CANADA
DEPARTMENT OF MINES
AND
TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
WATER SUPPLY PAPER No. 310

GROUND-WATER RESOURCES OF MATILDA TOWNSHIP, DUNDAS COUNTY, ONTARIO

By
E. B. Owen

OTTAWA
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INTRODUCTION

This report deals with the ground-water conditions of a township in the province of Ontario investigated by the Geological Survey of Canada. It is one of a series of ground-water reports on individual townships of Ontario.

All available information pertaining to the water wells in the area was recorded and water samples were taken for analysis. The elevation of the surface of the water in most of the wells was measured. As the ground-water conditions are directly related to the geology, the surface deposits were also studied and mapped.

Thanks are here extended to the farmers and to the residents of communities throughout the area for their co-operation and willingness to supply information regarding their wells. Valuable assistance was also given by well drillers and municipal waterworks authorities in the area.

Publication of Results

The essential information pertaining to ground-water conditions is being issued in reports covering each township investigated in the province of Ontario. These reports, as published, will be supplied directly to the proper municipal and township authorities. In addition, pertinent data on wells investigated in each township will be kept on file at Ottawa. The well record compilation sheets will not ordinarily accompany the reports, as, for most areas, they are too numerous. However, persons interested in individual wells may receive the information upon application to the Chief Geologist, Geological Survey of Canada, Ottawa. For this information the request should specify lot, concession, owner's name, and approximate location of the well -- at house, at barn, in pasture, etc.

With each report is a map consisting of two figures. Figure 1 shows the surface deposits that will be encountered in the area, and Figure 2 shows the positions of all wells for which records are available, together with the class of the well at each location.

GLOSSARY OF TERMS USED

Alluvium. Recent deposits of clay, silt, sand, gravel, and other material deposited in lake beds and in flood-plains of modern streams.

Aquifer. A porous bed, lens, pocket, or deposit of material that transmits water in sufficient quantity to satisfy pumping wells, flowing artesian wells, and springs.

Bedrock. Bedrock, as here used, refers to the consolidated deposits underlying the glacial drift. South of a line drawn between Midland, on Georgian Bay, and Kingston, the bedrock consists mainly of sedimentary rocks such as limestone, shale, slate, and sandstone; north of that line the bedrock consists chiefly of hard, crystalline, granitic rocks.

Contour. A line drawn on a map that passes through points that have the same elevation above mean sea-level.

Continental Ice-sheet. The great, broad ice-sheet that covered most of the surface of Canada many thousands of years ago.

Escarpment. A cliff or relatively steep slope separating two level or gently sloping areas.

Effluent Stream. A stream that receives water from a zone of saturation.

Flood-plain. A flat part in a river valley ordinarily above water, but covered with water when the river is in flood.

Glacial Drift. A general term that includes all the loose, unconsolidated materials that were deposited by the continental ice-sheet, or by waters associated with it. It includes till, deposits of stratified drift, and scattered boulders and rock fragments.

Several forms in which glacial drift occurs are as follows:

(1) End Moraine (Terminal Moraine). A more or less discontinuous ridge or series of ridges consisting of glacial drift that was laid down by the ice at the margin of a moving ice-sheet. The surface is characterized by irregular hills and undrained basins.

(2) Ground Moraine. A widely distributed moraine consisting of glacial drift deposited beneath an ice-sheet. The predominant material is till, which is clay containing stones. The topography may vary from flat to gently rolling.

(3) Kame Moraine. Assorted deposits of sandy and gravelly stratified drift laid down at or close to the ice margin. The topography is similar to that of an end moraine. Kame terraces are elongated deposits of this type laid down on the slopes of broad, flat-bottomed valleys.

(4) Drumlin. A smooth oval hill that has its long axis parallel with the direction of ice movement at that place. It is composed mainly of till.

(5) Esker. An irregular-crested ridge or series of discontinuous ridges of stratified drift deposited by a glacial stream that flowed beneath the continental ice-sheet or in deep crevasses within it. It is composed mainly of sand and gravel.

(6) Glacio-fluvial Deposits. Silt, sand, and gravel outwash deposited by streams resulting from the melting of the ice-sheet.

(7) Glacio-lacustrine Deposits. Clay, silt, and sand deposited in glacial lakes during the retreat of the ice-sheet. The clay deposits are commonly very distinctly stratified in layers a fraction of an inch to one or more feet in thickness; each layer is believed to represent deposition during one summer season and one winter season.

(8) Kame. An isolated mound or conical hill composed of stratified sand and gravel deposited in a crack or crevasse within the ice or in a depression along the ice front.

(9) Marine Deposits. Deposits laid down in the sea during the submergence that followed the withdrawal of the last ice-sheet. They consist chiefly of clay, silt, and sand, and have emerged beaches of sand and gravel associated with them.

(10) Shoreline. A discontinuous escarpment that indicates the former margin of a glacial lake or sea. It is accompanied by scattered deposits of sand and gravel located on former beaches and bars.

Ground Water. Sub-surface water in the zone of saturation below the water-table.

Hydrostatic Pressure. The pressure that causes water in a well to rise above the point at which it was first encountered.

Influent Stream. A stream that feeds water into a zone of saturation.

Impervious or Impermeable. Beds such as fine clays or shale are considered to be impervious or impermeable when they do not permit the perceptible passage or movement of ground water.

Pervious or Permeable. Beds are pervious or permeable when they permit the perceptible passage or movement of ground water, as, for example, porous sand, gravel, and sandstone.

Porosity. The porosity of a rock is its property of containing interstices or voids.

Pre-glacial Land Surface. The surface of the land as it existed before the ice-sheet covered it with drift.

Recent Deposits. Deposits that have been laid down by the agencies of water and wind since the disappearance of the continental ice-sheet; for example, alluvium in stream valleys.

Unconsolidated Deposits. The mantle or covering of loose, uncemented material overlying the bedrock. It consists of Glacial or Recent deposits of boulders, gravel, sand, silt, and clay.

Water-table. The upper limit of the part of the ground saturated with water. This may be near the surface or many feet below it. Water may be retained above the main water-table by a zone of impervious material; such water is said to be perched and its upper limit to be a perched water-table.

Wells. Holes sunk into the ground so as to obtain a supply of water. When no water is obtained they are referred to as dry holes. Wells yielding water are divided into four classes:

(1) Flowing Artesian Wells. Wells in which the water is under sufficient hydrostatic pressure to flow above the surface of the ground at the well.

(2) Non-flowing Artesian Wells. Wells in which the water is under hydrostatic pressure sufficient to raise it above the level of the aquifer, but not above the level of the ground at the well.

(3) Non-artesian Wells. Wells in which the water does not rise above the water-table or the aquifer.

(4) Intermittent Non-artesian Wells. Wells that are generally dry for a part of each year.

Zone of Saturation. The part of the ground, below a water-table that is saturated with water.

GENERAL DISCUSSION OF GROUND WATER

Almost all the water recovered from beneath the earth's surface for both domestic and industrial uses is meteoric water, that is, water derived from the atmosphere. Most of this water reaches the surface as rain or snow. Part of it is carried off by streams; part evaporates either directly from the surface and from the upper mantle of the soil or indirectly through transpiration of plants; the remainder infiltrates into the ground to be added to the ground-water supplies.

The proportion of the total precipitation that infiltrates from the surface into the zone of saturation will depend upon the surface topography and the type of soil or surface rock. More water will be absorbed in sandy or gravelly areas, for example, than in those covered with clay. Surface run-off will be greater in hilly areas than in those that are relatively flat. In sandy regions where relief is great, the first precipitation is absorbed and run-off only commences after continuous heavy rains. Light rains falling upon the surface of the earth during the growing season may be wholly absorbed by growing plants. The quantity of moisture lost through direct evaporation depends largely upon temperature, wind, and humidity. Ground water in areas overlain by pervious material may be recharged by influent streams carrying run-off from areas overlain by relatively impervious material.

Because of the large consumption of ground water in settled areas, it may seem surprising that precipitation can furnish and adequate supply. However, when it is borne in mind that a layer of water 1 inch deep over an area of 1 square mile amounts to approximately 14,520,000 imperial gallons, and that the annual precipitation in this region, for example, is about 30 inches, it will be seen that each year some 435,600,000 imperial gallons of water falls on each square mile. Although it would be impossible to determine the annual recharge of the ground-water supply of the area, if it were assumed that only 10 per cent of the total precipitation, namely 43,560,000 gallons, is contributed to the zone of saturation, it will be seen that the annual recharge for the entire area would be a very large volume. The annual consumption of water in all areas investigated is not known, but an estimate for some restricted areas, based on per capita consumption, shows it to be only about one-tenth of the annual recharge as estimated above.

In most regions of the world where precipitation is effective there is an underground horizon known as the ground-water level or water-table, which is the upper surface of the zone of saturation. The water-table commonly is a subdued replica of the surface topography. The water that enters from the surface into the unconsolidated deposits and rocks of the earth is drawn down by gravity to where it reaches the zone of saturation or comes in contact with a relatively impervious layer. Such a layer may stop further downward percolation, resulting in perched water and creating a perched water-table. If a water-table is at or near the surface, there will be a lake or swamp; if it is cut by a valley, there will be a stream in the valley. The terms influent and effluent are used with reference to streams and their relation to the water-table. An influent stream flows above the water-table and feeds water into the zone of saturation; an effluent stream flows at or below the water-table and receives water from the zone of saturation. An effluent stream may become influent and eventually dry up if the water-table is lowered sufficiently. The ground water in the zone of saturation is almost constantly on the move percolating towards some point of discharge, which may be a spring or a pumping well.

All rocks and soils are to some degree porous, that is, the individual grains or particles of which they are composed are partly surrounded by minute interstices or open spaces that form the receptacles and conduits of ground water. In most rocks and soils the interstices are connected and large enough for the water to move from one opening to another. In some rocks or soils, however, they are largely isolated or too small to allow movement of water. The porosity of a material varies directly with the size and number of its interstices, which in turn depend chiefly upon the size, shape, arrangement, and degree of assortment of the constituent particles. Horizons within the earth's crust of fine-grained rock such as shale, limestone or dolomite, or unconsolidated clay or silt, may have such small interstices that the contained water will not flow readily and wells penetrating them may derive little or no water from them. Such horizons are considered impervious. Beds of more coarse-grained materials such as sand, gravel, or sandstone have greater porosity and readily yield their waters to wells. They are called water-bearing beds or aquifers. A clean water-bearing gravel is one of the best sources of water. This is true whether the water is derived from the zone of saturation or from a bed of gravel confined above, between, or below beds of less pervious material.

Consolidated rocks usually considered to be impervious may sometimes produce water in relatively good supply from openings within them of primary or secondary origin. Those of primary origin, original interstices, were created when the rocks came into existence as a result of the processes by which they were formed; e.g. bedding planes, and intergranular spaces. Secondary interstices comprise joints and other fracture openings, solution openings, and openings produced by several processes of minor importance, such as the work of **plants** and animals, mechanical erosion, and recrystallization; all of these involve movement of a type that acted after the consolidation of the rock. The most important interstices with respect to water supplies are the original interstices, next to them are the fracture and solution openings.

The most common wells and those that in drift-covered areas yield the largest aggregate supply of ground water are water-table wells. These are wells that derive their water from the zone of saturation. Many shallow wells become dry during the late summer and winter, or during periods of extreme drought. In most cases this is due to the lowering of the water-table below the bottom of the well. The grouping together of a number of water-table wells within a limited area will also lower the yield of any one of the wells. This is especially true of water-producing formations of low permeability. When a well penetrates an aquifer confined by impervious beds, water will be forced upward by hydrostatic pressure exerted at the point where the well enters the aquifer. If the hydrostatic pressure is great enough to force the water to or above the surface, a flowing well is formed.

Springs are formed where the water-table, or some water-bearing aquifer, outcrops at the surface of the ground. The water emerging from water-table springs is free-running water flowing down the gradient of the water-table. In many cases these springs occur as slow seeps along the steeper slopes of stream valleys. A large number in one area could maintain a swamp. A group of permanent springs occurring in one area could provide sufficient water to maintain a lake or form the source of a stream.

GENERAL DISCUSSION OF GROUND-WATER ANALYSIS

The mineral content of ground water is of interest to many besides those industries seeking water of specific quality. Both the kind and quantity of mineral matter dissolved in natural water depend upon the texture and chemical composition of the rocks with which the water has been in contact. Pollution is caused by contact with organic matter or its decomposition products. Analyses of well waters for mineral content are made by the Mines Branch, Department of Mines and Technical Surveys, Ottawa.

In any given area, an attempt is made to secure samples of water representative of all major aquifers. The quantities of the various constituents for which tests are made are given as "parts per million", which refers to the proportion by weight of each constituent in 1,000,000 parts of water.

The following mineral constituents are those commonly found in natural waters in quantities sufficient to have a practical effect on the value of the waters for ordinary uses:

Silica (SiO_2) may be derived from the solution of almost any rock-forming silicate, although its chief source is the feldspars. It is commonly determined in the analysis of water for use in steam boilers, as silica is classed as an objectionable encrustant.

Calcium (Ca). The chief source of calcium dissolved in ground water is the solution of limestone, gypsum, and dolomite. The common compounds of calcium are calcium carbonate ($CaCO_3$) and calcium sulphate ($CaSO_4$), neither of which has injurious effects upon the consumer, but both of which cause hardness and, the former, boiler scale.

Magnesium (Mg). The chief source of magnesium in ground water is dolomite, a carbonate of calcium and magnesium. The sulphate of magnesium ($MgSO_4$) combines with water to form Epsom-salts ($MgSO_4.7H_2O$), and renders the water unwholesome if present in large amounts.

Sodium (Na) is found in all natural waters in various combinations, though its salts constitute only a small part of the total dissolved mineral matter in most waters in humid regions. Sodium salts may be present as a result of pollution by sewage, or of contamination by sea water either directly or by that enclosed in sediments of marine origin. Moderate quantities of these salts have little effect upon the suitability of a water for ordinary uses, but water containing sodium in excess of about 100 parts per million must be used with care in steam boilers to prevent foaming. Waters containing large quantities of sodium salts are injurious to crops and are, therefore, unfit for irrigation. The quantity of sodium salts may be so large as to render a water unfit for nearly all uses.

Potassium (K), like sodium, is derived originally from the alkaline feldspars and micas. It is of minor significance and is sometimes included with sodium in a chemical analysis.

Iron (Fe) is almost invariably present in well waters, but rarely in large amounts. Salts, or compounds, of iron are dissolved from many rocks as well as from iron sulphide deposits with which the ground water comes in contact. It may also be dissolved from well casings, water pipes, and other fixtures in quantities large enough to be objectionable. Upon exposure of the water to the atmosphere, dissolved iron separates as the hydrated oxide that imparts a yellowish brown discoloration. Excessive iron in water causes staining on porcelain or enamelled ware and renders the water unsuitable for laundry purposes. Water is not considered drinkable if the iron content is more than 0.5 parts per million.

Sulphates (SO_4). Deposits of gypsum ($CaSO_4 \cdot 2H_2O$) are the principal source of sulphates dissolved in ground water; soluble sulphates, chiefly of magnesium and sodium, are other sources. Sulphates cause permanent hardness in water and form injurious boiler scale. Sodium and magnesium sulphates are laxative when present in quantities of more than 900 parts per million.

Chloride (Cl) is derived chiefly from organic materials or from marine rocks and sediments. It occurs usually as sodium chloride and less commonly as calcium chloride and magnesium chloride. Sodium chloride is a characteristic constituent of sewage and a locally abnormal amount suggests pollution. However, because chlorides may be derived from many sources, such abnormal quantities should not, in themselves, be taken as positive proof of pollution. Chlorides impart a salty taste to water if they are present in excess of 300 parts per million.

Nitrates (NO_3) are of minor importance in the study of ground water. Relatively large quantities in a water may represent pollution by sewage, or drainage from barnyards, or even from fertilized fields. It is recommended that a bacteriological test be made of water showing an appreciable nitrate content if it is to be used for domestic purposes.

Carbonate (CO_3) forms a large percentage of the solid compounds held in solution by the average ground water. The two chief sources are the decomposition of feldspars and the solution of limestone by water carrying carbonic acid in solution, which is the primary agent in rock decomposition. They are indicated in the table of analyses as alkalinity. Calcium and magnesium carbonates cause hardness in water, whereas sodium carbonate causes softness.

Bicarbonate (HCO_3). Carbon dioxide dissolved in water renders the insoluble calcium and magnesium carbonates soluble as bicarbonates. Boiling reverses the process by changing the bicarbonates into insoluble carbonates, which form a coating on the sides of cooking utensils.

Total Dissolved Solids (Residue on Evaporation). The term is applied to the residue obtained when a sample of water is evaporated to dryness. Waters are considered high in dissolved mineral solids when they contain more than 500 parts per million, but may be accepted for domestic use up to that point if no better supply is available. Residents, accustomed to the waters, may use waters that carry well over 1,000 parts per million of total dissolved solids without inconvenience, although persons not used to such highly mineralized waters would find them objectionable.

Hardness is a condition imparted to waters chiefly by dissolved calcium and magnesium compounds. It here refers to the soap-destroying power of water, that is, the power of the water first to use a certain amount of soap to precipitate the above compoun s before a lather is produced. The hardness of water in its original state is its total hardness. Permanent hardness remains after the water has been boiled, and is caused by mineral salts that cannot be removed from solution by boiling. It can be reduced by treating the water with natural softeners, such as ammonia or sodium carbonate, or with many manufactured softeners. Temporary hardness can be eliminated by boiling, and is due to the presence of bicarbonates of calcium and magnesium. Waters containing larger quantities of sodium carbonate than of calcium and magnesium compounds are soft, but if the latter compounds are more abundant the water is hard. The following table[1] may be used to indicate the degree of hardness of a water:

Total Hardness

Parts per million	Character
0-50	Very soft
50-100	Moderately soft
100-150	Slightly hard
150-200	Moderately hard
200-300	Hard
300 and over	Very hard

1 Thresh, J. C., and Beale, J. F.; The Examination of Waters and Water Supplies, p. 21, London, 1925.

Part II

MATILDA TOWNSHIP, DUNDAS COUNTY, ONTARIO

Physical Features

Matilda township is in the southwest part of Dundas county and has an area of approximately 106 square miles. The township extends along the northwest side of the St. Lawrence River from a point $2\frac{1}{2}$ miles east of the village of Cardinal to $1\frac{3}{4}$ miles west of Morrisburg. The village of Iroquois, the largest community within the township, lies about 111 miles west of the city of Montreal.

The most distinctive topographic feature of Matilda township is the wide, flat, clay-sand plain that occupies the north, west, and central parts of the township and extends in some localities into the east part. A number of small, clay till drumlins, projecting through the sand and clay, provide the only relief in this part of the area. The elevation of the plain is approximately 250 feet. In the area adjacent to the St. Lawrence River and in the east part of the township, where clay till occurs on the surface, the topography is more rolling and hilly. The relief of the entire township is less than 50 feet. Bedrock, which consists of flat-lying Ordovician sedimentary formations, outcrops only in the southwest corner of the township, and does not appear to exert any great influence on the topography. A poorly marked divide between the basins of the Ottawa and St. Lawrence Rivers crosses the south part of the township in an east-west direction. North of Iroquois, the divide is only 2 miles from the St. Lawrence River whereas at the east boundary of the township it is approximately 3 miles. The general trend of the topography in the township is approximately south 15 degrees west.

The large area north of the divide is drained by numerous small tributaries of South Nation River, a small section of which appears in the extreme northwest corner of the township. The direction of flow of these small streams, which is controlled by the trend of the topography, is in a general northeasterly direction.

A graph has been prepared depicting the monthly precipitation from 1947 to the end of 1950 as measured at various meteorological stations in the area about Matilda township and the fluctuations in the water-table as measured at an observation well near the town of Morrisburg. The latter were provided through the courtesy of the Ontario Department of Mines.

From the graph, it will be noted that, during the months when the ground is not frozen the elevations of the water-table depend, to a large extent, upon the amount of precipitation falling upon the area. In general, the lowest amount of precipitation occurs during the months of August and September, and it is during this time that the water-table shows a steady decline, reaching its lowest point commonly in the month of October.

In the subsequent months, there are periods of considerable precipitation. However, because of the frozen condition of the ground, preventing downward percolation of water, along with the fact that much of the precipitation is in the form of snow, the water-table remains low during the winter months and does not commence to rise until the end of the month of February.

The highest elevation of the water-table is commonly reached during the months of May and June. This is probably due to the supplementing of the normal precipitation with water produced by the melting of the snow and ice accumulated on the surface during the winter months.

Precipitation in inches[*]

Station	Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Brockville	1950	6.0	3.6	4.6	2.5	1.8	1.4	3.2	5.6	1.3	2.8	5.8	3.7	42.3
	1949	3.6	3.3	2.8	4.7	2.8	2.3	1.9	3.0	4.4	1.8	4.5	3.4	38.5
	1948	3.1	3.0	4.6	2.6	3.2	3.8	3.5	1.8	0.6	2.9	5.4	3.6	38.1
	1947	4.7	2.4	5.5	2.1	7.0	4.5	6.0	1.6	4.5	1.0	3.7	3.1	46.1
	1946	3.4	2.7	1.4	2.1	4.3	1.8	2.9	2.0	3.2	5.7	3.3	4.9	37.7
Domville	1950	3.8	3.2	3.7	2.7	2.0	1.1	4.3	4.1	-	1.8	4.5	3.1	-
	1949	2.6	3.3	2.6	5.0	2.2	1.2	2.2	3.4	3.3	1.7	3.3	3.3	34.1
	1948	-	-	-	-	2.7	2.9	3.5	2.3	0.2	2.7	4.2	2.8	-
	1947	-	-	-	-	-	-	-	-	-	-	-	-	-
	1946	-	-	-	-	-	-	-	-	-	-	-	-	-
Kemptville	1950	3.8	3.6	3.6	3.0	1.8	1.3	3.0	3.9	1.0	1.9	4.4	2.6	33.9
	1949	3.2	3.0	2.1	4.6	2.8	0.6	2.2	4.8	3.2	1.7	3.5	2.4	34.6
	1948	1.4	2.1	3.3	2.1	2.9	3.1	3.4	2.9	0.6	2.9	4.1	3.5	32.3
	1947	3.6	1.7	5.5	1.9	4.0	3.4	7.4	2.3	5.2	0.3	2.7	1.5	39.5
	1946	2.9	1.5	1.2	2.3	3.8	1.6	2.0	1.6	2.7	5.0	3.5	3.8	31.9
Morrisburg	1950	4.5	3.7	3.8	2.8	1.3	1.8	4.9	5.1	1.4	2.0	5.9	4.4	41.6
	1949	3.2	4.0	2.6	4.2	2.6	0.8	1.9	1.9	5.0	2.0	3.7	3.1	35.0
	1948	1.6	3.3	3.8	2.4	2.8	3.5	3.1	3.6	0.1	3.0	5.1	3.6	35.9
	1947	5.3	3.0	5.9	2.1	5.6	5.8	7.7	1.6	5.8	0.6	3.7	3.0	50.1
	1946	3.0	2.0	1.8	2.6	4.6	1.6	1.5	1.5	4.5	6.4	3.8	4.3	37.6

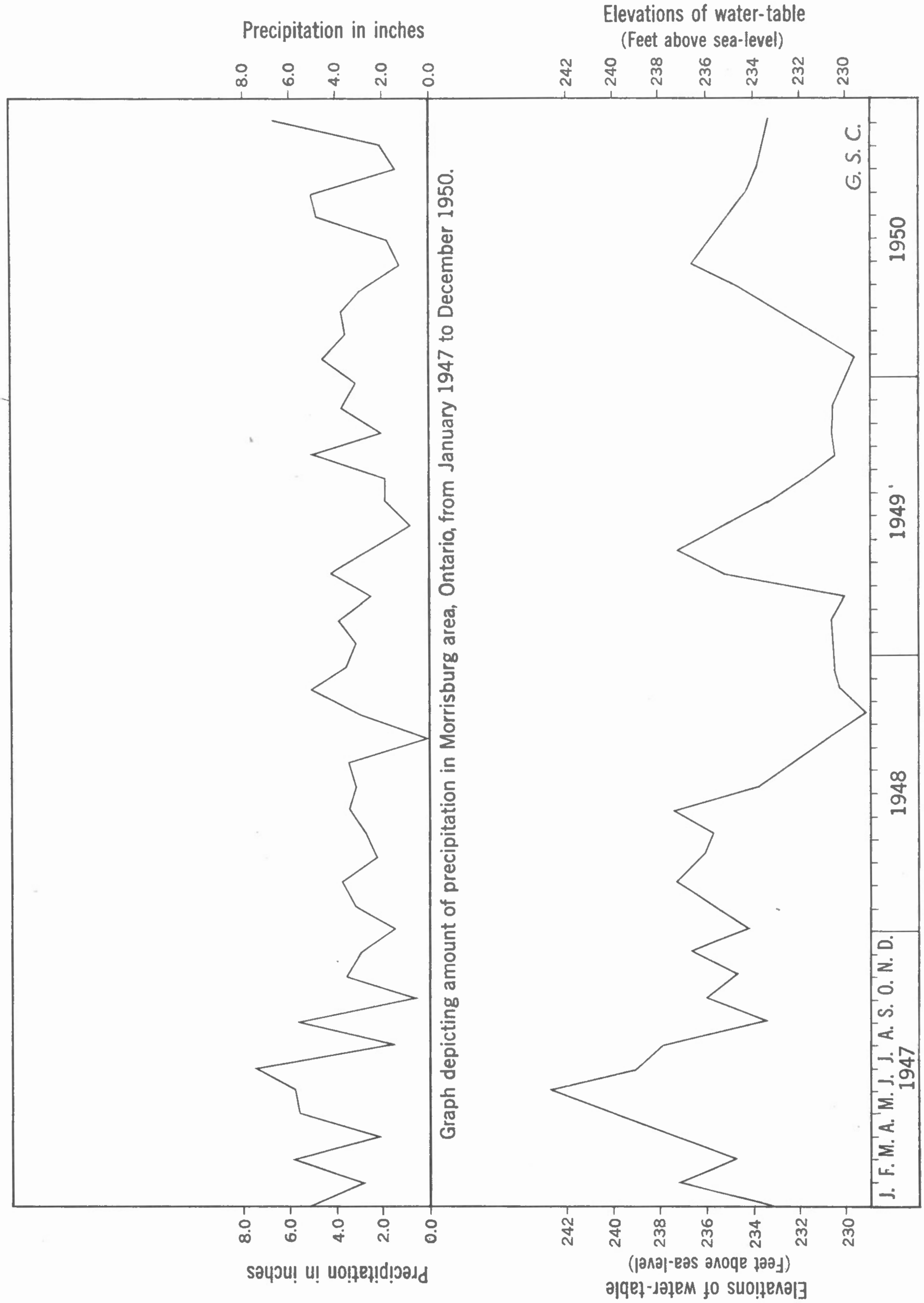
[*] Extracts from the 'Monthly Weather Map', Meteorological Service, Dominion of Canada.

WATER-TABLE ELEVATIONS

Name: W. T. Richardson
Address: R.R.-1 Morrisburg, Ontario
Well type: dug
Well depth: 25 feet (Aug. 22, 1950)
Well elevation: 248.0 feet above sea-level
Material from which ground water derived: clay till

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1947	235.4	237.2	234.9	237.4	240.1	242.8	239.0	237.9	233.7	236.1	234.9	236.8
1948	234.3		237.4	236.4	235.7	237.5	233.8		230.9	229.2	230.3	230.6
1949	230.6	230.7	230.1	235.3	237.4	235.3	233.4	231.9	230.5	230.7	230.5	229.6
1950				234.7	236.7			234.3	233.9		233.4	

Fluctuations of water-table, courtesy of the Ont. Dept. of Mines



Graph depicting amount of precipitation in Morrisburg area, Ontario, from January 1947 to December 1950.

Graph depicting fluctuations in water-table in Morrisburg area, Ontario, from January 1947 to December 1950.
(Courtesy of the Ontario Department of Mines)

Geology

Bedrock Formations. The township, which is located within the Ottawa-St. Lawrence Lowland, is underlain by Palaeozoic rocks of Ordovician age. These sedimentary formations are located on the west flank of a broad, synclinal structure that extends northeast across the counties of Dundas, Stormont, and Glengarry. The dip of the rocks underlying the township is extremely low and in a general northeast direction.

Table of Formations[1]

Era	Period	Sub Epoch	Formations	Thickness (Feet)	Lithology
Palaeozoic	Ordovician	Trenton and Black River	Ottawa	690-700	Limestone with a little shale and some sand at its base
		Disconformity			
		Chazy	St. Martin Rockcliffe	20-155 150-165	Impure limestone Shale with sandstone lenses
		Disconformity			
		Beekmantown	Oxford	240 (±)	Dolomite with a little shale at the top
			March	30 (+)	Interbedded sandstone and dolomite
	Ordovician or Cambrian		Nepean	up to 500	Sandstone
Great unconformity					
Precambrian (Archaean)?			Grenville		Crystalline limestone, quartzites and metamorphic rocks; associated granite, and granite-gneiss

[1] Wilson, A. E.: Geology of the Ottawa-St. Lawrence Lowland, Ontario and Quebec; Geol. Surv., Canada, Memoir 241, p. 9, (1946).

Matilda township is underlain by several formations, four of which come to the surface or directly underlie the drift in certain parts. The Oxford directly underlies the southwest part as well as a small area in the extreme northwest corner of the township. The succeeding Rockcliffe and St. Martin formations underlie broad, curving areas extending across the centre of the township from the north boundary to the St. Lawrence River. The Ottawa formation underlies the northeast part of the township. A number of small outcrops of the Oxford formation occur in the southwest part of the township between Iroquois and the west boundary.

Unconsolidated Deposits. The types of unconsolidated deposits occurring in the township, classified according to their origin and arranged in order of their deposition from oldest to youngest, are as follows: glacial, glacio-fluvial, and marine deposits. Recent deposits are relatively scarce and unimportant.

The glacial deposits that overlie bedrock throughout a large part of the township occur chiefly as ground moraine. Altogether, they are exposed for approximately 32 square miles, principally in the southeast part and along the east boundary of the township. Elsewhere they are buried beneath glacio-fluvial and marine deposits and are only encountered during drilling or excavating operations. In some localities in the north part of the township, they project above the surrounding flat plain as elongated hills and ridges of clay till. Many of these structures appear to be the upper parts of half-buried drumlins with their long axes parallel to the direction of the last ice movement. Some have the appearance of "islands" of clay till in a "sea" of marine sand and clay. Thin layers of till, reworked by the invading marine waters of the Champlain Sea, and thicker deposits of marine sand and gravel occur on the northwest flanks and tops of some of the higher ridges. They are frequently associated with accumulations of large boulders.

Glacio-fluvial deposits, in the form of kames, occur in the northwest corner of the township. They are continuous with larger deposits farther west in Edwardsburg township. The relief of these deposits has been considerably lowered by the planing action of waves so that at the present time they occur as low, scattered knolls and ridges of sand and fine gravel.

Although no outwash deposits of sand and gravel were observed on the surface of the township, the owners of a large number of wells drilled to bedrock, located in the north and central parts of township, reported beds of gravel, 2 to 6 feet thick, beneath marine clay and sand, and directly overlying bedrock. The fact that a number of wells drilled in the same area did not encounter the gravel suggests that, although the gravel beds are probably extensive, they are not continuous throughout the entire township.

The invasion and subsequent withdrawal of the Champlain Sea, which followed the retreat of the ice-sheet in the region, formed varied deposits of marine origin. The most extensive of these in Matilda township are deposits of marine clay and sand, which cover approximately two-thirds of the township and are located principally in the north, west, and central parts. Marine clay deposits extend over a large part of the township. Much of the clay is covered with a thin layer of marine sand, but a wide belt of the material is exposed extending from a point 3 miles south of the community of Brinston to the north boundary of the township. The area about Brinston, which is located near the centre of the marine clay area, has been aptly called the "Brinston Flats". Except for the above, and a few isolated areas in the south part of the township, marine clay can only be seen along the banks and in the bottoms of small creeks.

A thin layer of marine sand, varying from a few inches to a few feet in thickness, covers the west part of the township. This layer is continuous with thicker deposits farther west in Edwardsburg township. In most instances it overlies marine clay or clay till.

Recent deposits, such as alluvium, are rare in the township and are not considered to be of importance.

Variations in the thickness of the drift throughout the township were determined in many localities from the data compiled from a number of wells that were reported to have reached bedrock. The following table indicates the minimum and maximum thicknesses of drift where it could be determined in this way:

Concession	Lot	Minimum and maximum thickness of drift (Feet)	Concession	Lot	Minimum and maximum thickness of drift (Feet)
1	1	46- ?	2	23	33- ?
1	4	30- ?	2	26	37- ?
1	7	29- ?	2	29	36*-?
1	10	34- ?	2	32	56*-?
1	13	31- ?	2	35	19- ?
1	16	44- ?	2	38	41*-50*
1	19	18- ?	3	3	23- ?
1	22	26- ?	3	6	33- ?
1	25	25- ?	3	9	40*-?
1	28	53- ?	3	12	25- ?
1	31	37- ?	3	15	38- ?
1	34	30- ?	3	21	31- ?
1	37	10*-29	3	24	44*- ?
2	2	65*-?	3	27	28- ?
2	5	46*?	3	30	35*-?
2	8	60*-?	3	33	13-?
2	11	38- ?	4	1	21- ?
2	14	39- ?	4	4	35*- ?

Concession	Lot	Minimum and maximum thickness of drift (Feet)	Concession	Lot	Minimum and maximum thickness of drift (Feet)
4	10	42- ?	6	15	18*-19*
4	13	39- ?	6	18	21- ?
4	16	24- ?	6	21	30- ?
4	19	40*-?	6	24	15- ?
4	22	23- ?	6	27	20- ?
4	25	58*-59*	6	30	32- ?
4	28	50*-?	6	33	23*-?
4	31	24*-?	6	36	13- ?
4	34	11- ?			
4	37	22- ?	7	7	31*-37*
			7	10	5*- 12*
5	5	33- ?	7	13	13- ?
5	5	14- ?	7	16	12- ?
5	8	32*-39*	7	19	17- ?
5	11	22- ?	7	22	26- ?
5	14	36- ?	7	25	24- ?
5	17	36- ?	7	28	22- ?
5	20	31- ?	7	31	34*-37*
5	23	16-?	7	34	40*-?
5	26	42*-?	7	37	20*-?
5	29	24- ?			
5	32	19- ?	8	14	21- ?
5	35	21- ?	8	17	12-13
5	38	25- ?	8	20	17*-?
			8	26	20- ?
6	6	3*-22*	8	29	12*-24*
6	9	16*-30*	8	32	25*-?
6	12	21*-?	8	35	17*-19*

* To bedrock.

WATER SUPPLY

Because of the great areal extent of marine clay and clay till deposits, which in many cases do not yield satisfactory supplies of ground water, Matilda township is not as well supplied with water as the adjacent townships of Edwardsburg and Williamsburg. About 77.8 per cent of the wells are of the dug type, and 22.2 per cent were drilled, chiefly into bedrock. Approximately 80.1 per cent are obtaining their water from depths of 40 feet or less. A compilation of the well records shows that about 86.6 per cent of the wells have a permanent water supply sufficient for the present demands made upon them, and 12.6 per cent constitute wells that go dry intermittently. In describing the principal beds that yield water to the wells, the statements of owners and drillers as to the character of the aquifer were necessarily accepted.

Clay till in the township is not a good source of water. Commonly it constitutes a poor reservoir for ground-water storage as it takes up water slowly and holds relatively little. Furthermore, the slow circulation generally results in the quality of ground water obtained being poor. Many shallow wells dug in clay till are reported as being intermittent or low in summer, the reason being the low permeability of clay till that causes it to yield water slowly to wells. Consequently, a well in it can be easily pumped dry and takes a long time to recover. In later summer, when the water-table is low, the deceased area yielding water directly to the well renders the supply even more unsatisfactory. To overcome this difficulty, the owner should dig his well as deep as possible to form a reservoir large enough to provide sufficient water during times when large amounts are being withdrawn from the well.

A large number of wells, 12 to 38 feet deep, dug in clay till along highway No. 2, west of Iroquois, appear to yield sufficient quantities of ground water. This may result from the percolating of ground water down the hydraulic gradient south from the divide to the St. Lawrence River. It was reported that, when dug, a number of these wells encountered "springs" in the bottom of the well. The water was not under hydrostatic pressure although it flowed freely into the well during pumping operations. It is doubtful if the material yielding water at the bottom of these wells is clay till, but rather consists of a lens or pocket of sand and gravel, many of which are reported to be scattered throughout the till. The quantity of water yielded by these more porous materials would depend upon their relative extent. It is thought that the majority of these deposits draw their water from the confining till, and, accordingly, the chief result of their presence is to cause a greater area of till to yield its water to the well. In some instances, these wells yielded large quantities of water when first dug, but after a period of time had elapsed assumed the properties of wells deriving their entire supply of ground water from clay till, often going dry during the late summer or extended periods of drought and yielding only limited supplies during normal times.

Wells dug in clay till located along highway No. 2 east of Iroquois vary in depth from 20 to 40 feet, with an average of 28 feet. Approximately half of these wells are reported low in summer and one-third are intermittent. The average depths of wells dug in clay till along highway No. 2 west of Iroquois are as follows: sufficient supply, 29 feet; not used, 28 feet; low in summer, 26 feet; intermittent, 23.5 feet. From the above figures, it would appear that the most satisfactory wells are those that are 29 feet or more in depth.

There are many intermittent wells located along the road between cons. I and II extending from lots 18 to 24. In most instances these wells are not sufficiently deep. A well dug in clay till in this area must be at least 30 feet deep to yield satisfactory supplies of ground water. The supply of wells located immediately south of the ridge crossing the road approximately one mile south of Irena is more satisfactory, but a 40-foot well located on top of the same ridge is reported to be intermittent, This would suggest that the water-table lies at greater depths beneath rises in topography than in more level areas.

The average depths of wells dug in clay till along the road between cons. II and III, lots 1 to 14, are as follows: sufficient supply, 30 feet; low in summer, 29 feet; not used, 22 feet; and intermittent, 19 feet; and further north, in cons. IV and V, the average depths are: sufficient supply, 25.5 feet; low in summer, 25 feet; not used, 18 feet; intermittent, 14 feet. These figures indicate the necessity of deepening the intermittent wells if they are to provide sufficient quantities of ground water.

Wells dug in the clay till ridge extending northeast from Toyehill, lots 1 to 6, cons. VII and VIII, range from 17 to 34 feet in depth and are all reported to yield sufficient supplies of ground water for farm use. Most wells dug in the clay till ridges, which are scattered throughout the flat clay-sand areas in the north and west parts of township, should attain a minimum depth of 37 feet to be satisfactory. A number of the more shallow wells are reported to be intermittent. In the area 1 mile to 2 miles west of Irena, wells dug 16 to 25 feet in the flat sand areas are satisfactory, whereas in the higher clay till areas, wells dug as deep as 45 feet are reported to yield only fair supplies of ground water. The deepest dug well in the township, located in lot 3, con. II, is dug 61 feet in clay till and is reported to yield a satisfactory supply of water.

Ground water under hydrostatic pressure is seldom yielded directly by clay till. In most instances, the wells are non-artesian and are deriving their water from the zone of saturation below the water-table. Wells in areas in which clay till has been reworked are more satisfactory than in those areas where it has not. This is due to the greater permeability of the reworked material, which has had a large quantity of the finer particles washed from it.

The supply of ground water yielded by the kame deposits located in the northwest corner of the township is reported to be satisfactory. The water-table in this area is relatively low and, consequently, the average depth of dug wells is greater than in other parts of the township. Clay till underlies the greater part of these kame deposits. In many places satisfactory supplies of ground water can be obtained from the sand lying immediately above the till.

A large number of wells in the marine sand and clay areas located in the north part of the township, especially in the vicinity of the community of Hulbert, are reported to have encountered beds of sand and gravel beneath the marine sediments and directly overlying bedrock. It is thought that these deposits are outwash and that they could be developed into an important source of ground water for the north and west parts of the township.

The following are logs, as supplied by well owners, of representative wells that encountered sand and gravel below marine clay.

Lot. 22, con. V

Feet	
0 to 55	clay
55 to 56	gravel
at 56	bedrock

Lot 23, con. VI

Feet	
0 to 34	clay
at 34	gravel

Lot. 26, con. VII

Feet	
0 to 2	sand
2 to 39	clay
39 to 42	gravel
at 42	bedrock

Wells in lot 32, con. VI, lot 30, con. VII, and lots 33 and 34, con. VII, are also reported to be deriving their water from gravel deposits encountered below varied thicknesses of marine clay.

However, a number of wells drilled to bedrock in the same general area did not encounter gravel. This would suggest that the outwash deposits do not occur as a continuous sheet throughout the entire area but rather as scattered deposits possibly filling the lower areas in bedrock. The water encountered in the outwash materials, or "water-gravels" as they are referred to locally, is usually under considerable hydrostatic pressure and rises to within a few feet of surface. The fact that the "water-gravels" are capable of yielding large supplies of ground water is evident from the reports of various well owners who state that continuous pumping fails to lower the static level of the water in their wells. The 63-foot well drilled at the cheese factory at Hulbert, lot. 18, con. VIII, obtains up to 3,000 gallons of water a day from the "water-gravel" without lowering the level of the water in the well. A 50-foot well, drilled in lot 34, con. VI, which is reported to be obtaining its water from gravel below clay, flows slowly during the period November to July.

Deposits of marine clay that cover the north-central part of the township and underlie a large part of the marine sand areas yield various quantities of ground water to many wells. The problems encountered in attempting to obtain satisfactory supplies of ground water from marine clay are comparable with those in clay till areas. Marine clay is too dense to yield its water content readily, and wells dug in this material necessarily have to go a considerable distance below the water-table in order to provide a reservoir large enough to yield a satisfactory supply of water. Most wells dug in marine clay that are reported to be unsatisfactory, are so not because of the lowering of water-table but because of the poor permeability of the material.

In most cases, due to this extremely poor permeability, a well could be dug in clay a considerable distance below the water-table before there would be any evidence of free water in the well. It is suggested that the only method to accurately determine the location of the water-table in clay is by making laboratory tests to determine if the material is saturated. A well dug in clay would necessarily have to remain in disuse for a considerable length of time before the elevation of the surface of the free water would approach that of the water-table.

Although it is a more laborious task to dig a well in heavy marine clay than in sand or gravel, it is easier to penetrate the zone of saturation below the water-table and thus create a larger reservoir. In some wells, the marine clay was found to be so firm and compact that lining the well with rock or wooden cribbing was not considered necessary. It is doubtful, however, if wells such as these would be as satisfactory as those that have been properly lined.

When ground-water data were being gathered in the township (July 1950) the water-table in the marine clay areas appeared to be fairly high; in most places the surface of the water in the wells was from 4 to 6 feet below the ground surface. Most wells dug in the marine clay area were deep enough to contain sufficient water for ordinary farm needs. However, it was reported that some of the wells could be pumped dry, and took an extremely long time to recover. One such well, dug 20 feet in clay, occurs in lot 31, con. VII. This well should be deepened. A number of other wells in the marine clay area are not in use, which is usually a good indication that they do not yield a satisfactory supply of ground water. In the vicinity of Haddo, lots 28 to 34, cons. II and III, the marine sand overlying clay is very thin and all the water derived by dug wells is from the clay. The wells in this area, from 20 to 38 feet deep, are mostly satisfactory and provide sufficient water for normal uses. Wells of less depth are not satisfactory and should be deepened to provide a larger reservoir for the ground water. Wells from 9 to

15 feet deep, dug in clay, in lot 27, con. VI, are reported to be unsatisfactory, whereas a 39-foot well, in lot 32, con. V, is reported to yield excellent supplies of ground water. A well at Dixons Corners (No. 7 on the compilation sheet), dug 16 feet in clay, is reported to supply sufficient water for several families.

The marine sand deposits, which extend along the west part of the township, are exceedingly thin and are not considered a good source of ground water. Wells dug in this area usually obtain their water from the underlying marine clay, which is the predominant material underlying the sand, or from clay till or bedrock. Precipitation falling upon sandy areas rapidly sinks in and percolates downward until it reaches the more impervious marine clay or clay till. These materials slow the downward movement of the water to such an extent that the sand immediately above frequently becomes saturated with water, forming a perched water-table. A few wells dug down through the sand to the more impervious material are reported to have encountered "springs" in the bottom of the well. This is merely ground water seeping rapidly into the well from the porous, saturated sand. It is difficult to determine if the water in wells dug through sand into the underlying clay is perched or not because the great permeability of the sand permits surface water to pass through it and fill the well rapidly to the level of the water in the perched water-table.

So far as is known, there are no wells in the township deriving their water from alluvial deposits.

Altogether, some 214 wells have been drilled into bedrock in the township, and all are reported to be deriving at least part of their ground water from that source. The depths of the wells range from 15 197 feet with an average of 70.9 feet.

A compilation of data from wells reported drilled to bedrock in Matilda township, exclusive of communities, and arranged according to the formation from which the water is considered to be derived, is as follows:

Formation	Number of wells	Classification				Depths of wells (feet)			Depths to water (feet)			Quality		
		F.A.	N.F.A.	N.A.	I.W.	Min.	Max.	Ave.	Min.	Max.	Ave.	Hd.	Sft.	Sul.
Ottawa	53	0	13	39	1	15	127	70.0	3	19	7.6	53	0	0
St. Martin	47	0	33	14	0	33	183	79.1	2	23	10.0	39	5	3
Rockcliffe	84	2	47	34	1	21	197	69.4	0	53	9.4	79	2	2
Oxford	25	0	6	14	5		180	68.4	3	21	11.7	25	0	0
Total	209	2	99	101	7							196	7	5

The Oxford formation, which consists of grey limestone, magnesium limestone, and dolomite, is not considered an important source of ground water within Matilda township. Altogether some 25 wells are reported to be deriving their water from this source, of which 5 are intermittent and only 6 encountered water under pressure. The Oxford appears to be less satisfactory as a source of ground water when it occurs relatively close to surface. Seven wells deriving their water from the Oxford occur in a small area approximately 1 mile northwest of Iroquois, where bedrock is overlain by 11 to 18 feet of overburden. Of these wells, 5 are non-artesian and 2 are intermittent. Farther northwest, where bedrock exists at depths as great as 56 feet, a number of non-flowing artesian wells occur. Ground water derived from the Oxford is generally hard and clear with a low mineral content. Although it is not considered an excellent source of ground water, the Oxford formation will normally yield sufficient water to satisfy the needs of an average farm.

The Rockcliffe formation, consisting of grey-green shale with lenses of grey sandstone, constitutes the most important bedrock source of ground water in the township. Some 83 wells, of which 2 are flowing artesian and 47 non-flowing artesian, are deriving their water supply from this source. Several of the latter are reported to flow during part of each year, and in others the water levels were reported to remain constant during continuous pumping. A wide valley in bedrock, filled with from 60 to 85 feet of drift, exists between Iroquois and Rapide Plat and extends as far north as Rowena. A large number of non-flowing artesian wells deriving their ground-water supplies from the Rockcliffe occur in this area.

The flowing-artesian wells, in lot 31, con. VI, and lot 22, con. VIII, reported to be deriving their water from the Rockcliffe, are believed to be related to a drift-filled valley in bedrock extending from a point 2 miles east of Glen Stewart northeast to Hulbert and beyond. This same valley extends southwest into the Pittston area in adjacent Edwardsburg township where several flowing-artesian wells are known to occur.

The St. Martin formation, consisting of limestone, minor shale, and dolomite, directly overlies the Rockcliffe. Although the St. Martin underlies as much of the township as the Rockcliffe, about half as many wells are reported to be deriving their water from this source. The reason appears to be that the St. Martin is overlaid by a greater thickness of overburden than the Rockcliffe, necessitating drilling deeper and more expensive wells. Approximately 70 per cent of wells drilled into the St. Martin are non-flowing artesian, indicating that the formation is an excellent source of ground water. The water from a number of wells deriving their water from the St. Martin is reported to be very hard. Approximately 6 per cent of the wells for which information has been compiled were reported to have a strong hydrogen sulphide odour. Although the latter are not satisfactory for domestic purposes, they are being used in many places for stock.

A drift-filled valley in the bedrock surface cuts across the township in a northeast direction, passing about 1 mile west of the community of Brinston. Although this buried valley is located in the St. Martin formation for a considerable distance, no flowing-artesian wells are known to occur in its vicinity.

The Ottawa formation, which consists of grey limestone, with dolomite, shale, and sandstone in the lower part, is the uppermost bedrock formation underlying the township. The water-yielding properties of the Ottawa are comparable to the Oxford formation in that less than 25 per cent of wells drilled into it are reported to be non-flowing artesian.

However, in lot 6, con. VII, a 63-foot drilled well was reported to have encountered water in the Ottawa under sufficient hydrostatic pressure to force the water to within a few feet of the surface. The water level in this particular well cannot be lowered by continued pumping.

Two wells, both drilled into the Ottawa formation, were reported to have been affected by the earthquake of 1944, which centred in the Cornwall-Massena area some 26 miles to the east. One 70-foot well, in lot 13, con. V, went dry after the earthquake, continued dry for approximately a year, and then gradually came back to its original capacity. A second, 90-foot well, in lot 4, con. VI, drilled 72 feet into the Ottawa formation, reported an increased supply of ground water following the earthquake. The Ottawa is the only bedrock formation underlying the township whose aquifers were reported to have been disturbed by the earthquake.

Community Supplies

Ground-water conditions within the following three communities in the township of Matilda were investigated: Brinston, Dixons Corners, and Dundela. Maps showing the location of all wells for which information has been obtained and indicating both topographic and water-table contours accompany this report. Although the contours are somewhat generalized they are believed to be sufficiently accurate for the purpose for which they are being used. Compilation sheets containing pertinent data concerning the individual wells in each community are attached at the back of this report. To determine the depth to water in any one place, it is necessary only to subtract the elevation of the nearest water-table contour from that of the nearest surface contour.

Community of Brinston. The water supply of this community is derived entirely from privately owned wells. There are 24 wells in the community, of which 21 are dug and 3 are of the drilled type. The dug wells are all reported to derive their water from marine clay, whereas two of the drilled wells obtain their water supply from the underlying St. Martin formation and the third from sand underlying the marine clay.

The depths of the wells dug in marine clay vary from 8 to 23 feet, with an average of 14 feet. With the exception of three of the more shallow wells, which are intermittent, the supply of ground water yielded by marine clay is reported to be sufficient for domestic purposes. All the wells derive their water from the zone of saturation below the water-table. No ground water under hydrostatic pressure was encountered in the marine clay. It is thought that the intermittent wells should be deepened during the late summer when the water-table is at its lowest level.

It was reported that large supplies of ground water can be obtained from the underlying bedrock. Although no figures were acquired as to the maximum quantity of water that could be obtained, the well at the cheese factory was reported to yield 400 gallons a day without lowering the static level of the water in the well. The water encountered in the bedrock is under sufficient hydrostatic pressure to raise it a considerable distance in the well. Bedrock, underlying the community, is covered with approximately 30 feet of overburden.

One non-flowing artesian well is obtaining excellent supplies of ground water from sand underlying marine clay. The sand is possibly outwash material deposited immediately above bedrock during the retreat of the ice-sheet. It is not thought to be continuous over any large area and, accordingly, will not necessarily be penetrated in every well drilled to bedrock in the community.

Community of Dixons Corners. Ground-water conditions at Dixons Corners are similar to those at Brinston, as both communities are situated within the same marine, clay plain. There are 11 privately owned wells in Dixons Corners, 9 of which are dug and 2 drilled.

The dug wells, which are all reported to be obtaining their water from marine clay, vary in depth from 12 to 22 feet, with an average depth of 18 feet. The quantity of water yielded is reported to be satisfactory for domestic purposes. No intermittent wells were reported within the community.

One 45-foot drilled well that penetrated the underlying St. Martin formation at an unknown depth is reported to be obtaining excellent supplies of ground water. A second well drilled to a depth of 39 feet is obtaining water from gravel underlying marine clay. The water in both wells is under considerable hydrostatic pressure, especially in the spring, at which time the well obtaining water from gravel frequently flows at the surface.

The depth to bedrock is nowhere known exactly, but it must lie within 45 feet of the surface in the vicinity of the well reported to be obtaining its water from bedrock.

Community of Dundela. The community of Dundela is located along and across the crest of a large, clay-till drumlin striking in a general southwest direction. Information has been compiled on 14 wells in the community, 12 of which were dug and 2 drilled.

The dug wells, all of which are obtaining their ground-water supplies from clay till, vary in depth from 12 to 36 feet, with an average depth of 25 feet. It will be noted that the average depth of the dug wells at Dundela is much greater than at either Brinston or Dixons Corners. All the dug wells in the three communities are dependent upon ground water from the zone of saturation below the water-table for their water supply, and the greater depth of the wells in the till would indicate that the water-table is closer to the surface in the broad, flat, clay plain surrounding the communities of Brinston and Dixons Corners than in the higher clay-till area at Dundela. Except for one intermittent well, the quantity of water yielded by the clay till is reported to be satisfactory for domestic purposes, and deepening this well would probably result in it producing a sufficient supply of ground water.

One well, drilled to a depth of 96 feet, was reported to have encountered bedrock at 26 feet. Although the water encountered does not appear to be under hydrostatic pressure, the well was reported to yield supplies sufficient for all normal uses. It is thought that a large percentage of the water derived from this particular well is obtained from the overlying unconsolidated material or from the contact of the unconsolidated material and bedrock.

A number of the dug wells within the community are more than 26 feet in depth. This would indicate that undulations, possibly of a minor nature, occur in the underlying bedrock surface, and, accordingly, it would not be possible to predict accurately the depth to bedrock at any one point in the community.

ANALYSES OF WATER SAMPLES

Twelve samples of well waters from Matilda township were analyzed for their mineral content in the laboratory of the Mines Branch, Department of Mines and Technical Surveys, Ottawa. The samples were taken from wells varying in depth from 16 to 100 feet, with aquifers in both drift and bedrock. Most of the ground water except for two wells where the nitrate content is abnormally high, appears to be suitable for domestic and farm use. It is suggested that bacteriological tests should be made of these well waters if they are to be used for domestic purposes. Most contamination of well waters results from surface water seeping into the well, either at surface or at the bottom of the casing or cribbing. It was noted that one well whose nitrate content was reported to be zero is of excellent construction with little chance of contamination. Water derived from the St. Martin formation appears to contain the largest amount of sulphate and chloride compounds. The chlorides, if present in excess of

300 parts per million, would render the water saline to the taste. The analyses indicate that the Ottawa formation yields the hardest water and the chemical content of the water from the Rockcliffe formation varies considerably throughout the township.

Amounts[1] of Dissolved Mineral Matter in Well Waters collected in Matilda Township

Constituent	Well waters from glacial drift and bedrock (12 samples)		
	Maximum	Average	Minimum
Residue on evaporation(105°C)	1339	681.1	324
Calcium	160.5	776.0	28.0
Magnesium	100.3	40.2	21.6
Sodium	204.0	68.5	12.0
Potassium	224.0	35.9	2.4
Sulphate	197.1	75.2	17.7
Chloride	343.0	87.1	5.4
Nitrate	248.1	51.9	0.0
Bicarbonate	517.5	331.3	235.7
Carbonate	16.8	2.9	0.0
Silica (Col.)	23.2	12.0	7.8
Total hardness	621.0	3/5.7	156.5

[1]In parts per million

In answer to the requests of a number of well owners, the following method is recommended when it is desired to sterilize a well[2]: Mix one heaping tablespoonful of chlorinated lime with a little water to make a thin paste, being sure to break up all lumps; stir this paste into 1 quart of water; allow the mixture to stand a short time and pour off the clear liquid. The chlorine strength of the solution is about 1 per cent: 1 quart of the liquid is enough to sterilize 800 imperial gallons of water.

[2]Well Drilling, Technical Manual, TM 5-295, United States Government Printing Office, Washington, 1943.

Estimate the volume of water in gallons standing in the well, and for each 800 imperial gallons pour 1 quart of the sterilizing solution into the well. No harm is done if too much solution is used, and it is better to use too much than too little. Agitate the water thoroughly and let it stand for several hours, preferably over night, then flush the well thoroughly to remove all of the sterilizing agent. The sides of the well above the surface of the water can be sterilized by returning the water to the well during the first part of the flushing. Just before completion of the flushing, a sample of the water may be taken if required.

To determine the amount of chlorinated lime solution that should be added to the well waters, it is necessary to know the diameter of the well and the depth of water in the well. With this knowledge, together with the information given in the table below, the volume of water present in the well can be easily calculated and the correct amount of lime solution added.

Diameter of well (feet)	Number of imperial gallons per foot depth
2.0	19.6
2.5	30.6
3.0	44.1
3.5	59.9
4.0	78.3
4.5	99.1
5.0	122.3

CONCLUSIONS

This investigation warrants the following conclusions:

1. Ground-water resources in Matilda township, though not abundant, are adequate for domestic, stock, and community purposes.
2. To ensure a satisfactory supply of ground water, wells dug in clay-till areas should be a minimum of 35 feet in depth. Wells of less depth often become intermittent during the late summer or early autumn.
3. Wells in marine clay should be dug to a minimum depth of 28 feet to ensure a supply of ground water sufficient for domestic or farm use.
4. Outwash deposits of sand and gravel located between the marine clay deposits and underlying bedrock in the north part of the township might possibly be developed into an important source of ground water.
5. The Oxford formation constitutes a fair source of ground water within the township. Although there is only a limited number of non-flowing artesian wells in the Oxford, the water is mostly hard and clear with small amounts of total dissolved solids.
6. The Rockcliffe formation constitutes the most important single source of ground water in the bedrock underlying the township. Over half of the wells deriving their water from the Rockcliffe are non-flowing artesian and 2 flowing-artesian wells obtain their water from this source.
7. The supply of ground water that can be derived from the St. Martin formation is large. However, the presence of hydrogen sulphide in a number of the wells prevents some of the water from being used for domestic purposes. It is, however, satisfactory for stock.
8. Although some wells encountered ground water under considerable hydrostatic pressure in the Ottawa formation, most wells obtaining water from this source are non-artesian. The quality of the water

is comparable with that of the Oxford formation. It is hard and and clear and relatively low in total dissolved solids.

9. Flowing-artesian wells in the township appear to be related to a drift-filled pre-glacial valley in bedrock. This valley extends southwest from Matilda township into the Pittston area in adjacent Edwardsburgh township, where several flowing-artesian wells are known to occur.

10. The best supplies of ground water for the community of Brinston will be obtained from bedrock, which occurs about 30 feet below surface. Wells dug into marine clay to a depth of 15 feet or less are seldom satisfactory.

11. Although the marine clay covering the adjoining areas appears, in most instances, to be a satisfactory source of ground water, the best supplies of ground water in the community of Dixons Corners will be obtained by drilling through the clay into bedrock, which exists approximately 45 feet below the surface.

12. Although it is necessary to dig the wells considerably deeper in Dundela than in Dixons Corners or Brinston, the quantity of ground water yielded by the clay till is sufficient for normal domestic purposes. Bedrock of the Ottawa formation, at approximately 26 feet below the surface of ground, is capable of yielding large quantities of ground water.

Matilda Twp.

Summary of wells and springs used as a source of Water Supply, exclusive of Communities

Wells and springs	Concessions I	II	III	IV	V	VI	VII	VIII	Total number in township	Per cent of total
Total number	215	154	128	145	160	157	126	132	1217	
Dug	187	128	112	118	116	106	89	92	945	77.8
Bored	0	0	0	0	0	0	0	0	0	0
Drilled	35	26	16	25	44	50	37	40	272	22.2
Feet deep										
Wells 0-20	73	47	44	68	67	69	62	55	485	39.9
21-40	114	68	64	49	69	46	34	46	488	40.2
41-60	14	14	6	14	6	16	14	12	96	7.9
61-80	8	7	2	3	10	8	6	6	46	3.8
81-100	2	5	2	3	10	12	5	6	45	3.8
Over 100	2	7	3	2	2	2	0	5	23	1.9
Depth unknown	2	6	7	6		6	5	2	34	2.8
Wells that yield hard water	214	154	128	141	156	149	126	128	1199	98.5
soft water	1	0	0	4	4	4	0	4	18	1.5
salty water	0	0	0	0	0	0	0	0	0	0
Wells with aquifer in clay	17	26	24	40	59	49	62	65	342	28.40
In sand	21	11	18	15	3	6	5	14	93	7.50
In gravel	29	10	6	14	5	11	8	11	94	7.51
In clay till	121	81	69	55	64	40	23	10	463	38.0
In bedrock	27	26	11	18	24	45	25	32	209	17.2
Unknown	0			3	2	3	0	0	8	.66
Well types: flowing artesian	0	0	0	0	0	1	0	1	2	.16
Non-flowing artesian	17	12	9	18	10	18	19	16	119	9.82
Non-artesian	160	108	83	108	143	127	98	107	934	76.60
Intermittent	36	34	35	19	5	8	9	7	153	12.60
Dry holes	0	0	1	0	2	1	0	1	5	9.41
Not used	22	40	22	22	36	36	37	22	237	19.5
Springs	2	0	0	0	0	0	0	0	2	.16

Matilda Twp.

Summary of Wells and Springs used as a source of Water Supply (Communities)

Wells and Springs	Brinsten	Dixons Corners	Dundela	Total number in communities	Per cent of total
Total number	24	11	14	49	
Dug	22	9	12	43	87.9
Bored	0	0	0	0	0.0
Drilled	2	2	2	6	12.2
Feet deep					
Wells 0-20	18	5	3	26	53.1
20-40	4	4	9	17	34.7
40-60	0	2	0	2	4.1
60-80	1	0	0	1	2.0
80-100	0	0	1	1	2.0
Over 100	1	0	0	1	2.0
Depth unknown	0	0	1	1	2.0
Wells that yield hard water	23	11	14	48	98.0
Soft water	1	0	0	1	2.0
Salty water	0	0	0	0	0.0
Wells with aquifer in clay	20	9	0	29	59.2
In sand	2	0	0	2	4.1
In gravel	0	1	0	1	2.0
In clay till	0	0	12	12	24.5
In bedrock	2	1	2	5	10.2
Unknown	0	0	0	0	0.0
Well types: flowing artesian	0	0	0	0	0.0
Non-flowing artesian	3	2	0	5	10.1
Non-artesian	18	9	13	40	81.8
Intermittent	3	0	1	4	8.1
Dry holes	0	0	0	0	0.0
Not used	5	1	1	7	14.1
Springs	0	0	0	0	0.0

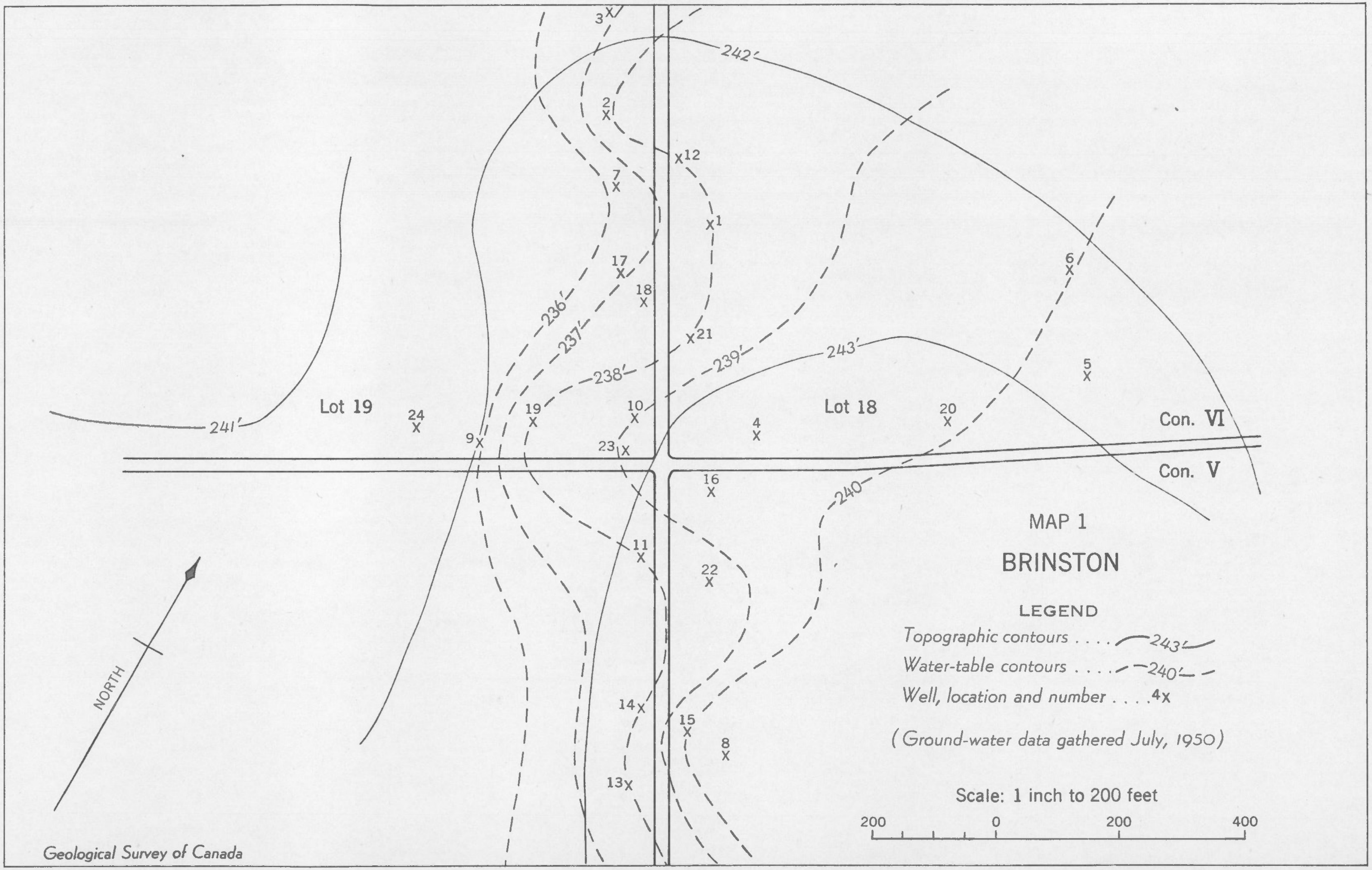
ANALYSES OF WELL WATERS FROM MATILDA TOWNSHIP, DUNDAS COUNTY, ONTARIO

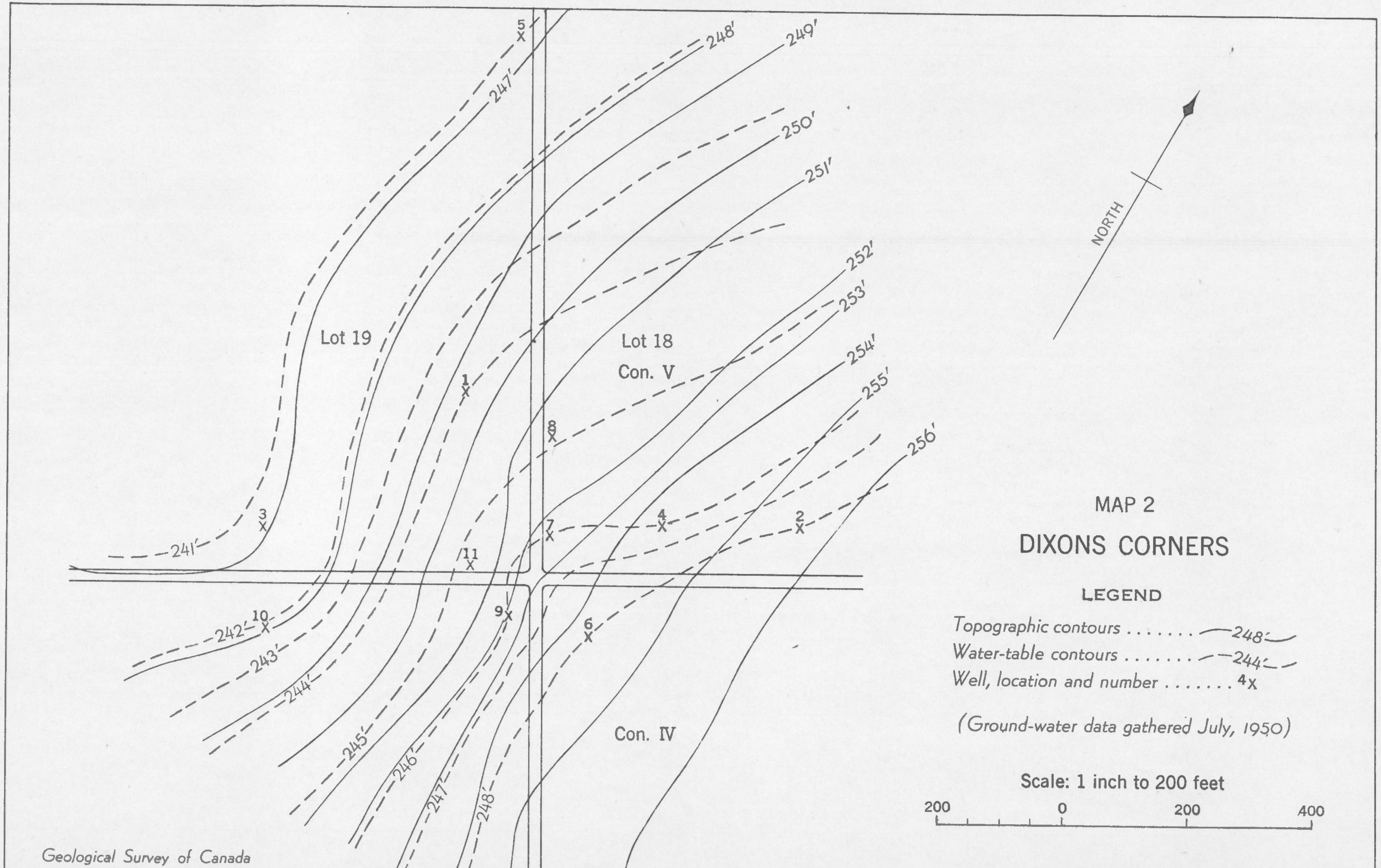
						Constituents as Analysed (parts per million)										Hardness as CaCo (pts/million)		
Sample number	Owner	Lot	Concession	Depth of Well Feet	*Aquifer	Residue on evaporation (pts/million)	Calcium (Ca)	Magnesium (Mg)	Sodium (Ne)	Potassium (K)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NC_3)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Silica Col. (S_1O_2)	Ca hardness	Ma hardness	Total hardness
1	W. McGowan	9	V	23	C.T.	706	112.0	28.6	20.5	15.0	41.6	97.0	64.2	265.7	0	7.8	279.4	117.7	397.1
2	W. McGowan	9	V	96	O.	1,339	160.5	50.0	23.4	224.0	197.1	67.3	248.1	517.5	0	12.2	400.5	205.8	606.3
3	P. Murphy	18	V	16	C.	610	92.5	32.8	21.3	50.0	81.5	30.7	69.8	341.6	0	11.6	230.8	135.0	365.8
4	Coleman Bros. garage	18	V	23	C.	324	75.1	22.1	12.0	2.9	17.7	5.4	1.8	343.8	0	12.4	187.4	90.9	278.3
5	A. R. Collison	22	VI	39	C.	506	40.0	21.6	126.0	9.2	24.3	121.5	0	293.0	0	10.6	99.8	90.1	189.9
6	R. Ennis	23	VI	100	St.M.	704	28.0	23.4	204.0	16.4	14.8	259.9	7.1	262.5	0	10.8	69.9	96.3	166.2
7	Glen Stewart cheese factory	31	VI	65	R.	400	28.9	20.5	88.0	8.5	21.8	70.0	1.0	251.1	9.6	10.2	72.1	84.4	156.5
8	C. Thorpe	23	VII	93	St.M.	888	48.5	31.2	216.0	9.6	44.9	343.0	1.4	235.7	0	10.2	121.0	128.4	249.4
9	E. Kirker	26	VII	47	R.	576	87.1	31.2	77.0	8.2	73.3	60.0	1.4	433.1	0	10.6	217.3	128.4	345.7
10	P. Arbic	10	VIII	20	C.	808	93.4	53.1	61.2	2.4	102.1	109.9	57.6	275.7	16.8	14.4	233.0	218.0	451.5
11	Ellis Bros.	19	VIII	85	St.M.	1,066	83.5	100.3	30.4	52.0	153.1	117.8	11.1	497.8	0	23.2	208.3	412.7	621.0
12	M. R. Sullivan	21	VIII	47	R.	1,146	81.7	67.3	42.0	32.4	130.5	72.8	159.5	257.2	8.2	10.0	203.8	276.9	480.7

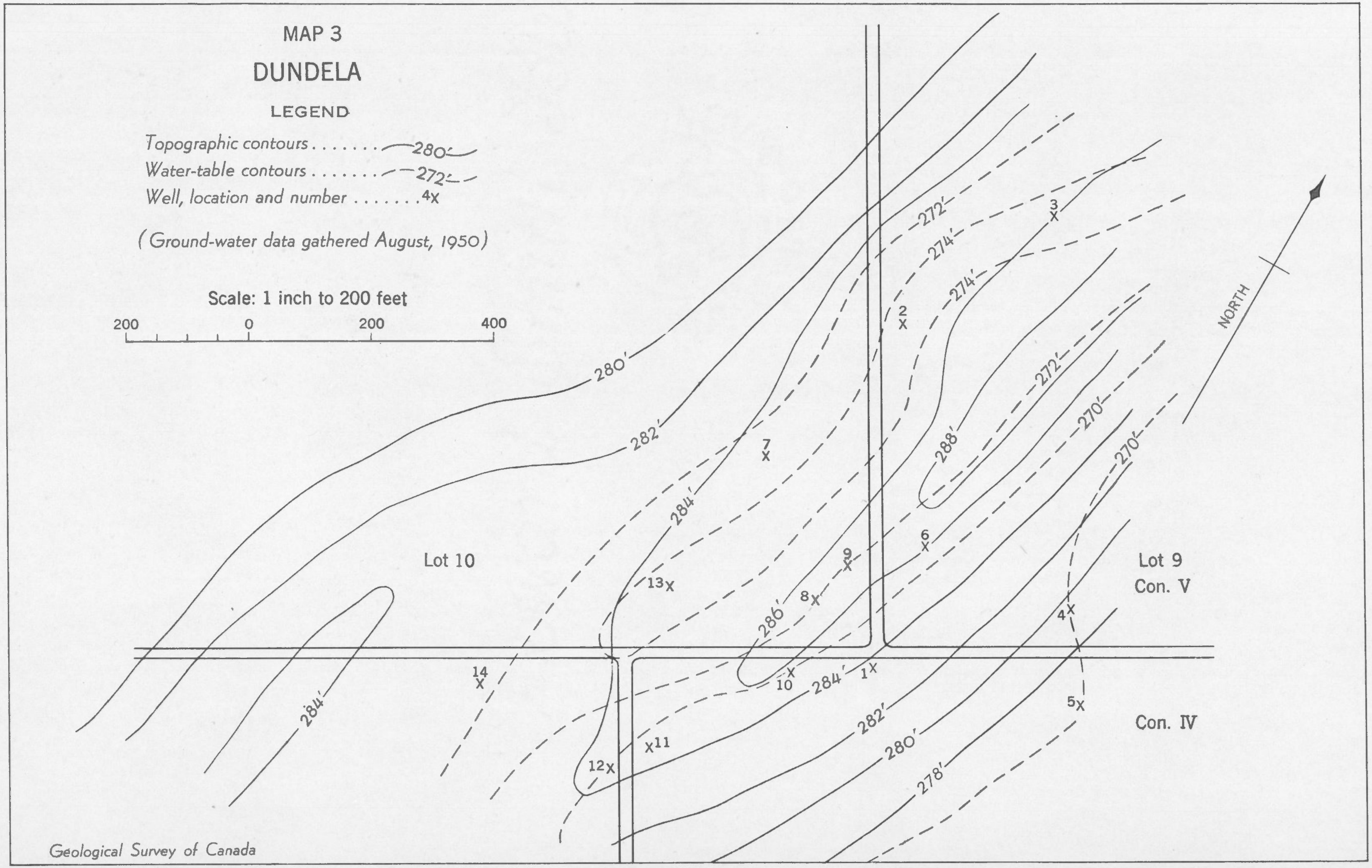
*C. - clay
S. - sand

G. - gravel
C.T. - clay till

O. - Ottawa formation
R. - Rockcliffe formation
St.M. - St. Martin formation


MAP 1
BRINSTON
LEGEND
Topographic contours .... 243'
Water-table contours .... 240'
Well, location and number 4x
(Ground-water data gathered July, 1950)
Scale: 1 inch to 200 feet
200
0
200
400
Lot 19
Lot 18
Con. VI
Con. V
242'
243'
241'
236'
237'
238'
239'
240
NORTH
3
2
12
7
1
17
18
21
5
6
19
10
20
24
4
9
23
16
11
22
14
15
8
13
Geological Survey of Canada


NORTH
Lot 19
Lot 18
Con. V
Con. IV
241′
242′
243′
244′
245′
246′
247′
248′
249′
250′
251′
252′
253′
254′
255′
256′
1
2
3
4
5
6
7
8
9
10
11
MAP 2
DIXONS CORNERS
LEGEND
Topographic contours .... 248′
Water-table contours .... 244′
Well, location and number 4X
(Ground-water data gathered July, 1950)
Scale: 1 inch to 200 feet
200 0 200 400
Geological Survey of Canada


MAP 3
DUNDELA
LEGEND
Topographic contours .... 280′
Water-table contours .... 272′
Well, location and number 4x
(Ground-water data gathered August, 1950)
Scale: 1 inch to 200 feet
200
0
200
400
NORTH
Lot 10
Lot 9
Con. V
Con. IV
280′
282′
284′
286′
288′
272′
274′
270′
278′
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Geological Survey of Canada

Community of Brinston

WELL RECORDS Matilda Township Dundas County, Province Ontario

LOCATION				DESCRIPTION					WATER LEVEL July 1950		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
Well No.	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	Above + Below − Surface	Elevation	Depth	Elevation	Aquifer	Quality	Used for °	
1	6	18	J. Adams	Dug	Plain	243	12	N.A.	-5M	238			Clay	Hard, clear	D.	Sufficient
2	6	19	Boyd	"	"	244	14	"	-6M	238			Sand (?)	" "	D.	Sufficient; at house
3	6	19	Boyd	Drilled(?)	"	242	39	N.F.A.	-12M	230			Sand	" "	S.	Sufficient; at barn
4	6	19	H. Boyd	Dug	"	243	15	I.W.	-5M	238			Clay	" "	S.	Goes dry during summer
5	6	18	H. Boyd	"	"	246	20	N.A.	-8M	238			"	" "	D.	Sufficient
6	6	18	H. Boyd	"	"	245	22	"	-5M	248			"	" "	S.	Sufficient for 15 head of stock
7	6	19	A. Brinston	"	"	242	14	"	-6M	236			"	" "	D.	Sufficient
8	5	18	Coleman Bros.	"	"	241	23	"	-4M	237			"	" "	D.	Sufficient for garage; 55°F
9	6	19	A. Coones	"	"	242	15	"	-6M	236			"	" "	D.	Sufficient
10	6	19	M. J. Davidson	"	"	245	14	"	-6M	239			"	" "		Not used
11	5	19	C. Grillson	"	"	243	14	"	-5M	238			"	" "	D.	Sufficient
12	6	18	E. Hamilton	"	"	242	12	"	-4M	238			"	" "	D.	"
13	5	19	R. Innes	"	"	241	11	"	-3M	238			"	" "		Not used
14	5	19	J. McGowan	"	"	243	13	"	-5M	238			"	" "	D.	Sufficient
15	5	18	E. McShane	"	"	242	11	"	-2M	240			"	" "		Not used
16	5	18	C. N. Murphy	"	"	243	15	"	-7M	236			"	" "	D.	Sufficient
17	6	19	A. S. Peterson	"	"	243	14	"	-6M	237			"	" "	D.	Not used
18	6	19	A. S. Peterson	"	"	243	12	"	-3M	240			"	" "		Not used
19	6	19	Wallace	"	"	243	183	N.F.A.	-5M	238			St. Martin	" "	D.	Sufficient; depth to bedrock unknown
20	6	18	Cheese Factory	"	"	243	65	"	-7M	236			"	soft, "	D.	Sufficient; yields 400 gallons per day; bedrock at 20 feet
21	6	18	Farmers' Co-operative	Dug	"	243	65	N.A.	-5M	238			Clay	hard, "		Not used
22	5	18		"	"	246	14	I.W.	-5M	238			"	" "	D.	Goes dry during summer
23	6	19		"	"	243	13	N.A.	-4M	239			"	" "	D.	Sufficient
24	6	19		"	"	242	8	I.W.	-4M	238			"	" "	D.	Goes dry during summer

*All elevations in feet above sea level.
†Sample taken for analysis.
M - Measured

+ Classification: F.A.—Flowing Artesian. N.A.—Non-Artesian. N.F.A.—Non-Flowing Artesian.

° Used for: S—Stock. I—Irrigation. M—Municipal. D—Domestic. G—Greenhouse or Garden.

Community of Dixons Corners

WELL RECORDS Matilda Township Dundas County, Province Ontario

LOCATION				DESCRIPTION					WATER LEVEL July 1950		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
Well No.	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	Above + Below − Surface	Elevation	Depth	Elevation	Aquifer	Quality	Used for °	
1	5	19	H.E. Boyd	Dug	Plain	248	20	N.A.	-4M	244			Clay	Hard, clear	D.	Sufficient
2	5	18	C. Hanson	"	"	256	22	"	-8M	248			"	" "	D.	"
3	5	19	H. Locke	Drilled	"	247	39	N.F.A.	-2M	245			Gravel under clay	" "	D.S.	Sufficient; sometimes flows during spring
4	5	18	Dairy	Dug	"	254	17	N.A.	-8M	246			Clay	" "	D.	Sufficient; yields 450 gallons per day
5	5	19	School	"	"	247	22	"	-6M	241			"	" "	D.	Sufficient
6	4	19		"	"	254	19	"	-6M	248			"	" " †	D.	"
7	5	18	P. Murphy	"	"	252	16	"	-6M	246			"	" "	D.	Sufficient; used by several families; 50°F.
8	5	18		"	"	252	12	"	-4M	247			"	" cloudy		Not used
9	4	19		"	"	252	21	"	-6M	246			"	" Clear	D.	Sufficient
10	4	19		"	"	248	12	"	-6M	242			"	" sulphur	D.	"
11	5	19		Drilled	"	251	45	N.F.A.	-5 M.	246			St. Martin	" Clear	D.	" depth to bedrock unknown

*All elevations in feet above sea level.
†Sample taken for analysis.
M - Measured

+ Classification: F.A.—Flowing Artesian. N.A.—Non-Artesian. N.F.A.—Non-Flowing Artesian.

° Used for: S—Stock. I—Irrigation. M—Municipal. D—Domestic. G—Greenhouse or Garden.

Community of Dundela

WELL RECORDS

Matilda Township Dundas County, Province Ontario

LOCATION				DESCRIPTION					WATER LEVEL July 1950		PRINCIPAL WATER-BEARING BED			WATER		REMARKS
Well No.	Conc.	Lot	Owner	Type	Topographic Situation	Elevation*	Depth	Classification +	Above + Below − Surface	Elevation	Depth	Elevation	Aquifer	Quality	Used for °	
1	4	9	W. A. Gordier	Dug	Hill	286	24	N.A.	-12M	274			Clay till	Hard, clear †	D.	Sufficient supply; at house
2	5	9	W. McGowan	"	Slope	287	23	"	-12M	275			" "	" " †	D.	" " " " 48°F.
3	5	9	W. McGowan	Drilled	"	286	96	"	-22M	264			Ottawa	" "	S.	Sufficient for 20 head of stock; at barn 48°F
4	5	9	S. C. Lapere	Dug	Hill	280	17	"	-10M	270			Clay till	" "	D.	Never goes dry; at house
5	4	9	E. Lapere	"	"	277	12	"	-7M	270			" "	" "	D.	Sufficient supply; at house
6	5	9	A. McIntosh	"	"	286	23	"	-15M	271			" "	" "	D.	" " " "
7	5	10	A. McIntosh	"	Slope	285	25	"	-18M	267			" "	" "	S.	Sufficient for 13 head of stock; at barn
8	5	10	H. McIntosh	"	Hill	287	27	"	-15M	272			" "	" "	D.	Sufficient supply; at house
9	5	10	Fred Morrell	"	"	287	24	I.W.	-15M	272			" "	" "	D.	Insufficient supply; at house
10	4	9	S. Pitt	"	"	285	31	N.A.	-15M	270			" "	Hard, Clear	D.	Sufficient supply; at house
11	4	9	J. Tuttle	"	"	287	31	"	-18M	269			" "	" "	D.	" " " "
12	4	10	J. Tuttle	"	"	287	36	"	-17M	270			" "	Hard, sulfur	S.	Sufficient for 30 head of stock; at barn
13	5	10	United Church Par.	"	Slope	286	29	"	-11M	275			" "	Hard, clear	D.	Sufficient supply; at house
14	4	10	Dundela School	Drilled	Plain	283							Bedrock (?)	Hard cloudy		Not used

*All elevations in feet above sea level.
†Sample taken for analysis.
M - Measured

+ Classification: F.A.—Flowing Artesian. N.A.—Non-Artesian. N.F.A.—Non-Flowing Artesian.

° Used for: S—Stock. I—Irrigation. M—Municipal. D—Domestic. G—Greenhouse or Garden.