAD WATERVILLE (WATTS FARM)	1997 DT 1899 1997 PP 55168868 1997 101 10953 1130/150 2002 202 329 1303/367
55386163 (30) 9:69:11: 1045000064600 MU1107	D	WALSH JOHN JOSEPH	RR 1 768 THOMPSON RD WATERVILLE NS CA B0P1V0	08131597 $3100.00 4.0 Ac +/- 2003-07-10	THOMPSON ROAD WATERVILLE (EAST OF)	1999 DT 3413 1999 PP 55168330 1999 101 6277 1203/726 2003 101 3596 1382/925 2003 201 3597 1382/930
55411433 : : :		NO OWNER NAME ON FILE	NO ADDRESS ON FILE	NO MATCH VALUE N/A		
55411839 : : :		NO OWNER NAME ON FILE	NO ADDRESS ON FILE	NO MATCH VALUE N/A		
55411847 : : :		NO OWNER NAME ON FILE	NO ADDRESS ON FILE	NO MATCH VALUE N/A		
55411854 : : :		NO OWNER NAME ON FILE	NO ADDRESS ON FILE	NO MATCH VALUE N/A		

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MU1107							
55168850	D	WALSH CHESTER T	RR 1 384 BOND RD	04799496	384 BOND ROAD	FC 02006900	04799496
9:69:11:JT	D	WALSH MABEL JOSEPHINE	WATERVILLE NS CA	$35800.00	WATERVILLE ([M])	1985 101 15544	644/568
0245030064680	D	DOUCETTE LISA MARIE	B0P1V0	1.6 Ac +/-		1992 101 Z1890519	189/519
1045000064600				2002-04-18		1992 101 Z3630506	363/506
MU1107						1999 101 1243	1178/182
						2001 101 2493	1264/244
55168868 (31)	P	TWIN MOUNTAIN CONSTRUCTION	RR 2 WATERVILLE NS	00484687	BOND ROAD	1993 IP 55289821	
9:69:11:		LTD	CA B0P1V0	$106400.00	WATERVILLE	1995 DT 113	
0245040064680				25.00 Ac	(REMAINDER OF HOME	1995 IP 55341549	
1045000064600				2002-04-23	FARM)	1995 IP 55342216	
0245030064680						1997 DT 1117	
MU1107						1997 DT 1493	
						1997 DT 1899	
						1997 IP 55365829	
						1997 IP 55366868	
						1997 IP 55370829	
						1965 T3 A729 FP	
						1997 S1 970124 69	
						1997 S1 970179 69	
						1997 S1 P10709 FP	
						1997 S1 P10773 FP	
						1974 101 1974	366/785
						1991 101 Z8730093	873/93
						1992 101 Z3660774	366/774
						1997 101 10953	1130/150
						2002 202 329	1303/367
55168876	P	PLEASANT VALLEY ENTERPRISES	R R 2 BERWICK NS CA	08067112	466 BOND ROAD	1965 T3 A729 FP	
9:69:11:		LIMITED	B0P1E0	$125100.00	WATERVILLE LOT NT	1991 S1 P8722 FP	
0245040064680				8.8 Ac +/-	(-470- EAST OF BOND	1991 101 11157	873/104
0245030064680				2002-12-17	ROAD ALSO NO 1	2002 201 8993	1358/704
1045000064600					HIGHWAY)		

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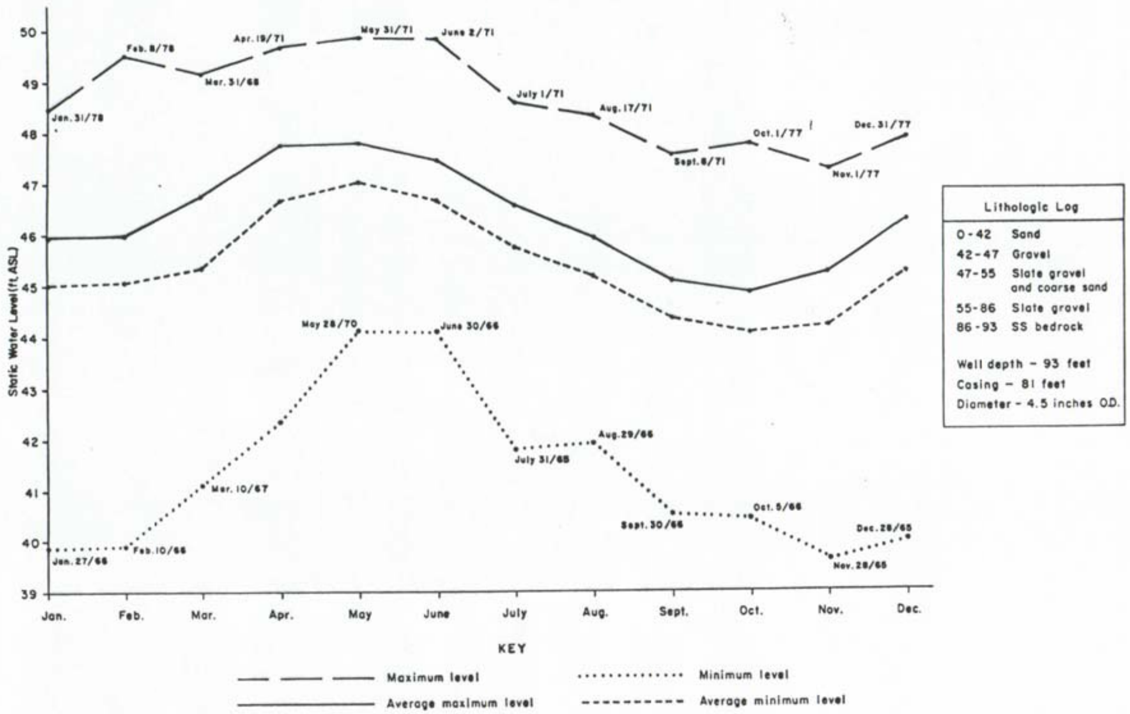
Date: November 26, 2003 LORIS USER : QUERY2 Page 000009

APPENDIX C

Groundwater Hydrograph for the Period 1965 to 1981 From Observation Well 001, Coldbrook

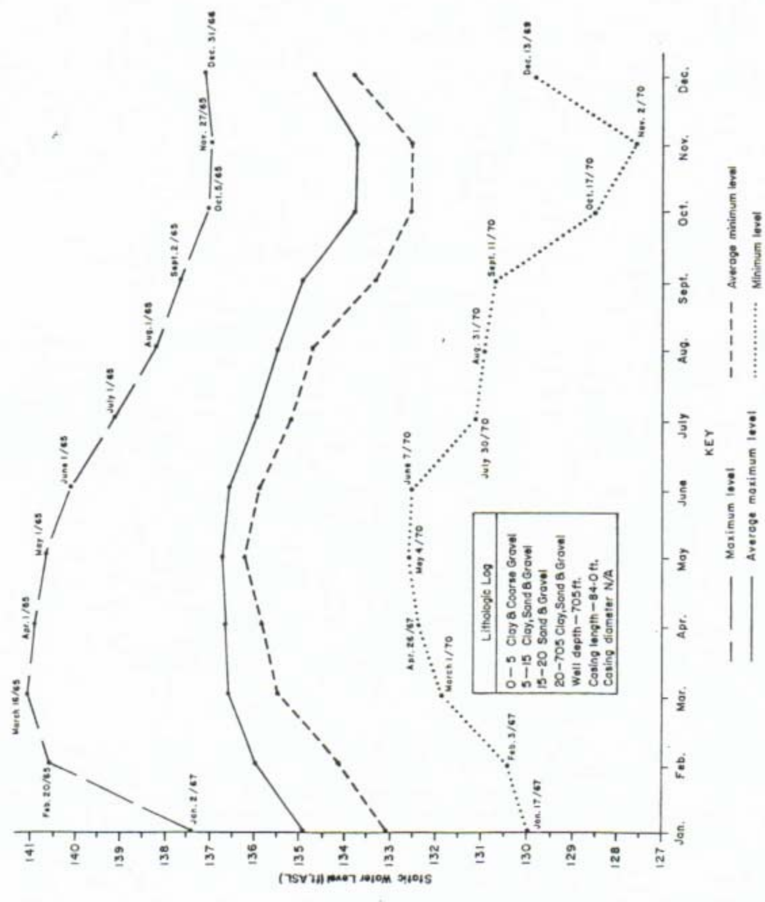
FIGURE 5 **Groundwater Hydrograph for the Period 1965 to 1981 From Observation Well 001 , Coldbrook.**



COLDBROOK - N.S.D.O.E. OBSERVATION WELL 001, FEBRUARY 1965-1981

APPENDIX D

Groundwater Hydrograph for the Period 1965 to 1973 from Observation Well 032, Berwick



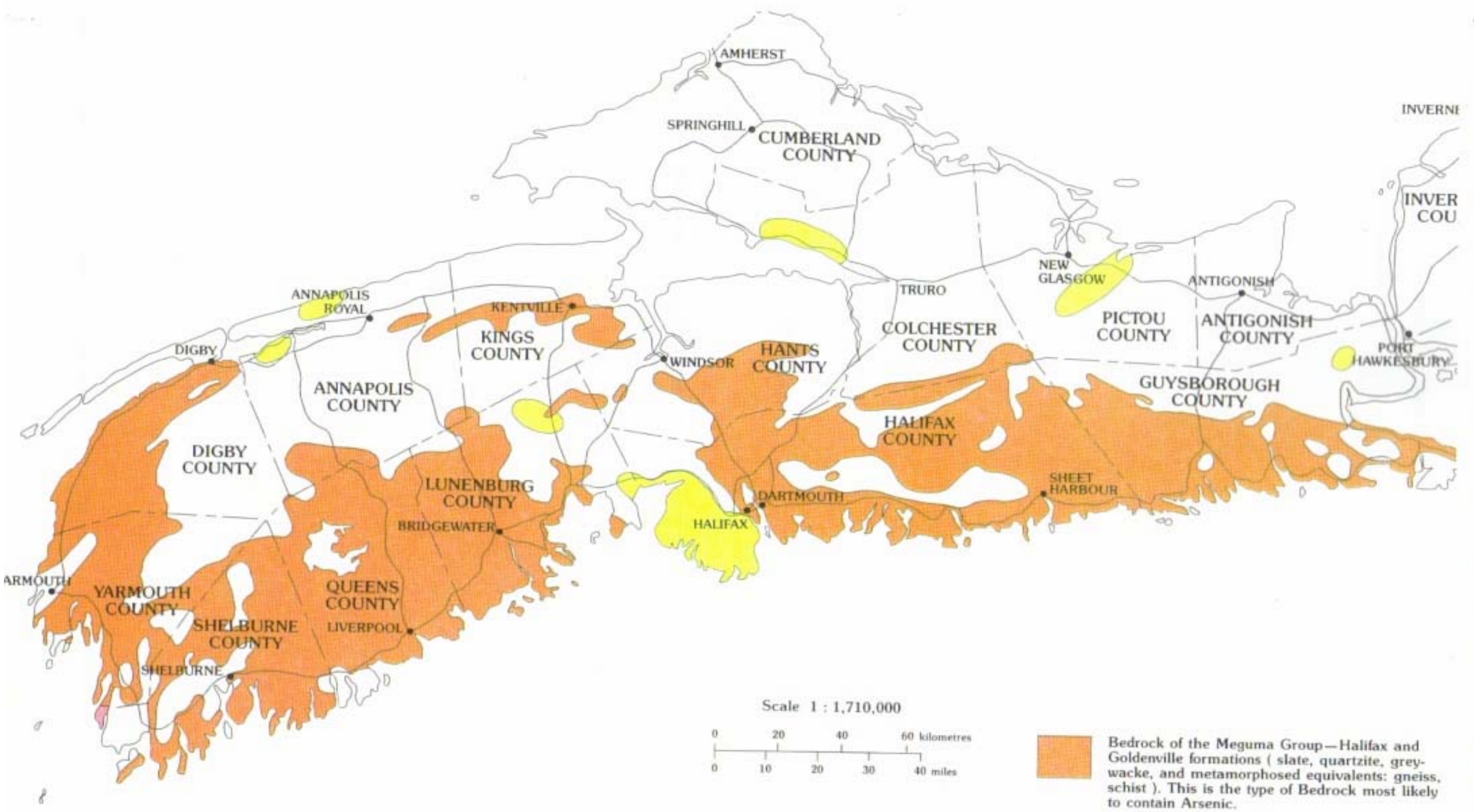
BERWICK – N.S.D.O.E. OBSERVATION WELL 032, FEBRUARY 1965 – AUGUST 1973

APPENDIX E

Naturally Occurring Arsenic in Groundwater in Nova Scotia

Naturally Occurring Arsenic in Groundwater in Nova Scotia

Showing locations where Arsenic is likely to occur in wells or has been found in groundwater.



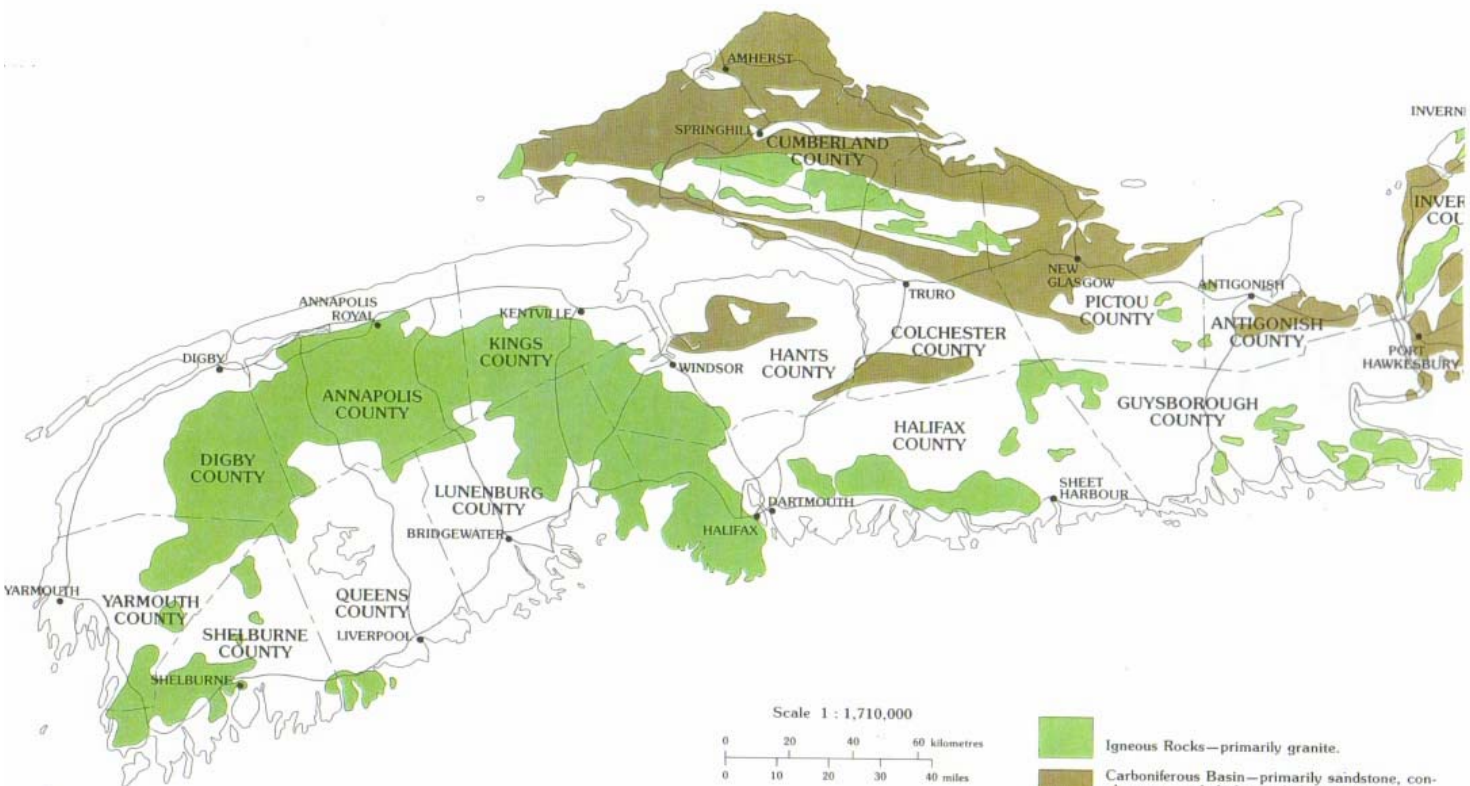
Nova Scotia Department of Health

APPENDIX F

Naturally Occurring Uranium in Groundwater in Nova Scotia

Naturally Occurring Uranium in Groundwater in Nova Scotia

Showing the types of Bedrock where wells are most likely to contain Uranium.



Scale 1 : 1,710,000

0 20 40 60 kilometres

0 10 20 30 40 miles

Igneous Rocks—primarily granite.

Carboniferous Basin—primarily sandstone, conglomerate and shales, includes Pictou, Canso and Cumberland Groups.

NOTE: The occurrence of uranium in groundwater is most probably *not* restricted to the areas shown.

Nova Scotia Department of Health

APPENDIX G

Selected Photos of the site

Photo #1. An example of the complex stratigraphy in the Quaternary sand and Gravel deposits in which shallow groundwater flow systems occur.

Photo #2. The composting site in the northern portion of the active pit showing 3 of the 6 existing monitoring wells on the site.

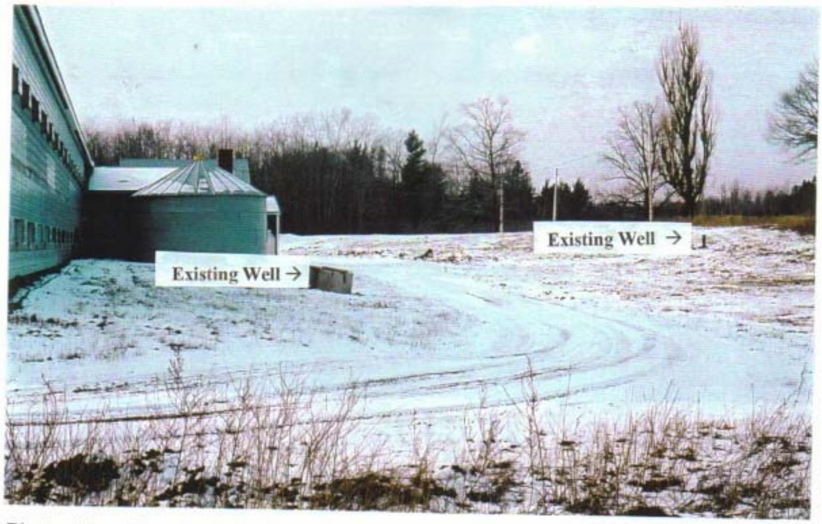


Photo #3. The nearest water wells located west of the active extraction area and the composting site. View west from active extraction area.

Photo #4. A section of Rochford Brook flowing east and located north of the composting site. View south on access road.

APPENDIX H

Procedures and Protocols for Field methods

PROCEDURE FOR DOCUMENTATION OF FIELD DATA

Documentation of field information should include sufficient material so that the field program can be reconstructed without relying on the memory of field personnel. Data must be collected and documented in a clear, concise and organized manner. Ideally this information should be recorded in a bound logbook. For legality reasons, the pages of the field book should be numbered consecutively. All entries in logbooks should be made in waterproof ink and corrections should be lined-out deletions that are initialled and dated. Field books should be kept in a secure place and copied as soon as possible. The completion of daily logs may be beneficial. Entries in the logbook may include the following:

- Site name
- Borehole or well number
- Field Supervisor's name and company affiliation
- Date and time of sample collection
- Sample number, location, and depth
- Sampling method
- Observations at the sampling site
- Unusual conditions
- Information concerning drilling decisions
- Decontamination observations
- Weather conditions
- Names and addresses of field contacts
- Names and responsibilities of field crew members
- Names and titles of any site visitors
- Location, description, and log of photographs
- References for all maps and photographs
- Information concerning sampling changes, scheduling modification, and change orders
- Summary of daily tasks and documentation on any cost or scope of work changes required by field conditions
- Signature and date by personnel responsible for observations

PROCEDURE FOR SITE CLEARANCES

In addition to overhead services, a variety of underground utilities such as electrical, telephone, water and sewer lines, pipelines and tanks may exist at any particular site. As well, in some areas contaminants may have been buried in the subsurface. Accordingly subsurface drilling and excavation sites MUST BE cleared prior to proceeding with the designated field work. Completion of this screening is almost always the responsibility of the Field Site Supervisor.

Screening may consist of one or all of the following:

- contacting the appropriate agencies such as telephone, electrical and hydro companies;
- review of Facility drawings that show the position of known underground services, or
- geophysical reconnaissance using electromagnetic or magnetic methods.

If unknown utilities or contaminant sources (e.g., drums, pipelines, tanks) are contacted during the investigation, work must stop until the appropriate persons are contacted. The locations of such utilities or sources are generally marked and included in subsequent site plans.

PROCEDURE FOR DECONTAMINATION

The overall objective of multimedia sampling programs is to obtain samples which accurately depict the chemical, physical, and/or biological conditions at the sampling site. Extraneous contaminant materials can be brought onto the sampling location and/or introduced into the medium of interest during the sampling program (e.g., by bailing or pumping of groundwater with equipment previously contaminated at another sampling site). Trace quantities of these contaminant materials can consequently be captured in a sample and lead to false positive analytical results and, ultimately to an incorrect assessment of the contaminant conditions associated with the site. Decontamination of sampling equipment (e.g., bailers, pumps, tubing, soil and sediment sampling equipment) and field support equipment (e.g., drill rigs, vehicles) is therefore generally required prior to use at sites to ensure that sampling cross-contamination is prevented and that on-site contaminants are not carried off-site.

The following is a list of equipment that may be needed to perform decontamination:

- brushes
- wash tubs
- buckets
- scrapers, flat bladed
- hot water - high-pressure sprayer
- disposal drums (205 litre with secure lids)
- sponges or paper towels
- detergent (simple green)
- potable tap water
- garden-type water sprayers
- spray bottles
- methanol

Personnel

A temporary personnel decontamination line may be set up around the exclusion zone at each site. If contamination is not encountered, a dry decontamination station may be established which consists of discarding of disposable personal protective equipment (PPE).

If HNu or Gastector readings indicate that contamination has been encountered (i.e., action levels are exceeded requiring an upgrade from initial PPE levels), or if the initial PPE is B or C, a complete personnel decontamination station will be established.

The temporary decontamination line should provide space to wash and rinse rubber boots, gloves, and all sampling or measuring equipment prior to placing the equipment into a vehicle. It should provide a container to dispose of used disposable items such as gloves, tape or tyvek (if used).

The decontamination procedure for field personnel may include:

1. glove and rubber boot wash in a detergent solution
2. glove and rubber boot rinse
3. scraping soil from non-rubber boots
4. duct tape removal, if appropriate
5. outer glove removal
6. coverall removal
7. respirator removal (if used)
8. inner glove removal (if used)

Sampling Equipment

The following steps will be used to decontaminate sampling equipment:

- Personnel will dress in suitable PPE to reduce personal exposure

- Gross contamination on equipment should be scraped off at the sampling or investigation site.

- Equipment that will not be damaged by water should be placed in a wash tub containing a low-sudsing detergent along with potable water and scrubbed with a bristle brush or similar utensil. Equipment should be rinsed with tap water in a second wash tub, followed by a potable water rinse.

- Equipment such as split spoons and stainless steel trowels that will not be damaged by solvents may be sprayed with methanol, using a spray bottle. The equipment should then rinsed with potable water, wiped and allowed to air dry. Heavy equipment (i.e., augers, drill rods, excavator buckets should not be cleaned using methanol. In highly contaminated sites, drilling rigs and/or excavators should be decontaminated at a central decontamination area.

- Equipment that may be damaged by water should be carefully wiped clean using a sponge first rinsed in detergent water, then rinsed with potable water. Care will be taken to prevent any equipment damage.

- Rinse and detergent water should be replaced with new solutions between borings or sample locations.

Following decontamination, equipment should be placed in a clean area or on clean plastic sheeting to prevent contact with potentially contaminated soil. If the equipment is not used immediately, the equipment should be covered or wrapped in plastic sheeting or heavy-duty garbage bags to minimize contact with potential airborne contamination.

Equipment Leaving the Site

Vehicles used for non-contamination activities may be cleaned on an as-needed basis, using soap and water on the outside and vacuuming the inside. On-site cleaning may be required for very dirty vehicles which will be leaving the area. On-site investigation equipment such as trucks, drilling rigs, backhoes, trailers, etc., may need to be pressure washed on-site before the equipment is removed from the site to limit exposure of off-site personnel to potential contaminants.

Wastewater

Liquid waste water from decontamination activities, monitoring well development and purging, and rinse water are generally considered to represent substantially reduced sources of contaminants than existing on-site sources. The two most feasible means of disposing waste water include on-site sewer collection systems and ground surface discharge in away from the well that overlie areas of known soil and/or groundwater

Waste waters containing separate phase liquids (e.g., LNAPL, DNAPL or visibly contaminated water) should be contained for off-site disposal at an approved facility.

Other Wastes

Solid wastes from heavy equipment decontamination, drilling cuttings or test pit activities with evident contamination should be contained and segregated for subsequent disposal. When the containers are full, they should be labelled with its contents and date, using paint or another permanent maker.

Other solid wastes, such as used personal protective clothing, water sample filters, spent sampling materials, that are obviously contaminated should also be containerized and disposed of in an appropriate manner.

Documentation

Decontamination of sampling and drilling equipment should be documented in the field notebook. The information entered may include the following:

- Field Supervisor and company affiliation
- date and start and end times
- type of decontamination procedure used
- number and type of samples collected
- decontamination observations
- weather conditions

Quality Assurance Requirements

Equipment rinsate samples should be taken of the decontaminated sampling equipment to verify the effectiveness of the decontamination procedures. The rinsate procedure should include rinsing potable water through or over a decontaminated sampling tool (e.g., a split spoon sampler or bailer) and collecting the rinsate water in sample bottles, which will be sent to the laboratory for analysis. The rinsate procedure, including the sample number, should be recorded in the field notebook.

PROCEDURE FOR ENVIRONMENTAL DRILLING

This procedure describes the methodologies associated with drilling and typical monitor well installations used for environmental testing purposes. The following is a list of materials which may be required during an environmental drilling program:

- drill rig capable of installing wells to the desired depth
- well construction materials:
  - threaded PVC casing (typically 50 mm diameter & minimum schedule 40)
  - screen (typically 50 mm diameter, slot size to vary dependant on geological formation)
- bentonite pellets/chips
- filter pack sand (no. 2 or coarser)
- cement/bentonite mixture for grouting
- stainless steel centralizers, if appropriate
- protective well casing with locking cap
- high-pressure steamer/cleanser
- decontamination equipment/supplies
- wash/rinse tub
- detergent
- sampling containers (ie plastic ziplock bags) & labels
- weighted tape
- water level tape
- deionized water
- appropriate health and safety equipment
- log book
- borehole log sheets
- geotechnical field guide

The most common methods of drilling within surficial deposits involve the use of either *hollow stem auger flights (HSA)* or *continuous flight augers (CFA).* Auger drilling allows for borehole penetration without introducing water which could inhibit the collection of representative soil samples.

The flanges of the HSAs are welded onto a larger diameter pipe than the CFAs. The flights are linked together such that the stem is hollow throughout the drill string. The cutting bit has a finger plug which prevents loose soil from entering the stem. A split-spoon sampling device may be lowered inside the drill string and driven through the finger plug and ahead of the cutting bit for an in situ sample as required. The HSA string, therefore, serves as a form of casing because it does not have to be withdrawn each time a sample is collected. One can obtain more accurate samples using this method.

There are several advantages of HSA boreholes. First, the method is rapid in most unconsolidated, fine to medium-grained geologic materials. Second, drilling fluids are not used to remove cuttings and, therefore, the in situ chemical conditions of the borehole are not further degraded by either diluting contaminants with added water or contributing suspended solids from drilling muds used to stabilize the borehole walls in soft materials. Third, HSA flights are easily cleaned and decontaminated. Fourth, the auger flights serve as a form of casing, which allows monitoring wells to be constructed by raising the flights as needed. Fifth, the drilling rate is better than with the CFA because the drill string remains in the boring until it is completed.

One minor disadvantage of the HSA is that clearing and decontamination require more time than with the CFA due to the interior surfaces present. Another disadvantage is that drilling below the water table, especially in fluid soils such as supersaturated or "flowing" sands, may be difficult if the head in the string is less than the head in the formation. Such a head difference may result in the inflow of groundwater and sediment around the cutting bit and finger plug. .

The most common methods of drilling within bedrock involve the use of either a *tricone* or *diamond drill bit* for coring. Coring provides several advantages. Most importantly, it allows for the retrieval of in-situ bedrock samples rather than drill cuttings.

The core barrel is approximately 1.5 m in length and is equipped with a diamond coring bit. The nominal core diameter will be 8 cm (i.e., 3 inches - NQ size). The water supply should be obtained from a source known to be clean (free of contaminants). Optimally it should be sampled prior to use. If not, obtain a sample and have it analysed as part of the testing program.

Monitor Well Installations

The procedure for monitoring well installation using HSAs is as follows (a typical construction diagram is shown on Figure 1):

1. Measure and record depth of completed boring using a weighted tape.

2. Prepare all well construction materials. All personnel that handle the casing should don a clean pair of rubber or surgical gloves.

3. Assemble screen and casing as it is lowered into the boring inside the hollow stem augers. Attach stainless steel centralizers as required. Be sure that the end cap is well secured on the bottom length of pipe. The tops of all well casings will be fitted with slip caps which can be easily removed by hand.

   The screen length of the monitoring wells will vary, dependant on the design and overall objectives of the field testing program. For instance, where the presence of volatile compounds less dense than water (LNAPLs) is a potential concern, care must be taken to ensure that the screen zone spans the water table surface. Enough screen must be installed to allow for seasonal fluctuations of the water table.

4 Record level of top of casing and screened interval. Adjust screen interval by raising assembly to desired interval, if necessary, otherwise add 15 cm of sand to raise the bottom of the boring to the base of the end cap.

5. Calculate and record the volume of the sand pack, bentonite seal, and backfill in grout required for existing boring conditions.

6. Add filter pack sand around the annulus of the screen, repeatedly taking depth soundings to monitor the level of the sand (allow sufficient time for the filter sand to settle through the water column outside the casing before measuring the sand level). Extend the filter pack sand to at least 0.6 m above the top of the well screen.

7. Following sand filter pack placement, slowly add a 0.6 to 1 m high bentonite seal on top of the sand filter. **Adding the bentonite pellets or chips too quickly may cause bridging**. If required, add 5 litres of potable water per 0.3 m of bentonite to initiate swelling of the pellets or chips. The completed bentonite seal should be allowed to hydrate for approximately 30 minutes. If required, grout should be placed in the well annulus with a tremie pipe initially located about 3 m above the top of a bentonite seal. The grout should be pumped through the pipe which is pulled up incrementally until the desired height is reached. The grout may consist of a mixture of Portland cement and bentonite grout or a high-yield bentonite grout. The grout should be prepared in an above-ground rigid container by first thoroughly mixing the high-yield bentonite with water and then, if appropriate, mixing in cement.

8. Add first a 3 or 4 cm thick layer of sand to facilitate identifying the top of the bentonite seal. Then add an additional 26 or 27 cm of sand above the seal.

9. If grout is not used above the bentonite seal to complete the well installation, backfill the annular space using drilling cuttings or by allowing the natural sand formation to collapse around the well screen when the augers are pulled. Repeated depth soundings should be taken to monitor the level of backfilling and detect possible bridging. The final level of backfilling should be approximately 1 m below ground surface. It may be advantageous to repeat one or more bentonite seals if the distance to ground surface is greater than several meters. Typically in unconsolidated materials, the annular space above the bentonite or grout seal, between the borehole and well will be backfilled with drilling cuttings generated during the drilling. Alternatively and depending upon the character of the geologic material, collapse of native materials into the annular space, above the bentonite or grout seal, can serve as backfill.

10. After backfilling, a surface seal should be installed using either cement/bentonite mixture. This will deter surface water leakage into the well.

11. The well head should be protected with either an above ground casing or flush mount cover. The surface seal will depend upon whether a flush or above ground completion is required. For an above ground well completion and following placement of the backfill, the boring diameter of the upper 1 m should be filled with a sand or sand/bentonite mixture. If a flush mount completion is required and following placement of the backfill, the boring diameter of the upper 0.6 to 1 m of the hole annulus will typically be filled with concrete consisting of a cement and sand mix. A water-tight security plug should be installed on top of the PVC riser when using flush mount covers.

12. A reference point for surveying should be clearly established at each monitor well location. This point is often located on the lip of the PVC riser pipe and represents the mark in which water level measurements are taken.

The following information may be recorded in the field book:

- Bottom of the boring
- Casing depth (if intermediate steel casing is left in the hole)
- Screen details; location(s), slot size
- Sand packs
- Bentonite seals
- Sand units above bentonite seals
- Backfill material and origin (i.e., cuttings or collapse)
- Height of riser without slip cap (above ground surface)
- Protective casing detail
- The quantity and composition of the grout, seals, and sand pack actually used during construction
- Start and completion dates
- Discussion of all procedures and any problems encountered during drilling and well construction

PROCEDURE FOR SOIL AND/OR BEDROCK SAMPLING

The procedure for collecting, labelling, storing, and transporting subsurface soil samples is described below:

- Select the appropriate sampler (split spoon or continuous soil sampler) and sampling interval

- Decontaminate the drilling and sampling equipment and ensure that appropriate health & safety precautions are applied

- The resistance to soil penetration should be measured using a split-spoon sampler in accordance with ASTM D-1586. Penetration resistance (i.e., blow counts) for each 15 cm increment should be recorded. Typically, a count of 50 blows for 15 cm indicates refusal.

- Open the split-spoon or continuous soil sampler and measure the recovery. Scrape off any soil from the recovered sample with a stainless steel knife.

- Determine and identify the use of the recovered sample. This will either be for soil classification and stratigraphic logging, chemical, head space, or geotechnical analysis

- If chemical analysis of the sample is required, the sample must be handled quickly, especially if it is loose or crumbling, to avoid losing volatile contaminants. The following procedures should be followed:

    - For volatile organic analysis, fill vials completely full with soil from the split spoon. If required, duplicate samples will be collected from the same split spoon, adjacent to the initial sample interval.
    - Obtain sufficient soil for subsequent head space analysis, if applicable. If only relative field values are required, it is appropriate to store these samples in a plastic zip lock bag
    - For inorganic parameter analysis, composite the remaining soil by thoroughly mixing the soil from the split spoon or continuous sampler in a decontaminated stainless steel bowl with a decontaminated stainless steel spatula or spoon. If required, duplicate samples will be collected from the remaining composite soil.
    - Label, store, transport and document the samples as appropriate

- Soil sample descriptions may include the following observations:

- ***colour*** - soil colours should be described using a single colour description preceded, when necessary, by a modifier to denote variations in shade or colour mixtures. Since colour may be helpful in correlating stratigraphic units, it is important to be consistent. A colour chart is often useful. Colour should be described when the sample is still moist. If it is a split spoon sample, break the sample in half vertically.

- ***texture*** - texture is described as the relative angularity of the particles; ie: sand sized grains or larger may be rounded, sub-rounded, angular or sub-angular

- ***composition & consistency***- describes the nature of the sample; ie: clay, silt, sand, gravel etc, and the approximate amounts. For example a sample composed primarily of silt but with some sand and clay components could be described as a sandy clayey silt

- ***bedding*** - describes the existence of beds or layers (strata), laminae, or other tabular and essentially horizontal units

- ***cohesiveness*** - describes the capacity to stick or adhere together

- ***fabric*** - describes the orientation of the particles composing a soil or rock

- ***friability*** - describes how easily the sample crumbles

- ***grading*** - describes the degree of mixing of size classes in a sedimentary material. Well graded implies more or less uniform distribution from coarse to fine; poorly graded implies uniformity in size or lack of a continuous distribution

- ***plasticity*** - is the property of material which enables it to undergo permanent deformation without appreciable volume change or elastic rebound, and without rupture

- ***moisture*** - describes the water content; terms such as dry, damp, wet and saturated apply

- ***visual contamination*** - includes observations regarding the presence/absence of staining and/or other obvious indications of contamination ie: petroleum hydrocarbons

- Where appropriate, colour, texture or bedding terminology discussed above can be used in describing the rock core. In addition the following information may be recorded.

  - ***rock type*** - core should be classified in terms of the rock type (e.g, sandstone, siltstone, granite)

- ***rock quality designation (RQD)*** - the classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting or weathering in the rock mass and are not counted. Care must be exercised to identify breaks in the core due to the drilling or recovery process. The following descriptions will be used for appropriate RQD values:

RQD (%)	ROCK QUALITY DESCRIPTIONS (one term for each RQD value as appropriate)
90 - 100	Excellent, intact, very sound
75 - 90	Good, massive, moderately jointed or sound
50 - 75	Fair, block and seamy, fractured
25 - 50	Poor, shattered and very seamy or block, severely fractured
0 - 25	Very poor, crushed, very severely fractured

- ***bedding*** - this terminology is based upon the spacing between beds, as follows:

SPACING (mm)	BEDDING, LAMINATIONS, BANDS	DISCONTINUITIES
2000 - 6000	Very thick	Very wide
600- 2000	Thick	Wide
200 - 600	Medium	Moderate
60 - 200	Thin	Close
20 - 60	Very thin	Very close
< 20	Laminated	Extremely close
< 6	Thinly laminated	

- ***weathering*** - slightly weathered implies limited surface discontinuities, such as iron staining. Moderately weathered implies discontinuities throughout the rock mass, although the rock is not friable. Highly weathered implies discontinuities throughout the rock mass, and friable rock.

- ***apertures*** - describes orientation, spacing, persistence of the fracture or joint and mineral presence

Examples of a borehole record and typical well construction diagram are included with this procedure.

PROCEDURE FOR GROUNDWATER SAMPLING

A typical sample collection exercise involves a number of steps including pre-trip planning and preparation, on-site work, sample storage and shipping and laboratory analysis.

Pre-trip preparations include identifying the location of the site, how many wells are to be sampled, their sizes and construction details, the required analyses, what duplicate or control samples are needed and where the samples will be sent for analysis. The field equipment needed for the job should also be identified and prepared. Preparation may include the decontamination of equipment or the acquisition of equipment designed for one-time use only. Environment Canada's TABS on Contaminated Sites, TABS #5 provides a good summary of pre-trip planning and equipment decontamination techniques.

On-site work includes measuring static groundwater levels, inspecting wells, collecting samples and storing samples for transport to the laboratory. These steps, and quality assurance and quality control procedures, are described in detail in the sections that follow.

Measuring Static Water Levels

Upon arriving at a site to collect groundwater samples from monitoring wells, the first step should be to locate each monitoring well and remove the well covers and caps. Sealed well caps, such as rubber J-Plugs should be removed with caution as pressure may have built up in the well since the well was last opened. Reasons for this include rising groundwater levels in the well resulting in compression of the air above the water surface or the potential build-up of hydrocarbon vapours in the air space. All well caps should be removed to allow the water levels to stabilize.

Static water levels should be recorded in all wells over as short a time period as possible. This is particularly important in coastal areas, such as Nova Scotia, where tidal fluctuations could result in changes in groundwater levels over a short period of time. Groundwater levels may also change as recently infiltrated rainwater discharges from the system or in response to changes in atmospheric pressure. Although these variations may be small, they may be significant in areas with very shallow groundwater gradients and could result in the misinterpretation of groundwater flow directions.

Water levels should be measured twice in each well to verify the accuracy of the reading. It is also a good practice to re-measure the static water level in the first well at the end of the procedure to verify that the level has not changed.

When using measuring devices that must contact the water, it is important to thoroughly clean the device between monitoring wells. The method of decontamination will vary depending on the contaminants in question and may involve the use of soaps, alcohol or special solvents to ensure all traces of the contaminant are removed. Rinsing with distilled water is often done as a final step of the decontamination process. If relative contaminant levels are known in the monitoring wells, starting with the least contaminated well and moving to progressively more contaminated wells is one approach to minimizing the potential for cross-contamination.

A number of methods are available for determining static water levels, however the most common is to use a water level probe and meter. These devices usually consist of a plastic or fiberglass tape measure connected to a probe. Wires running inside the tape connect the probe to an audible and/or visual indicator that signals when the probe touches the water surface. The depth to the water at this point is measured off of the tape. Water levels are usually recorded relative to the top of the well casing which has been previously surveyed. This allows for the comparison of relative water levels in the monitoring wells so that groundwater flow directions and gradients may be determined. It is good practice to mark the top of the well casing, in a permanent manner, at the location where the elevation was surveyed. All subsequent water levels are then recorded relative to this position to ensure accurate water level elevations are calculated.

Other methods are available for measuring water levels. A weighted tape measure, coated with water finding paste or chalk, may be lowered into the well until the end of it is definitely below the water surface. The tape is read at the position of the top of the casing and the tape is withdrawn. The location of the water surface, relative to the tape, is determined from the location where the chalk or paste is still present. The difference between the two readings is the depth to the water from the top of the well. Another method involves the use of ultrasonic devices that do not contact the water but rather measure the time it takes sound waves to travel to the water surface and back again. These devices are calibrated to convert this time to a distance.

At some sites, the measurement of free product thickness may also be necessary. Free product refers to free phase hydrocarbons floating on the surface of the water as opposed to being dissolved in it. Again a number of methods are available for determining free product thickness. Product probes are available that emit a specific sound when in contact with hydrocarbons and another sound in the presence of water. The difference between the locations where each sound is first heard is the free product thickness. Another method is to use a weighted tape measure coated with chalk on one side and water finding paste on the other. After submerging the tape a sufficient distance to ensure it has fully penetrated the free product layer, the tape is withdrawn and the two sides of the tape are compared. The chalk will be washed away from that portion of the tape that penetrated both the free product and the water whereas the water finding paste will only be washed away from the portion of the tape that contacted the water. The difference between the two readings is the free product layer thickness.

Monitoring Well Inspections

While measuring the static water level in each well, it is also a good time to inspect the well for damage or other potential problems. This could include damage from vehicles, vandalism or frost heaving. In addition the ground in the vicinity of the well may be washed away or caving in allowing surface water to move down the outside of the well casing. The integrity of the well seal must be determined whenever any damage is found. If the possibility exists that water in the well is being influenced by the entry of surface water, soil particles and/or soil organisms, a decision will have to be made as to whether a sample should be collected. In some cases, analytical costs may be low enough that it is worth submitting the sample and then interpreting what effects, if any, the damage has had on water quality from the results. In other cases, however, analytical costs may be high enough that it is not worth the risk of submitting a sample for which the results may not be valid. In still other cases, such as regulatory compliance monitoring programs, anomalous results may result in problems for yourself and the client and it may not be worth the risk of collecting samples from damaged wells.

In any event, the damage should be recorded. If possible, well repairs may be carried out at the time, the well thoroughly purged, and samples collected as usual. If immediate repair is not possible, subsequent site visits should include provisions to repair the damaged well.

Well Purging

The purpose of purging a well prior to sample collection is to ensure that samples are representative of groundwater conditions. Purging may not always be necessary. In deeper wells, the use of dedicated submersible pumps allows sample collection within the screened portion of the well without disturbing stagnant water at the air-water interface. This is more appropriate in coarse grain geologic materials. Purging should always be carried out in low to moderate permeability formations.

In some cases purging will be completed when the well goes dry. However in many cases the well will recover at a rate faster than it is being purged. In these cases an accepted rule of thumb is to purge three to five times the volume of the water in the well (see below). Another approach is to monitor groundwater physical or chemical properties, such as temperature, conductivity and/or dissolved oxygen, during the purging process. Purging may be considered complete when these parameters stabilize.

The volume of water in a monitoring well may be calculated as:

$$\text{Volume (L)} = \frac{[\text{Total well depth (cm)} - \text{depth to water (cm)}] \times 3.14 \times \text{well radius (cm)}}{1000}$$

Purging may be done using a bailer that will eventually be used for collecting the sample from that well, or using dedicated sample collection tubing and foot valves (Waterra® tubing) if they have been installed in the well. In large diameter wells (e.g. 300 mm or greater) a pump may be required to purge the well sufficiently.

Purging should be done over the entire depth of water in the well. This ensures that water from the deepest portions of the well is removed and replaced with 'fresh' water from the surrounding formation.

Sample Collection

Types of Samples

There are two general types of samples that may be collected, **Grab Samples** and **Composite Samples**. Grab samples are collected over a very short time period and represent a snapshot of the groundwater quality at a specific place and time. Grab samples may be further designated as **Discrete Samples**, samples collected from a specific depth only, or **Depth-Integrated Samples**, samples that are collected over a predetermined portion of the well. Depth-integrated samples may be collected over the entire depth of the well. Grab samples are generally less expensive to collect than composite samples as they require less time to collect.

Composite samples are actually the combination of a number of grab samples. These may be collected by mixing equal water volumes collected at regular time intervals. These samples are referred to as **Sequential Composite Samples**. In situations where water is constantly being pumped from a well, the collected water volumes should be proportional to the total volume of water discharged over the previous time period. These samples are referred to as **Flow Proportional Composite Samples**.

Composite sampling is not suitable for the collection of volatile organic samples, as these substances will be lost from the sample between sample collection events.

Sampling Devices

Samples may be collected using either bottom loading bailers, dedicated sample collection tubing and foot valves (Waterra® tubing) or submersible pumps. The choice of sampling device is often dictated by the intended analytical technique or by physical well conditions. The use of Waterra® tubing causes some aeration of the sample, making it inappropriate for the collection of samples such as those intended to undergo Volatile Organic Carbon analysis. In situations where the saturated zone is very deep, the head required to push the water to the surface may be so great that Waterra® tubing will not work.

Bailers may be disposable or designed to be decontaminated and reused. Reusable bailers should be thoroughly cleaned, before going to the site, using a procedure appropriate for the analysis being conducted. The use of disposable bailers is generally preferred as it minimizes the potential for the cross contamination of samples. Even with very diligent decontamination practices, re-usable bailers become scratched over time. Contaminants can collect in these scratches making decontamination difficult or impossible. In the case of disposable bailers, only new bailers should be used. A different bailer and rope should be used for each monitoring well.

The practice of leaving dedicated bailers in a monitoring well for extended periods of time may or may not be appropriate depending on the contaminants in question. In some cases the bailers may become contaminated through the adsorption of contaminants onto the bailer. Samples collected for the analysis of heavy hydrocarbons, solvents, pesticides and/or metals are some examples of cases where a new bailer should be used for each sampling event.

A variety of pumps are available for collecting groundwater samples. Peristaltic pumps may be used with dedicated sample collection tubing to ensure that the pump never contacts the sample. An added benefit of peristaltic pumps is that multiple sample collection tubes may be installed in a well, with each tube terminating at a different depth. Some type of seals should be present in the well to ensure water from different levels in the well is not mixed. A major drawback of these pumps is that they require power to operate and may be bulky, making their use impractical in remote settings.

Submersible pumps may also be used for sample collection, however the expense associated with these pumps, and the power needed to operate them, makes their use limited in practice. Controllers are available to regulate the speed at which these pumps operate. Operating these pumps at low flow rates minimizes sample aeration and the entrainment of sediment in the sample.

Another sample collection technique involves the use of hand operated vacuum pumps. These pumps are not suitable for the collection of volatile samples due to the fact that these substances will volatilize very easily in the presence of a vacuum.

Regardless of the sample collection method employed, every effort should be made to ensure that the sample collection device does not come into contact with the opening on the sample bottle. Sampling devices should not be used for more than one well. If this is necessary, such as when using submersible pumps, the sample collection device must be thoroughly decontaminated between wells. Again, a good practice in these cases is to always start at the well with the lowest expected concentration and finish at the most contaminated well.

Sample Containers

The intended analysis and the laboratory that will be providing the analysis usually dictate the choice of sample container. Factors that must be considered include:

- the volume of sample needed for the analytical technique,
- potential interactions between the sample and the sample container material,
- the affect of light on the sample, and
- the need to ensure there is absolutely no air bubbles in the sample container

Environment Canada TABS on Contaminated Sites, TABS #5 provides examples of the types of sample containers needed for specific analytical techniques. In any event the chosen laboratory should be consulted to determine the types, sizes and number of sample containers necessary for an intended sampling program.

Sampling Procedure

1. Allow the well to recover following purging.
2. Clean gloves (latex, nitrile, or similar) should be worn for each monitoring well. Not only will this minimize the possibility of cross-contamination of samples, in some cases it will also protect the sampler.

3. Ensure that the proper sample bottles are ready.
4. If filtering is necessary, place the filter in the sampling device. Note that field filtering is not possible when using bailers. Filters are designed to be used only once and they should not be re-used, even for the same well. This is due to the fact that once a filter has been saturated and allowed to dry, there will likely be deposits on the filter media that will affect concentrations in subsequent samples. Samples collected for organic analyses, suspended solids or total metals should not be filtered. Samples collected for the analysis of dissolved metals, particularly very turbid samples, should be filtered in the field.
5. If preservatives are required, they should be added to the bottle first. One exception to this is when collecting samples for metal analysis in polyethylene bottles. In this case, the nitric acid (used to preserve samples for metal analysis) should be added after the sample has been collected.
6. Collect the sample, minimizing sample aeration and air contact to avoid the loss of volatile compounds.
7. The level to which a particular sample bottle is filled will vary depending on the intended analysis. Some parameters (for example volatile organics) will volatilize into any headspace left in the bottle. In these cases bottles must be filled so that no air bubbles remain after the bottle has been capped. In other cases, some headspace is desirable. Reasons for this may include the need for the analytical laboratory to add reagents upon receiving the sample, or to allow lab personnel to handle a sample with minimal spillage in the case of hazardous samples.
8. Duplicate samples may be required depending on the needs of the client and the number of samples included in the monitoring program.
9. A sample record log should be filled out immediately.
10. The samples should be kept cool and in the dark. Portable coolers and ice are ideal for this. The use of ice cubes or crushed ice is preferable to ice packs to ensure that samples remain in contact with the ice and are kept cool. Steps should also be taken to ensure that sample labels remain legible in the presence of melting ice and water. Permanent markers or ink should be used when filling out labels. Procedures such as wrapping clear cellophane packing tape over the labels or placing sample containers in sealed 'zip-lock' plastic bags will protect sample labels.
11. Samples should be delivered to the laboratory as soon as possible and always within the recommended maximum holding time recommended for the intended analytical technique.

<u>Sampling Free Product</u>

The following procedure should be used when collecting samples of free product. It should be noted that bottom loading bailers must be used for this purpose. The use of Waterra® tubing or pumps may result in mixing of the free product and water in the sample. Even the use of low flow sampling pumps may not be appropriate as it will be difficult to ensure the pump intake remains in the free product layer only.

1. Carefully lower a bottom loading bailer to the product layer (as determined during the measurement of static water levels and free product layer thickness). Lower the bailer an addition 150 mm.
2. Withdraw the bailer. Measure the oil thickness.
3. Carefully remove the water from the bailer by opening the check valve slightly. This water should be collected in a container for proper disposal.
4. Transfer the recovered free product to a suitable sample bottle, typically a 45 ml septum vial, ensuring that there is no air space in the vial.

Free product samples should not be stored in the same shipping containers as water samples as cross contamination may occur.

Quality Assurance/Quality Control (QA/QC)

<u>Control Samples</u>

A proper Quality Assurance/Quality Control (QA/QC) program is necessary to ensure that data obtained are accurate and representative of actual groundwater conditions. An integral part of a QA/QC program involves the collection of quality control samples such as duplicates, blanks, spikes and background samples.

Duplicates samples are collected from the same well, assigned a different sample number, and submitted for analysis. A general rule of thumb is to collect duplicates for 5%of the total number of samples.

Blank samples are useful to determine if extraneous contamination is affecting the samples. There are a variety of blank samples, including trip blanks, used to determine if cross contamination has occurred during sample shipping and storage; field blanks, used to determine if contamination has occurred due to contaminated preservatives or from air-borne contaminants at the site; and equipment blanks, used to ensure equipment decontamination procedures are effective.

Spike samples are samples that prepared by adding a known mass of the contaminant in question to contaminant free water. These samples should be prepared at a concentration ten times the analytical detection limit. Spiked samples provide a measure of the accuracy of the analyses. When prepared in the field, spiked samples also provide an indication of the effects of losses during sample handling and transport. Losses may occur due to microbial degradation, volatilization, adsorption, photo degradation or other processes.

Background samples (also referred to as control site samples) are necessary to determine baseline groundwater quality at the site. These samples are collected from a well or wells up gradient of the contaminant source.

Sample Tracking

Proper record keeping and documentation is also an important part of any QA/QC program. These records ensure analytical results are credible and defensible by providing details of sample collection and handling procedures.

Sample record logs should be completed for each sample collected. These logs should contain the following information:

- sampler
- site location
- date
- well identification number
- unique sample number
- type of sample (field sample, duplicate sample, blank, spike, grab sample, composite sample)
- type of analysis to be conducted
- preservatives used
- whether the sample was filtered or not

Chain of custody records are used to identify all personnel responsible for handling the samples and to provide the information necessary to track the samples. These records contain areas to be filled out each time the samples change hands. The person handing over the samples and the person accepting them both sign the form and indicate the date and time. These forms also show the sample numbers assigned by the sampler, the laboratory internal sample numbers and the required analyses. These records must accompany the samples at all times.

Appendix XIII: Archaeological Resource Inventory

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MARITIME ARCHAEOLOGICAL RESOURCE INVENTORY
INVENTAIRE DES RESSOURCES ARCHÉOLOGIQUES DES MARITIMES

SITE SURVEY FORM
FORMULE DE RELEVÉ DE SITE

(ZCY) - Kings
(ZMR) - 21 H/2
(ZUTM) - 8192
(ZCU) Micmac?

1. Site No. T / Site N° T

2. Suggested Site Name / Nom du site (suggeré)

3. Site Type / Type de site (a) (ZT) Burials
(ZTK) (b) Prehistoric?; Indigenous Historic?

4. Relative Age / Âge relatif

☑ unknown / inconnu ☐ 10,000 + ☐ 3,000 + ☐ 500 + ☐ 500 –

5. Method of Age Determination / Méthode de calcul de l'âge

6. Descriptive Location / Description de l'emplacement (ZLOC) Kentville

7. Access Location / Lieu d'accès au site

~~7K9~~

8. General Site Description / Description globale du site (ZDE) Erskine stated that, "In the excavation of the ground in front of the Cornwallis Inn to make a shopping centre, an Indian graveyard was unearthed. The date is uncertain."

9. ~~Site Geology / Géologie du site~~

10. Site Vegetation / Végétation du site

11. Shoreline Type / Type de littoral

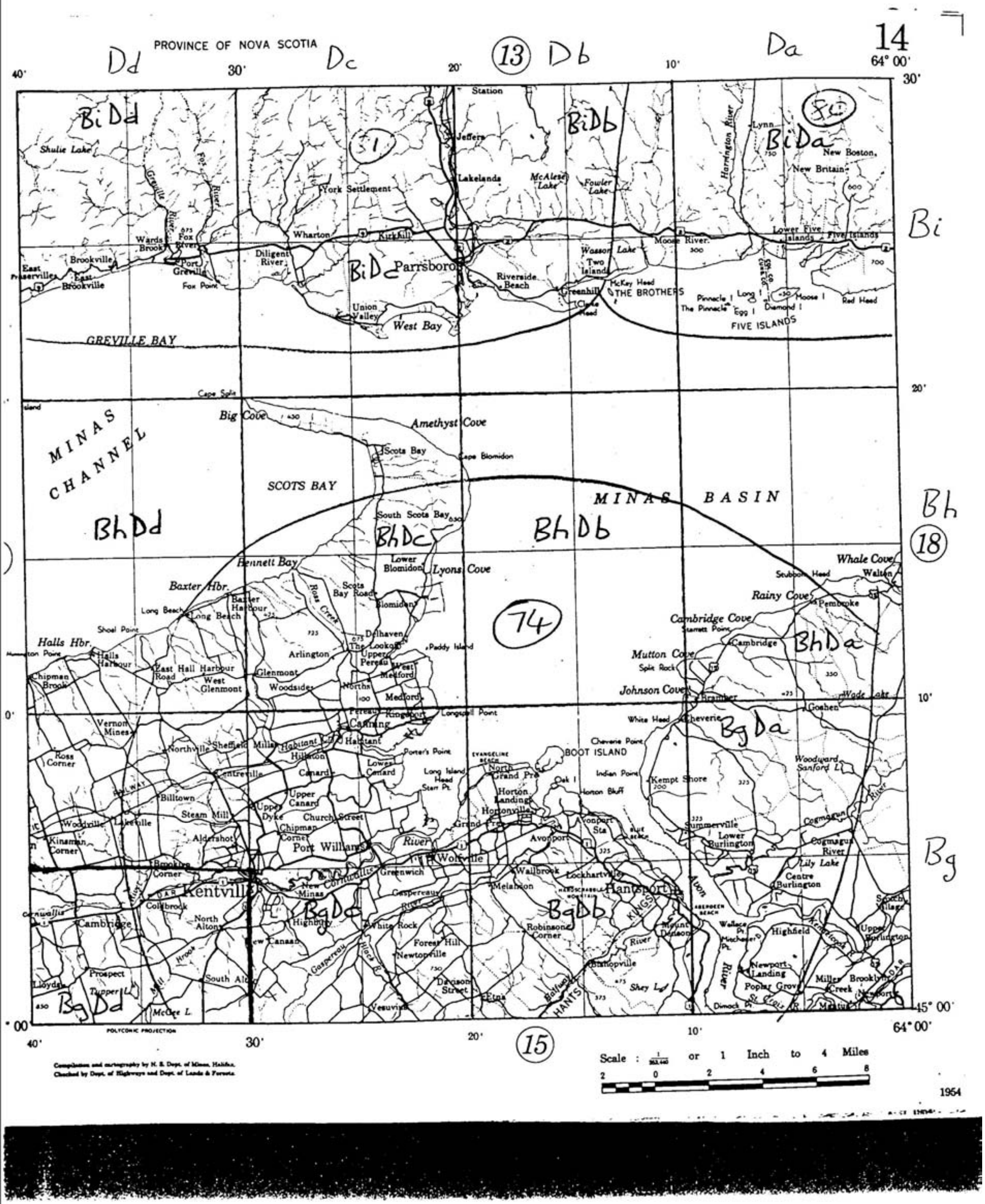
12. Man-made Shoreline Structures / Ouvrages du littoral faits de main d'homme

13. Site Dimensions / Dimensions du site (a) observed: / observées: L. Long. w. Larg.
(b) estimated: / estimatives: L. Long. w. Larg.
(c) total hectares: / nombre d'hectares: observed / observé estimated / estimatif

Site No. / Site N° (ZBN) BgDd-1

C+//

Appendix XIV: Archaeological Resource Map



Appendix XV: Public Meeting Notice

Limits in R-3 zone meant to match expectations

BY SARA KEDDY
The Register

Berwick tightened up some loopholes in its planning and land use guidelines after back-to-back public meetings and a vote last week.

While no one other than town councillors and members of the Planning Advisory Committee were in attendance, the public consultation at 6:30 p.m. and the public hearing at 6:45 p.m. were held according to law.

"This is as tight as it gets, and is a little quicker than what we otherwise would have hoped for," said town planner Chris Millier of the 4Site Group.

PAC arranged the schedule to clear an item off its table that's been there for over six months.

Berwick's R-3 zoning allows for multiple units and buildings on designated land. Millier said most people would assume that means a triplex on the lot, when, under the current Land Use Bylaw and Municipal Planning Strategy, a developer could put as many as three seven-unit buildings on the lot.

■ "Concern had been expressed about the degree of flexibility and the range of opportunity."

– Chris Millier, planner

"Concern had been expressed about the degree of flexibility and the range of opportunity currently in the R-3 zone," Millier said. "These amendments will limit development in R-3 to three units - a triplex - in a single building."

Any kind of development that involves more units or buildings would only be approved through a development agreement with the town. The change gives Berwick "greater influence and say," Millier said, and it can "evaluate a proposal on its individual merits." Those could include site specific details related to access, sewer hook-up, building placement and frontage. The town may also want details in a development agreement that ensure a project suits a neighbourhood and fits well with surrounding properties.

The public consultation was held first, and members of Berwick's PAC were on hand in case any issues were raised before heading into the public hearing. The hearing itself only lasted moments, and council in its regular session passed the amendments.

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NOTICE TO RESIDENTS OF WATERVILLE & AREA

WHO? Interested persons and Residents of Waterville & Area, Kings Co. NS.

WHAT? You are encouraged to attend an information meeting

WHY? To hear details and to comment on a proposed aggregate pit on the Bond Road

WHERE? Waterville Fire Hall

WHEN? 7:00 p.m. to 8:30 p.m. on Wednesday, October 29, 2003

Twin Mountain Construction Ltd. (proponent)
R.R.1 Waterville, NS, Canada
B0P 1V0

58503257

NOTICE TO RESIDENTS OF CAMBRIDGE & AREA

On September 19, 2003 Lawson Bennett Trucking Ltd. (the proponent) received approval from the Nova Scotia Department of Environment & Labour for the expansion of an Aggregate Pit in Cambridge, Kings Co. NS.

In accordance with the terms and conditions of the Approval, the proponent is required to set up a Community Liaison Committee to coordinate public concerns regarding pit activities.

Interested persons and residents of Cambridge & area are encouraged to attend a public meeting.

WHY? To nominate a slate of officers and to create the terms of reference for the Committee

WHERE? Cambridge Community Center

WHEN? 7:00 p.m. to 8:30 p.m. on Thursday, November 07, 2003

Lawson Bennett Trucking Ltd.
R.R.1 Kentville, NS, Canada
B4N 3V7

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Appendix XVI: Meeting Registration

Registration: Aggregate Pit *Expansion*

Waterville Fire Hall, Waterville Kings Co., NS

7:00 p.m. Wednesday, October 29, 2003

Proponent—Twin Mountain Construction Ltd.

R.R.1 Waterville, Kings Co., NS

	Name	Telephone	Address
1	Steve Munro	538-9602	307 Bond Rd.
2	Phyllis [illegible]	" "	" " "
3	Chester + Mabel Walsh	538-8768	384 Bond Rd.
4	Violet Mc [illegible]	5[illegible]-7423	364 Bond Rd
5	M. A. Avila	538-9684	276 Bond Rd
6	Cecile M. [illegible]	5389684	Waterville Bond Rd
7	[illegible]	679 3244	21 maple Dr.
8	[illegible]	679-5200	6375 Hwy #1 Cambridge.
9	Cynthia Jones	538-9304	5338 Hwy 1 Waterville
10	Mike [illegible]	5383798	Sommerset N.S.
11	Bob + Laurie Buckle	538-7436	RR 1 Waterville
12	Larry [illegible]	538-8588	Waterville
13	Nancy Kelly	538-3189	The Register
14	[illegible]	538-3275	Cambridge Kings Co
15	Vaughn [illegible]	538-8120	Waterville
16	Jordan Rogers	538-5553	waterville
17	Bob Olsen	679-4879	Cold Brook
18	Judy Rockwell	538-9102	Waterville
19	[illegible] Schofield		Waterville
20	Randy Rockwell	538-9102	Thompson Rd., Waterville

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Registration: Aggregate Pit *Expansion*

Waterville Fire Hall, Waterville Kings Co., NS

7:00 p.m. Wednesday, October 29, 2003

Proponent—Twin Mountain Construction Ltd.

R.R.1 Waterville, Kings Co., NS

	Name	Telephone	Address
21	Bob Weldon	538-7202	Thompson Rd,
22	Martha Weldon	"	"
23	Darrul Beddle	538-3055	1728 189 Bond Road
24	Judy Swinamer	538-8691	761 Thompson Rd
25	Marjorie Swinamer	765-3523	here for my mother who could not be here
26	Faye Little	538-9450	446 Little Brown Road
27			BoPIRO
28	Phillip [illegible]	538-1402	5298 Hwy #1 Waterville
29	Harold Barkhouse	5384673	
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