CANADA

DEPARTMENT OF MINES

AND

TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

WATER SUPPLY PAPER No. 318

GROUND-WATER RESOURCES OF WILLIAMSBURGH 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.

<u>Ground Water.</u> Sub-surface water in the zone of saturation below the water-table.

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

<u>Influent Stream.</u> A stream that feeds water into a zone of saturation.

<u>Impervious or Impermeable.</u> 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.

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

<u>Porosity.</u> The porosity of a rock is its property of containing interstices or voids.

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

<u>Recent Deposits.</u> 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 ($CaSO_4.2H_2O$) 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

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

PART II

WILLIAMSBURGH TOWNSHIP, DUNDAS COUNTY, ONTARIO

PHYSICAL FEATURES

Williamsburgh township is in the southeast part of Dundas county and has an area of approximately 99 square miles. The township extends along the northwest side of the St. Lawrence River from a point $1\frac{3}{4}$ miles west of the town of Morrisburg to $7\frac{1}{2}$ miles east of the same municipality. The town of Morrisburg, the largest community within the township, lies about 105 miles west of the city of Montreal.

The topography of the greater part of Williamsburgh township is that of ground moraine. It is rolling or undulating with no main topographic features. An area of flat-lying marine sand and clay extends south from the north boundary immediately east of Winchester Springs, to the area about the community of Williamsburg. The areal extent of this sand-clay plain, which constitutes the largest "flat" in the entire township, is approximately 10 square miles. A number of small, clay till ridges, projecting through the sand and clay, provide the only relief in the area. The general trend of the topography varies from north-south to south 10 degrees west. Bedrock, which consists of flat-lying Ordovician sedimentary formations, is exposed in a few, scattered outcrops in the north part of the township. The depth of overburden is such that except in the north part of the township, bedrock does not exert any great influence upon the topography.

A poorly marked divide between the basins of the Ottawa and St. Lawrence Rivers crosses the centre of the township in a southwesterly direction. The divide crosses Highway 19 about $1\frac{1}{4}$ miles south of the community of Williamsburg and intersects the east boundary of the township in concession VI.

Both sides of the divide are drained by numerous, small creeks whose directions of flow are controlled to a great extent by the trend of the topography. The creeks, south of the divide, empty directly into the St. Lawrence River whereas those on the north flow into South Nation River and thence to the Ottawa. Hoasic Creek, possibly the largest in the township, empties into the St. Lawrence River 1 mile east of the town of Morrisburg. The fact that swamp deposits cover 25 per cent of the township is an indication that the surface drainage is relatively poor.

The township as a whole has a relief of more than 75 feet. It ranges from altitudes greater than 300 feet above sea-level in several localities in the northeast part of the township to less than 225 feet at the St. Lawrence River in the southeast corner.

Graphs have 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. Data for 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 the frozen condition of the ground prevents downward percolation of water and because 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 February.

The highest elevation of the water-table is 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 [x]

Station	Year	Jan.	Feb.	March	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	4.2	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	3.1	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

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

WATER-TABLE ELEVATIONS AT OBSERVATION WELL

Name: W. T. Richardson

Address: R.R. No. 1, Morrisburg, Ontario

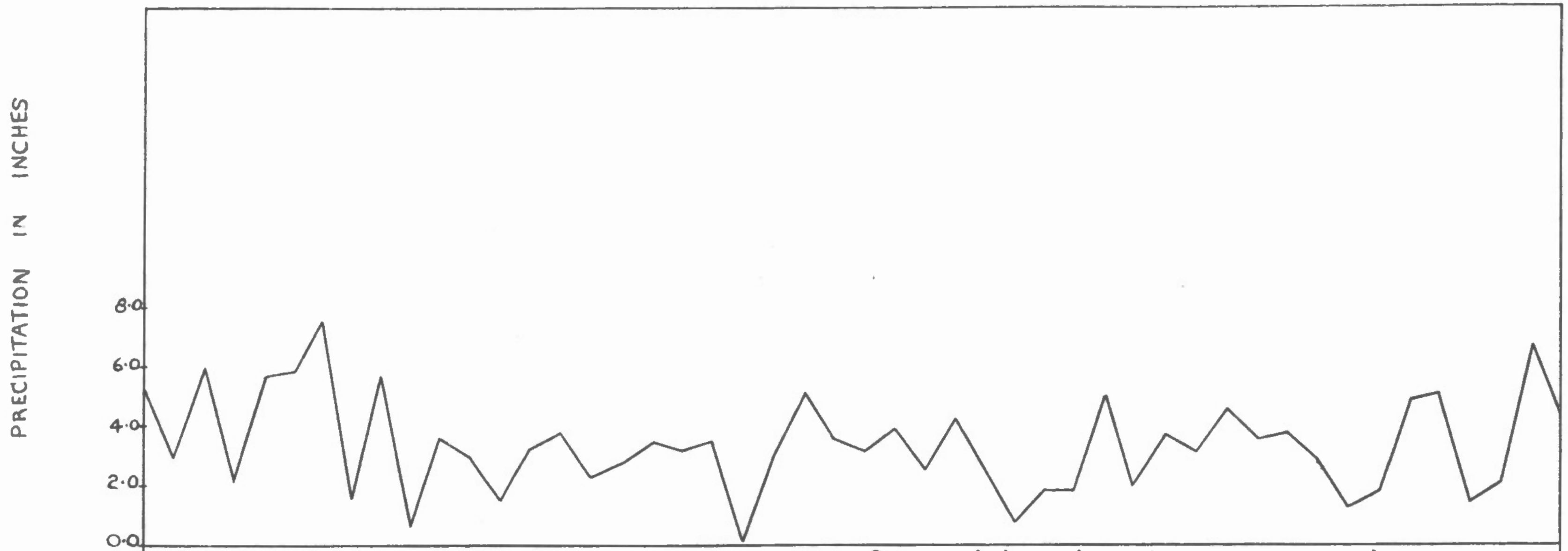
Well type: dug

Well depth: 25 feet (Aug. 22, 1951)

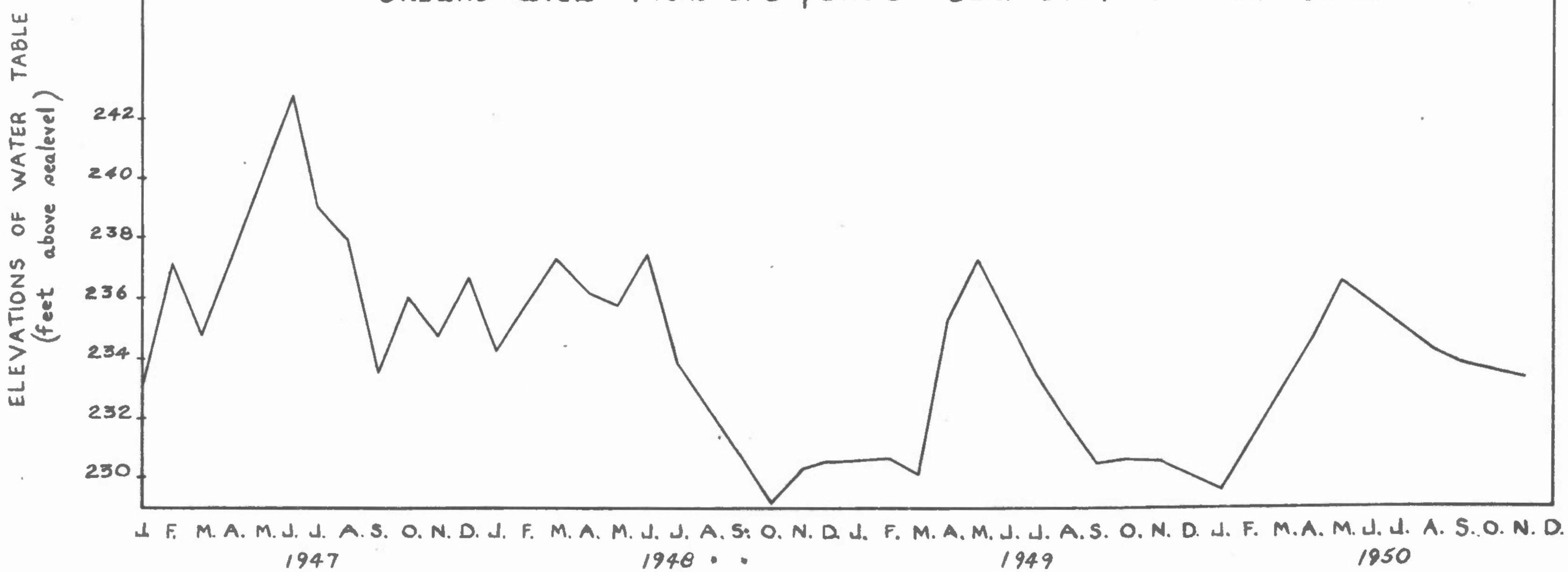
Well elevation: 248.0 feet above sea-level

Material from which ground water derived: clay till

Year	Jan.	Feb.	March	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	



Graph depicting the amount of precipitation in the Morrisburg, Ontario area from the period Jan. 1947 to Dec. 1950.



Graph depicting the fluctuations in the water table in the Morrisburg, Ontario area from the period Jan. 1947 to Dec. 1950.
(Courtesy of the Ont. Dept. of Mines)

GEOLOGY

Bedrock Formations

The township, which is located within the Ottawa-St. Lawrence lowland, is underlain by Palaeozoic rocks of Ordovician age. In most cases the rocks are flat-lying or gently undulating with no general direction of strike or dip.

TABLE OF FORMATIONS[1]

Era	Period	Sub-epoch	Formation	Thickness (feet)	Lithology
Palaeozoic	Ordovician	Trenton and Black River	Ottawa	690-700	Limestone with a little shale and some sand at base
		Disconformity			
		Chazy	St. Martin	20-155	Impure limestone
			Rockcliffe	150-165	Shale with sandstone lenses
		Disconformity			
		Beekmantown	Oxford	240(±)	Dolomite with a little shale at top
			March	30(+)	Interbedded sandstone and dolomite
	Ordovician or Cambrian		Nepean	up to 500	Sandstone
Great Unconformity					
Precambrian (Archean)			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, Mem. 241, p. 9 (1946).

Williamsburgh township is underlain by several formations, of which the Ottawa comes to the surface or directly underlies the drift in the entire township except for the southeast corner and extreme south part where its place is taken by the St. Martin formation. A number of small outcrops of the Ottawa formation occur in the northeast part of the township.

Unconsolidated Material

The types of unconsolidated material occurring in the township, classified according to their origin and arranged in order of their deposition from oldest to youngest, are as follows: glacial, marine, and Recent.

The glacial drift that covers approximately 86 per cent of the township occurs chiefly as ground moraine. The ground moraine, consisting mainly of clay till, is composed largely of material derived from the underlying Palaeozoic rocks and contains many boulders and rock fragments of local origin. The unweathered till varies from a bluish grey, compact, unstratified clay till to a dark brownish, looser, sandy clay till. An excellent section of clay till occurs along the east branch of Hoasic Creek about 1 mile south of the C.N.R. tracks. Here the creek has cut a 15-foot vertical face in the till disclosing boulders of limestone and crystalline rocks up to 12 inches in diameter embedded in a clayey matrix. Numerous, artificial excavations on the outskirts of the town of Morrisburg have exposed clay till at various depths. Information obtained from numerous well owners indicates that the considerable areas of swamp lands in the township are underlain by clay till. This is excellent evidence of the relative impermeability of the till. 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.

The invasion and subsequent withdrawal of the Champlain Sea, which followed the retreat of the ice-sheet in the region, formed a variety of deposits of marine origin. The largest of these is an area of flat-lying clay and sand extending from Winchester Springs south to the community of Williamsburg in the northwest part of the township. Smaller areas of the same materials occur throughout concessions VII and VIII. An irregular deposit of marine clay extends along the northwest bank of the St. Lawrence River from the east boundary of the township west to within 1 mile of Morrisburg.

Recent beds of fine to coarse sand, formed during earlier and higher stages of the St. Lawrence River, extend along the northwest bank of the river, in the same general area as the marine clay. The alluvium overlies much of the marine material in the area and is continuous with similar deposits to the east in adjacent Osnabruk township. They are bounded on the north by an irregular, former river bluff whose elevation is approximately 248 feet above sea-level. A number of dunes, whose material was probably derived from the alluvial sand, occur along the base of this bluff. In the vicinity of Riverside and East Williamsburg, ridges of clay till, projecting above the surrounding sand and clay, probably existed as islands when the river was at a higher elevation.

No beds of glacio-fluvial origin are known to occur in the township. In other townships located within the Ottawa-St. Lawrence Lowlands, beds of this type have been found to be located mainly in valleys between the higher clay till ridges and buried beneath a covering of marine sand, silt, and clay. The most likely location for glacio-fluvial material in Matilda township appears to be beneath the marine clay and sand occurring in the Williamsburg-Winchester Springs area.

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 encountered bedrock. The following table indicates the minimum and maximum thicknesses of drift in some of these localities.

Concession	Lot	Minimum and maximum thicknesses of drift (feet)	Concession	Lot	Minimum and maximum thicknesses of drift (feet)
I	1	30-?	I	19	15-30
I	4	15-99	I	22	13-30
I	7	11-38	I	25	16-78[x]
I	10	17-?	I	28	12-?
I	13	22-49	I	31	14-?
I	16	28-41	I	34	14-70[x]
			I	37	13-32

Concession	Lot	Minimum and maximum thicknesses of drift (feet)	Concession	Lot	Minimum and maximum thicknesses of drift (feet)
II	2	17-30	IV	25	18-?
II	5	8-48	IV	28	17-60^{x}
II	8	12-?	IV	31	11-50
II	11	11-33	IV	34	12-27
II	17	13-47^{x}	IV	37	6-22
II	20	5-43			
II	23	12-26	V	2	14-33
II	26	19-71^{x}	V	5	18-?
II	29	13-45	V	11	18-?
II	32	22-?	V	14	12-28
II	35	35-?	V	23	10-25^{x}
			V	26	32-?
III	3	19-43	V	29	22-40^{x}
III	6	9-26	V	32	10-?
III	9	17-28	V	35	16-?
III	15	6-21			
III	18	15-?	VI	2	11-?
III	21	21-?	VI	5	19-35
III	24	23-?	VI	11	11-28
III	27	8-66	VI	20	10-21^{x}
III	30	18-?	VI	23	20^{x}-43^{x}
III	33	22-?	VI	26	16-33
III	36	20-?	VI	29	18-?
			VI	32	14-20^{x}
IV	1	15-30	VI	35	2^{x}-18^{x}
IV	4	14-35^{x}			
IV	7	21-?	VII	3	12-?
IV	10	20-?	VII	6	2^{x}-?
IV	13	18-36	VII	9	15-28
IV	19	27-?	VII	12	9^{x}-22^{x}
IV	22	19-28	VII	15	16-27

Concession	Lot	Minimum and maximum thicknesses of drift (feet)	Concession	Lot	Minimum and maximum thicknesses of drift (feet)
VII	18	$13-53^x$	VIII	10	10^x-18^x
VII	24	16^x-21^x	VIII	13	17-?
VII	27	22-?	VIII	16	$13-30^x$
VII	30	6^x-8^x	VIII	19	10-31
VII	33	3^x-22^x	VIII	22	25-37
VII	36	13^x-15^x	VIII	25	9-22
			VIII	31	14^x-28^x
VIII	1	7^x-18^x	VIII	34	6^x-?
VIII	4	14^x-16^x	VIII	37	17^x-?
VIII	7	9^x-11^x			

x - To bedrock

WATER SUPPLY

As a whole, Williamsburgh township appears to be fairly well supplied with ground water for both domestic and stock purposes. About 82.7 per cent of the wells are of the dug type and 23.9 per cent are drilled, chiefly into bedrock. Approximately 86.5 per cent of the wells obtain their water from depths of 40 feet or less. A survey of the well records show that about 89.9 per cent of the wells have a permanent water supply, sufficient for the present demands made upon them; and the remainder constitute dry holes and wells that go dry intermittently, especially during periods of extended drought. The description of the principal beds that yield water to the wells was based chiefly on the statements of owners and drillers as to the character of the aquifer.

Although the clay till in the township is by far the most common material yielding water to producing wells, it constitutes a poor reservoir for ground-water storage as it takes up water slowly and holds relatively little. Furthermore, the quality of the ground water is generally poor because of the slow circulation. Many shallow wells, dug in clay till, are reported to be 'intermittent' or 'low in summer'. The reason for this is the low permeability of clay till, which causes it to yield its water slowly to wells. Such wells are, consequently, easily pumped dry and take a comparatively long time to recover. In late summer when the water-table is low, the decreased area of material yielding water directly to the well renders the supply even more unsatisfactory. To overcome this difficulty, the owner should dig his well sufficiently deep to form a reservoir holding enough water to permit a large amount to be withdrawn before emptying the well.

The average depth of the different classes of wells dug in clay till in lots 22 to 37, con. I, which includes the area about the town of Morrisburg, is as follows: sufficient supply, 30.6 feet; low in summer, 26.7 feet; intermittent wells, 14.7 feet; not used, 22.4 feet. Along the road separating cons. I and II, the average depth is: sufficient supply, 36.4 feet; low in summer, 24.6 feet; intermittent wells, 19.6 feet; not used, 21.1 feet.

The water wells classified as having "sufficient supply" are those that are reported to yield "satisfactory" supplies of ground water during the entire year. "Intermittent wells" are those that go dry during some period of the year, but wells described as "low in summer" do not go entirely dry, although the water level recedes to a point during the late summer to early autumn where it is not possible to obtain a large supply of water. Wells that are "not in use" are included because it was found that the chief reason for their not being used was that they could not supply satisfactory quantities of water when it was required.

It will be noted that the figures for the average depths range from a maximum for those wells with "sufficient supply", to a minimum for those with an "intermittent supply". The average depth of wells "not in use" is usually, but not always, found between those classified as "low in summer" and "intermittent".

These relationships are found to be consistent throughout the township. In any one locality, the depths of the individual wells of each of the above mentioned classes depend upon the depths to the water-table and, as the depth to the water-table varies considerably across the township, the average depth of the wells varies in accordance.

The comparative figures mentioned above indicate the necessity of deepening wells in clay till that do not provide sufficient quantities of ground water during the entire year. Wells that are intermittent would have to be deepened more than those classified as "low in summer". It is suggested to farmers or other persons planning to dig a well in clay till that the well be dug during the late summer or early autumn when the water-table is normally at its lowest point. If a sufficient supply of water can be obtained at this time, it is reasonable to assume that the well will yield a satisfactory supply of water during the entire year. The following figures should also be considered; a well 4 feet in diameter holds 78.3 gallons of water per foot of depth, and a well 3 feet in diameter holds 44.1 gallons per foot. Before digging the well the prospective owner should make a fairly accurate estimate of the amount of water required and construct it accordingly.

It was reported that a number of wells dug to various depths in clay till encountered a "spring" 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 more probably consists of a lens or pocket of sand or gravel, many of which are reported to be scattered throughout the till. The quantity of water yielded by these more porous materials depends upon the extent of the aquifer. It is believed that the most of these sand and gravel lenses draw their water from the confining till, and, consequently, the chief result of their presence is to cause a greater area of till to yield its water to the well. Some of these wells yielded large quantities of water when first dug, but after a period of time, assumed the properties of wells deriving their entire water 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. In lots 18 to 20, con. II, it was authentically reported that 6 non-artesian wells, all dug into clay till, are obtaining their water from gravel located within the till. The depths of these particular wells range from 5 to 43 feet with an average depth of 20 feet.

Ground water under hydrostatic pressure is seldom yielded 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. A possible exception is one of two wells dug to the same depth in clay till, 100 feet apart and at approximately the same elevation, located in lot 19, con. V. The level of the surface of the water in one well is 6 feet higher than that in the other. It is possible, in this case, that the well in which the water stands higher is non-flowing artesian, that is, the ground water encountered by the well was under some hydrostatic pressure.

Sufficient supplies of ground water, some of which is under pressure, are frequently obtained at the contact of clay till and the underlying bedrock. For wells such as these, the aquifer has been described on the compilation sheets as, "contact, till-bedrock". It is thought, however, that, although most of the ground water enters the well at the contact, some water enters from the till higher up in the well. Much of the till lying immediately above bedrock is saturated with water. This does not necessarily imply that, at that point, the true water-table is in the till. It may be at a considerable depth below in the bedrock, and the water in the till may be perched, its slow percolation downward through the till being even more retarded by the presence of bedrock. This is suggested by the fact that the till appears to be saturated with water only immediately above bedrock that is massive and where there are few cracks or joint planes to carry the ground water farther downward into the rock. Several wells of this type are located in lots 19 to 27, con. VIII, in the vicinity of the community of Dunbar. The depths of the wells depend upon the depth to bedrock at each particular location. These wells are all reported to be satisfactory and to be yielding sufficient quantities of ground water.

A number of wells dug into the marine sand and clay deposits occurring in the Williamsburg-Winchester Springs area have encountered what is locally called a "water gravel" lying beneath the clay. Although no flowing-artesian wells were reported, the water contained in those "water gravels" is under sufficient hydrostatic pressure to force it up considerable distances in the wells. It is thought that these porous gravel beds consist of outwash material and are similar to those encountered beneath the marine sediments approximately 8 miles west in the vicinity of the community of Hulbert, Matilda township. These beds could possibly be developed into an important local source of ground water.

The following is the log of a well dug in lot 25, con. VIII, which encountered "water gravel" beneath marine clay.

0 to 10 feet	-	marine clay
10 to 11 "	-	hard, compact sand
11 to 14 "	-	quicksand
14 to 22 "	-	"water gravel"

It was reported in this particular well that the water was under considerable pressure and that continual pumping could not lower the water level in the well below 10 feet from surface.

The marine clay beds that are scattered throughout the township yield various quantities of water to wells, 63 of which are non-artesian and the remaining 8 intermittent. 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 the water-table but because of the low permeability of the material. Owing to this poor permeability, most wells could be dug in clay a considerable distance below the water-table before there would be any free water in the well. It is suggested that the only accurate method to locate water-table in clay is to test the material for saturation in the laboratory. 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.

The largest and most important areas of marine clay in Williamsburgh township are in concessions I and VIII. Altogether, 49 dug wells in concession I are reported to obtain their water from marine clay. These wells vary in depth from 9 to 41 feet with an average depth of 22.2 feet. One group of 16 wells in lots 14 to 17 has an average depth of 26.5 feet. All wells in clay in concession I have been classified as non-artesian with the exception of 7 intermittent. The depths of the intermittent wells range from 10 to 37 feet, indicating that there is no depth in the marine clay below which water may be obtained with certainty. There are 11 dug wells in concession VIII that are obtaining their supply of ground water from marine clay. These wells, which are much shallower than those in concession I, vary in depth from 9 to 19 feet with an average of only 14.7 feet. The 9-foot well is the only intermittent one in the concession, the remainder being classified as non-artesian. It is thought that deepening any intermittent well in the township deriving its water from marine clay would make it more satisfactory.

Exclusive of the community of Williamsburg only 9 wells are reported to be deriving their supply of ground water from the area of marine sand extending north from this community to Winchester Springs. The depths of these wells vary from 8 to 28 feet, with an average depth of 16.1 feet. The depths of wells deriving their ground-water supplies from sand farther south in concessions I and II are much greater. Here the wells range from 11 to 54 feet in depth, with an average of 28.6 feet.

Precipitation falling upon these sandy areas sinks in rapidly and percolates downward until it reaches the more impervious marine clay. The clay slows the downward percolation of the water to such an extent that the sand immediately above frequently becomes saturated with water to form a perched water-table. A few wells dug down through the sand are reported to have encountered "quicksand" or "springs" in the bottom of the well. This is merely sand saturated with ground water lying above the marine clay. 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 perched water-table. It is probable that the water in shallow wells, 15 feet or less in depth and dug in marine sand overlying clay, is perched, and that yielded by the deeper wells dug in the same material is from below the true water-table. Shallow wells, depending upon perched water, will go dry more readily and are more likely to be intermittent than deep wells in the same locality. The thickness of the saturated part of the sand immediately overlying marine clay is, in most places, from 1 foot to 3 feet. Most wells of this type are dug down through the sand until either the clay is encountered or the sand becomes so fluid as to render further deepening of the well extremely difficult. The depth of such a well is a good indication of the thickness of the sand at that point.

A few "sand-point" wells, formed by driving casing chiefly 2 inches in diameter into the sand, are found in the area about the community of Williamsburg. Although the small reservoir of water in the pipe allows wells such as these to be pumped dry rapidly, the high permeability of the sand permits them to refill quickly. Most owners claim that they are satisfactory for domestic use but not for watering any large number of stock, which would indicate that they are not capable of yielding large quantities of ground water over relatively short periods of time.

Altogether, some 160 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 such wells range from 11 to 275 feet with an average of 107.9 feet.

A compilation of data from wells reported drilled to bedrock in Williamsburgh township, 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)			DEPTH TO WATER (feet)			QUALITY			
		F.A.	N.F.A.	N.A.	I.W.	Min.	Max.	Ave.	Min.	Max.	Ave.	Hard	Soft	Saline	Sulphur
Ottawa	148	0	30	113	5	87	176	118.2	3	30	12	139	2	1	6
St.Martin	12	1	8	3	0	11	275	63.9	2	33	12.7	11	0	0	1
TOTAL	160	1	38	116	5							150	2	1	7

The above figures do not take into consideration wells drilled into bedrock within the communities of Mariatown and Williamsburg. One well was drilled in the latter to a depth of 365 feet.

The St. Martin formation, consisting of limestone, minor shale, and dolomite, underlies the southwest and extreme south parts of Williamsburgh township. Along Kings Highway No. 2, between lots 7 to 15, con. I, it was encountered at depths from 50 to 60 feet, and in lot 25, con. I, midway between Riverside and Morrisburg, at 78 feet from the surface.

Although the St. Martin formation underlies approximately 20 per cent of Williamsburgh township, it is the source of ground water for only 7.5 per cent of the wells drilled to bedrock. From the information compiled, however, the St. Martin would appear to be an excellent source of ground water. Approximately 75 per cent of the wells penetrating the St. Martin encountered water under sufficient hydrostatic pressure to force it a considerable distance up into the well. A flowing artesian well, drilled to a depth of 119 feet in lot 14, con. I, is thought to be deriving its supply of ground water from this source. The piezometric surface of the water at this point is approximately 6 feet above the surface of the ground, and, on September 13, 1951, the rate of flow of the well was 36 gallons an hour. The temperature of the water was 42° F. The ground water obtained from the St. Martin is reported to be very hard; only one well, located in lot 5, con. I, was observed to have a strong hydrogen sulphide odour.

The Ottawa formation, which consists of grey limestone with dolomite, shale, and sandstone in the lower part, underlies 80 per cent of the township. Because of the relatively thin layer of drift covering bedrock in the north part of Williamsburgh township, 69 per cent of the wells in the township drilled into this formation are located in concessions VI, VII and VIII. This is especially true in the northwest and northeast corners of the township where the nearness of the flat-lying bedrock to surface is reflected in the extremely flat topography.

The quantity of ground water yielded to the individual wells by the Ottawa formation is not as large as from the underlying St. Martin. In some localities it appears to be a matter of chance if an aquifer yielding a sufficient supply is encountered by drilling. In lot 35, con. VI, for instance, two wells that are intermittent have been drilled into the Ottawa formation to depths of 95 and 100 feet, and in lot 36 in the same concession, wells drilled 30 and 100 feet, also into the Ottawa, have been described as highly satisfactory. Similar conditions have been encountered in other parts of Williamsburgh township. It is reported by well drillers that, except for the top few feet, the Ottawa formation is massive with a few joint or bedding planes sufficiently open to form good aquifers. A few wells, however, have been reported to be obtaining large quantities of ground water from the Ottawa. A well, drilled 23 feet, at the cheese factory in Dunbar, concession VIII, for instance, will produce from 175 to 250 gallons an hour, and a well in lot 3, con. VIII, drilled 100 feet into the Ottawa is reported to yield 900 gallons an hour.

Altogether, some 148 wells are reported to be drawing their supply of ground water from the Ottawa formation, of these, 30 (20.3 per cent) are non-flowing artesian, 5 (3.4 per cent) are intermittent, and the remaining 113 (76.3 per cent) are non-artesian. These percentages compare closely with those of wells in adjacent Matilda township also considered to obtain their ground water from the Ottawa.

The small proportion of wells encountering water under pressure in the Ottawa formation as compared with those in the St. Martin is thought to be due, in part, to the absence of shaly members in the former. Ground water encountered beneath shale, which is relatively impervious to its passage, is often under considerable hydrostatic pressure.

A number of wells believed to derive their supply of ground water from the Ottawa formation have been reported as containing 'sulphur'. In most instances, this means that the water has a strong odour of hydrogen sulphide gas. At least three of these wells have been reported as non-flowing artesian. In adjacent Matilda township, all ground water containing hydrogen sulphide gas was thought to be coming from either the St. Martin or Rockcliffe formations and not from the Ottawa. Accordingly, it is possible that some of the sulphur contaminated ground water in Williamsburgh township may in fact be coming from the underlying St. Martin formation rather than from the Ottawa as reported.

The figures for the depths to bedrock, obtained from the drillers and owners of many water wells, indicate a gradual decrease in the elevation of the bedrock surface from east to west across Williamsburgh township. No buried channels or valleys, such as were encountered in adjacent Matilda township, appear to exist in the surface of the bedrock underlying the township.

COMMUNITY SUPPLIES

Detailed studies were made of ground water conditions in the communities of Mariatown and Williamsburg. Maps showing the location of all wells for which information has been obtained, topographic contours for both communities, and water-table contours for Williamsburg 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. 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. Compilation sheets containing pertinent data concerning the individual wells in each community are included at the back of this report.

Community of Mariatown. Although this community is situated on the bank of the St. Lawrence River, its water supply is derived entirely from privately owned, dug wells. The depths of these wells vary from 16 to 40 feet with an average of 24.6 feet, and in all instances the aquifer was reported to be clay till. Bedrock, which probably lies between 50 and 65 feet below the surface of the ground, was not encountered in any well.

With the exception of 2 wells, the quantity of water yielded by the wells in Mariatown is thought to be sufficient for domestic purposes, but not for watering a large number of stock. It is reported that most wells can be pumped dry quite easily and take a long time to recover. This is characteristic of wells deriving their entire water supply directly from till.

The depth to water was measured in 23 wells. It was found that the variations in the elevation of the water levels in the individual wells was so great that it was not possible to contour the water-table. This extreme variation is probably because some of the wells had recently been pumped and were in the process of slowly recovering to the level of the water-table.

Sufficient ground water for the purpose of fire fighting can probably not be obtained from any dug well within the community. The proximity of the St. Lawrence River, however, makes Mariatown much more fortunate than most small communities in the quantity of water available for this purpose.

Community of Williamsburg. The water supply of the community of Williamsburg is derived entirely from privately owned wells. Altogether, there are 86 wells supplying ground water to the inhabitants of the community. Of these, 40 are dug and 24 are drilled, chiefly into the underlying Ottawa formation, and 21 consist of sand points driven to various depths into the marine sand that constitutes the surface material in the south and west parts of the community. No information was obtained regarding the remaining well.

The following table is a compilation of the wells within the community arranged according to the material or formation from which they derive their supply of ground water. Two wells for which there is insufficient information have not been included.

Material or Formation	Number of wells	CLASSIFICATION				DEPTHS OF WELLS (feet)			DEPTH TO WATER (feet)			QUALITY			
		F.A.	N.F.A.	N.A.	I.W.	Min	Max	Ave.	Min	Max	Ave.	Hard	Soft	Saline	Sulphur
Sand	18	0	0	17	0	4	48	18.9	2	9	4.6	18	0	0	0
Clay	10	0	0	9	1	12	20	14.7	4	10	7.6	10	0	0	1
Clay till	33	0	0	25	9	11	45	18.4	4	15	7.9	32	1	0	0
Gravel	3	0	1	1	1	12	80	35.0	6	12	9.0	3	0	0	0
Ottawa Limestone	20	0	19	1	0	85	365	123.7	5	20	8.8	19	1	1	9
TOTAL	84	0	20	53	11							82	2	1	10

The wells put down into sand, clay, or clay till all derive their supply of ground water from the zone of saturation below the water-table, and are accordingly classified as non-artesian. A number of these wells were reported as intermittent, but it is thought that they would yield satisfactory quantities of ground water if deepened.

Most sand points used to obtain water from the marine sand within the community consist of a casing 2 inches in diameter. Most of these wells yield enough water to satisfy the needs of the average home, and in two cases the supply was reported to be sufficient for the operation of a restaurant. The fact that none of these sand-point wells is intermittent indicates that the sand is exceedingly permeable and yields its water readily. It also suggests that the sand points have been driven sufficiently far below the lowest elevations to which the water-table will drop during its seasonal fluctuations to assure a permanent supply of ground water.

The Ottawa formation, which directly underlies the unconsolidated materials within the community, is considered to be an excellent source of ground water. A well drilled to a total depth of 129 feet, 69 feet of which is in bedrock, was reported to yield sufficient water to satisfy the demands of two houses, both equipped with pressure systems attached directly to the one well. A second well, located at the hotel, was drilled to a depth of 365 feet. This particular well, which is one of the deepest in the township, was reported to yield up to 4,000 gallons a day without lowering the level of the water in the well.

A large percentage of the water in the community, derived from the Ottawa formation, has a slightly saline taste and emits a faint odour of hydrogen sulphide gas. Residents accustomed to these waters use them without inconvenience, although persons not used to such waters would probably find them objectionable.

Depth to bedrock was obtained for only 5 wells within the community, insufficient information on which to attempt to describe the surface of bedrock.

ANALYSES OF WATER SAMPLES

Ten samples of well waters from Williamsburgh township were analysed for their mineral content in the laboratory of the Mines Branch, Department of Mines and Technical Surveys, Ottawa. The samples were taken from wells from 17 to 119 feet deep with aquifers in both drift and bedrock.

The nitrate and chloride content of a large number of wells sampled appear to be abnormally high, indicating the possibility of contamination. It is suggested, therefore, that bacteriological test be made of these 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 the surface or at the bottom of the cribbing or casing. This is chiefly due to poor well construction.

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

Constituent	Well waters from glacial drift and bedrock (10 samples)		
	Maximum	Average	Minimum
Residue on evaporation (105°C.)	1324.0	707.8	332.0
Calcium	140.0	90.3	47.0
Magnesium	106.2	37.5	16.8
Sodium	276.0	74.7	6.4
Potassium	266.0	59.8	1.5
Sulphate	256.8	134.1	60.9
Chloride	256.8	35.9	6.0
Nitrate	165.9	58.5	0.0
Bicarbonate	734.4	339.7	231.8
Carbonate	7.2	0.7	0.0
Silica (Col.)	16.9	12.6	6.8
Total hardness	646.6	372.4	227.2

[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]:

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

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 and then 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.

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 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 Williamsburgh township, although not abundant, are adequate for domestic, stock, and community purposes.
2. Clay till is not considered a good source for ground water. However many wells dug in this material encounter layers or pockets of sand or gravel that may yield considerable quantities of water.
3. Clay constitutes the most unsatisfactory source of ground water of all the unconsolidated materials in Williamsburgh township, and wells dug in clay may go a considerable distance below the water-table before there is evidence of free water in the well.
4. Wells dug in clay and clay till that are reported as 'low in summer' or 'intermittent' would yield larger quantities of ground water if deepened. The deepening process should take place in the late summer or early autumn, when the water-table is normally at its lowest point.
5. Throughout the township, wells in sand are commonly dug down to the top of the underlying clay. Shallow wells, dug to a maximum depth of 15 feet in sand, are probably deriving their water from a perched water-table. Such wells are commonly classed as 'low in summer' or 'intermittent'.
6. The quantity and quality of the ground water yielded by the bedrock formations directly underlying Williamsburgh township appear to be satisfactory for normal domestic and farm use.
7. The quantity of ground water yielded by the clay till in the area about the community of Mariatown is sufficient for domestic but not for farm purposes.
8. The most satisfactory sources of ground water within the community of Williamsburg is the marine sand, which is chiefly located in the south part of the community, and the underlying Ottawa limestone, which constitutes the bedrock formation directly underlying the community.

Williamsburgh Township

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	195	155	141	115	125	134	152	173	1190	
Dug	165	142	128	106	102	101	118	122	984	82.7
Bored	0	0	0	0	0	0	0	0	0	0.0
Drilled	30	13	13	9	20	32	30	47	284	23.9
Driven	0	0	0	0	3	1	0	2	6	0.5
Wells 0 - 20 feet deep	38	45	50	52	60	58	19	104	486	40.8
21 - 40	126	92	83	51	46	50	51	45	544	45.7
41 - 60	14	12	3	6	3	3	10	7	58	4.9
61 - 80	1	4	3	3	5	10	3	6	35	2.9
81 - 100	8	0	1	1	2	11	3	3	29	2.4
over - 100	7	1	1	0	2	1	5	8	25	2.1
Depths unknown	1	1	0	2	7	1	1	0	13	1.1
Wells that yield hard water	195	154	141	115	123	131	143	168	1170	98.4
soft water	1	1	0	0	2	2	2	3	11	0.9
salty water	0	0	0	0	0	0	1	0	1	0.1
sulphur water	1	0	0	0	1	1	1	4	8	0.7
Wells with aquifer in clay	49	0	1	1	5	4	0	11	71	6.0
in sand	9	6	0	1	6	1	1	0	24	2.0
in gravel	15	9	2	4	11	0	0	2	43	3.6
in clay till	109	135	134	102	84	99	117	111	892	74.8
in bedrock	13	6	5	7	19	30	34	46	160	13.4
unknown	0	0	0	0	0	0	0	0	0	0.0
Well types: Flowing artesian	1	1	0	0	0	0	0	0	2	0.2
Non-flowing artesian	10	7	5	4	8	1	1	10	46	3.9
Non-artesian	165	125	115	92	111	123	142	149	1022	85.9
Intermittent	18	21	21	18	5	9	7	11	110	9.2
Dry holes	0	0	0	1	1	1	2	3	8	0.7
Not used	41	33	35	22	17	18	22	25	213	17.9
Springs	1	2	0	0	0	0	0	0	3	0.3

Williamsburgh Township

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

Wells and springs	Communities Mariatown	Williamsburg	Total number in communities	Per cent of total
Total number	25	86	111	
Dug	25	40	65	58.6
Bored	0	0	0	0.0
Drilled	0	24	24	21.6
Driven	0	21	21	18.9
Wells: 0.20 feet deep	10	42	52	46.8
21 - 40	15	14	29	26.1
41 - 60	0	3	3	2.7
61 - 80	0	1	1	0.9
81 - 100	0	5	5	4.5
Over - 100	0	12	12	10.8
Depth unknown	0	9	9	8.1
Wells that yield hard water	25	84	109	98.2
soft water	0	2	2	1.8
salty water	0	1	1	0.9
sulphur water	0	7	7	6.3
Wells with aquifer in clay	0	10	10	9.1
in sand	0	18	18	16.2
in gravel	0	3	3	2.7
in clay till	25	33	58	52.2
in bedrock	0	20	20	18.1
unknown	0	2	2	1.8
Well types: Flowing artesian	0	0	0	0.0
Non-flowing artesian	0	19	19	17.1
Non-artesian	23	54	77	69.4
Intermittent	2	10	12	10.8
Dry holes	0	0	0	0.0
Not used	0	6	0	0.0
Springs	0	0	0	0.0

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

Sample number	Owner	Lot	Concession	Depth of well	Aquifer	Residue on evaporation (pts. per million)	Constituents as analysed (parts per million)										Hardness as CACO3 (parts per million		
							Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Sulphate (SO 4)	Chloride (Cl)	Nitrate (No3)	Bicarbonate HCO3	Carbonate CO3	Silica Col. ($Si\ O_2$)	Ca hardness	Mg hardness	Total hardness
1	G. Baker	7	I	33	C.T.	586.0	87.0	39.6	38.0	9.1	242.4	18.5	3.2	268.4	0	9.2	217.1	163.0	308.1
2	A. G. Perley	14	I	119	St.M.	966.0	47.0	26.7	276.0	2.7	256.8	243.5	0.0	231.8	7.2	6.8	117.3	109.9	227.2
3	Tweedie	26	I	87	St.M.	350.0	67.0	30.2	12.3	1.7	60.9	6.0	0.0	292.8	0	12.8	167.2	124.3	291.5
4	E. Barkley	25	V	17	C.T.	508.0	112.2	22.3	38.0	13.2	124.7	40.5	31.9	356.2	0	8.4	279.9	91.8	371.7
5	P. Locke	26	V	32	G.	332.0	89.0	16.8	30.0	33.5	74.9	25.0	127.6	259.6	0	12.8	222.1	69.1	291.2
6	C. Hess	30	VI	98	Ott.	458.0	101.0	33.4	6.4	1.5	73.2	15.5	1.6	378.2	0	15.6	252.0	137.4	389.4
7	H. Berkley	33	VI	100	Ott	1172.0	140.0	40.6	26.0	266.0	86.8	256.3	113.4	624.6	0	16.9	349.3	167.1	516.4
8	R. Barkley	19	VIII	31	C.T.	536.0	99.0	28.0	46.0	35.5	67.9	36.5	56.7	451.4	0	16.0	247.0	115.2	362.2
9	C.F. Marcellus	21	VIII	75	Ott.	1324.0	84.0	106.2	43.2	160.0	252.7	29.5	85.1	734.4	0	15.6	209.6	437.0	646.6
10	W.M. Marcellus	22	VIII	25	C.T.-Ott.	846.0	77.0	31.0	131.0	75.0	100.4	87.5	165.9	419.7	0	11.6	192.1	127.6	319.7

C.T. - Clay till
G. - Gravel

Ott - Ottawa
Ox. - Oxford
St.M. - St. Martin

ABBREVIATIONS

The following is a list of abbreviations used in the included water well compilation sheets for the communities of Mariatown and Williamsburg.

Type, column 4

D. = dug
Drl. = drilled
Spt. - sandpoint

Depth to water surface, column 7

M. - measured

Aquifer, column 9

C. = clay
C.T. = clay till
G. = gravel
S. = sand
Ot. - Ottawa formation

Quality, column 11

C. = clear
H. = hard
S. = soft
Sal. - saline
Sul. - sulphurous

Use, column 12

D. = domestic
N. = not used
S. - stock

Community of Williamsburg, Williamsburgh township, Dundas county, Ontario

Well No.	Con.	Lot	Type	Altitude in feet above sea-level	Depth (feet)	Depth to water surface (feet) (Sept. 1950)	Depth to bedrock (feet)	Aquifer	Yield (gals. per hour) (approx.)	Quality	Use	Remarks
1	2	3	4	5	6	7	8	9	10	11	13	13
1	V	30	D.	268	11	7M		C.T.		H.C.	D.	Goes dry during late summer.
2	V	30	Spt.	266	15	3		S.		H.C.	D.	Sufficient; at house.
3	V	30	Spt.	266	15	3M		S.		H.C.	N.	
4	V	30	Drl.	266	202	6M	75	Ot.		S.Sal.	D.	Sufficient for three families
5	V	30	D.	264	15	9M	75	S.		H.C.	N.	
6	V	31	Spt.	266	21	4		S.		H.C.	D.	Sufficient; at house.
7	V	30	D.	276	21	13M		C.T.		H.C.	D.	"
8	V	30	Drl.	268	100		40	Ot.		H.C.	D.	"
9	V	31	Drl.	268	200	7M	100	Ot.		H.C.	D.	Sufficient; at house.
10	V	30	Spt.	278	41	12		C.T.		H.C.	D.	"
11	V	30	D.	268	12	7		C.T.		H.C.	D.	Goes dry during late summer.
12	V	31	D.	266	11	4M		C.T.		H.C.	D.	Sufficient.
13	V	30	Drl.	274	88	11M		Ot.		H.Sul.	D.	"
14	V	30	D.	272	12	9M		G.		H.C.	D.	Goes dry during late summer.
15	V	30	Spt.	266				S.		H.C.	D.	Sufficient; at house.
16	V	31	D.	266	4	2M		S.		H.C.	N.	
17	V	31	Spt.	266				S.		H.C.	D.	Sufficient.
18	V	32	Drl.	264	85			Ot.	10 +	H.C.	D.S.	Sufficient; at house.
19	V	30	D.	268	13	6M		C.T.		H.C.	D.	Sufficient.
20	V	32	Drl.	266	12			C.		H.C.	D.	"
21	V	30	D.	270	14	6M		C.T.		H.C.	D.	Goes dry during late summer.
22	V	31	D.	264	14	7M		C.		H.C.	D.	Goes dry during late summer.
23	V	30	D.	276	34	16M		C.T.		H.C.	D.	Sufficient.
24	V	31	D.	266	15	10M		C.		H.C.	D.	"
25	V	31	Drl.	266	125	12	60	Ot.	20 +	H.C.	D.	"
26	V	30	Spt.	270	24	5		C.T.		H.C.	D.	"

(Williamsburgh Cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
27	V	31	Spt.	266				C.T.		H.C.	D	Sufficiont.
28	V	31	D.	266	14	8		C.		H.C.	D.	"
29	V	31	Drl.	266	365	5M		Ot.	165	H.Sul.	D.	Sufficiont for hotol
30	V	31	D.	266	17	10M		C.T.		H.C.	D.	Sufficiont
31	V	31	D.	268	14	7		C.		H.C.	D.	Sufficiont
32	V	31	Spt.	266	20			C.		H.C.	D.	"
33	V	30	Spt.	266	24	4		S.		H.C.	D.	" ; at garago
34	V	30	D.	266	11	7M		S.		H.C.	D.	"
35	V	31	D.	264	13	4M		C.		H.Sul.	D.	"
36	V	30	D.	268	17	9M		C.T.		H.C.	D.	"
37	V	30	Drl.	268				Ot.		H.Sul.	D.	"
38	V	31	D.	264	12	6M		C.		H.C.	D.	"
39	V	30	Drl.	278	90	10		Ot.		H.C.	D.	"
40	V	31	D.	268	17	8M		C.T.		H.C.	D.	"
41	V	30	D.	266	14	8M		S.		H.C.	D.	"
42	V	31	D.	266	14	7M		C.T.		H.C.	D.	"
43	V	30	Drl.	272	160			Ot.	20 +	H.C.	D.	" for two familios
44	V	30	Drl.	268	110	5M		Ot.		H.Sul.	N.	
45	V	31	Drl.	266	132	5	65	Ot.		H.C.	D.	"
46	V	30	Drl.	270						H.C.	D.	"
47	V	31	Spt.	266	22	4		S.		H.C.	D.	"
48	V	30	D.	270	12	7M		C.T.		H.C.	D.	Goos dry during sumor.
49	V	31	D.	266	9	3M		S.		H.C.	N.	Sufficiont; at houso.
50	V	31	Drl.	270	148	17	97	Ot.		H.Sul.	D.	" at garago.
51	V	31	D.	270	12	7M		C.T.		H.C.	S.	"
52	V	30	Spt.	268	20	7		C.T.		H.C.	D.	Sufficiont
53	V	31	Drl.	270	80	12		G.	30 +	H.C.	D.	"
54	V	31	D.	266	16	6M		C.T.		H.C.	D.	"
55	V	30	Spt.	266	19	4		S.		H.C.	D.	"
56	V	30	D.	272	11	8M		C.T.		H.C.	D.	Goos dry during lato summor.
57	V	31	D.	268	13	8M		C.T.		H.C.	D.	" " " " "
58	V	30	D.	274	13	6M		G.		H.C.	D.	Sufficiont.
59	V	30	Spt.	266	27	5		C.T.		H.C.	D.	Sufficiont.

(Williamsburgh Cont'd)

1	2	3	4	5	6	7	8	9	10	11	12	13
60	V	30	Spt.	266	22	4		S.		H.C.	D.	Sufficiont; at houso.
61	V	31	Spt.	266	27	4		S.		H.C.	D.	" at garago.
62	V	30	Spt.	268	45	8M		C.T.		H.C.	D.	"
63	V	30	Spt.	266	25	5		C.T.		H.C.	D.	"
64	V	30	D.	272	15	10M		C.T.		H.C.	D.	"
65	V	30	Drl.	274	98	6		Ot.		H.Sul.	D.	"
66	V	30	Drl.	272	114	6M		Ot.		H.Sul.	D.	"
67	V	30	Drl.	270	110	6		Ot.		H.Sul.	D.	Flows during spring.
68	V	30	D.	270	13	7		C.T.		H.C.	D.	Sufficiont.
69	V	30	D.	268	11	6M		C.T.		H.C.	D.	Goos dry during summor.
70	V	31	D.	266	12	6M		C.T.		H.C.	D.	" " " "
71	V	30	Drl.	268				Ot.		H.C.	D.	Sufficiont.
72	V	30	Spt.	266	27			C.T.		H.C.	D.	"
73	V	31	D.	266	13	6M		C.T.		H.C.	D.	"
74	V	31	D.	268	25	10		C.T.		S.C.	D.	"
75	V	29	Drl.	282	178	6	10	Ot.		H.Sul.	D.	"
76	V	30	Drl.	268	15			Ot.		H.C.	D.	"
77	V	31	L.	266	15	10M		C.		H.C.	D.	"
78	V	30	D.	268	15	8M		C.T.	15 +	H.C.	D.	Sufficiont for throo familios
79	V	30	Drl.	274	169	20		Ot.		H.C.	D.	"
80	V	30		268						H.C.	D.	"
81	V	30	Spt.	266	22	4		S.		H.C.	D.	"
82	V	31	D.	268	12	7		C.T.		H.C.	N.	
83	V	31	L.	272	21	15M		C.T.		H.C.	D.	"
84	V	31	Spt.	266	15	4		S		H.C.	D.	"
85	V	31	D.	264	15	9M		C.		H.C.	D.	"
86	V	31	Drl.	268	48	8M		S.	15 +	H.C.	D.S.	"

Community of Mariatown, Williamsburgh township, Dundas county, Ontario

Well No.	Con.	Lot	Type	Altitude in feet above sea-level	Depth (feet)	Depth to water surface (feet) (Sept. 1950)	Depth to bedrock (feet)	Aquifer	Yield (gals. per hour) (approx.)	Quality	Use	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13
1	I	36	D	254	17	12M		C.T.		H.C.	D.	Sufficient.
2	I	36	D	249	25	17M		C.T.		H.C.	D.	"
3	I	36	D	260	33	15M		C.T.		H.C.	D.	"
4	I	36	D	258	31	15M		C.T.		H.C.	D.	"
5	I	37	D	249	40	26M		C.T.		H.C.	D.	Sufficient for tourist camp.
6	I	37	D	248	32	24M		C.T.	19 ±	H.C.	S.	Sufficient; at barn.
7	I	37	D	259	16	9M		C.T.		H.C.	D.	Sufficient.
8	I	36	D	256	23	14M		C.T.		H.C.	D.	"
9	I	37	D	242	20	15M		C.T.		H.C.	D.	Sufficient for tourist home and cabins.
10	I	36	D	260	30	14M		C.T.		H.C.	D.	Sufficient.
11	I	36	D	260	22	15M		C.T.		H.C.	D.	"
12	I	37	D	251	20	13M		C.T.		H.C.	D.	"
13	I	37	D	252	26	18M		C.T.		H.C.	D.	"
14	I	36	D	260	38	15M		C.T.	10 +	H.C.	D.S.	"
15	I	36	D	258	16			C.T.		H.C.	D.	"
16	I	36	D	256	18	14M		C.T.		H.C.	D.	" ; at house.
17	I	36	D	254	19	9M		C.T.	6 ±	H.C.	S.	Sufficient; at barn.
18	I	36	D	258	34	22M		C.T.		H.C.	D.	Sufficient.
19	I	36	D	257	18			C.T.		H.C.	D.	Dry when examined.
20	I	37	D	252	20	14M		C.T.		H.C.	D.	Sufficient.
21	I	37	D	249	22	15M		C.T.		H.C.	D.	"
22	I	37	D	246	23	9M		C.T.		H.C.	D.	"
23	I	37	D	246	27	23M		C.T.		H.C.	D.	"
24	I	36	D	257	17	14M		C.T.		H.C.	D.	"
25	I	36	D	251	27	20M		C.T.		H.C.	D.S.	"